Cloud PDF Report: PROJECT2 – Tom Gibson – 23222095

reference, for accessing the endpoints

http://localhost:15672/#/queues

http://localhost:5002/users/all

http://localhost:5006/books/all

Exercise one: Service setup

1.1) Create a folder with the namePRACTICAL2_FirstName_LastName_StudentIDand a subfolder named exercise_one ☑

1.2) Download the source codeUserService.zipfrom Brightspace and extract it to the folder exercise_one ☑

1.3) Using a base image of your choice, create a Dockerfile that will be used to run the UserService. Make sure the service runs on port 5002 in the container ☑

1.4) In the exercise_one folder, create a docker_compose.yml file. Add two services: UserService and a database service. The database service should be based on a Postgres database. Set up the necessary network and volume for the database service ☑

1.5) Run docker-compose up and, using curl, test all the endpoints and ensure they work as expected (save data, retrieve, update and delete based on student_id. ☑

docker-compose up --build

Test the /users/add Endpoint:

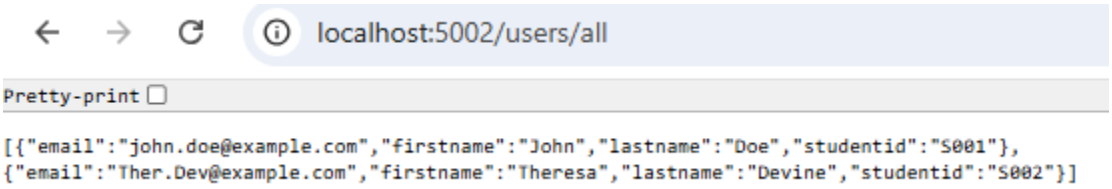
curl -X POST -H "Content-Type: application/json" \

-d '{"studentid": "S001", "firstname": "John", "lastname": "Doe", "email": "john.doe@example.com"}' \ http://localhost:5002/users/add

```
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_Gibson_23222095\exercise_one
> curl -Method POST -Uri "http://localhost:5002/users/add" `
>> -Headers @{ "Content-Type" = "application/json" } `
>> -Body '{ "studentid": "S001", "firstname": "John", "lastname": "Doe", "email": "john.d
oe@example.com" }'


StatusCode        : 201
StatusDescription : CREATED
Content           : {"email":"john.doe@example.com","firstname":"John","lastname":"Doe",
                    "studentid":"S001"}

RawContent        : HTTP/1.1 201 CREATED
                    Connection: close
                    Content-Length: 88
                    Content-Type: application/json
                    Date: Sun, 24 Nov 2024 13:39:22 GMT
                    Server: Werkzeug/3.1.3 Python/3.10.15

                    {"email":"john.doe@example.co...
Forms             : {}
Headers           : {[Connection, close], [Content-Length, 88], [Content-Type,
                    application/json], [Date, Sun, 24 Nov 2024 13:39:22 GMT]...}
Images            : {}
InputFields       : {}
Links             : {}
ParsedHtml        : mshtml.HTMLDocumentClass
RawContentLength  : 88
```

Retrieve All Users (GET /users/all):

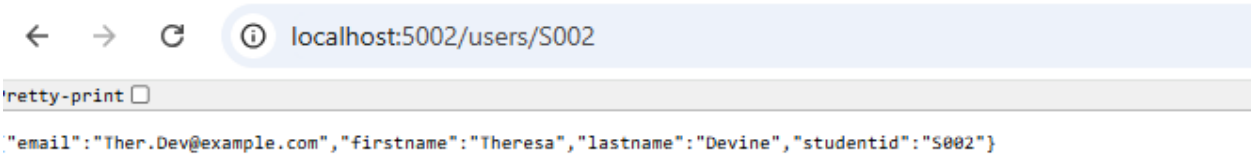
/users/all



...or:
curl -Method GET http://localhost:5002/users/all

```
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_Gibson_23222095\exercise_one
> curl -Method GET http://localhost:5002/users/all


StatusCode        : 200
StatusDescription : OK
Content           : [{"email":"john.doe@example.com","firstname":"John","lastname":"Doe"
                    ,"studentid":"S001"},{"email":"Ther.Dev@example.com","firstname":"Th
                    eresa","lastname":"Devine","studentid":"S002"}]

RawContent        : HTTP/1.1 200 OK
                    Connection: close
                    Content-Length: 184
                    Content-Type: application/json
                    Date: Sun, 24 Nov 2024 14:03:16 GMT
                    Server: Werkzeug/3.1.3 Python/3.10.15

                    [{"email":"john.doe@example.com",...
Forms             : {}
Headers           : {[Connection, close], [Content-Length, 184], [Content-Type,
                    application/json], [Date, Sun, 24 Nov 2024 14:03:16 GMT]...}
Images            : {}
InputFields       : {}
Links             : {}
ParsedHtml        : mshtml.HTMLDocumentClass
RawContentLength  : 184
```

