

Desenvolvimento de Aplicações com Arquitetura Baseada em Microservices

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[IF1007] - Tópicos Avançados em SI 4
<https://github.com/IF1007/if1007>

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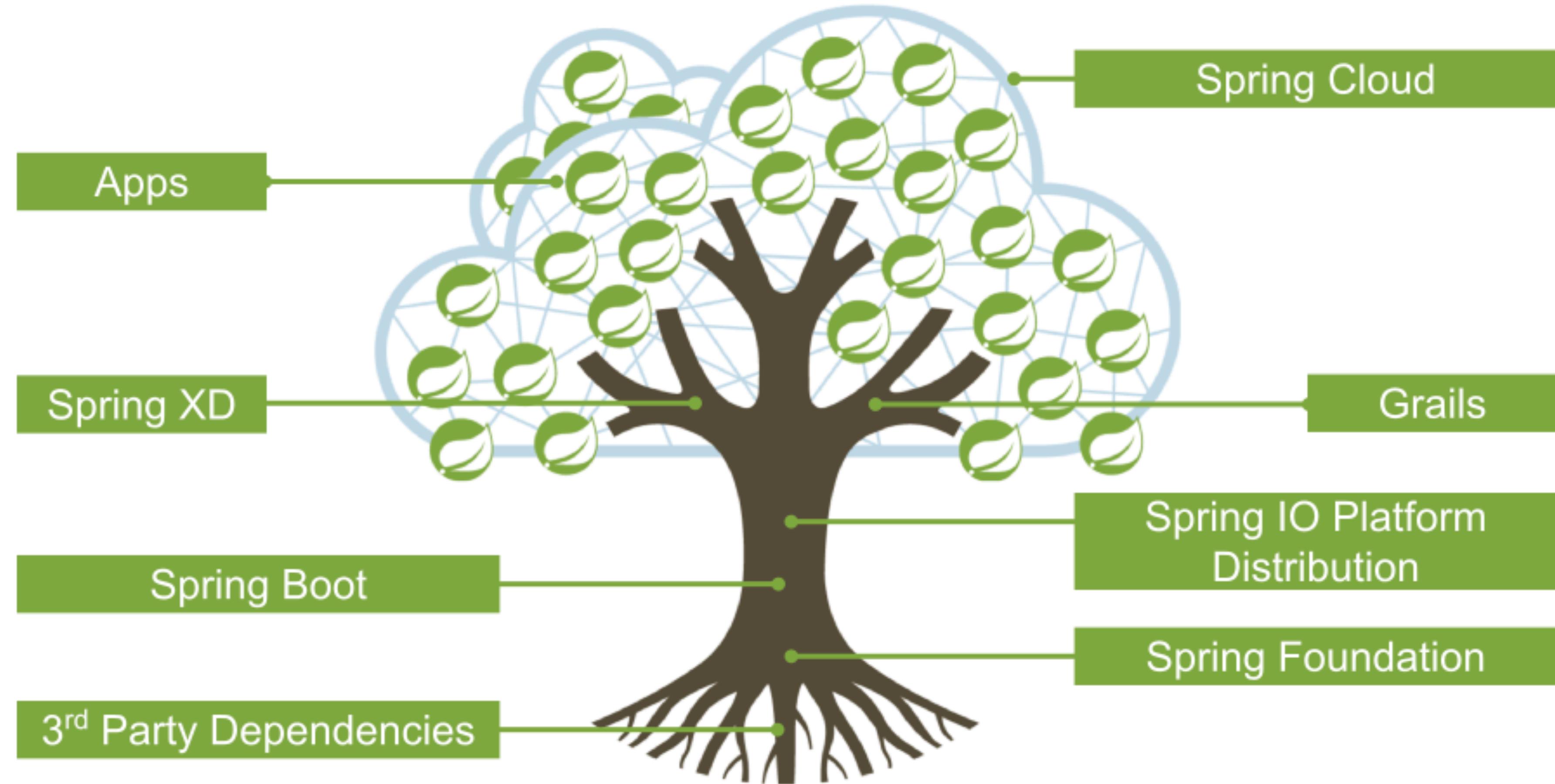


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Resources

- There is no textbook required. However, the following are some books that may be recommended:
 - [Building Microservices: Designing Fine-Grained Systems](#)
 - [Spring Microservices](#)
 - [Spring Boot: Acelere o desenvolvimento de microserviços](#)
 - [Microservices for Java Developers A Hands-on Introduction to Frameworks and Containers](#)
 - [Migrating to Cloud-Native Application Architectures](#)
 - [Continuous Integration](#)
 - [Getting started guides from spring.io](#)



Building Microservices with Spring Boot

Context

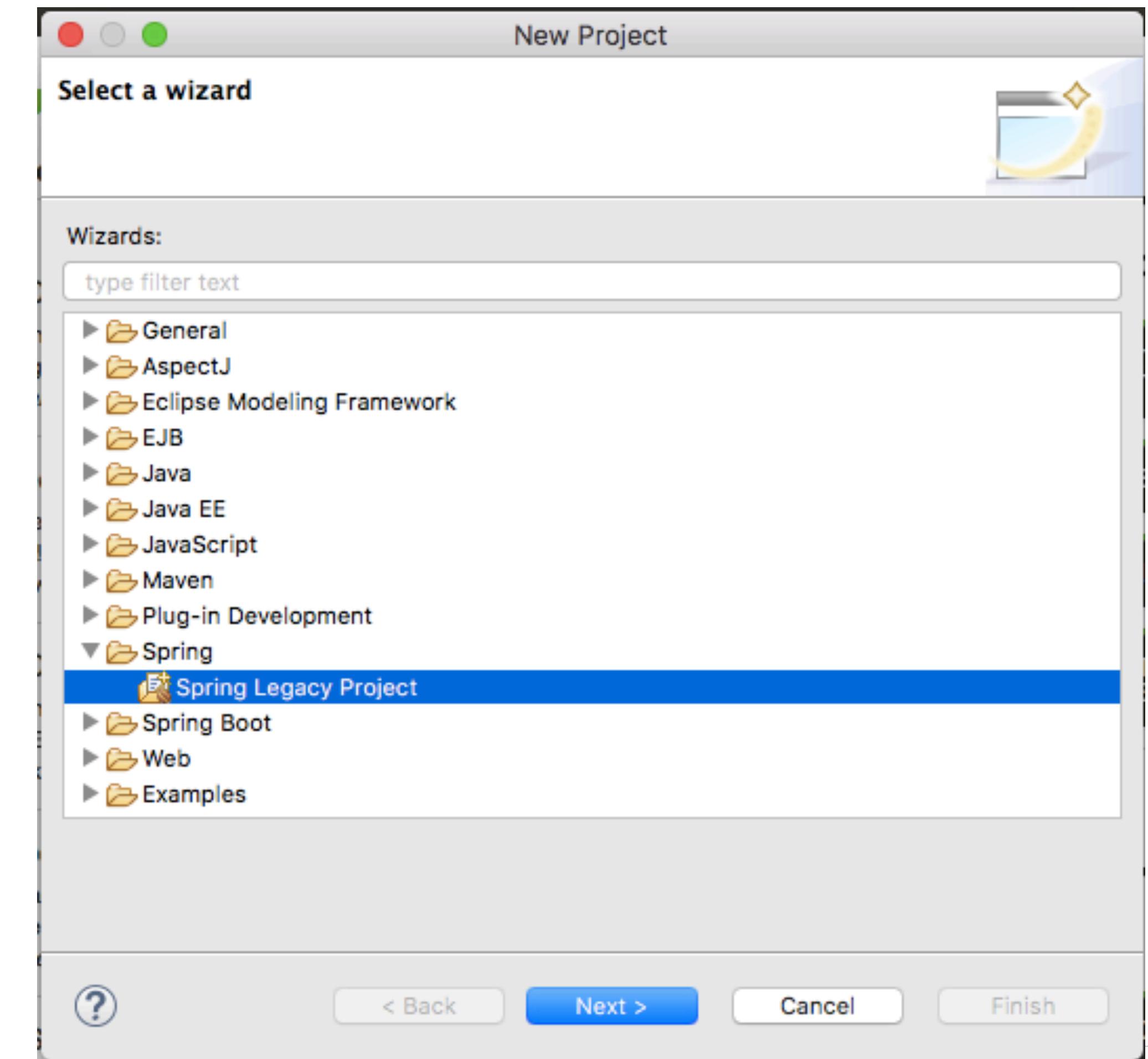
- Spring Boot is a framework to develop production-ready microservices in Java
- We will see..
 - Setting up the latest Spring development environment
 - Developing RESTful services using the Spring framework
 - Using Spring Boot to build fully qualified microservices
 - Useful Spring Boot features to build production-ready microservices

Setting up a development environment

- JDK 1.8: <http://www.oracle.com/technetwork/java/javase/downloads/jdk8-downloads-2133151.html>
- Spring Tool Suite 3.9.2 (STS): <https://spring.io/tools/sts/all>
 - Alternately, other IDEs such as IntelliJ IDEA, NetBeans, or Eclipse could be used
- Maven 3.3.1: <https://maven.apache.org/download.cgi>
 - Similarly, alternate build tools such as Gradle can be used
- This class is based on the following versions of Spring libraries:
 - Spring Framework 4.2.6.RELEASE
 - Spring Boot 1.3.5.RELEASE

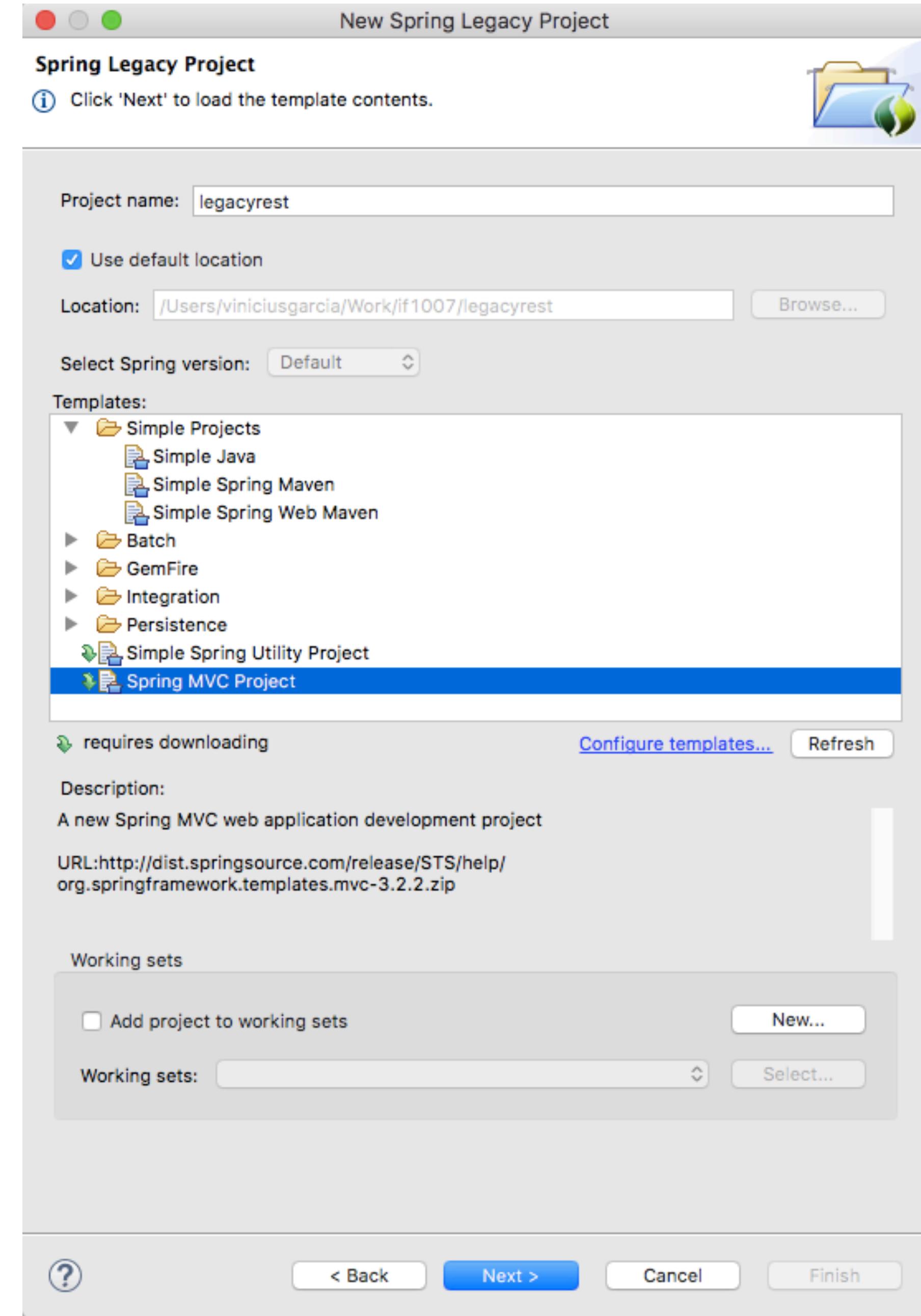
Developing a RESTful service – the legacy approach

- The following are the steps to develop the first RESTful service:
 - Start STS and set a workspace of choice for this project
 - Navigate to File | New | Project
 - Select Spring Legacy Project as shown in the following screenshot and click on Next:



Developing a RESTful service – the legacy approach

- Select Spring MVC Project as shown in the following diagram and click on Next:



Developing a RESTful service – the legacy approach

- Select a top-level package name of choice. This example uses
`br.ufpe.cin.if1007.lec03.legacyrest` as the top-level package
- Then, click on Finish
- This will create a project in the STS workspace with the name `legacyrest`
- Before proceeding further, `pom.xml` needs editing

Developing a RESTful service – the legacy approach

- Change the Spring version to 4.2.6.RELEASE, as follows:

