《Software Engineering Project》

Project report

Title：Design and implementation of library management system

Class：18lq Computer Science 1 Class Group

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Catalogue

1. Design and implementation of library management system

Software requirements: The system includes three roles: system administrator, librarian and borrower. The system functions include test paper entry, test paper generation, automatic test paper correction, score export, etc.

Please complete the report following the below format and send it to xdh628@163.com before next Sunday（December 19th）.

Body part

1. System introduction

A Library Management System is a software built to handle the primary housekeeping functions of a library. Libraries rely on library management systems to manage asset collections as well as relationships with their members. Library management systems help libraries keep track of the books and their checkouts, as well as members' subscriptions and profiles.

Library management systems also involve maintaining the database for entering new books and recording books that have been borrowed with their respective due dates.

2. System Requirements

We will focus on the following set of requirements while designing the Library Management System:

1. *Any library member should be able to search books by their title, author, and subject category as well by the publication date.*
2. *Each book will have a unique identification number and other details including a rack number, which will help to physically locate the book.*
3. *There could be more than one copy of a book, and library members should be able to checkout and reserve any copy.*
   We will call each copy of a book, a book item.
4. *The system should be able to retrieve information like who took a particular book or what are the books checked-out by a specific library member.*
5. *There should be a maximum limit (5) on how many books a member can check out.*
6. *There should be a maximum limit (10) on how many days a member can keep a book.*
7. *The system should be able to collect fines for books returned after the due date.*
8. *Members should be able to reserve books that are not currently available.*
9. *The system should be able to send notifications whenever the reserved books become available, as well as when the book is not returned within the due date.*
10. *Each book and member card will have a unique barcode. The system will be able to read barcodes from books and members' library cards.*

