In this chat, I provided the Ai with the same exact information as in chat 1, but , I did not instruct it to generate the domain/services/Daos code first or anything else, but as in all the other chats before this, the AI generated them by itself and the resutls of the code were pretty good and close to the other chats. The Ai used the architecture I provided it with at the start of the conversation, used much detail in its answers and needed very little prompts to generate all the step definitions of all the features provided.

# Phase 4 Chat 2

**User**

**Act as a software developer. I have a library system application written in java and I have created some Gherkin Scenarios based on different features of the library application. I will provide you with these features/scenarios and the code of all the domain classes with their attributes and methods that you need, and then I will ask you to provide me the implementation code of the Step definitions for each feature, in java. I want your architecture to have Domain classes, Data Access Objects for saving/deleting entities and Service classes. Do you have any questions?**

**ChatGPT**

Your plan sounds clear, and I'm ready to help. Here is a breakdown of how we can proceed:

1. \*\*Provide Domain Classes\*\*: Share the Java code for your domain classes including their attributes and methods.

2. \*\*Gherkin Scenarios\*\*: Provide the Gherkin scenarios for the features of your library system application.

3. \*\*Implementation of Step Definitions\*\*: I will provide the Java implementation code for the Step definitions for each feature based on the Gherkin scenarios.

4. \*\*Architecture Details\*\*: I will ensure the code is structured into Domain classes, Data Access Objects (DAOs) for handling the database operations, and Service classes for the business logic.

Feel free to start by providing the domain classes and the Gherkin scenarios. Once I have this information, I'll proceed with creating the Step definitions and necessary implementation code.

**User**

**The domain classes are:**

**1)class "Book" with the attributes:**

**private ISBN isbn,**

**private String title,**

**private String publication,**

**private int publicationyear,**

**private Publisher publisher,**

**private Set<Item> items = new HashSet<Item>(),**

**private Set<Author> authors = new HashSet<Author>(),**

**and with the methods:**

**Setters and Getters for every attribute and a constructor,**

**public Set<Item> getItems(),**

**public void addItem(Item item),**

**public void removeItem(Item item),**

**Set<Item> friendItems(),**

**public void addAuthor(Author author),**

**public void removeAuthor(Author author),**

**Set<Author> friendAuthors()**

**2)class "Borrower" with the attributes:**

**private int borrowerNo,**

**private TelephoneNumber telephone,**

**private EmailAddress emailAddress,**

**private Address address,**

**private BorrowerCategory category,**

**private Person person = new Person(),**

**private Set<Loan> loans = new HashSet<Loan>(),**

**and with the methods:**

**Setters and Getters for every attribute and a constructor,**

**public Set<Loan> getLoans(),**

**Set<Loan> friendLoans(),**

**public int countPendingItems(),**

**public boolean canBorrow(),**

**public LocalDate getLoanDue(LocalDate loanDate),**

**public Money getDailyFine()**

**3)class "BorrowerCategory" with the attributes:**

**private String description,**

**private int maxLendingItems,**

**private int maxLendingDays,**

**private Money dailyFine,**

**and with the methods:**

**Setters and Getters for every attribute and a constructor,**

**public LocalDate getLoanDue(LocalDate loanDate),**

**public boolean canBorrow(int pendingItems)**

**4)class "Item" with the attributes:**

**private int itemNumber = 0,**

**private Book book,**

**private ItemState state = ItemState.NEW**

**and with the methods:**

**Setters and Getters for every attribute and a constructor,**

**public Loan borrow(Borrower borrower),**

**public void available(),**

**public void withdraw(),**

**public void lost(),**

**5)enum class "ItemState" with the Enum values :**

**NEW,AVAILABLE,LOANED,LOST,WITHDRAWN**

**6)class "Loan" with the attributes:**

**private LocalDate loanDate = SystemDate.now(),**

**private LocalDate returnDate,**

**private Borrower borrower,**

**private Item item**

**and with the methods:**

**Setters and Getters for every attribute and a constructor,**

**public LocalDate getDue(),**

**public boolean isPending(),**

**public void returnItem(),**

**public boolean isOverdue(),**

**public long daysToDue(),**

**public long getOverdue(),**

**public Money getFine(),**

**7)class "Person" with the attributes:**

**private String firstName,**

**private String lastName,**

**and with the methods:**

**Setters and Getters for every attribute and a constructor**

**In the next message I will provide you with the features/scenarios**

**ChatGPT**

Great, I have noted down the details of your domain classes. Now, please provide the Gherkin scenarios for the features of your library system application. Once I have those, I'll be able to help you implement the Step definitions and necessary service, DAO, and domain logic in Java.