Retrieve a Specific User (GET /users/S002):



...or:

curl -Method GET http://localhost:5002/users/S002

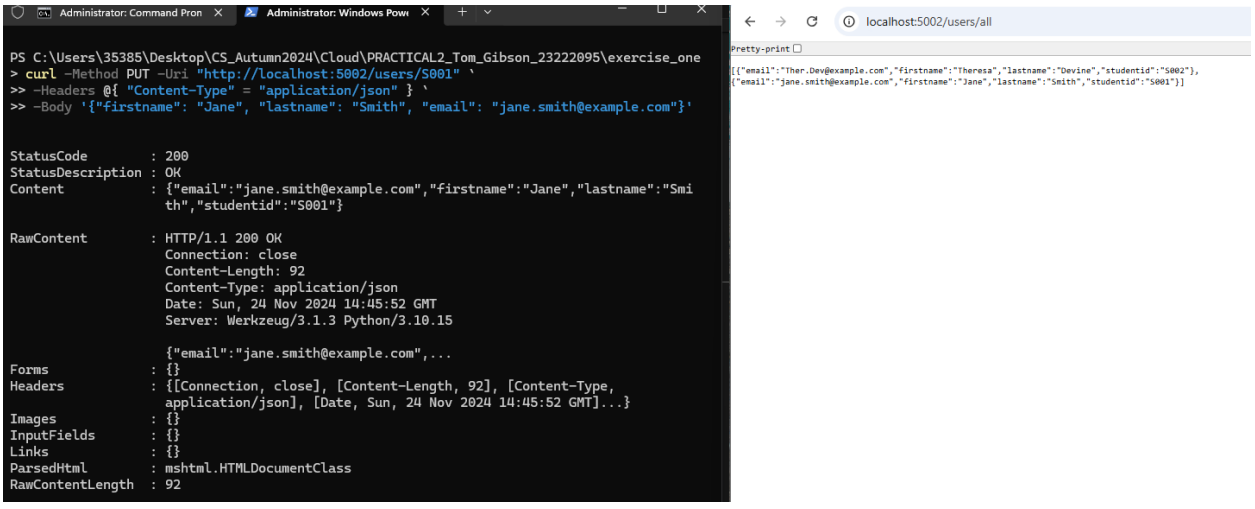
```
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_Gibson_23222095\exercise_one
> curl -Method GET http://localhost:5002/users/S002


StatusCode        : 200
StatusDescription : OK
Content           : {"email":"Ther.Dev@example.com","firstname":"Theresa","lastname":"De
                    vine","studentid":"S002"}

RawContent        : HTTP/1.1 200 OK
                    Connection: close
                    Content-Length: 94
                    Content-Type: application/json
                    Date: Sun, 24 Nov 2024 14:05:18 GMT
                    Server: Werkzeug/3.1.3 Python/3.10.15

                    {"email":"Ther.Dev@example.com","f...
Forms             : {}
Headers           : {[Connection, close], [Content-Length, 94], [Content-Type,
                    application/json], [Date, Sun, 24 Nov 2024 14:05:18 GMT]...}
Images            : {}
InputFields       : {}
Links             : {}
ParsedHtml        : mshtml.HTMLDocumentClass
RawContentLength  : 94
```

Update a User (PUT /users/<studentid>) by studentid:

