DBMS Project Report

PES University

Database Management Systems

UE18CS252

Submitted By

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The database created is of a library. The entities present are branch, customer, customer_subscription, author, books, borrowed. These entities are connected by meaningful relationships. Triggers have been set for borrowed entity, as well as the other entities for the names, dates, etc. Transactions made include updation of the borrowed table as a customer borrows books. The subscription and customer table also can be updated when a new customer subscribes to the library.

Capabilities of this system include automatically calculating the due date of a borrowed book, the fine to be payed if needed, the return status of that particular book. It can also show which books are in which branch of the library, along with the addresses of these branches, with a correct query.

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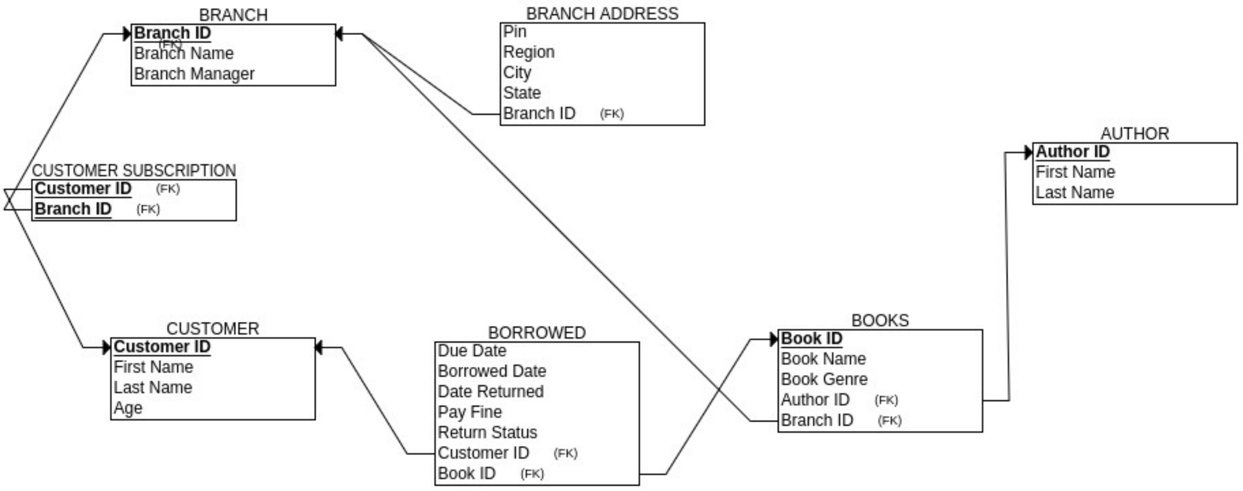
Introduction

The miniworld chosen is of a library. The entities present are branch, branch_address, customer, customer_subscription, author, books, borrowed. The branch and branch_address entities hold the branch ID and the corresponding branch details. Customer entity holds details of the customer. Author holds details of the author. Books holds the book details along with the author ID of the one who wrote the book. Here, we are assuming that only one author works on books. There are no co-authors for any books. Borrowed holds the logs for any book borrowed by customers.
Transactions of the system include creation of all the tables, creating the triggers, inserting and updating the tables with relevant information.

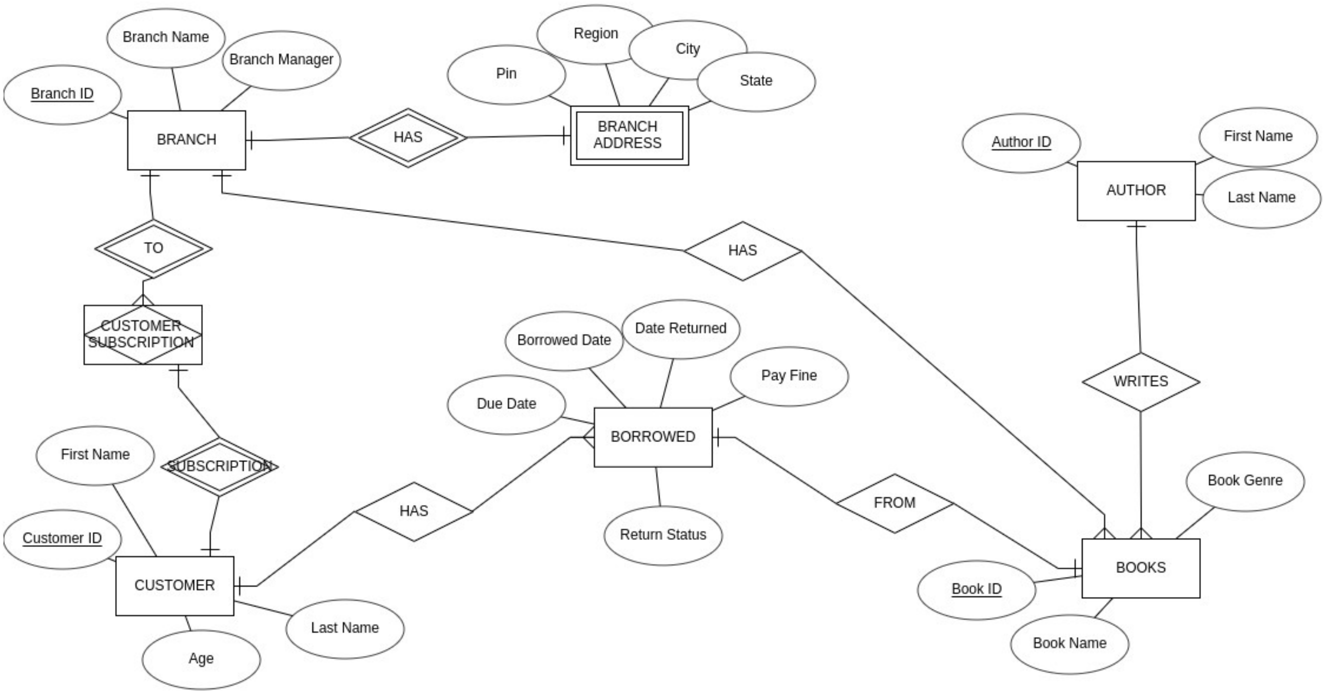
Data Model

The branch and customer have an associative entity customer_subscription between them. The books and author are connected with a relationship that the author writes (a) book(s). The borrowed entity is connected to customer and books entities as the customer borrows books from the books table. The primary keys in their respective tables are branchID, customerID, bookID and authorID. These act as foreign keys for a few other tables. The primary keys, names, addresses ,etc are all of type varchar. The pin in the address is of integer type. The borrowedDate, dueDate, dateReturned attributes are of type date.

RELATIONAL SCHEMA



ER DIAGRAM



FD and Normalization

A 2NF may be violated when there is a non-prime attribute dependent on the proper subset of any candidate key of the table. Meaning, the non-prime attribute should not depend on the prime attribute of the table. A 3NF may be violated when any non-prime attribute is transitively dependent on the candidate key.
Functional dependencies in my tables are as follows:

branchID -> branchName,branchManager
branchID -> pin,region,city,state
customerID -> firstName,lastName,age
customerID -> branchID
authorID -> firstName,lastName
bookID -> bookName,bookGenre
bookID -> branchID
bookID -> authorID
customerID -> dueDate,borrowedDate,dateReturned
customerID -> bookID