**User**

**The Gherkin scenarios are :**

**The first feature is :**

**Feature: Borrower handling by the system**

**The system can register a new person, modify their credentials or delete their account**

**User Story: As a librarian,**

**I want to efficiently manage the loaning process of books to registered borrowers**

**So that borrowers can easily borrow books from the library.**

**Scenario: Registering a new borrower**

**This scenario describes the process of registering a new borrower in the library system**

**Given George Red is not registered as a borrower**

**When George Red gets registered in the system with a unique borrower number and his details**

**Then the system successfully stores the borrower's details**

**Scenario: Borrower trying to register has registered before**

**This scenario describes what happens when the system tries to register a new borrower who has already registered before**

**Given George Red is registered as a borrower**

**When the system attempts to register George Red with a unique borrower number and his details**

**Then the system informs that the user already exists**

**Scenario: Updating the borrower's details when he is registered**

**This scenario describes the process of updating the details of a borrower who has already registered before**

**Given George Red is registered as a borrower**

**When George Red updates his borrowing details**

**Then the system saves the changes**

**Scenario: Updating the borrower's details when he hasn't registered**

**This scenario describes what happens when the system tries to update the details of a borrower who has not registered before**

**Given George Red is not registered as a borrower**

**When George Red tries to update his borrowing details**

**Then the system displays an error message indicating that George Red does not exist**

**Scenario: Deleting a borrower**

**This scenario describes the process of deleting the account of a borrower who has already registered**

**Given George Red is registered as a borrower**

**When the system deletes George Red's account**

**Then the system removes George Red's details**

**Scenario: Deleting a borrower when he hasn't registered**

**This scenario describes what happens when the system tries to delete the account of a borrower who has not registered before**

**Given George Red is not registered as a borrower**

**When the system attempts to delete George Red's account**

**Then the system informs that the borrower does not exist**

**Scenario: Handling unreturned items of books**

**This scenario describes what happens when the system tries to delete the account of a borrower who has pending items to return**

**Given George Red is registered as a borrower**

**And George Red has pending items**

**When the system attempts to delete George Red's account**

**Then the system does not remove George Red's details**

**And the system informs about the pending items**

**The second feature is :**

**Feature: Delayed Return Notification**

**User Story**

**a Library Manager**

**I want the loan system to automatically notify via email those who have delayed the return of an item**

**So that borrowers are informed when they have delayed the return of an item**

**Scenario: Notifying the borrower via email**

**This scenario handles the case where an item hasn't been returned on time and the system must notify the borrower via email**

**Given George Red has borrowed the item Harry Potter**

**And Harry Potter's due date has passed**

**And George Red has an email address**

**When the system executes the delayed return notification process**

**Then George Red receives an email notification for the return of the item**

**Scenario: Borrower does not have an email address**

**This scenario handles the case where an item hasn't been returned on time and the system must notify the user via email but he doesn't have one**

**Given George Red has borrowed the item Harry Potter**

**And Harry Potter's due date has passed**

**And George Red does not have an email address**

**When the system executes the delayed return notification process**

**Then George Red does not receive an email notification for the return of the item**

**The third feature is :**

**Feature: Loaning items**

**The library application allows for the librarian to loan an item of a book to a borrower based**

**on some conditions of the system**

**User story: As a library member**

**I want to be able to borrow items**

**So that I can study them at home**

**Scenario: Successful loaning of an item**

**This scenario describes the successful process of loaning an item to a borrower that is entitled to borrow**

**Given the library has the item Harry Potter available**

**And George Red is a registered borrower**

**And George Red has 2 pending items to be returned**

**And George Red has been assigned a maximum lending limit of 5**

**When George Red borrows the item Harry Potter**

**Then the system successfully loans the item Harry Potter to George Red with a due date set**

**And George Red's pending items increase to 3**

**Scenario: Borrower can borrow only one item due to his lending limit**

**This scenario describes the successful process of loaning only one but not two items to a borrower that is entitled to borrow only one item**

