CSCI-5408

DATA MANAGEMENT, WAREHOUSING, & ANALYTICS

ASSIGNMENT – 1

Problem 2: Custom DBMS Using Java

Banner ID: B00977669

GitLab Assignment Link:
https://git.cs.dal.ca/saji/csci5408_w24_b00977669_christin_saji

Table of Contents

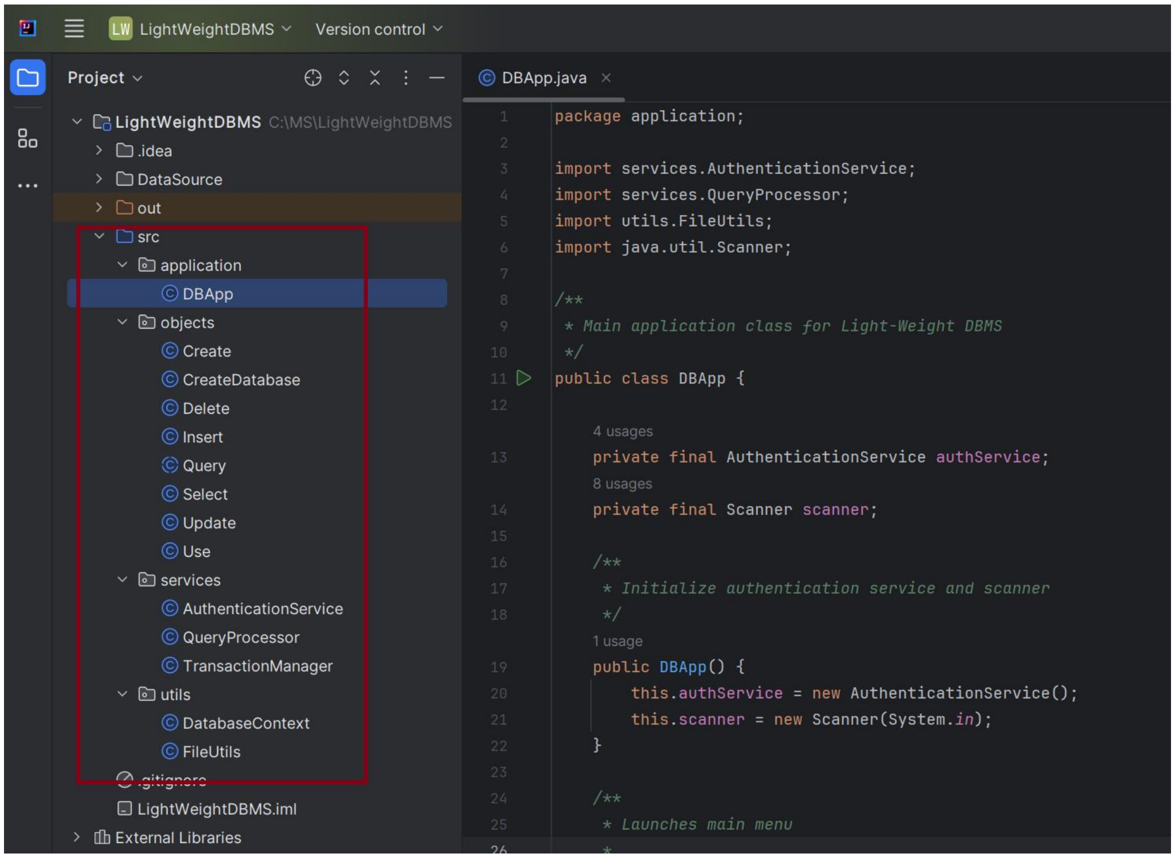
Task 1: Documentation of Design Principle

Application Architecture

The lightweight database management system is structured using a **layered architecture** style, with this the system is divided into a number of layers, each of which is responsible for a different task and interacts with the layers above and below it [1].

Application is structured as follows:

- **Presentation Layer (application)** – This package is the entry point of the application which handles user interaction and provides a command-line interface.
- **Business Logic Layer (services)** – This package encapsulates the core business logic and operations of the application.
- **Data Access Layer (objects)** – This package contains various query types which directly manipulates the database files.
- **Utility Layer (utils)** – This package provides supporting functionalities across the application.



```java
package application;

import services.AuthenticationService;
import services.QueryProcessor;
import utils.FileUtils;
import java.util.Scanner;

/**
 * Main application class for Light-Weight DBMS
 */
public class DBApp {

    4 usages
    private final AuthenticationService authService;
    8 usages
    private final Scanner scanner;

    /**
     * Initialize authentication service and scanner
     */
    1 usage
    public DBApp() {
        this.authService = new AuthenticationService();
        this.scanner = new Scanner(System.in);
    }

    /**
     * Launches main menu
     *
```

Figure 1 Application Architecture for lightweight database management system.

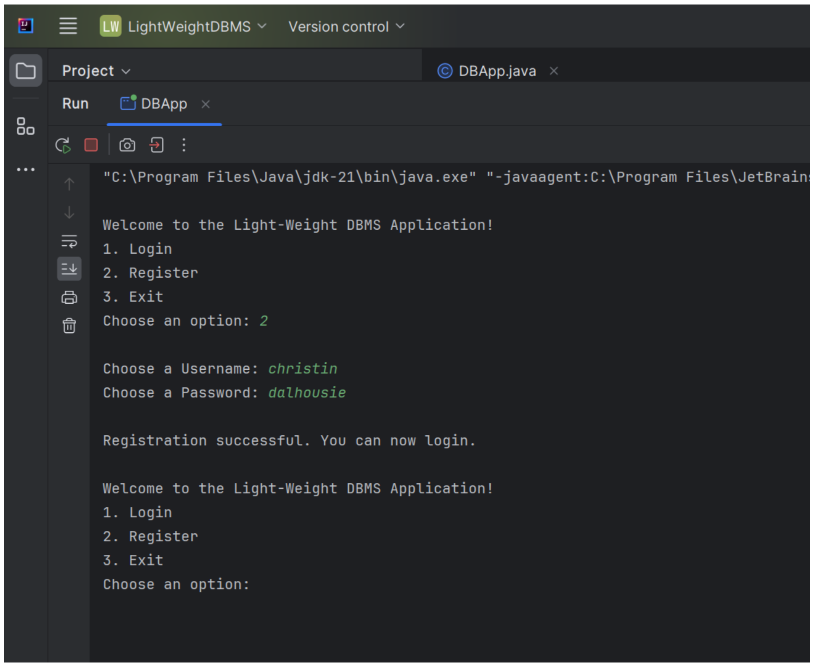
Following Single Responsibility Principle, each class is responsible for one job [2]. For example, ‘QueryProcessor’ is responsible for interpreting and directing SQL queries, ‘AuthenticationService’ handles user authentication, and ‘FileUtils’ manages file operations.

‘Query’ class is abstract, allowing for extension to handle various types of queries (‘Select’, ‘Insert’, ‘Update’, ‘Delete’) without modifying the base class this satisfies Open/Closed Principle. Also, from ‘Query’ class all classes inherit this ensures than any subclass can replace the ‘Query’ class without affecting the correctness of the program satisfying Liskov Substitution Principle.

Task 2: User Authentication

Register Process

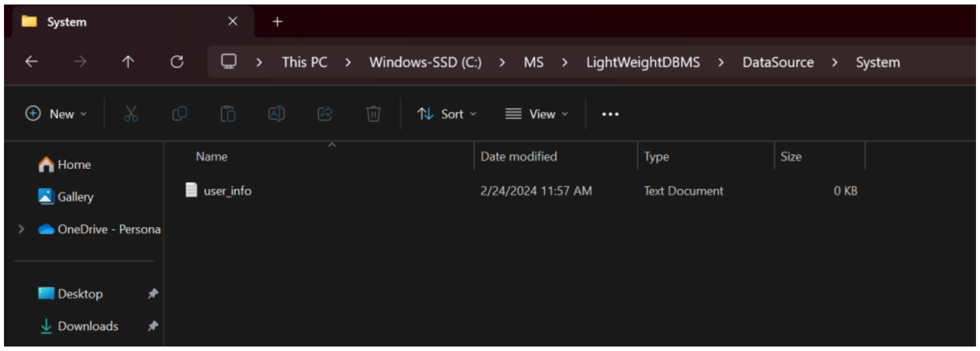
The menu of the lightweight database management system is displayed when the application is run. When user selects option 2 to register as shown in Figure 2, the user is able to successfully register with the system.



```
"C:\Program Files\Java\jdk-21\bin\java.exe" "-javaagent:C:\Program Files\JetBrain

Welcome to the Light-Weight DBMS Application!
1. Login
2. Register
3. Exit
Choose an option: 2

Choose a Username: christin
Choose a Password: dalhousie

Registration successful. You can now login.

Welcome to the Light-Weight DBMS Application!
1. Login
2. Register
3. Exit
Choose an option:
```