> curl -Method PUT -Uri "http://localhost:5002/users/S001" `

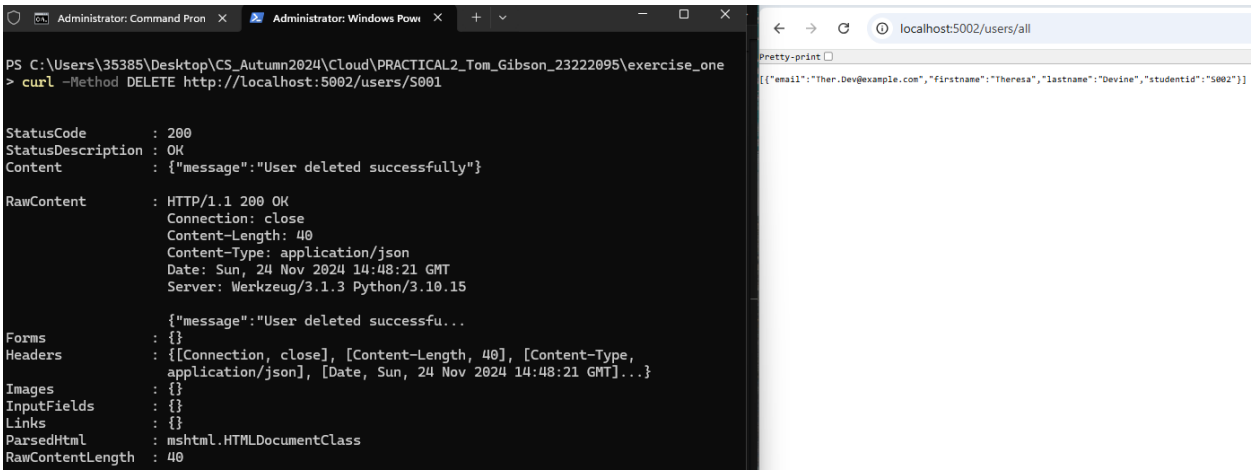
>> -Headers @{ "Content-Type" = "application/json" } `

>> -Body '{"firstname": "Jane", "lastname": "Smith", "email": "jane.smith@example.com"}'



Delete a User (DELETE /users/<studentid>), by studentid:

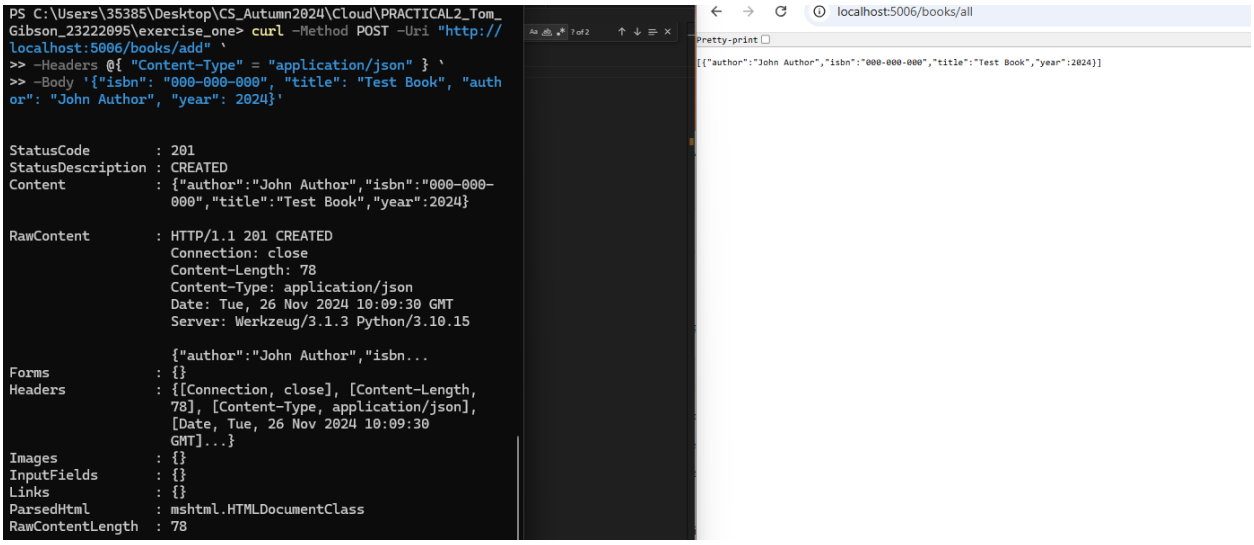
curl -Method DELETE http://localhost:5002/users/S001



1.6) Duplicate UserService and create BookService ☑

1.7) Make the necessary modifications in the code to satisfy the properties of the BookService described above. BookService should run on port 5006 ☑

Verify database exists, adding 1 book:



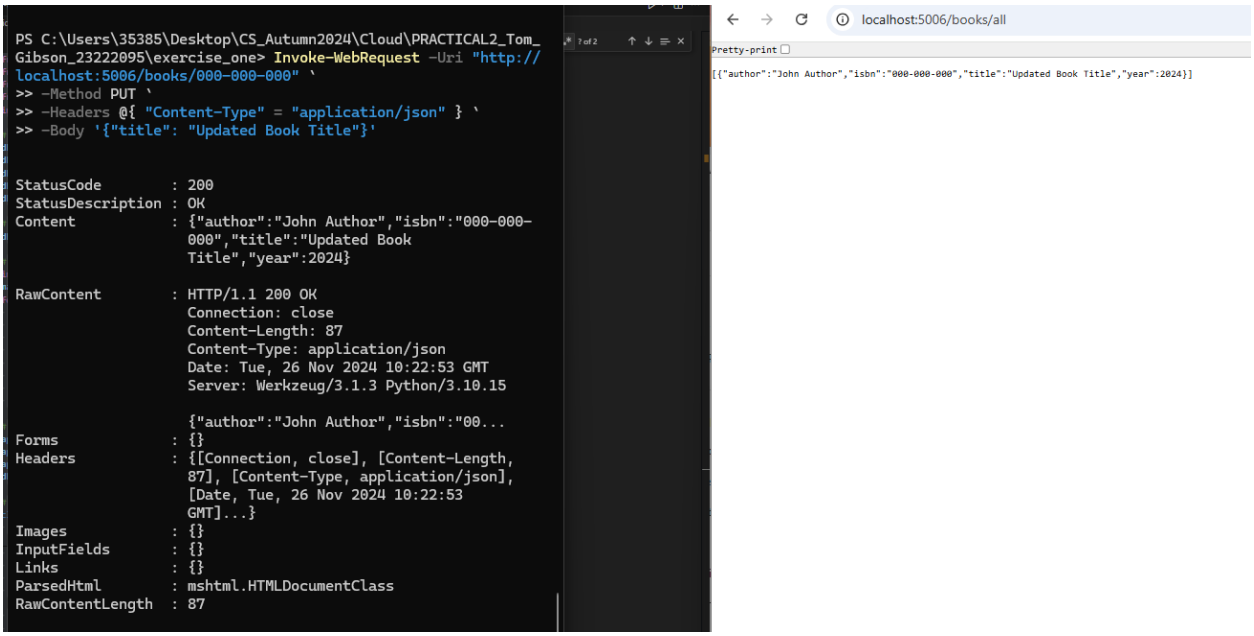
Retrieve all books:

```
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_
Gibson_23222095\exercise_one> curl -Method GET http://localho
st:5006/books/all


StatusCode        : 200
StatusDescription : OK
Content           : [{"author":"John Author","isbn":"000-000
                    -000","title":"Test Book","year":2024}]

RawContent        : HTTP/1.1 200 OK
                    Connection: close
                    Content-Length: 80
                    Content-Type: application/json
                    Date: Tue, 26 Nov 2024 10:18:28 GMT
                    Server: Werkzeug/3.1.3 Python/3.10.15

                    [{"author":"John Author","isbn":"0...
Forms             : {}
Headers           : {[Connection, close], [Content-Length,
                    80], [Content-Type, application/json],
                    [Date, Tue, 26 Nov 2024 10:18:28
                    GMT]...}
Images            : {}
InputFields       : {}
Links             : {}
ParsedHtml        : mshtml.HTMLDocumentClass
RawContentLength  : 80
```

Get book by ID/ ISBN:

```
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_
Gibson_23222095\exercise_one> curl -Method GET http://localho
st:5006/books/000-000-000


StatusCode        : 200
StatusDescription : OK
Content           : {"author":"John Author","isbn":"000-000-
                    000","title":"Test Book","year":2024}

RawContent        : HTTP/1.1 200 OK
                    Connection: close
                    Content-Length: 78
                    Content-Type: application/json
                    Date: Tue, 26 Nov 2024 10:19:10 GMT
                    Server: Werkzeug/3.1.3 Python/3.10.15

                    {"author":"John Author","isbn":"00...
Forms             : {}
Headers           : {[Connection, close], [Content-Length,
                    78], [Content-Type, application/json],
                    [Date, Tue, 26 Nov 2024 10:19:10
                    GMT]...}
Images            : {}
InputFields       : {}
Links             : {}
ParsedHtml        : mshtml.HTMLDocumentClass
RawContentLength  : 78
```

Update a book:



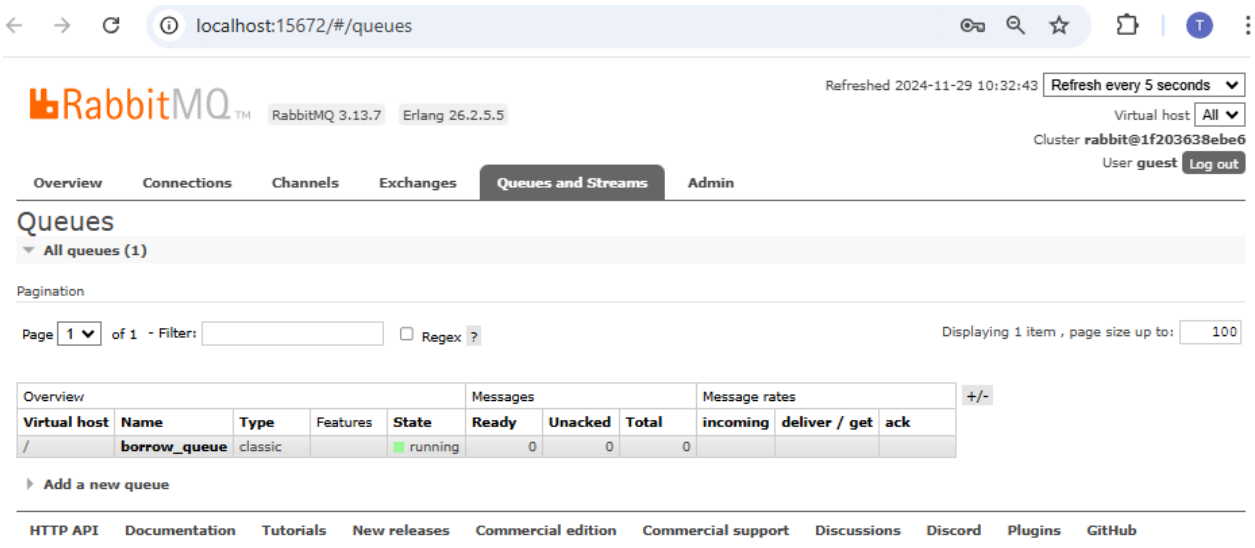
Exercise Two: Asynchronous communication with RabbitMQ

2.1) Duplicate exercise_one to exercise_two ☑

2.2) Set up RabbitMQ ☑

2.3) Make some modifications to theUserService

- connect to the RabbitMQ service ☑

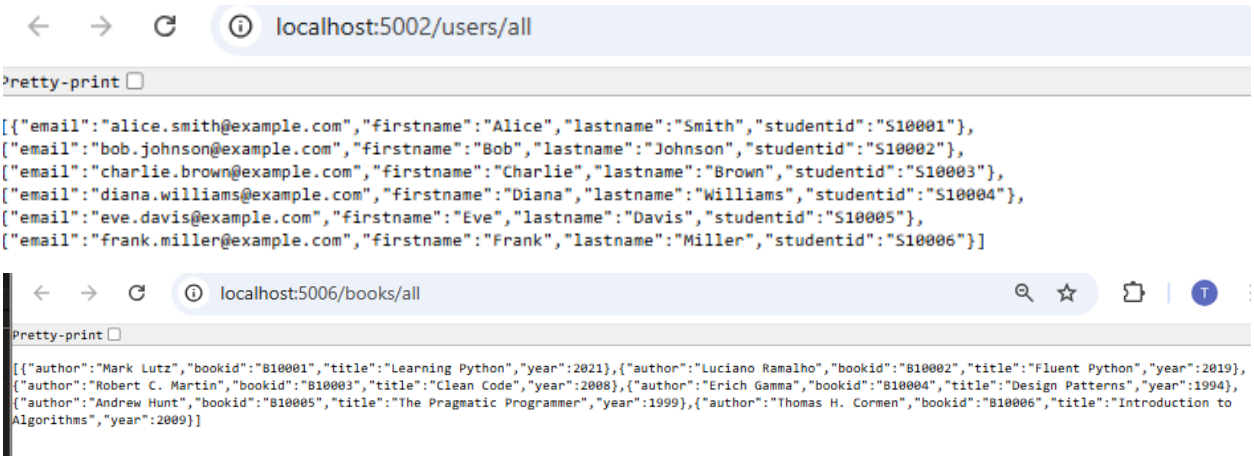


- Remember to change the username and password on the second line to read from environment variables ☑

```
# Establish connection to RabbitMQ
credentials = pika.PlainCredentials(
    os.getenv("RABBITMQ_DEFAULT_USER", "guest"),
    os.getenv("RABBITMQ_DEFAULT_PASS", "guest")
)
```