**Given the library has the items Harry Potter and Moby Dick available**

**And George Red is a registered borrower**

**And George Red has 2 pending items to be returned**

**And George Red has been assigned a maximum lending limit of 3**

**When George Red tries to borrow both items**

**Then the system successfully loans the item Harry Potter to George Red with a due date set**

**And the system does not loan Moby Dick to George Red due to the lending limit reached**

**And George Red's pending items increase to 3**

**Scenario: Item not found**

**This scenario describes the edge case where the library system cannot find the item, so the loan isn't happening**

**Given the item Harry Potter is in the library but not in the system**

**And George Red is a registered borrower**

**When George Red tries to borrow the item Harry Potter**

**Then the system returns an error due to the item's status**

**And the system withdraws the item Harry Potter**

**Scenario: The borrower is not eligible to borrow**

**This scenario describes the unsuccessful process of loaning an item to a borrower that has reached his max lending limit**

**Given the library has the item Harry Potter available**

**And George Red is a registered borrower**

**And George Red has 3 pending items to be returned**

**And George Red has been assigned a maximum lending limit of 3**

**When George Red tries to borrow the item Harry Potter**

**Then the system doesn't allow the loan**

**And George Red's pending items remain 3**

**and the last feature is :**

**Feature: Returning a borrowed item to the library**

**The borrower returns the book copy in the library and then the system needs to accept it based on some conditions**

**User story: As a librarian**

**I want to accurately record the return of one or more books**

**So that books are returned on time, and late returns are fined**

**Scenario: Successful return of an item**

**This scenario describes the successful process of returning an item by a borrower**

**Given George Red borrowed the item Animal Kingdom 5 days prior to today's date**

**And George Red has been assigned maximum lending days of 10**

**When the return of Animal Kingdom is processed**

**Then the system marks the state of Animal Kingdom as AVAILABLE**

**And George Red has one less pending item**

**And George Red does not pay a fine**

**And the return date of the loan is set to today's date**

**Scenario: Late return of an item from a borrower**

**This scenario describes what happens when a borrower returns a loaned item late and has to pay a fine**

**Given George Red borrowed the item Animal Kingdom 10 days prior to today's date**

**And George Red has been assigned maximum lending days of 7**

**When the return of Animal Kingdom is processed**

**Then the system marks the state of Animal Kingdom as AVAILABLE**

**And George Red pays a fine based on the borrower category**

**And the return date of the loan is set to today's date**

**ChatGPT**

Based on the given domain classes and Gherkin scenarios, we will follow a structured approach to implement the Step definitions and necessary service, DAO, and domain logic in Java.

Here is the plan:

1. \*\*Data Access Objects (DAOs)\*\*: Create DAOs for each of the domain classes to handle the database operations.

2. \*\*Services\*\*: Create service classes to encapsulate the business logic.

3. \*\*Step Definitions\*\*: Implement the step definitions based on the Gherkin scenarios.

### Step 1: Create Data Access Objects (DAOs)

\*\*BorrowerDAO.java\*\*

```java

import java.util.HashMap;

import java.util.Map;

public class BorrowerDAO {

private Map<Integer, Borrower> borrowers = new HashMap<>();

public void save(Borrower borrower) {

borrowers.put(borrower.getBorrowerNo(), borrower);

}

public Borrower findById(int borrowerNo) {

return borrowers.get(borrowerNo);

}

public void delete(int borrowerNo) {

borrowers.remove(borrowerNo);

}

public boolean exists(int borrowerNo) {

return borrowers.containsKey(borrowerNo);

}

}

```

### Step 2: Create Service Classes

\*\*BorrowerService.java\*\*

```java

public class BorrowerService {

private BorrowerDAO borrowerDAO;

public BorrowerService(BorrowerDAO borrowerDAO) {

this.borrowerDAO = borrowerDAO;

}

public void registerBorrower(Borrower borrower) throws Exception {

if (borrowerDAO.exists(borrower.getBorrowerNo())) {

throw new Exception("Borrower already exists");

}

borrowerDAO.save(borrower);

}

public void updateBorrower(Borrower borrower) throws Exception {

if (!borrowerDAO.exists(borrower.getBorrowerNo())) {

throw new Exception("Borrower does not exist");

}

borrowerDAO.save(borrower);

}

public void deleteBorrower(int borrowerNo) throws Exception {

if (!borrowerDAO.exists(borrowerNo)) {

throw new Exception("Borrower does not exist");

}

Borrower borrower = borrowerDAO.findById(borrowerNo);

if (borrower.countPendingItems() > 0) {

throw new Exception("Borrower has pending items");

}

borrowerDAO.delete(borrowerNo);

}

}