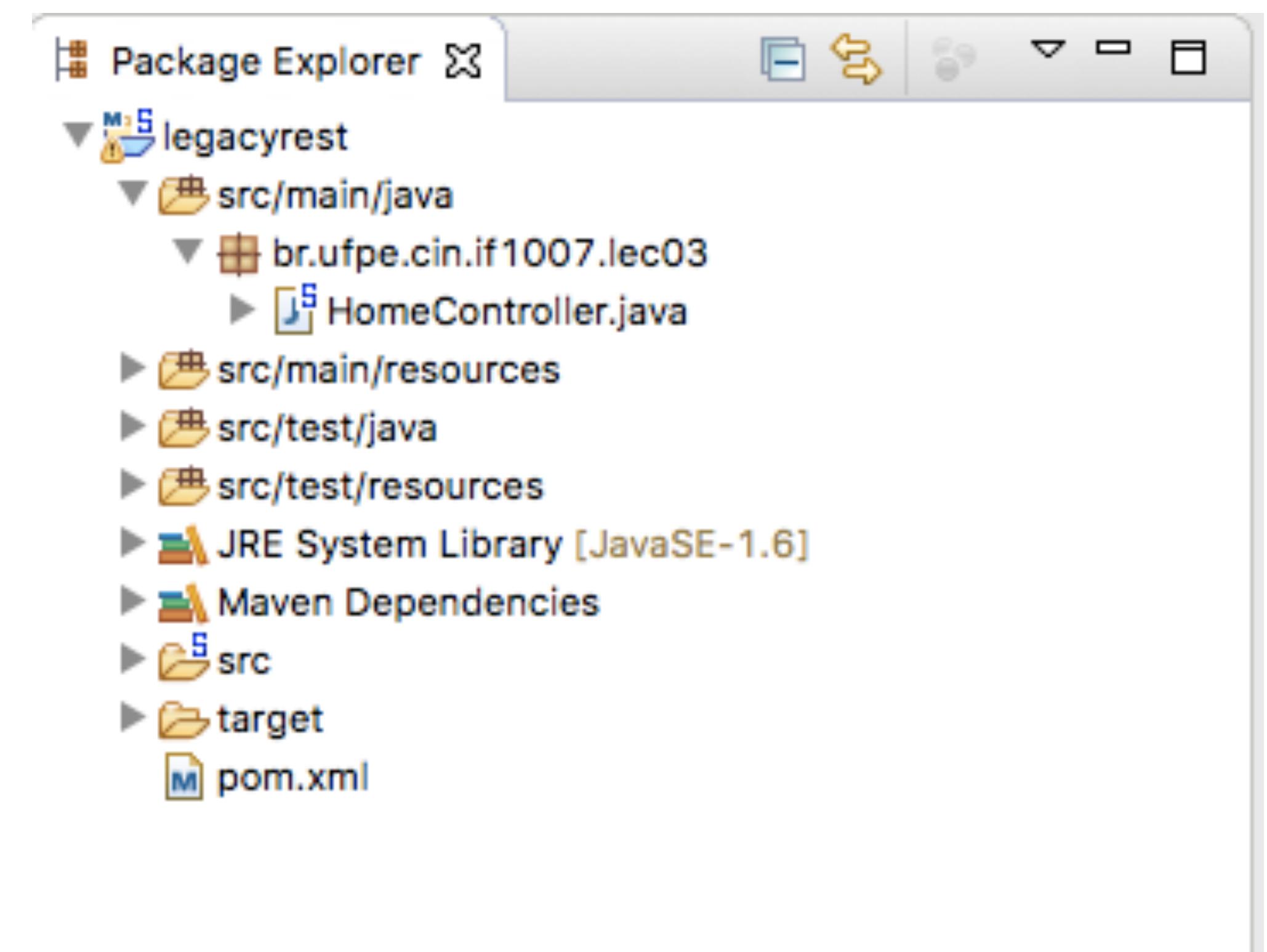
```
<org.springframework-version>4.2.6.RELEASE</org.springframework-version>
```

- Add Jackson dependencies in the pom.xml file for JSON-to-POJO and POJO-to-JSON conversions. Note that the 2.*.* version is used to ensure compatibility with Spring 4.

```
<dependency>
    <groupId>com.fasterxml.jackson.core</groupId>
    <artifactId>jackson-databind</artifactId>
    <version>2.6.4</version>
</dependency>
```

Developing a RESTful service – the legacy approach

- Some Java code needs to be added. In Java Resources, under [legacyrest](#), expand the package and open the default `HomeController.java` file:



Developing a RESTful service – the legacy approach

- To model the greeting representation, you create a resource representation class. Provide a plain old java object with fields, constructors, and accessors for the id and content data



A screenshot of an IDE showing the Greeting.java file. The code defines a class named Greeting with a private String field message. It includes a constructor that takes a String message and sets it to the field. It also includes two accessor methods: getMessage() which returns the message, and setMessage(String message) which sets the message.

```
package br.ufpe.cin;

public class Greeting {
    private String message;

    public Greeting(String message) {
        this.message = message;
    }

    public String getMessage() {
        return message;
    }

    public void setMessage(String message) {
        this.message = message;
    }
}
```

Developing a RESTful service – the legacy approach

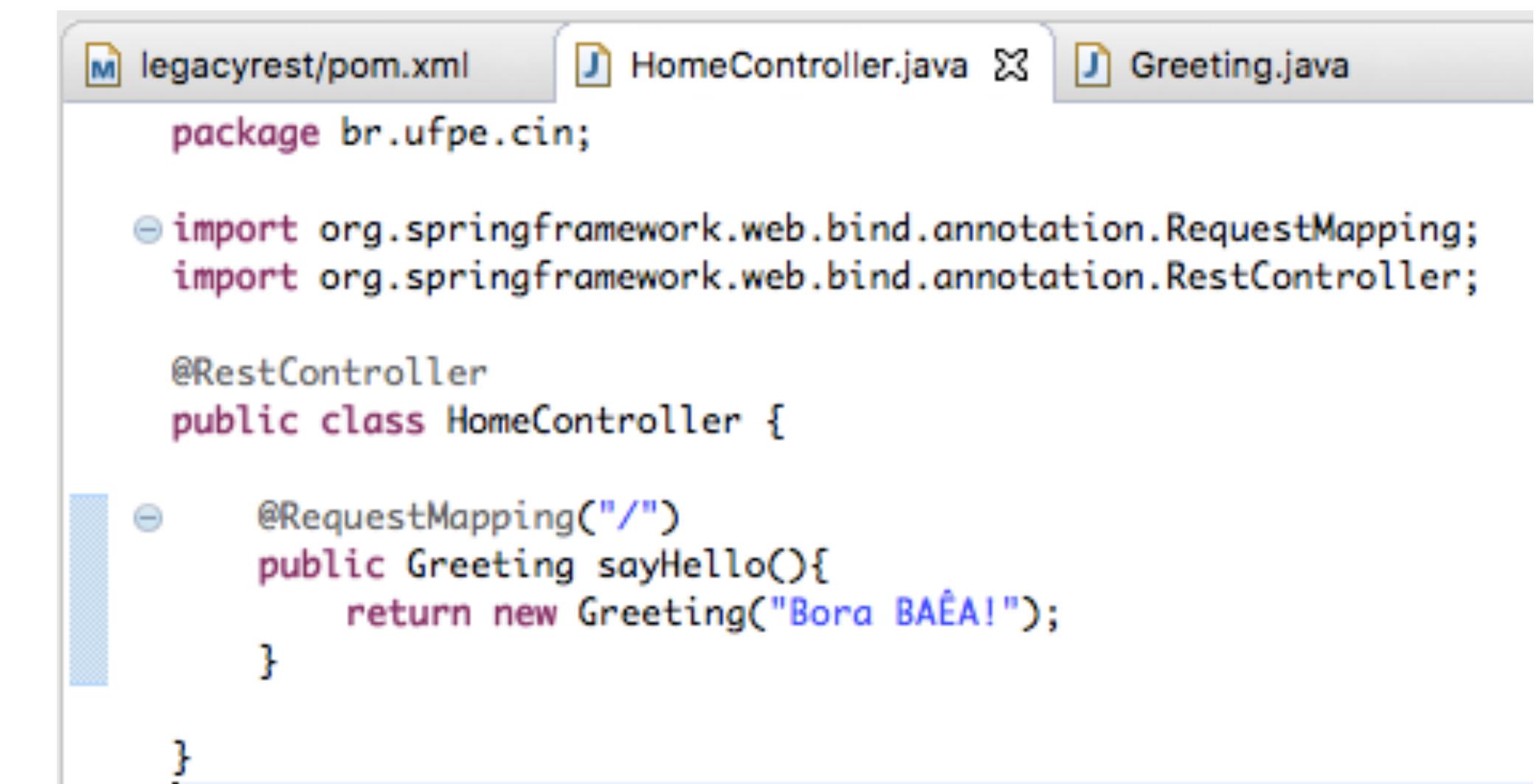
- The default implementation is targeted more towards the MVC project. Rewriting `HomeController.java` to return a JSON value in response to the REST call will do the trick. The resulting `HomeController.java` file will look similar to the following:

```
package br.ufpe.cin.if1007.lec03;  
  
import org.springframework.web.bind.annotation.RequestMapping;  
import org.springframework.web.bind.annotation.RestController;  
  
/**  
 * Handles requests for the application home page.  
 */  
@RestController  
public class HomeController {  
    @RequestMapping("/")  
    public Greet sayHello(){  
        return new Greet("Bora BAÊA!");  
    }  
}  
  
class Greet {  
    private String message;  
    public Greet(String message) {  
        this.message = message;  
    }  
    public String getMessage() {  
        return message;  
    }  
    public void setMessage(String message) {  
        this.message = message;  
    }  
}
```

Developing a RESTful service – the legacy approach

- Examining the code, there are now two classes:
 - `Greeting`: This is a simple Java class with getters and setters to represent a data object. There is only one attribute in the `Greeting` class, which is `message`.
 - `HomeController.java`: This is nothing but a Spring controller REST endpoint to handle HTTP requests.
- Note that the annotation used in `HomeController` is `@RestController`, which automatically injects `@Controller` and `@ResponseBody` and has the same effect as the following code:

```
@Controller  
  
@ResponseBody  
  
public class HomeController { }
```



The screenshot shows an IDE interface with two tabs open: `legacyrest/pom.xml` and `HomeController.java`. The `HomeController.java` tab is active, displaying the following Java code:

```
package br.ufpe.cin;  
  
import org.springframework.web.bind.annotation.RequestMapping;  
import org.springframework.web.bind.annotation.RestController;  
  
@RestController  
public class HomeController {  
  
    @RequestMapping("/")  
    public Greeting sayHello(){  
        return new Greeting("Bora BAÃA!");  
    }  
}
```

Moving from traditional web applications to microservice

- At first glance, the preceding RESTful service is a fully qualified interoperable REST/JSON service.
- However, it is not fully autonomous in nature.
- This is primarily because the service relies on an underlying application server or web container.
- In the preceding example, a war was explicitly created and deployed on a Tomcat server

Using Spring Boot to build RESTful microservices

- The framework uses an opinionated approach **over configurations** for decision making, thereby **reducing** the effort required in **writing a lot of boilerplate code** and configurations
- Spring Boot only **autoconfigures** build files – for example, POM files in the case of Maven
- One of the great outcomes of Spring Boot is that it **almost eliminates** the need to have traditional XML configurations
- Enables microservices' development by **packaging** all the required runtime dependencies in a fat executable JAR file

Developing the Spring Boot Java microservice using STS

The screenshot shows the Eclipse Spring Tool Suite (STS) interface. It consists of three main windows:

- New Spring Starter Project**: This window is used to define project details. The "Service URL" is set to `http://start.spring.io`, the "Name" is `lecture3.bootrest`, and the "Type" is `Maven`. Other fields like "Java Version" (8), "Group" (`br.ufpe.cin.lecture3`), and "Artifact" (`bootrest`) are also filled.
- New Spring Starter Project Dependencies**: This window lists available Spring Boot dependencies. The "Spring Boot Version" is set to `1.5.9`. Under the "Web" category, several options are listed, including `Azure`, `Cloud AWS`, `Cloud Circuit Breaker`, `Cloud Config`, `Cloud Contract`, `Cloud Core`, `Cloud Discovery`, `Cloud Messaging`, `Cloud Routing`, `Cloud Tracing`, `Core`, `I/O`, `NoSQL`, `Ops`, `Pivotal Cloud Foundry`, `SQL`, `Social`, `Template Engines`, and `Web`.
- Package Explorer**: This view shows the project structure for `lecture3.bootrest [boot]`. It includes `src/main/java` (containing `Application.java`), `src/main/resources`, `src/test/java`, `JRE System Library [JavaSE-1.8]`, `Maven Dependencies`, `src` (containing `target` with `mvnw` and `mvnw.cmd`, and `pom.xml`), `legacyrest`, and `Servers`.