3. Detailed design

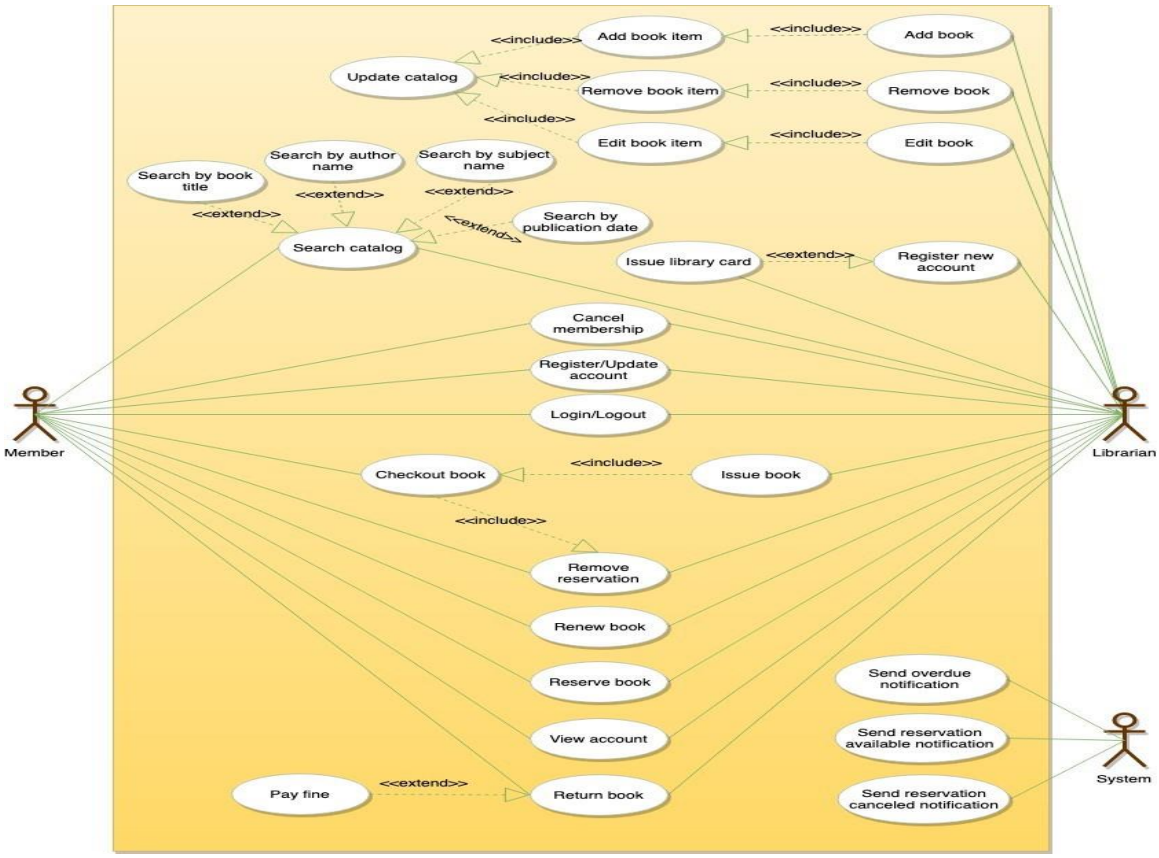
1. Use case diagram

We have three main actors in our system:

- *Librarian: Mainly responsible for adding and modifying books, book items, and users. The Librarian can also issue, reserve, and return book items.*
- *Member: All members can search the catalog, as well as checkout, reserve, renew, and return a book.*
- *System: Mainly responsible for sending notifications for overdue books, canceled reservations, etc.*

Here are the top use cases of the Library Management System:

- *Add/Remove/Edit book: To add, remove or modify a book or book item.*
- *Search catalog: To search books by title, author, subject or publication date.*
- *Register new account/cancel membership: To add a new member or cancel the membership of an existing member.*
- *Checkout book: To borrow a book from the library.*
- *Reserve book: To reserve a book which is not currently available.*
- *Renew a book: To re-borrow an already checked-out book.*
- *Return a book: To return a book to the library which was issued to a member.*



2. Class diagram