```

### Step 3: Implement Step Definitions

\*\*BorrowerStepDefinitions.java\*\*

```java

import io.cucumber.java.en.Given;

import io.cucumber.java.en.When;

import io.cucumber.java.en.Then;

import static org.junit.Assert.\*;

public class BorrowerStepDefinitions {

private BorrowerDAO borrowerDAO = new BorrowerDAO();

private BorrowerService borrowerService = new BorrowerService(borrowerDAO);

private Borrower borrower;

private Exception exception;

@Given("George Red is not registered as a borrower")

public void george\_red\_is\_not\_registered\_as\_a\_borrower() {

borrower = new Borrower(1, /\*other details\*/);

borrowerDAO.delete(borrower.getBorrowerNo());

}

@When("George Red gets registered in the system with a unique borrower number and his details")

public void george\_red\_gets\_registered\_in\_the\_system() {

try {

borrowerService.registerBorrower(borrower);

} catch (Exception e) {

exception = e;

}

}

@Then("the system successfully stores the borrower's details")

public void the\_system\_successfully\_stores\_the\_borrower\_s\_details() {

assertNull(exception);

assertNotNull(borrowerDAO.findById(borrower.getBorrowerNo()));

}

@Given("George Red is registered as a borrower")

public void george\_red\_is\_registered\_as\_a\_borrower() {

borrower = new Borrower(1, /\*other details\*/);

borrowerDAO.save(borrower);

}

@When("the system attempts to register George Red with a unique borrower number and his details")

public void the\_system\_attempts\_to\_register\_george\_red() {

try {

borrowerService.registerBorrower(borrower);

} catch (Exception e) {

exception = e;

}

}

@Then("the system informs that the user already exists")

public void the\_system\_informs\_that\_the\_user\_already\_exists() {

assertNotNull(exception);

assertEquals("Borrower already exists", exception.getMessage());

}

@When("George Red updates his borrowing details")

public void george\_red\_updates\_his\_borrowing\_details() {

borrower.setEmailAddress(new EmailAddress("newemail@example.com"));

try {

borrowerService.updateBorrower(borrower);

} catch (Exception e) {

exception = e;

}

}

@Then("the system saves the changes")

public void the\_system\_saves\_the\_changes() {

assertNull(exception);

assertEquals("newemail@example.com", borrowerDAO.findById(borrower.getBorrowerNo()).getEmailAddress().getEmail());

}

@When("George Red tries to update his borrowing details")

public void george\_red\_tries\_to\_update\_his\_borrowing\_details() {

try {

borrowerService.updateBorrower(borrower);

} catch (Exception e) {

exception = e;

}

}

@Then("the system displays an error message indicating that George Red does not exist")

public void the\_system\_displays\_an\_error\_message() {

assertNotNull(exception);

assertEquals("Borrower does not exist", exception.getMessage());

}

@When("the system deletes George Red's account")

public void the\_system\_deletes\_george\_red\_s\_account() {

try {

borrowerService.deleteBorrower(borrower.getBorrowerNo());

} catch (Exception e) {

exception = e;

}

}

@Then("the system removes George Red's details")

public void the\_system\_removes\_george\_red\_s\_details() {

assertNull(exception);

assertNull(borrowerDAO.findById(borrower.getBorrowerNo()));

}

@When("the system attempts to delete George Red's account")

public void the\_system\_attempts\_to\_delete\_george\_red\_s\_account() {

try {

borrowerService.deleteBorrower(borrower.getBorrowerNo());

} catch (Exception e) {

exception = e;

}

}

@Then("the system informs that the borrower does not exist")

public void the\_system\_informs\_that\_the\_borrower\_does\_not\_exist() {

assertNotNull(exception);

assertEquals("Borrower does not exist", exception.getMessage());

}

@Given("George Red has pending items")

public void george\_red\_has\_pending\_items() {

Loan loan = new Loan(LocalDate.now().minusDays(5), null, borrower, new Item(1, /\*other details\*/));

borrower.getLoans().add(loan);

}

@Then("the system does not remove George Red's details")

public void the\_system\_does\_not\_remove\_george\_red\_s\_details() {

assertNotNull(exception);

assertEquals("Borrower has pending items", exception.getMessage());

}

@Then("the system informs about the pending items")

public void the\_system\_informs\_about\_the\_pending\_items() {

assertNotNull(exception);

assertEquals("Borrower has pending items", exception.getMessage());

}

}

```

The implementation includes the data access object for the `Borrower`, the service class handling the business logic, and the step definitions for the feature "Borrower handling by the system". Similar steps can be followed for implementing the rest of the features and scenarios. Let me know if you want the implementations for other features or any specific part elaborated.

**User**

**implement all the step definitions of all the features I provided you with**

**ChatGPT**

Sure, I'll provide the complete implementation of the step definitions for all the features and scenarios you provided. To keep the response organized, I'll group the step definitions by feature.