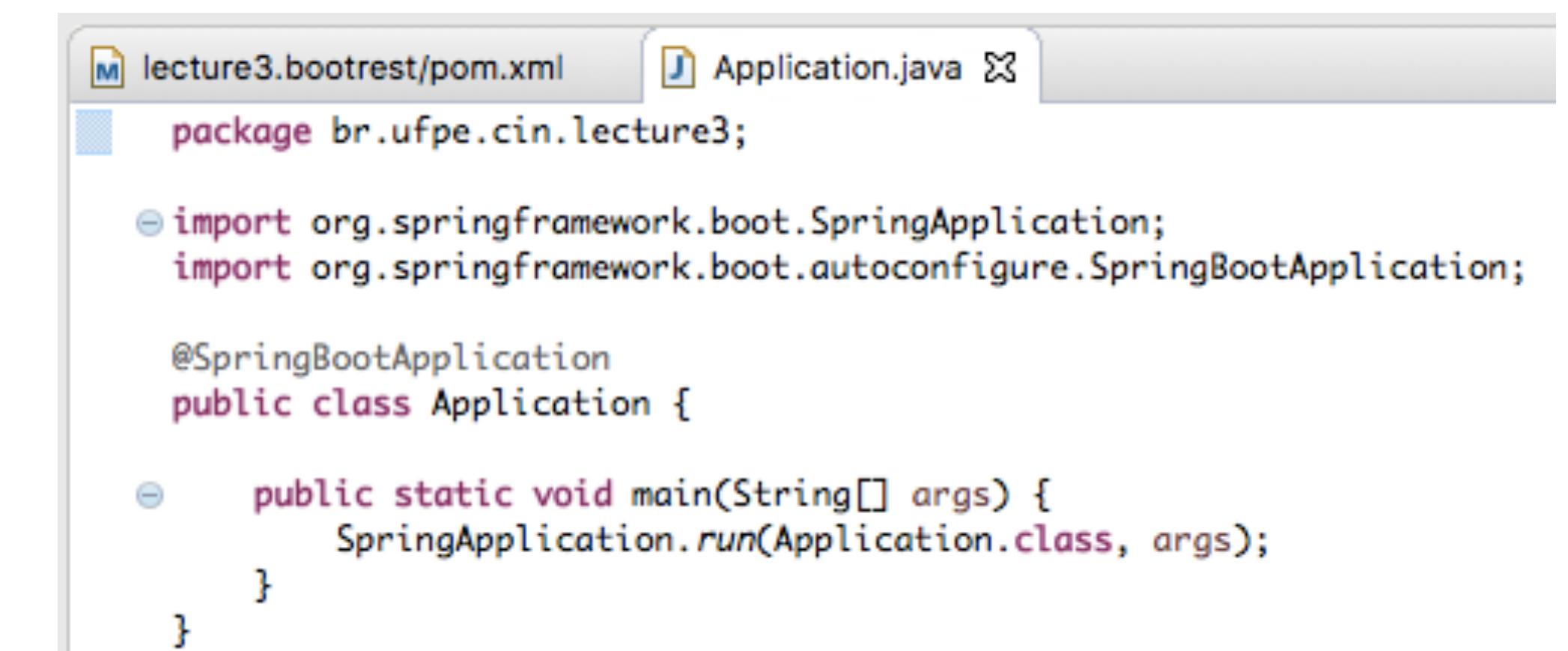
Examining the POM file

- The `spring-boot-starter-parent` pattern is a bill of materials (BOM), a pattern used by Maven's dependency management
- Reviewing the dependency section, one can see that this is a clean and neat POM file with only two dependencies
 - `spring-boot-starter-web` adds all dependencies required for a Spring MVC project
 - also includes dependencies to Tomcat as an embedded HTTP listener

```
lecture3.bootrest/pom.xml
<?xml version="1.0" encoding="UTF-8"?>
<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/xsd/maven-4.0.0.xsd">
  <modelVersion>4.0.0</modelVersion>
  <groupId>br.ufpe.cin.lecture3</groupId>
  <artifactId>bootrest</artifactId>
  <version>0.0.1-SNAPSHOT</version>
  <packaging>jar</packaging>
  <name>lecture3.bootrest</name>
  <description>Demo project for Spring Boot</description>
  <parent>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-parent</artifactId>
    <version>1.5.9.RELEASE</version>
    <relativePath/> <!-- lookup parent from repository -->
  </parent>
  <properties>
    <project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>
    <project.reporting.outputEncoding>UTF-8</project.reporting.outputEncoding>
    <java.version>1.8</java.version>
  </properties>
  <dependencies>
    <dependency>
      <groupId>org.springframework.boot</groupId>
      <artifactId>spring-boot-starter-web</artifactId>
    </dependency>
    <dependency>
      <groupId>org.springframework.boot</groupId>
      <artifactId>spring-boot-starter-test</artifactId>
      <scope>test</scope>
    </dependency>
  </dependencies>
  <build>
    <plugins>
      <plugin>
        <groupId>org.springframework.boot</groupId>
        <artifactId>spring-boot-maven-plugin</artifactId>
      </plugin>
    </plugins>
  </build>
```

Examining Application.java

- There is only a `main` method in `Application`, which will be invoked at startup as per the Java convention
 - calling the `run` method on `SpringApplication`.
- The magic is done by the `@SpringBootApplication` annotation
 - `@Configuration`
 - `@EnableAutoConfiguration`
 - `@ComponentScan`



A screenshot of an IDE showing the `Application.java` file. The code is as follows:

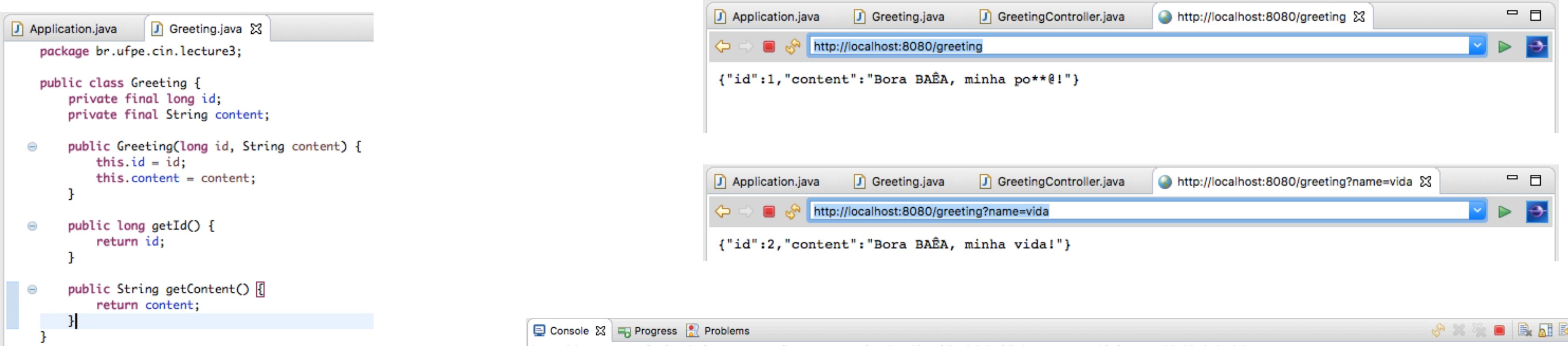
```
package br.ufpe.cin.lecture3;

import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;

@SpringBootApplication
public class Application {

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

Developing the Spring Boot Java microservice using STS



The screenshot shows the Eclipse IDE interface with several windows:

- Code Editor:** Shows the `Greeting.java` file content:

```
package br.ufpe.cin.lecture3;

public class Greeting {
    private final long id;
    private final String content;

    public Greeting(long id, String content) {
        this.id = id;
        this.content = content;
    }

    public long getId() {
        return id;
    }

    public String getContent() {
        return content;
    }
}
```
- Browsers:** Two browser windows are open, both displaying JSON responses from the application.
 - The top browser window shows the response for `http://localhost:8080/greeting`:

```
{"id":1,"content":"Bora BAÃA, minha po**@!"}
```
 - The bottom browser window shows the response for `http://localhost:8080/greeting?name=vida`:

```
{"id":2,"content":"Bora BAÃA, minha vida!"}
```
- Console:** Shows the Spring Boot startup logs:

```
:
:
:
:: Spring Boot ::   (v1.5.9.RELEASE)

2018-01-20 21:10:08.536  INFO 22520 --- [           main] br.ufpe.cin.lecture3.Application      : Starting Application on McLaren-Mark-III.local with PID 22520 (/Users/viniciosgarcia/Work/if1007/lecture
2018-01-20 21:10:08.539  INFO 22520 --- [           main] br.ufpe.cin.lecture3.Application      : No active profile set, falling back to default profiles: default
2018-01-20 21:10:08.573  INFO 22520 --- [           main] o.s.w.c.e.t.TomcatEmbeddedServletContainer : Refreshing org.springframework.boot.context.embedded.AnnotationConfigEmbeddedWebApplicationContext@6366e
2018-01-20 21:10:09.490  INFO 22520 --- [           main] o.a.c.c.C.[Tomcat].[localhost].[/]     : Tomcat initialized with port(s): 8080 (http)
2018-01-20 21:10:09.499  INFO 22520 --- [           main] o.apache.catalina.core.StandardService : Starting service [Tomcat]
2018-01-20 21:10:09.500  INFO 22520 --- [           main] o.apache.catalina.core.StandardEngine  : Starting Servlet Engine: Apache Tomcat/8.5.23
2018-01-20 21:10:09.548  INFO 22520 --- [ost-startStop-1] o.a.c.c.C.[Tomcat].[localhost].[/]     : Initializing Spring embedded WebApplicationContext
2018-01-20 21:10:09.548  INFO 22520 --- [ost-startStop-1] o.s.web.context.ContextLoader       : Root WebApplicationContext: initialization completed in 978 ms
2018-01-20 21:10:09.646  INFO 22520 --- [ost-startStop-1] o.s.b.w.servlet.ServletRegistrationBean : Mapping servlet: 'dispatcherServlet' to [/]
2018-01-20 21:10:09.649  INFO 22520 --- [ost-startStop-1] o.s.b.w.servlet.FilterRegistrationBean  : Mapping filter: 'characterEncodingFilter' to: [/]
2018-01-20 21:10:09.649  INFO 22520 --- [ost-startStop-1] o.s.b.w.servlet.FilterRegistrationBean  : Mapping filter: 'hiddenHttpMethodFilter' to: [/]
2018-01-20 21:10:09.649  INFO 22520 --- [ost-startStop-1] o.s.b.w.servlet.FilterRegistrationBean  : Mapping filter: 'httpPutFormContentFilter' to: [/]
2018-01-20 21:10:09.650  INFO 22520 --- [ost-startStop-1] o.s.b.w.servlet.FilterRegistrationBean  : Mapping filter: 'requestContextFilter' to: [/]
2018-01-20 21:10:09.987  INFO 22520 --- [           main] s.w.s.m.m.a.RequestMappingHandlerAdapter : Looking for @ControllerAdvice: org.springframework.boot.context.embedded.AnnotationConfigEmbeddedWebAppl
2018-01-20 21:10:10.031  INFO 22520 --- [           main] s.w.s.m.m.a.RequestMappingHandlerMapping : Mapped "[/greeting]" onto public br.ufpe.cin.lecture3.Greeting br.ufpe.cin.lecture3.GreetingController
2018-01-20 21:10:10.034  INFO 22520 --- [           main] s.w.s.m.m.a.RequestMappingHandlerMapping : Mapped "[/error]" onto public org.springframework.http.ResponseEntity<java.util.Map<java.lang.String,
2018-01-20 21:10:10.034  INFO 22520 --- [           main] s.w.s.m.m.a.RequestMappingHandlerMapping : Mapped "[[/error],produces=[text/html]]" onto public org.springframework.web.servlet.ModelAndView org.sp
2018-01-20 21:10:10.066  INFO 22520 --- [           main] o.s.w.s.handler.SimpleUrlHandlerMapping : Mapped URL path [/webjars/**] onto handler of type [class org.springframework.web.servlet.resource.ResourceHttpRequestHandler]
2018-01-20 21:10:10.066  INFO 22520 --- [           main] o.s.w.s.handler.SimpleUrlHandlerMapping : Mapped URL path [/**] onto handler of type [class org.springframework.web.servlet.resource.ResourceHttpRequestHandler]
2018-01-20 21:10:10.108  INFO 22520 --- [           main] o.s.w.s.handler.SimpleUrlHandlerMapping : Mapped URL path [/**/favicon.ico] onto handler of type [class org.springframework.web.servlet.resource.ResourceHttpRequestHandler]
2018-01-20 21:10:10.249  INFO 22520 --- [           main] o.s.j.e.a.AnnotationMBeanExporter       : Registering beans for JMX exposure on startup
2018-01-20 21:10:10.295  INFO 22520 --- [           main] s.b.c.e.t.TomcatEmbeddedServletContainer : Tomcat started on port(s): 8080 (http)
2018-01-20 21:10:10.299  INFO 22520 --- [           main] br.ufpe.cin.lecture3.Application      : Started Application in 1.973 seconds (JVM running for 2.495)
```

Testing the Spring Boot microservice

- There are multiple ways to test REST/JSON Spring Boot microservices
 - The easiest way is to use a web browser or a curl command pointing to the URL



A screenshot of a macOS terminal window titled "viniciusgarcia — bash — 80x24". The window shows the command "curl http://localhost:8080/greeting?name=kiev" being run, followed by its JSON response: {"id":4,"content":"Bora BAÉA, minha kiev!"}.

- There are number of tools available to test RESTful services, such as Postman, Advanced REST client, SOAP UI, Paw, and so on

The Spring Boot configuration

- Understanding the Spring Boot autoconfiguration
 - Convention over configuration by scanning the dependent libraries available in the class path
 - For each `spring-boot-starter-*` dependency in the POM file, Spring Boot executes a default `AutoConfiguration` class
 - It is possible to exclude the autoconfiguration of certain libraries

```
@EnableAutoConfiguration(exclude= {  
    DataSourceAutoConfiguration.class})
```

The Spring Boot configuration

- Overriding default configuration values
 - It is also possible to override default configuration values using the `application.properties` file
 - STS provides an easy-to-autocomplete, contextual help on `application.properties`
 - `server.port` is edited to be set as `9090`. Running this application again will start the server on port `9090`.