Here are the main classes of our Library Management System:

Library: The central part of the organization for which this software has been designed. It has attributes like 'Name' to distinguish it from any other libraries and 'Address' to describe its location.

Book: The basic building block of the system. Every book will have ISBN, Title, Subject, Publishers, etc.

Book Item: Any book can have multiple copies; each copy will be considered a book item in our system. Each book item will have a unique barcode.

Account: We will have two types of accounts in the system, one will be a general member, and the other will be a librarian.

Library Card: Each library user will be issued a library card, which will be used to identify users while issuing or returning books.

Book Reservation: Responsible for managing reservations against book items.

Book Lending: Manage the checking-out of book items.

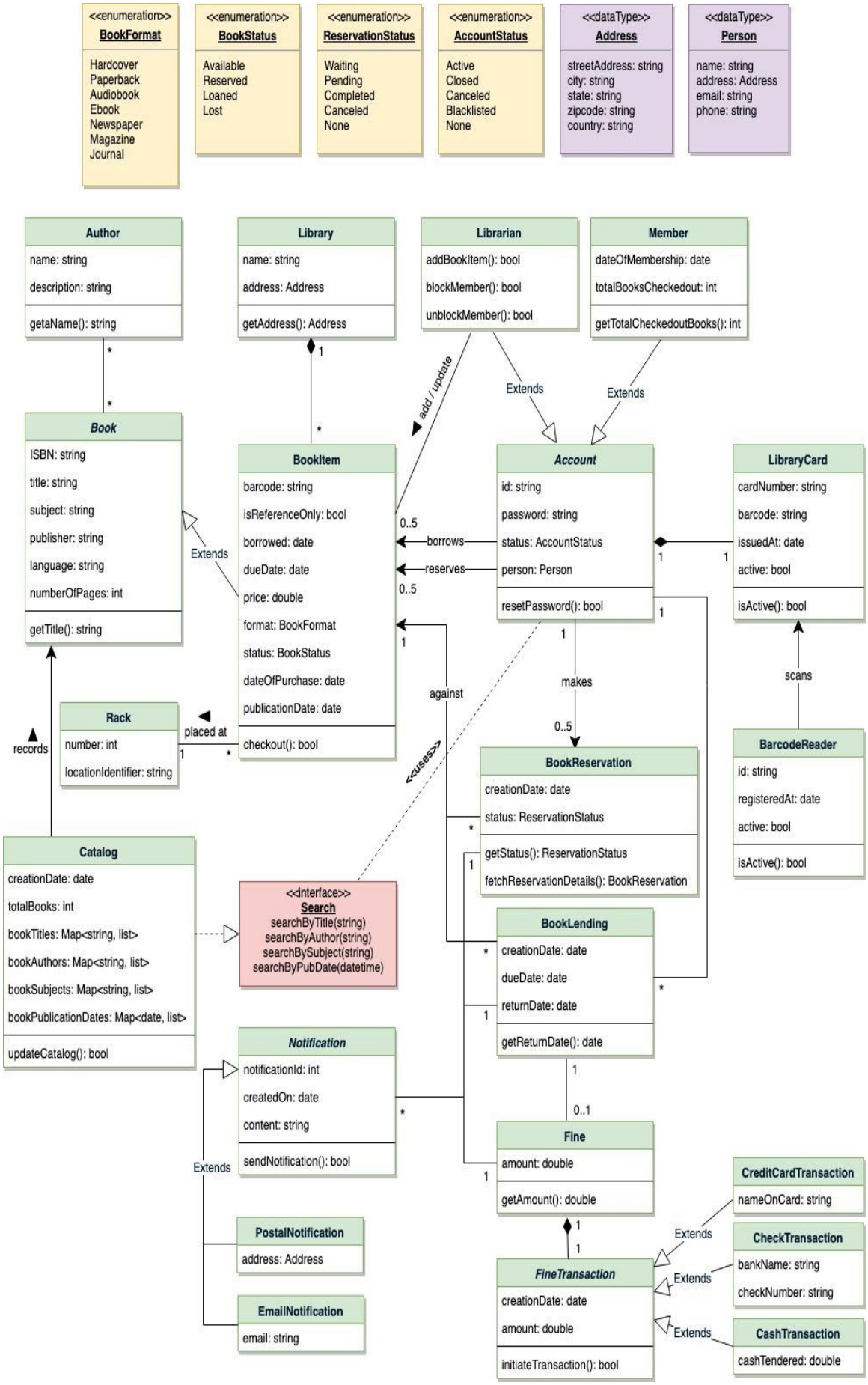
Catalog: Catalogs contain list of books sorted on certain criteria. Our system will support searching through four catalogs: Title, Author, Subject, and Publish-date.

