

## COMP30220 Distributed Systems Practical

### Lab 5: REST Services

Work individually. Submit your code on csmoodle.ucd.ie by the deadline given on moodle. Please submit a single ZIP file (name is <student-num>.zip) containing your source code and any text files required for the solution.

Download the original version of Quoco again (do not attempt to adapt your answer to the previous lab).

The broad objective of this practical is to adapt the code provided to use RESTful Web Services (REST) for interaction between each of the 3 quotation services and the broker and between the broker and the client. In the final version, each of these components should be deployable as a separate docker image and you should provide a docker-compose file that can be used to deploy the images.

To help you complete this challenge, I have broken the problem up into a set of tasks. My advice is to create a separate set of projects for your solution, and for you to copy code from the original project as needed.

As an additional step, please download the Postman application (<http://postman.com>). You will need to create an account, but this is free to do.

#### Task 1: Setting up the Project Structure

Grade: E

As with all other laboratories, we will create a multi-module maven project with the following subprojects:

- **core**: contains the common code (abstract base classes & any data classes)
- **auldfellas**: The Auldfella's Quotation Service
- **dodgydrivers**: The Dodgy Drivers Quotation Service
- **girlpower**: The Girl Power Quotation Service
- **broker**: The broker service
- **client**: The client service

For all projects, the **groupId** should be "lab5" and for the main project the **artifactId** should be "quoco-rest". For the main project, copy a **pom.xml** from one of the previous labs. Do the same for the core module. For the remainder of the modules, copy the **pom.xml** from the "phone book" project I did in class. Finally, for the client module pom.xml you should also include the exec-maven-plugin. Remember to add the lab5:core:0.0.1 dependency to every module but the core module.

The following steps will help you set up the **core** project:

- a) Create a "src/main/java" folder and copy the "service.core" package into it (remember that you have to create a "service/core" subfolder within the "src/main/java" folder and copy the Java source files into the "service/core" folder.
- b) Delete the BrokerService & QuotationService interfaces. Remove "implements QuotationService" from the AbstractQuotationService class.
- c) Modify the Quotation and ClientInfo classes to be Java Beans.

*Remember, a class is a Java Bean if it is a data class, if it has a default constructor (a constructor with no parameters), if its fields are private, and it has set/get methods for each field.*

- d) Compile & Install the "core" project

## Task 2: Creating and Testing the Auldfellas Quotation Services

Grade: D

The second task involves creating a distributed version of the Quotation Services. I will start by explaining how to do it for one of the services – auldfellas – and you will need to do the same thing for the other services.

- a) Create the “src/main/java” folder structure and copy the “service.auldfellas” package into it.
- b) Remove the reference to the QuotationService interface. Annotate the class with @RestController.
- c) Copy **quotations** field declaration and createQuotation(...) method below:

```
private Map<String, Quotation> quotations = new HashMap<>();

@RequestMapping(value="/quotations",method=RequestMethod.POST)
public ResponseEntity<Quotation> createQuotation(@RequestBody ClientInfo info) {
    Quotation quotation = generateQuotation(info);
    quotations.put(quotation.getReference(), quotation);
    String path = ServletUriComponentsBuilder.fromCurrentContextPath().
        build().toUriString()+ "/quotations/"+quotation.getReference();
    HttpHeaders headers = new HttpHeaders();
    headers.setLocation(new URI(path));
    return new ResponseEntity<>(quotation, headers, HttpStatus.CREATED);
}
```

Similarly to the phone book example completed in class, the above code handles a POST request that is submitted to the “/quotations” URI. This URI references the list of quotations generated by the quotation service. The request body includes client information that is used to generate a quotation resource. This resource is accessible through the “/quotations/{reference}” URI pattern. The specific URI for the newly created resource is passed via the Location: header of the response together a representation of the newly created resource. Technically, this is all we need to implement to make the Auldfellas quotation service work, but, for completeness, we should also implement a mechanism to get a representation of the quotation resource:

```
@RequestMapping(value="/quotations/{reference}",method=RequestMethod.GET)
public Quotation getResource(@PathVariable("reference") String reference) {
    Quotation quotation = quotations.get(reference);
    if (quotation == null) throw new NoSuchQuotationException();
    return quotation;
}
```

Notice the `NoSuchQuotationException` that is thrown. This class is simply one that extends the `RuntimeException` class (unchecked exception). The only difference is that we must also annotate the exception to indicate what response code should be returned if the exception occurs:

```
@ResponseStatus(value = HttpStatus.NOT_FOUND)
public class NoSuchQuotationException extends RuntimeException {
    static final long serialVersionUID = -6516152229878843037L;
}
```

- d) The last change to this class involves modifying the `generateQuotation()` method implementation to adhere to the Java Bean implementation (fields are no longer public) – you will get compilation errors if you try to compile the codebase without doing this. You will also need to remove the `@Overrides` annotation from the method as it no longer implements the `QuotationService` interface.