```
server.port 9090

spring.j
  spring.jackson.date-format : String
  spring.jackson.deserialization : Map<com.fasterxml.jackson.databind.DeserializationFeature>
  spring.jackson.generator : Map<com.fasterxml.jackson.core.JsonGenerator.Feature>
  spring.jackson.joda-date-time-format : String
  spring.jackson.locale : Locale
  spring.jackson.mapper : Map<com.fasterxml.jackson.databind.MapperFeature>
  spring.jackson.parser : Map<com.fasterxml.jackson.core.JsonParser.Feature>
  spring.jackson.property-naming-strategy : String
  spring.jackson.serialization : Map<com.fasterxml.jackson.databind.SerializationFeature>
  spring.jackson.serialization-inclusion : com.fasterxml.jackson.annotation.JsonInclude$Include
  spring.jackson.time-zone : TimeZone
  spring.jersey.application-path : String
  spring.jersey.filter.order : int
  spring.jersey.init : Map<String, String>
  spring.jersey.type : org.springframework.boot.autoconfigure.jersey.JerseyProperties$Type
  spring.json.indi-name : String
```

The Spring Boot configuration

- Changing the location of the configuration file
 - In order to align with the Twelve-Factor app, configuration parameters need to be externalized from the code
 - Spring Boot externalizes all configurations into application.properties. However, it is still part of the application's build. Furthermore, properties can be read from outside the package ~> spring.config.location could be a local file location
- The following command starts the Spring Boot application with an externally provided configuration file:

```
$java -jar target/bootadvanced-0.0.1-SNAPSHOT.jar --  
spring.config.name=bootrest.properties
```

The Spring Boot configuration

- Reading custom properties
 - At startup, `SpringApplication` loads all the properties and adds them to the Spring `Environment` class
 - Autowire the Spring `Environment` class into the `GreetingController` class.
 - Edit the `GreetingController` class to read the custom property from `Environment` and add a log statement to print the custom property to the console

1. Add the following property to the `application.properties` file:

```
bootrest.customproperty=hello
```

2. Then, edit the `GreetingController` class as follows:

```
@Autowired  
Environment env;  
  
Greet greet(){  
    logger.info("bootrest.customproperty  
"+ env.getProperty("bootrest.customprop-  
erty"));  
    return new Greet("Hello World!");  
}
```

3. Rerun the application. The log statement prints the custom variable in the console, as follows:

```
org.rvslab.chapter2.GreetingController  
: bootrest.customproperty hello
```

The Spring Boot configuration

- Using a .yaml file for configuration
 - simply replace `application.properties` with `application.yaml` and add the following property

server

port: 9080

The Spring Boot configuration

- Using multiple configuration profiles
 - It is possible to have different profiles such as development, testing, staging, production, and so on

```
"mvn -Dspring.profiles.active=production install  
mvn -Dspring.profiles.active=development install
```

```
spring:  
  profiles: development  
server:  
  port: 9090  
---  
  
spring:  
  profiles: production  
server:  
  port: 8080
```

- Active profiles can be specified programmatically using the `@ActiveProfiles` annotation ~> test cases

```
@ActiveProfiles("test")
```

Changing the default embedded web server

```
<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-web</artifactId>
    <exclusions>
        <exclusion>
            <groupId>org.springframework.boot</groupId>
            <artifactId>spring-boot-starter-tomcat</artifactId>
        </exclusion>
    </exclusions>
</dependency>

<dependency>
    <groupId>org.springframework.boot</groupId>
    <artifactId>spring-boot-starter-undertow</artifactId>
</dependency>
```

Implementing Spring Boot security

- Securing microservices with basic security

```
<dependency>  
    <groupId>org.springframework.boot</groupId>  
    <artifactId>spring-boot-starter-security</artifactId>  
</dependency>  
  
    @EnableGlobalMethodSecurity  
    @SpringBootApplication  
    public class Application {  
        public static void main(String[] args) {  
            SpringApplication.run(Application.class, args);  
        }  
    }
```

Implementing Spring Boot security

- Securing microservices with basic security
 - The default basic authentication assumes the user as being user. The default password will be printed in the console at startup.
 - Alternately, the username and password can be added in application.properties

security.user.name=guest

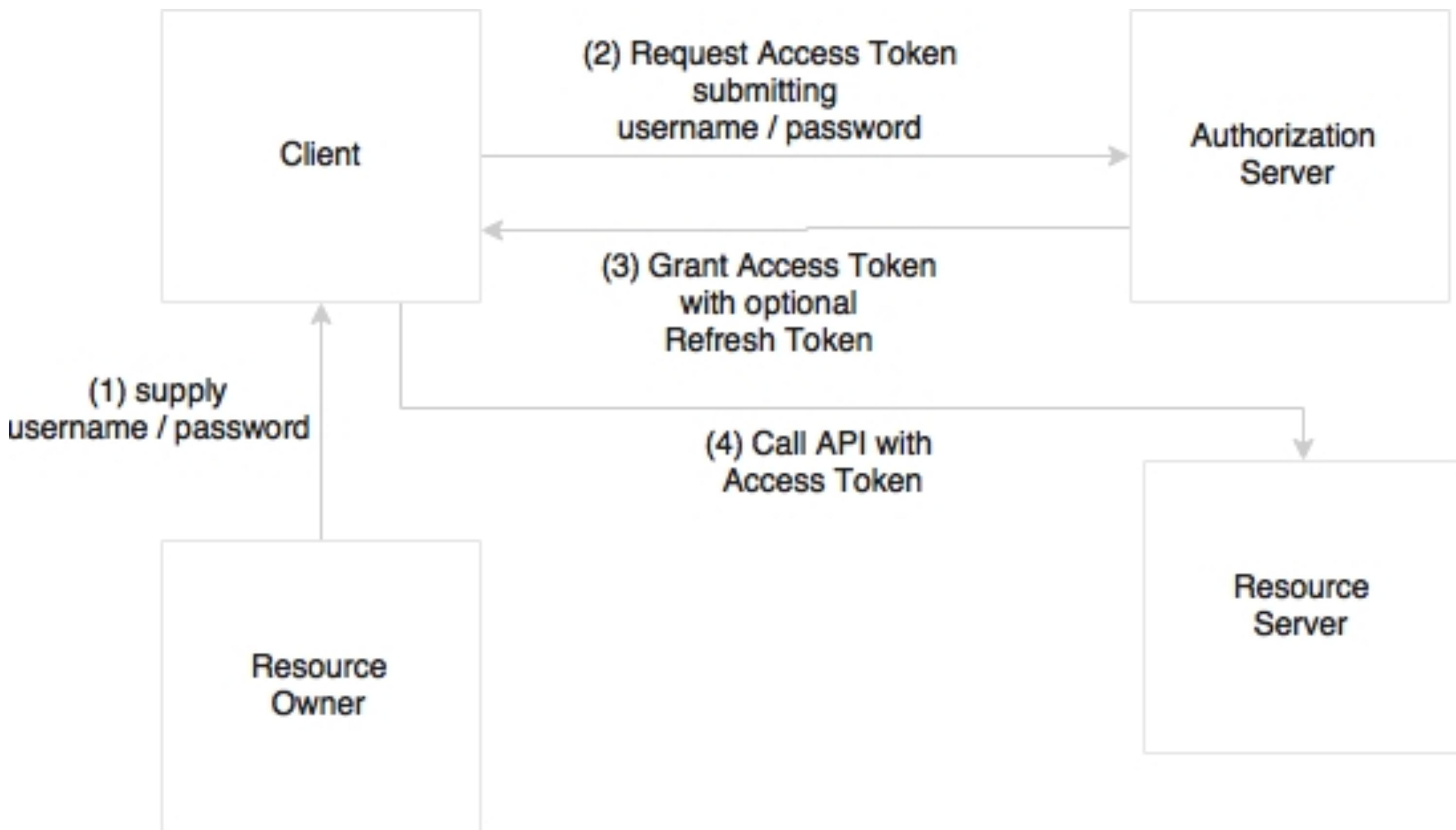
security.user.password=guest123

```
@Test
public void testSecureService() {
    String plainCreds = "guest:guest123";
    HttpHeaders headers = new HttpHeaders();
    headers.add("Authorization", "Basic " +
    new String(Base64.encode(plainCreds.get-
    Bytes())));
    HttpEntity<String> request = new HttpEn-
    tity<String>(headers);
    RestTemplate restTemplate = new RestTem-
    plate();

    ResponseEntity<Greet> response = rest-
    Template.exchange("http://localhost:8080",
    HttpMethod.GET, request, Greet.class);
    Assert.assertEquals("Hello World!",
    response.getBody().getMessage());
}
```

Implementing Spring Boot security

- Securing a microservice with [OAuth2](#)



Securing a microservice with OAuth2

- As a first step, update pom.xml with the OAuth2 dependency, as follows:

```
<dependency>
<groupId>org.springframework.security.
oauth</groupId>

    <artifactId>spring-security-oauth2</
artifactId>

    <version>2.0.9.RELEASE</version>

</dependency>
```

- Next, add two new annotations, `@EnableAuthorizationServer` and `@EnableResourceServer`, to the Application.java file

```
@EnableResourceServer
@EnableAuthorizationServer
@SpringBootApplication

public class Application {
```

- Add the following properties to the application.properties file:

```
security.user.name=guest
security.user.password=guest123
security.oauth2.client.clientId:
trustedclient
security.oauth2.client.clientSecret:
trustedclient123
security.oauth2.client.authorized-
grant-types:
authorization_code,refresh_token,p
assword
security.oauth2.client.scope:
openid
```

- Then, add another test case to test OAuth2

```
@Test

public void testOAuthService() {

    ResourceOwnerPasswordResourceDetails resource = new ResourceOwnerPasswordResourceDetails();

    resource.setUsername("guest");

    resource.setPassword("guest123");

    resource.setAccessTokenUri("http://localhost:8080/oauth/token");

    resource.setClientId("trustedclient");

    resource.setClientSecret("trustedclient123");

    resource.setGrantType("password");

    DefaultOAuth2ClientContext clientContext = new DefaultOAuth2ClientContext();

    OAuth2RestTemplate restTemplate = new OAuth2RestTemplate(resource, clientContext);

    Greet greet = restTemplate.getForObject("http://localhost:8080", Greet.class);

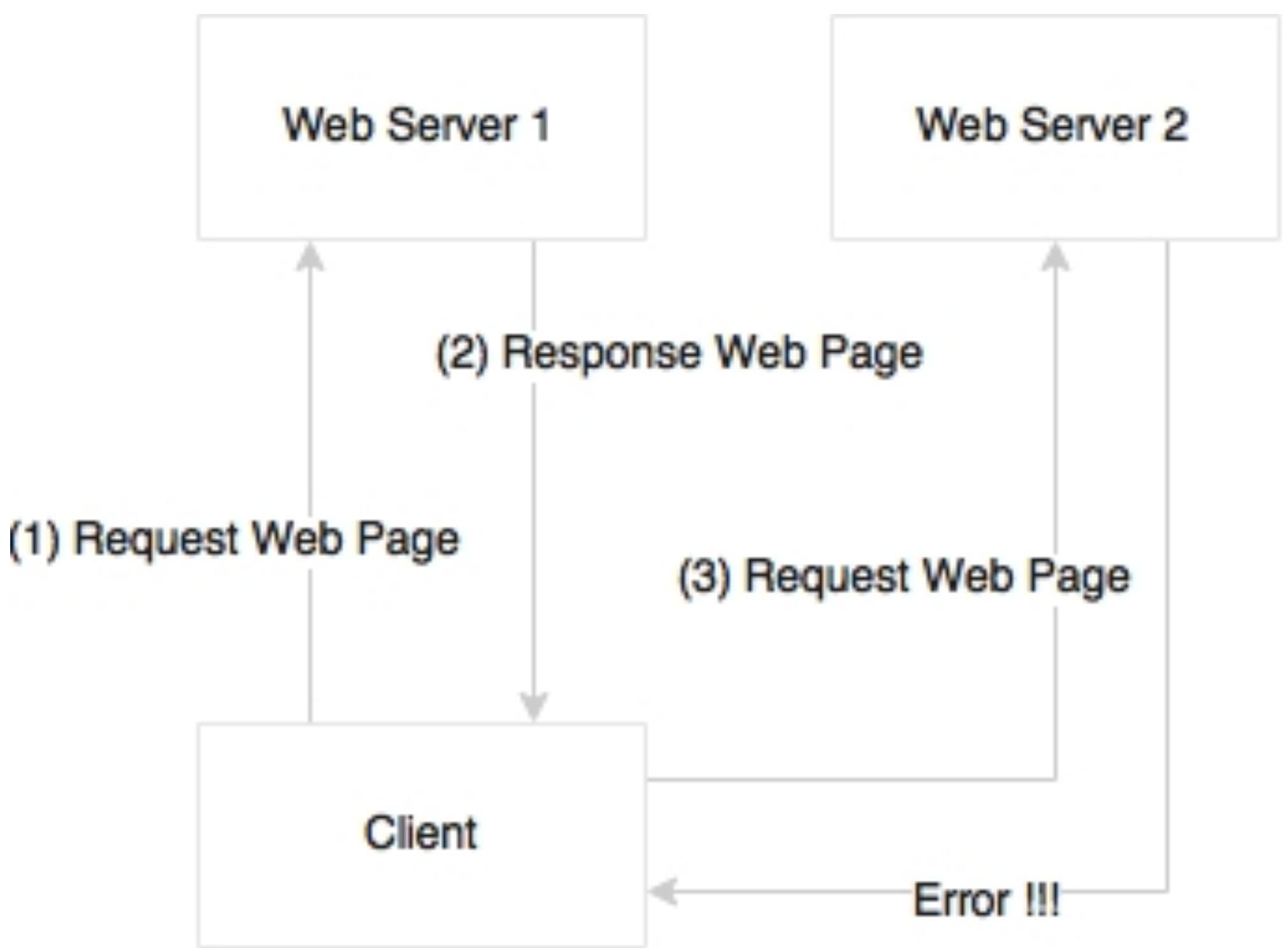
    Assert.assertEquals("Hello World!", greet.getMessage());
}
```

Securing a microservice with OAuth2

- Rerun the application using `mvn install`.
 - The first two test cases will fail, and the new one will succeed.
 - This is because the server only accepts OAuth2-enabled requests.
- These are quick configurations provided by Spring Boot out of the box but are not good enough to be production grade.
 - We may need to customize `ResourceServerConfigurer` and `AuthorizationServerConfigurer` to make them production-ready.

Enabling cross-origin access for microservices

- Browsers are generally restricted when client-side web applications running from one origin request data from another origin
- Enabling cross-origin access is generally termed as CORS (Cross-Origin Resource Sharing)
- With microservices, as each service runs with its own origin, it will easily get into the issue of a client-side web application consuming data from multiple origins



Enabling cross-origin access for microservices

- Spring Boot provides a simple declarative approach to enabling cross-origin requests
 - By default, all the origins and headers are accepted

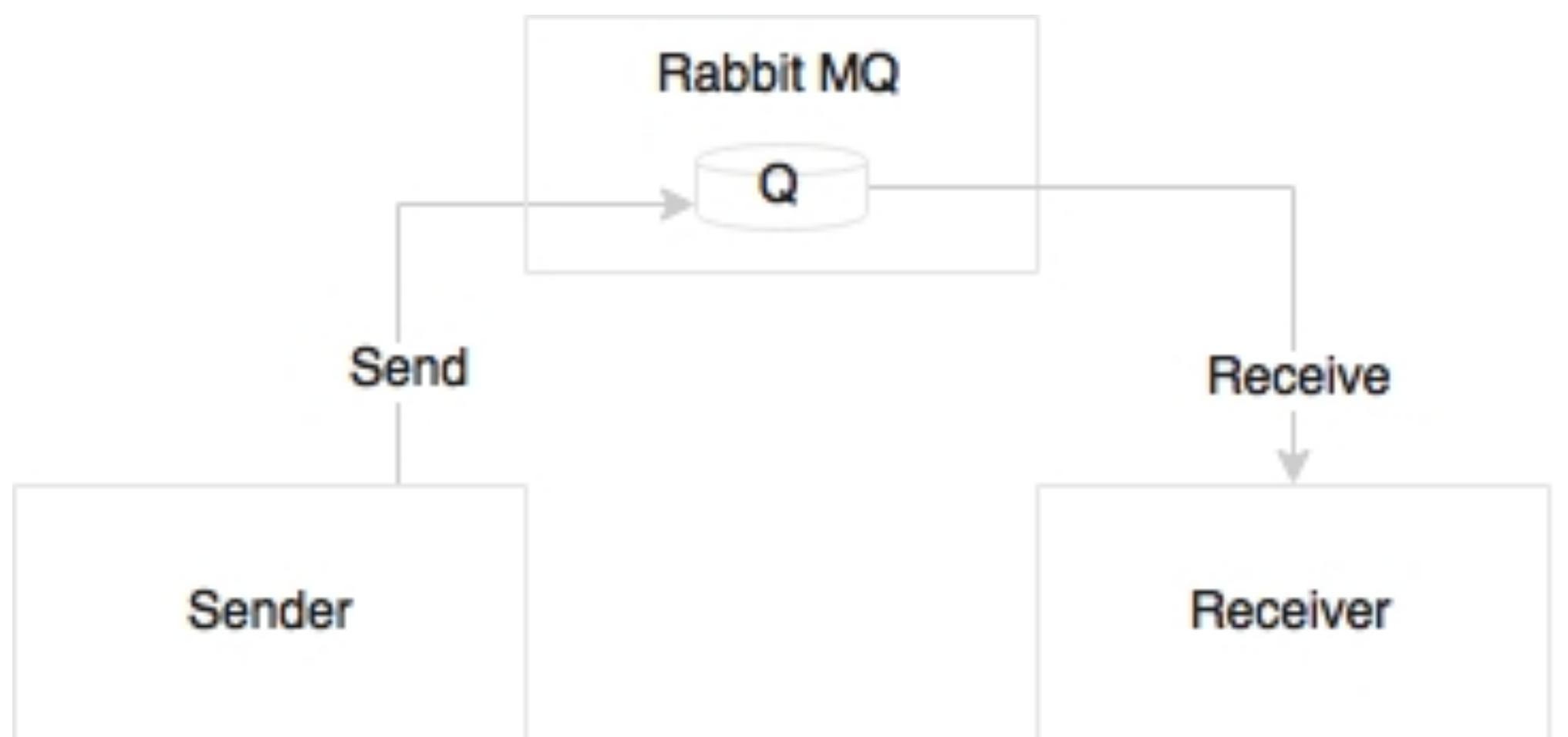
```
@RestController
class GreetingController{
    @CrossOrigin
    @RequestMapping("/")
    Greet greet(){
        return new Greet("Hello World!");
    }
}
```

- The `@CrossOrigin` annotation enables a method or class to accept cross-origin requests