Fine: This class will be responsible for calculating and collecting fines from library members.

Author: This class will encapsulate a book author.

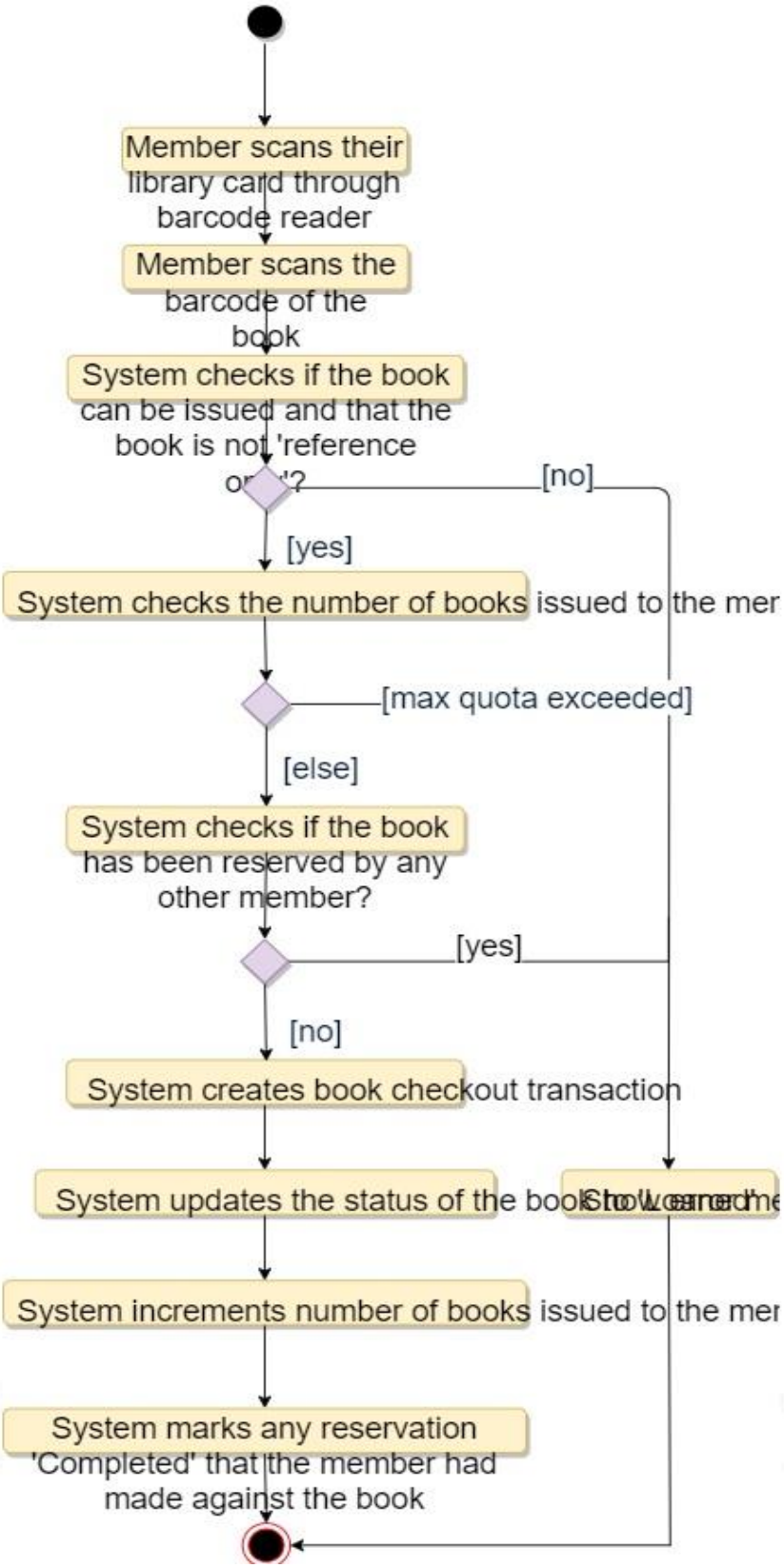
Rack: Books will be placed on racks. Each rack will be identified by a rack number and will have a location identifier to describe the physical location of the rack in the library.