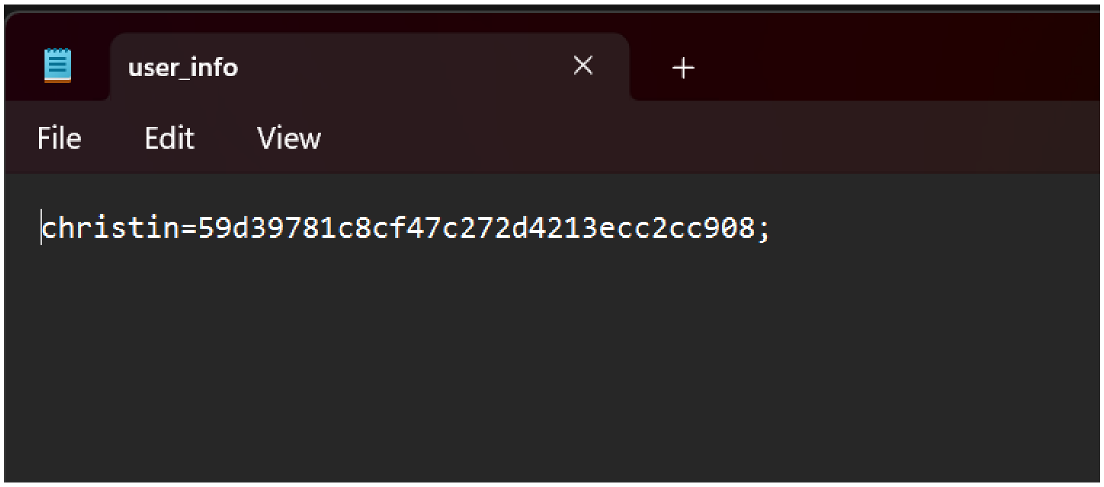
Figure 2 Successful registration process

User credentials are stored safely in a `user_info` text file, and the password is hashed using the MD5 algorithm.


System
This PC > Windows-SSD (C:) > MS > LightWeightDBMS > DataSource > System
New
Sort
View
Home
Gallery
OneDrive - Persona
Desktop
Downloads

Name	Date modified	Type	Size
user_info	2/24/2024 11:57 AM	Text Document	0 KB

Figure 3 'user_info' contains all the user credentials

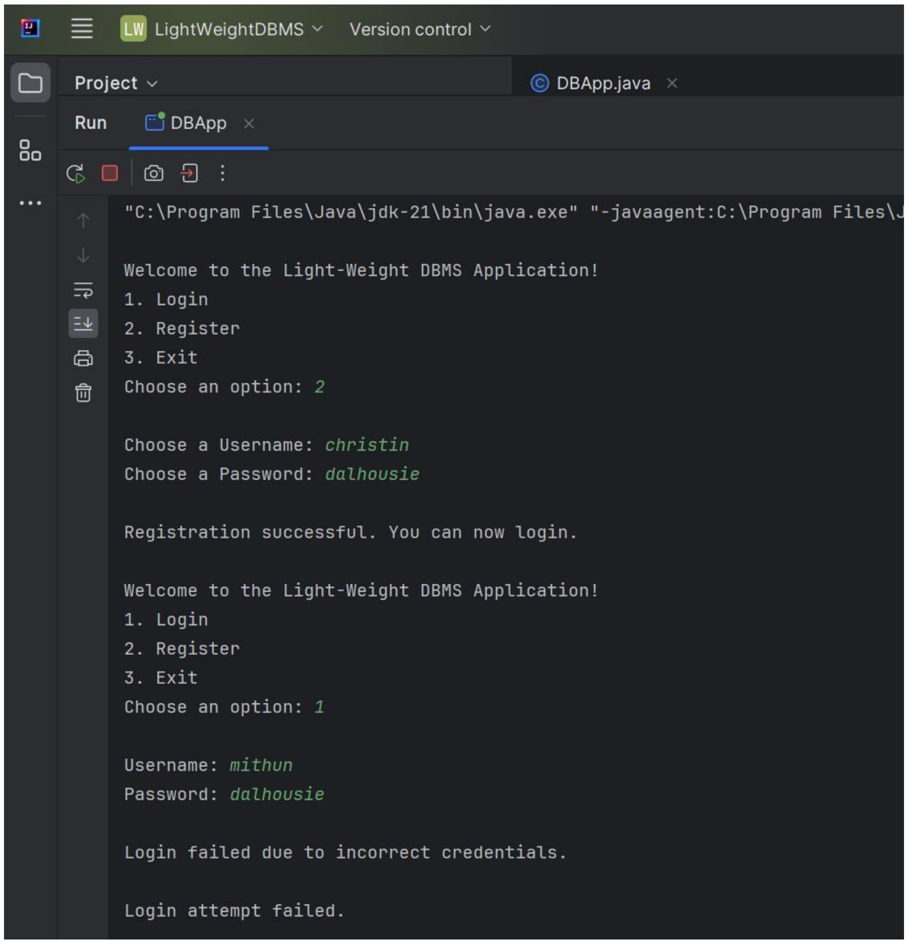


```
christin=59d39781c8cf47c272d4213ecc2cc908;
```

Figure 4 'user_info' contains username with MD5 hashed password

Login Process

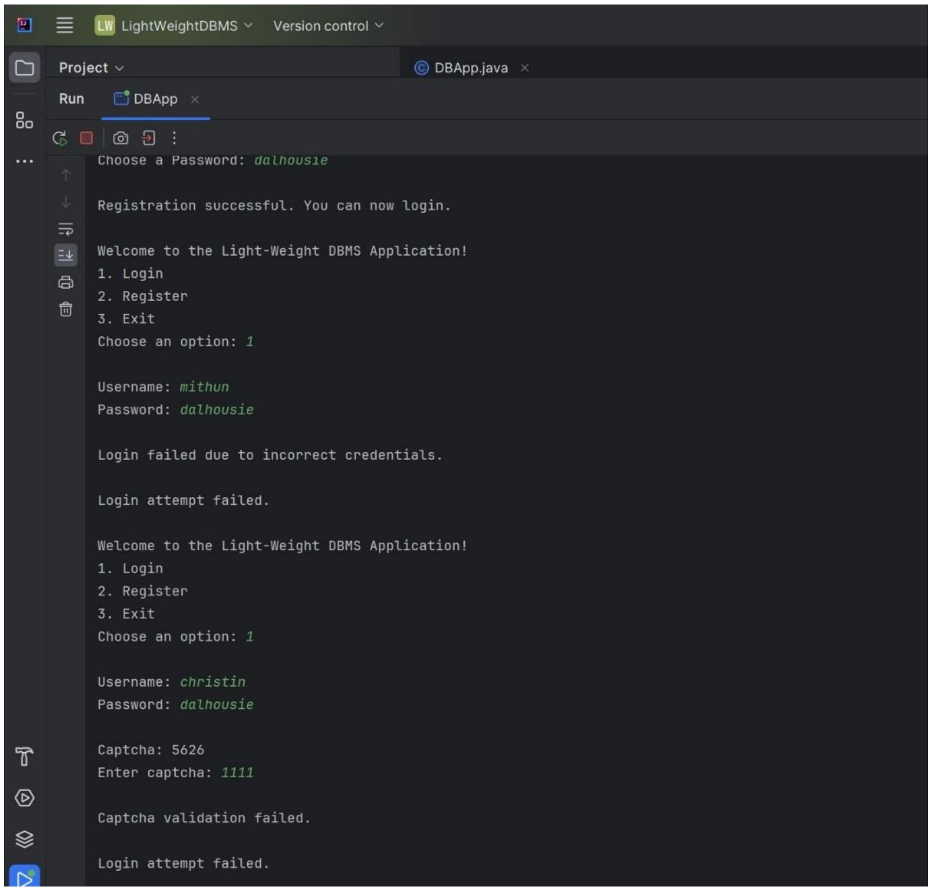
When a user enters incorrect credentials, they won't be able to log in to the system.



```
"C:\Program Files\Java\jdk-21\bin\java.exe" "-javaagent:C:\Program Files\J

Welcome to the Light-Weight DBMS Application!
1. Login
2. Register
3. Exit
Choose an option: 2

Choose a Username: christin
Choose a Password: dalhousie

Registration successful. You can now login.

Welcome to the Light-Weight DBMS Application!
1. Login
2. Register
3. Exit
Choose an option: 1

Username: mithun
Password: dalhousie

Login failed due to incorrect credentials.

Login attempt failed.
```