```
@CrossOrigin("http://mytrustedorigin.com")
```
- Global CORS can be enabled using the `WebMvcConfigurer` bean and customizing the `addCorsMappings(CorsRegistry registry)` method

Implementing Spring Boot messaging

- In an **ideal case**, all microservice interactions are **expected** to happen **asynchronously** using publish-subscribe semantics.
 - Spring Boot provides a hassle-free mechanism to configure messaging solutions
- In this example, we will create a Spring Boot application with a sender and receiver, both connected through an external queue



Implementing Spring Boot messaging

The image consists of two side-by-side screenshots of the Spring Initializr web application. The left screenshot shows the 'New Spring Starter Project' configuration screen, where a user is creating a project named 'lecture3.bootmessaging'. The right screenshot shows the 'New Spring Starter Project Dependencies' screen, where the 'AMQP' dependency is selected from a list of available dependencies.

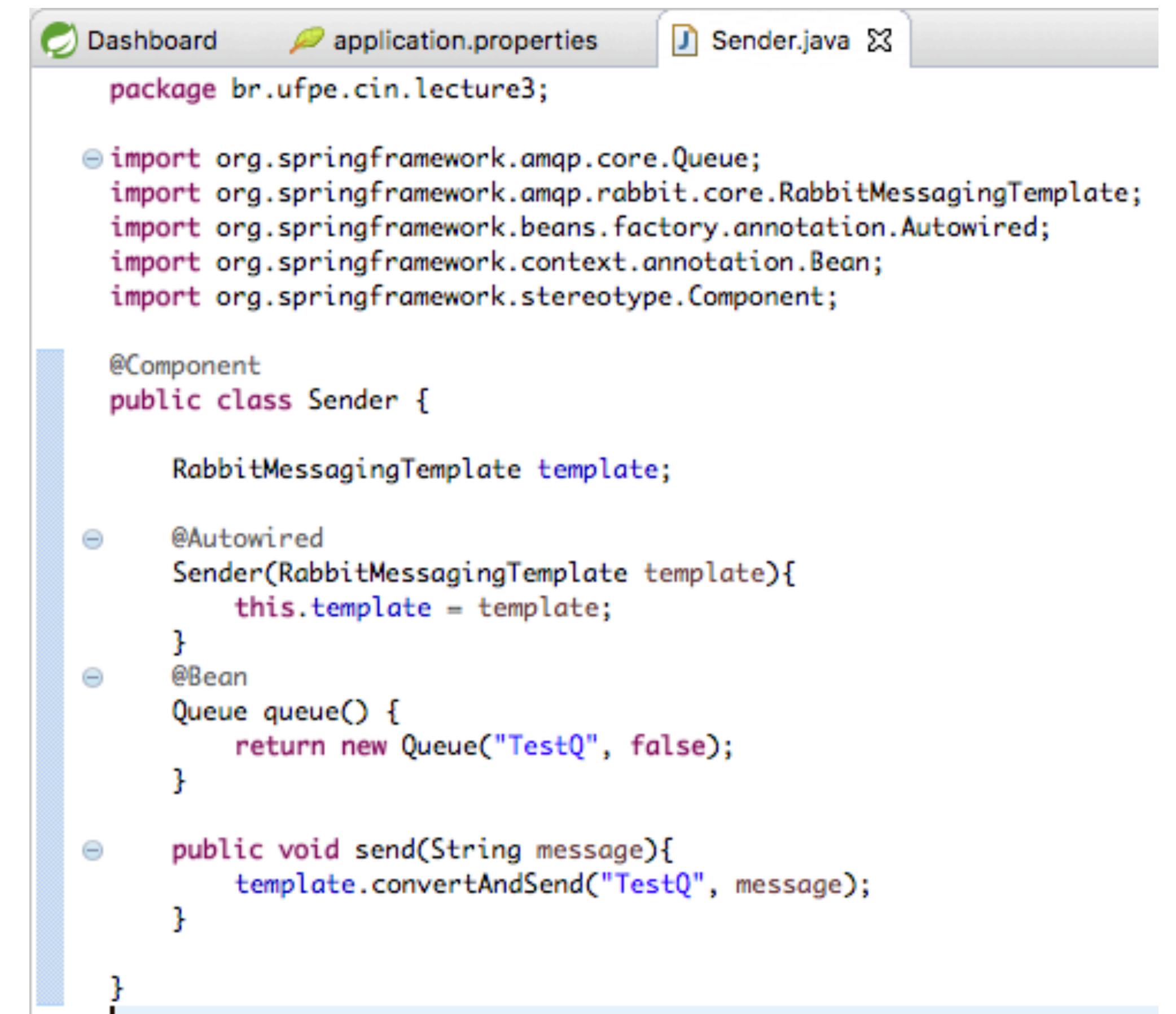
Rabbit MQ will also be needed for this example. Download and install the latest version of Rabbit MQ from <https://www.rabbitmq.com/download.html>

Implementing Spring Boot messaging

- Follow the installation steps documented on the site. Once ready, start the RabbitMQ server via the following command:
 - `$./rabbitmq-server`
- Make the configuration changes to the application.properties file to reflect the RabbitMQ configuration. The following configuration uses the default port, username, and password of RabbitMQ:
 - `spring.rabbitmq.host=localhost`
 - `spring.rabbitmq.port=5672`
 - `spring.rabbitmq.username=guest`
 - `spring.rabbitmq.password=guest`

Implementing Spring Boot messaging

- Add a message sender component and a queue named `TestQ` of the `org.springframework.amqp.core.Queue` type to the `Application.java` file under `src/main/java`.
`RabbitMessagingTemplate` is a convenient way to send messages, which will abstract all the messaging semantics



The screenshot shows a code editor window with the tab bar showing "Dashboard", "application.properties", and "Sender.java". The "Sender.java" tab is active. The code in the editor is:

```
package br.ufpe.cin.lecture3;

import org.springframework.amqp.core.Queue;
import org.springframework.amqp.rabbit.core.RabbitMessagingTemplate;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.context.annotation.Bean;
import org.springframework.stereotype.Component;

@Component
public class Sender {

    RabbitMessagingTemplate template;

    @Autowired
    Sender(RabbitMessagingTemplate template){
        this.template = template;
    }

    @Bean
    Queue queue() {
        return new Queue("TestQ", false);
    }

    public void send(String message){
        template.convertAndSend("TestQ", message);
    }
}
```

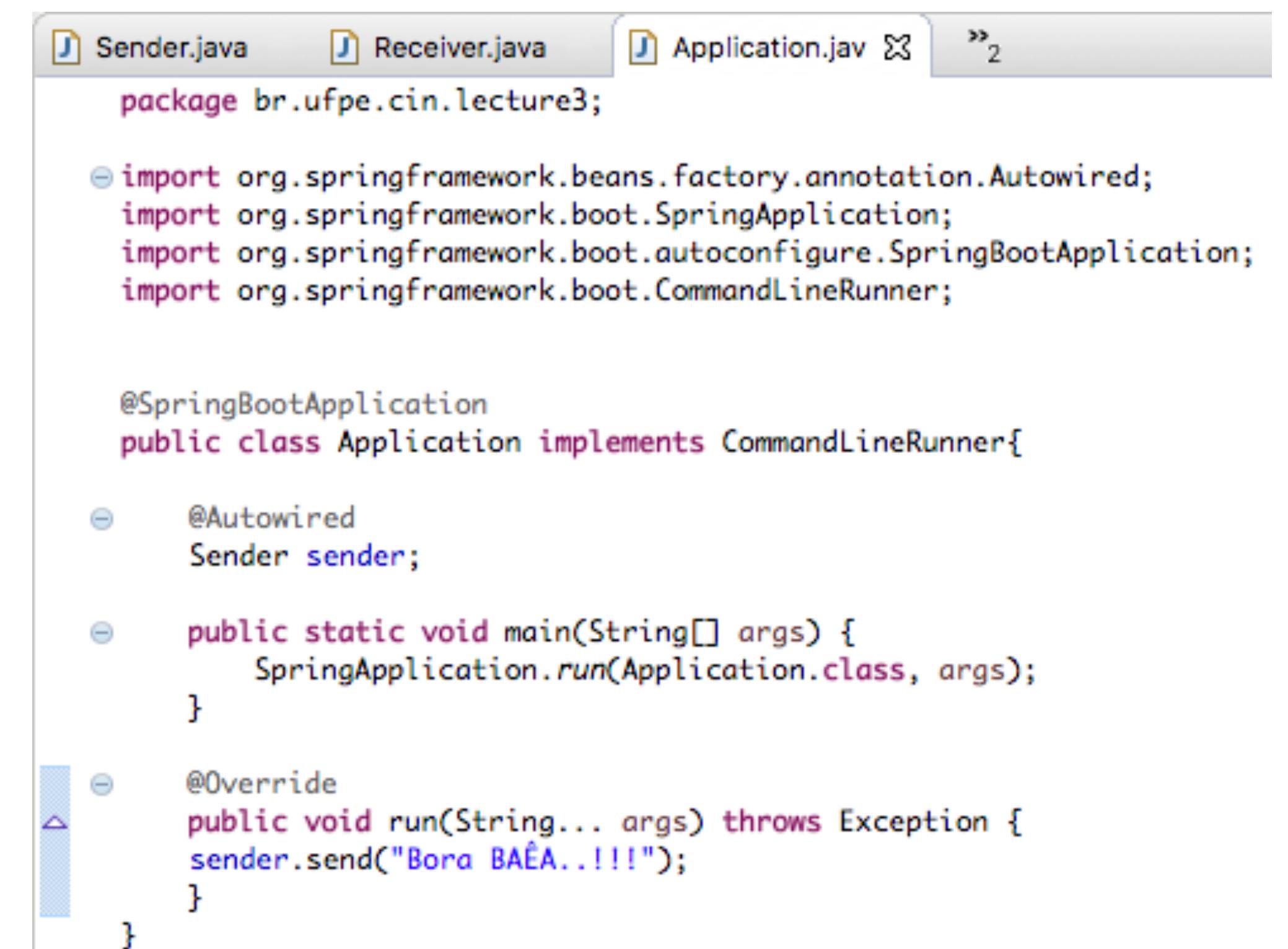
Implementing Spring Boot messaging

- To receive the message, all that needs to be used is a **@RabbitListener** annotation. Spring Boot autoconfigures all the required boilerplate configurations

```
package br.ufpe.cin.lecture3;  
  
import org.springframework.amqp.rabbit.annotation.RabbitListener;  
import org.springframework.stereotype.Component;  
  
@Component  
public class Receiver {  
  
    @RabbitListener(queues = "TestQ")  
    public void processMessage(String content) {  
        System.out.println(content);  
    }  
}
```

Implementing Spring Boot messaging

- The last piece of this exercise is to wire the sender to our main application and implement the `run` method of `CommandLineRunner` to initiate the message sending. When the application is initialized, it invokes the `run` method of `CommandLineRunner`
- Run the application as a Spring Boot application and verify the output. The following message will be printed in the console



A screenshot of an IDE showing the `Application.java` file. The code implements the `CommandLineRunner` interface and uses `@Autowired` to inject the `Sender` dependency. It overrides the `run` method to send a message to the receiver.