- e) Next, create an Application class in the auldfellas package that looks like the code below:

```
package service.auldfellas;

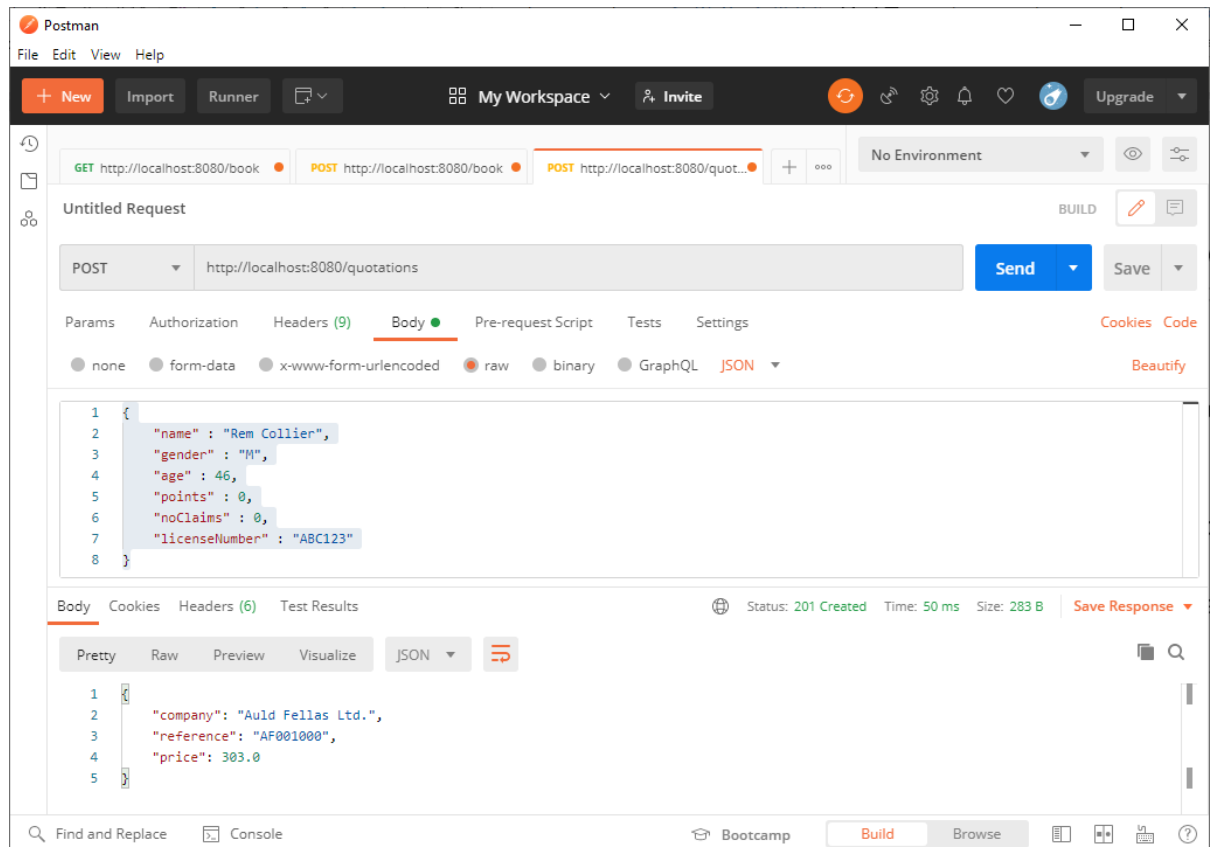
@SpringBootApplication
public class Application {
    public static void main(String[] args) {
        SpringApplication.run(Application.class, args);
    }
}
```

- f) Fix any missing imports and try to compile & run the “auldfellas” project – remember to run the project use “mvn spring-boot:run”.