Figure 5 Login process failed due to incorrect credentials

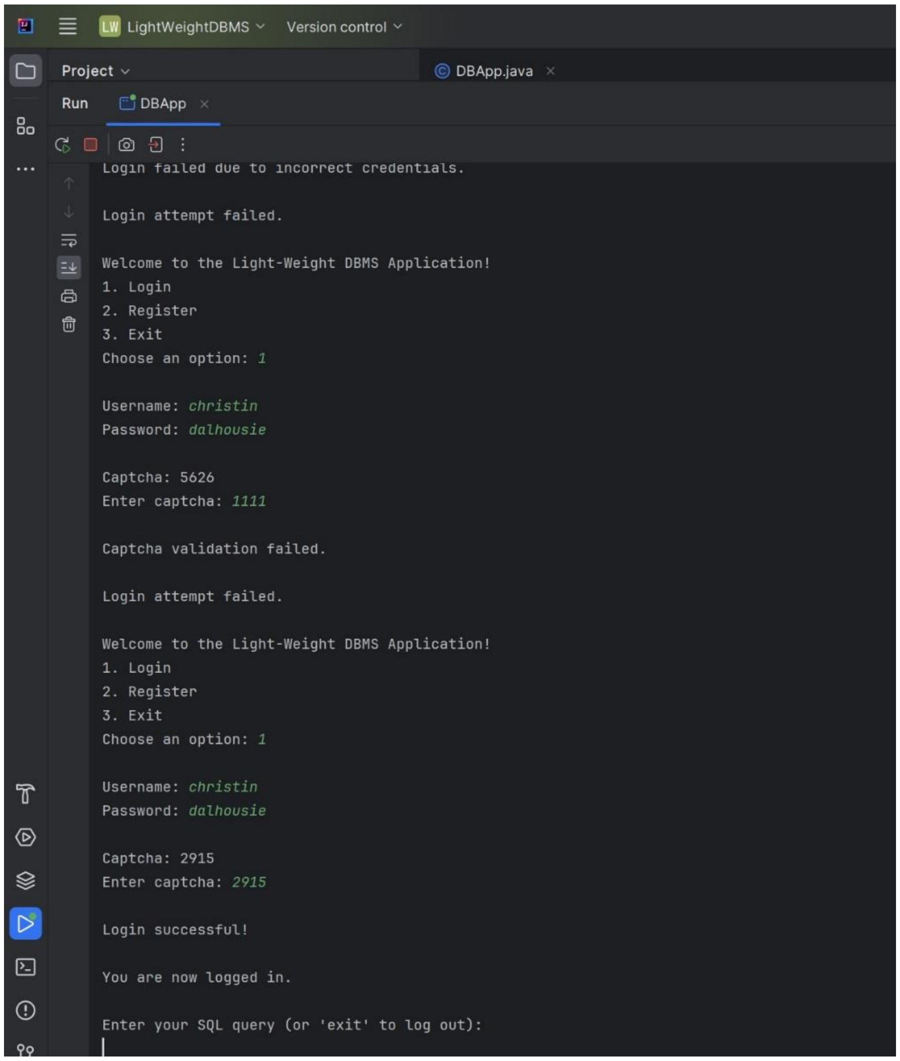
After entering the correct credentials to log in, the user will be prompted to enter a randomly generated 4-digit captcha. If they enter the incorrect captcha, they won't be allowed into the system.



```
Choose a Password: dalhousie

Registration successful. You can now login.

Welcome to the Light-Weight DBMS Application!
1. Login
2. Register
3. Exit
Choose an option: 1

Username: mithun
Password: dalhousie

Login failed due to incorrect credentials.

Login attempt failed.

Welcome to the Light-Weight DBMS Application!
1. Login
2. Register
3. Exit
Choose an option: 1

Username: christin
Password: dalhousie

Captcha: 5626
Enter captcha: 1111

Captcha validation failed.

Login attempt failed.
```

Figure 6 Incorrect captcha

After successfully entering the correct credentials and captcha, the user is allowed to perform SQL operations in the system.



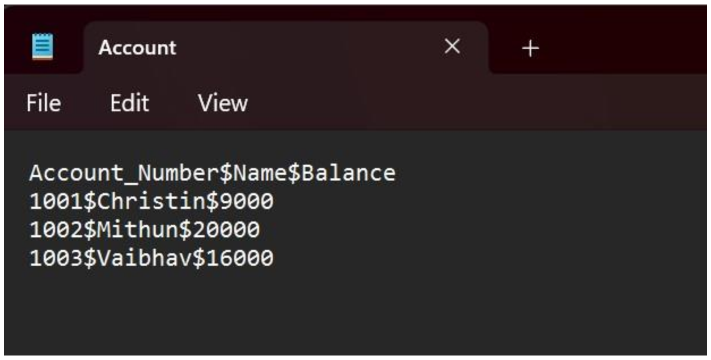
```
Login failed due to incorrect credentials.

Login attempt failed.

Welcome to the Light-Weight DBMS Application!
1. Login
2. Register
3. Exit
Choose an option: 1

Username: christin
Password: dalhousie

Captcha: 5626
Enter captcha: 1111

Captcha validation failed.

Login attempt failed.

Welcome to the Light-Weight DBMS Application!
1. Login
2. Register
3. Exit
Choose an option: 1

Username: christin
Password: dalhousie

Captcha: 2915
Enter captcha: 2915

Login successful!

You are now logged in.

Enter your SQL query (or 'exit' to log out):
```

Figure 7 Successful login after entering correct credentials with captcha

Task 3:

Task 3.1: Design of Persistent Storage

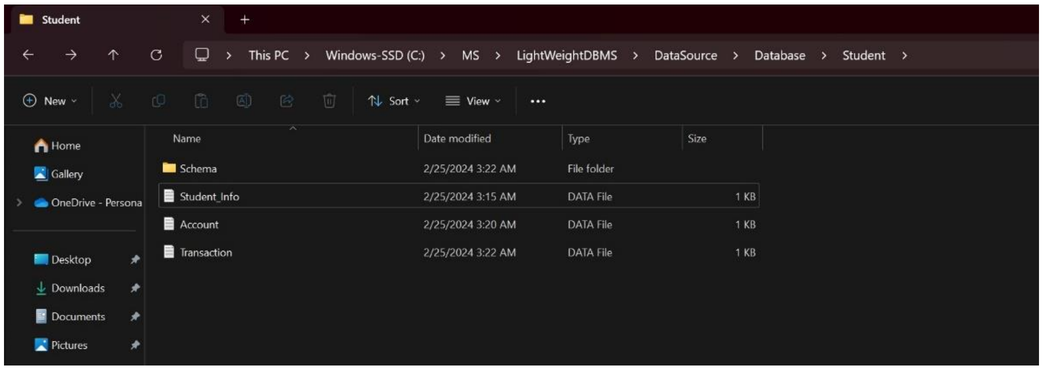
Novelty Task: Table data is stored using a custom delimiter separated by $.



```
Account_Number$Name$Balance
1001$Christin$9000
1002$Mithun$20000
1003$Vaibhav$16000
```

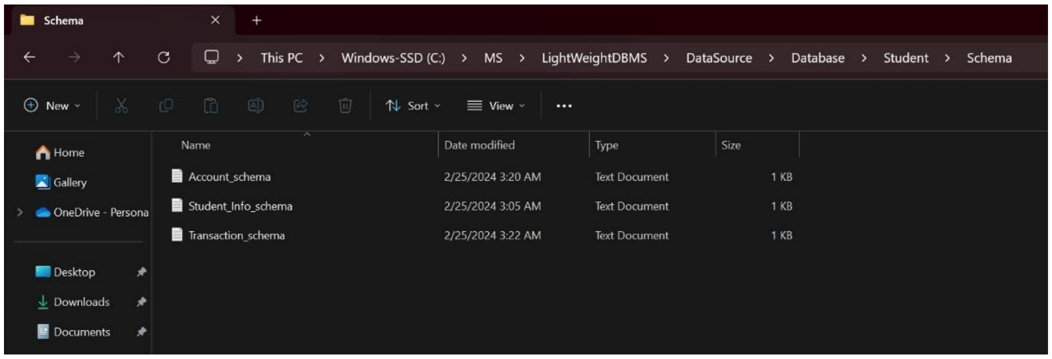
Figure 8 Table data stored using custom delimiter

When each table is created, it creates a `(table_name).data` file extension, and its metadata is stored in the `Schema` folder as `(table_name)_schema.txt`.


Student
This PC > Windows-SSD (C:) > MS > LightWeightDBMS > DataSource > Database > Student >
New
Sort
View
Home
Gallery
OneDrive - Persona
Desktop
Downloads
Documents
Pictures

Name	Date modified	Type	Size
Schema	2/25/2024 3:22 AM	File folder	
Student_Info	2/25/2024 3:15 AM	DATA File	1 KB
Account	2/25/2024 3:20 AM	DATA File	1 KB
Transaction	2/25/2024 3:22 AM	DATA File	1 KB

Figure 9 Table data are stored in (table_name).data file extension


Schema
This PC > Windows-SSD (C:) > MS > LightWeightDBMS > DataSource > Database > Student > Schema
New
Sort
View
Home
Gallery
OneDrive - Persona
Desktop
Downloads
Documents

Name	Date modified	Type	Size
Account_schema	2/25/2024 3:20 AM	Text Document	1 KB
Student_Info_schema	2/25/2024 3:05 AM	Text Document	1 KB
Transaction_schema	2/25/2024 3:22 AM	Text Document	1 KB

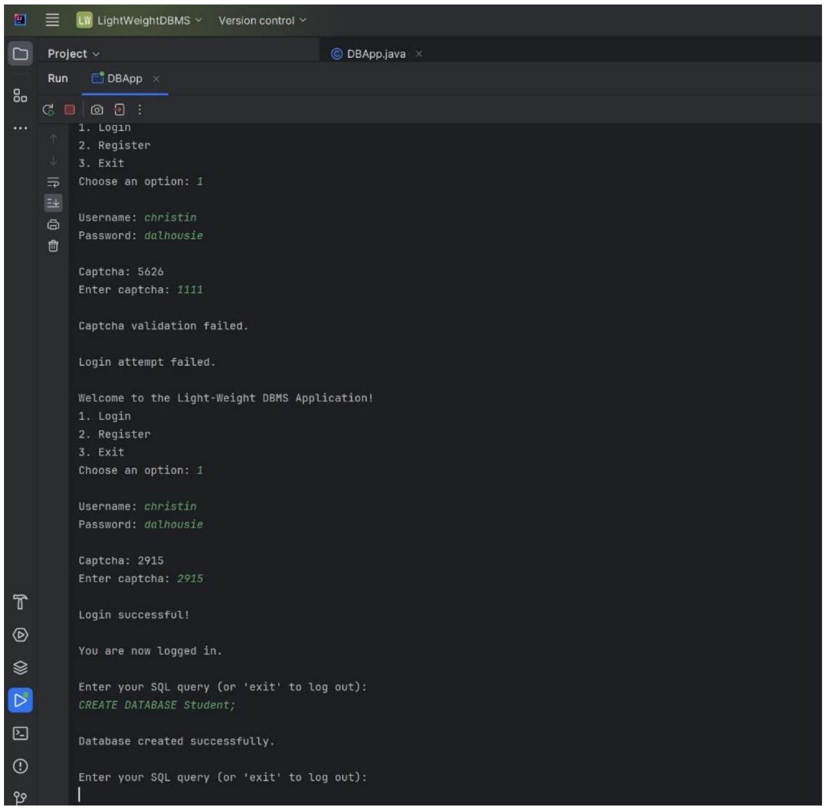
Figure 10 Each table has their own schema file