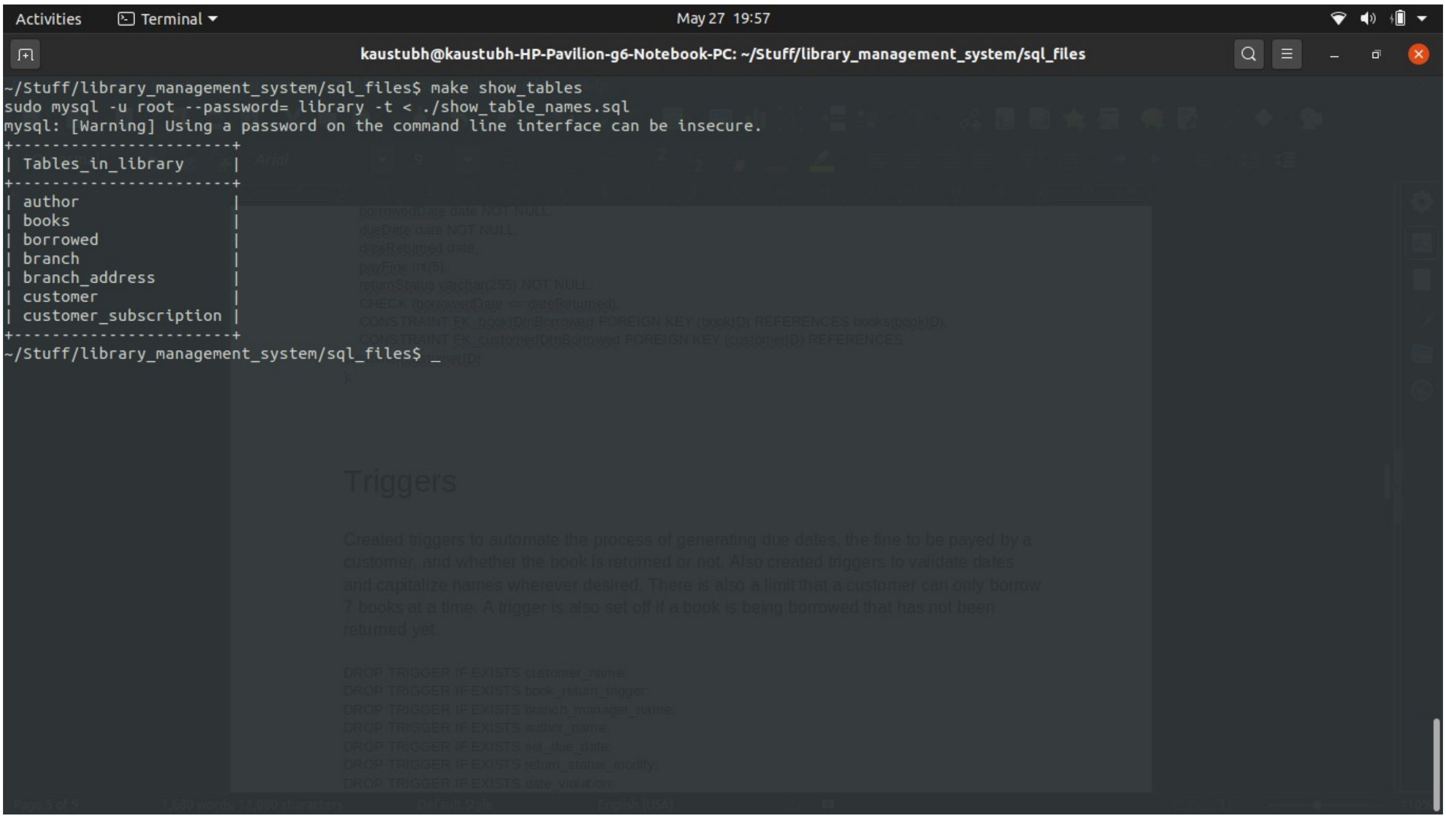
All relations are in Boyce Codd NF (BCNF).

Hypothetical examples of violations:

If I had columns within the branch entity, specifying the bookIDs along with the book details, it would violate 3NF.
If I also had book details in the author entity, it would violate 3NF.
If branch details were in customer_subscription, it would violate 3NF.

DDL

```
CREATE TABLE branch (
   branchID varchar(10) NOT NULL,
   branchName varchar(255) NOT NULL,
   branchManager varchar(255),
   CONSTRAINT PK_branchID PRIMARY KEY (branchID)
);

CREATE TABLE branch_address (
   branchID varchar(10) NOT NULL,
   pin int(7),
   region varchar(255),
   city varchar(255) NOT NULL,
   state varchar(255) NOT NULL,
   CONSTRAINT FK_branchIDInAddress FOREIGN KEY (branchID) REFERENCES branch(branchID)
);


CREATE TABLE customer (
   customerID varchar(10) NOT NULL,
   firstName varchar(255) NOT NULL,
   lastName varchar(255),
   age int(3),
   CHECK (age>=4),
   CONSTRAINT PK_customerID PRIMARY KEY (customerID)
);

CREATE TABLE customer_subscription (
   customerID varchar(10) NOT NULL,
   branchID varchar(10) NOT NULL,
   CONSTRAINT FK_branchIDInSubscription FOREIGN KEY (branchID) REFERENCES branch(branchID),
   CONSTRAINT FK_customerIDInSubscription FOREIGN KEY (customerID) REFERENCES
customer(customerID)
);

CREATE TABLE author (
   authorID varchar(10) NOT NULL,
   firstName varchar(255) NOT NULL,
   lastName varchar(255),
   CONSTRAINT PK_authorID PRIMARY KEY (authorID)
);

CREATE TABLE books (
   bookID varchar(10) NOT NULL,
   bookName varchar(255) NOT NULL,
   bookGenre varchar(255) NOT NULL,
   authorID varchar(10) NOT NULL,
   branchID varchar(10) NOT NULL,
   CONSTRAINT PK_bookID PRIMARY KEY (bookID),
   CONSTRAINT FK_authorIDInBooks FOREIGN KEY (authorID) REFERENCES author(authorID),
   CONSTRAINT FK_branchIDInBooks FOREIGN KEY (branchID) REFERENCES branch(branchID)
);

CREATE TABLE borrowed (
   customerID varchar(10) NOT NULL,
   bookID varchar(10) NOT NULL,
   borrowedDate date NOT NULL,
   dueDate date NOT NULL,
   dateReturned date,
   payFine int(5),
   returnStatus varchar(255) NOT NULL,
   CHECK (borrowedDate <= dateReturned),
   CONSTRAINT FK_bookIDInBorrowed FOREIGN KEY (bookID) REFERENCES books(bookID),
   CONSTRAINT FK_customerIDInBorrowed FOREIGN KEY (customerID) REFERENCES
customer(customerID)
);
```


Activities
Terminal
May 27 19:57
kaustubh@kaustubh-HP-Pavilion-g6-Notebook-PC: ~/Stuff/library_management_system/sql_files

```
~/Stuff/library_management_system/sql_files$ make show_tables
sudo mysql -u root --password= library -t < ./show_table_names.sql
mysql: [Warning] Using a password on the command line interface can be insecure.
+-----------------------+
| Tables_in_library     |
+-----------------------+
| author                |
| books                 |
| borrowed              |
| branch                |
| branch_address        |
| customer              |
| customer_subscription |
+-----------------------+
~/Stuff/library_management_system/sql_files$ _
```

Triggers

Created triggers to automate the process of generating due dates, the fine to be payed by a customer, and whether the book is returned or not. Also created triggers to validate dates and capitalize names wherever desired. There is also a limit that a customer can only borrow 7 books at a time. A trigger is also set off if a book is being borrowed that has not been returned yet.

