Spring Boot - Tutorial

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– Version 0.3, 26.08.2019

Spring Boot is a rapid application development platform built on top of the popular Spring Framework.

1. Spring Boot

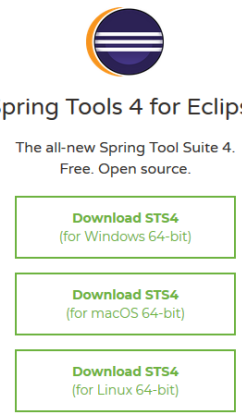
`Spring Boot` is an opinionated framework built on top of the `Spring Framework`. You can find out more about the Spring framework and its modules in our Spring tutorial (https://www.vogella.com/tutorials/Spring/article.html).

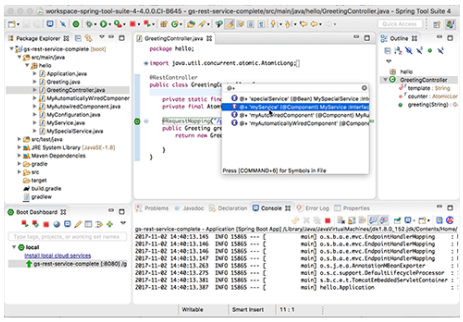
Spring typical requires a lot of configuration. Spring Boot simplifies this setup by providing defaults for many features. You can still adjust the defaults according to your needs.

Spring Boot is mostly used to create web applications but can also be used for command line applications. A Spring Boot web application can be built to a stand-alone JAR. This JAR contains an embedded web server that can be started with `java -jar`. Spring Boot provides selected groups of auto configured features and dependencies, which makes it faster to get started.

Spring Tools Suite installation

You can download the Spring Tools Suite from its Spring project website (https://spring.io/tools/sts).



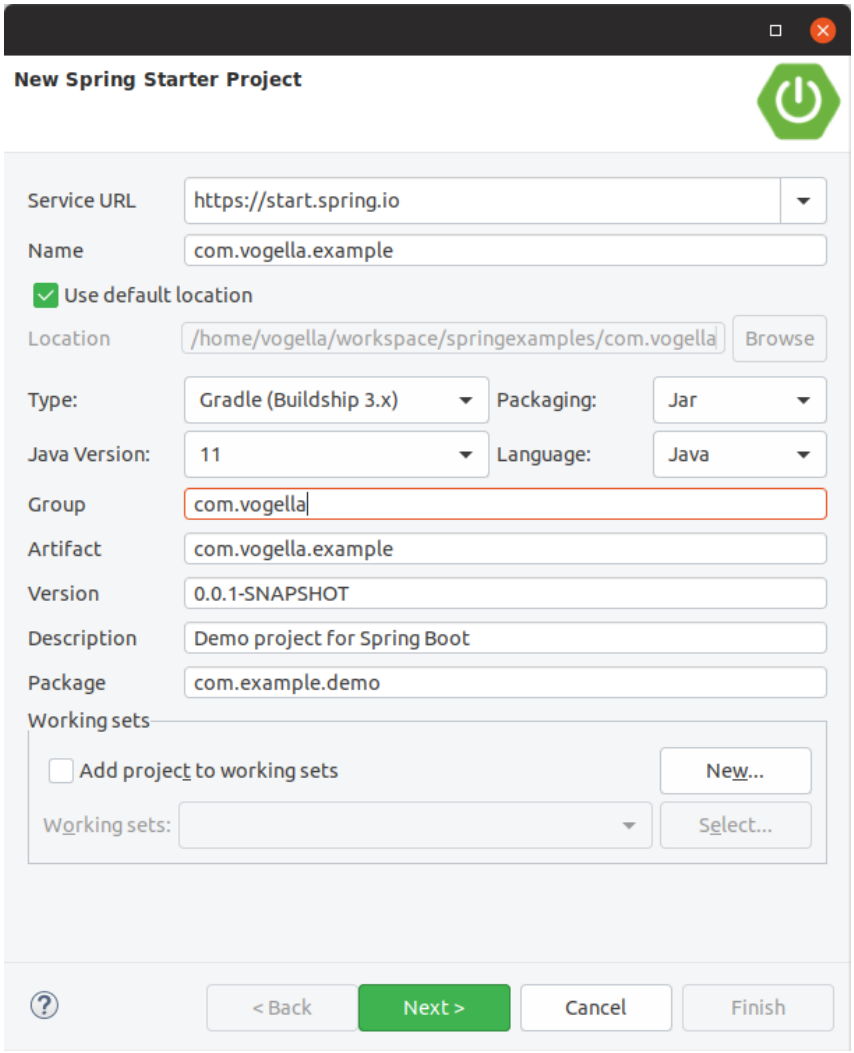


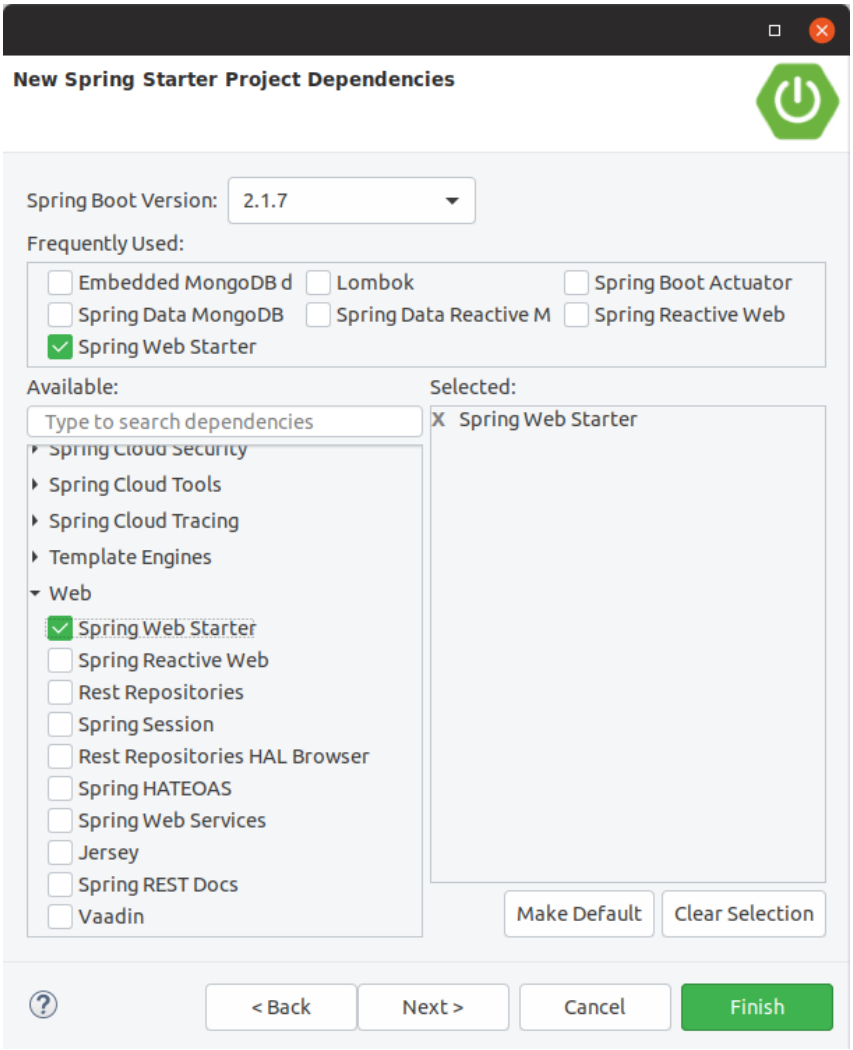
Afterwards unpack it and STS is ready to be started.

Once you have started the Spring Tool Suite click on File › New › Spring Starter Project to open the project creation wizard.

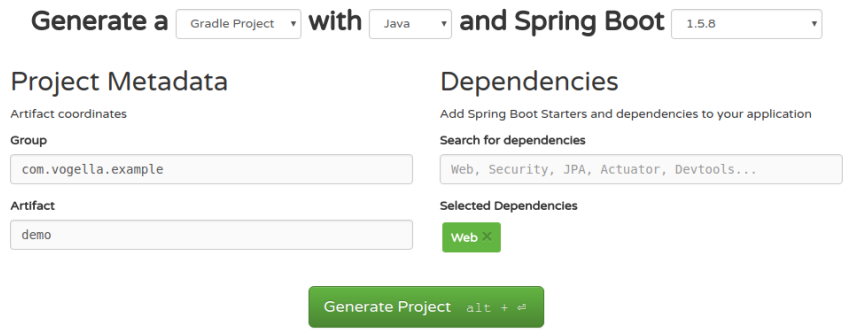
2. Example: Create Spring Boot application

Once you have started the Spring Tool Suite click on File › New › Spring Starter Project to open the project creation wizard. For this example, we'll choose a Gradle based project with the web starter dependency.


New Spring Starter Project
Service URL
https://start.spring.io
Name
com.vogella.example
Use default location
Location
/home/vogella/workspace/springexamples/com.vogella
Browse
Type:
Gradle (Buildship 3.x)
Packaging:
Jar
Java Version:
11
Language:
Java
Group
com.vogella
Artifact
com.vogella.example
Version
0.0.1-SNAPSHOT
Description
Demo project for Spring Boot
Package
com.example.demo
Working sets
Add project to working sets
New...
Working sets:
Select...
< Back
Next >
Cancel
Finish



Alternatively you can create your project directly with the online wizard (https://start.spring.io/) and import it into your favorite IDE.



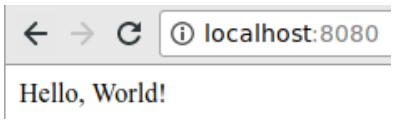
Three folders were automatically created:

- `src/main/java` - used to save all java source files
- `src/main/resources` - used for templates and any other files
- `src/main/test -used for tests

Open your project and create a new controller class named `HelloWorldController.java` in the `com.vogella.example` package of the `src/main/java` folder:

```java
package com.vogella.example;

import org.springframework.stereotype.Controller;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.ResponseBody;

@Controller
public class HelloWorldController {

    @RequestMapping("/")
    @ResponseBody
    String index() {
        return "Hello, World!";
    }

}
```

Start the class `Application` as a `Spring Boot App`. The embedded server starts listening on port 8080. When you point your browser to `http://localhost:8080` you should see the welcome message:



3. Exercise - Configuring Spring Boot for web based applications

In the following exercises your create a web-based issue reporting tool. With this tool users can submit issues they found on a website.

3.1. Configure

This example application needs more JAR libraries. For this, open the `build.gradle` file in the root folder of the project. Add the following to the section 'dependencies'.

```groovy
    implementation('org.springframework.boot:spring-boot-starter-thymeleaf')
    implementation('org.springframework.boot:spring-boot-starter-data-jpa')
    runtime('org.springframework.boot:spring-boot-devtools')
    runtime('com.h2database:h2')
```

Then `Right Click > Gradle > Refresh Gradle Project`.

These libraries serve the following purpose.

Thymeleaf

Thymeleaf is a powerful template processing engine for the Spring framework.

Spring Boot Devtools

The Spring Boot Devtools provides an ensemble of very useful tools that enhance the development experience a lot. Such as Automatic recompiling upon saving and much more.

Spring Data JPA

Spring Data JPA makes it easy to implement JPA based repositories and build Spring-powered applications that use data access technologies.

H2

H2 is a Java SQL database. It's a lightweight database that can be run in-memory.

3.2. Validate

Your `build.gradle` should now look like this

```groovy
plugins {
    id 'org.springframework.boot' version '2.1.7.RELEASE'
    id 'io.spring.dependency-management' version '1.0.8.RELEASE'
    id 'java'
}

group = 'com.vogella'
version = '0.0.1-SNAPSHOT'
sourceCompatibility = '11'

repositories {
    mavenCentral()
}

dependencies {
    implementation 'org.springframework.boot:spring-boot-starter-web'
    implementation('org.springframework.boot:spring-boot-starter-thymeleaf')
    implementation('org.springframework.boot:spring-boot-starter-data-jpa')
    runtime('org.springframework.boot:spring-boot-devtools')
    runtime('com.h2database:h2')
    testImplementation 'org.springframework.boot:spring-boot-starter-test'
}
```

Start your application with `Right Click on your Project > Run As > Spring Boot App`.

3.3. Test reload

Since we have the `dev-tools` dependency added to the project we can use it's `live-reload` functionality. Without any further configuration it reloads the application every time you save a file in the project.

Change the "Hello, World!" in your HelloWorldController class to something else. Save and press reload in your web browser. The message returned by the web application should have changed.

4. Exercise - Creating a web @Controller

Create a new package with the name `com.vogella.example.controller` in the `src/main/java` folder. In there create the following Class `IssueController`.

```java
package com.vogella.example.controller;

import org.springframework.stereotype.Controller;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PostMapping;
import org.springframework.web.bind.annotation.ResponseBody;

@Controller                     //                                  (1)
public class IssueController {

    @GetMapping("/issuereport") //                                  (2)
    @ResponseBody
    public String getReport() { //                                  (3)
        return "issues/issuereport_form";
    }

    @PostMapping("/issuereport") //                                 (4)
    @ResponseBody
    public String submitReport() { //                               (5)
        return "issues/issuereport_form";
    }

    @GetMapping("/issues")
    @ResponseBody
    public String getIssues() {  //                                 (6)
        return "issues/issuereport_list";
    }
}
```

This class contains the methods responsible for handling incoming web requests.

1. The class is annotated with the `@Controller` annotation to tell the Spring framework that it is a controller.

2. The `@GetMapping` annotation above the method signals the Spring Core that this method should only handle `GET` requests.
3. The `getReport()` method later will return the base form template in which the user can submit the issue they found. Right now it only returns a string, the functionality will be added later.
4. The `@PostMapping` annotation signals that this method should only handle `POST` requests and thus only gets called when a `POST` request is received.
5. The `submitReport()` method is responsible for handling the user input after submitting the form. When the data is received and handled (e.g. added to the database), this method returns the same `issuereport` template from the first controller method.
6. the `getIssues()` method will handle the HTML template for a list view in which all the requests can be viewed. This method will return a template with a list of all reports that were submitted. The `@ResponseBody` annotation will be removed in a later step. For now we need to output just the text to the HTML page. If we would remove it now the framework would search for a template with the given name and since there is none would throw an error.

4.1. Validate

Since we use the dependency `dev-tools` of the SpringBoot framework the server already recompiled the code for us. We only need to refresh the page. If you navigate to localhost:8080/issuereport (http://localhost:8080/issuereport) you should see the text `issuereport_form`.

5. Exercise - Creating an entity data class

In this exercise you create a data class that represents an issue report by a user.

5.1. Create entity data class

Create the following new class in the `com.vogella.example` package.

```java
package com.vogella.example.entity;

import java.sql.Date;
import javax.persistence.Entity;
import javax.persistence.GeneratedValue;
import javax.persistence.GenerationType;
import javax.persistence.Id;
import javax.persistence.Table;

@Entity// #1
@Table(name = "issues")// #2
public class IssueReport {
    @Id
    @GeneratedValue(strategy = GenerationType.AUTO)
    private long id;
    private String email;
    private String url;
    private String description;
    private boolean markedAsPrivate;
    private boolean updates;
    private boolean done;
    private Date created;
    private Date updated;

    public IssueReport() {}
}
```

1. The `@Entity` annotation tells our JPA provider Hibernate that this class should be mapped to the database.

2. Set the database table name with the `@Table(name = "issues")` annotation. By explicitly setting the table name you avoid the possibility of accidently breaking the database mapping by renaming the class later on.

The values of the fields `email`, `url`, `description`, `markedAsPrivate` and `updates` will be coming from the form the user submitted. The others will be generated on creation or when the report is updated.

To let Spring instantiate the `Issue` object from the submitted html form we have to implement `getters` and `setters`, as Spring expects a valid Java Bean and won't use reflection to set the fields. To automatically generate them `Right Click` in the source code window of the `IssueReport` class. Then select the `Source` sub-menu; from that menu selecting `Generate Getters and Setters` will cause a wizard window to appear. Select all fields and select the `Generate button`.

5.2. Validation

Your `IssueReport` class should look like this:

JAVA

```java
package com.vogella.example.entity;

import java.sql.Date;
import javax.persistence.Entity;
import javax.persistence.GeneratedValue;
import javax.persistence.GenerationType;
import javax.persistence.Id;

@Entity
@Table(name = "issues")
public class IssueReport {
    @Id
    @GeneratedValue(strategy = GenerationType.AUTO)
    private long id;
    private String email;
    private String url;
    private String description;
    private boolean markedAsPrivate;
    private boolean updates;
    private boolean done;
    private Date created;
    private Date updated;

    public IssueReport() {}

    public String getEmail() {
        return email;
    }

    public void setEmail(String email) {
        this.email = email;
    }

    public String getUrl() {
        return url;
    }

    public void setUrl(String url) {
        this.url = url;
    }

    public String getDescription() {
        return description;
    }

    public void setDescription(String description) {
        this.description = description;
    }

    public boolean isMarkedAsPrivate() {
        return markedAsPrivate;
    }

    public void setMarkedAsPrivate(boolean markedAsPrivate) {
        this.markedAsPrivate = markedAsPrivate;
    }

    public boolean isUpdates() {
        return updates;
    }

    public void setUpdates(boolean updates) {
        this.updates = updates;
    }

    public boolean isDone() {
        return done;
    }

    public void setDone(boolean done) {
        this.done = done;
    }

    public Date getCreated() {
        return created;
    }

    public void setCreated(Date created) {
        this.created = created;
    }
```

```
    public Date getUpdated() {
        return updated;
    }

    public void setUpdated(Date updated) {
        this.updated = updated;
    }
}
```

6. Exercise - Creating Templates using Thymeleaf

Thymeleaf is a powerful template engine that can be used with the Spring framework. It lets you write plain HTML code while also using Java objects for data binding. You've already added the Library to your project when you configured it in Exercise - Configuring Spring Boot for web based applications.

6.1. HTML Templates

We create our templates in the `src/main/resources` resource folder. Create and open the folder `src/main/resources/templates/issues`. Create the following files in this folder:

- `issuereport_form.html` - this file will be served on the route `/issuereport`.
- `issuereport_list.html` - this file will be served on the `/issues` route.

But to achieve this, we need to configure our controller to do so.

6.2. Serving HTML Templates

Currently all our controller methods use the `@ResponseBody` annotation. With this annotation in place the String returned by our controller methods gets sent to the browser as plain text. If we remove it, the Thymeleaf library will look for an HTML Template with the name returned.

Each route will then return the name of the template it should serve.

getReport()

`issues/issuereport_form`

submitReport()

`issues/issuereport_form`

getIssues()

`issues/issurereport_list`

You specify the folder structure inside your `templates` folder separated by forward slashes. But it's important that the String doesn't start with a `/`. So this **won't** work: `/issues/issuereport_form`.

Since we want to pass data into the template we also need to add a `Model` to the method parameters. Add `Model model` to the controller methods parameters. These will be automatically injected when the endpoint is called. Since this is fully done by the Spring framework we don't have to worry about this. In the next step we'll add attributes to the `Model` object to make them available in the template.

The `IssueController` class should look like this:

```java
package com.vogella.example.controller;

import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PostMapping;

@Controller
public class IssueController {
    @GetMapping("/issuereport")
    public String getReport(Model model) {
        return "issues/issuereport_form";
    }
    @PostMapping("/issuereport")
    public String submitReport(Model model) {
        return "issues/issuereport_form";
    }
    @GetMapping("/issues")
    public String getIssues(Model model) {
        return "issues/issuereport_list";
    }
}
```

Now the Framework will look for the templates with the given name and serve them to the browser.

6.3. Binding objects to templates

Now we want to pass some data to the template. This is done by adding parameters to the methods of the controller. Change the controller to the following.

```java
package com.vogella.example.controller;

import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PostMapping;

import com.vogella.example.entity.IssueReport;

@Controller
public class IssueController {
    @GetMapping("/issuereport")
    public String getReport(Model model) {
        model.addAttribute("issuereport", new IssueReport()); \\ #1
        return "issues/issuereport_form";
    }
    @PostMapping(value="/issuereport")
    public String submitReport(IssueReport issueReport, Model model) {  \\ #2
        model.addAttribute("issuereport", new IssueReport());  \\ #3
        model.addAttribute("submitted", true); \\ #4
       return "issues/issuereport_form";
    }
    @GetMapping("/issues")
    public String getIssues(Model model) {
        return "issues/issuereport_list";
    }
}
```

Spring provides a `Model` object which can be passed into the controller. You can configure this model object via the `addAttribute()` method. The first parameter in this method is the key under which the second parameter can be accessed. You will use this name to refer to this object in the template.