```
package br.ufpe.cin.lecture3;

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

@SpringBootApplication
public class Application implements CommandLineRunner{

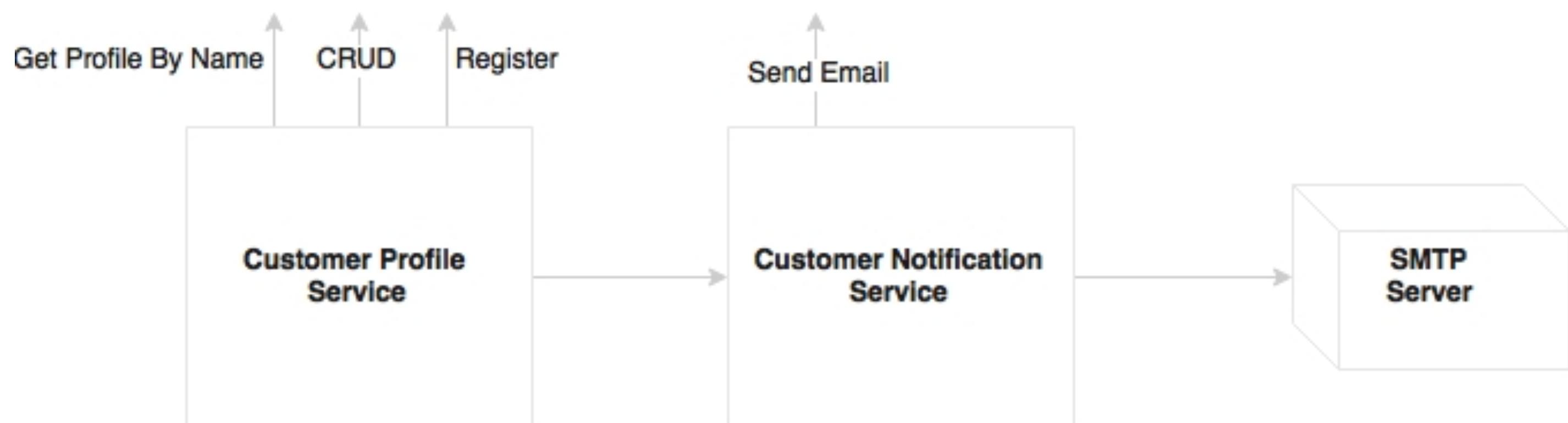
    @Autowired
    Sender sender;

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

    @Override
    public void run(String... args) throws Exception {
        sender.send("Bora BAÃA..!!!");
    }
}
```

Developing a comprehensive microservice example

- The Customer Profile microservice exposes methods to **create, read, update, and delete (CRUD)** a customer and a registration service to register a customer.
- The registration process applies certain business logic, saves the customer profile, and sends a message to the Customer Notification microservice.
- The Customer Notification microservice accepts the message sent by the registration service and sends an e-mail message to the customer using an SMTP server.
- Asynchronous messaging is used to integrate Customer Profile with the Customer Notification service

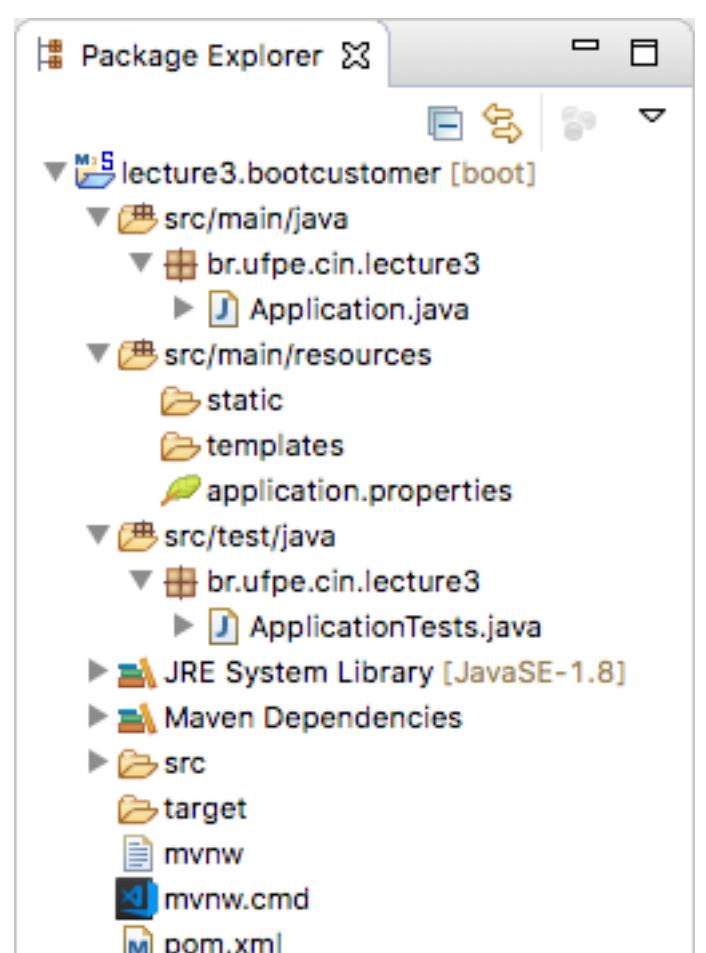
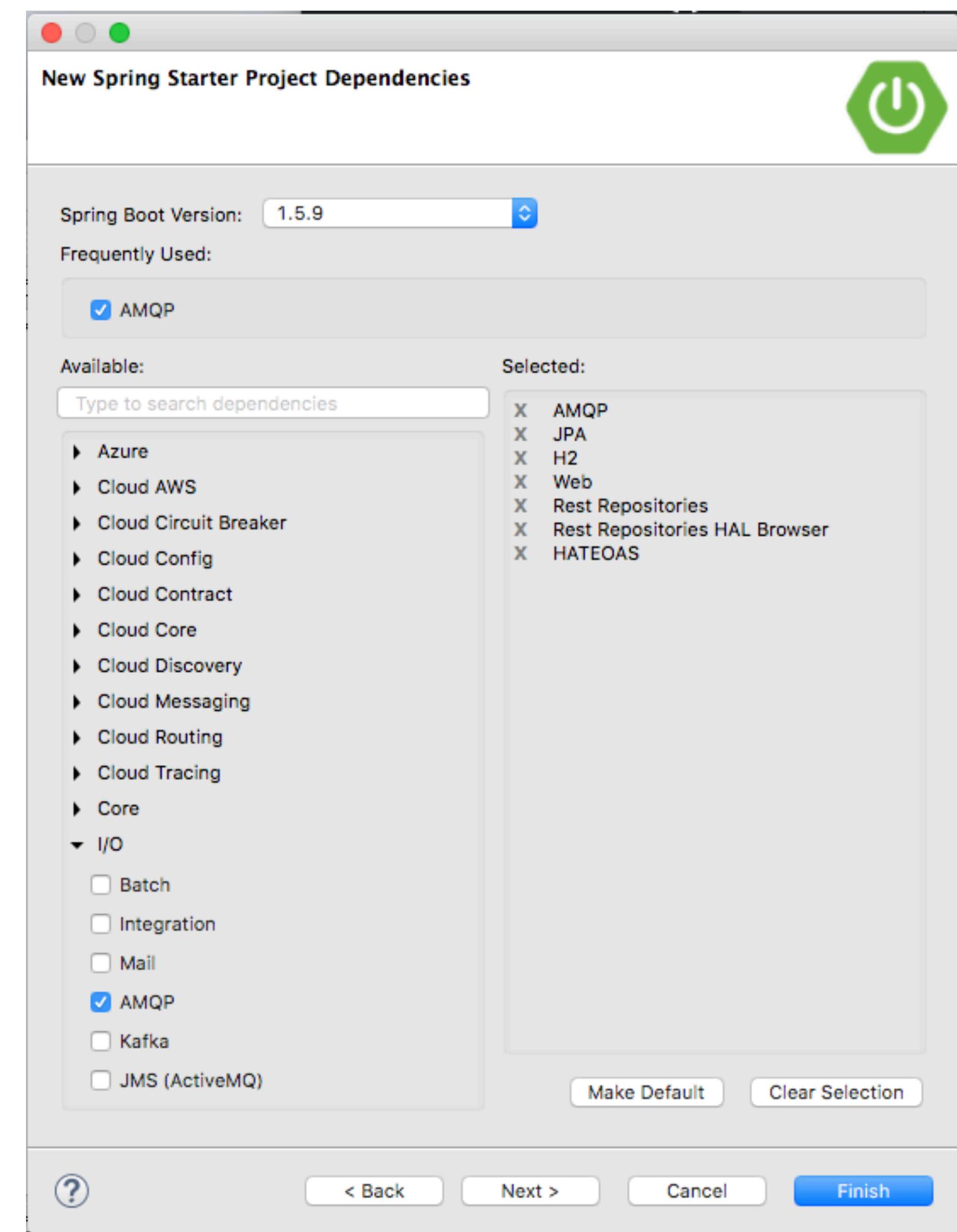
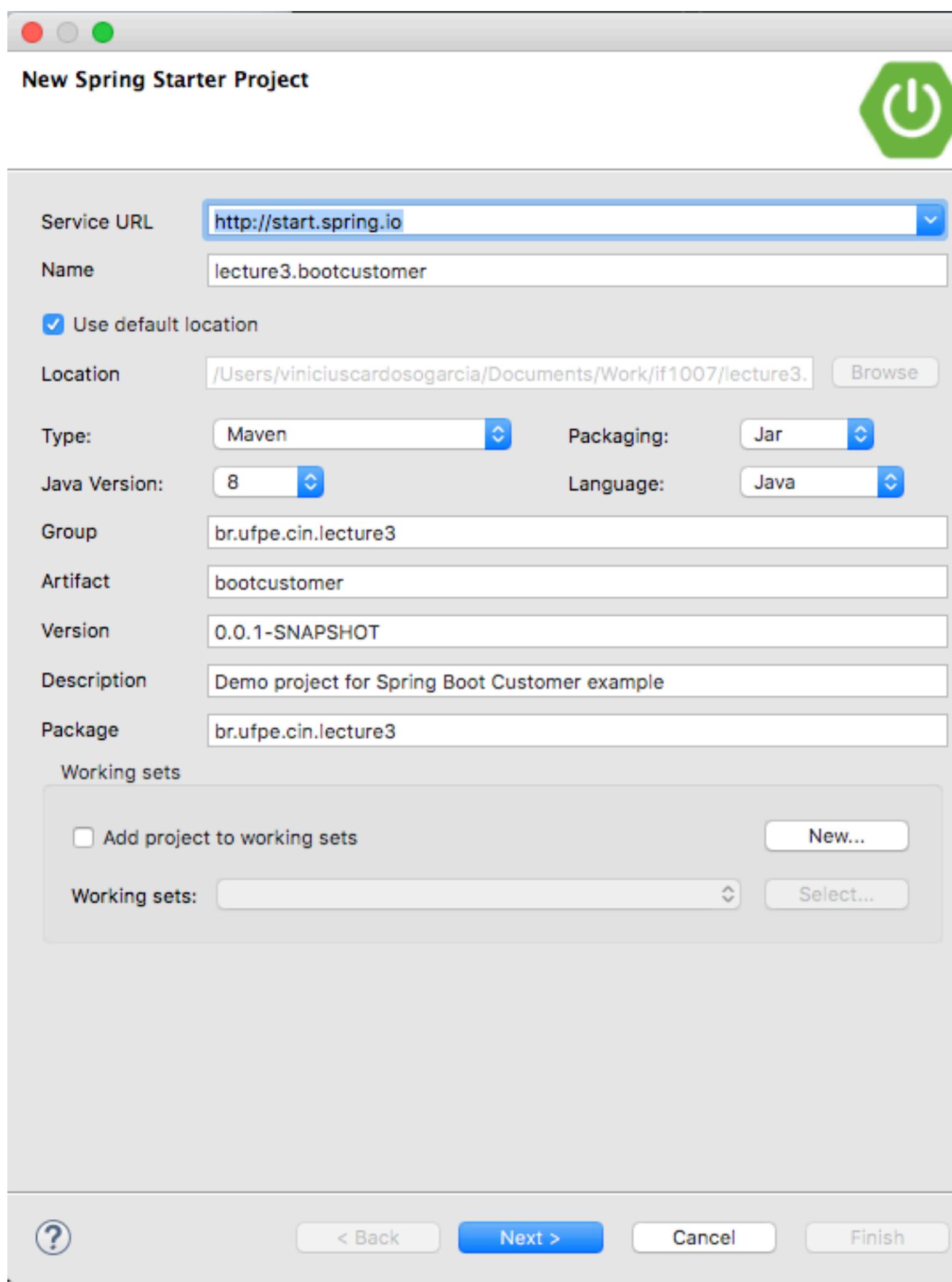


Developing a comprehensive microservice example



- **CustomerController** in the diagram is the REST endpoint, which invokes a component class, **CustomerComponent**. The component class/bean handles all the business logic. **CustomerRepository** is a Spring data JPA repository defined to handle the persistence of the **Customer** entity

Developing a comprehensive microservice example



Developing a comprehensive microservice example

- Start building the application by adding an Entity class named **Customer**. For simplicity, there are only three fields added to the **Customer** Entity class: the autogenerated **id** field, **name**, and **email**