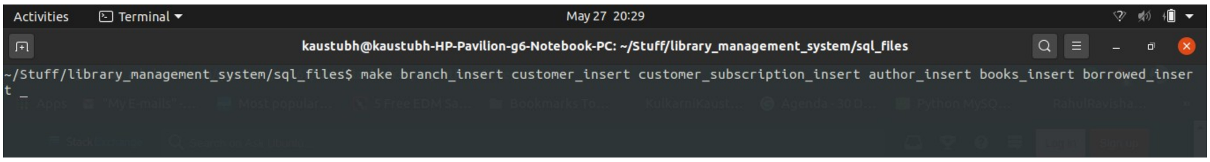
```
DROP TRIGGER IF EXISTS customer_name;
DROP TRIGGER IF EXISTS book_return_trigger;
DROP TRIGGER IF EXISTS branch_manager_name;
DROP TRIGGER IF EXISTS author_name;
DROP TRIGGER IF EXISTS set_due_date;
DROP TRIGGER IF EXISTS return_status_modify;
DROP TRIGGER IF EXISTS date_violation;
DROP TRIGGER IF EXISTS borrow_limit;
DROP TRIGGER IF EXISTS book_constraints;

DELIMITER //

CREATE TRIGGER customer_name
   BEFORE INSERT ON customer
   FOR EACH ROW
BEGIN
   SET NEW.firstName = CONCAT(UPPER(SUBSTRING(NEW.firstName, 1, 1)),
LOWER(SUBSTRING(NEW.firstName, 2)));
   IF NEW.lastName IS NOT NULL THEN
      SET NEW.lastName = CONCAT(UPPER(SUBSTRING(NEW.lastName, 1, 1)),
LOWER(SUBSTRING(NEW.lastName, 2)));
   END IF;
END//

CREATE TRIGGER author_name
   BEFORE INSERT ON author
   FOR EACH ROW
BEGIN
   SET NEW.firstName = CONCAT(UPPER(SUBSTRING(NEW.firstName, 1, 1)),
LOWER(SUBSTRING(NEW.firstName, 2)));
   IF NEW.lastName IS NOT NULL THEN
      SET NEW.lastName = CONCAT(UPPER(SUBSTRING(NEW.lastName, 1, 1)),
LOWER(SUBSTRING(NEW.lastName, 2)));
   END IF;
END//

CREATE TRIGGER branch_manager_name
   BEFORE INSERT ON branch
   FOR EACH ROW
BEGIN
   SET NEW.branchManager = UPPER(NEW.branchManager);
END//

CREATE TRIGGER book_constraints
   BEFORE INSERT ON borrowed
   FOR EACH ROW
BEGIN
   DECLARE nBooks int(1);
   SET nBooks= (SELECT COUNT(bookID) FROM borrowed WHERE customerID = NEW.customerID AND
returnStatus = 'NOT RETURNED');
   IF (nBooks > 7) THEN
      SIGNAL SQLSTATE '46000'
         SET MESSAGE_TEXT = 'Cannot borrow more than 7 books.';
   END IF;
END//

CREATE TRIGGER borrow_limit
   BEFORE INSERT ON borrowed
   FOR EACH ROW
BEGIN
```

```
    DECLARE bID varchar(10);
    SET bID = (SELECT bookID FROM borrowed WHERE bookID = NEW.bookID AND returnStatus = 'NOT
RETURNED');
    IF bID IS NOT NULL THEN
        SIGNAL SQLSTATE '47000'
            SET MESSAGE_TEXT = 'Cannot borrow book. Already borrowed and not yet returned.';
    END IF;
END//

CREATE TRIGGER set_due_date
    BEFORE INSERT ON borrowed
    FOR EACH ROW
BEGIN
    SET NEW.dueDate = DATE_ADD(NEW.borrowedDate, interval 14 day);
END//

CREATE TRIGGER book_return_trigger
    BEFORE UPDATE ON borrowed
    FOR EACH ROW
BEGIN
    IF NEW.dateReturned IS NOT NULL THEN
        IF NEW.dateReturned > OLD.dueDate THEN
            SET NEW.payFine = 10 * DATEDIFF (NEW.dateReturned, OLD.dueDate);
        END IF;
        IF NEW.dateReturned < OLD.dueDate THEN
            SET NEW.payFine = 0;
        END IF;-
        SET NEW.returnStatus = 'RETURNED';
    END IF;
END//

CREATE TRIGGER date_violation
    BEFORE INSERT ON borrowed
    FOR EACH ROW
BEGIN
    IF (NEW.borrowedDate > NOW()) THEN
        SIGNAL SQLSTATE '45000'
            SET MESSAGE_TEXT = 'Cannot insert a borrowed date that is in the future.';
    END IF;
END//

DELIMITER ;
```

SQL Queries

INSERTIONS

Screenshot of the command used:



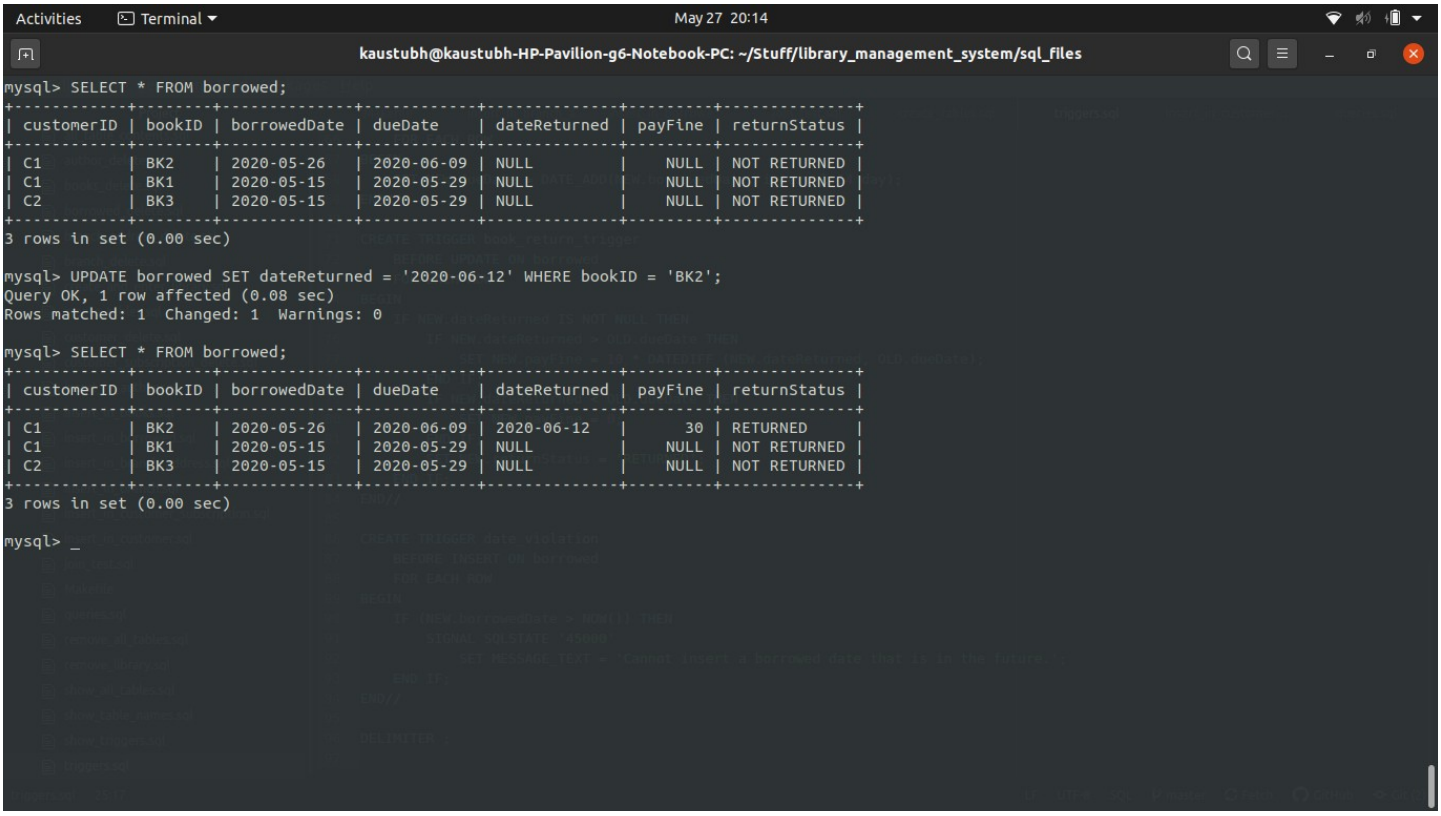
Activities
Terminal
May 27 20:29
kaustubh@kaustubh-HP-Pavilion-g6-Notebook-PC: ~/Stuff/library_management_system/sql_files

```
~/Stuff/library_management_system/sql_files$ make branch_insert customer_insert customer_subscription_insert author_insert books_insert borrowed_inser
t _
```

SIMPLE QUERIES

Sentence: Book with bookID ‘BK3’ has been returned on 2020-06-15. Update the borrowed table with relevant information.