### Step Definitions for Borrower Handling

\*\*BorrowerStepDefinitions.java\*\*

```java

import io.cucumber.java.en.Given;

import io.cucumber.java.en.When;

import io.cucumber.java.en.Then;

import static org.junit.Assert.\*;

import java.time.LocalDate;

import java.util.HashSet;

public class BorrowerStepDefinitions {

private BorrowerDAO borrowerDAO = new BorrowerDAO();

private BorrowerService borrowerService = new BorrowerService(borrowerDAO);

private Borrower borrower;

private Exception exception;

@Given("George Red is not registered as a borrower")

public void george\_red\_is\_not\_registered\_as\_a\_borrower() {

borrower = new Borrower(1, /\* TelephoneNumber \*/, /\* EmailAddress \*/, /\* Address \*/, /\* BorrowerCategory \*/, new Person("George", "Red"), new HashSet<>());

borrowerDAO.delete(borrower.getBorrowerNo());

}

@When("George Red gets registered in the system with a unique borrower number and his details")

public void george\_red\_gets\_registered\_in\_the\_system() {

try {

borrowerService.registerBorrower(borrower);

} catch (Exception e) {

exception = e;

}

}

@Then("the system successfully stores the borrower's details")

public void the\_system\_successfully\_stores\_the\_borrower\_s\_details() {

assertNull(exception);

assertNotNull(borrowerDAO.findById(borrower.getBorrowerNo()));

}

@Given("George Red is registered as a borrower")

public void george\_red\_is\_registered\_as\_a\_borrower() {

borrower = new Borrower(1, /\* TelephoneNumber \*/, /\* EmailAddress \*/, /\* Address \*/, /\* BorrowerCategory \*/, new Person("George", "Red"), new HashSet<>());

borrowerDAO.save(borrower);

}

@When("the system attempts to register George Red with a unique borrower number and his details")

public void the\_system\_attempts\_to\_register\_george\_red() {

try {

borrowerService.registerBorrower(borrower);

} catch (Exception e) {

exception = e;

}

}

@Then("the system informs that the user already exists")

public void the\_system\_informs\_that\_the\_user\_already\_exists() {

assertNotNull(exception);

assertEquals("Borrower already exists", exception.getMessage());

}

@When("George Red updates his borrowing details")

public void george\_red\_updates\_his\_borrowing\_details() {

borrower.setEmailAddress(new EmailAddress("newemail@example.com"));

try {

borrowerService.updateBorrower(borrower);

} catch (Exception e) {

exception = e;

}

}

@Then("the system saves the changes")

public void the\_system\_saves\_the\_changes() {

assertNull(exception);

assertEquals("newemail@example.com", borrowerDAO.findById(borrower.getBorrowerNo()).getEmailAddress().getEmail());

}

@When("George Red tries to update his borrowing details")

public void george\_red\_tries\_to\_update\_his\_borrowing\_details() {

try {

borrowerService.updateBorrower(borrower);

} catch (Exception e) {

exception = e;

}

}

@Then("the system displays an error message indicating that George Red does not exist")

public void the\_system\_displays\_an\_error\_message() {

assertNotNull(exception);

assertEquals("Borrower does not exist", exception.getMessage());

}

@When("the system deletes George Red's account")

public void the\_system\_deletes\_george\_red\_s\_account() {

try {

borrowerService.deleteBorrower(borrower.getBorrowerNo());

} catch (Exception e) {

exception = e;

}

}

@Then("the system removes George Red's details")

public void the\_system\_removes\_george\_red\_s\_details() {

assertNull(exception);

assertNull(borrowerDAO.findById(borrower.getBorrowerNo()));

}

@When("the system attempts to delete George Red's account")

public void the\_system\_attempts\_to\_delete\_george\_red\_s\_account() {

try {

borrowerService.deleteBorrower(borrower.getBorrowerNo());

} catch (Exception e) {

exception = e;

}

}

@Then("the system informs that the borrower does not exist")

public void the\_system\_informs\_that\_the\_borrower\_does\_not\_exist() {

assertNotNull(exception);

assertEquals("Borrower does not exist", exception.getMessage());

}

@Given("George Red has pending items")

public void george\_red\_has\_pending\_items() {

Item item = new Item(1, new Book(/\* ISBN \*/, "Harry Potter", "Publication", 2020, new Publisher(), new HashSet<>(), new HashSet<>()), ItemState.LOANED);

Loan loan = new Loan(LocalDate.now().minusDays(5), null, borrower, item);

borrower.getLoans().add(loan);

}

@Then("the system does not remove George Red's details")

public void the\_system\_does\_not\_remove\_george\_red\_s\_details() {

assertNotNull(exception);

assertEquals("Borrower has pending items", exception.getMessage());

}

@Then("the system informs about the pending items")

public void the\_system\_informs\_about\_the\_pending\_items() {

assertNotNull(exception);

assertEquals("Borrower has pending items", exception.getMessage());

}

}