Task 3.2: Implementation of Queries (DDL & DML)

CREATE DATABASE

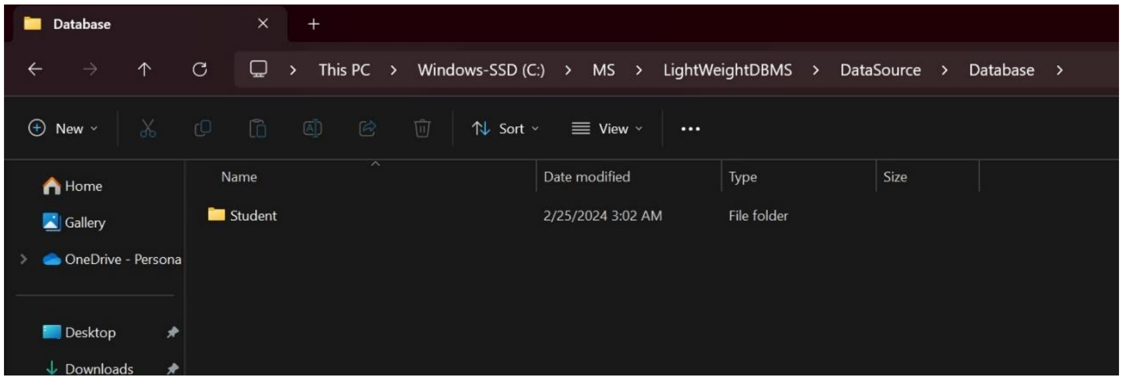
Query: CREATE DATABASE Student;

It creates a folder named after the `Database_Name` in the file system.



```
1. Login
2. Register
3. Exit
Choose an option: 1

Username: christin
Password: dalhousie

Captcha: 5626
Enter captcha: 1111

Captcha validation failed.

Login attempt failed.

Welcome to the Light-Weight DBMS Application!
1. Login
2. Register
3. Exit
Choose an option: 1

Username: christin
Password: dalhousie

Captcha: 2915
Enter captcha: 2915

Login successful!

You are now logged in.

Enter your SQL query (or 'exit' to log out):
CREATE DATABASE Student;

Database created successfully.

Enter your SQL query (or 'exit' to log out):
```

Figure 11 CREATE DATABASE operation

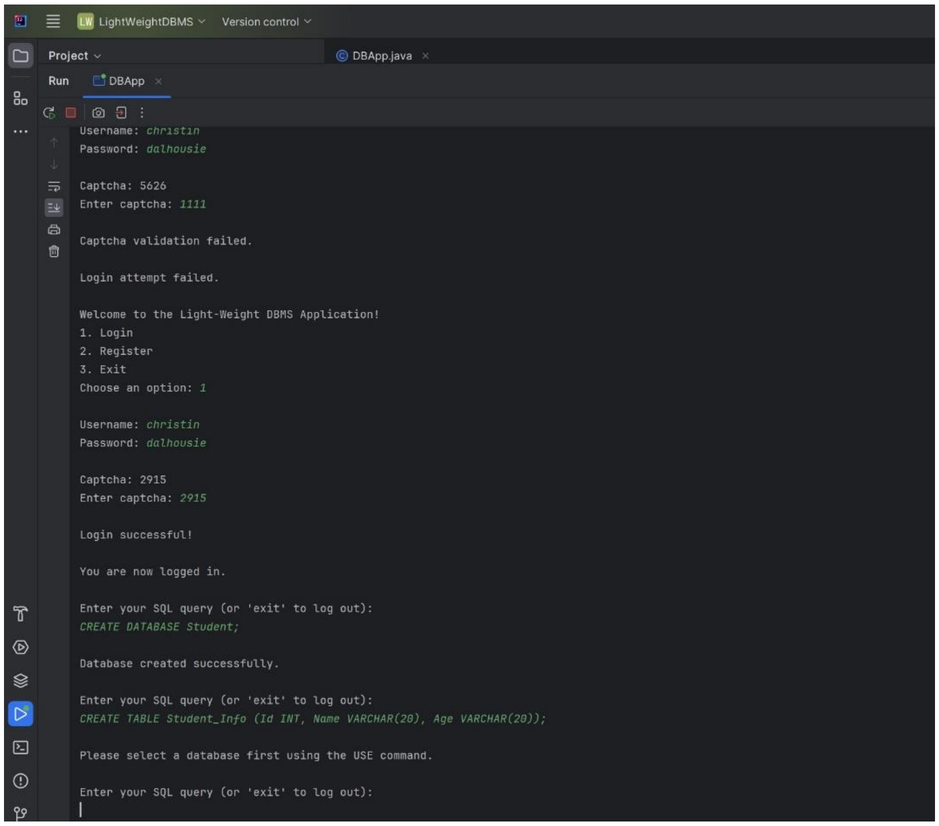

Database
This PC > Windows-SSD (C:) > MS > LightWeightDBMS > DataSource > Database >
New
Sort
View
Home
Gallery
OneDrive - Persona
Desktop
Downloads

Name	Date modified	Type	Size
Student	2/25/2024 3:02 AM	File folder	

Figure 12 Student folder is generated for the database

USE

If a user tries to access using a DML command, they will be prompted to first select the database.

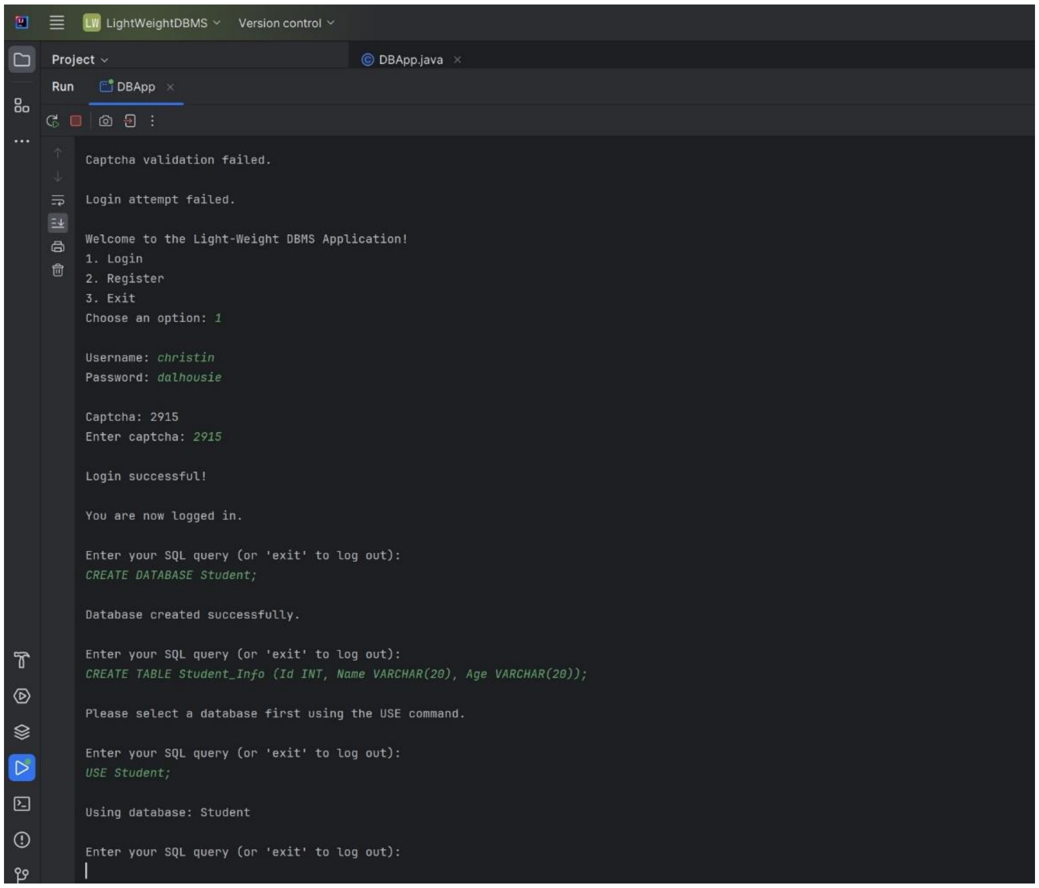


```
Username: christin
Password: dalhousie

Captcha: 5626
Enter captcha: 1111

Captcha validation failed.

Login attempt failed.

Welcome to the Light-Weight DBMS Application!
1. Login
2. Register
3. Exit
Choose an option: 1

Username: christin
Password: dalhousie

Captcha: 2915
Enter captcha: 2915

Login successful!

You are now logged in.

Enter your SQL query (or 'exit' to log out):
CREATE DATABASE Student;

Database created successfully.

Enter your SQL query (or 'exit' to log out):
CREATE TABLE Student_Info (Id INT, Name VARCHAR(20), Age VARCHAR(20));

Please select a database first using the USE command.

Enter your SQL query (or 'exit' to log out):
```

Figure 13 Using DML commands without selecting database

Query: USE DATABASE Student

Selecting the database makes it the active database for the DML operations.