1. This will pass a new `IssueReport` object to the template
2. This will deliver the data submitted via the form to this method. In the `submitReport()` method we also want to handle the data submitted via the form.
3. This will pass a new `IssueReport` object to the template. To do this we also need to add `IssueReport issueReport` to the method parameters.

4. Since we want the template to show some kind of feedback upon receiving the form data, we add another attribute containing a boolean. If it's set to `true` the template will show some kind of modal or confirming message. Since this boolean is only passed to the template if the route hit from the user was via `POST` HTTP method (and thus only upon form submission) the confirmation message is ONLY shown after the form was submitted.

The objects defined as method parameters will automatically be constructed and injected by the Spring framework.

6.4. Creating a template

To use the objects passed in, we need to use specific Thymeleaf HTML syntax in the templates. All properties and attributes in an HTML file that are being used by Thymeleaf and are not standard HTML. They will begin with the prefix `th:`.

We will start with the following basic HTML document with a form in it. Add the following coding to the `issuereport_form.html` file:

```HTML
<!DOCTYPE html>
<html xmlns:th="http://www.thymeleaf.org">
<head>
    <title>Vogella Issuereport</title>
    <link rel="stylesheet" href="./style.css" />
    <meta charset="UTF-8" />
</head>
<body>
    <div class="container">
        <form method="post" action="#">
            <h3>Vogella Issuereport</h3>
            <input type="text" placeholder="Email" id="email"/>
            <input type="text" placeholder="Url where the issue was found on"
id="url"/>
            <textarea placeholder="Description of the issue" rows="5"
id="description"></textarea>

            <label for="private_id">
               Private?
               <input type="checkbox" name="private" id="private_id"/>
            </label>
            <label for="updates_id">
                Keep me posted
                <input type="checkbox" id="updates_id" name="updates"/>
            </label>

            <input type="submit" value="Submit"/>
        </form>

        <div class="result_message">
            <h3>Your report has been submitted.</h3>
            <p>Find all issues <a href="/issues">here</a></p>
        </div>
    </div>
</body>
</html>
```

This does not have any logic or data-binding in it, yet.

Without the attribute `xmlns:th="http://www.thymeleaf.org"` in the `<html>` tag, your editor might show warnings because he doesn't know the attributes prefixed with `th:`.

Now the file will be served on the route `/issuereport` (http://localhost:8080/issuereport). If you have the application still running you can navigate to the route or click the link.

6.5. Data-binding

Now we want to tell Spring that this form should populate the fields of the `IssueReport` object we passed earlier. This is done by adding `th:object="${issuereport}"` to the `<form>` tag in `issuereport_form.html`: `<form method="post" th:action="@{/issuereport}" th:object="${issuereport}">`

`th:action` is the syntax for adding the action that should happen upon submission of the form.

Remember that we set the name of the `IssueReport` object to `issuereport`? We refer to it now by using that name. The same can be done with any name and object.

This alone will not tell Spring to auto-populate the fields in the object. We need to specify in the `<input>` elements what field this should represent. This is done by adding the attribute `th:field="*{}"`.

`${}` is the way to refer to objects that were passed to the template, using SpEL. `*{}` is the syntax to refer to fields of the object bound to the form.

Add the following attributes to the `<input>` and `<textarea>` elements respectively.

```
<input type="text" placeholder="Email" id="email" th:field="*{email}"/>
```

```
<input type="text" placeholder="Url where the issue was found on" id="url" th:field="*{url}"/>
```

```
<textarea placeholder="Description of the issue" rows="5" id="description" th:field="*{description}"></textarea>
```

```
<input type="checkbox" name="private" id="private_id" th:field="*{markedAsPrivate}"/>
```

```
<input type="checkbox" id="updates_id" name="updates" th:field="*{updates}"/>
```

We also wanted to show some kind of confirmation modal upon submission. A modal for this already exists in the template: `<div class="result_message">`. But this should obviously be hidden until the user submits an issue. This is done via a conditional expression. Namely `th:if=""`.

Remember that we passed a boolean with the name `submitted` in the `submitReport()` method? We could now use this to determine if we should show the confirmation modal.

Add `th:if="${submitted}"` to the `<div class="result_message">`. The result should look like this: `<div class="result_message" th:if="${submitted}">`

Now the class `result_message` will only be displayed if `submitted` is `true`.

The reason for this is that we hardcoded the `submitted` boolean ONLY to the `POST` request mapping. Thus it will only be added to the template if the `HTTP` method was `POST`. So only if the form was submitted.

The `issuereport_form.html` should now look like this:

```HTML
<!DOCTYPE html>
<html xmlns:th="http://www.thymeleaf.org">
<head>
    <title>Vogella Issuereport</title>
<link rel="stylesheet" href="./style.css" />
    <meta charset="UTF-8" />
</head>
<body>
    <div class="container">
        <form method="post" action="#" th:object="${issuereport}"
th:action="@{/issuereport}">
            <h3>Vogella Issue Report</h3>
            <input type="text" placeholder="Email" id="email" th:field="*
{email}"/>
            <input type="text" placeholder="Url where the issue was found on"
id="url" th:field="*{url}" />
            <textarea placeholder="Description of the issue" rows="5"
id="description" th:field="*{description}" ></textarea>

            <label for="private_id">
                Private?
                <input type="checkbox" name="private" id="private_id"
th:field="*{markedAsPrivate}" />
            </label>

            <label for="updates_id">
                Keep me posted
                <input type="checkbox" id="updates_id" name="updates"
th:field="*{updates}" />
            </label>

            <input type="submit" value="Submit"/>
        </form>


        <div class="result_message" th:if="${submitted}">
            <h3>Your report has been submitted.</h3>
            <p>Find all issues <a href="/issues">here</a></p>
        </div>
    </div>
</body>
</html>
```

6.6. List view

Now we will create the HTML page for the issue report list. Add the following coding to `issuereport_list.html`.

(https://www.vogella.com/)

```HTML
<!DOCTYPE html>
<html xmlns:th="http://www.thymeleaf.org">
<head>
    <title>Vogella Issuereport</title>
    <link rel="stylesheet" href="./style.css" />
    <meta charset="UTF-8" />
</head>
<body>
    <div class="container issue_list">
        <h2>Issues</h2>
        <br />
        <table>
            <tr>
                <th>Url</th>
                <th class="desc">Description</th>
                <th>Done</th>
                <th>Created</th>
            </tr>
            <th:block th:each="issue : ${issues}">
                <tr>
                    <td ><a th:href="@{${issue.url}}" th:text="${issue.url}">
</a></td>
                    <td th:text="${issue.description}">...</td>
                    <td><span class="status" th:classappend="${issue.done} ?
done : pending"></span></td>
                    <td th:text="${issue.created}">...</td>
                </tr>
            </th:block>
        </table>
    </div>
</body>
</html>
```

`th:classappend` conditionally adds classes to an element if the expression passed to it is true or false.

`th:each="issue : ${issues}"` will loop over the issues list.

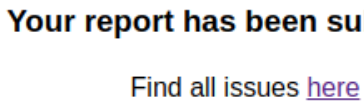
6.7. Optional: Stylesheets

If you want to have some styling for the page, this snippet styles it a bit. This is optional and does not change the behavior of the application in any way. It is already linked to both HTML pages via the `<link rel="stylesheet" href="./style.css" />` element in the `<head>` section. Create a new file in the `static` folder in `src/main/resources`. Name it `style.css` and copy the following snippet into it.

```css
*{
    padding: 0;
    margin: 0;
    box-sizing: border-box;
}
body{
    font-family: sans-serif;
}
.container {
    width: 100vw;
    height: 100vh;
    padding: 100px 0;
    text-align: center;
}
.container form{
    width: 100%;
    height: 100%;
    margin: 0 auto;
    max-width: 350px;
}
.container form input[type="text"], .container form textarea{
    width: 100%;
    padding: 10px;
    border-radius: 3px;
    border: 1px solid #b8b8b8;
    font-family: inherit;
    margin-bottom: 20px;
}
.container h3{
    margin-bottom: 20px;
}
.container form input[type="submit"]{
    max-width: 250px;
    margin: auto;
    display: block;
    width: 55%;
    padding: 10px;
    background: darkorange;
    border: 1px solid #b8b8b8;
    border-radius: 3px;
    margin-top: 20px;
    cursor: pointer;
}
.issue_list table{
    text-align: left;
    border-collapse: collapse;
    border: 1px #b8b8b8 solid;
    margin: auto;
}
.issue_list .desc{
    min-width: 500px;
}
.issue_list td, .issue_list th{
    border-bottom: 1px #b8b8b8 solid;
    border-top: 1px #b8b8b8 solid;
    padding: 5px;
}
.issue_list tr{
    height: 35px;
    transition: background .25s;

}
.issue_list tr:hover{
    background: #eee;
}
.issue_list .status.done:after{
    content: '✓';
}
```

6.8. Validate

Reload the page on the `http://localhost:8080/issuereport`. The styling should have been applied. Enter some values in the fields and press submit. Now the `result_message` `<div>` will also be shown.



The route `/issues` will show an empty list. This is because we have nothing added there yet.

7. Exercise - Embedding a database

In this exercise you will learn how to use a database to store the users issues and query them to show them on the list view.

7.1. Setup

We will use the `h2` database for this. You already added this to your project in Exercise - Configuring Spring Boot for web based applications. Spring Boot automatically picks up and configures `h2` when it's on the classpath.

Now we only need to write a repository to interface with the db.

Create a new package called `com.vogella.example.repositories`. In here create a new `interface` with the name `IssueRepository`. This `interface` should extend the `interface` 'JpaRepository<>' from the package `org.springframework.data.jpa.repository`. Pass in `IssueReport` as the first parameter and `Long` as the second. This represents the object you are storing and the id it has inside the database.

Your `interface` should now look like this:

```java
package com.vogella.example.repository;

import org.springframework.data.jpa.repository.JpaRepository;

import com.vogella.example.entity.IssueReport;

public interface IssueRepository extends JpaRepository<IssueReport, Long>{
}
```

This alone would already be enough to fetch all the entries from the database, add new entries and do all basic CRUD operations.

But we want to fetch all entries which are not marked private and show them on the public list view. This is done by adding a custom query string to a method. Add this method to your `interface`

```java
package com.vogella.example.repository;

import java.util.List;

import org.springframework.data.jpa.repository.Query;
import org.springframework.data.jpa.repository.JpaRepository;

import com.vogella.example.entity.IssueReport;

public interface IssueRepository extends JpaRepository<IssueReport, Long> {
    @Query(value = "SELECT i FROM IssueReport i WHERE markedAsPrivate =
false")
    List<IssueReport> findAllButPrivate();
```

The annotation `@Query` lets us add custom JPQL queries that are executed upon calling the method.

We also want to get all IssueReport reported by the same email-address. This is also done with a custom method. But for this we don't need a custom `@Query`. It's enough to create a method named `findAllByXXX`. `XXX` is a placeholder for the column you want to select by from the database. The value for this is passed in as a method parameter.

Add the following to your `interface` as well:

```java
package com.vogella.example.repository;

import java.util.List;

import org.springframework.data.jpa.repository.Query;
import org.springframework.data.jpa.repository.JpaRepository;

import com.vogella.example.entity.IssueReport;

public interface IssueRepository extends JpaRepository<IssueReport, Long> {
    @Query(value = "SELECT i FROM IssueReport i WHERE markedAsPrivate =
false")
    List<IssueReport> findAllButPrivate();

    List<IssueReport> findAllByEmail(String email);
}
```

7.2. Using the repository

Go back to your controller class `IssueController.java` and add a new field of the repository interface to the class. Since the `@Controller` is managed by Spring the `IssueRepository` will automatically be injected into the constructor.

```java
package com.vogella.example.controller;

import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.ModelAttribute;
import org.springframework.web.bind.annotation.PostMapping;

import com.vogella.example.entity.IssueReport;
import com.vogella.example.repository.IssueRepository;

@Controller
public class IssueController {
    IssueRepository issueRepository;

    public IssueController(IssueRepository issueRespository) {
        this.issueRepository = issueRepository;
    }

    @GetMapping("/issuereport")
    public String getReport(Model model) {
        model.addAttribute("issuereport", new IssueReport());
        return "issues/issuereport_form";
    }

    @PostMapping(value="/issuereport")
    public String submitReport(IssueReport issueReport, Model model) {
        model.addAttribute("submitted", true);
        model.addAttribute("issuereport", new IssueReport());
        return "issues/issuereport_form";
    }

    @GetMapping("/issues")
    public String getIssueReport(Model model) {
        return "issues/issuereport_list";
    }
}
```

7.2.1. Saving records to the database

To save a record to the database simply use the method `save()` from the `IssueRepository` interface and pass the object you want to store. In this case this is the received data on the path `/issuereport`.

```java
package com.vogella.example.controller;

import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.ModelAttribute;
import org.springframework.web.bind.annotation.PostMapping;

import com.vogella.example.entity.IssueReport;
import com.vogella.example.repository.IssueRepository;

@Controller
public class IssueController {
    IssueRepository issueRepository;

    public IssueController(IssueRepository issueRespository) {
        this.issueRepository = issueRepository;
    }

    @GetMapping("/issuereport")
    public String getReport(Model model) {
        model.addAttribute("issuereport", new IssueReport());
        return "issues/issuereport_form";
    }

    @PostMapping(value="/issuereport")
    public String submitReport(IssueReport issueReport, Model model) {
        IssueReport result = this.issueRepository.save(issueReport);
        model.addAttribute("submitted", true);
        model.addAttribute("issuereport", result);
        return "issues/issuereport_form";
    }

    @GetMapping("/issues")
    public String getIssueReport(Model model) {
        return "issues/issuereport_list";
    }
}
```

This saves the given object to the database and then returns the freshly saved object. You should always continue with the entity returned by the repository, because it contains the id set by the database and might have changed in other ways too.

7.3. Redirecting after POST

If you post a IssueReport to the server and then refresh the page (F5) you'll notice that the browser wants the send the posted information again. This could make users accidentally post an issue multiple times. For this ŕeason we'll redirect them in our controller method.

```java
    @PostMapping(value="/issuereport")
    public String submitReport(IssueReport issueReport, RedirectAttributes ra)
{
        this.issueRepository.save(issueReport);
        ra.addAttribute("submitted", true);
        return "redirect:/issuereport";
    }
```

7.3.1. Fetching all records from the database

Normally this would be done using `findAll()`. But in this case we don't want to include records that are marked as private and for this we created the method `findAllButPrivate()`.

```java
package com.vogella.example.controller;

import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.ModelAttribute;
import org.springframework.web.bind.annotation.PostMapping;

import com.vogella.example.entity.IssueReport;
import com.vogella.example.repository.IssueRepository;

@Controller
public class IssueController {
    IssueRepository issueRepository;

    public IssueController(IssueRepository issueRespository) {
        this.issueRepository = issueRepository;
    }

    @GetMapping("/issuereport")
    public String getReport(Model model, @RequestParam(name = "submitted",
required = false) boolean submitted) {
        model.addAttribute("submitted", submitted);
        model.addAttribute("issuereport", new IssueReport());
        return "issues/issuereport_form";
    }

    @PostMapping(value="/issuereport")
    public String submitReport(IssueReport issueReport, RedirectAttributes ra)
{
        this.issueRepository.save(issueReport);
        ra.addAttribute("submitted", true);
        return "redirect:/issuereport";
    }

    @GetMapping("/issues")
    public String getIssueReport(Model model) {
        model.addAttribute("issues",
this.issueRepository.findAllButPrivate());
       return "issues/issuereport_list";
    }
}
```

7.4. Validate

Your `IssueController` should now look like this:

```java
package com.vogella.example.controller;

import org.springframework.stereotype.Controller;
import org.springframework.ui.Model;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PostMapping;
import org.springframework.web.bind.annotation.RequestParam;
import org.springframework.web.servlet.mvc.support.RedirectAttributes;

import com.vogella.example.entity.IssueReport;
import com.vogella.example.repositories.IssueRepository;

@Controller
public class IssueController {
    IssueRepository issueRepository;

    public IssueController(IssueRepository issueRepository) {
        this.issueRepository = issueRepository;
    }

    @GetMapping("/issuereport")
    public String getReport(Model model, @RequestParam(name = "submitted",
required = false) boolean submitted) {
        model.addAttribute("submitted", submitted);
        model.addAttribute("issuereport", new IssueReport());
        return "issues/issuereport_form";
    }

    @PostMapping(value="/issuereport")
    public String submitReport(IssueReport issueReport, RedirectAttributes ra)
{
        this.issueRepository.save(issueReport);
        ra.addAttribute("submitted", true);
        return "redirect:/issuereport";
    }

    @GetMapping("/issues")
    public String getIssues(Model model) {
        model.addAttribute("issues",
this.issueRepository.findAllButPrivate());
       return "issues/issuereport_list";
    }
}
```

The `IssueRepository` should look like this:

```java
package com.vogella.example.repositories;

import java.util.List;

import org.springframework.data.jpa.repository.Query;
import org.springframework.data.jpa.repository.JpaRepository;

import com.vogella.example.entity.IssueReport;

public interface IssueRepository extends JpaRepository<IssueReport, Long> {
    @Query(value = "SELECT i FROM IssueReport i WHERE markedAsPrivate =
false")
    List<IssueReport> findAllButPrivate();

    List<IssueReport> findAllByEmail(String email);
}
```

Go ahead and reload the form and enter some data. Now click `submit` and go to the route `/issues` (http://localhost:8080/issues). You should see the previously entered data.

8. Exercise - Making the information available via REST

If you want to access your data from another application or make it available for the public your best and most secure way is a REST api. Luckily the SpringBoot framework has useful methods for this.

8.1. Setup

Create a new class named `IssueRestController`. You may create a new package for this or use the existing `com.vogella.example.controller` package. To tell Spring that this is a RestController and that the methods inside this controller should return JSON data, add the `@RestController` annotation to the class.

The setup for the routes is similar to normal routes. Use the `@GetMapping` for `GET` requests. And `@PostMapping` for `POST` requests. The difference is that this time you don't want templates to be rendered. So the return type for the methods should be whatever you want to return. E.g. `IssueReport` or even `List<IssueReport>`.

JAVA

```java
package com.vogella.example.controller;

import java.util.List;

import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RestController;

import com.vogella.example.entity.IssueReport;

@RestController
@RequestMapping("/api/issues")
public class IssueRestController {
    @GetMapping
    public List<IssueReport> getIssues() {
        return null;
    }

    @GetMapping("/{id}")
    public IssueReport getIssue(@PathVariable("id") long id) {
        return null;
    }
}
```

If you want to access a variable in the URL (in this case `id`) you do this by first declaring it a variable in the `@GetMapping` arguments (`{id}`). Then you tell Spring to inject it into your method by adding a parameter with the `@PathVariable` annotation. You might notice the `@RequestMapping` annotation we put above our class definition. Using this annotation at the class level allows us to extract the part of the path that is shared by all endpoints defined in the class.

8.2. Making the data available

Accessing the data is pretty easy too. Just (re-)use the previously created `IssueRepository` and return the values from the methods in there.

(https://www.vogella.com/)

```java
package com.vogella.example.controller;

import java.util.List;
import java.util.Optional;

import org.springframework.http.HttpStatus;
import org.springframework.http.ResponseEntity;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RestController;

import com.vogella.example.entity.IssueReport;
import com.vogella.example.repositories.IssueRepository;

@RestController
@RequestMapping("/api/issues")
public class IssueRestController {
    private IssueRepository issueRepository;

    public IssueRestController(IssueRepository issueRepository) {
        this.issueRepository = issueRepository;
    }

    @GetMapping
    public List<IssueReport> getIssues() {
        return this.issueRepository.findAllButPrivate();
    }

    @GetMapping("/{id}")
    public ResponseEntity<IssueReport> getIssue(@PathVariable("id")
Optional<IssueReport> issueReportOptional) {
        if (!issueReportOptional.isPresent() ) {
            return new ResponseEntity<>(HttpStatus.NOT_FOUND);
        }

        return new ResponseEntity<>(issueReportOptional.get(), HttpStatus.OK);
    }
}
```

Again the `IssueRepository` is automatically injected into the class. You can still use the custom query method `findAllButPrivate()`.

The `getIssue` method is a little more interesting. You might notice that we let Spring inject an `Optional<IssueReport>` into the method. This is done with the help of `DomainClassConverter$ToEntityConverter` which takes the id we specified with `@PathVariable` and tries to retrieve the respective entity from the database. If Spring couldn't find an entity with the given id we return an empty response with status code 404 in the guard clause. Otherwise the entity gets returned as JSON.