UPDATE borrowed SET dateReturned = '2020-06-12' WHERE bookID = 'BK2';
(This updates the table with a returned date and the triggers take care of all other fields once the book with bookID ‘BK3’ is returned)

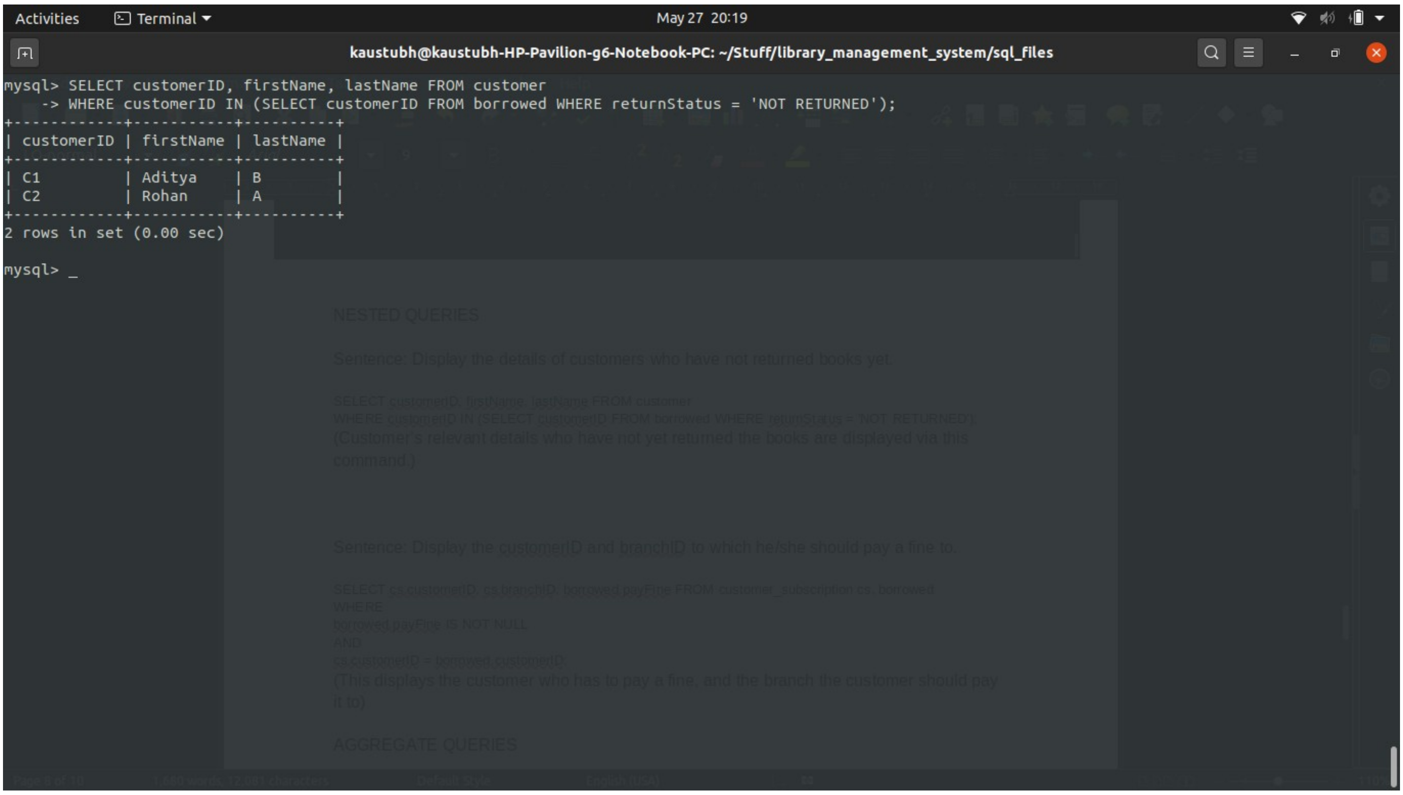

Activities
Terminal
May 27 20:14
kaustubh@kaustubh-HP-Pavilion-g6-Notebook-PC: ~/Stuff/library_management_system/sql_files

```
mysql> SELECT * FROM borrowed;
+------------+--------+--------------+------------+--------------+---------+--------------+
| customerID | bookID | borrowedDate | dueDate    | dateReturned | payFine | returnStatus |
+------------+--------+--------------+------------+--------------+---------+--------------+
| C1         | BK2    | 2020-05-26   | 2020-06-09 | NULL         |    NULL | NOT RETURNED |
| C1         | BK1    | 2020-05-15   | 2020-05-29 | NULL         |    NULL | NOT RETURNED |
| C2         | BK3    | 2020-05-15   | 2020-05-29 | NULL         |    NULL | NOT RETURNED |
+------------+--------+--------------+------------+--------------+---------+--------------+
3 rows in set (0.00 sec)

mysql> UPDATE borrowed SET dateReturned = '2020-06-12' WHERE bookID = 'BK2';
Query OK, 1 row affected (0.08 sec)
Rows matched: 1  Changed: 1  Warnings: 0

mysql> SELECT * FROM borrowed;
+------------+--------+--------------+------------+--------------+---------+--------------+
| customerID | bookID | borrowedDate | dueDate    | dateReturned | payFine | returnStatus |
+------------+--------+--------------+------------+--------------+---------+--------------+
| C1         | BK2    | 2020-05-26   | 2020-06-09 | 2020-06-12   |      30 | RETURNED     |
| C1         | BK1    | 2020-05-15   | 2020-05-29 | NULL         |    NULL | NOT RETURNED |
| C2         | BK3    | 2020-05-15   | 2020-05-29 | NULL         |    NULL | NOT RETURNED |
+------------+--------+--------------+------------+--------------+---------+--------------+
3 rows in set (0.00 sec)

mysql> _
```

NESTED QUERIES

Sentence: Display the details of customers who have not returned books yet.

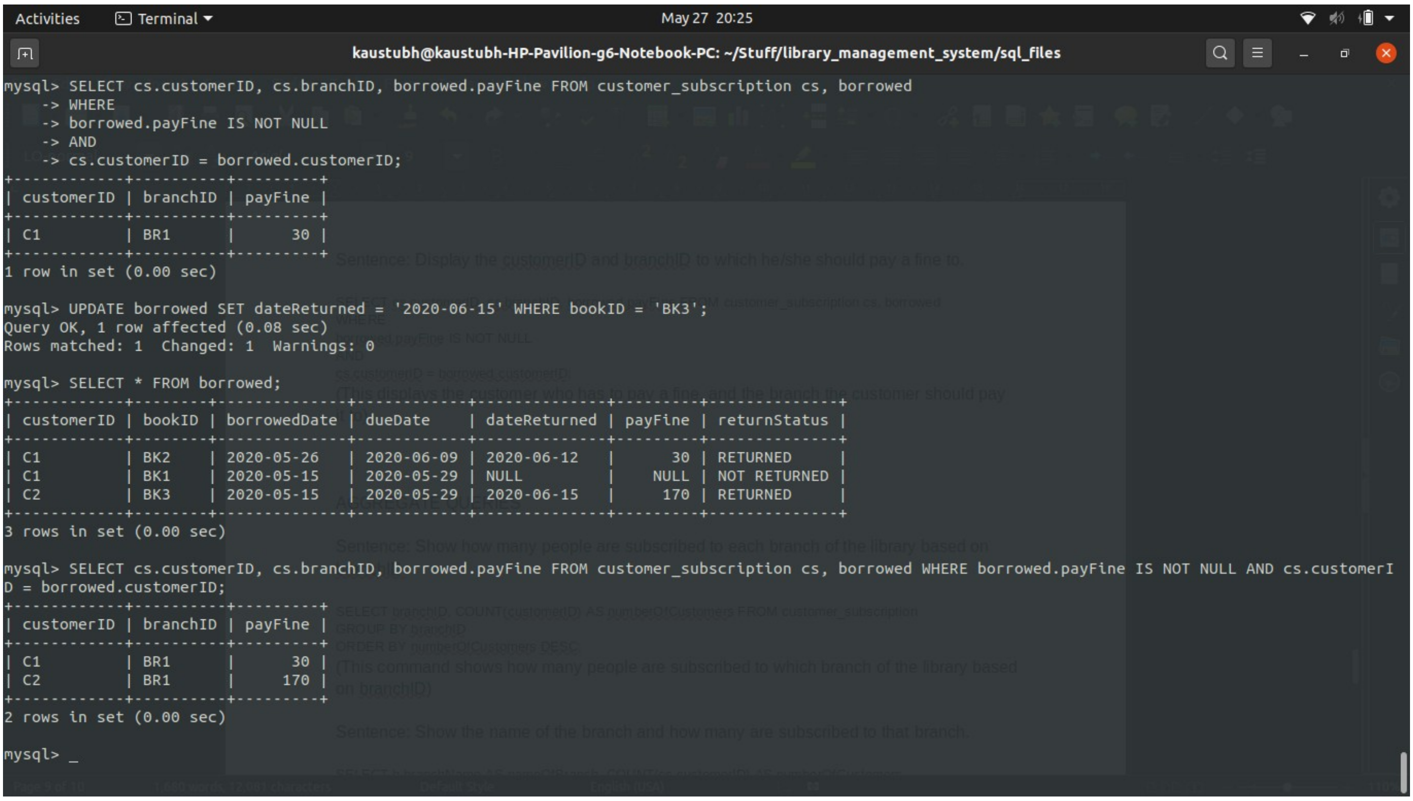
SELECT customerID, firstName, lastName FROM customer
WHERE customerID IN (SELECT customerID FROM borrowed WHERE returnStatus = 'NOT RETURNED');
(Customer’s relevant details who have not yet returned the books are displayed via this command.)