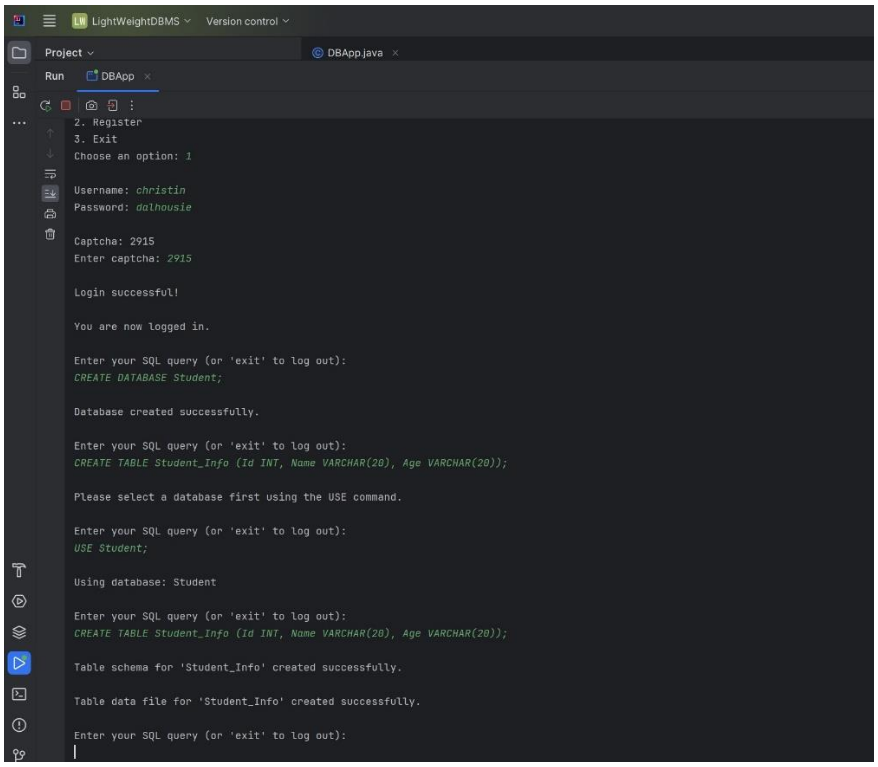
```
Captcha validation failed.

Login attempt failed.

Welcome to the Light-Weight DBMS Application!
1. Login
2. Register
3. Exit
Choose an option: 1

Username: christin
Password: dalhousie

Captcha: 2915
Enter captcha: 2915

Login successful!

You are now logged in.

Enter your SQL query (or 'exit' to log out):
CREATE DATABASE Student;

Database created successfully.

Enter your SQL query (or 'exit' to log out):
CREATE TABLE Student_Info (Id INT, Name VARCHAR(20), Age VARCHAR(20));

Please select a database first using the USE command.

Enter your SQL query (or 'exit' to log out):
USE Student;

Using database: Student

Enter your SQL query (or 'exit' to log out):
```

Figure 14 USE Student to select Student database

CREATE TABLE

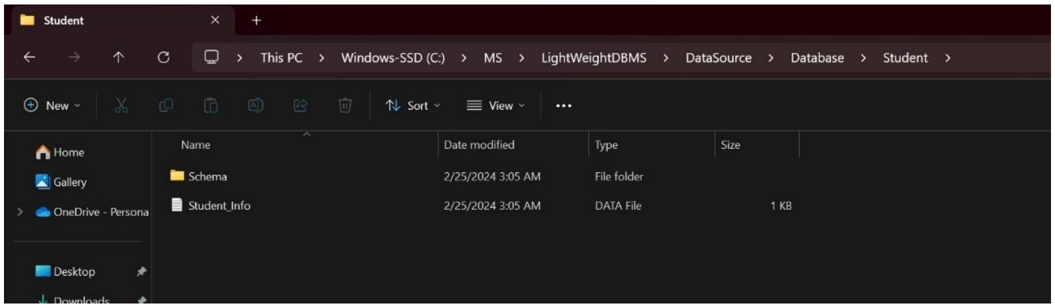
Query: CREATE TABLE Student_Info (Id INT, Name VARCHAR(20), Age VARCHAR(20));

This creates a `Student_info.data` file to store the table data inside the `Student` folder, and the metadata of the table is stored inside the `Schema` folder.



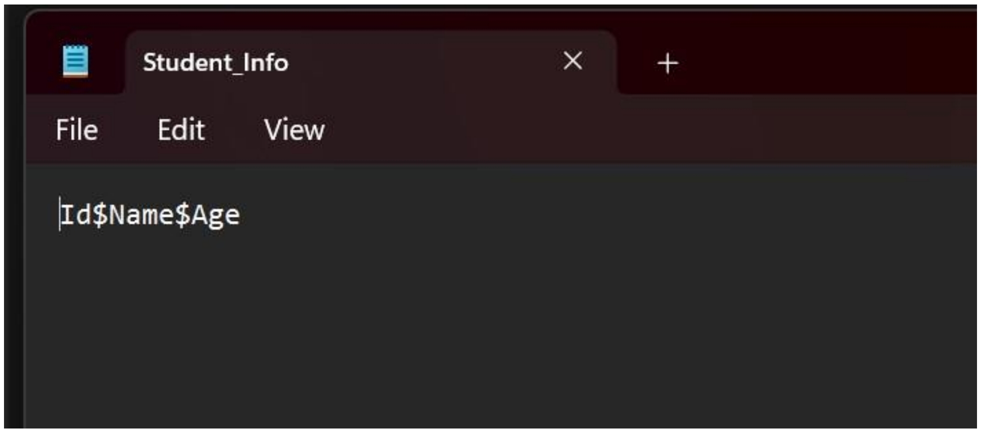
```
2. Register
3. Exit
Choose an option: 1

Username: christin
Password: dalhousie

Captcha: 2915
Enter captcha: 2915

Login successful!

You are now logged in.

Enter your SQL query (or 'exit' to log out):
CREATE DATABASE Student;

Database created successfully.

Enter your SQL query (or 'exit' to log out):
CREATE TABLE Student_Info (Id INT, Name VARCHAR(20), Age VARCHAR(20));

Please select a database first using the USE command.

Enter your SQL query (or 'exit' to log out):
USE Student;

Using database: Student

Enter your SQL query (or 'exit' to log out):
CREATE TABLE Student_Info (Id INT, Name VARCHAR(20), Age VARCHAR(20));

Table schema for 'Student_Info' created successfully.

Table data file for 'Student_Info' created successfully.

Enter your SQL query (or 'exit' to log out):
```

Figure 15 CREATE TABLE operation


Student
This PC > Windows-SSD (C:) > MS > LightWeightDBMS > DataSource > Database > Student >
New
Sort
View
Home
Gallery
OneDrive - Persona
Desktop
Downloads

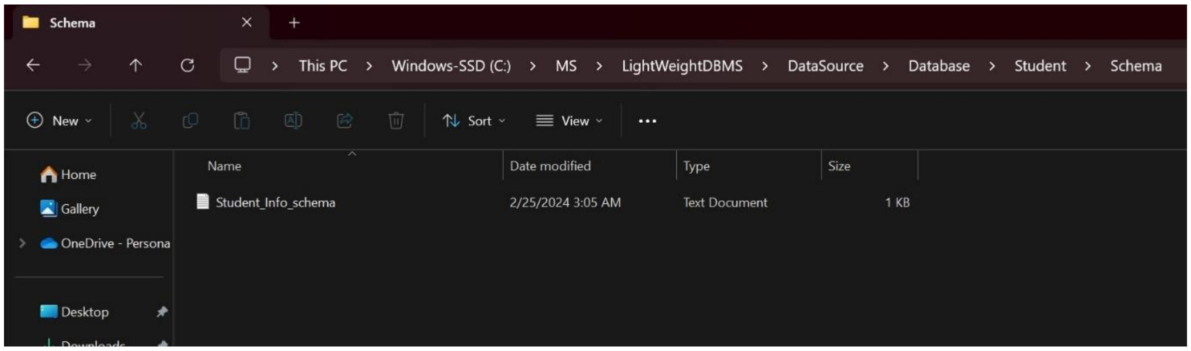
Name	Date modified	Type	Size
Schema	2/25/2024 3:05 AM	File folder	
Student_Info	2/25/2024 3:05 AM	DATA File	1 KB