```
Dashboard Customer.java X
package br.ufpe.cin.lecture3;

import javax.persistence.Entity;
import javax.persistence.GeneratedValue;
import javax.persistence.GenerationType;
import javax.persistence.Id;

@Entity
public class Customer {

    @Id
    @GeneratedValue(strategy = GenerationType.AUTO)
    private Long id;
    private String name;
    private String email;

    public Customer () {}

    public Customer(String name, String email) {
        super();
        this.name = name;
        this.email = email;
    }

    public Long getId() {}

    public void setId(Long id) {}

    public String getName() {}

    public void setName(String name) {}

    public String getEmail() {}

    public void setEmail(String email) {}

    @Override
    public String toString() {
        return "Customer [id=" + id + ", name=" + name + ", email=" + email + "]";
    }
}
```



Developing a comprehensive microservice example

- Add a repository class to handle the persistence handling of Customer.
CustomerRepository extends the standard JPA repository. This means that all CRUD methods and default finder methods are automatically implemented by the Spring Data JPA repository



The screenshot shows a code editor with tabs for 'Dashboard', 'Customer.java', and 'CustomerRepository.java'. The 'CustomerRepository.java' tab is active, displaying the following Java code:

```
package br.ufpe.cin.lecture3;

import java.util.Optional;

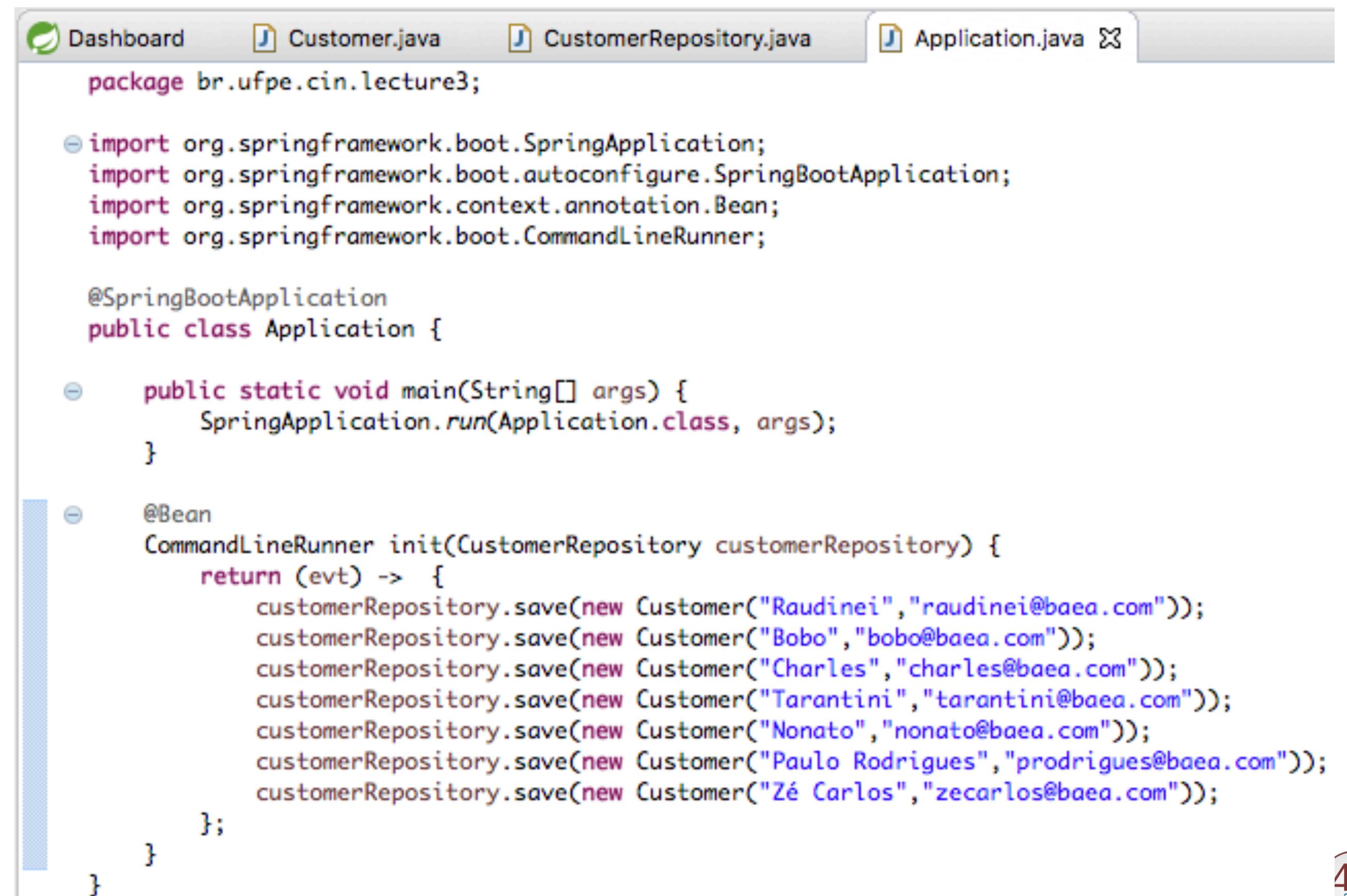
import org.springframework.data.jpa.repository.JpaRepository;
import org.springframework.data.repository.query.Param;
import org.springframework.data.rest.core.annotation.RepositoryRestResource;

@RepositoryRestResource
public interface CustomerRepository extends JpaRepository<Customer, Long> {
    Optional<Customer> findByName(@Param("name") String name);
}
```

See more information about HATEOAS at <https://spring.io/understanding/HATEOAS>

Developing a comprehensive microservice example

- Update the [Application.java](#) file by adding [CommandLineRunner](#) to initialize the repository with some customer records



```
Dashboard Customer.java CustomerRepository.java Application.java

package br.ufpe.cin.lecture3;

import org.springframework.boot.SpringApplication;
import org.springframework.boot.autoconfigure.SpringBootApplication;
import org.springframework.context.annotation.Bean;
import org.springframework.boot.CommandLineRunner;

@SpringBootApplication
public class Application {

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

    @Bean
    CommandLineRunner init(CustomerRepository customerRepository) {
        return (evt) -> {
            customerRepository.save(new Customer("Raudinei", "raudinei@baea.com"));
            customerRepository.save(new Customer("Bobo", "bobo@baea.com"));
            customerRepository.save(new Customer("Charles", "charles@baea.com"));
            customerRepository.save(new Customer("Tarantini", "tarantini@baea.com"));
            customerRepository.save(new Customer("Nonato", "nonato@baea.com"));
            customerRepository.save(new Customer("Paulo Rodrigues", "prodriques@baea.com"));
            customerRepository.save(new Customer("Zé Carlos", "zecarlos@baea.com"));
        };
    }
}
```

Developing a comprehensive microservice example

- Run the application as Spring Boot App. Open the HAL browser and point the browser to <http://localhost:8080>
- In the **Explorer** section, point to `http://localhost:8080/customers` and click on **Go**. This will list all the customers in the **Response Body** section of the HAL browser
- In the **Explorer** section, enter [http://localhost:8080/customers?
size=2&page=1&sort=name](http://localhost:8080/customers?size=2&page=1&sort=name) and click on **Go**. This will automatically execute paging and sorting on the repository and return the result
 - As the page size is set to **2** and the first page is requested, it will come back with two records in a sorted order

Developing a comprehensive microservice example

- Review the Links section.
As shown in the following screenshot, it will facilitate navigating **first**, **next**, **prev**, and **last**. These are done using the HATEOAS links automatically generated by the repository browser

Links

rel	title	name / index	docs	GET	NON-GET
first					
prev					
self					
next					
last					
profile					
search					

Developing a comprehensive microservice example

- Add a controller class, **CustomerController**, to handle service endpoints. There is only one endpoint in this class, **/register**, which is used to register a customer. If successful, it returns the **Customer** object as the response

```
package br.ufpe.cin.lecture3;  
  
import org.springframework.beans.factory.annotation.Autowired;  
import org.springframework.web.bind.annotation.RequestBody;  
import org.springframework.web.bind.annotation.RequestMapping;  
import org.springframework.web.bind.annotation.RequestMethod;  
import org.springframework.web.bind.annotation.RestController;  
  
@RestController  
public class CustomerController {  
  
    CustomerRegistrar customerRegistrar;  
  
    @Autowired  
    CustomerController(CustomerRegistrar customerRegistrar){  
        this.customerRegistrar = customerRegistrar;  
    }  
  
    @RequestMapping( path="/register", method = RequestMethod.POST)  
    Customer register(@RequestBody Customer customer){  
        return customerRegistrar.register(customer);  
    }  
}
```

Developing a comprehensive microservice example

- A `CustomerRegistrar` component is added to handle the business logic.
- In this component class, while registering a customer, we will just check whether the customer name **already exists** in the database or not.
- If it does not exist, then we will insert a new record, and otherwise, we will send an error message back

```
package br.ufpe.cin.lecture3;  
  
import java.util.Optional;  
  
import org.springframework.beans.factory.annotation.Autowired;  
import org.springframework.stereotype.Component;  
  
@Component  
public class CustomerRegistrar {  
  
    CustomerRepository customerRespository;  
  
    @Autowired  
    CustomerRegistrar(CustomerRepository customerRespository){  
        this.customerRespository = customerRespository;;  
    }  
  
    Customer register(Customer customer){  
        Optional<Customer> existingCustomer = customerRespository.findByName(customer.getName());  
        if (existingCustomer.isPresent()){  
            throw new RuntimeException("is already exists");  
        } else {  
            customerRespository.save(customer);  
        }  
        return customer;  
    }  
}
```

Developing a comprehensive microservice example

- Restart the Boot application and test using the HAL browser via the URL <http://localhost:8080>
- Point the **Explorer** field to <http://localhost:8080/customers>
 - Review the results in the **Links** section
 - Click on the **NON-GET** option against self. This will open a form to create a **new customer**

The screenshot shows the HAL browser interface. At the top, there's a table titled 'Links' with columns for rel, title, name / index, docs, GET, and NON-GET. It lists three links: 'self', 'profile', and 'search'. The 'self' link has a green arrow icon under 'GET' and an orange info icon under 'NON-GET'. A tooltip for the 'NON-GET' icon says 'Perform non-GET request'. Below this is a modal dialog titled 'Create/Update Customer' with fields for 'Name' (set to 'World') and 'Email' (set to 'world@hello.com'). Under 'Action:', it shows 'POST' and the URL 'http://localhost:8080/register'. At the bottom right of the dialog is a blue 'Make Request' button. In the bottom right corner of the slide, there are logos for 'Centro de Informática UFF' (with a '40 años' badge) and social media icons for Facebook, LinkedIn, Twitter, and Google+.

Developing a comprehensive microservice example

- Now, integrating the Customer Notification service to notify the customer
- Update `CustomerRegistrar` to call the second service. This is done through messaging. In this case, we injected a `Sender` component to send a notification to the customer by passing the customer's e-mail address to the sender

```
package br.ufpe.cin.lecture3;  
import java.util.Optional;...  
  
@Component  
public class CustomerRegistrar {  
  
    CustomerRepository customerRespository;  
    Sender sender;  
  
    @Autowired  
    CustomerRegistrar(CustomerRepository customerRespository, Sender sender){  
        this.customerRespository = customerRespository;  
        this.sender = sender;  
    }  
  
    Customer register(Customer customer){  
        Optional<Customer> existingCustomer = customerRespository.findByName(customer.getName());  
        if (existingCustomer.isPresent()){  
            throw new RuntimeException("is already exists");  
        } else {  
            customerRespository.save(customer);  
            sender.send(customer.getEmail());  
        }  
        return customer;  
    }  
}
```

Developing a comprehensive microservice example

- The sender component will be based on RabbitMQ and AMQP. In this example, [RabbitMessagingTemplate](#) is used as explored in the last messaging example
- The [@Lazy](#) annotation is a useful one and it helps to increase the boot startup time.
- These beans will be initialized only when the need arises

```
package br.ufpe.cin.lecture3;

import org.springframework.amqp.core.Queue;
import org.springframework.amqp.rabbit.core.RabbitMessagingTemplate;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.context.annotation.Bean;
import org.springframework.stereotype.Component;
import org.springframework.context.annotation.Lazy;

@Component
@Lazy
public class Sender {
    RabbitMessagingTemplate template;

    @Autowired
    Sender(RabbitMessagingTemplate template){
        this.template = template;
    }