Activities
Terminal
May 27 20:19
kaustubh@kaustubh-HP-Pavilion-g6-Notebook-PC: ~/Stuff/library_management_system/sql_files

```
mysql> SELECT customerID, firstName, lastName FROM customer
    -> WHERE customerID IN (SELECT customerID FROM borrowed WHERE returnStatus = 'NOT RETURNED');
+------------+-----------+----------+
| customerID | firstName | lastName |
+------------+-----------+----------+
| C1         | Aditya    | B        |
| C2         | Rohan     | A        |
+------------+-----------+----------+
2 rows in set (0.00 sec)

mysql> _
```

Sentence: Display the customerID and branchID to which he/she should pay a fine to.

SELECT cs.customerID, cs.branchID, borrowed.payFine FROM customer_subscription cs, borrowed
WHERE
borrowed.payFine IS NOT NULL
AND
cs.customerID = borrowed.customerID;
(This displays the customer who has to pay a fine, and the branch the customer should pay it to)


Activities
Terminal
May 27 20:25
kaustubh@kaustubh-HP-Pavilion-g6-Notebook-PC: ~/Stuff/library_management_system/sql_files

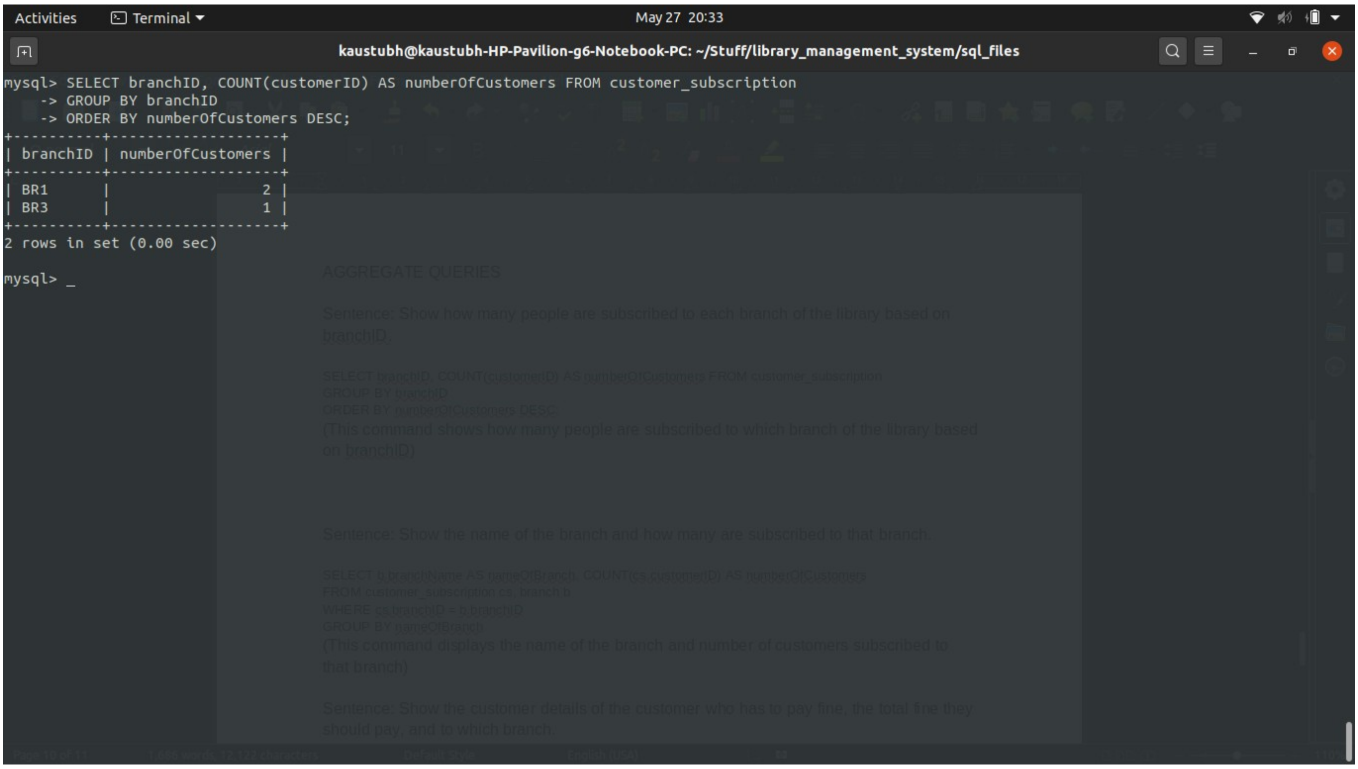
```
mysql> SELECT cs.customerID, cs.branchID, borrowed.payFine FROM customer_subscription cs, borrowed
    -> WHERE
    -> borrowed.payFine IS NOT NULL
    -> AND
    -> cs.customerID = borrowed.customerID;
+------------+----------+---------+
| customerID | branchID | payFine |
+------------+----------+---------+
| C1         | BR1      |      30 |
+------------+----------+---------+
1 row in set (0.00 sec)

mysql> UPDATE borrowed SET dateReturned = '2020-06-15' WHERE bookID = 'BK3';
Query OK, 1 row affected (0.08 sec)
Rows matched: 1  Changed: 1  Warnings: 0

mysql> SELECT * FROM borrowed;
+------------+--------+--------------+------------+--------------+---------+--------------+
| customerID | bookID | borrowedDate | dueDate    | dateReturned | payFine | returnStatus |
+------------+--------+--------------+------------+--------------+---------+--------------+
| C1         | BK2    | 2020-05-26   | 2020-06-09 | 2020-06-12   |      30 | RETURNED     |
| C1         | BK1    | 2020-05-15   | 2020-05-29 | NULL         |    NULL | NOT RETURNED |
| C2         | BK3    | 2020-05-15   | 2020-05-29 | 2020-06-15   |     170 | RETURNED     |
+------------+--------+--------------+------------+--------------+---------+--------------+
3 rows in set (0.00 sec)

mysql> SELECT cs.customerID, cs.branchID, borrowed.payFine FROM customer_subscription cs, borrowed WHERE borrowed.payFine IS NOT NULL AND cs.customerI
D = borrowed.customerID;
+------------+----------+---------+
| customerID | branchID | payFine |
+------------+----------+---------+
| C1         | BR1      |      30 |
| C2         | BR1      |     170 |
+------------+----------+---------+
2 rows in set (0.00 sec)

mysql> _
```

AGGREGATE QUERIES

Sentence: Show how many people are subscribed to each branch of the library based on branchID.

```
SELECT branchID, COUNT(customerID) AS numberOfCustomers FROM customer_subscription
GROUP BY branchID
ORDER BY numberOfCustomers DESC;
```

(This command shows how many people are subscribed to which branch of the library based on branchID)