- Run docker-compose up and make sure the UserService works as intended. You can use curl or postman to make a POST request to borrow a book ☑

```
users_db=# \dt
         List of relations
 Schema |  Name   | Type  |  Owner
--------+---------+-------+----------
 public | books   | table | postgres
 public | borrows | table | postgres
 public | users   | table | postgres
(3 rows)
```



Code for adding a user:

Invoke-WebRequest -Uri "http://localhost:5002/users/add" -Method POST -Headers @{ "Content-Type" = "application/json" } -Body '{ "studentid": "S10001", "firstname": "Alice", "lastname": "Smith", "email": "alice.smith@example.com" }'

Code for adding a book:

Invoke-WebRequest -Uri "http://localhost:5006/books/add" -Method POST -Headers @{ "Content-Type" = "application/json" } -Body '{ "bookid": "B10001", "title": "Learning Python", "author": "Mark Lutz", "year": 2021 }'

```
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_Gibson_23222095\exercise_two\BorrowService> Invoke-WebRequest -Uri "http://localhost:5008/bor
row" -Method POST -Headers @{
>>     "Content-Type" = "application/json"
>> } -Body '{
>>     "studentid": "S10001",
>>     "bookid": "B10001"
>> }'


StatusCode        : 201
StatusDescription : CREATED
Content           : {"message":"Book B10001 successfully borrowed by student S10001."}

RawContent        : HTTP/1.1 201 CREATED
                    Connection: close
                    Content-Length: 67
                    Content-Type: application/json
                    Date: Fri, 29 Nov 2024 10:31:34 GMT
                    Server: Werkzeug/3.1.3 Python/3.10.15

                    {"message":"Book B10001 succe...
Forms             : {}
Headers           : {[Connection, close], [Content-Length, 67], [Content-Type, application/json],
                    [Date, Fri, 29 Nov 2024 10:31:34 GMT]...}
Images            : {}
InputFields       : {}
Links             : {}
ParsedHtml        : mshtml.HTMLDocumentClass
RawContentLength  : 67
```

Invalid Students and Books Check Functions: ☑

```
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_Gibson_23222095\exercise_two\BorrowService> Invoke-WebRequest -Uri "http://localhost:5008/bor
row" -Method POST -Headers @{
>>     "Content-Type" = "application/json"
>> } -Body '{
>>     "studentid": "InvalidStudent",
>>     "bookid": "B10002"
>> }'
Invoke-WebRequest : {"error":"Student InvalidStudent does not exist."}
At line:1 char:1
+ Invoke-WebRequest -Uri "http://localhost:5008/borrow" -Method POST -H ...
+ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
    + CategoryInfo          : InvalidOperation: (System.Net.HttpWebRequest:HttpWebRequest) [Invoke-WebRequest], WebException
    + FullyQualifiedErrorId : WebCmdletWebResponseException,Microsoft.PowerShell.Commands.InvokeWebRequestCommand
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_Gibson_23222095\exercise_two\BorrowService> Invoke-WebRequest -Uri "http://localhost:5008/bor
row" -Method POST -Headers @{
>>     "Content-Type" = "application/json"
>> } -Body '{
>>     "studentid": "S10001",
>>     "bookid": "InvalidBook"
>> }'
Invoke-WebRequest : {"error":"Book InvalidBook does not exist."}
At line:1 char:1
+ Invoke-WebRequest -Uri "http://localhost:5008/borrow" -Method POST -H ...
+ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
    + CategoryInfo          : InvalidOperation: (System.Net.HttpWebRequest:HttpWebRequest) [Invoke-WebRequest], WebException
    + FullyQualifiedErrorId : WebCmdletWebResponseException,Microsoft.PowerShell.Commands.InvokeWebRequestCommand
```