9. Testing Spring Boot Applications

As long as you use constructor or setter injection you can write unit tests without any dependency on Spring. Either create the dependencies of the class under test with the `new` keyword or mock them.

If you need to write integration tests you need Spring support to load a Spring ApplicationContext for your test.

To add testing support to your Spring Boot application you can require `spring-boot-starter-test` in your build configuration. Besides testing support for Spring boot `spring-boot-starter-test` adds a handful of other useful libraries for your tests like JUnit, Mockito and AssertJ.

10. Rolling back database changes after tests

If you want Spring to roll back your database changes after a test finishes you can add `@Transactional` to your test class. If you run a `@SpringBootTest` with either `RANDOM_PORT` or `DEFINED_PORT` your test will get executed in a different thread than the server. This means that every transaction initiated on the server won't be rolled back. Using `@Transactional` on a test class can hide errors because changes don't get actually flushed to the database. Another option is to force Spring to commit

the transaction at the end of the test with `@Commit` and manually reset/reload the database state after every test. This approach works but makes your tests hard to parallelize.

11. Test annotations

Spring Boot provides several test annotations that allow you to decide which parts of the application should get loaded. To keep test startup times minimal you should only load what your test actually needs. For these annotations to work you have to add the `@RunWith(SpringRunner.class)` annotation to your test class. You can find an overview of all the auto-configurations that get loaded by a particular annotation in the Spring Boot manual (https://docs.spring.io/spring-boot/docs/current/reference/html/test-auto-configuration.html).

11.1. @SpringBootTest

The `@SpringBootTest` annotation searches upwards from the test package until it finds a `@SpringBootApplication` or `@SpringBootConfiguration`. The Spring team advises to place the Application class into the root package, which should ensure that your main configuration is found by your test. This means that your test will start with all Spring managed classes loaded. You can set the `webEnvironment` attribute if you want to change which ApplicationContext is created:

- MOCK (default): loads a `WebApplicationContext` but mocks the servlet environment
- RANDOM_PORT: loads an `EmbeddedWebApplicationContext` with servlet containers in their own thread, listening on a random port
- DEFINED_PORT: loads an `EmbeddedWebApplicationContext` with servlet containers in their own thread, listening on their configured port
- NONE: loads an `ApplicationContext` with no servlet environment

To make calls to the server started by your test you can let Spring inject a `TestRestTemplate`:

```java
@RunWith(SpringRunner.class)
@SpringBootTest(webEnvironment = SpringBootTest.WebEnvironment.RANDOM_PORT)
public class SpringIntegrationTest {

    @Autowired
    private TestRestTemplate restTemplate;
    // ...
}
```

11.2. @WebMvcTest

WebMvcTests are used to test controller behavior without the overhead of starting a web server. In conjunction with mocks it is possible to test that routes are configured correctly without the overhead of executing the operations associated with the endpoints. A WebMvcTest configures a MockMvc instance that can be used to simulate network calls.

(https://www.vogella.com/)

```java
import static
org.springframework.test.web.servlet.request.MockMvcRequestBuilders.get;
import static
org.springframework.test.web.servlet.result.MockMvcResultMatchers.status;
import static
org.springframework.test.web.servlet.result.MockMvcResultMatchers.view;

@RunWith(SpringRunner.class)
@WebMvcTest(UserController.class)
public class UserLoginIntegrationTest {
    @Autowired
    private MockMvc mvc;
    @MockBean
    private UserService userService;

    @Test
    public void loginTest() throws Exception {
        mvc.perform(get("/login"))
            .andExpect(status().isOk())
            .andExpect(view().name("user/login"));
    }
}
```

If you want Spring to load additional classes you can specify an include filter:

```java
@WebMvcTest(value = UserController.class, includeFilters = {
@ComponentScan.Filter(type = FilterType.ASSIGNABLE_TYPE, classes =
UserService.class) })
```

11.3. @DataJpaTest

DataJpaTests load `@Entity` and `@Repository` but not regular `@Component` classes. This makes it possible to test your JPA integration with minimal overhead. You can inject a `TestEntityManager` into your test, which is an `EntityManager` specifically designed for tests. If you want to have your JPA repositories configured in other tests you can use the `@AutoConfigureDataJpa` annotation. To use a different database connection than the one specified in your configuration you can use `@AutoConfigureTestDatabase`.

```java
@RunWith(SpringRunner.class)
@DataJpaTest
public class JpaDataIntegrationTest {

    @Autowired
    private UserRepository userRepository;

    // ...
}
```

12. Mocking

Spring Boot provides the `@MockBean` annotation that automatically creates a mock object. When this annotation is placed on a field this mock object is automatically injected into any class managed by Spring that requires it.

```java
@RunWith(SpringRunner.class)
@WebMvcTest(UserController.class)
public class UserTest {

    @MockBean
    private UserService userService;
    @Autowired
    private MockMvc mvc;

    @Test
    public void loginTest() throws Exception {
        when(userService.login(anyObject())).thenReturn(true);
        mvc.perform(get("/login"))
            .andExpect(status().isOk())
            .andExpect(view().name("user/login"));
    }
}
```

13. MockMvc

`MockMvc` is a powerful tool that allows you to test controllers without starting an actual web server. In an `@WebMvcTest` MockMvc gets auto configured and can be injected into the test class with `@Autowired`. To auto configure MockMvc in a different test you can use the `@AutoConfigureMockMvc` annotation. Alternatively you can create it yourself:

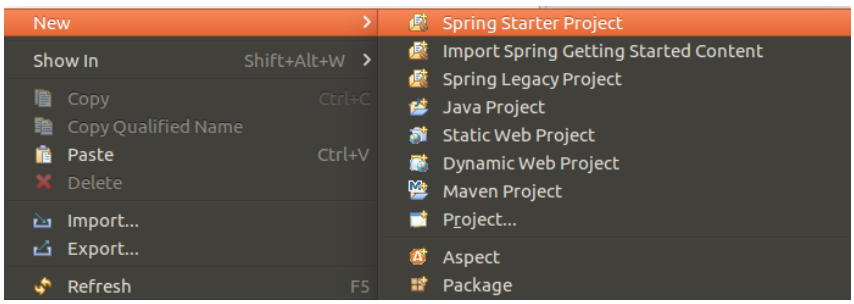
```java
@Autowired
private WebApplicationContext webApplicationContext;
private MockMvc mvc;

@Before
public void setUp() throws Exception {
    mvc = MockMvcBuilders.webAppContextSetup(webApplicationContext).build();
}
```


14. Spring Boot 2.0

The second major release of Spring Boot is based on new features coming with Version 5 of the Spring Framework. Since reactive functional programming has proven to be a great concept for asynchronous processing of code this is one of the main new features coming with Spring Boot 2.0

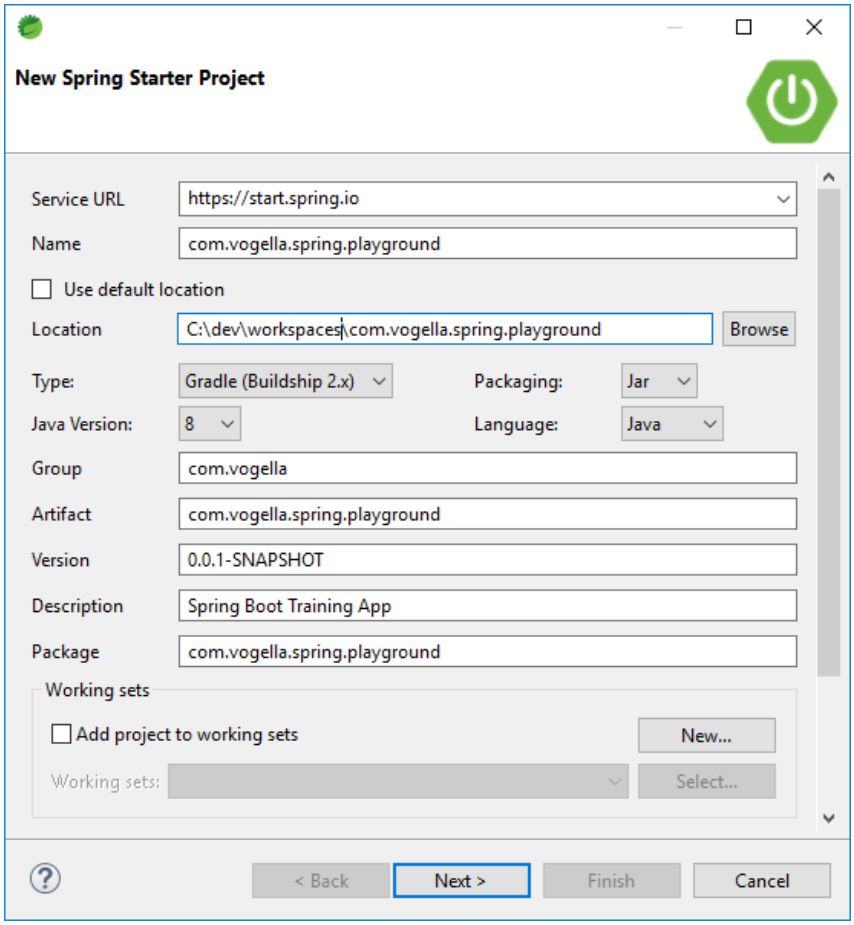
15. Exercise: Create a reactive Spring Boot project

In the Spring Tool Suite just right click in the *Package Explorer* and go to New > Spring Starter Project



Use the following settings in the project creation dialog:

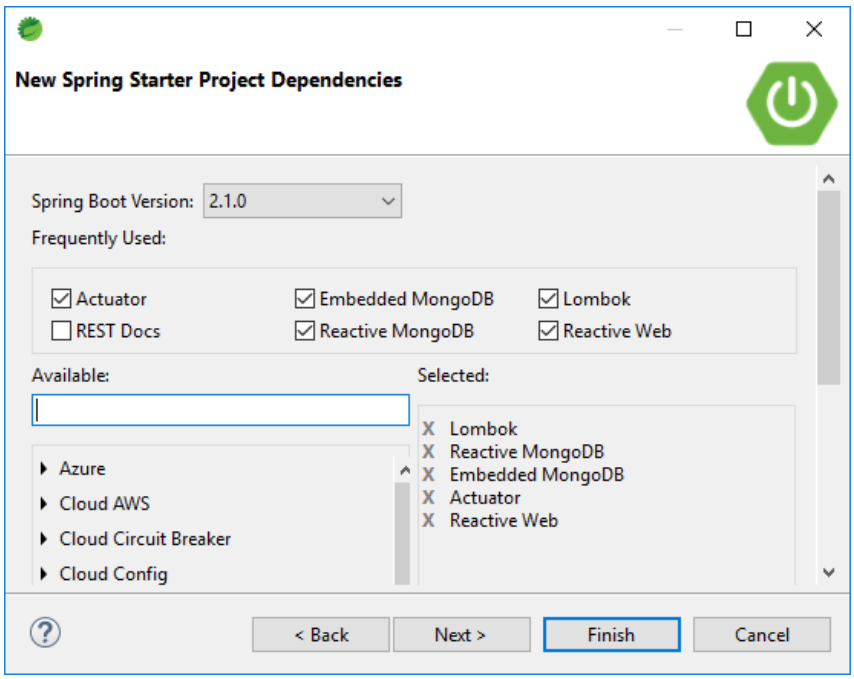
The project is called *com.vogella.spring.playground* and we use Gradle as build system.



When pressing `Next` the desired dependencies can be specified.

First select Spring Boot Version **2.1.0** and the following dependencies:

- Lombok
- MongoDB
- Reactive MongoDB
- Embedded MongoDB
- Actuator
- Reactive Web



Then press `Finish` so that the project will be generated.

Please avoid to add spring web mvc dependencies, otherwise webflux won´t work properly.

If this cannot be avoided the reactive `WebApplicationType` has to be set explicitly:

```java
@SpringBootApplication
public class Application {

    public static void main(String[] args) {
        SpringApplication springApplication = new
SpringApplication(Application.class);

springApplication.setWebApplicationType(WebApplicationType.RE
ACTIVE);
        springApplication.run(args);
    }
}
```

16. Exercise: @Component and @Service annotations

Create a *com.vogella.spring.playground.di* package inside the *com.vogella.spring.playground* project. This package should contain an interface called `Beer`.

```java
package com.vogella.spring.playground.di;

public interface Beer {
    String getName();
}
```

Then create a class called `Flensburger`. The `@Component` annotation specifies that the Spring Framework can create an instance of this class once it is needed.

```java
package com.vogella.spring.playground.di;

import org.springframework.stereotype.Component;

@Component
public class Flensburger implements Beer {

    @Override
    public String getName() {
        return "Flensburger";
    }

}
```

Now a beer instance can be injected into another class, which deserves a beer.

Let´s say we have a service called `BarKeeperService`, which can do something with the beer. The `@Service` annotation does basically the same as the `@Component` annotation, but marks it as service.

(https://www.vogella.com/)

```java
package com.vogella.spring.playground.di;

import org.slf4j.Logger;
import org.slf4j.LoggerFactory;
import org.springframework.stereotype.Service;

@Service
public class BarKeeperService {

    Logger LOG = LoggerFactory.getLogger(BarKeeperService.class);

    private Beer beer;

    public BarKeeperService(Beer beer) {
        this.beer = beer;
    }

    public void logBeerName() {
        LOG.info(beer.getName());
    }
}
```

Now go into the `Application` class and inject the `BarKeeperService` via method injection by using the `@Autowired` annotation.

```java
package com.vogella.spring.playground;

import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;

import com.vogella.spring.playground.di.BarKeeperService;

@SpringBootApplication
public class Application {

    public static void main(String[] args) {
        SpringApplication.run(Application.class, args);
    }

    @Autowired
    public void setBeerService(BarKeeperService beerService) {
        beerService.logBeerName();
    }
}
```

Now you can run the application and see *Barkeeper serves Flensburger* in the logs.

17. Exercise: @Configuration and @Bean annotation

A `@Configuration` class can be used to configure your beans programmatically. So now we create a class called `BeerConfig`, which is capable of creating beer instances/beans.

```java
package com.vogella.spring.playground.di;

import org.springframework.context.annotation.Bean;
import org.springframework.context.annotation.Configuration;

@Configuration
public class BeerConfig {

    @Bean
    public Beer getBecks() {
        return new Beer() {
            @Override
            public String getName() {
                return "Becks";
            }
        };
    }
}
```

Now try to start the application and figure out what went wrong.

Then add the `@Primary` annotation to whatever beer you like most and rerun the application, which should now print your primary beer.

The `@Primary` annotation can be placed below or above `@Bean` or `@Component` depending on the place you need it.

Do not forget to press `CTRL` + `SHIFT` + `O` to organize the import of the `org.springframework.context.annotation.Primary` annotation.

18. Optional Exercise: `@Qualifier` annotation

Different components or beans can also be qualified by using the `@Qualifier` annotation. This approach is used to handle ambiguity of components of the same type, in case the `@Primary` approach is not sufficient.

```java
@Component
@Qualifier("Flensburger")
public class Flensburger implements Beer {

    @Override
    public String getName() {
        return "Flensburger";
    }

}
```

(1)

(1) Qualify the `Flensburger` class with the *Flensburger* qualifier

```java
package com.vogella.playground.di;

@Configuration
public class BeerConfig {

    @Bean
    @Qualifier("Becks")
    public Beer getBecks() {
        return new Beer() {
            @Override
            public String getName() {
                return "Becks";
            }
        };
    }
}
```

(1)

(1) Qualify the becks beer bean with the *Becks* qualifier.

After the different beers have been qualified, a certain bean can be demanded by using the `@Qualifier` annotation as well.

```java
@Service
public class BarKeeperService {

    Logger LOG = LoggerFactory.getLogger(BarKeeperService.class);

    private Beer beer;

    public BarKeeperService(@Qualifier("Flensburger") Beer beer) {
        this.beer = beer;
    }

    public void logBeerName() {
        LOG.info("Barkeeper serves " + beer.getName());
    }
}
```

19. Exercise: Getting all available types of a bean or component

What if you want to get all available instances of a certain class or interface?

You can simply create a list and spring automatically gathers all beer beans and components and passes them to the barkeeper.

```java
package com.vogella.spring.playground.di;

import java.util.List;

import org.slf4j.Logger;
import org.slf4j.LoggerFactory;
import org.springframework.stereotype.Service;

@Service
public class BarKeeperService {

    Logger LOG = LoggerFactory.getLogger(BarKeeperService.class);

    private List<Beer> beer;

    public BarKeeperService(List<Beer> beer) {
        this.beer = beer;
    }

    public void logBeerName() {
        beer.stream().map(Beer::getName).forEach(LOG::info);
    }
}
```

20. Exercise: Using the configuration class with property values

`@Configuration` classes are often also used to configure certain beans, which for example can be done by reading values from property files or environment settings.

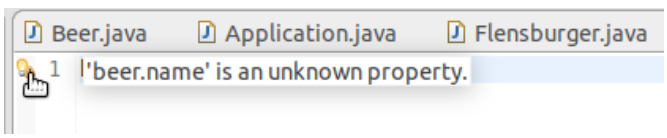
In order to read certain properties the `@Value` annotation can be used.

The *src/main/resources* source folder contains an *application.properties* file, which can be used to configure the spring application or custom property values can be added as well.

Now add the *beer.name* property to the *application.properties* file.

```properties
beer.name=Carlsberg
```

The editor of the *application.properties* file might complain about an unknown property, but it is just fine to add custom properties. Usually the *application.properties* file is used to configure Spring properties.



In the next optional exercise you can also use your own property file.

Inside the `BeerConfig` class a `getBeerNameFromProperty` method, which reads the *beer.name* property, is added.

```java
package com.vogella.spring.playground.di;

import java.util.List;
import java.util.stream.Collectors;

import org.springframework.beans.factory.annotation.Qualifier;
import org.springframework.beans.factory.annotation.Value;
import org.springframework.context.annotation.Bean;
import org.springframework.context.annotation.Configuration;

@Configuration
public class BeerConfig {

    // ... other beans

    @Bean
    public Beer getBeerNameFromProperty(@Value("${beer.name}") String
beerName) {
        return new Beer() {
            @Override
            public String getName() {
                return beerName;
            }
        };
    }
}
```

21. Optional Exercise: Adding a dedicated properties file

Create a new *beers.properties* file in the *src/main/resources* source folder and add the following property.

```properties
beer.names=Bitburger,Krombacher,Berliner Kindl
```

Now with a dedicated properties file the `@Configuration` class has to point to this, because other property files are not automatically parsed like the *application.properties* file. The `@PropertySource` annotation can be used to archieve this.

```java
package com.vogella.spring.playground.di;

import java.util.List;
import java.util.stream.Collectors;

import org.springframework.beans.factory.annotation.Qualifier;
import org.springframework.beans.factory.annotation.Value;
import org.springframework.context.annotation.Bean;
import org.springframework.context.annotation.Configuration;
import org.springframework.context.annotation.PropertySource;

@Configuration
@PropertySource("classpath:/beers.properties")
public class BeerConfig {

    // ... other beans

    @Bean
    public List<Beer> getBeerNamesFromProperty(@Value("${beer.names}")
List<String> beerNames) {
        return beerNames.stream().map(bN -> new Beer() {

            @Override
            public String getName() {
                return bN;
            }
        }).collect(Collectors.toList());
    }
}
```

22. Optional Exercise: Using lombok to craft a beer

Let´s create a `BeerImpl` class to make the creation of a beer instance easier and to avoid these anonymous inner classes.

```java
package com.vogella.spring.playground.di;

import lombok.AllArgsConstructor;
import lombok.Data;

@Data
@AllArgsConstructor
public class BeerImpl implements Beer {

    private String name;
}
```

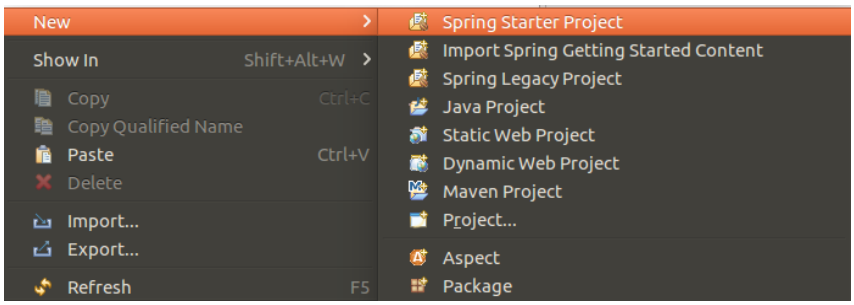
Lombok will automatically generate the `getName` method of the `Beer` interface.