To test your service, run Postman and create a POST request with url: “http://localhost:8080/quotations”. Copy the JSON below into the body of the request and click the “Send” button.

```
{
  "name" : "Rem Collier",
  "gender" : "M",
  "age" : 46,
  "points" : 0,
  "noClaims" : 0,
  "licenseNumber" : "ABC123"
}
```

You should see a response like the one below (notice that Spring Boot automatically converts the Quotation objects into JSON):



You can also try to access the other URIs that you have implemented. Notice that we have not implemented any update or delete functionality – this is because such functionality is not accessible to the quotation system.

- g) The final step of this task is to write some code to test this service. To do this, we will do some work on the “client” project. This will be a temporary version of the client code that we will use to test the quotation service we have just created.

In creating this client, we will use the `RestTemplate` class. This is a Spring API that simplified the task of creating a client that can interact with a RESTful Service. The code below is a simple example of how to use this API.

Copy the `pom.xml` file you created in step (a) of this task into the client folder. Modify the `artifactId` to be “client” and the main class to be “`client.Client`”. Generate the “`src/main/java`” folder structure and create a `Client` class. Copy the `displayProfile()`, `displayQuotation()`, and the clients data field from the old `client.Main` class into this new class. Copy the code below:

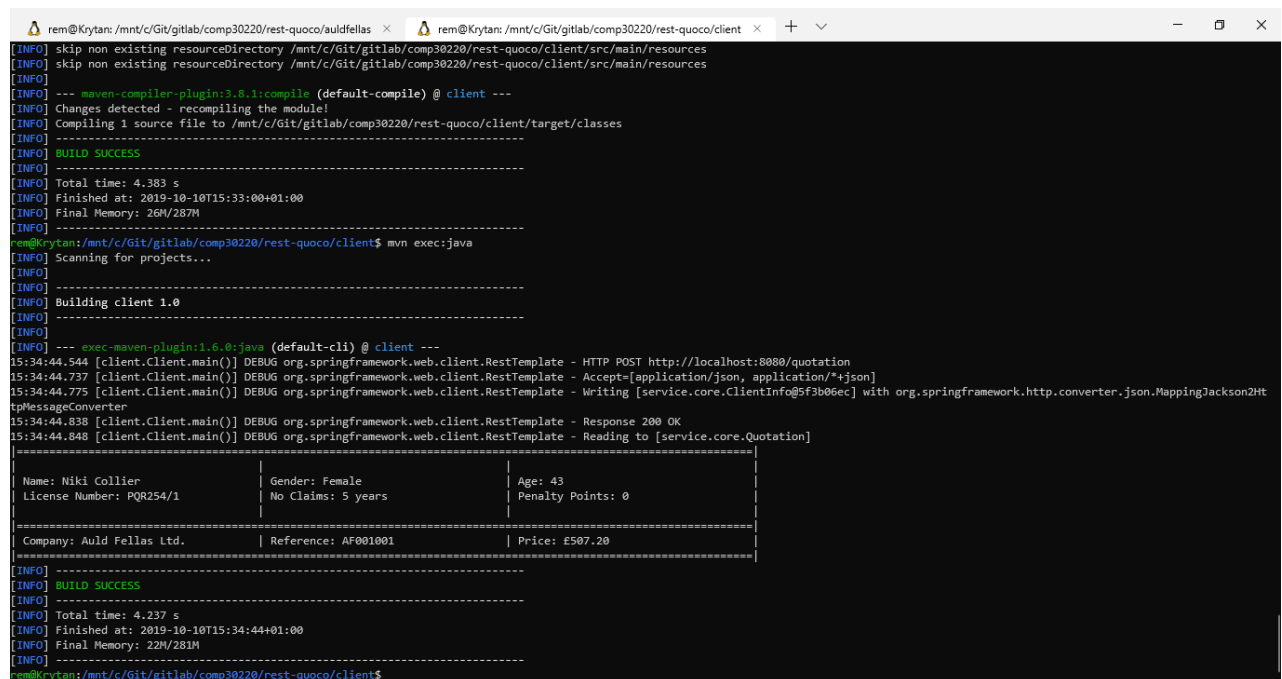
```
public static void main(String[] args) {
    RestTemplate restTemplate = new RestTemplate();
    HttpEntity<ClientInfo> request = new HttpEntity<>(clients[0]);
    Quotation quotation =
        restTemplate.postForObject("http://localhost:8080/quotations",
            request, Quotation.class);
    displayProfile(clients[0]);
    displayQuotation(quotation);
}
```

Also, add the following imports to use the `RestTemplate` class.

```
import org.springframework.web.client.RestTemplate;
import org.springframework.http.HttpEntity;
```

Note that I have hardcoded the URL of the service here. This is sufficient for testing purposes.