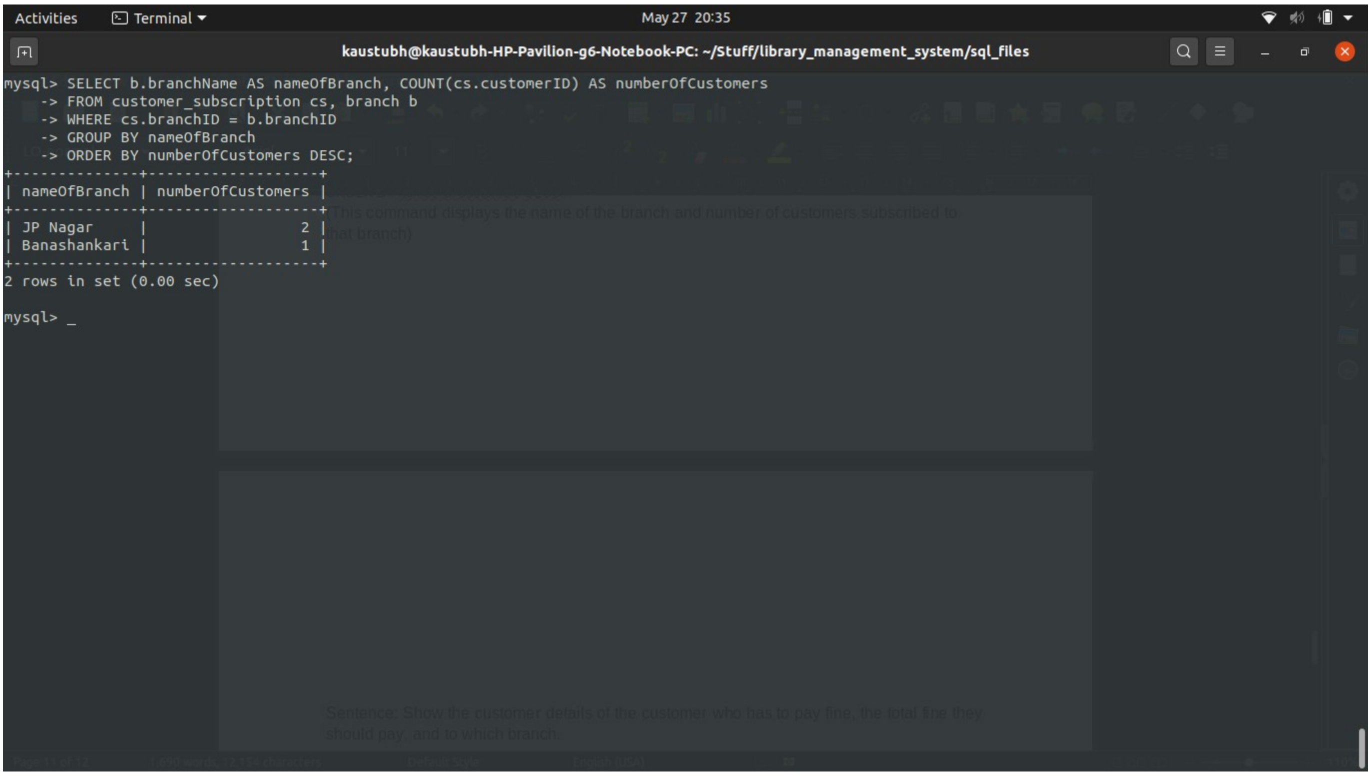

Activities
Terminal
May 27 20:33
kaustubh@kaustubh-HP-Pavilion-g6-Notebook-PC: ~/Stuff/library_management_system/sql_files

```
mysql> SELECT branchID, COUNT(customerID) AS numberOfCustomers FROM customer_subscription
    -> GROUP BY branchID
    -> ORDER BY numberOfCustomers DESC;
+----------+-------------------+
| branchID | numberOfCustomers |
+----------+-------------------+
| BR1      |                 2 |
| BR3      |                 1 |
+----------+-------------------+
2 rows in set (0.00 sec)

mysql> _
```

Sentence: Show the name of the branch and how many are subscribed to that branch.

```
SELECT b.branchName AS nameOfBranch, COUNT(cs.customerID) AS numberOfCustomers
FROM customer_subscription cs, branch b
WHERE cs.branchID = b.branchID
GROUP BY nameOfBranch
ORDER BY numberOfCustomers DESC;
```

(This command displays the name of the branch and number of customers subscribed to that branch)

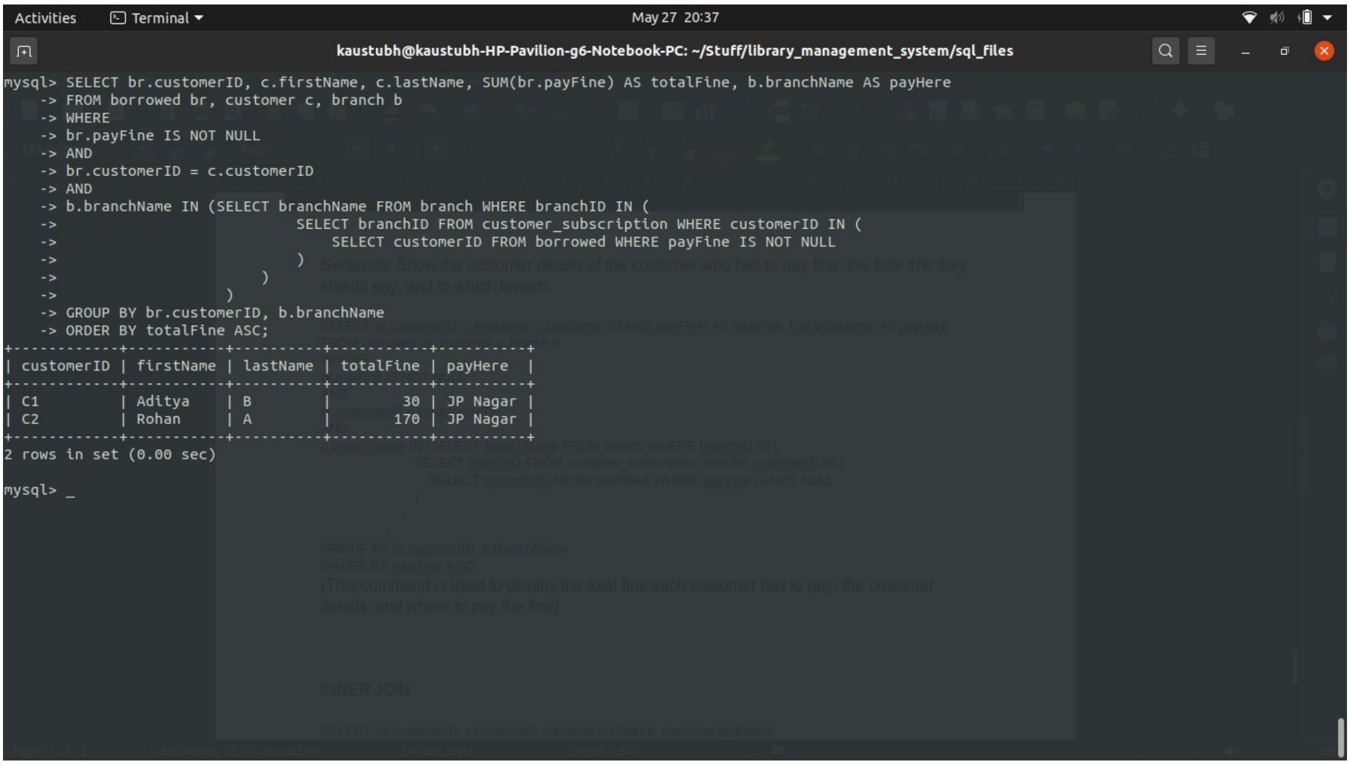

Activities
Terminal
May 27 20:35
kaustubh@kaustubh-HP-Pavilion-g6-Notebook-PC: ~/Stuff/library_management_system/sql_files

```
mysql> SELECT b.branchName AS nameOfBranch, COUNT(cs.customerID) AS numberOfCustomers
    -> FROM customer_subscription cs, branch b
    -> WHERE cs.branchID = b.branchID
    -> GROUP BY nameOfBranch
    -> ORDER BY numberOfCustomers DESC;
+--------------+-------------------+
| nameOfBranch | numberOfCustomers |
+--------------+-------------------+
| JP Nagar     |                 2 |
| Banashankari |                 1 |
+--------------+-------------------+
2 rows in set (0.00 sec)

mysql> _
```