Then the code of the former exercises can be even shorter.

```java
@Configuration
@PropertySource("classpath:/beers.properties")
public class BeerConfig {

    // ... other beans

    @Bean
    public List<Beer> getBeerNamesFromProperty(@Value("${beer.names}")
List<String> beerNames) {
        return
beerNames.stream().map(BeerImpl::new).collect(Collectors.toList());
    }
}
```

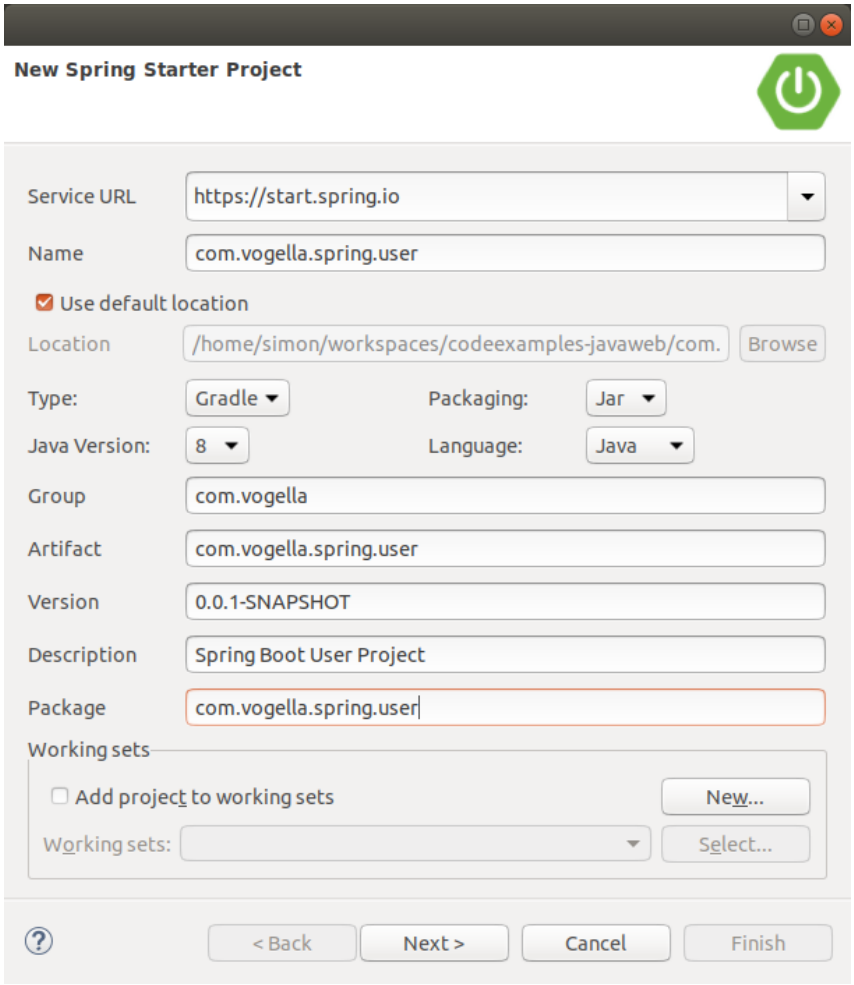
23. Exercise: Create a User project

In the Spring Tool Suite just right click in the *Package Explorer* and go to New > Spring Starter Project



Use the following settings in the project creation dialog:

The project is called *com.vogella.spring.user* and we use Gradle as build system.



When pressing `Next` the desired dependencies can be specified.

First select Spring Boot Version **2.1.0** and the following dependencies:

- Lombok
- Reactive MongoDB
- Embedded MongoDB
- Actuator
- Reactive Web
- DevTools

Then press `Finish` so that the project will be generated.

24. Exercise: Create a User domain model

Create another package called *com.vogella.spring.user.domain* and create a *User* class inside it.

(https://www.vogella.com/)

```java
package com.vogella.spring.user.domain;

import java.time.Instant;
import java.util.ArrayList;
import java.util.List;

import com.fasterxml.jackson.annotation.JsonIgnoreProperties;

import lombok.AllArgsConstructor;
import lombok.Data;
import lombok.NoArgsConstructor;

@Data                                                    (1)
@NoArgsConstructor                                       (2)
@AllArgsConstructor                                      (3)
@Builder                                                 (4)
@JsonIgnoreProperties(ignoreUnknown = true)              (5)
public class User {

    private long id;

    @Builder.Default                                     (6)
    private String name = "";

    @Builder.Default
    private String email = "";

    @Builder.Default
    private String password = "";

    @Builder.Default
    private List<String> roles = new ArrayList<>();

    @Builder.Default
    private Instant lastLogin = Instant.now();

    private boolean enabled;

    public User(long id) {
        this.id = id;
    }
}
```

1. The *User* class is a simple data class and the *@Data* annotation of the Lombok library automatically generates getters and setters for the properties and *hashCode()*, *equals()* and *toString()* methods.
2. If a certain constructor is implemented and a constructor with no arguments should still be available the *@NoArgsConstructor* annotation can be used.
3. This is a convenience annotation to provide a constructor with all available field automatically
4. This annotation automatically generates a Builder for a class. Usually used for classes with many field, that may have default values.
5. The User is also supposed to be serialized and deserialized with JSON, Spring uses the Jackson library for this by default. @JsonIgnoreProperties(ignoreUnknown = true) specifies that properties, which are available in the JSON String, but not specified as class members will be ignored instead of raising an Exception.
6. The `@Builder.Default` annotation tells Lombok to apply these default values, if nothing else will be set during the creation of a User object

25. Exercise: Creating a reactive rest controller

Create a package private *UserRestController* class inside a *com.vogella.spring.user.controller* package.

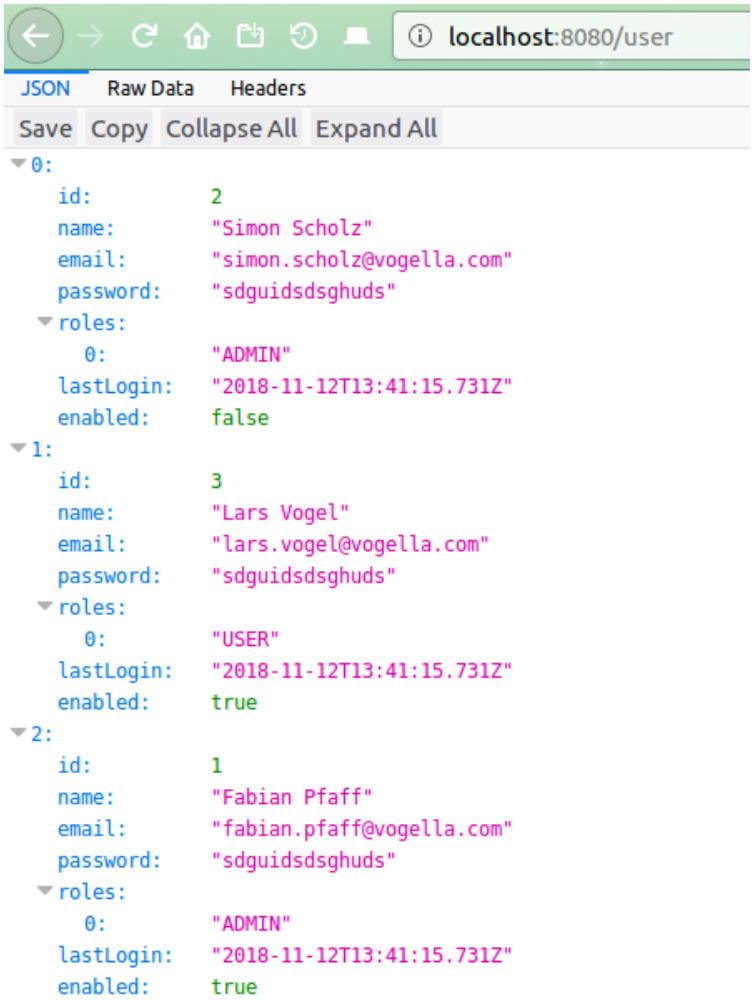
(https://www.vogella.com/)

```java
package com.vogella.spring.user.controller;

import java.time.Instant;
import java.util.Collections;

import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RestController;

import com.vogella.spring.user.domain.User;

import reactor.core.publisher.Flux;

@RestController                                                    (1)
@RequestMapping("/user")                                           (2)
class UserRestController {                                         (3)

    private Flux<User> users;                                      (4)

    public UserRestController() {
        users = createUserModel();
    }

    private Flux<User> createUserModel() {
        User user = new User(1, "Fabian Pfaff", "fabian.pfaff@vogella.com",
"sdguidsdsghuds",
                Collections.singletonList("ADMIN"), Instant.now(), true);
        User user2 = new User(2, "Simon Scholz", "simon.scholz@vogella.com",
"sdguidsdsghuds",
                Collections.singletonList("ADMIN"), Instant.now(), false);
        User user3 = new User(3, "Lars Vogel", "lars.vogel@vogella.com",
"sdguidsdsghuds",
                Collections.singletonList("USER"), Instant.now(), true);

        return Flux.just(user, user2, user3);
    }

    @GetMapping                                                    (5)
    public Flux<User> getUsers() {
        return users;
    }
}
```

1. The `@RestController` annotation tells Spring that this class is a rest controller, which will be instantiated by the Spring framework
2. The `@RequestMapping` annotation is used to point to a default prefix for the rest endpoints defined in this rest controller
3. Rest controllers should be package private since they should only be created by the Spring framework and not by anyone else by accident
4. `Flux<T>` is a type of the Reactor Framework, which implements the reactive stream api like RxJava does.
5. The @GetMapping annotation tells Spring that the endpoint http://{yourdomain}/user should invoke the *getUsers()* method.

Now start the application by right clicking the project and clicking on Run as > Spring Boot App.

Now let's test the result when navigating to http://localhost:8080/user.



What we can see here is that the result is shown as JSON. By default the *@RestController* annotation handles this and if no specific mime type for the response is requested the result will be the object serialized as JSON. By default Spring uses the Jackson library the serialize and deserialize Java objects from and to JSON.

26. Exercise: Passing parameters to the rest api

Since the amount of users can potentially increase really fast it would be nice to have search capabilities so that clients do not have to receive the whole list of Users all the time and do the search on the client side.

(https://www.vogella.com/)

```java
package com.vogella.spring.user.controller;

import java.time.Instant;
import java.util.Collections;

import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RequestParam;
import org.springframework.web.bind.annotation.RestController;

import com.vogella.spring.user.domain.User;

import reactor.core.publisher.Flux;
import reactor.core.publisher.Mono;

@RestController
@RequestMapping("/user")
class UserRestController {

    // more code ...

    @GetMapping
    public Flux<User> getUsers(@RequestParam(name = "limit", required = false,
defaultValue = "-1") long limit) {                                              (1)
        if(-1 == limit) {
            return users;
        }
        return users.take(limit);
    }

    @GetMapping("/{id}")
    public Mono<User> getUserById(@PathVariable("id") long id) {                (2)
        return Mono.from(users.filter(user -> id == user.getId()));
    }
}
```

(1) @RequestParam can be used to request parameters and also apply default values, if the parameter is not required

(2) Spring will automatically map the *{id}* from a request to be a method parameter when the `@PathVariable` annotation is used

27. Exercise: Posting data to the rest controller

It is nice to receive data, but we also want to create new Users.

```java
package com.vogella.spring.user.controller;

import java.time.Instant;
import java.util.Collections;

import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.PostMapping;
import org.springframework.web.bind.annotation.RequestBody;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RequestParam;
import org.springframework.web.bind.annotation.RestController;

import com.vogella.spring.user.domain.User;

import reactor.core.publisher.Flux;
import reactor.core.publisher.Mono;

@RestController
@RequestMapping("/user")
class UserRestController {

    // more code ...

    @PostMapping                                                                (1)
    public Mono<User> newUser(@RequestBody User user) {
        Mono<User> userMono = Mono.just(user);
        users = users.mergeWith(userMono);                                      (2)
        return userMono;
    }
}
```

1. `@PostMapping` is used to specify that data has to be posted
2. The `mergeWith` method merges the existing Flux with the new `Mono<User>` containing the posted `User` object

Curl or any rest client you like, e.g., RESTer (https://addons.mozilla.org/de/firefox/addon/rester/) for Firefox, can be used to post data to the rest endpoint.

```curl
curl -d '{"id":100, "name":"Spiderman"}' -H "Content-Type: application/json" -
X POST http://localhost:8080/user
```

This will return the "New custom User" and show it on the command line.

28. Exercise: Sending a delete request

Last but not least Users should also be deleted by using the rest API.

```java
package com.vogella.spring.user.controller;

import java.time.Instant;
import java.util.Collections;

import org.springframework.web.bind.annotation.DeleteMapping;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.PostMapping;
import org.springframework.web.bind.annotation.RequestBody;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RequestParam;
import org.springframework.web.bind.annotation.RestController;

import com.vogella.spring.user.domain.User;

import reactor.core.publisher.Flux;
import reactor.core.publisher.Mono;

@RestController
@RequestMapping("/user")
class UserRestController {

    // more code ...
    @DeleteMapping("/{id}")                                          (1)
    public Mono<Void> deleteUser(@PathVariable("id") int id) {       (2)
        users = users.filter(user -> user.getId() != id);
        return users.then();
    }
}
```

1. `@DeleteMapping` can be used for delete rest operations and curly braces + name like *{id}* can be used as alternative of using query parameters like ?id=3
2. `@PathVariable` specifies the path, which will be used for the {id} path variable

User no. 3 can be deleted, since we learned how to create new users now.

```curl
curl -X DELETE http://localhost:8080/user/3
```

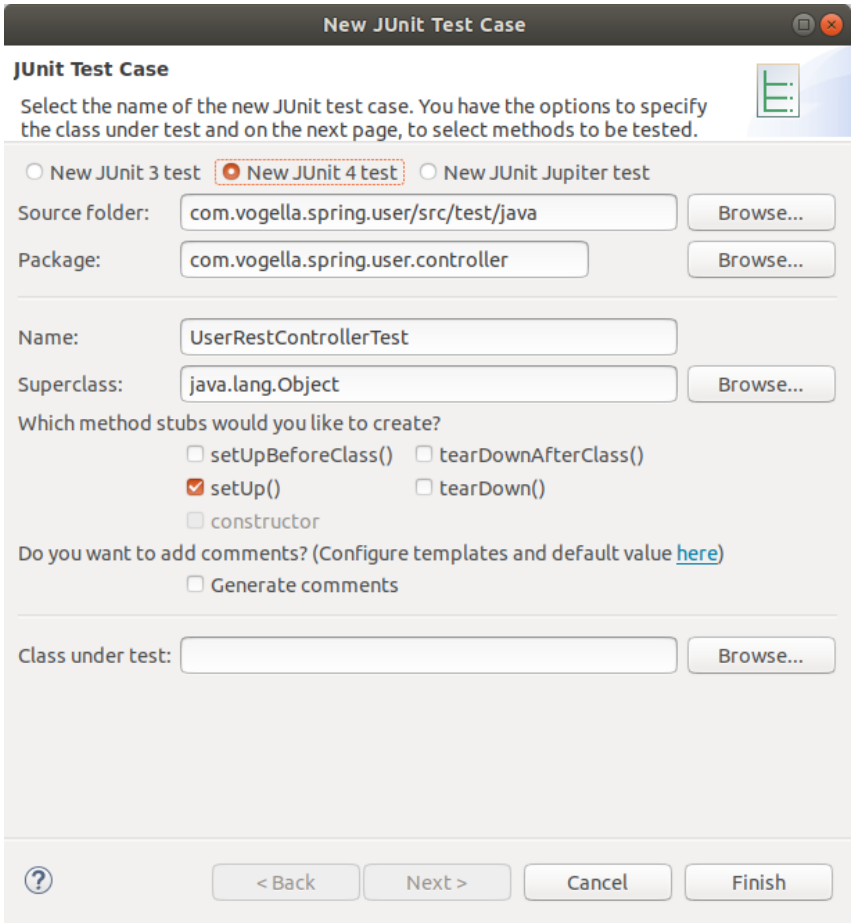
After using this curl command the remaining Users are returned without User no. 3.

Call the http://localhost:8080/user method again to check whether the deletion was successful.

29. Exercise: Testing the RestController

Now that we have implemented all the behavior we want in the controller, we should really write some tests to make sure that it behaves correctly.

The tests reside in the `src/test/java` test folder. Create a new package called `com.vogella.spring.user.controller` inside the test folder. The advantage of using the same package names as in the `src/main/java` folder is that you can access protected and package private methods in your tests.



Then key in the test setup for a `@WebFluxTest`:

```java
@RunWith(SpringRunner.class)
@WebFluxTest(UserRestController.class)
public class UserRestControllerTest {

    @Autowired
    private ApplicationContext context;
    private WebTestClient webTestClient;

    @Before
    public void setUp() {
        webTestClient =
WebTestClient.bindToApplicationContext(context).configureClient().baseUrl("/")
.build();
    }

}
```

1. `@WebFluxTest` starts a Spring application with only this Controller loaded, shortening the test startup time
2. `@Autowired` since no other class should instanciate a test class we can use field injection
3. `WebTestClient` allows us to programatically make reactive REST calls in our tests

UserRestControllerTest.java

```java
    @Test
    public void getUserById_userIdFromInitialDataModel_returnsUser() throws
Exception {
        ResponseSpec rs = webTestClient.get().uri("/user/1").exchange();

        rs.expectStatus().isOk()                                    (1)
            .expectBody(User.class)                                 (2)
            .consumeWith(result -> {                                (3)
                User user = result.getResponseBody();
                assertThat(user).isNotNull();
                assertThat(user.getName()).isEqualTo("Fabian Pfaff");
            });
    }
```

1. `expectStatus` http response status must be 200
2. `expectBodyList()` the response body must be convertible to the `User` class
3. `consumeWith()` accepts a consumer for the response, validations get placed inside the consumer

Great, our code works like a charm. But our previous test only tests the happy path. Now we write a tests that tests what happens if the server receives an unknown id.

UserRestControllerTest.java

```java
    @Test
    public void getUserById_invalidId_error() throws Exception {
        ResponseSpec rs = webTestClient.get().uri("/user/-1").exchange();

        rs.expectStatus().isNotFound();
    }
```

When you run this test you'll notice that it fails. Our controller doesn't return the right http status in case he can't find the entity.

We want the endpoint to return a 404 not found response.

UserRestController.java

```java
import org.springframework.http.HttpStatus;
import org.springframework.http.ResponseEntity;
import org.springframework.web.server.ResponseStatusException;
import reactor.core.publisher.Mono;

    @GetMapping("/{id}")
    public Mono<ResponseEntity<User>> getUserById(@PathVariable("id") long id)
{
        Mono<User> foundUser = Mono.from(users.filter(user -> id ==
user.getId()));
        return foundUser
                    .map(user -> ResponseEntity.ok(user))
                    .switchIfEmpty(Mono.error(new
ResponseStatusException(HttpStatus.NOT_FOUND)));
    }
```

30. Exercise: Testing user creation

When a new resource is created we expect a well behaved REST api to responed with a 201 status code and let us know where to find the new resource. Spring does the latter via the *LOCATION* header. Let's write a test that checks for this behavior.

```java
    @Test
    public void createUser_validUserInput_userCreated() throws Exception {
        ResponseSpec rs = webTestClient.post().uri("/user")
                .body(BodyInserters.fromObject(
                        User.builder().name("Jonas
Hungershausen").email("jonas.hungershausen@vogella.com").build()))      (1)
                .exchange();

        rs.expectStatus().isCreated().expectHeader()                    (2)
          .valueMatches("LOCATION", "^/user/\\d+");                     (3)
    }
```

1. `BodyInserters` offers various methods to fill the request body
2. expecting the 201 response status
3. verifying that the http header contains the correct value

Running this test should fail. Let's adjust the controller to returns the proper response.

```java
    @PostMapping
    public Mono<ResponseEntity<Object>> newUser(@RequestBody Mono<User>
userMono, ServerHttpRequest req) {
        userMono = userMono.map(user -> {
            user.setId(6);
            return user;
        });
        users = users.mergeWith(userMono);
        return userMono.map(u ->
ResponseEntity.created(URI.create(req.getPath() + "/" + u.getId())).build());
    }
```

Now run the test again to verify the fix.