Notification: This class will take care of sending notifications to library members.

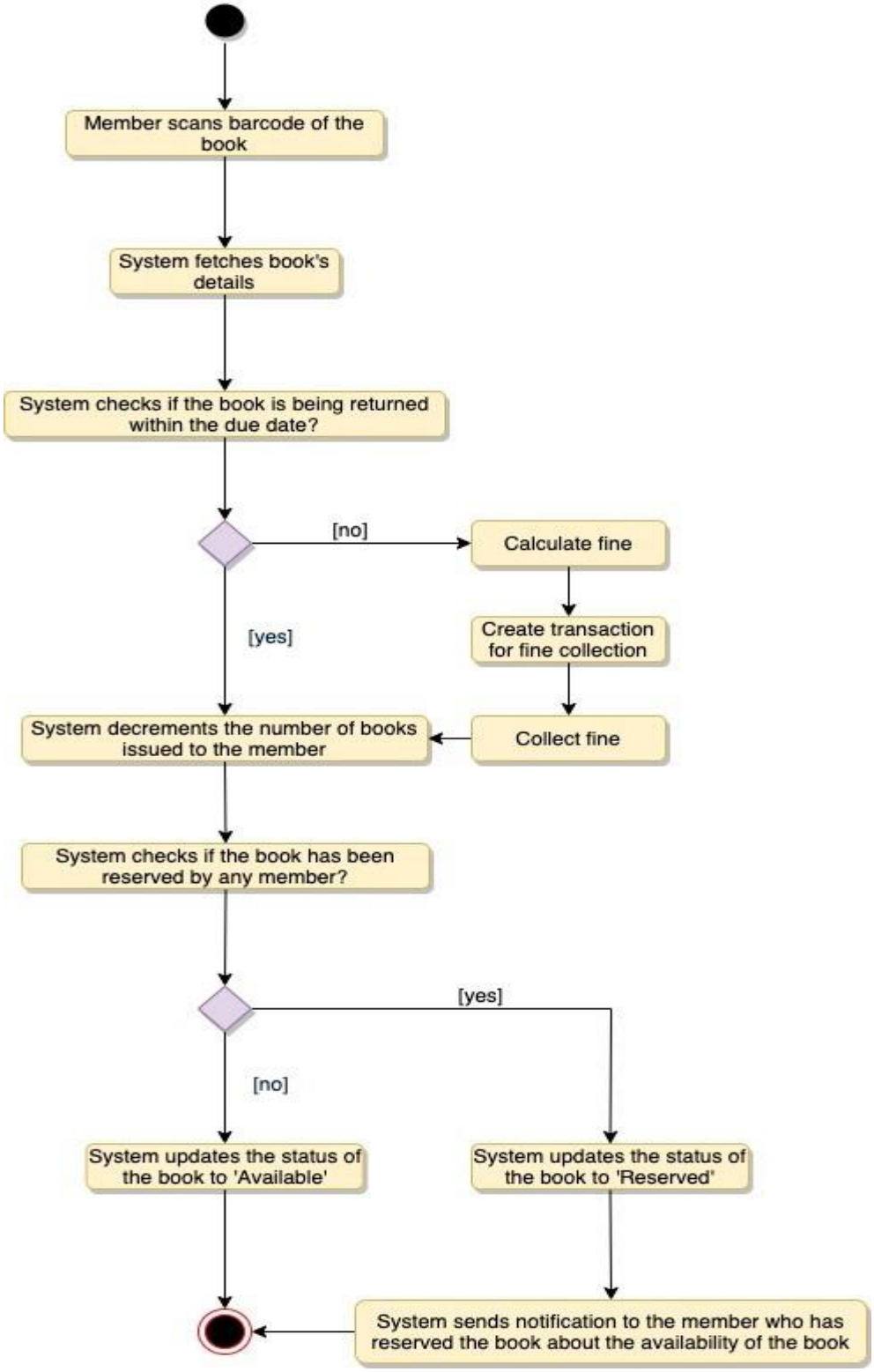

<<enumeration>>
BookFormat
Hardcover
Paperback
Audiobook
Ebook
Newspaper
Magazine
Journal
<<enumeration>>
BookStatus
Available
Reserved
Loaned
Lost
<<enumeration>>
ReservationStatus
Waiting
Pending
Completed
Canceled
None
<<enumeration>>
AccountStatus
Active
Closed
Canceled
Blacklisted
None
<<dataType>>
Address
streetAddress: string
city: string
state: string
zipcode: string
country: string
<<dataType>>
Person
name: string
address: Address
email: string
phone: string
Author
name: string
description: string
getaName(): string
Library
name: string
address: Address
getAddress(): Address
Librarian
addBookItem(): bool
blockMember(): bool
unblockMember(): bool
Member
dateOfMembership: date
totalBooksCheckedout: int
getTotalCheckedoutBooks(): int
Book
ISBN: string
title: string
subject: string
publisher: string
language: string
numberOfPages: int
getTitle(): string
BookItem
barcode: string
isReferenceOnly: bool
borrowed: date
dueDate: date
price: double
format: BookFormat
status: BookStatus
dateOfPurchase: date
publicationDate: date
checkout(): bool
Account
id: string
password: string
status: AccountStatus
person: Person
resetPassword(): bool
LibraryCard
cardNumber: string
barcode: string
issuedAt: date
active: bool
isActive(): bool
Rack
number: int
locationIdentifier: string
BookReservation
creationDate: date
status: ReservationStatus
getStatus(): ReservationStatus
fetchReservationDetails(): BookReservation
BarcodeReader
id: string
registeredAt: date
active: bool
isActive(): bool
Catalog
creationDate: date
totalBooks: int
bookTitles: Map<string, list>
bookAuthors: Map<string, list>
bookSubjects: Map<string, list>
bookPublicationDates: Map<date, list>
updateCatalog(): bool
<<interface>>
Search
searchByTitle(string)
searchByAuthor(string)
searchBySubject(string)
searchByPubDate(datetime)
BookLending
creationDate: date
dueDate: date
returnDate: date
getReturnDate(): date
Notification
notificationId: int
createdOn: date
content: string
sendNotification(): bool
Fine
amount: double
getAmount(): double
PostalNotification
address: Address
EmailNotification
email: string
FineTransaction
creationDate: date
amount: double
initiateTransaction(): bool
CreditCardTransaction
nameOnCard: string
CheckTransaction
bankName: string
checkNumber: string
CashTransaction
cashTendered: double
Extends
add / update
borrows
reserves
makes
against
<<uses>>
placed at
records
scans
0..5
0..1