Sentence: Show the customer details of the customer who has to pay fine, the total fine they should pay, and to which branch.

```
SELECT br.customerID, c.firstName, c.lastName, SUM(br.payFine) AS totalFine, b.branchName AS payHere
FROM borrowed br, customer c, branch b
WHERE
br.payFine IS NOT NULL
AND
br.customerID = c.customerID
AND
b.branchName IN (SELECT branchName FROM branch WHERE branchID IN (
                        SELECT branchID FROM customer_subscription WHERE customerID IN (
                           SELECT customerID FROM borrowed WHERE payFine IS NOT NULL
                        )
                     )
                  )
GROUP BY br.customerID, b.branchName
ORDER BY totalFine ASC;
```

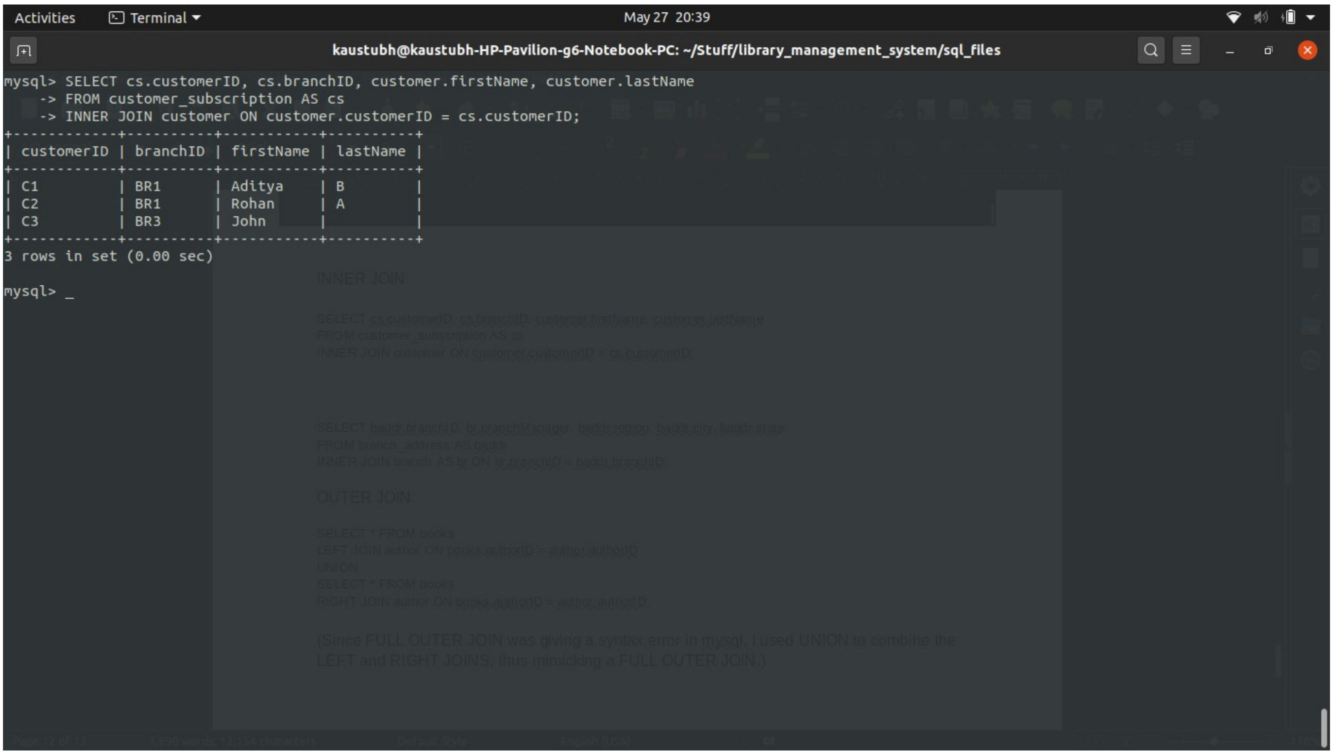
(This command is used to display the total fine each customer has to pay, the customer details, and where to pay the fine)


Activities
Terminal
May 27 20:37
kaustubh@kaustubh-HP-Pavilion-g6-Notebook-PC: ~/Stuff/library_management_system/sql_files

```
mysql> SELECT br.customerID, c.firstName, c.lastName, SUM(br.payFine) AS totalFine, b.branchName AS payHere
    -> FROM borrowed br, customer c, branch b
    -> WHERE
    -> br.payFine IS NOT NULL
    -> AND
    -> br.customerID = c.customerID
    -> AND
    -> b.branchName IN (SELECT branchName FROM branch WHERE branchID IN (
    ->                          SELECT branchID FROM customer_subscription WHERE customerID IN (
    ->                              SELECT customerID FROM borrowed WHERE payFine IS NOT NULL
    ->                          )
    ->                      )
    ->                 )
    -> GROUP BY br.customerID, b.branchName
    -> ORDER BY totalFine ASC;
+------------+-----------+----------+-----------+----------+
| customerID | firstName | lastName | totalFine | payHere  |
+------------+-----------+----------+-----------+----------+
| C1         | Aditya    | B        |        30 | JP Nagar |
| C2         | Rohan     | A        |       170 | JP Nagar |
+------------+-----------+----------+-----------+----------+
2 rows in set (0.00 sec)

mysql> _
```

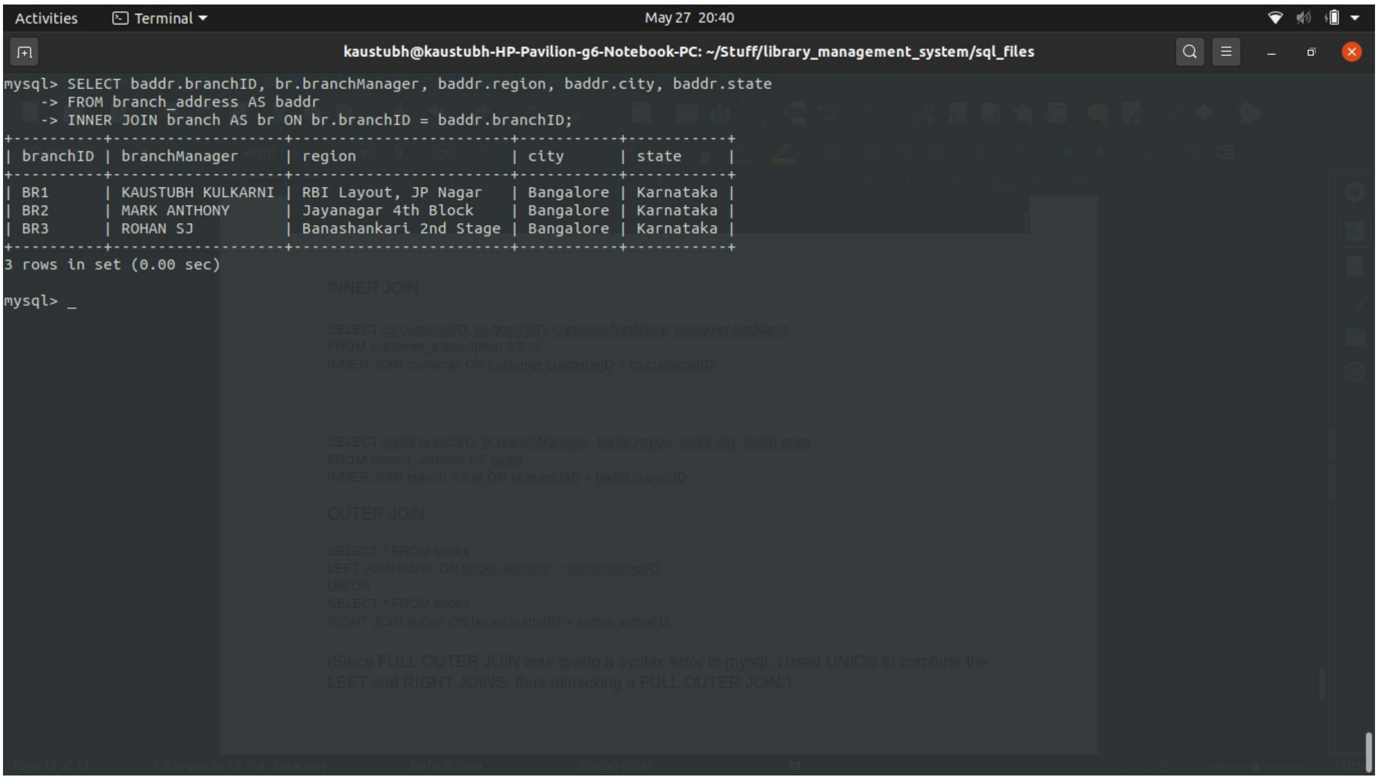
INNER JOIN

SELECT cs.customerID, cs.branchID, customer.firstName, customer.lastName
FROM customer_subscription AS cs
INNER JOIN customer ON customer.customerID = cs.customerID;