31. Optional Exercise: Write tests for the rest of the endpoints

Implement tests for the rest of the endpoints. Try to consider the happy path as well as the possible failures and invalid inputs.

For example:

- `POST /user/search` should return status 400 if the given json can't be mapped to user
- `DELETE /user/{id}` should return status 404 if the id is not valid
- `DELETE /user/{id}` should return status 204 if a user was successfully deleted == Exercise: Creating a service for the business logic

Creating an initial model should not be part of the `UserRestController` itself. A rest controller should simply specify the rest API and then delegate to a service, which handles the business logic in behind.

Therefore a `UserService` class should be created in the *com.vogella.spring.user.service* package.

(https://www.vogella.com/)

```java
package com.vogella.spring.user.service;

import java.time.Instant;
import java.util.Collections;

import org.springframework.stereotype.Service;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.RequestBody;
import org.springframework.web.bind.annotation.RequestParam;

import com.vogella.spring.user.domain.User;

import reactor.core.publisher.Flux;
import reactor.core.publisher.Mono;

@Service
public class UserService {

    private Flux<User> users;

    public UserService() {
        users = createUserModel();
    }

    private Flux<User> createUserModel() {
        User user = new User(1, "Fabian Pfaff", "fabian.pfaff@vogella.com",
"sdguidsdsghuds",
                Collections.singletonList("ADMIN"), Instant.now(), true);
        User user2 = new User(1, "Simon Scholz", "simon.scholz@vogella.com",
"sdguidsdsghuds",
                Collections.singletonList("ADMIN"), Instant.now(), false);
        User user3 = new User(1, "Lars Vogel", "lars.vogel@vogella.com",
"sdguidsdsghuds",
                Collections.singletonList("USER"), Instant.now(), true);

        return Flux.just(user, user2, user3);
    }

    public Flux<User> getUsers(@RequestParam(name = "limit", required = false,
defaultValue = "-1") long limit) {
        if (-1 == limit) {
            return users;
        }
        return users.take(limit);
    }

    public Mono<User> findUserById(@PathVariable("id") long id) {
        return Mono.from(users.filter(user -> id == user.getId()));
    }

    public Mono<User> newUser(@RequestBody User user) {
        Mono<User> userMono = Mono.just(user);
        users = users.mergeWith(userMono);
        return userMono;
    }

    public Mono<Void> deleteUser(@PathVariable("id") int id) {
        users = users.filter(user -> user.getId() != id);
        return users.then();
    }
}
```

1 The @Service annotation specifies this `UserService` as spring service, which will be created when it is demanded by other classes like the refactored `UserRestController`.

Basically we just moved everything into another class, but left out the rest controller specific annotations.

Now the `UserRestController` looks clearly arranged and just delegates the rest requests to the `UserService`.

(https://www.vogella.com/)

```java
package com.vogella.spring.user.controller;

import org.springframework.web.bind.annotation.DeleteMapping;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PathVariable;
import org.springframework.web.bind.annotation.PostMapping;
import org.springframework.web.bind.annotation.RequestBody;
import org.springframework.web.bind.annotation.RequestMapping;
import org.springframework.web.bind.annotation.RequestParam;
import org.springframework.web.bind.annotation.RestController;

import com.vogella.spring.user.domain.User;
import com.vogella.spring.user.service.UserService;

import reactor.core.publisher.Flux;
import reactor.core.publisher.Mono;

@RestController
@RequestMapping("/user")
class UserRestController {

    private UserService userService;

    public UserRestController(UserService userService) {
        this.userService = userService;
    }

    @GetMapping
    public Flux<User> getUsers(@RequestParam(name = "limit", required = false,
defaultValue = "-1") long limit) {
        return userService.getUsers(limit);
    }

    @GetMapping("/{id}")
    public Mono<ResponseEntity<User>> findUserById(@PathVariable("id") long
id) {
        return userService.findUserById(id)
                .map(user -> ResponseEntity.ok(user))
                .switchIfEmpty(Mono.error(new
ResponseStatusException(HttpStatus.NOT_FOUND)));
    }

    @PostMapping
    public Mono<ResponseEntity<Object>> newUser(@RequestBody User user,
ServerHttpRequest req) {
        return userService.newUser(user)
                    .map(u -> ResponseEntity.created(URI.create(req.getPath()
+ "/" + u.getId()))).build());
    }

    @DeleteMapping("/{id}")
    public Mono<Void> deleteUser(@PathVariable("id") int id) {
        return userService.deleteUser(id);
    }
}
```

1 Since the Spring framework instantiates the `UserRestController` it is able to find the `UserService`, which is demanded in the `UserRestController` constructor. This works, because the `UserService` class has the `@Service` annotation being applied.

32. Exercise: `@SpringBootTest`

Execute the tests in `UserRestControllerTest` again. You'll find that they break because of the introduction of the `UserService`. The RestController now needs the UserService as an collaborator but since our test only loads the web slice for the UserRestController it's not available.

One easy way to get around this it to transform the test into an intergration test that loads the full Spring application. This is slower but ensures that the UserService is available for injection.

Create a new class called `UserRestControllerIntegrationTest` with the `@SpringBootTest` annotation and paste in the tests from `UserRestController`:

(https://www.vogella.com/)

```java
@RunWith(SpringRunner.class)
@SpringBootTest
public class UserRestControllerIntegrationTest {
        // test code copied from UserRestController..
}
```

The tests should all pass then.

33. Exercise: Writing mocks for `@WebFluxTest` tests

That we can test the UserController with a `@SpringBootTest` is nice, but we still want to be able to use `@WebFluxTests` To test controllers with collaborators we'll mock them out with Mockito.

To define a mock object in a Spring test we can use the `@MockBean` annotation. Define the mocked UserService as a field in the test class and Spring will automatically pick it up and inject it at runtime:

UserRestControllerTest.java

```java
    @MockBean
    private UserService userService;
```

Then adjust the tests. In the setup phase we define the desired mock behavior and then trigger the test call as before:

UserRestControllerTest.java

```java
    @Test
    public void getUserById_userIdFromInitialDataModel_returnsUser() throws
Exception {
        int id = 1;
        String name = "Fabian Pfaff";

when(userService.findUserById(id)).thenReturn(Mono.just(User.builder().name(na
me).build()));

        ResponseSpec rs = webTestClient.get().uri("/user/" + id).exchange();

        rs.expectStatus().isOk().expectBody(User.class).consumeWith(result ->
{
            User user = result.getResponseBody();
            assertThat(user).isNotNull();
            assertThat(user.getName()).isEqualTo(name);
        });
    }
```

For the test with the invalid id we return an empty result:

UserRestControllerTest.java

```java
    @Test
    public void getUserById_invalidId_404() throws Exception {
        long invalidId = -1;
        when(userService.findUserById(invalidId)).thenReturn(Mono.empty());

        ResponseSpec rs = webTestClient.get().uri("/user/" +
invalidId).exchange();

        rs.expectStatus().isNotFound();
    }
```

The user creation only reads the id from the created user, so this is enough to make the test pass:

UserRestControllerTest.java

```java
    @Test
    public void createUser_validUserInput_userCreated() throws Exception {
        long id = 42;
        when(userService.newUser(ArgumentMatchers.any()))                    (1)
            .thenReturn(Mono.just(User.builder().id(id).build()));

        ResponseSpec rs = webTestClient.post().uri("/user")
                .body(BodyInserters.fromObject(
                        User.builder().name("Jonas
Hungershausen").email("jonas.hungershausen@vogella.com").build()))
                .exchange();

        rs.expectStatus().isCreated().expectHeader().valueEquals("LOCATION",
"/user/" + id);                                                              (2)
    }
```

(1) `ArgumentMatchers.any()` with ArgumentMatchers we can match on certain input patterns, in this case we match on any input

(2) Since we mock the response we can expect the actual id and don't have to match with regex.

34. Optional Exercise: Write mocks for all endpoint tests

If you've done the earlier optional exercise **Write tests for the rest of the endpoints** you still have some tests that fail because of the missing UserService. If you haven't completed the earlier exercise go ahead and do it now.

Write mocks for all test methods you've implemented to make them pass again.

35. Using `@DataMongoTest`

`@DataMongoTest` starts a test with only the Spring persistence slice loaded. This means that all repositories are available for injection.

Since `UserRepository#findAll()` returns a `Flux` we'll use the `StepVerifier`. The `StepVerifier` is used to lazily define expectations about a reactive `Producer`. Only when `StepVerifier#verify()` is called the verification is actually started.

```java
@RunWith(SpringRunner.class)
@DataMongoTest
public class UserMongoIntegrationTest {

    @Autowired
    private UserRepository userRepository;

    @Test
    public void save_validUserInput_canBeFoundWithFindAll() throws Exception {
        userRepository.save(User.builder().id(1).name("Lars Vogel").build())

.mergeWith(userRepository.save(User.builder().id(2).name("Simon
Scholz").build()))
                .blockLast();

        Flux<User> users = userRepository.findAll();

        StepVerifier.create(users)                                           (1)
            .recordWith(ArrayList::new)                                      (2)
            .expectNextCount(2)                                              (3)
            .consumeRecordedWith(userList -> {                               (4)
                    assertThat(userList).withFailMessage("Should contain user
with name <%s>", "Simon Scholz")
                            .anyMatch(user -> user.getName().equals("Simon
Scholz"));
            }).expectComplete()
            .verify();
    }
}
```

(1) `create()` prepare a StepVerifier for the Flux

2. `recordWith()` tells the verifier which Collection type to use when we later call `consumeRecordedWith`
3. verifies how many elements the Publisher pushes, equivalent to `assertThat(userList).hasSize(2);`
4. inside the `consumeWith` block you can place all your assertions on the result

If you're writing an application using JPA then you'll have to use the `@DataJpaTest` annotation instead.

36. Exercise: Reactive database access with Spring Data

Using reactive Reactor types like `Flux<T>` is really nice and powerful, but keeping the User data in-memory is not.

In former chapters, where the project has been created MongoDB dependencies have already been selected.

MongoDB has the benefit that it comes with a reactive database driver, which other databases like JDBC cannot offer. Hopefully in the future other databases catch up and provide reactive asynchronous database drivers as well.

But don't be scared, if you haven't used MongoDB yet, because there is a `compile('org.springframework.boot:spring-boot-starter-data-mongodb-reactive')` dependency in your *build.gradle* file, which provides an abstraction layer around the database.

In order to find, save and delete `User` objects in the MongoDB a `UserRepository` in the *com.vogella.spring.user.data* package should be created.

```java
package com.vogella.spring.user.data;

import org.springframework.data.repository.reactive.ReactiveCrudRepository;

import com.vogella.spring.user.domain.User;

public interface UserRepository extends ReactiveCrudRepository<User, Long> {

}
```

Now Spring can create a `ReactiveCrudRepository` for `User` objects at runtime automatically, which provides ©reate, ®ead, (U)pdate and (D)elete capabilties.

The `ReactiveCrudRepository` class is similar to Spring Datas' `CrudRepository` class, but is able to return reactive asynchronous types rather than synchronous types.

Now we have to enable MongoDB to work with `User` objects:

(https://www.vogella.com/)

```java
package com.vogella.spring.user.domain;

import java.time.Instant;
import java.util.ArrayList;
import java.util.List;

import org.springframework.data.annotation.Id;

import com.fasterxml.jackson.annotation.JsonIgnoreProperties;

import lombok.AllArgsConstructor;
import lombok.Builder;
import lombok.Data;
import lombok.NoArgsConstructor;

@Data
@NoArgsConstructor
@AllArgsConstructor
@Builder
@JsonIgnoreProperties(ignoreUnknown = true)
public class User {

    @Id                                                    (1)
    private long id;
    @Builder.Default
    private String name = "";

    @Builder.Default
    private String email = "";

    @Builder.Default
    private String password = "";

    @Builder.Default
    private List<String> roles = new ArrayList<>();

    @Builder.Default
    private Instant lastLogin = Instant.now();

    private boolean enabled;

    public User(long id) {
        this.id = id;
    }

}
```

(1) @Id is used to specify the id of the object, which is supposed to be stored in the database

Now the `UserService` should be updated to store the data by using the `UserRepository`.

(https://www.vogella.com/)

```java
package com.vogella.spring.user.service;

import java.time.Instant;
import java.util.Arrays;
import java.util.Collections;

import org.springframework.stereotype.Service;

import com.vogella.spring.user.data.UserRepository;
import com.vogella.spring.user.domain.User;

import reactor.core.publisher.Flux;
import reactor.core.publisher.Mono;

@Service
public class UserService {

    private UserRepository userRepository;

    public UserService(UserRepository UserRepository) {                    (1)
        this.userRepository = UserRepository;
        createUserModel();
    }

    private void createUserModel() {
        User user = new User(1, "Fabian Pfaff", "fabian.pfaff@vogella.com",
"sdguidsdsghuds",
                Collections.singletonList("ADMIN"), Instant.now(), true);
        User user2 = new User(2, "Simon Scholz", "simon.scholz@vogella.com",
"sdguidsdsghuds",
                Collections.singletonList("ADMIN"), Instant.now(), false);
        User user3 = new User(3, "Lars Vogel", "lars.vogel@vogella.com",
"sdguidsdsghuds",
                Collections.singletonList("USER"), Instant.now(), true);

        userRepository.saveAll(Arrays.asList(user, user2, user3)).subscribe();
    }                                                                      (2)

    public Flux<User> getUsers(long limit) {
        if (-1 == limit) {
            return userRepository.findAll();
        }
        return userRepository.findAll().take(limit);
    }

    public Mono<User> findUserById(long id) {
        return userRepository.findById(id);
    }

    public Mono<User> newUser(User User) {
        return userRepository.save(User);
    }

    public Mono<Void> deleteUser(long id) {
        return userRepository.deleteById(id);
    }
}
```

(1) Even tough the `UserRepository` interface is not annotated with @Service, @Bean, @Component or something similar it is automatically injected. The Spring Framework creates an instance of the `UserRepository` at runtime once it is requested by the `UserService`, because the `UserRepository` is derived from `ReactiveCrudRepository`.

(2) For the initial model the 3 Users from former chapters are now stored in the MongoDB.

For all other operations the `ReactiveCrudRepository` default methods, which return Reactor types, are used (`findAll`, `findById`, `save`, `deleteById`).

37. Exercise: Implement custom query methods

Basically everything can be done by using CRUD operations. In case a `User` should be found by looking for text in the summary the `findAll()` method can be used and the service can iterate over the `Flux<User>` in order to find appropriate `User` objects.

```java
public static Flux<User> getByEmail(String email) {
    Flux<User> findAll = userRepository.findAll();
    Flux<User> filteredFlux = findAll.filter(user ->
user.getUserEmail().toLowerCase().contains(email.toLowerCase()));
    return filteredFlux;
}
```

But wait, is it really efficient to get all Users and then filter them?

Modern databases can do this way more efficient by for example using the SQL *LIKE* statement. In general it is way better to delegate the query of certain elements to the database to gain more performance.

Spring data provides way more possibilities than just using the CRUD operations, which are derived from the `ReactiveCrudRepository` interface.

Inside the almost empty `UserRepository` class custom method with a certain naming schema can be specified and Spring will take care of creating appropriate query out of them.

So rather than filtering the Users from the database on ourselves it can be done like this:

```java
package com.vogella.spring.user.data;

import org.springframework.data.repository.reactive.ReactiveCrudRepository;

import com.vogella.spring.user.domain.User;

import reactor.core.publisher.Flux;

public interface UserRepository extends ReactiveCrudRepository<User, Long> {

    Flux<User> findByEmailContainingIgnoreCase(String email);
}
```

We leave it up to the reader to make use of the `findByEmailContainingIgnoreCase` in the `UserService` and then make use of it in the `UserRestController` by providing a http://localhost:8080/search rest endpoint.

The schema possibilities for writing such methods are huge, but out of scope in this exercise.

You can also write real queries by using the `@Query` annotation.

```java
// Just pretend that a User has a category to see the @Query
syntax

@Query("from User a join a.category c where
c.name=:categoryName")
Flux<User> findByCategory(@Param("categoryName") String
categoryName);
```

38. Exercise: Using Example objects for queries

With the query method schema lots of properties of the `User` class can be combined for a query, but sometimes this can also be very verbose:

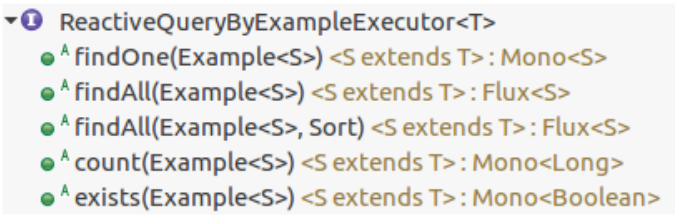
```java
// could be even worse...
Flux<User>
findByEmailContainingAndRolesContainingAllIgnoreCaseAndEnabledIsTrue(String
email, String role);
```

It would be nicer to create an instance of a `User` and then pass it to a find method.

```java
User user = new User(1);
User theUserWithIdEquals1 = userRepository.find(user);
```

Unfortunately the `ReactiveCrudRepository` does not provide such a method.

But this capability is proivded by the `ReactiveQueryByExampleExecutor<T>` class.




```java
package com.vogella.spring.user.data;

import
org.springframework.data.repository.query.ReactiveQueryByExampleExecutor;
import org.springframework.data.repository.reactive.ReactiveCrudRepository;

import com.vogella.spring.user.domain.User;

import reactor.core.publisher.Flux;

public interface UserRepository extends ReactiveCrudRepository<User, Long>,
ReactiveQueryByExampleExecutor<User> {

    Flux<User> findByEmailContainingIgnoreCase(String email);

    Flux<User>
findByEmailContainingAndRolesContainingAllIgnoreCaseAndEnabledIsTrue(String
email, String role);
}
```

1 By implementing the `ReactiveQueryByExampleExecutor<User>` interface the methods above can be used to query by using `Example` objects.

So instead of using a `findByEmailContainingAndRolesContainingAllIgnoreCaseAndEnabledIsTrue` method an `Example` can be used to express the same:

Please add the following methods to the `UserService` class.

```java
public Mono<User> findUserByExample(User user) {
    ExampleMatcher matcher = ExampleMatcher.matching().withIgnoreCase()
            .withMatcher("email", GenericPropertyMatcher::contains)
            .withMatcher("role", GenericPropertyMatcher::contains)
            .withMatcher("enabled", GenericPropertyMatcher::exact);
    Example<User> example = Example.of(user, matcher);
    return userRepository.findOne(example);
}
```

When looking for exact matches no `ExampleMatcher` has to be configured.

```java
public Mono<User> findUserByExampleExact(User user) {
    Example<User> example = Example.of(user);
    return userRepository.findOne(example);
}
```

The `UserRestController` can make use of this like that:

```java
@PostMapping("/search")
public Mono<User> getUserByExample(@RequestBody User user) {
    return userService.findUserByExample(user);
}
```

39. Extracting the database setup code

Until now the database setup code resides in the `UserService`. During development this works well, but eventually we want more control over when this code is run.

One way to do this is to extract the code into a `SmartInitializingSingleton`. Implementing this interface gives the guarantee that all beans are fully set up when `afterSingletonsInstantiated()` is called.

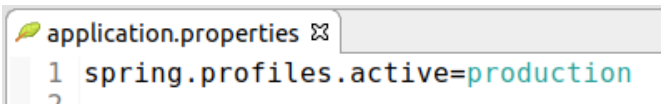
The `UserDataInitializer` is supposed to be created in the *com.vogella.spring.user.initialize* package.

```java
package com.vogella.spring.user.initialize;

import java.time.Instant;
import java.util.Arrays;
import java.util.Collections;

import org.springframework.beans.factory.SmartInitializingSingleton;
import org.springframework.context.annotation.Profile;
import org.springframework.stereotype.Component;

import com.vogella.spring.user.data.UserRepository;
import com.vogella.spring.user.domain.User;

@Profile("!production")
@Component
public class UserDataInitializer implements SmartInitializingSingleton {

    private UserRepository userRepository;

    public UserDataInitializer(UserRepository userRepository) {
        this.userRepository = userRepository;
    }

    @Override
    public void afterSingletonsInstantiated() {
        User user = new User(1, "Fabian Pfaff", "fabian.pfaff@vogella.com",
"sdguidsdsghuds",
                Collections.singletonList("ADMIN"), Instant.now(), true);
        User user2 = new User(2, "Simon Scholz", "simon.scholz@vogella.com",
"sdguidsdsghuds",
                Collections.singletonList("ADMIN"), Instant.now(), false);
        User user3 = new User(3, "Lars Vogel", "lars.vogel@vogella.com",
"sdguidsdsghuds",
                Collections.singletonList("USER"), Instant.now(), true);

        userRepository.saveAll(Arrays.asList(user, user2, user3)).subscribe();
    }

}
```

(1)

(1) `@Profile("!production")` this stops Spring from loading this bean when the "production" profile is activated

Profiles can be activated by specifying them in the *application.properties* file inside the `src/main/resources/` folder.




```properties
spring.profiles.active=production
```

Please startup the server without the production profile and with the production profile being activated. You can see the difference by navigating to http://localhost:8080/user for both scenarios.

