Library Book Management System

1 Problem Domain Requirements

1.1 Business Rules:

- Students can borrow and return library books using the system.
- Administrators can add, delete, and modify library book information.
- Administrators can evaluate student borrowing records and blacklist students.
- Students can access library book information. They can search a specific book.
- Title refers to the basic information of a book, while copy represents a specific physical copy of the book. So one title can have 0 to many copies. Each copy can only have one title.
- Students can borrow many books at the same time.

1.2 Possible Nouns

book, student, administrator, title, copy, record, email

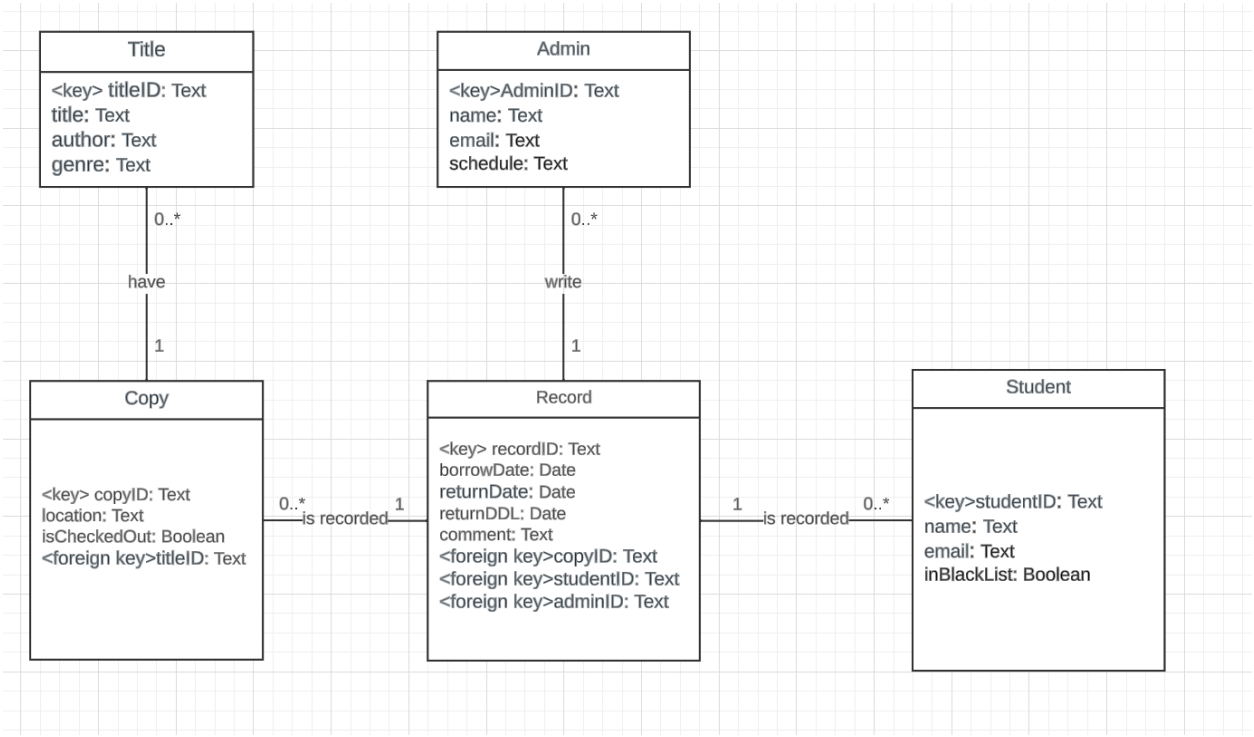
1.3 Possible Actions

- AddBook: To add a new book to the library's collection.
- DeleteBook: To remove a book from the library's collection.
- UpdateBook: To modify book information in the library.
- AddStudent: To register a new student in the system.
- BlacklistStudent: To restrict a student's borrowing privileges.
- UnblacklistStudent: To remove the restriction from a blacklisted student.
- BorrowBook: To check out a book from the library.
- ReturnBook: To return a borrowed book to the library.
- AddEvaluation: To provide feedback on a student's borrowing behavior.