```

### Step Definitions for Delayed Return Notification

\*\*DelayedReturnNotificationStepDefinitions.java\*\*

```java

import io.cucumber.java.en.Given;

import io.cucumber.java.en.When;

import io.cucumber.java.en.Then;

import static org.junit.Assert.\*;

import java.time.LocalDate;

import java.util.HashSet;

public class DelayedReturnNotificationStepDefinitions {

private BorrowerDAO borrowerDAO = new BorrowerDAO();

private NotificationService notificationService = new NotificationService(borrowerDAO);

private Borrower borrower;

private Book book;

private Item item;

private Exception exception;

@Given("George Red has borrowed the item Harry Potter")

public void george\_red\_has\_borrowed\_the\_item\_harry\_potter() {

book = new Book(/\* ISBN \*/, "Harry Potter", "Publication", 2020, new Publisher(), new HashSet<>(), new HashSet<>());

item = new Item(1, book, ItemState.LOANED);

borrower = new Borrower(1, /\* TelephoneNumber \*/, new EmailAddress("george@example.com"), /\* Address \*/, /\* BorrowerCategory \*/, new Person("George", "Red"), new HashSet<>());

Loan loan = new Loan(LocalDate.now().minusDays(10), null, borrower, item);

borrower.getLoans().add(loan);

borrowerDAO.save(borrower);

}

@Given("Harry Potter's due date has passed")

public void harry\_potter\_s\_due\_date\_has\_passed() {

// This is already handled in the previous step

}

@Given("George Red has an email address")

public void george\_red\_has\_an\_email\_address() {

assertNotNull(borrower.getEmailAddress());

}

@When("the system executes the delayed return notification process")

public void the\_system\_executes\_the\_delayed\_return\_notification\_process() {

try {

notificationService.notifyDelayedReturn();

} catch (Exception e) {

exception = e;

}

}

@Then("George Red receives an email notification for the return of the item")

public void george\_red\_receives\_an\_email\_notification\_for\_the\_return\_of\_the\_item() {

assertNull(exception);

// Add assertion to check if the email was sent (implementation dependent)

}

@Given("George Red does not have an email address")

public void george\_red\_does\_not\_have\_an\_email\_address() {

borrower.setEmailAddress(null);

borrowerDAO.save(borrower);

}

@Then("George Red does not receive an email notification for the return of the item")

public void george\_red\_does\_not\_receive\_an\_email\_notification\_for\_the\_return\_of\_the\_item() {

assertNull(exception);

// Add assertion to check if the email was not sent (implementation dependent)

}

}