40. Validations with JSR-303

So far the `UserController` accepts any input for a new user entity. To stop clients to create entities with invalid data we can add validations. Java provides a way to define validation rules by placing @annotations on fields.

The user object must only be created when a valid email and password have been provided:

```java
package com.vogella.spring.user.domain;

import java.time.Instant;
import java.util.ArrayList;
import java.util.List;

import javax.validation.constraints.Email;
import javax.validation.constraints.NotEmpty;
import javax.validation.constraints.Size;

import org.springframework.data.annotation.Id;

import com.fasterxml.jackson.annotation.JsonIgnoreProperties;

import lombok.AllArgsConstructor;
import lombok.Builder;
import lombok.Data;
import lombok.NoArgsConstructor;

@Data
@NoArgsConstructor
@AllArgsConstructor
@Builder
@JsonIgnoreProperties(ignoreUnknown = true)
public class User {

    @Id
    private long id;
    @Builder.Default
    private String name = "";

    @NotEmpty
    @Email
    @Builder.Default
    private String email = "";

    @Size(min = 8, max = 254)
    @Builder.Default
    private String password = "";

    @Builder.Default
    private List<String> roles = new ArrayList<>();

    @Builder.Default
    private Instant lastLogin = Instant.now();

    private boolean enabled;

    public User(long id) {
        this.id = id;
    }

}
```

To tell Spring that it should run the validations in the controller we have to add a `@Valid` annotation to the incoming data:

```java
    @PostMapping
    public Mono<ResponseEntity<Object>> newUser(@RequestBody @Valid Mono<User>
userMono, ServerHttpRequest req) {
        return userMono.flatMap(user -> {
            return userService.newUser(user)
                    .map(u -> ResponseEntity.created(URI.create(req.getPath()
+ "/" + u.getId())).build());
        });
    }
```

Now try to create a user like we've done in a former exercise and see what happens:

```curl
curl -d '{"id":100, "name":"Spiderman"}' -H "Content-Type: application/json" -
X POST http://localhost:8080/user
```

This time the response contains a 400 error code and complains about the invalid email and password field.

Therefore the request has to be updated to include a valid email adress and password.

```curl
curl -d '{"id":100, "name":"Spiderman", "email":"me@spidey.com",
"password":"WithGreatPowerComesGreatResponsibility"}' -H "Content-Type:
application/json" -X POST http://localhost:8080/user
```

This time the *Spiderman* user is successfully added to the list of users, which can be verified by navigating to http://localhost:8080/user.

41. Exercise: Write your own custom validation

So far we've used annotations provided by JSR-303, but now we'll create our own. The goal is to make sure that we only save roles for our users that the application knows about.

User.java

```java
import java.lang.annotation.Documented;
import java.lang.annotation.ElementType;
import java.lang.annotation.Retention;
import java.lang.annotation.RetentionPolicy;
import java.lang.annotation.Target;

import javax.validation.Constraint;
import javax.validation.Payload

@Target({ ElementType.FIELD })                                  1
@Retention(RetentionPolicy.RUNTIME)                             2
@Constraint(validatedBy = { ValidRolesValidator.class })        3
@Documented                                                     4
public @interface ValidRoles {

    String message() default "Invalid role detected";           5

    Class<?>[] groups() default {};                             6

    Class<? extends Payload>[] payload() default {};            7
}
```

1. `@Target` Where the annotation is allowed to be placed, we only allow fields
2. `@Retention` Annotation needs to be around at runtime to be read with reflection
3. `@Constraint` Marks the annotation as a validation and links to the validator
4. `@Documented` become part of the Java doc of the target class
5. `message()` required field, message to show the user after failed validation
6. `groups()` groups allow you to control when certain validations are run
7. `payloud()` can be used to provide additional metadata, eg., severity level

The Validator has to implement `ConstraintValidator` and gets the value of the field injected:

User.java

(https://www.vogella.com/)

```java
import java.util.Collection;
import java.util.List;

import javax.validation.ConstraintValidator;
import javax.validation.ConstraintValidatorContext;

import com.google.common.collect.Lists;

public class ValidRolesValidator implements ConstraintValidator<ValidRoles,
Collection<String>> {

    private List<String> validRoles = Lists.newArrayList("ROLE_USER",
"ROLE_ADMIN");

    @Override
    public boolean isValid(Collection<String> collection,
ConstraintValidatorContext context) {
        return collection.stream().allMatch(validRoles::contains);
    }

}
```

Finally we can add the annotation to the field in the `User` class and Spring will do the rest:

User.java

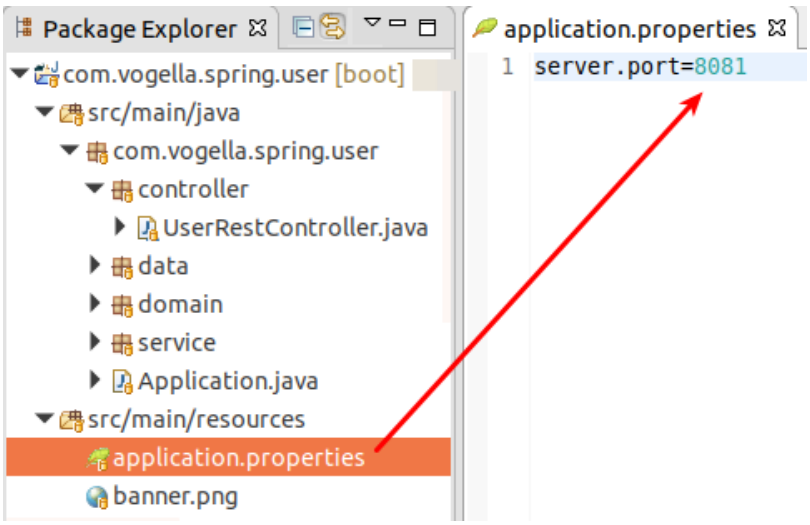
```java
    @ValidRoles
    private List<String> roles = new ArrayList<>();
```

42. Exercise: Change the default port of the web app

By default Spring Boot uses port 8080, but this can be changed by using the *server.port* property in the *application.properties* file.

For the upcoming exercises each project needs a distinct port.

The port for the user project should be changed to *8081*.



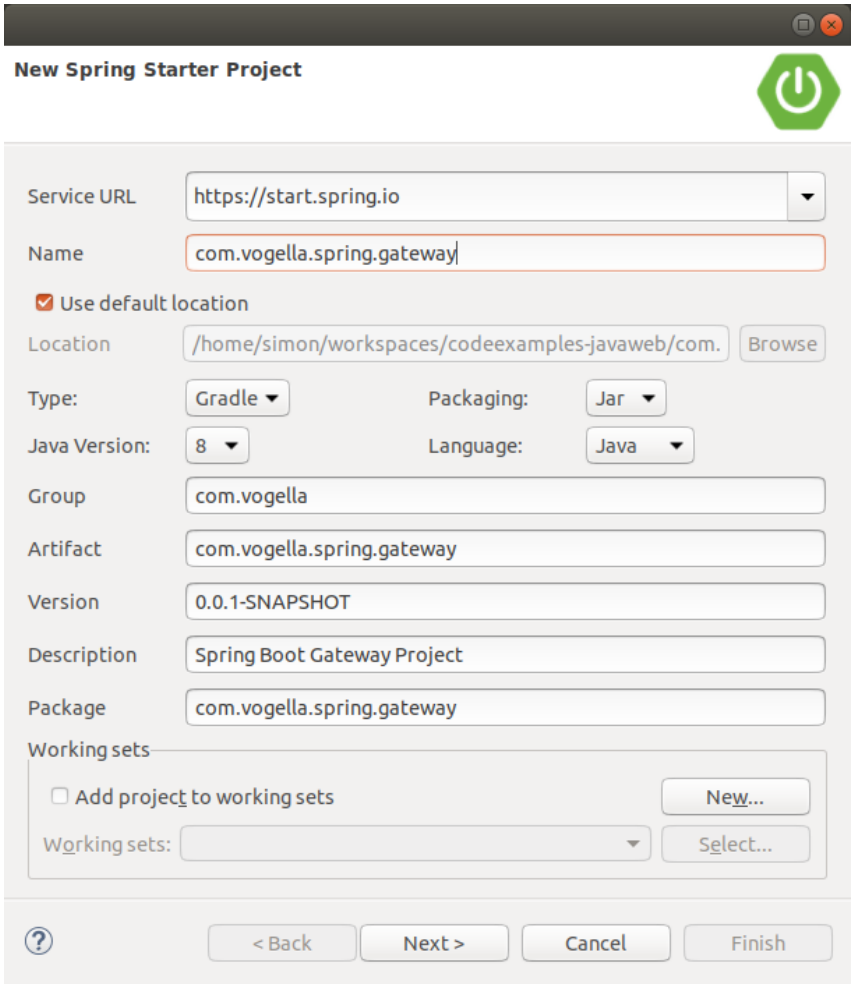

```properties
server.port=8081
```

43. Exercise: Spring Cloud Gateway project

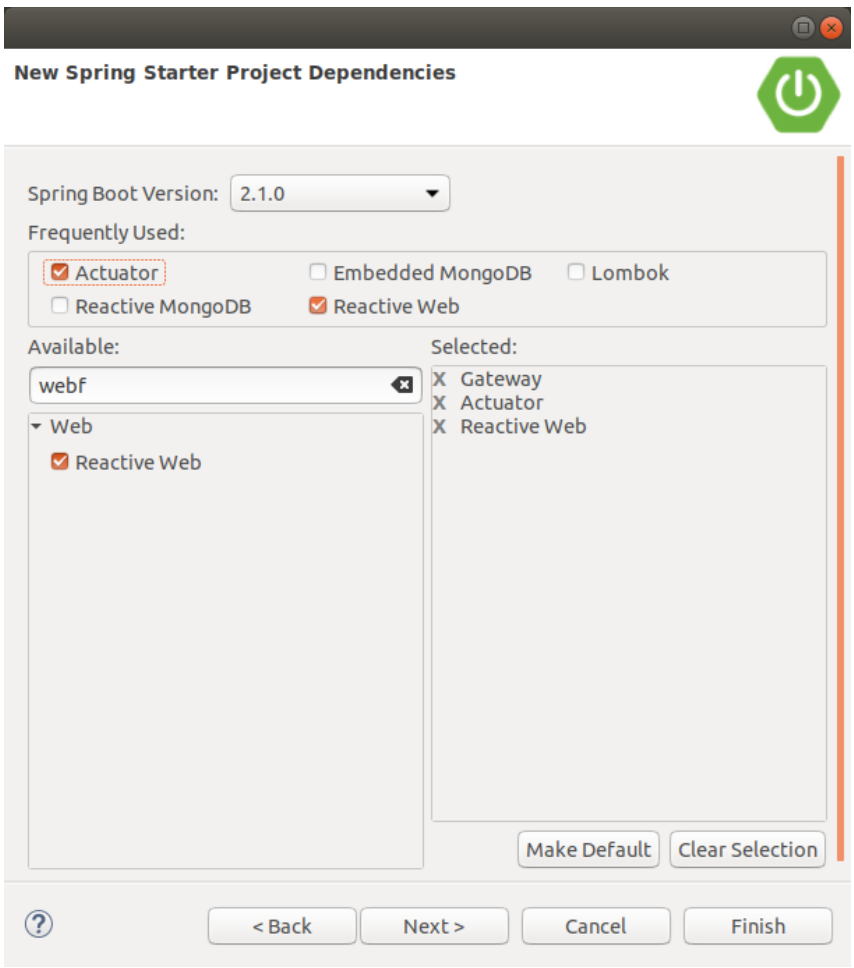
The user application has become bigger meanwhile, but we do not want to end up with a huge monolithic server application.

Micro services have become more public and Spring Cloud helps to manage this architecture.

First of all we'd like to create a new project called *com.vogella.spring.gateway*.



Press `Next` and add the following dependencies:



This gateway project will be used as facade, which delegates to different micro services, e.g., the user project (*com.vogella.spring.user*).

First of all the ports should be changed so that the gateway uses port 8080 and the port of the user project should have been changed to 8081. This can be archived by changing the *server.port* property in the *application.properties* file in both projects.

In case port 8080 is already blocked on your machine you can choose a different port, e.g. 8090, and target this instead.

In order to route to other micro services from the gateway a `RouteLocator` bean has to be created. Therefore we create a `RouteConfig` class, which will be responsible of the `RouteLocator` creation.

```java
package com.vogella.spring.gateway;

import org.springframework.cloud.gateway.route.RouteLocator;
import org.springframework.cloud.gateway.route.builder.RouteLocatorBuilder;
import org.springframework.context.annotation.Bean;
import org.springframework.context.annotation.Configuration;

@Configuration
public class RouteConfig {
    @Bean
    public RouteLocator customRouteLocator(RouteLocatorBuilder builder) {
        return builder.routes().route("users", r ->
                r.path("/user/**")
                .uri("http://localhost:8081"))
                .build();
    }
}
```

Currently the *Greenwich.M1* version is used and therefore the *build.gradle* file of the gateway project has to be changed.

To make it easy, please just override it for now with the following contents:

```xml
buildscript {
    ext {
        springBootVersion = '2.1.0.M3'
    }
    repositories {
        mavenCentral()
        maven { url "https://repo.spring.io/milestone" }
    }
    dependencies {
        classpath("org.springframework.boot:spring-boot-
gradle-plugin:${springBootVersion}")
    }
}

apply plugin: 'java'
apply plugin: 'eclipse'
apply plugin: 'org.springframework.boot'
apply plugin: 'io.spring.dependency-management'

group = 'com.vogella'
version = '0.0.1-SNAPSHOT'
sourceCompatibility = 1.8

repositories {
    mavenCentral()
    maven { url "https://repo.spring.io/milestone" }
}


ext {
    springCloudVersion = 'Greenwich.M1'
}

dependencies {
    implementation('org.springframework.boot:spring-boot-
starter-actuator')
    implementation('org.springframework.boot:spring-boot-
starter-webflux')
    implementation('org.springframework.cloud:spring-cloud-
starter')
    implementation('org.springframework.cloud:spring-cloud-
starter-gateway')
    testImplementation('org.springframework.boot:spring-boot-
starter-test')
    testImplementation('io.projectreactor:reactor-test')
}

dependencyManagement {
    imports {
        mavenBom "org.springframework.cloud:spring-cloud-
dependencies:${springCloudVersion}"
    }
}
```

Afterwards refresh the Gradle dependencies by using the context menu while selecting the *com.vogella.spring.gateway* project.

Gradle > Refresh Gradle Project

Once this has been done the gateway server **and** the user server should be started.

Now the gateway is able to delegate requests to the user server.

You can try this by navigating to http://localhost:8080/user and should receive the users in json format.

You can also navigate to http://localhost:8081/user and should get the same result, but directly from the user server.

44. Exercise: Spring Cloud service discovery

Currently the gateway just points to the user service directly and we do not see any real benefit of having this facade in front of the user service.

One huge benefit of using micro service architectures is that additional services can be spawned, which can be load balanced, if one service is too busy.

For service discovery a generic name for services has to be applied. This can be done by using the *spring.application.name* property.

For the user project the *application.properties* file should look like this:

```
JAVA
server.port=8081
spring.application.name=user
```

We want to use Netflix Eureka for service discovery and therefore have to add a dependency to `org.springframework.cloud:spring-cloud-starter-netflix-eureka-client`.

The *build.gradle* should be adjusted to look like this:

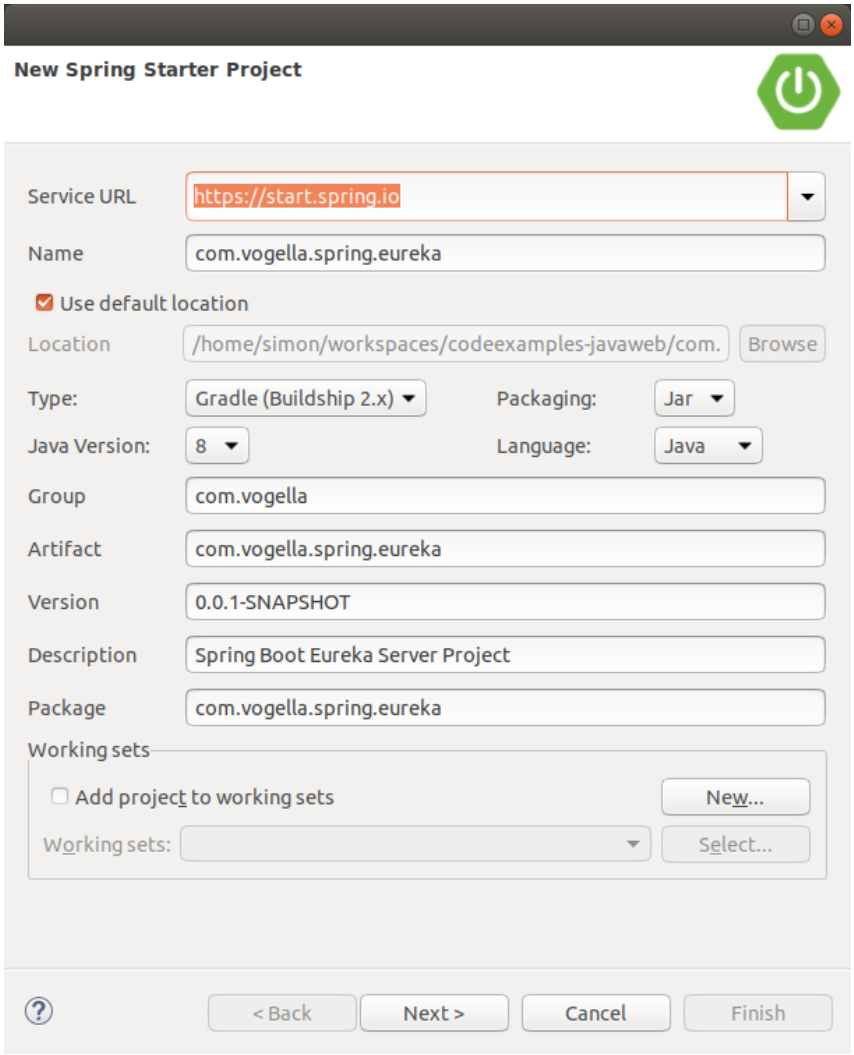
```
JAVA
buildscript {
    ext {
        springBootVersion = '2.1.0.RELEASE'
    }
    repositories {
        mavenCentral()
    }
    dependencies {
        classpath("org.springframework.boot:spring-boot-gradle-
plugin:${springBootVersion}")
    }
}

apply plugin: 'java'
apply plugin: 'eclipse'
apply plugin: 'org.springframework.boot'
apply plugin: 'io.spring.dependency-management'

group = 'com.vogella'
version = '0.0.1-SNAPSHOT'
sourceCompatibility = 1.8

repositories {
    mavenCentral()
    maven { url "https://repo.spring.io/milestone" }                    1
}

ext {
    springCloudVersion = 'Greenwich.M1'                                 2
}

dependencies {
    implementation('org.springframework.boot:spring-boot-starter-actuator')
    implementation('org.springframework.boot:spring-boot-starter-data-mongodb-
reactive')
    implementation('org.springframework.boot:spring-boot-starter-webflux')
    implementation('org.springframework.cloud:spring-cloud-starter-netflix-
eureka-client')                                                         3
    compileOnly('org.projectlombok:lombok')
    testImplementation('org.springframework.boot:spring-boot-starter-test')
    testImplementation('de.flapdoodle.embed:de.flapdoodle.embed.mongo')
    testImplementation('io.projectreactor:reactor-test')
}

dependencyManagement {                                                  4
    imports {
        mavenBom "org.springframework.cloud:spring-cloud-
dependencies:${springCloudVersion}"
    }
}
```

1. The milestone repositories have to be added, because the Spring Cloud Greenwich version is published as milestone for now.
2. Store the Spring Cloud version in a ext project property
3. Add the org.springframework.cloud:spring-cloud-starter-netflix-eureka-client dependency

4. dependencyManagement for Spring Cloud dependencies has to be applied

Now refresh the Gradle dependencies by clicking **Gradle > Refresh Gradle Project** and add the `@EnableDiscoveryClient` to the `Application` class and the user project is ready to be discovered by Netflix Eureka. == Exercise: Create a Netflix Eureka server

Create a new Spring project called *com.vogella.spring.eureka*.