    @Bean
    Queue queue() {
        return new Queue("CustomerQ", false);
    }

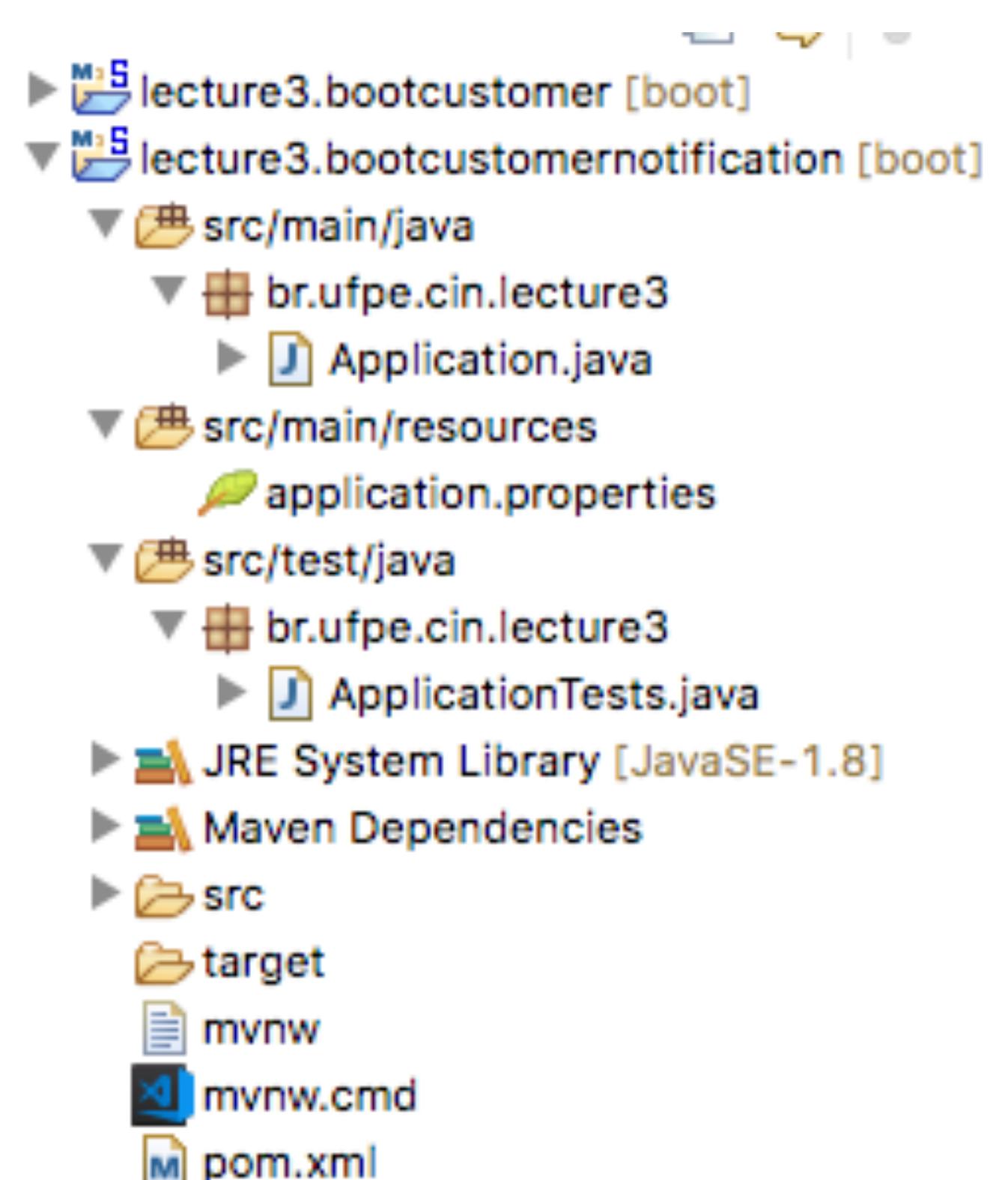
    public void send(String message){
        template.convertAndSend("CustomerQ", message);
    }
}
```

Developing a comprehensive microservice example

- We will also update the application.property file to include Rabbit MQ-related properties
 - `spring.rabbitmq.host=localhost`
 - `spring.rabbitmq.port=5672`
 - `spring.rabbitmq.username=guest`
 - `spring.rabbitmq.password=guest`

Developing a comprehensive microservice example

- To consume the message and send e-mails, we will create a notification service.
- For this, let's create another Spring Boot service,
lecture3.bootcustomernotification.
 - Make sure that the **AMQP** and **Mail** starter libraries are selected when creating the Spring Boot service. Both **AMQP** and **Mail** are under **I/O**.



Developing a comprehensive microservice example

- Add a **Receiver** class.
The **Receiver** class waits for a message on customer.
- This will receive a message sent by the Customer Profile service. On the arrival of a message, it sends an e-mail

```
package br.ufpe.cin.lecture3;

import org.springframework.amqp.core.Queue;
import org.springframework.amqp.rabbit.annotation.RabbitListener;
import org.springframework.beans.factory.annotation.Autowired;
import org.springframework.context.annotation.Bean;
import org.springframework.stereotype.Component;

@Component
public class Receiver {

    @Autowired
    Mailer mailer;

    @Bean
    Queue queue(){
        return new Queue("CustomerQ", false);
    }

    @RabbitListener(queues = "CustomerQ")
    public void processMessage(String email) {
        System.out.println(email);
        mailer.sendMail(email);
    }
}
```

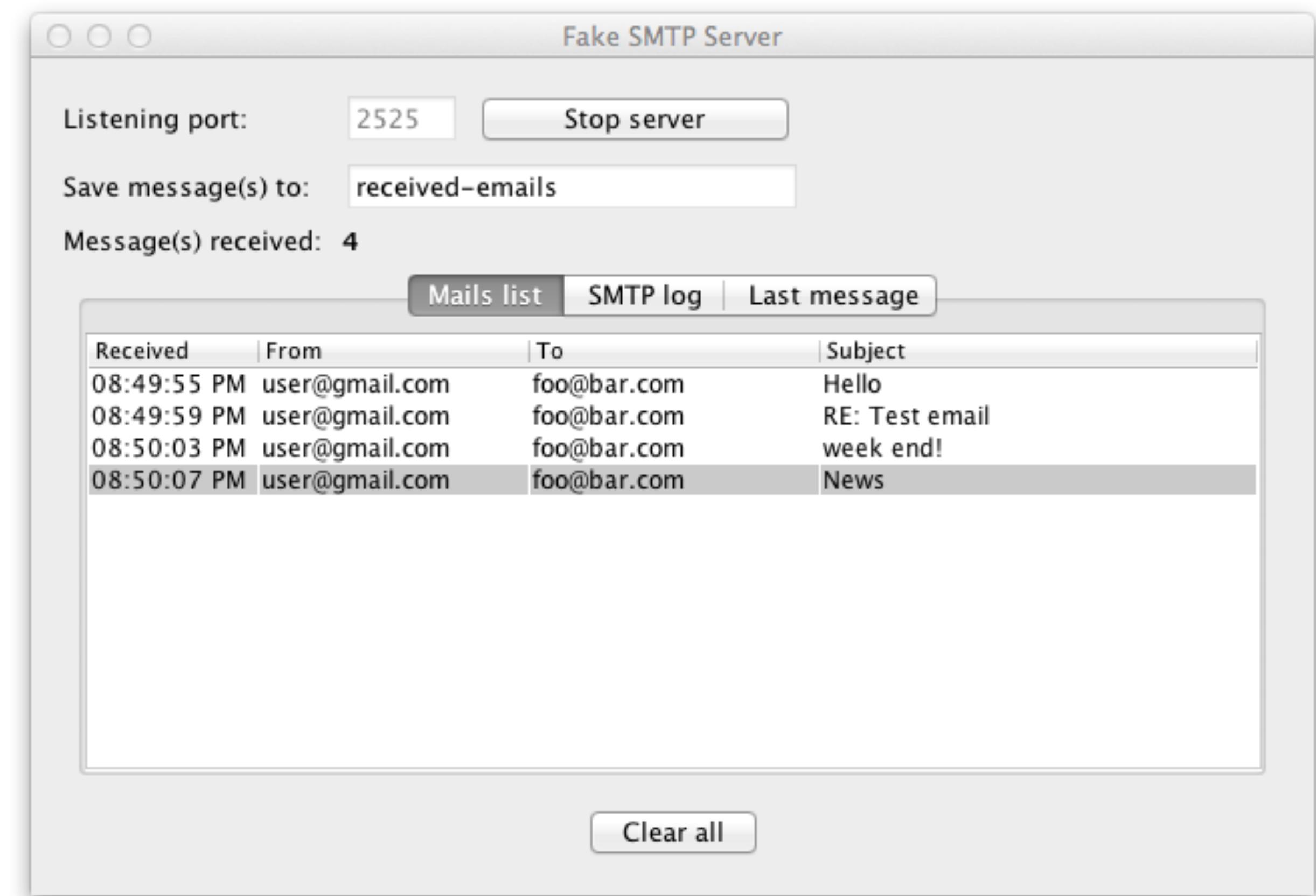
Developing a comprehensive microservice example

- Add another component to send an e-mail to the customer. We will use **JavaMailSender** to send an e-mail via code
- Behind the scenes, Spring Boot automatically configures all the parameters required by **JavaMailSender**

```
package br.ufpe.cin.lecture3;  
  
import org.springframework.beans.factory.annotation.Autowired;  
import org.springframework.mail.SimpleMailMessage;  
import org.springframework.mail.javamail.JavaMailSender;  
import org.springframework.stereotype.Component;  
  
@Component  
public class Mailer {  
  
    @Autowired  
    private JavaMailSender javaMailService;  
  
    public void sendMail(String email){  
        SimpleMailMessage mailMessage=new SimpleMailMessage();  
        mailMessage.setTo(email);  
        mailMessage.setSubject("Registration");  
        mailMessage.setText("Successfully Registered");  
        javaMailService.send(mailMessage);  
    }  
}
```

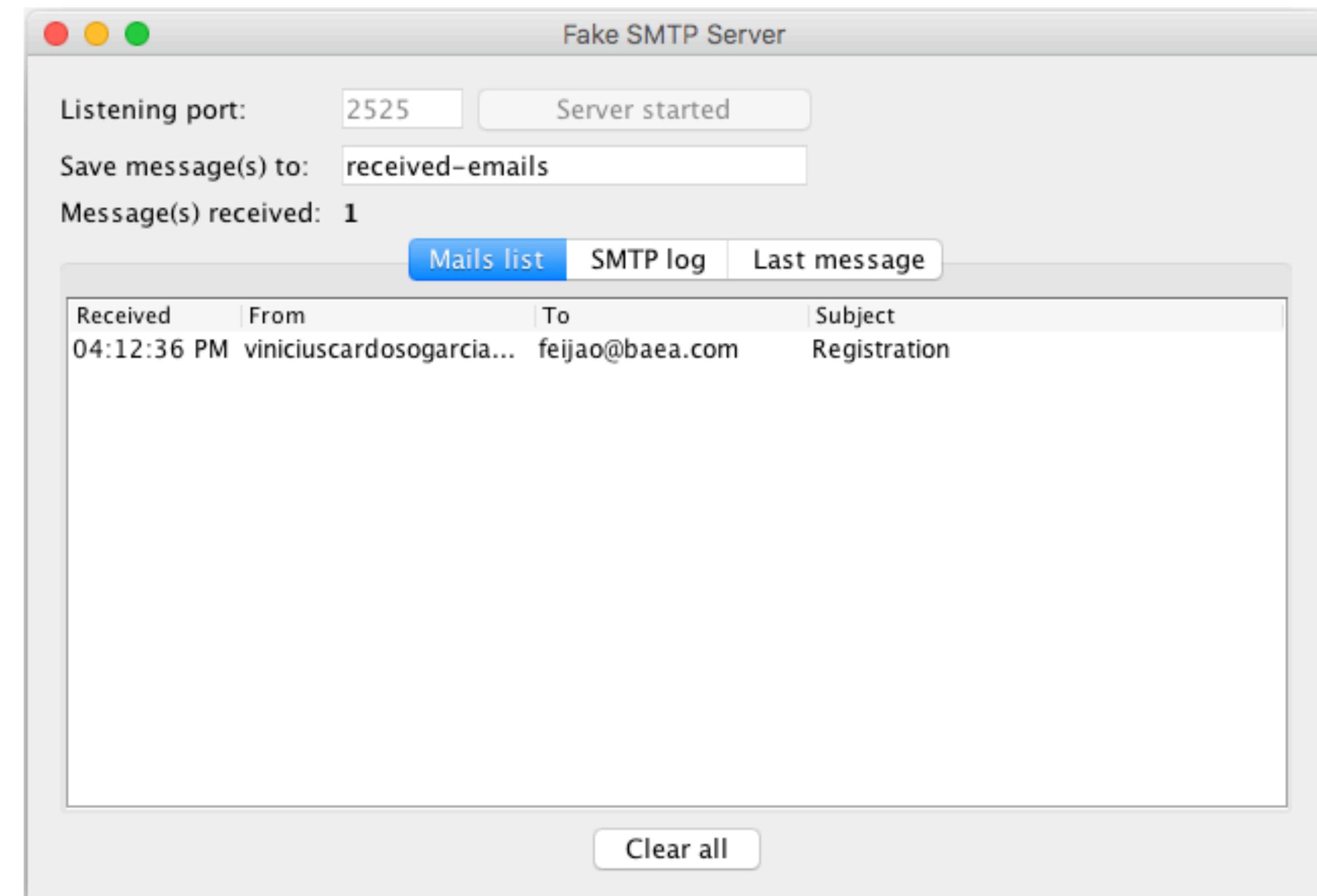
Developing a comprehensive microservice example

- To test SMTP, a test setup for SMTP is required to ensure that the mails are going out. In this example, FakeSMTP will be used. You can download FakeSMTP from <http://nilhcem.github.io/FakeSMTP>
- Once you download `fakeSMTP-2.0.jar`, run the SMTP server



Developing a comprehensive microservice example

- Start both the Spring Boot apps. Open the browser and repeat the customer creation steps through the HAL browser. In this case, immediately **after** submitting the request, we will be able to see the e-mail in the SMTP GUI.
- Internally, the Customer Profile service **asynchronously** calls the Customer Notification service, which, in turn, sends the e-mail message to the SMTP server



Spring Boot actuators

- We explored most of the Spring Boot features required to develop a microservice. Now, some of the production-ready operational aspects of Spring Boot need to be explored
- Spring Boot actuators provide an excellent **out-of-the-box** mechanism to monitor and manage Spring Boot applications in production

Homework 3.1

- Browse the spring.io/guides, follow to the **Building a RESTful Web Service with Spring Boot Actuator**
- Show your results and impressions

Homework 3.2

- Documenting microservices
 - The traditional approach of API documentation is either by writing service specification documents or using static service registries. With a large number of microservices, it would be hard to keep the documentation of APIs in sync.
 - Microservices can be documented in many ways. This homework intend to explore how microservices can be documented using the popular **Swagger** framework.
 - Create a new **Spring Starter Project** and select **Web** in the library selection window. Name the project `lecture3.swagger`. Learn how to use **Springfox Swagger** library e using a similar `bootrest` project, show the results.

Documenting microservices with Springfox Swagger



Api Documentation

Api Documentation

Created by Contact Email

[Apache 2.0](#)

basic-error-controller : Basic Error Controller

Show/Hide | List Operations | Expand Operations

greet-controller : Greet Controller

Show/Hide | List Operations | Expand Operations

DELETE / greet

GET / greet

HEAD / greet

OPTIONS / greet |

PATCH / greet

POST / greet

PUT / greet

[BASE URL: / , API VERSION: 1.0]