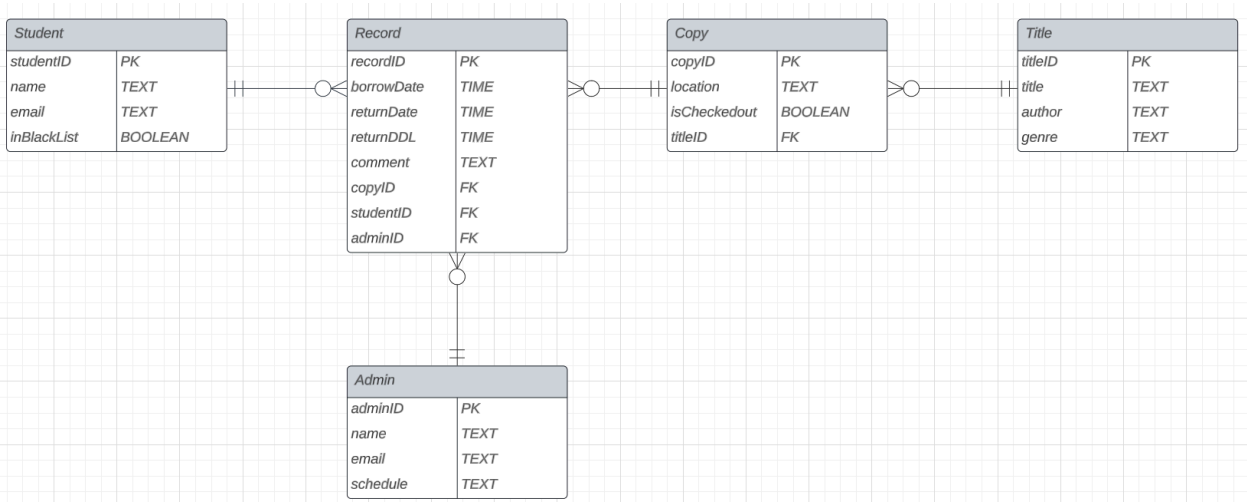
2 Conceptual model in UML

Explanation:

- Title refers to the basic information of a book, while Copy represents a specific physical copy of the book. The relationship between these two class is one-to-many.
- A student can borrow many copies. A copy can be borrowed by many students. The relationship between these two class is many-to-many



3 ERD


Student
studentID PK
name TEXT
email TEXT
inBlackList BOOLEAN
Record
recordID PK
borrowDate TIME
returnDate TIME
returnDDL TIME
comment TEXT
copyID FK
studentID FK
adminID FK
Copy
copyID PK
location TEXT
isCheckedout BOOLEAN
titleID FK
Title
titleID PK
title TEXT
author TEXT
genre TEXT
Admin
adminID PK
name TEXT
email TEXT
schedule TEXT

4 Define a relational schema

4.1 Schema

- Student(studentID, name, email, inBlackList)
- Record(recordID, borrowTime, returnTime, returnDDL, comment, *copyID*, *studentID*, *adminID*)
- Admin(adminID, name, email, schedule)
- Copy(copyID, location, isCheckedOut, *titleID*)
- Title(titleID, title, author, genre)

4.2 BCNF

A functional dependency exists between two sets of attributes in a relation when the value of one set of attributes uniquely determines the value of another set.

In table “Student”, we can use studentID uniquely determines other set’s value.

In table “Record”, we can use recordID uniquely determines other set’s value.

In table “Admin”, we can use adminID uniquely determines other set’s value.

In table “Copy”, we can use copyID uniquely determines other set’s value.

In table “Title”, we can use titleID uniquely determines other set’s value.