Press `Next` and add the *Eureka Server* dependency('*org.springframework.cloud:spring-cloud-starter-eureka-server*') and then press finish.

When the project is created the `@EnableEurekaServer` annotation has to be added the application config.

```java
@SpringBootApplication
@EnableEurekaServer
public class Application {
    public static void main(String[] args) {
        SpringApplication.run(Application.class, args);
    }
}
```

And these would be the default *application.yml* for the Eureka server.

If you still have a *application.properties* file you can rename it to *application.yml*.

```yml
server:
  port: 8761
eureka:
  client:
    registerWithEureka: false
    fetchRegistry: false
```

Now you can navigate to http://localhost:8761 with a browser and see the Eureka dashboard and the services, which have been discovered.

You should now (re-)start the user server and then see the user service in the Eureka dashboard:

45. Exercise: Start Eureka server with Spring Cloud Cli

In a previous exercise the spring cloud cli has been installed.

By running `spring cloud --list` in the command line available cloud services can be found.

Besides others *eureka* is listed as well.

In order to start it you can run `spring cloud eureka` in the command line.

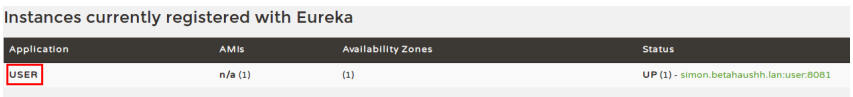
Once the eureka server has been started it prints the following to the command line:

```CONSOLE
eureka: To see the dashboard open http://localhost:8761

Type Ctrl-C to quit.
```

Starting the eureka server with Spring Cloud CLI may take awail. Just be patient or try to create a new Spring Boot project, which is described in the next NOTE of this exercise.

Now you can navigate to http://localhost:8761 with a browser and see the Eureka dashboard and the services, which have been discovered.

You should now (re-)start the user server and then see the user service in the Eureka dashboard:



In case you do not want to use the Spring Cloud CLI you can easily create a Eureka server on your own by creating a new Spring Boot project. Add the Netflix Eureka Server depenedency (*'org.springframework.cloud:spring-cloud-starter-eureka-server'*) and add the `@EnableEurekaServer` annotation to the application config.

```java
@SpringBootApplication
@EnableEurekaServer
public class Application {
    public static void main(String[] args) {
        SpringApplication.run(Application.class, args);
    }
}
```

And these would be the default *application.yml* for the Eureka server:

```yml
server:
  port: 8761
eureka:
  client:
    registerWithEureka: false
    fetchRegistry: false
```

46. Exercise: Let the gateway find services load balanced

Now that we are able to add services to the Eureka server, we no longer want to address services via its physical address, but by service name.

So instead of pointing to the user server by using *http://localhost:8081* with the `RouteLocator` in the gateway project a different *uri* can be used.

```java
package com.vogella.spring.gateway;

import org.springframework.cloud.client.discovery.EnableDiscoveryClient;
import org.springframework.cloud.gateway.route.RouteLocator;
import org.springframework.cloud.gateway.route.builder.RouteLocatorBuilder;
import org.springframework.context.annotation.Bean;
import org.springframework.context.annotation.Configuration;

@Configuration
@EnableDiscoveryClient                                          (1)
public class RouteConfig {
    @Bean
    public RouteLocator customRouteLocator(RouteLocatorBuilder builder) {
        return builder.routes()
                .route("users", r -> r.path("/user/**")
                .uri("lb://user"))                              (2)
                .build();
    }
}
```

(1) The gateway itself has also to be registered to eureka to make it work properly

(2) lb stands for load balanced

Load balanced means that Eureka can now decide to which user service instance it passes the request, in case several user service instances are running.

The *application.properties* of the gateway project have to look like this:

```properties
server.port=8080
spring.application.name=gateway                                 (1)

spring.cloud.gateway.discovery.locator.enabled=true             (2)
spring.cloud.gateway.discovery.locator.lower-case-service-id=true (3)
```

1. Service name in the eureka registry
2. The discovery locator has to be enabled to make the `RouteLocator` work
3. By default services are written with upper case letters and this setting allows lower case

The `implementation('org.springframework.cloud:spring-cloud-starter-netflix-eureka-client')` dependency has to be added to the gateway as well in the *build.gradle* as well.

Now three server should be started: Eureka server, Gateway server and the User server.

When navigating to the http://localhost:8080/user end point the same result as before should be returned as response.

The big benefit is that it is now possible to start several user server on different ports and eureka will load balance the requests.

47. Exercise: Using a Circuit Breaker

Sometimes services are not available any more and you might want to provide a fallback. That is the point where circuit breaker come into play.

A popular implementation is the Netflix Hystrix fault tolerance library.

Imagine all user services are down and you still want to return a fallback from the gateway when the */user* end point is requested.

First of all the `implementation('org.springframework.cloud:spring-cloud-starter-netflix-hystrix')` has to be added to the *build.gradle* file of the *com.vogella.spring.gateway* project.

After the gradle dependencies have been refreshed, we can either add the `@EnableCircuitBreaker` annotation to a `@Configuration` class.

```java
@Configuration
@EnableDiscoveryClient
@EnableCircuitBreaker
public class RouteConfig {

    // ... more code ...
}
```

or the `@SpringCloudApplication` annotation instead of the `@SpringBootApplication` annotation can be used.

```java
@SpringCloudApplication
public class Application {

    public static void main(String[] args) {
        SpringApplication.run(Application.class, args);
    }
}
```

1. `@SpringCloudApplication` applies both `@EnableDiscoveryClient` and `@EnableCircuitBreaker`

Once the Hystrix circuit breaker has been enabled a filter for providing a hystrix fallback can be applied to the `RouteLocator`.

```java
@Configuration
@EnableDiscoveryClient
@EnableCircuitBreaker
public class RouteConfig {
    @Bean
    public RouteLocator customRouteLocator(RouteLocatorBuilder builder) {
        return builder.routes()
                .route("user",
                        r -> r.path("/user/**")
                                .filters(f -> f.hystrix(c ->
c.setName("fallback")
                                        .setFallbackUri("forward:/fallback")))
                                .uri("lb://user"))
                .build();
    }
}
```

(1) (2) (3)

1. Can be omitted in case the `@SpringCloudApplication` annotation has been applied
2. Can be omitted in case the `@SpringCloudApplication` annotation has been applied
3. Set a fallback name and fallback uri, which will be used in case the *lb://user* uri cannot be reached

In order to make this *forward:/fallback* work a rest controller, which acts as a fallback has to be created:

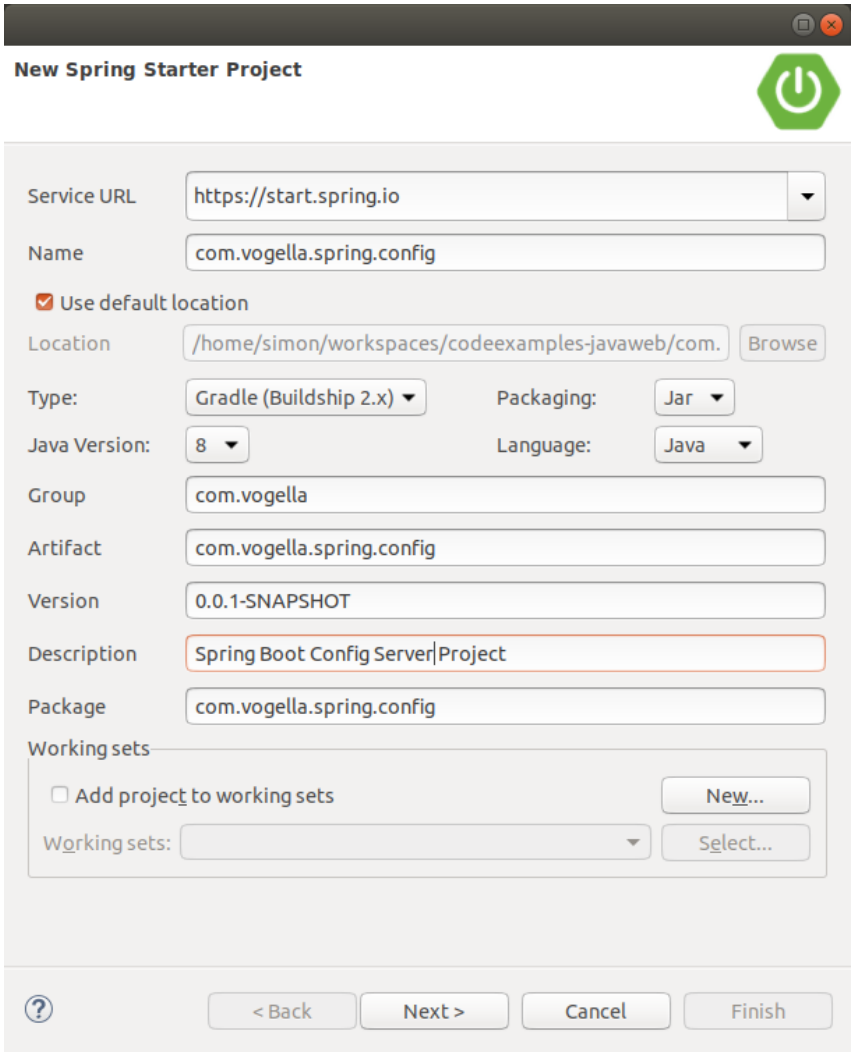
```java
package com.vogella.spring.gateway;

import org.springframework.http.HttpStatus;
import org.springframework.http.ResponseEntity;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.RestController;

import reactor.core.publisher.Mono;

@RestController
class HystrixFallbackContoller {

    @GetMapping("/fallback")
    public Mono<ResponseEntity<String>> userFallback() {
        return
Mono.just(ResponseEntity.status(HttpStatus.SERVICE_UNAVAILABLE).build());
    }
}
```

A better fallback would be to return a default user or asking another service for users.

48. Exercise: Spring Cloud Config Server

Configuring several different micro services can be struggling, because by default the configuration resides inside the build jar file. Therefore the configurations are not easily available for system admins and you do not want to build a new jar file every time a configuration has to be changed.

In order to centralize this configuration a Config Server can be created. Create a new project called *com.vogella.spring.config*.



Press `Next`, add the *Config Server* (org.springframework.cloud:spring-cloud-config-server) as dependency and press `Finish`.

Add the `@EnableConfigServer` annotation to the `com.vogella.spring.config.Application` class.

```java
@SpringBootApplication
@EnableConfigServer
public class Application {

    public static void main(String[] args) {
        SpringApplication.run(Application.class, args);
    }
}
```

(1)

(1) Tells Spring that this Spring Boot application is a Config Server

Now this Config Server needs to be configured in its *application.properties* so that it points to a Git repository, where the configurations should reside.

application.properties

```properties
server.port=8888
spring.cloud.config.server.git.uri=https://github.com/vogellacompany/codeexamples-javaweb/
spring.cloud.config.server.git.searchPaths=config
```

(1) (2) (3)

(1) The default port for Config Server is usually port 8888.

(2) This property is used to point to a git repository, which contains configuration files

(3) A *searchPath* is used to point to subfolders (can also be a list)

49. Exercise: Spring Cloud Config client

Different micro services, e.g., *com.vogella.spring.user*, should now get their configuration from the Config Server rather than holding their own configuration.

The *application.properties* file can be deleted from the *com.vogella.spring.user* project. Instead of using the *application.properties* a *bootstrap.properties* now has to be added to the `src/main/resources` folder.

bootstrap.properties

```
PROPERTIES
spring.application.name=user                              1
spring.cloud.config.uri=http://localhost:8888             2
management.security.enabled=false                         3
```

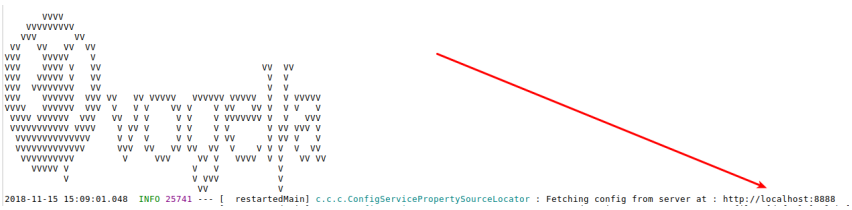
1. Besides Eureka, also the Cloud Config Server makes use of this property to find the right config file in the git repo
2. Tells this Config Server client where to find the Config Server
3. Disable security right now for convenience, but it will be added again later ;-)

In order to enable the user project to talk to a Cloud Config Server the `implementation('org.springframework.cloud:spring-cloud-starter-config')` dependency has to be added to the *build.gradle* file.

Do not forget to refresh the Gradle project.

Now start the Eureka Server, the Config Server and finally the user server.

Look into the console log of the user application and validate that the remote properties in the git repo have been used.



50. Exercise: Local Git Repository with configurations

Create your own local git repository and provide a *user.properties* for the configuration in the git repository.

```
CONSOLE
mkdir config

git init

echo 'server.port=8081' > user.properties

git add .

git commit -m "Added user config"
```

Now the Cloud Config Server can point to the local repository by changing the *application.properties* of the *com.vogella.spring.config* project.

```
PROPERTIES
server.port=8888
spring.cloud.config.server.git.uri=file://${path-to-repo}   1
```

1. ${path-to-repo} has to be replaced by the actual path to the previously created repo

Now again start the Eureka Server, the Config Server and finally the user server.

Look into the console log of the user application and validate that the remote properties in the git repo have been used.

51. Exercise: Add Spring Security to the classpath

To ensure that not everyone can read any user, the rest end point should be secured.

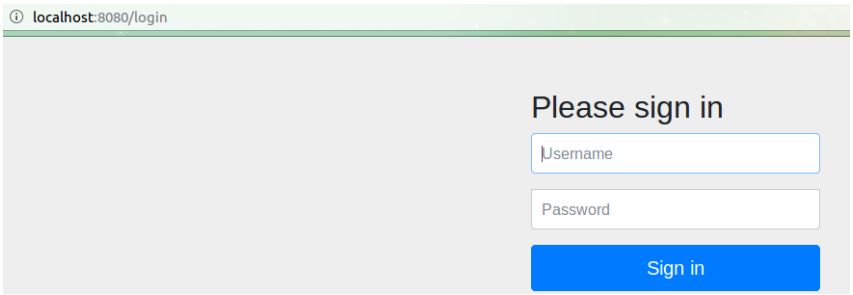
To achieve this the `org.springframework.boot:spring-boot-starter-security` compile dependency has to be added.

```groovy
dependencies {

    // more dependencies ...

    compile('org.springframework.boot:spring-boot-starter-security')
    testImplementation('org.springframework.security:spring-security-test')
}
```

Spring Boot automatically adds default security settings to the web application by adding this dependency.

Again try to get all users by navigating to http://localhost:8080/user in the browser.

Now you should be redirected to http://localhost:8080/login and being faced with a login page.



The default user is called *user* and the password can be found in the console.

```
Using generated security password: 64c68d82-0448-465b-8b97-a7002c612d25
```

52. Exercise: Configure Spring Security with user repository

Using a password from the console is not that secure and it would be better to use the users from the database to authenticate.

We want to modify the `User` class by adding an additional constructor:

User.java

```java
public User(User user) {
    this.id = user.id;
    this.name = user.name;
    this.email = user.email;
    this.password = user.password;
    this.roles = user.roles;
    this.lastLogin = user.lastLogin;
    this.enabled = user.enabled;
}
```

1. Basically this is a copy constructor to create new `User` instances by copying the field values from an existing user object.

In order to achieve this create a *com.vogella.spring.user.security* package and create a *ServiceReactiveUserDetailsService* class in this package.

```java
package com.vogella.spring.user.security;

import java.util.Collection;
import java.util.stream.Collectors;

import org.springframework.security.core.GrantedAuthority;
import org.springframework.security.core.authority.SimpleGrantedAuthority;
import
org.springframework.security.core.userdetails.ReactiveUserDetailsService;
import org.springframework.security.core.userdetails.UserDetails;
import org.springframework.stereotype.Component;

import com.vogella.spring.user.domain.User;
import com.vogella.spring.user.service.UserService;

import reactor.core.publisher.Mono;

@Component
public class ServiceReactiveUserDetailsService implements
ReactiveUserDetailsService {

    private UserService userService;

    public ServiceReactiveUserDetailsService(UserService userService) {
        this.userService = userService;
    }

    @Override
    public Mono<UserDetails> findByUsername(String username) {
        return userService
            .findUserByEmail(username)                                    (1)
            .map(CustomUserDetails::new);                                 (2)
    }

    static class CustomUserDetails extends User implements UserDetails {

        private static final long serialVersionUID = -2466968593900571404L;

        public CustomUserDetails(User user) {
            super(user);
        }

        @Override
        public Collection<? extends GrantedAuthority> getAuthorities() {
            return getRoles()                                             (3)
                .stream()
                .map(authority -> new SimpleGrantedAuthority(authority))
                .collect(Collectors
                    .toList());
        }

        @Override
        public String getUsername() {
            return getEmail();                                            (4)
        }

        @Override
        public boolean isAccountNonExpired() {
            return true;
        }

        @Override
        public boolean isAccountNonLocked() {
            return true;
        }

        @Override
        public boolean isCredentialsNonExpired() {
            return true;
        }
    }
}
```

(1) The email adress is supposed to be used for a login and therefore the email is queried

2. Make use of an adapter for the `UserDetails` interface so that `CustomUserDetails` can be returned in by the overridden `findByUsername` method.
3. Map the roles to be authorities
4. Use the Users email as unique user name

For the other values we simply return true for now. The `UserDetails` class also has also an `isEnabled` and `getPassword`, which is already being implemented by the `User` class.

This `ReactiveUserDetailsService` implementation will be claimed by Spring Security and used to authenticate users with the formlogin or basic auth header.

We also want to use a proper password encoder for our users, which are created in the `UserDataInitializer` class.

Therefore we create a `SecurityConfig` class in the *com.vogella.spring.user.security* package.

JAVA

```
package com.vogella.spring.user.security;

import org.springframework.context.annotation.Bean;
import
org.springframework.security.config.annotation.method.configuration.EnableReac
tiveMethodSecurity;
import
org.springframework.security.config.annotation.web.reactive.EnableWebFluxSecur
ity;
import org.springframework.security.crypto.factory.PasswordEncoderFactories;
import org.springframework.security.crypto.password.PasswordEncoder;

@EnableWebFluxSecurity
@EnableReactiveMethodSecurity
public class SecurityConfig {

    @Bean
    public PasswordEncoder passwordEncoder() {
        return PasswordEncoderFactories
            .createDelegatingPasswordEncoder();
    }
}
```

The `DelegatingPasswordEncoder` automatically uses the latest and greatest encryption algorithm and therefore is the best choice to be used as PasswordEncoder.

Since a `PasswordEncoder` is now available as bean it can be injected into our `UserDataInitializer` class to encode the given passwords.

(https://www.vogella.com/)

```java
package com.vogella.spring.user.initialize;

import java.time.Instant;
import java.util.Arrays;
import java.util.Collections;

import org.springframework.beans.factory.SmartInitializingSingleton;
import org.springframework.context.annotation.Profile;
import org.springframework.security.crypto.password.PasswordEncoder;
import org.springframework.stereotype.Component;

import com.vogella.spring.user.data.UserRepository;
import com.vogella.spring.user.domain.User;

@Profile("!production")
@Component
public class UserDataInitializer implements SmartInitializingSingleton {

    private UserRepository userRepository;
    private PasswordEncoder passwordEncoder;

    public UserDataInitializer(UserRepository userRepository, PasswordEncoder
passwordEncoder) {
        this.userRepository = userRepository;
        this.passwordEncoder = passwordEncoder;
    }

    @Override
    public void afterSingletonsInstantiated() {
        User user = new User(1, "Fabian Pfaff", "fabian.pfaff@vogella.com",
passwordEncoder
            .encode("fap"),
                Collections
                    .singletonList("ROLE_ADMIN"),
                Instant
                    .now(),
                true);
        User user2 = new User(2, "Simon Scholz", "simon.scholz@vogella.com",
passwordEncoder
            .encode("simon"),
                Collections
                    .singletonList("ROLE_ADMIN"),
                Instant
                    .now(),
                false);
        User user3 = new User(3, "Lars Vogel", "lars.vogel@vogella.com",
passwordEncoder
            .encode("vogella"),
                Collections
                    .singletonList("ROLE_USER"),
                Instant
                    .now(),
                true);

        userRepository.saveAll(Arrays.asList(user, user2, user3)).subscribe();
    }

}
```

1. Inject the `PasswordEncoder`
2. Make use of the `PasswordEncoder` to encode the user passwords

> Optional Exercise: We leave it to the reader to also make use of the `PasswordEncoder` in the `UserService` `newUser` method for new users.