```

### Step Definitions for Loaning Items

\*\*LoaningItemsStepDefinitions.java\*\*

```java

import io.cucumber.java.en.Given;

import io.cucumber.java.en.When;

import io.cucumber.java.en.Then;

import static org.junit.Assert.\*;

import java.util.HashSet;

public class LoaningItemsStepDefinitions {

private BorrowerDAO borrowerDAO = new BorrowerDAO();

private BookDAO bookDAO = new BookDAO();

private LoanService loanService = new LoanService(borrowerDAO, bookDAO);

private Borrower borrower;

private Book bookHarryPotter;

private Book bookMobyDick;

private Item itemHarryPotter;

private Item itemMobyDick;

private Exception exception;

@Given("the library has the item Harry Potter available")

public void the\_library\_has\_the\_item\_harry\_potter\_available() {

bookHarryPotter = new Book(/\* ISBN \*/, "Harry Potter", "Publication", 2020, new Publisher(), new HashSet<>(), new HashSet<>());

itemHarryPotter = new Item(1, bookHarryPotter, ItemState.AVAILABLE);

bookHarryPotter.addItem(itemHarryPotter);

bookDAO.save(bookHarryPotter);

}

@Given("George Red is a registered borrower")

public void george\_red\_is\_a\_registered

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\_borrower() {

borrower = new Borrower(1, /\* TelephoneNumber \*/, new EmailAddress("george@example.com"), /\* Address \*/, new BorrowerCategory("Standard", 5, 10, new Money(10)), new Person("George", "Red"), new HashSet<>());

borrowerDAO.save(borrower);

}

@Given("George Red has {int} pending items to be returned")

public void george\_red\_has\_pending\_items\_to\_be\_returned(int pendingItems) {

for (int i = 0; i < pendingItems; i++) {

Item item = new Item(i + 1, bookHarryPotter, ItemState.LOANED);

Loan loan = new Loan(LocalDate.now().minusDays(5), null, borrower, item);

borrower.getLoans().add(loan);

}

}

@Given("George Red has been assigned a maximum lending limit of {int}")

public void george\_red\_has\_been\_assigned\_a\_maximum\_lending\_limit\_of(int maxLendingLimit) {

borrower.getCategory().setMaxLendingItems(maxLendingLimit);

borrowerDAO.save(borrower);

}

@When("George Red borrows the item Harry Potter")

public void george\_red\_borrows\_the\_item\_harry\_potter() {

try {

loanService.loanItem(borrower.getBorrowerNo(), itemHarryPotter.getItemNumber());

} catch (Exception e) {

exception = e;

}

}

@Then("the system successfully loans the item Harry Potter to George Red with a due date set")

public void the\_system\_successfully\_loans\_the\_item\_harry\_potter\_to\_george\_red\_with\_a\_due\_date\_set() {

assertNull(exception);

assertEquals(ItemState.LOANED, itemHarryPotter.getState());

assertNotNull(itemHarryPotter.getBorrow().getDue());

}

@Then("George Red's pending items increase to {int}")

public void george\_red\_s\_pending\_items\_increase\_to(int pendingItems) {

assertEquals(pendingItems, borrower.countPendingItems());

}

@Given("the library has the items Harry Potter and Moby Dick available")

public void the\_library\_has\_the\_items\_harry\_potter\_and\_moby\_dick\_available() {

bookMobyDick = new Book(/\* ISBN \*/, "Moby Dick", "Publication", 2020, new Publisher(), new HashSet<>(), new HashSet<>());

itemMobyDick = new Item(2, bookMobyDick, ItemState.AVAILABLE);

bookMobyDick.addItem(itemMobyDick);

bookDAO.save(bookMobyDick);

}

@When("George Red tries to borrow both items")

public void george\_red\_tries\_to\_borrow\_both\_items() {

try {

loanService.loanItem(borrower.getBorrowerNo(), itemHarryPotter.getItemNumber());

loanService.loanItem(borrower.getBorrowerNo(), itemMobyDick.getItemNumber());

} catch (Exception e) {

exception = e;

}

}

@Then("the system does not loan Moby Dick to George Red due to the lending limit reached")

public void the\_system\_does\_not\_loan\_moby\_dick\_to\_george\_red\_due\_to\_the\_lending\_limit\_reached() {

assertNotNull(exception);

assertEquals("Borrower has reached the maximum lending limit", exception.getMessage());

assertEquals(ItemState.AVAILABLE, itemMobyDick.getState());

}

@Given("the item Harry Potter is in the library but not in the system")

public void the\_item\_harry\_potter\_is\_in\_the\_library\_but\_not\_in\_the\_system() {

bookHarryPotter = new Book(/\* ISBN \*/, "Harry Potter", "Publication", 2020, new Publisher(), new HashSet<>(), new HashSet<>());

itemHarryPotter = new Item(1, bookHarryPotter, ItemState.NEW);

bookHarryPotter.addItem(itemHarryPotter);

}

@When("George Red tries to borrow the item Harry Potter")

public void george\_red\_tries\_to\_borrow\_the\_item\_harry\_potter() {

try {

loanService.loanItem(borrower.getBorrowerNo(), itemHarryPotter.getItemNumber());

} catch (Exception e) {

exception = e;

}

}

@Then("the system returns an error due to the item's status")

public void the\_system\_returns\_an\_error\_due\_to\_the\_item\_s\_status() {

assertNotNull(exception);

assertEquals("Item is not available for loan", exception.getMessage());

}

@Then("the system withdraws the item Harry Potter")

public void the\_system\_withdraws\_the\_item\_harry\_potter() {

assertEquals(ItemState.WITHDRAWN, itemHarryPotter.getState());

}

@When("George Red tries to borrow the item Harry Potter")

public void george\_red\_tries\_to\_borrow\_the\_item\_harry\_potter\_again() {

try {

loanService.loanItem(borrower.getBorrowerNo(), itemHarryPotter.getItemNumber());

} catch (Exception e) {

exception = e;

}

}

@Then("the system doesn't allow the loan")

public void the\_system\_doesn\_t\_allow\_the\_loan() {

assertNotNull(exception);

assertEquals("Borrower has reached the maximum lending limit", exception.getMessage());

}

@Then("George Red's pending items remain {int}")

public void george\_red\_s\_pending\_items\_remain(int pendingItems) {

assertEquals(pendingItems, borrower.countPendingItems());

}

}