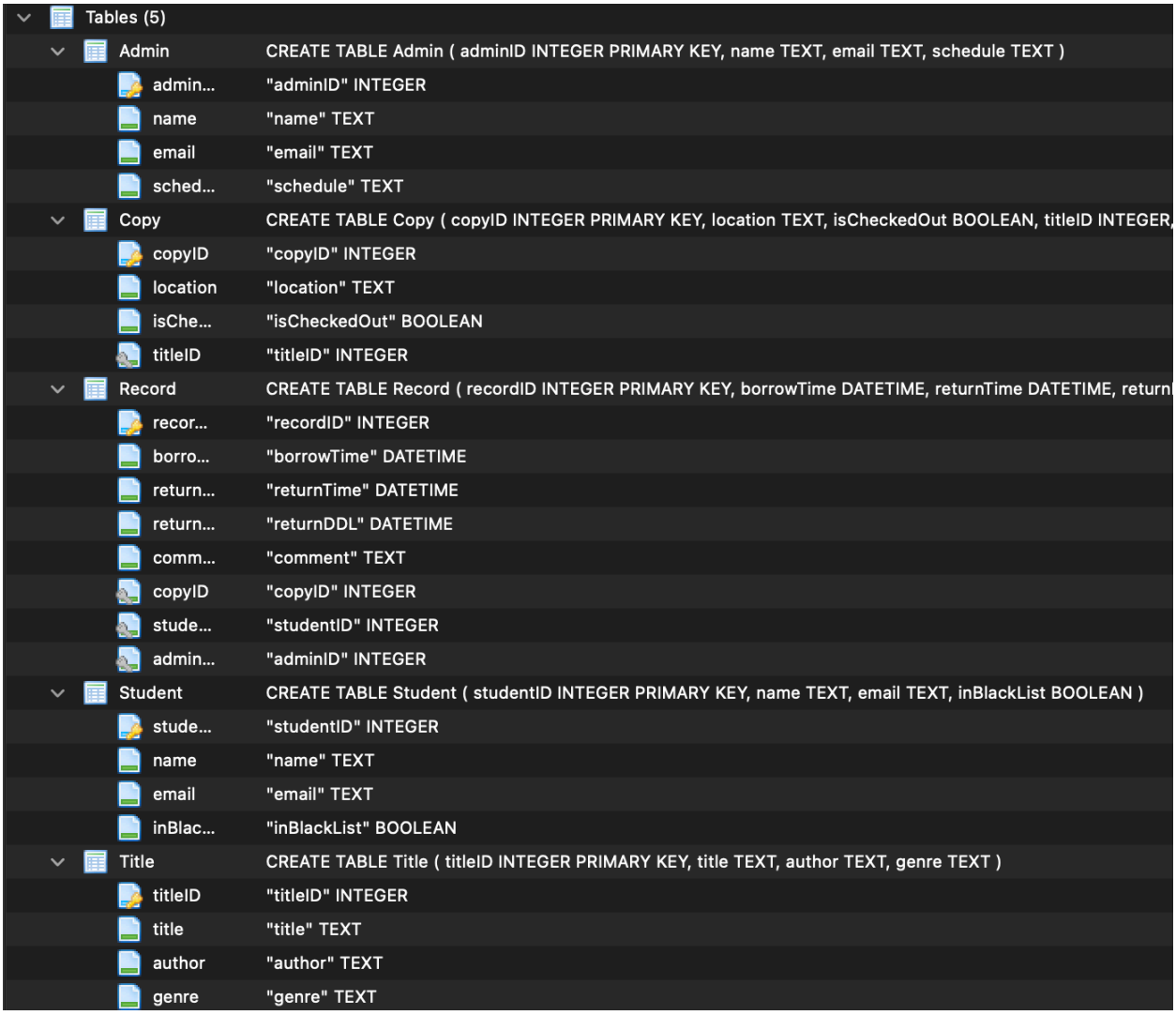
In conclusion, the schema is in at least BCNF.