3. Activity diagrams

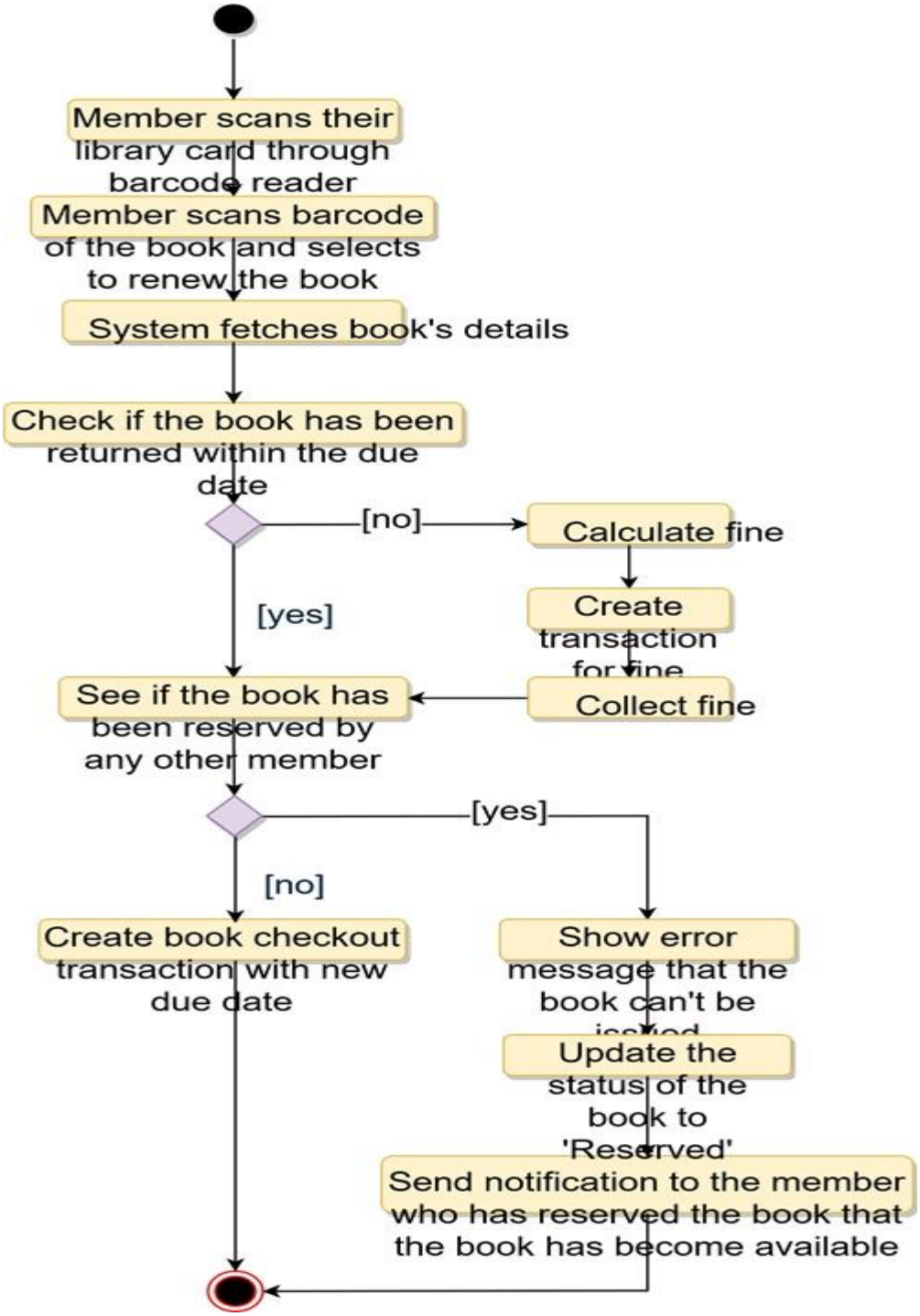
Checkout a book: Any library member or librarian can perform this activity. Here are the set of steps to checkout a book:



Return a book: Any library member or librarian can perform this activity. The system will collect fines from members if they return books after the due date. Here are the steps for returning a book:



Renew a book: While renewing (re-issuing) a book, the system will check for fines and see if any other member has not reserved the same book, in that case the book item cannot be renewed.



Code

Here is the code for the use cases mentioned above:

1. Check-out a book,

2. Return a book, and

3. Renew a book.

Note: This code only focuses on the design part of the use cases. Since you are not required to write a fully executable code in an interview, you can assume parts of the code to interact with the database, payment system, etc.