Figure 16 Creates Student_Info.data to store table data



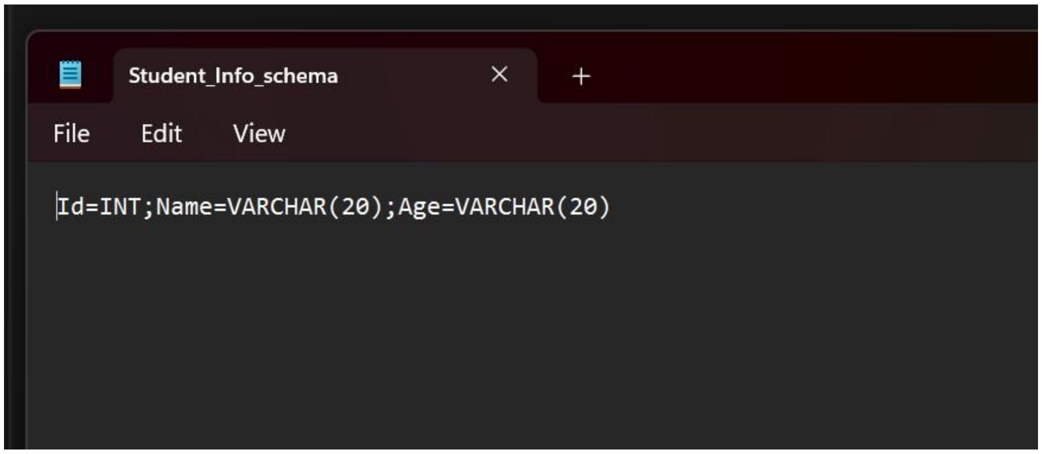
```
Id$Name$Age
```

Figure 17 Student_info with header


Schema
This PC > Windows-SSD (C:) > MS > LightWeightDBMS > DataSource > Database > Student > Schema
New
Sort
View
Home
Gallery
OneDrive - Persona
Desktop

Name	Date modified	Type	Size
Student_Info_schema	2/25/2024 3:05 AM	Text Document	1 KB

Figure 18 Student_Info_schema to store meta-data



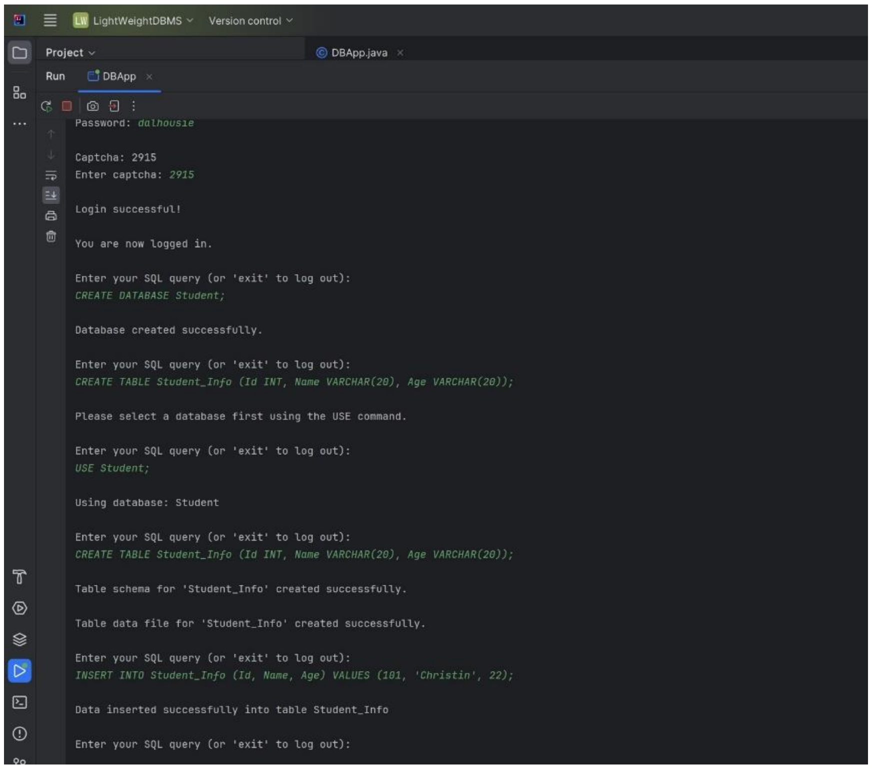
```
Id=INT;Name=VARCHAR(20);Age=VARCHAR(20)
```

Figure 19 Meta-data of Student_Info table

INSERT

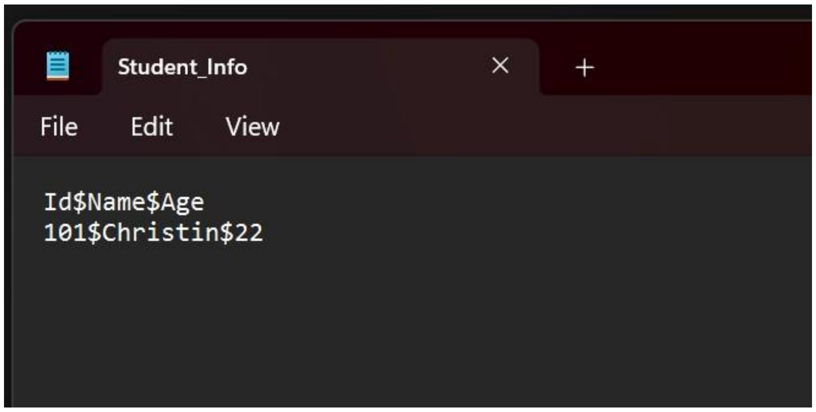
Query: INSERT INTO Student_Info (Id, Name, Age) VALUES (101, ‘Christin’, 22);

The insert operation puts the data inside the `Student_Info.data`, with each value separated by the custom delimiter $.



```
Password: dalhousie

Captcha: 2915
Enter captcha: 2915

Login successful!

You are now logged in.

Enter your SQL query (or 'exit' to log out):
CREATE DATABASE Student;

Database created successfully.

Enter your SQL query (or 'exit' to log out):
CREATE TABLE Student_Info (Id INT, Name VARCHAR(20), Age VARCHAR(20));

Please select a database first using the USE command.

Enter your SQL query (or 'exit' to log out):
USE Student;

Using database: Student

Enter your SQL query (or 'exit' to log out):
CREATE TABLE Student_Info (Id INT, Name VARCHAR(20), Age VARCHAR(20));

Table schema for 'Student_Info' created successfully.

Table data file for 'Student_Info' created successfully.

Enter your SQL query (or 'exit' to log out):
INSERT INTO Student_Info (Id, Name, Age) VALUES (101, 'Christin', 22);

Data inserted successfully into table Student_Info

Enter your SQL query (or 'exit' to log out):
```

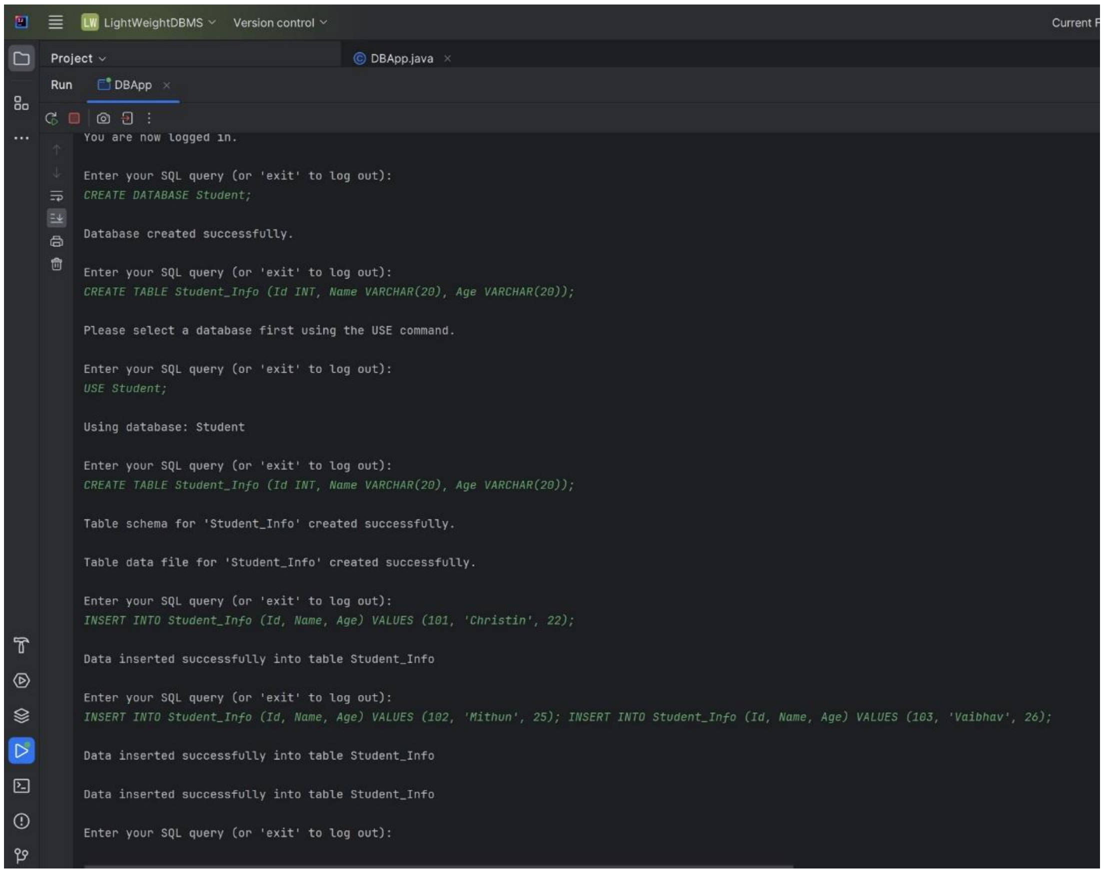
Figure 20 INSERT operation to the Student_Info table



```
Id$Name$Age
101$Christin$22
```