To verify that now the users from the database are used try to navigate to http://localhost:8080/user and you'll be redirected to a login form, where you can type in *simon.scholz@vogella.com* as user and *simon* as password. (See `UserDataInitializer` for other names and passwords)

And now you should be able to see the user json again. == Exercise: Using JWT token for authentication

(https://www.vogella.com/)

Using a form login or http basic authentication has some drawbacks, because with http basic authentication the user credentials have to be sent together with each and every request. A form login is also not always suitable in case you're not using a browser to access the data.

JWT tokens offer the possibility to exchange bearer tokens for each request, where authentication is necessary.

To make use of this we need to be able to generate these tokens by using a `JWTUtil`.

(https://www.vogella.com/)

```java
package com.vogella.spring.user.security;

import java.util.Date;
import java.util.HashMap;
import java.util.Map;

import org.springframework.beans.factory.annotation.Value;
import org.springframework.stereotype.Component;

import com.vogella.spring.user.domain.User;

import io.jsonwebtoken.Claims;
import io.jsonwebtoken.Jwts;
import io.jsonwebtoken.SignatureAlgorithm;

@Component
public class JWTUtil {

    @Value("${jwt.secret}")
    private String secret;

    @Value("${jwt.expiration}")
    private String expirationTime;

    public Claims getAllClaimsFromToken(String token) {
        return
Jwts.parser().setSigningKey(secret).parseClaimsJws(token).getBody();
    }

    public String getUsernameFromToken(String token) {
        return getAllClaimsFromToken(token).getSubject();
    }

    public Date getExpirationDateFromToken(String token) {
        return getAllClaimsFromToken(token).getExpiration();
    }

    private Boolean isTokenExpired(String token) {
        final Date expiration = getExpirationDateFromToken(token);
        return expiration.before(new Date());
    }

    public String generateToken(User user) {
        Map<String, Object> claims = new HashMap<>();
        claims.put("role", user.getRoles());
        claims.put("enable", user.isEnabled());
        return doGenerateToken(claims, user.getEmail());
    }

    private String doGenerateToken(Map<String, Object> claims, String
username) {
        Long expirationTimeLong = Long.parseLong(expirationTime); //in second

        final Date createdDate = new Date();
        final Date expirationDate = new Date(createdDate.getTime() +
expirationTimeLong * 1000);
        return Jwts.builder()
                .setClaims(claims)
                .setSubject(username)
                .setIssuedAt(createdDate)
                .setExpiration(expirationDate)
                .signWith(SignatureAlgorithm.HS512, secret)
                .compact();
    }

    public Boolean validateToken(String token) {
        return !isTokenExpired(token);
    }
}
```

To learn more about JWT tokens you can get further information on https://jwt.io/

The `JWTUtil` class makes use of the *jwt.secret* and *jwt.expiration* properties, which we'll add to the *bootstrap.properties* file for now.

(https://www.vogella.com/)

The next thing to do is to create a rest end point to obtain a JWT token, which can be used for authorization.

Create an `AuthRequest`, `AuthResponse` and a `AuthRestController` class inside the *com.vogella.spring.user.controller* package.

JAVA

```java
package com.vogella.spring.user.controller;

import lombok.AllArgsConstructor;
import lombok.Data;
import lombok.NoArgsConstructor;
import lombok.ToString;

@Data
@NoArgsConstructor
@AllArgsConstructor
@ToString
public class AuthRequest {
    private String email;
    private String password;
}
```

JAVA

```java
package com.vogella.spring.user.controller;

import lombok.AllArgsConstructor;
import lombok.Data;
import lombok.NoArgsConstructor;
import lombok.ToString;

@Data
@NoArgsConstructor
@AllArgsConstructor
@ToString
public class AuthResponse {
    private String token;
}
```

(https://www.vogella.com/)

```java
package com.vogella.spring.user.controller;

import java.security.Principal;

import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.http.HttpStatus;
import org.springframework.http.ResponseEntity;
import org.springframework.security.access.prepost.PreAuthorize;
import org.springframework.security.core.annotation.AuthenticationPrincipal;
import
org.springframework.security.core.userdetails.ReactiveUserDetailsService;
import org.springframework.security.crypto.password.PasswordEncoder;
import org.springframework.web.bind.annotation.GetMapping;
import org.springframework.web.bind.annotation.PostMapping;
import org.springframework.web.bind.annotation.RequestBody;
import org.springframework.web.bind.annotation.RestController;

import com.vogella.spring.user.domain.User;
import com.vogella.spring.user.security.JWTUtil;

import reactor.core.publisher.Mono;

@RestController
public class AuthRestController {

    @Autowired
    private JWTUtil jwtUtil;

    @Autowired
    private PasswordEncoder passwordEncoder;

    @Autowired
    private ReactiveUserDetailsService userDetailsService;

    @PostMapping("/auth")
    public Mono<ResponseEntity<AuthResponse>> auth(@RequestBody AuthRequest
ar) {
        return userDetailsService
            .findByUsername(ar
                .getEmail())
            .map((userDetails) -> {
                if (passwordEncoder
                    .matches(ar
                        .getPassword(),
                            userDetails
                                .getPassword())) {
                    return ResponseEntity
                        .ok(new AuthResponse(jwtUtil
                            .generateToken((User) userDetails)));
                } else {
                    return ResponseEntity
                        .status(HttpStatus.UNAUTHORIZED)
                        .build();
                }
            });
    }
}
```

With this */auth* end point a JWT token can be obtained in case the sent `AuthRequest` has correct credentials.

Try to obtain a JWT token by using curl or your favorite rest client:

```console
curl -d '{"email":"simon.scholz@vogella.com", "password":"simon"}' -H
"Content-Type: application/json" -X POST http://localhost:8080/auth
```

Something similar to this should be returned:

```console
{
  "token":
"eyJhbGciOiJIUzUxMiJ9.eyJzdWIiOiJsYXJzLnZvZ2VsQHZvZ2VsbGEuY29tIiwicm9sZSI6WyJS
TOxFX1VTRVIiXSwiZW5hYmxlIjpOcnVlLCJleHAiOjE1NDIzNTQOMTIsImlhdCI6MTUOMjMyNTYxMn
O.zBVx_-
Npp3y6_6EqIpEVWy4EtQoCoO1Ii8lSsI1w3X2imIUkrylTOgabgbNo8HgSunMwCujz1d5uIZ6JuGyc
Qw"
}
```

Now that you got a valid JWT token the server side has to validate this token and secure the application in case the token is not valid.

In order to achieve that several classes have to be created:

```java
package com.vogella.spring.user.security;

import java.util.List;
import java.util.stream.Collectors;

import org.springframework.beans.factory.annotation.Autowired;
import
org.springframework.security.authentication.ReactiveAuthenticationManager;
import
org.springframework.security.authentication.UsernamePasswordAuthenticationToke
n;
import org.springframework.security.core.Authentication;
import org.springframework.security.core.authority.SimpleGrantedAuthority;
import org.springframework.stereotype.Component;

import io.jsonwebtoken.Claims;
import reactor.core.publisher.Mono;

@Component
public class AuthenticationManager implements ReactiveAuthenticationManager {

    @Autowired
    private JWTUtil jwtUtil;

    @Override
    public Mono<Authentication> authenticate(Authentication authentication) {
        String authToken = authentication.getCredentials().toString();

        String username;
        try {
            username = jwtUtil.getUsernameFromToken(authToken);
        } catch (Exception e) {
            username = null;
        }
        if (username != null && jwtUtil.validateToken(authToken)) {
            Claims claims = jwtUtil.getAllClaimsFromToken(authToken);
            List<String> roles = claims.get("role", List.class);
            UsernamePasswordAuthenticationToken auth = new
UsernamePasswordAuthenticationToken(username, null, roles
                    .stream().map(authority -> new
SimpleGrantedAuthority(authority)).collect(Collectors.toList()));
            return Mono.just(auth);
        } else {
            return Mono.empty();
        }
    }
}
```

(https://www.vogella.com/)

```java
package com.vogella.spring.user.security;

import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.http.HttpHeaders;
import org.springframework.http.server.reactive.ServerHttpRequest;
import
org.springframework.security.authentication.ReactiveAuthenticationManager;
import
org.springframework.security.authentication.UsernamePasswordAuthenticationToke
n;
import org.springframework.security.core.Authentication;
import org.springframework.security.core.context.SecurityContext;
import org.springframework.security.core.context.SecurityContextImpl;
import
org.springframework.security.web.server.context.ServerSecurityContextRepositor
y;
import org.springframework.stereotype.Component;
import org.springframework.web.server.ServerWebExchange;

import reactor.core.publisher.Mono;

@Component
public class SecurityContextRepository implements
ServerSecurityContextRepository{

    @Autowired
    private ReactiveAuthenticationManager authenticationManager;

    @Override
    public Mono<Void> save(ServerWebExchange swe, SecurityContext sc) {
        throw new UnsupportedOperationException("Not supported yet.");
    }

    @Override
    public Mono<SecurityContext> load(ServerWebExchange swe) {
        ServerHttpRequest request = swe.getRequest();
        String authHeader =
request.getHeaders().getFirst(HttpHeaders.AUTHORIZATION);

        if (authHeader != null && authHeader.startsWith("Bearer ")) {
            String authToken = authHeader.substring(7);
            Authentication auth = new
UsernamePasswordAuthenticationToken(authToken, authToken);
            return
this.authenticationManager.authenticate(auth).map((authentication) -> {
                return new SecurityContextImpl(authentication);
            });
        } else {
            return Mono.empty();
        }
    }
}
```

```java
package com.vogella.spring.user.security;

import org.springframework.context.annotation.Configuration;
import org.springframework.web.reactive.config.CorsRegistry;
import org.springframework.web.reactive.config.WebFluxConfigurer;

@Configuration
public class CORSFilter implements WebFluxConfigurer {

    @Override
    public void addCorsMappings(CorsRegistry registry) {

registry.addMapping("/**").allowedOrigins("*").allowedMethods("*").allowedHead
ers("*");
    }
}
```

After these classes have been created we also want to add a custom `SecurityWebFilterChain` bean inside the `SecurityConfig` class:

(https://www.vogella.com/)

```java
package com.vogella.spring.user.security;

import org.springframework.context.annotation.Bean;
import org.springframework.http.HttpMethod;
import
org.springframework.security.authentication.ReactiveAuthenticationManager;
import
org.springframework.security.config.annotation.method.configuration.EnableReac
tiveMethodSecurity;
import
org.springframework.security.config.annotation.web.reactive.EnableWebFluxSecur
ity;
import org.springframework.security.config.web.server.ServerHttpSecurity;
import org.springframework.security.crypto.factory.PasswordEncoderFactories;
import org.springframework.security.crypto.password.PasswordEncoder;
import org.springframework.security.web.server.SecurityWebFilterChain;
import
org.springframework.security.web.server.context.ServerSecurityContextRepositor
y;

@EnableWebFluxSecurity
@EnableReactiveMethodSecurity
public class SecurityConfig {

    @Bean
    public PasswordEncoder passwordEncoder() {
        return PasswordEncoderFactories
            .createDelegatingPasswordEncoder();
    }

    @Bean
    public SecurityWebFilterChain securitygWebFilterChain(ServerHttpSecurity
http,                                                                    (1)
            ReactiveAuthenticationManager authenticationManager,
            ServerSecurityContextRepository securityContextRepository) {
        return http
            .csrf()
            .disable()
            .formLogin()
            .disable()
            .httpBasic()
            .disable()
            .authenticationManager(authenticationManager)
            .securityContextRepository(securityContextRepository)
            .authorizeExchange()
            .pathMatchers(HttpMethod.OPTIONS)
            .permitAll()
            .pathMatchers("/auth")
            .permitAll()
            .anyExchange()
            .authenticated()
            .and()
            .build();

    }
}
```

(1) This is the new method, the rest of the class except of the imports stays the same

With this `SecurityWebFilterChain` you now need to pass the JWT token as authentication header to the server.

```
curl -H "Authorization: Bearer <your-token>" -H "Content-Type:
application/json" -X GET http://localhost:8080/user                      (1)
```

(1) *<your-token>* must be replaced by your actual token, which you obtained from the */auth* rest end point.

53. Exercise: Taking roles into account to constrain access

We have specified that any request besides the */auth* request has to be authorized in the `SecurityConfig`.

But so far we didn't take the different roles of the user into account. This can be done in several ways like further adjusting the `SecurityWebFilterChain` or using the `@PreAuthorize` annotation.

We can say that any delete request can only the done by ADMIN users:

SecurityConfig.java

```java
@Bean
public SecurityWebFilterChain securitygWebFilterChain(ServerHttpSecurity http,
        ReactiveAuthenticationManager authenticationManager,
        ServerSecurityContextRepository securityContextRepository) {
    return http
        .csrf()
        .disable()
        .formLogin()
        .disable()
        .httpBasic()
        .disable()
        .authenticationManager(authenticationManager)
        .securityContextRepository(securityContextRepository)
        .authorizeExchange()
        .pathMatchers(HttpMethod.OPTIONS)
        .permitAll()
        .pathMatchers("/auth")
        .permitAll()
        .pathMatchers(HttpMethod.DELETE)                    // 1
        .hasAuthority("ADMIN")                              // 2
        .anyExchange()
        .authenticated()
        .and()
        .build();

}
```

1. Specify for any delete request
2. authority has to be ADMIN

The `pathMatchers` method is also overloaded and you can be more precise about this, but you can also make use of the `@PreAuthorize` annotation. This `@PreAuthorize` annotation can for example be added to the `deleteUser` method in the `UserService` class.

(https://www.vogella.com/)

```java
package com.vogella.spring.user.service;

import org.springframework.data.domain.Example;
import org.springframework.data.domain.ExampleMatcher;
import org.springframework.data.domain.ExampleMatcher.GenericPropertyMatcher;
import org.springframework.security.access.prepost.PreAuthorize;
import org.springframework.stereotype.Service;

import com.vogella.spring.user.data.UserRepository;
import com.vogella.spring.user.domain.User;

import reactor.core.publisher.Flux;
import reactor.core.publisher.Mono;

@Service
public class UserService {

    private UserRepository userRepository;

    public UserService(UserRepository UserRepository) {
        this.userRepository = UserRepository;
    }

    public Flux<User> getUsers(long limit) {
        if (-1 == limit) {
            return userRepository.findAll();
        }
        return userRepository.findAll().take(limit);
    }

    public Mono<User> findUserById(long id) {
        return userRepository.findById(id);
    }

    public Mono<User> findUserByEmail(String email) {
        return userRepository.findByEmail(email);
    }

    public Mono<User> findUserByExample(User user) {
        ExampleMatcher matcher = ExampleMatcher.matching().withIgnoreCase()
                .withMatcher("email", GenericPropertyMatcher::contains)
                .withMatcher("role", GenericPropertyMatcher::contains)
                .withMatcher("enabled", GenericPropertyMatcher::exact);
        Example<User> example = Example.of(user, matcher);
        return userRepository.findOne(example);
    }

    public Mono<User> newUser(User User) {
        return userRepository.save(User);
    }

    @PreAuthorize("hasAuthority('ADMIN')")
    public Mono<Void> deleteUser(long id) {
        return userRepository.deleteById(id);
    }

}
```

(1)

(1) Before this method will be invoked the `@PreAuthorize` checks whether to logged in user has the *ADMIN* authority.

You can try this by logging in with different user, which have different roles/authorities.

54. Exercise: Generating RestDocs from Tests

In this exercise we'll generate documentation for our REST api from test definitions.

In the `com.vogella.spring.user` project, add the following to your `build.gradle` file in the right places:

build.gradle

(https://www.vogella.com/)

```groovy
buildscript {
    ext {
        springBootVersion = '2.1.0.RELEASE'
    }
    repositories {
        mavenCentral()
        jcenter()
    }
    dependencies {
        classpath("org.springframework.boot:spring-boot-gradle-
plugin:${springBootVersion}")
        classpath('org.asciidoctor:asciidoctor-gradle-plugin:1.5.9.2')
    }
}

// ... other plugins
apply plugin: 'org.asciidoctor.convert'

ext {
    // ...
    snippetsDir = file('build/generated-snippets')
}

dependencies {
    // ... other dependencies
    asciidoctor('org.springframework.restdocs:spring-restdocs-asciidoctor')
    testCompile('org.springframework.restdocs:spring-restdocs-webtestclient')
}

test {
    outputs.dir snippetsDir
}

asciidoctor {
    inputs.dir snippetsDir
    dependsOn test
}

bootJar {
    dependsOn asciidoctor
    from ("${asciidoctor.outputDir}/html5") {
        into 'static/docs'
    }
}
```

Then create a new test class:

(https://www.vogella.com/)

```java
package com.vogella.spring.user.controller;

import static
org.springframework.restdocs.request.RequestDocumentation.parameterWithName;
import static
org.springframework.restdocs.request.RequestDocumentation.pathParameters;
import static
org.springframework.restdocs.webtestclient.WebTestClientRestDocumentation.docu
ment;
import static
org.springframework.restdocs.webtestclient.WebTestClientRestDocumentation.docu
mentationConfiguration;

import org.junit.Before;
import org.junit.Rule;
import org.junit.Test;
import org.junit.runner.RunWith;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.boot.test.context.SpringBootTest;
import org.springframework.context.ApplicationContext;
import org.springframework.restdocs.JUnitRestDocumentation;
import org.springframework.security.test.context.support.WithMockUser;
import org.springframework.test.context.junit4.SpringRunner;
import org.springframework.test.web.reactive.server.WebTestClient;
import
org.springframework.test.web.reactive.server.WebTestClient.ResponseSpec;

import com.vogella.spring.user.domain.User;

@RunWith(SpringRunner.class)
@SpringBootTest
public class UserRestDocsControllerTest {

    @Rule
    public JUnitRestDocumentation restDocumentation = new
JUnitRestDocumentation();

    @Autowired
    private ApplicationContext context;

    private WebTestClient webTestClient;

    @Before
    public void setUp() {
        this.webTestClient =
WebTestClient.bindToApplicationContext(context).configureClient().baseUrl("/")

.filter(documentationConfiguration(restDocumentation)).build();
    }

    @Test
    @WithMockUser
    public void shouldReturnUser() throws Exception {
        ResponseSpec rs = webTestClient.get().uri("/user/{id}", 1).exchange();

        rs.expectStatus().isOk().expectBody(User.class)
                .consumeWith(document("sample",

pathParameters(parameterWithName("id").description("The id of the User
entity"))));
    }
}
```

Create a new folder in your project directory: "/src/docs/asciidoc". Then create an adoc template that includes the auto-generated snippets from the test:

(https://www.vogella.com/)

```adoc
= Spring REST Docs with WebTestClient
Simon Scholz (c) 2018 vogella GmbH;
:doctype: book
:icons: font
:source-highlighter: highlightjs

Application demonstrating how to use Spring REST Docs with Spring Framework's
WebTestClient.

cURL request:

include::{snippets}/sample/curl-request.adoc[]

HTTPie request:

include::{snippets}/sample/httpie-request.adoc[]

HTTP request:

include::{snippets}/sample/http-request.adoc[]

Request body:

IMPORTANT: The following snippet is empty because it does not have any request
body.

include::{snippets}/sample/request-body.adoc[]

HTTP response:

include::{snippets}/sample/http-response.adoc[]

Response body:

include::{snippets}/sample/response-body.adoc[]

Path Parameters:

include::{snippets}/sample/path-parameters.adoc[]
```

There are probably failing tests in your project. Deactivate all other test classes with `@Ignore` before proceeding.

To trigger the build run

```
./gradlew bootJar
```

The generated snippets reside in `/build/generated-snippets/sample`. The documentation file generated from the `index.adoc` template can be found at `/build/asciidoc/html5/index.html`.

55. Spring Boot resources

Spring Boot test manual (https://docs.spring.io/spring-boot/docs/current/reference/html/boot-features-testing.html)

56. vogella training and consulting support

(https://learn.vogella.com/) (https://www.vogella.com/training/) (https://www.vogella.com/consulting/)

Appendix A: Copyright, License and Source code

(https://www.vogella.com/)