Compile and run this code – you should see a single client with a single quote from “Auld Fellas Ltd.”



```
rem@Krytan: /mnt/c/Git/gitlab/comp30220/rest-quoco/auldfellas x rem@Krytan: /mnt/c/Git/gitlab/comp30220/rest-quoco/client x + v
[INFO] skip non existing resourceDirectory /mnt/c/Git/gitlab/comp30220/rest-quoco/client/src/main/resources
[INFO] skip non existing resourceDirectory /mnt/c/Git/gitlab/comp30220/rest-quoco/client/src/main/resources
[INFO] --- maven-compiler-plugin:3.8.1:compile (default-compile) @ client ---
[INFO] Changes detected - recompiling the module!
[INFO] Compiling 1 source file to /mnt/c/Git/gitlab/comp30220/rest-quoco/client/target/classes
[INFO] BUILD SUCCESS
[INFO] Total time: 4.383 s
[INFO] Finished at: 2019-10-10T15:33:00+01:00
[INFO] Final Memory: 26M/287M
[INFO] ---
rem@Krytan: /mnt/c/Git/gitlab/comp30220/rest-quoco/client$ mvn exec:java
[INFO] Scanning for projects...
[INFO] Building client 1.0
[INFO] ---
[INFO] --- exec-maven-plugin:1.6.0:java (default-cli) @ client ---
15:34:44.544 [client.Client.main()] DEBUG org.springframework.web.client.RestTemplate - HTTP POST http://localhost:8080/quotation
15:34:44.737 [client.Client.main()] DEBUG org.springframework.web.client.RestTemplate - Accept=[application/json, application/*+json]
15:34:44.775 [client.Client.main()] DEBUG org.springframework.web.client.RestTemplate - Writing [service.core.ClientInfo@9f3b00ec] with org.springframework.http.converter.json.MappingJackson2Htt
pMessageConverter
15:34:44.838 [client.Client.main()] DEBUG org.springframework.web.client.RestTemplate - Response 200 OK
15:34:44.848 [client.Client.main()] DEBUG org.springframework.web.client.RestTemplate - Reading to [service.core.Quotation]
=====
Name: Niki Collier      Gender: Female      Age: 43
License Number: PQR254/1  No Claims: 5 years  Penalty Points: 0
=====
Company: Auld Fellas Ltd.  Reference: AF001001  Price: £507.20
=====
[INFO] BUILD SUCCESS
[INFO] Total time: 4.237 s
[INFO] Finished at: 2019-10-10T15:34:44+01:00
[INFO] Final Memory: 22M/283M
[INFO] ---
rem@Krytan: /mnt/c/Git/gitlab/comp30220/rest-quoco/client$
```

### Task 3: Implementing the Other services

Grade: C

Repeat the steps of task 2 to create and test the “girlpower” and “dodgydrivers” projects.

**Note: a challenge here is to run multiple versions of spring boot concurrently (by default, it runs on port 8080). To make this change, you need to create an `application.properties` file (it is a text file that is created in the**

*src/main/resources folder). To configure Spring Boot to run on port 8081, the application.properties file should contain the following line:*

```
server.port=8081
```