5 Create Tables

5.1 SQL

```
CREATE TABLE IF NOT EXISTS Student (
    studentID INTEGER PRIMARY KEY,
    name TEXT,
    email TEXT,
    inBlackList BOOLEAN
);

CREATE TABLE IF NOT EXISTS Record (
    recordID INTEGER PRIMARY KEY,
    borrowTime DATETIME,
    returnTime DATETIME,
    returnDDL DATETIME,
    comment TEXT,
    copyID INTEGER,
    studentID INTEGER,
    adminID INTEGER,
    FOREIGN KEY (copyID) REFERENCES Copy(copyID),
    FOREIGN KEY (studentID) REFERENCES Student(studentID),
    FOREIGN KEY (adminID) REFERENCES Admin(adminID)
);

CREATE TABLE IF NOT EXISTS Admin (
    adminID INTEGER PRIMARY KEY,
    name TEXT,
    email TEXT,
    schedule TEXT
);

CREATE TABLE IF NOT EXISTS Copy (
    copyID INTEGER PRIMARY KEY,
    location TEXT,
    isCheckedOut BOOLEAN,
    titleID INTEGER,
    FOREIGN KEY (titleID) REFERENCES Title(titleID)
);

CREATE TABLE IF NOT EXISTS Title (
    titleID INTEGER PRIMARY KEY,
    title TEXT,
    author TEXT,
    genre TEXT
);
```

5.2 Screenshots



6 Populate the tables with test data

I use chatGPT to help me generate the data and then check the data manually to make sure they satisfy the foreign key constrain. The result is as follows:

adminID	name	email	schedule
Filter	Filter	Filter	Filter
1	John Smith	john.smith@example.com	Monday to Friday, 9 AM - 5 PM
2	Alice Johnson	alice.johnson@example.com	Tuesday and Thursday, 10 AM - 6 PM
3	Michael Brown	michael.brown@example.com	Monday, Wednesday, and Friday, 8 AM - 4 PM
4	Emily Davis	emily.davis@example.com	Wednesday and Saturday, 11 AM - 7 PM
5	David Wilson	david.wilson@example.com	Thursday, 1 PM - 9 PM

studentID	name	email	inBlackList
Filter	Filter	Filter	Filter
1	Alice Johnson	alice.johnson@example.com	0
2	John Smith	john.smith@example.com	1
3	Michael Brown	michael.brown@example.com	0
4	Emily Davis	emily.davis@example.com	0
5	David Wilson	david.wilson@example.com	1

titleID	title	author	genre
Filter	Filter	Filter	Filter
1	The Great Gatsby	F. Scott Fitzgerald	Fiction
2	To Kill a Mockingbird	Harper Lee	Fiction
3	1984	George Orwell	Science Fiction

copyID	location	isCheckedOut	titleID
Filter	Filter	Filter	Filter
1	Shelf A, Section 1	0	1
2	Shelf B, Section 2	0	2
3	Shelf C, Section 3	0	1
4	Shelf D, Section 4	1	3
5	Shelf E, Section 1	0	2

recordID	borrowTime	returnTime	returnDDL	comment	copyID	studentID	adminID
Filter	Filter	Filter	Filter	Filter	Filter	Filter	Filter
1	2023-10-01 08:00:00	2023-10-03 16:00:00	2023-10-10 16:00:00	Good condition	1	1	1
2	2023-09-25 10:30:00	2023-09-28 14:15:00	2023-10-05 14:15:00	No issues	2	2	2
3	2023-10-05 15:45:00	2023-10-08 10:30:00	2023-10-15 10:30:00	Returned on time	3	3	3
4	2023-10-12 11:15:00	2023-10-14 17:30:00	2023-10-21 17:30:00	Minor damage	4	4	4
5	2023-09-28 13:00:00	2023-09-30 12:30:00	2023-10-07 12:30:00	Late return	5	5	5
6	2023-10-02 10:45:00	2023-10-04 14:00:00	2023-10-11 14:00:00	Excellent condition	1	2	1
7	2023-10-11 09:30:00	2023-10-14 15:45:00	2023-10-21 15:45:00	No issues	2	3	2
8	2023-10-03 08:30:00	2023-10-06 16:15:00	2023-10-13 16:15:00	Minor scratches	3	4	3
9	2023-09-26 14:45:00	2023-09-29 11:00:00	2023-10-06 11:00:00	Late return	4	5	4
10	2023-10-09 10:00:00	2023-10-12 12:30:00	2023-10-19 12:30:00	Good condition	5	1	5

7 Define and execute at least five queries

7.1 Query contains a join of at least three tables

```
SELECT
    R.borrowTime AS BorrowTime,
    R.returnTime AS ReturnTime,
    R.returnDDL AS ReturnDeadline,
    S.name AS StudentName,
    C.location AS CopyLocation,
    T.title AS TitleName
FROM Record AS R
JOIN Student AS S ON R.studentID = S.studentID
JOIN Copy AS C ON R.copyID = C.copyID
JOIN Title AS T ON C.titleID = T.titleID;
```

From this query, we can know the relationship between studentName and the TitleName clearly.