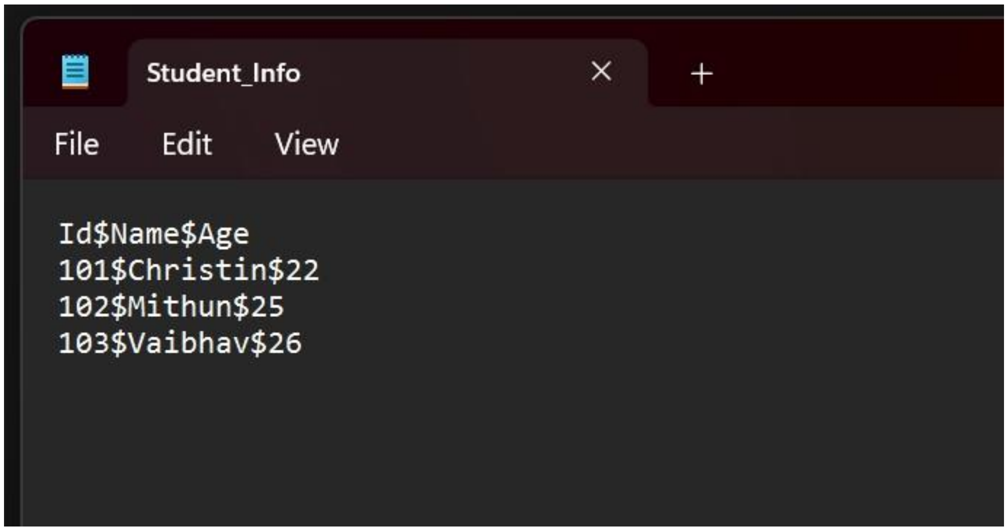
Figure 21 Data stored in Student_Info using custom delimiter

The insert operation also supports multiple insert statements to be entered together, and the values are stored in the data file.



```
You are now logged in.

Enter your SQL query (or 'exit' to log out):
CREATE DATABASE Student;

Database created successfully.

Enter your SQL query (or 'exit' to log out):
CREATE TABLE Student_Info (Id INT, Name VARCHAR(20), Age VARCHAR(20));

Please select a database first using the USE command.

Enter your SQL query (or 'exit' to log out):
USE Student;

Using database: Student

Enter your SQL query (or 'exit' to log out):
CREATE TABLE Student_Info (Id INT, Name VARCHAR(20), Age VARCHAR(20));

Table schema for 'Student_Info' created successfully.

Table data file for 'Student_Info' created successfully.

Enter your SQL query (or 'exit' to log out):
INSERT INTO Student_Info (Id, Name, Age) VALUES (101, 'Christin', 22);

Data inserted successfully into table Student_Info

Enter your SQL query (or 'exit' to log out):
INSERT INTO Student_Info (Id, Name, Age) VALUES (102, 'Mithun', 25); INSERT INTO Student_Info (Id, Name, Age) VALUES (103, 'Vaibhav', 26);

Data inserted successfully into table Student_Info

Data inserted successfully into table Student_Info

Enter your SQL query (or 'exit' to log out):
```

Figure 22 Inserting multiple data to Student_Info table



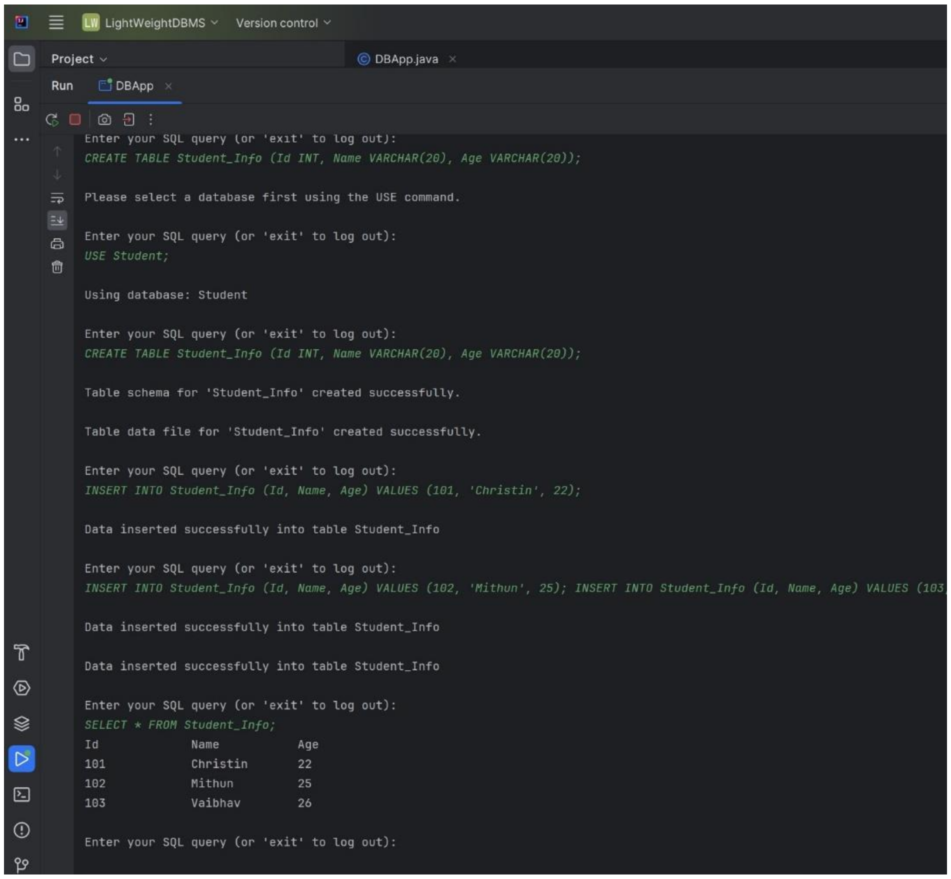
```
Id$Name$Age
101$Christin$22
102$Mithun$25
103$Vaibhav$26
```

Figure 23 Multiple rows of data in Student_Info table seperated by custom delimiter

SELECT

Query: SELECT * FROM Student_Info;

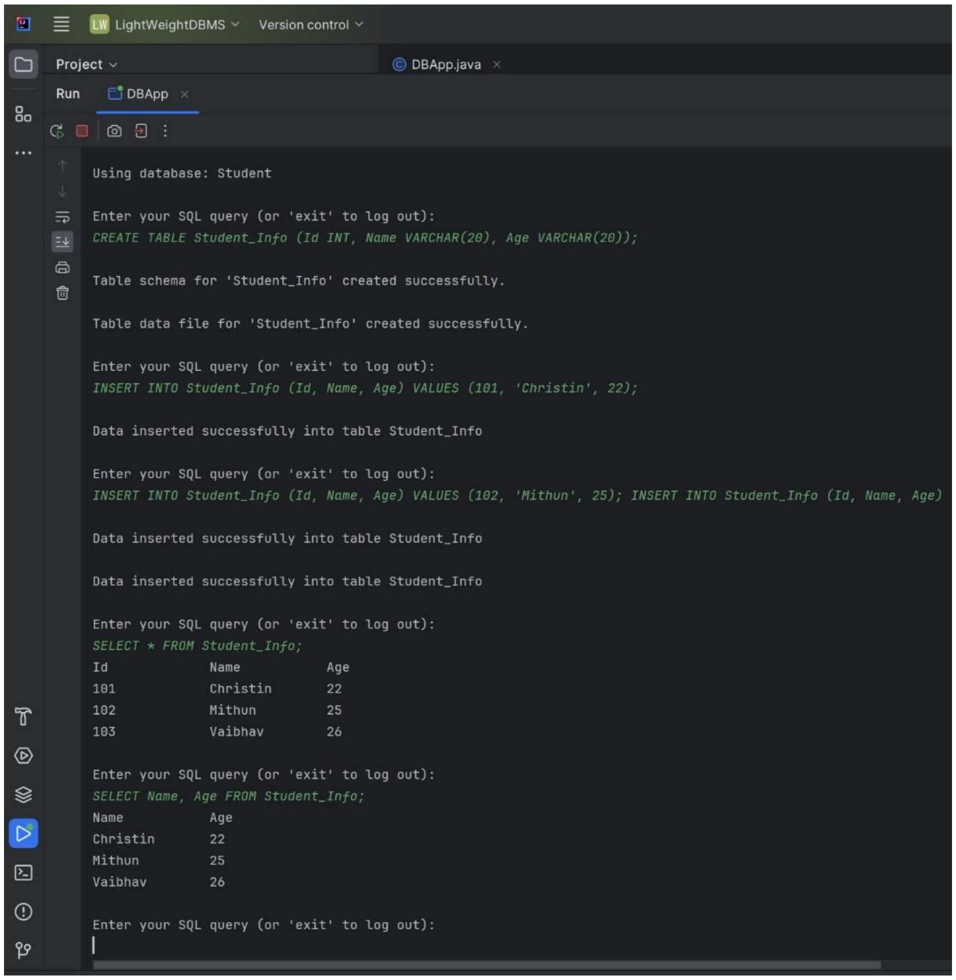
It selects all the columns and displays them nicely spaced.



```
Enter your SQL query (or 'exit' to log out):
CREATE TABLE Student_Info (Id INT, Name VARCHAR(20), Age VARCHAR(20));

Please select a database first using the USE command.

Enter your SQL query (or 'exit' to log out):
USE Student;

Using database: Student

Enter your SQL query (or 'exit' to log out):
CREATE TABLE Student_Info (Id INT, Name VARCHAR(20), Age VARCHAR(20));

Table schema for 'Student_Info' created successfully.

Table data file for 'Student_Info' created successfully.

Enter your SQL query (or 'exit' to log out):
INSERT INTO Student_Info (Id, Name, Age) VALUES (101, 'Christin', 22);

Data inserted successfully into table Student_Info

Enter your SQL query (or 'exit' to log out):
INSERT INTO Student_Info (Id, Name, Age) VALUES (102, 'Mithun', 25); INSERT INTO Student_Info (Id, Name, Age) VALUES (103

Data inserted successfully into table Student_Info

Data inserted successfully into table Student_Info

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Student_Info;
Id              Name            Age
101             Christin        22
102             Mithun          25
103             Vaibhav         26

Enter your SQL query (or 'exit' to log out):
```