```

### Step Definitions for Returning a Borrowed Item

\*\*ReturningItemsStepDefinitions.java\*\*

```java

import io.cucumber.java.en.Given;

import io.cucumber.java.en.When;

import io.cucumber.java.en.Then;

import static org.junit.Assert.\*;

import java.time.LocalDate;

import java.util.HashSet;

public class ReturningItemsStepDefinitions {

private BorrowerDAO borrowerDAO = new BorrowerDAO();

private BookDAO bookDAO = new BookDAO();

private ReturnService returnService = new ReturnService(borrowerDAO, bookDAO);

private Borrower borrower;

private Book bookAnimalKingdom;

private Item itemAnimalKingdom;

private Exception exception;

@Given("George Red borrowed the item Animal Kingdom {int} days prior to today's date")

public void george\_red\_borrowed\_the\_item\_animal\_kingdom\_days\_prior\_to\_today\_s\_date(int daysPrior) {

bookAnimalKingdom = new Book(/\* ISBN \*/, "Animal Kingdom", "Publication", 2020, new Publisher(), new HashSet<>(), new HashSet<>());

itemAnimalKingdom = new Item(1, bookAnimalKingdom, ItemState.LOANED);

bookAnimalKingdom.addItem(itemAnimalKingdom);

borrower = new Borrower(1, /\* TelephoneNumber \*/, new EmailAddress("george@example.com"), /\* Address \*/, new BorrowerCategory("Standard", 5, 10, new Money(10)), new Person("George", "Red"), new HashSet<>());

Loan loan = new Loan(LocalDate.now().minusDays(daysPrior), null, borrower, itemAnimalKingdom);

borrower.getLoans().add(loan);

borrowerDAO.save(borrower);

bookDAO.save(bookAnimalKingdom);

}

@Given("George Red has been assigned maximum lending days of {int}")

public void george\_red\_has\_been\_assigned\_maximum\_lending\_days\_of(int maxLendingDays) {

borrower.getCategory().setMaxLendingDays(maxLendingDays);

borrowerDAO.save(borrower);

}

@When("the return of Animal Kingdom is processed")

public void the\_return\_of\_animal\_kingdom\_is\_processed() {

try {

returnService.returnItem(borrower.getBorrowerNo(), itemAnimalKingdom.getItemNumber());

} catch (Exception e) {

exception = e;

}

}

@Then("the system marks the state of Animal Kingdom as AVAILABLE")

public void the\_system\_marks\_the\_state\_of\_animal\_kingdom\_as\_available() {

assertEquals(ItemState.AVAILABLE, itemAnimalKingdom.getState());

}

@Then("George Red has one less pending item")

public void george\_red\_has\_one\_less\_pending\_item() {

assertEquals(0, borrower.countPendingItems());

}

@Then("George Red does not pay a fine")

public void george\_red\_does\_not\_pay\_a\_fine() {

assertEquals(0, borrower.getLoans().iterator().next().getFine().getAmount().intValue());

}

@Then("the return date of the loan is set to today's date")

public void the\_return\_date\_of\_the\_loan\_is\_set\_to\_today\_s\_date() {

assertEquals(LocalDate.now(), borrower.getLoans().iterator().next().getReturnDate());

}

@Then("George Red pays a fine based on the borrower category")

public void george\_red\_pays\_a\_fine\_based\_on\_the\_borrower\_category() {

assertEquals(30, borrower.getLoans().iterator().next().getFine().getAmount().intValue());

}

}

```

### Conclusion

This implementation includes the data access object (DAO) for `Borrower` and `Book`, the service classes (`BorrowerService`, `NotificationService`, `LoanService`, and `ReturnService`) handling the business logic, and the step definitions for the features "Borrower handling by the system", "Delayed Return Notification", "Loaning items", and "Returning a borrowed item to the library".

Make sure to implement the remaining DAOs (`BookDAO`, `LoanDAO`) and the service classes (`

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NotificationService`, `LoanService`, and `ReturnService`) similarly. You may also need to add additional utility classes like `EmailService` to handle email notifications.

Feel free to reach out if you need further assistance or more details on any part of the implementation.