BorrowTime	ReturnTime	ReturnDeadline	StudentName	CopyLocation	TitleName
2023-10-01 08:00:00	2023-10-03 16:00:00	2023-10-10 16:00:00	Alice Johnson	Shelf A, Section 1	The Great Gatsby
2023-09-25 10:30:00	2023-09-28 14:15:00	2023-10-05 14:15:00	John Smith	Shelf B, Section 2	To Kill a Mockingbird
2023-10-05 15:45:00	2023-10-08 10:30:00	2023-10-15 10:30:00	Michael Brown	Shelf C, Section 3	The Great Gatsby
2023-10-12 11:15:00	2023-10-14 17:30:00	2023-10-21 17:30:00	Emily Davis	Shelf D, Section 4	1984

7.2 Query contains a subquery

```
SELECT S.name AS StudentName
FROM Student AS S
WHERE (
    SELECT COUNT(*)
    FROM Record AS R
    WHERE R.studentID = S.studentID
) > (
    SELECT AVG(BorrowCount)
    FROM (
        SELECT studentID, COUNT(*) AS BorrowCount
        FROM Record
        GROUP BY studentID
    ) AS StudentBorrowCount
);
```

From this query, we can calculate the names of students who have borrowed books more frequently than the average

	StudentName
1	Alice Johnson

7.3 Group by with a having clause

```
SELECT studentID, COUNT(*) AS BorrowCount
FROM Record
GROUP BY studentID
HAVING COUNT(*) > 3;
```

From this query, we can know the id of students who have borrowed books three times more

studentID	BorrowCount
1	4

7.4 Complex search criterion

```
SELECT *
FROM Record
WHERE (returnTime < returnDDL) AND (borrowTime BETWEEN '2023-10-10 00:00:00' AND
'2023-10-15 23:59:59')
```

From this query, we can know the information of record that returned on time and borrowed between 2023-10-10 and 2023-10-15

recordID	borrowTime	returnTime	returnDDL	comment	copyID	studentID	adminID
4	2023-10-12 11:15:00	2023-10-14 17:30:00	2023-10-21 17:30:00	Minor damage	4	4	4
7	2023-10-11 09:30:00	2023-10-14 15:45:00	2023-10-21 15:45:00	No issues	2	3	2

7.5 Experiment with advanced query mechanisms：SELECT CASE/WHEN

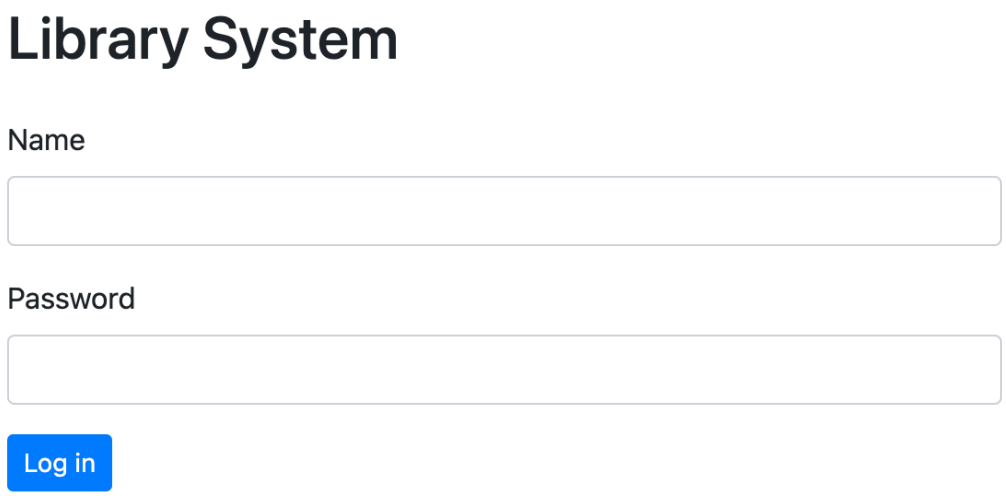
```
SELECT recordID ,
case
        when returnTime<returnDDL then "on time"
        when  returnTime>returnDDL then "late"
        end as status
FROM Record;
```