Student can only borrow 5 books: ☑

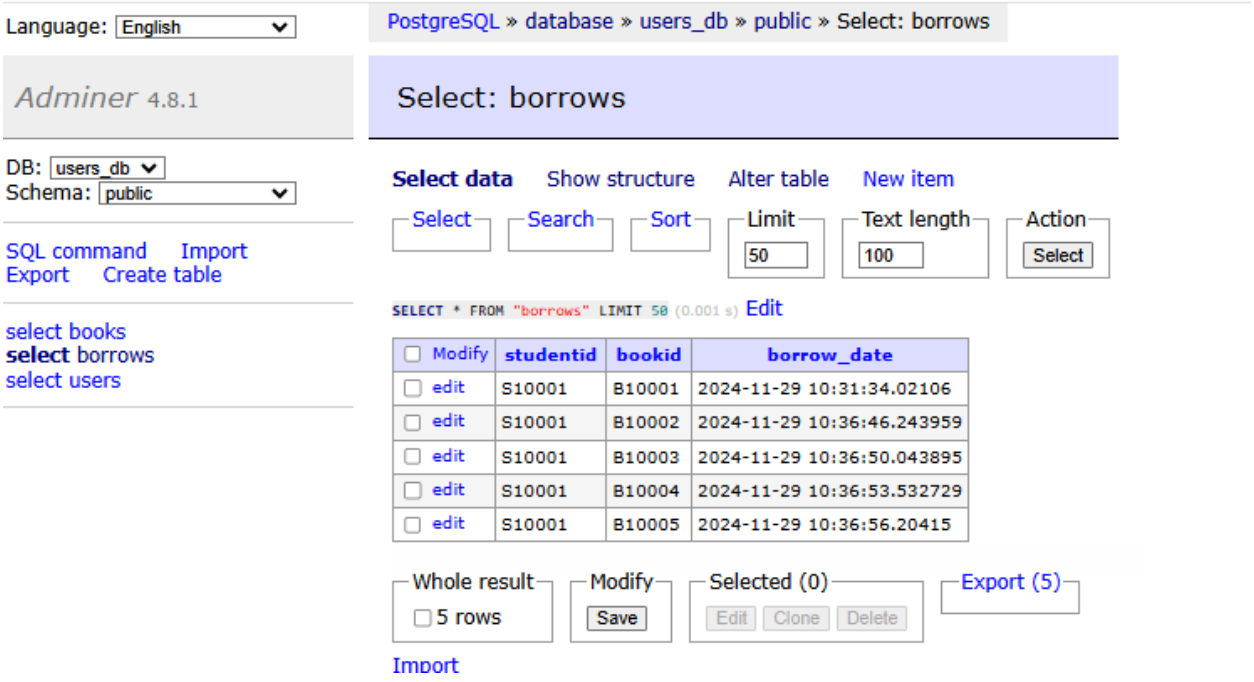
```
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_Gibson_23222095\exercise_two\BorrowService> Invoke-WebRequest -Uri "http://localhost:5008/bor
row" -Method POST -Headers @{
>>     "Content-Type" = "application/json"
>> } -Body '{
>>     "studentid": "S10001",
>>     "bookid": "B10006"
>> }'
Invoke-WebRequest : {"error":"Student S10001 has already borrowed 5 books."}
At line:1 char:1
+ Invoke-WebRequest -Uri "http://localhost:5008/borrow" -Method POST -H ...
+ ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
    + CategoryInfo          : InvalidOperation: (System.Net.HttpWebRequest:HttpWebRequest) [Invoke-WebRequest], WebException
    + FullyQualifiedErrorId : WebCmdletWebResponseException,Microsoft.PowerShell.Commands.InvokeWebRequestCommand
```

c. Be able to return a list of all books borrowed by a given user at a given time ☑

```
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_Gibson_23222095\exercise_two\BorrowService> Invoke-WebRequest -Uri "http://localhost:5008/bor
rows/S10001" -Method GET


StatusCode        : 200
StatusDescription : OK
Content           : [{"bookid":"B10001","borrow_date":"Fri, 29 Nov 2024 10:31:34 GMT","studentid":"S10001"},{"bookid":"B10002","borrow_date":"Fri, 29
                    Nov 2024 10:36:46 GMT","studentid":"S10001"},{"bookid":"B10003","borro...
RawContent        : HTTP/1.1 200 OK
                    Connection: close
                    Content-Length: 437
                    Content-Type: application/json
                    Date: Fri, 29 Nov 2024 10:37:48 GMT
                    Server: Werkzeug/3.1.3 Python/3.10.15

                    [{"bookid":"B10001","borrow_date"...
Forms             : {}
Headers           : {[Connection, close], [Content-Length, 437], [Content-Type, application/json], [Date, Fri, 29 Nov 2024 10:37:48 GMT]...}
Images            : {}
InputFields       : {}
Links             : {}
ParsedHtml        : mshtml.HTMLDocumentClass
RawContentLength  : 437
```