#### Task 4: Implementing the Broker and Client

Grade: B

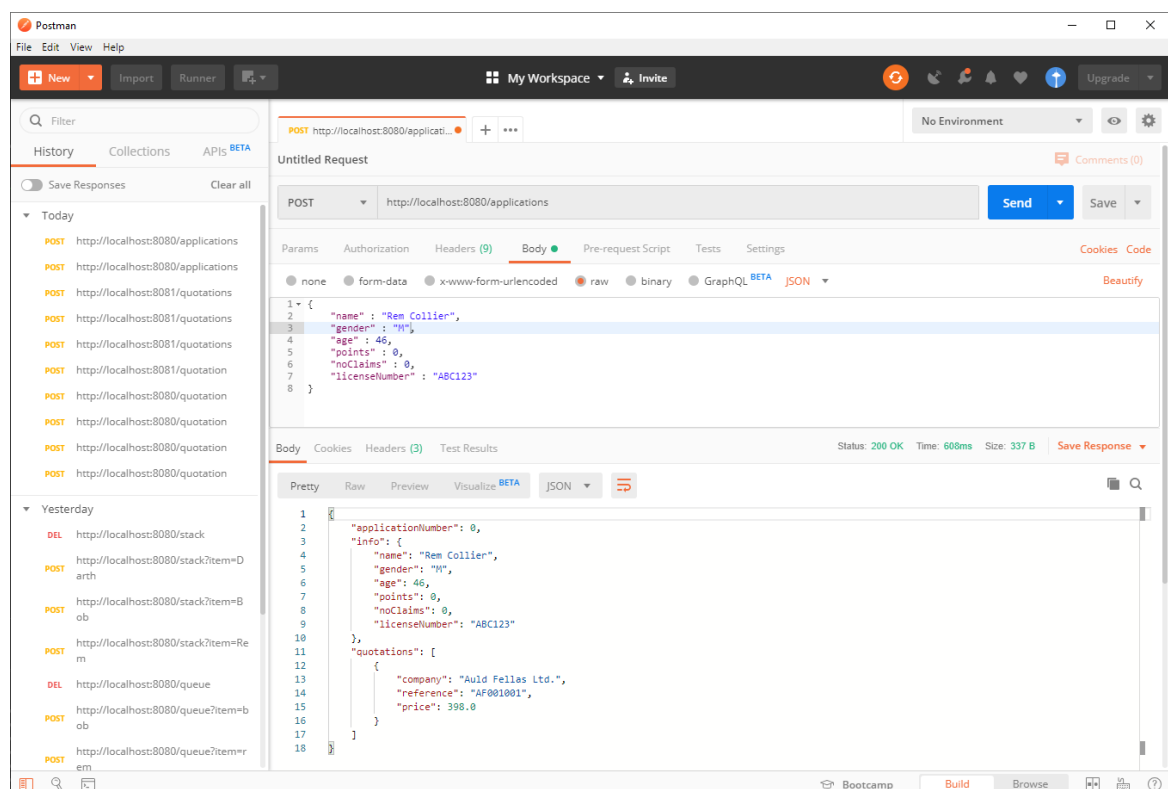
Now we have working quotation services, the next task is to create and test the broker.

- Create a service.broker.Application class that implements the same main method as Task 2(e).
- Convert the LocalBrokerService into a REST service – use the URI (/applications) to model the list of applications. Like the Quotation Services, this URI should support POST operations. The expected behaviour associated with this operation is to call the getQuotations() method which connects to the Quotation Services using the RestTemplate developed in Task 2(g). The List of Quotations returned by this method should be associated with the ClientInfo and a unique application-number and stored in a Map (where the key is the application number).

**NOTE: the concept of an application is new to the system. An application is a combination of some ClientInfo, a List of Quotations, and a unique identifier (the application number). The identifier can be an integer value that is unique to each application (rank in an ArrayList is not a valid application number because rank changes). You should create a new class service.core.ClientApplication to model this (it will need to be added to the core project and will need to be a Java Bean). Instances of this class should be stored in a Map in the same way that Quotations were stored in Task 2(d). As with the web services implementation, you should prefer concrete classes (e.g. ArrayList) over interfaces (e.g. List). Modify the code as necessary.**

**NOTE: The implementation of the getQuotations() method should be modified in a similar way to what we did in the web services lab (an array of URIs). Ideally, this list should be passed as a parameter to the method that creates the Application (this is more tricky to do here because there is no direct link between the main() method and the controllers).**

Run this application and test it using Postman – the output should look like the screenshot below:



- c) Create a method to handle GET requests submitted to the URI (/applications/{application-number}) which is used to refer to an individual application.
- d) Create a method to handle GET requests submitted to the URI (/applications) which returns a list of ClientApplication objects.
- e) Modify the test client to lookup the broker and modify the main() method to loop through and print out all the quotations returned by the broker service.
- f) Compile and run both projects 😊

### Task 5: Containerisation

**Grade: A**

The final task is to convert the output of task 4 into a set of docker images and an associated docker compose file. You should map the broker port so that it can be accessed by external programs and then run the client using maven.

***There is no need to make the client into a docker image.***

### Additional Marks

+ grades (e.g. A+) can be attained through consideration of boundary cases, good exception handling, nice features that enhance the quality of your solution.

- grades (e.g. A-) can be attained through lack of commenting and indentation, bad naming conventions or sloppy code.