Enums and Constants.py

Project

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venv library root

Account, Member, and Librarian.py

BookItem.py

BookReservation, BookLending, and Fine.py

Enums and Constants.py

main.py

Search interface and Catalog.py

External Libraries

Scratches and Consoles

Enums and Constants.py × Account, Member, and Librarian.py × BookReservatio

```python
from abc import ABC
from enum import Enum

import self as self

#\/

class BookFormat(Enum):
    HARDCOVER, PAPERBACK, AUDIO_BOOK, EBOOK, NEWSPAPER, MAGAZINE, JOURNAL = 1, 2, 3, 4, 5, 6, 7


class BookStatus(Enum):
    AVAILABLE, RESERVED, LOANED, LOST = 1, 2, 3, 4


class ReservationStatus(Enum):
    WAITING, PENDING, CANCELED, NONE = 1, 2, 3, 4


class AccountStatus(Enum):
    ACTIVE, CLOSED, CANCELED, BLACKLISTED, NONE = 1, 2, 3, 4, 5


class Address:
    def __init__(self, street, city, state, zip_code, country):
        self.__street_address = street
        self.__city = city
        self.__state = state
        self.__zip_code = zip_code
        self.__country = country


class Person(ABC):
    def __init__(self, name, address, email, phone):
        self.__name = name
        self.__address = address
        self.__email = email
        self.__phone = phone


class Constants:
    self.MAX_BOOKS_ISSUED_TO_A_USER = 5
    self.MAX_LENDING_DAYS = 10
```

Account, Member, and Librarian: These classes represent various people that interact with our system:

Enums and Constants.py × Account, Member, and L

```python
from abc import ABC
from datetime import datetime

from BookItem import BookLending, BookStatus


def reset_password():
    None


class AccountStatus:
    pass


class Account(ABC):
    def __init__(self, id, password, person, status=AccountStatus.Active):
        self.__id = id
        self.__password = password
        self.__status = status
        self.__person = person


class Librarian(Account):
    def __init__(self, id, password, person, status=AccountStatus.Active):
        super().__init__(id, password, person, status)

    def add_book_item(self, book_item):
        None

    def block_member(self, member):
        None

    def un_block_member(self, member):
        None


class Constants:
    pass


class BookReservation:
    pass


class ReservationStatus:
    pass


class Member(Account):
    def __init__(self, id, password, person, status=AccountStatus.Active):
        super().__init__(id, password, person, status)
        self.__date_of_membership = datetime.date.today()
        self.__total_books_checkedout = 0

    def get_total_books_checkedout(self):
        return self.__total_books_checkedout

    def reserve_book_item(self, book_item):
        None

    def increment_total_books_checkedout(self):
        None
```

Enums and Constants.py × Account, Member, and Librarian.py

```python
    def renew_book_item(self, book_item):
        None

    def checkout_book_item(self, book_item, ReservationStatus=None):
        if self.get_total_books_checked_out() ≥ Constants.MAX_BOOKS_ISSUED_TO_A_USER:
            print("The user has already checked-out maximum number of books")
            return False
        book_reservation = BookReservation.fetch_reservation_details(
            book_item.get_barcode())
        if book_reservation ≠ None and book_reservation.get_member_id() ≠ self.get_id():
            # book item has a pending reservation from another user
            print("self book is reserved by another member")
            return False
        elif book_reservation ≠ None:
            # book item has a pending reservation from the give member, update it
            book_reservation.update_status(ReservationStatus.COMPLETED)

        if not book_item.checkout(self.get_id()):
            return False

        self.increment_total_books_checkedout()
        return True

    def check_for_fine(self, book_item_barcode, Fine=None):
        book_lending = BookLending.fetch_lending_details(book_item_barcode)
        due_date = book_lending.get_due_date()
        today = datetime.date.today()
        # check if the book has been returned within the due date
        if today > due_date:
            diff = today - due_date
            diff_days = diff.days
            Fine.collect_fine(self.get_member_id(), diff_days)

    def return_book_item(self, book_item):
        self.check_for_fine(book_item.get_barcode())
        book_reservation = BookReservation.fetch_reservation_details(
            book_item.get_barcode())
        if book_reservation ≠ None:
            # book item has a pending reservation
            book_item.update_book_item_status(BookStatus.RESERVED)
            book_reservation.send_book_available_notification()
        book_item.update_book_item_status(BookStatus.AVAILABLE)

    def renew_book_item(self, book_item):
        self.check_for_fine(book_item.get_barcode())
        book_reservation = BookReservation.fetch_reservation_details(
            book_item.get_barcode())
        # check if self book item has a pending reservation from another member
        if book_reservation ≠ None and book_reservation.get_member_id() ≠ self.get_member_id():
            print("self book is reserved by another member")
            self.decrement_total_books_checkedout()
            book_item.update_book_item_state(BookStatus.RESERVED)
            book_reservation.send_book_available_notification()
            return False
        elif book_reservation ≠ None:
            # book item has a pending reservation from self member
            book_reservation.update_status(ReservationStatus.COMPLETED)
        BookLending.lend_book(book_item.get_bar_code(), self.get_member_id())
        book_item.update_due_date(
            datetime.datetime.now().AddDays(Constants.MAX_LENDING_DAYS))
        return True
```