Verification using adminer:

http://localhost:8080



Student returning a borrowed book:

```
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_Gibson_23222095\exercise_two\BorrowService> Invoke-WebRequest -Uri "http://localhost:5008/ret
urn" -Method DELETE -Headers @{
>>     "Content-Type" = "application/json"
>> } -Body '{
>>     "studentid": "S10001",
>>     "bookid": "B10001"
>> }'


StatusCode        : 200
StatusDescription : OK
Content           : {"message":"Book B10001 successfully returned by student S10001."}

RawContent        : HTTP/1.1 200 OK
                    Connection: close
                    Content-Length: 67
                    Content-Type: application/json
                    Date: Fri, 29 Nov 2024 10:53:41 GMT
                    Server: Werkzeug/3.1.3 Python/3.10.15

                    {"message":"Book B10001 successful...
Forms             : {}
Headers           : {[Connection, close], [Content-Length, 67], [Content-Type, application/json], [Date, Fri, 29 Nov 2024 10:53:41 GMT]...}
Images            : {}
InputFields       : {}
Links             : {}
ParsedHtml        : mshtml.HTMLDocumentClass
RawContentLength  : 67
```

Exercise Three: Deployment with Kubernetes ☑

1. Duplicate exercise_two to exercise_three. All new changes should now be made in this folder. ☑

2. For our deployment to work, we need convert our docker-compse.yml file into Kubernetes deployment. Follow the instruction on the kompose webpage. ☑

3. To test and make sure each service is working, setup port-forward from the pod to the host ☑

```
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_Gibson_23222095\exercise_three> kubectl g
et pods
NAME                           READY   STATUS      RESTARTS       AGE
adminer-5f7f659fc7-cmtvj       1/1     Running     0              171m
bookservice-97ccd7999-pqxhp    1/1     Running     0              6m56s
borrowservice-cf6bc8575-msmdh  1/1     Running     11 (31m ago)   58m
database-7c8b546d69-npssd      1/1     Running     0              41m
debug-pod                      1/1     Running     0              32m
dns-test                       1/1     Running     0              33m
rabbitmq-84f79c7685-ngk8x      1/1     Running     0              76m
rabbitmq-test                  0/1     Completed   0              65m
rabbitmq-tester                0/1     Completed   0              84m
userservice-dcf4f88d7-29kc6    1/1     Running     11 (31m ago)   58m
```

Port forwarding works for each pod:

```
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_Gibson_23222095\exercise_three> kubectl p
ort-forward pod/rabbitmq-84f79c7685-ngk8x 5672:5672
Forwarding from 127.0.0.1:5672 -> 5672
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_Gibson_23222095\exercise_three> kubectl p
ort-forward pod/rabbitmq-84f79c7685-ngk8x 15672:15672
Forwarding from 127.0.0.1:15672 -> 15672
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_Gibson_23222095\exercise_three> kubectl p
ort-forward pod/userservice-dcf4f88d7-29kc6 5002:5002
Forwarding from 127.0.0.1:5002 -> 5002
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_Gibson_23222095\exercise_three> kubectl p
ort-forward pod/borrowservice-cf6bc8575-msmdh 5008:5008
Forwarding from 127.0.0.1:5008 -> 5008
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_Gibson_23222095\exercise_three> kubectl p
ort-forward pod/bookservice-97ccd7999-pqxhp 5006:5006
Forwarding from 127.0.0.1:5006 -> 5006
```

And testing using curl again:

```
PS C:\Users\35385\Desktop\CS_Autumn2024\Cloud\PRACTICAL2_Tom_Gibson_23222095\exercise_three> curl http://localhost:
5006/books/all


StatusCode        : 200
StatusDescription : OK
Content           : [{"author":"Mark Lutz","bookid":"B10001","title":"Learning
                    Python","year":2021},{"author":"Luciano
                    Ramalho","bookid":"B10002","title":"Fluent
                    Python","year":2019},{"author":"Robert C. Martin","bookid"...
RawContent        : HTTP/1.1 200 OK
                    Connection: close
                    Content-Length: 513
                    Content-Type: application/json
                    Date: Fri, 29 Nov 2024 15:49:35 GMT
                    Server: Werkzeug/3.1.3 Python/3.10.15

                    [{"author":"Mark Lutz","bookid":"...
Forms             : {}
Headers           : {[Connection, close], [Content-Length, 513], [Content-Type, application/json],
                    [Date, Fri, 29 Nov 2024 15:49:35 GMT]...}
Images            : {}
InputFields       : {}
Links             : {}
ParsedHtml        : mshtml.HTMLDocumentClass
RawContentLength  : 513
```