From this query, we can see clearly which record is late or not

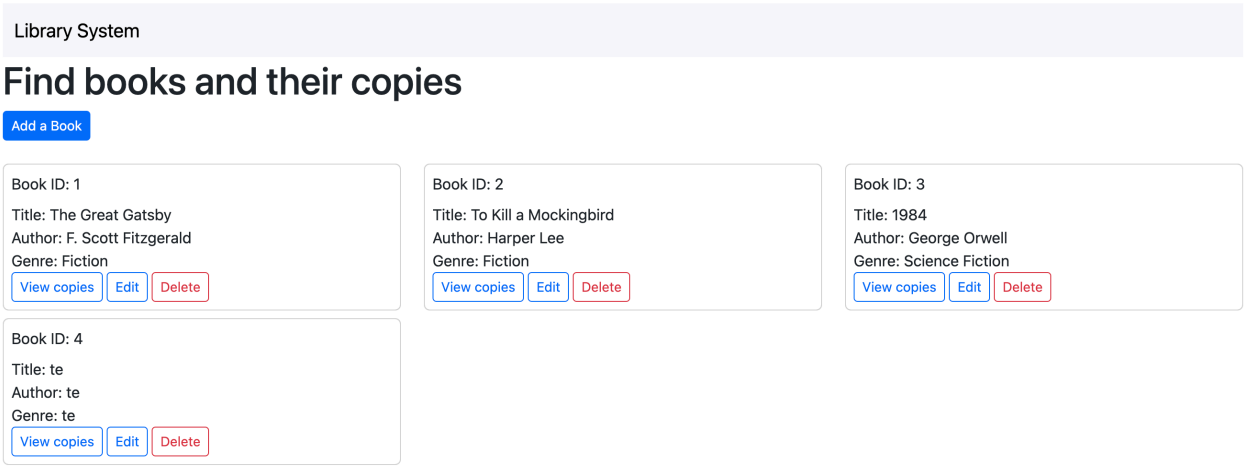
recordID	status
1	on time
2	on time
3	on time
4	on time
5	late
6	on time
7	on time
8	on time

8 Create a basic Node + Express application

This is the log in page



In this page, we can find all books and their copies.
The operations are “add new book”, “delete a book” or “edit a book”



When we delete a book, we must also delete all its copies as the copies have foreign key bookID. The relative codes are showed in picture:

```
router.get("/titles/:titleID/delete", async function (req, res) {

  try {
    const sqlResDelete = await deleteTitle(req.params.titleID);
    await deleteCopy(req.params.titleID);
    const titles = await getTitles();
    if (sqlResDelete.changes === 1) {
      res.render("index", { titles, err: "Book deleted", type: "success" });
    } else {
      res.render("index", {
        titles,
        err: "Error deleting the book",
        type: "danger",
      });
    }
  } catch (exception) {
    const titles = await getTitles();
    res.render("index", {
      titles,
      err: "Error executing the SQL",
      type: "danger",
    });
  }
});
```

```
async function deleteTitle(titleID) {
  const db = await connect();
  try {
    const stmt = await db.prepare(`DELETE FROM Title
    WHERE
      titleID = :titleID
    `);

    stmt.bind({
      ":titleID": titleID,
    });

    const result = await stmt.run();

    await stmt.finalize();

    return result;
  } finally {
    await db.close();
  }
}
```

```
async function deleteCopy(titleID) {
  const db = await connect();
  try {
    const stmt = await db.prepare(`DELETE FROM Copy
  WHERE
    titleID = :titleID
  `);

    stmt.bind({
      ":titleID": titleID,
    });

    const result = await stmt.run();

    await stmt.finalize();

    return result;
  } finally {
    await db.close();
  }
}
```

In this page, we can see all the copies of a specific book. And we can also add a copy