Book Reservation, Bookending, and Fine: These classes represent a book reservation, lending, and fine collection, respectively.

```python
class BookReservation:
    def __init__(self, creation_date, status, book_item_barcode, member_id):
        self.__creation_date = creation_date
        self.__status = status
        self.__book_item_barcode = book_item_barcode
        self.__member_id = member_id

    def fetch_reservation_details(self, barcode):
        None


class BookLending:
    def __init__(self, creation_date, due_date, book_item_barcode, member_id):
        self.__creation_date = creation_date
        self.__due_date = due_date
        self.__return_date = None
        self.__book_item_barcode = book_item_barcode
        self.__member_id = member_id

    def lend_book(self, barcode, member_id):
        None

    def fetch_lending_details(self, barcode):
        None


class Fine:
    def __init__(self, creation_date, book_item_barcode, member_id):
        self.__creation_date = creation_date
        self.__book_item_barcode = book_item_barcode
        self.__member_id = member_id

    def collect_fine(self, member_id, days):
        None
```

Book Item: Encapsulating a book item, this class will be responsible for processing the reservation, return, and renewal of a book item.

```python
from abc import ABC, abstractmethod

class Book(ABC):
    def __init__(self, ISBN, title, subject, publisher, language, number_of_pages):
        self.__ISBN = ISBN
        self.__title = title
        self.__subject = subject
        self.__publisher = publisher
        self.__language = language
        self.__number_of_pages = number_of_pages
        self.__authors = []


class BookLending:
    pass


class BookStatus:
    pass


class BookItem(Book):
    def __init__(self, barcode, is_reference_only, borrowed, due_date, price, book_format, status, date_of_purchase, publication_date, placed_at):
        self.__barcode = barcode
        self.__is_reference_only = is_reference_only
        self.__borrowed = borrowed
        self.__due_date = due_date
        self.__price = price
        self.__format = book_format
        self.__status = status
        self.__date_of_purchase = date_of_purchase
        self.__publication_date = publication_date
        self.__placed_at = placed_at

    def checkout(self, member_id):
        if self.get_is_reference_only():
            print("self book is Reference only and can't be issued")
            return False
        if not BookLending.lend_book(self.get_bar_code(), member_id):
            return False
        self.update_book_item_status(BookStatus.LOANED)
        return True


class Rack:
    def __init__(self, number, location_identifier):
        self.__number = number
        self.__location_identifier = location_identifier
```

Search interface and Catalog: The Catalog class will implement the Search interface to facilitate searching of books.

```
pys E:\rimon\DocS
venv library roo
Account, Memb
BookItem.py
BookReservatior
Enums and Cons
main.py
Search interface
External Libraries
Scratches and Cons
```

```python


from abc import ABC


def search_by_subject(subject):
    None


def search_by_pub_date(publish_date):
    None


class Search(ABC):
    def search_by_title(self, title):
        None

    def search_by_author(self, author):
        None


class Catalog(Search):
    def __init__(self):
        self.__book_titles = {}
        self.__book_authors = {}
        self.__book_subjects = {}
        self.__book_publication_dates = {}

    def search_by_title(self, query):
        # return all books containing the string query in their title.
        return self.__book_titles.get(query)

    def search_by_author(self, query):
        # return all books containing the string query in their author's name.
        return self.__book_authors.get(query)

```