Activities
Terminal
May 27 20:39
kaustubh@kaustubh-HP-Pavilion-g6-Notebook-PC: ~/Stuff/library_management_system/sql_files

```
mysql> SELECT cs.customerID, cs.branchID, customer.firstName, customer.lastName
    -> FROM customer_subscription AS cs
    -> INNER JOIN customer ON customer.customerID = cs.customerID;
+------------+----------+-----------+----------+
| customerID | branchID | firstName | lastName |
+------------+----------+-----------+----------+
| C1         | BR1      | Aditya    | B        |
| C2         | BR1      | Rohan     | A        |
| C3         | BR3      | John      |          |
+------------+----------+-----------+----------+
3 rows in set (0.00 sec)

mysql> _
```

SELECT baddr.branchID, br.branchManager, baddr.region, baddr.city, baddr.state
FROM branch_address AS baddr
INNER JOIN branch AS br ON br.branchID = baddr.branchID;

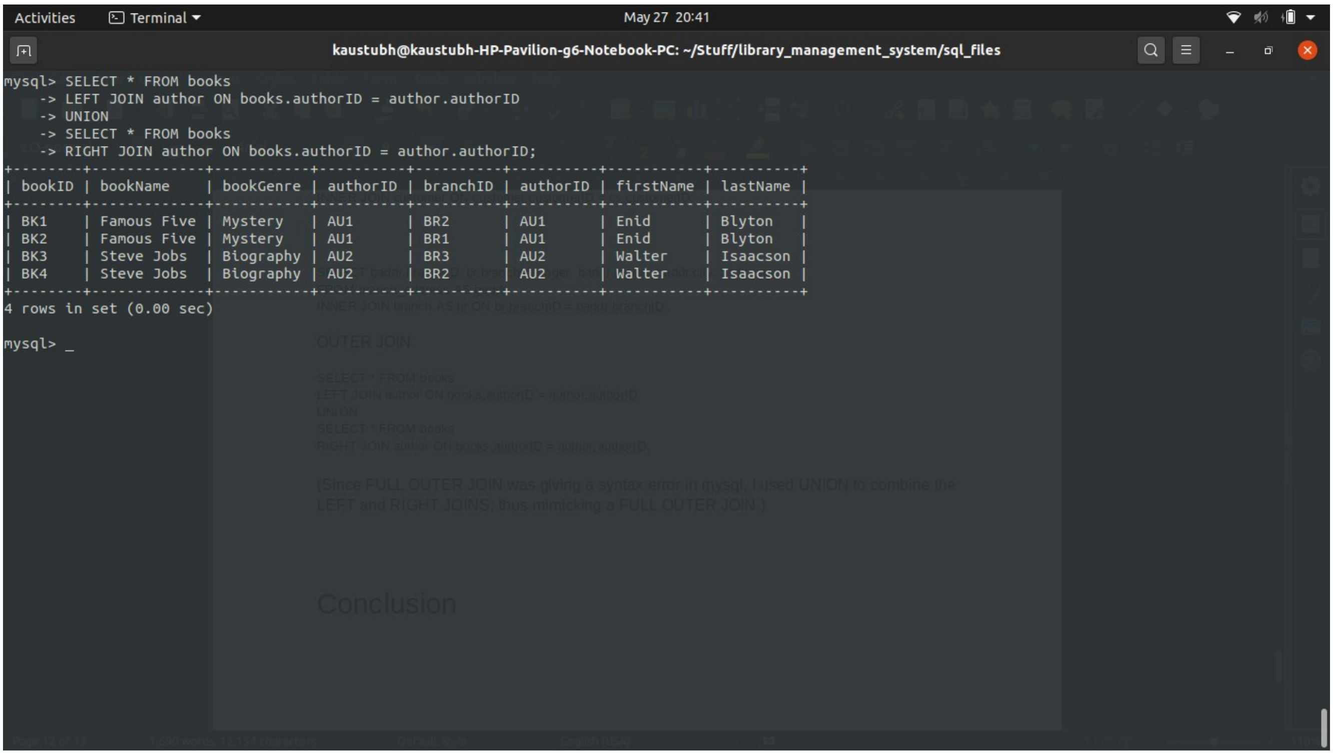

Activities
Terminal
May 27 20:40
kaustubh@kaustubh-HP-Pavilion-g6-Notebook-PC: ~/Stuff/library_management_system/sql_files

```
mysql> SELECT baddr.branchID, br.branchManager, baddr.region, baddr.city, baddr.state
    -> FROM branch_address AS baddr
    -> INNER JOIN branch AS br ON br.branchID = baddr.branchID;
+----------+------------------+-----------------------+-----------+-----------+
| branchID | branchManager    | region                | city      | state     |
+----------+------------------+-----------------------+-----------+-----------+
| BR1      | KAUSTUBH KULKARNI | RBI Layout, JP Nagar  | Bangalore | Karnataka |
| BR2      | MARK ANTHONY     | Jayanagar 4th Block   | Bangalore | Karnataka |
| BR3      | ROHAN SJ         | Banashankari 2nd Stage | Bangalore | Karnataka |
+----------+------------------+-----------------------+-----------+-----------+
3 rows in set (0.00 sec)

mysql> _
```

OUTER JOIN

SELECT * FROM books
LEFT JOIN author ON books.authorID = author.authorID
UNION
SELECT * FROM books
RIGHT JOIN author ON books.authorID = author.authorID;

(Since FULL OUTER JOIN was giving a syntax error in mysql, I used UNION to combine the LEFT and RIGHT JOINS, thus mimicking a FULL OUTER JOIN.)


Activities
Terminal
May 27 20:41
kaustubh@kaustubh-HP-Pavilion-g6-Notebook-PC: ~/Stuff/library_management_system/sql_files

```
mysql> SELECT * FROM books
    -> LEFT JOIN author ON books.authorID = author.authorID
    -> UNION
    -> SELECT * FROM books
    -> RIGHT JOIN author ON books.authorID = author.authorID;
+--------+-------------+-----------+----------+----------+----------+-----------+----------+
| bookID | bookName    | bookGenre | authorID | branchID | authorID | firstName | lastName |
+--------+-------------+-----------+----------+----------+----------+-----------+----------+
| BK1    | Famous Five | Mystery   | AU1      | BR2      | AU1      | Enid      | Blyton   |
| BK2    | Famous Five | Mystery   | AU1      | BR1      | AU1      | Enid      | Blyton   |
| BK3    | Steve Jobs  | Biography | AU2      | BR3      | AU2      | Walter    | Isaacson |
| BK4    | Steve Jobs  | Biography | AU2      | BR2      | AU2      | Walter    | Isaacson |
+--------+-------------+-----------+----------+----------+----------+-----------+----------+
4 rows in set (0.00 sec)

mysql> _
```

Conclusion

This system can be used to manage a small library quite efficiently. It can be used to track returned and not returned books. It can also track fines to be payed by customers, which branch has which book, etc. All in all, it is accurate and can be used on a small scale.

LIMITATIONS

There is no UI for customers or library management staff.

FUTURE ENHANCEMENTS

Keeping track of the books borrowed and returned, and if they are available in the particular branch or not.
Keeping one more table for premium customers who can keep the book for longer and also borrow more books.
Can store customer e-mail IDs and phone numbers to contact them in case of any clarification.