*Figure 24 SELECT * to select all the columns and display it*

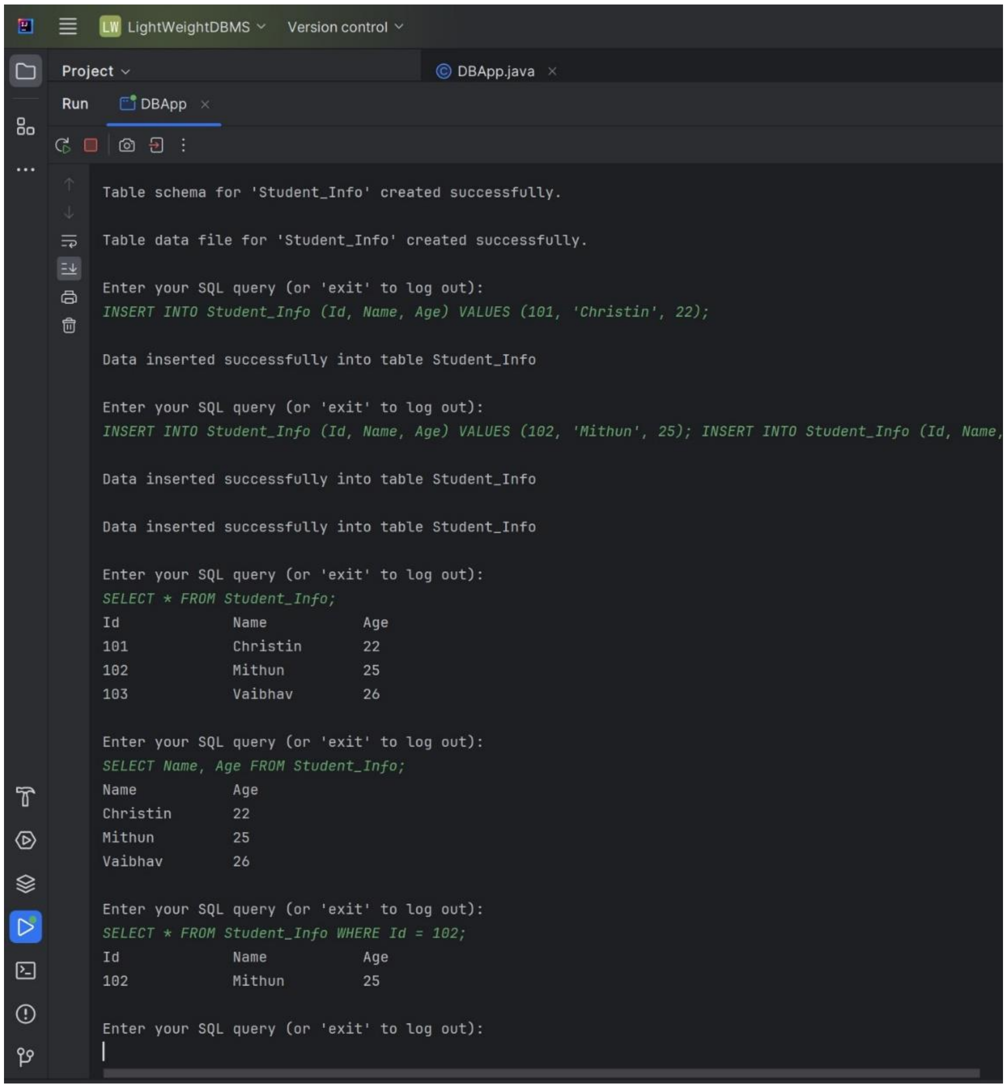
We can select particular columns, and it will display that information.



```
Using database: Student

Enter your SQL query (or 'exit' to log out):
CREATE TABLE Student_Info (Id INT, Name VARCHAR(20), Age VARCHAR(20));

Table schema for 'Student_Info' created successfully.

Table data file for 'Student_Info' created successfully.

Enter your SQL query (or 'exit' to log out):
INSERT INTO Student_Info (Id, Name, Age) VALUES (101, 'Christin', 22);

Data inserted successfully into table Student_Info

Enter your SQL query (or 'exit' to log out):
INSERT INTO Student_Info (Id, Name, Age) VALUES (102, 'Mithun', 25); INSERT INTO Student_Info (Id, Name, Age)

Data inserted successfully into table Student_Info

Data inserted successfully into table Student_Info

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Student_Info;
Id          Name          Age
101         Christin      22
102         Mithun        25
103         Vaibhav       26

Enter your SQL query (or 'exit' to log out):
SELECT Name, Age FROM Student_Info;
Name        Age
Christin    22
Mithun      25
Vaibhav     26

Enter your SQL query (or 'exit' to log out):
```

Figure 25 Selecting particular columns

Using the WHERE clause, we can display the particular information we need.



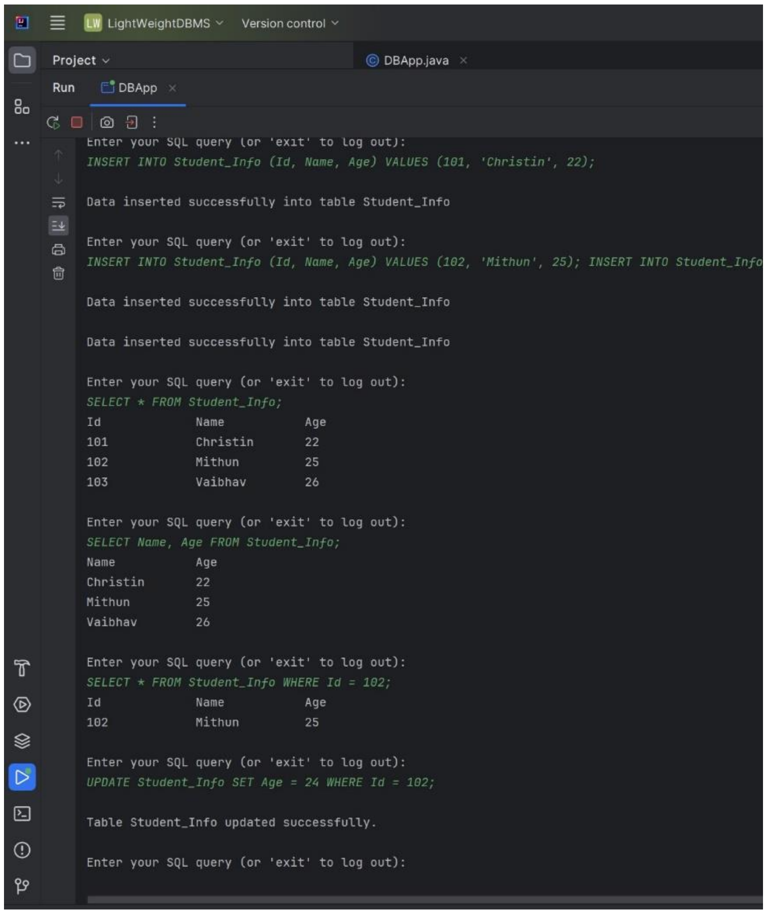
```
Table schema for 'Student_Info' created successfully.

Table data file for 'Student_Info' created successfully.

Enter your SQL query (or 'exit' to log out):
INSERT INTO Student_Info (Id, Name, Age) VALUES (101, 'Christin', 22);

Data inserted successfully into table Student_Info

Enter your SQL query (or 'exit' to log out):
INSERT INTO Student_Info (Id, Name, Age) VALUES (102, 'Mithun', 25); INSERT INTO Student_Info (Id, Name,

Data inserted successfully into table Student_Info

Data inserted successfully into table Student_Info

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Student_Info;
Id              Name            Age
101             Christin        22
102             Mithun          25
103             Vaibhav         26

Enter your SQL query (or 'exit' to log out):
SELECT Name, Age FROM Student_Info;
Name            Age
Christin        22
Mithun          25
Vaibhav         26

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Student_Info WHERE Id = 102;
Id              Name            Age
102             Mithun          25

Enter your SQL query (or 'exit' to log out):
```

Figure 26 Using WHERE clause to display particular information

UPDATE

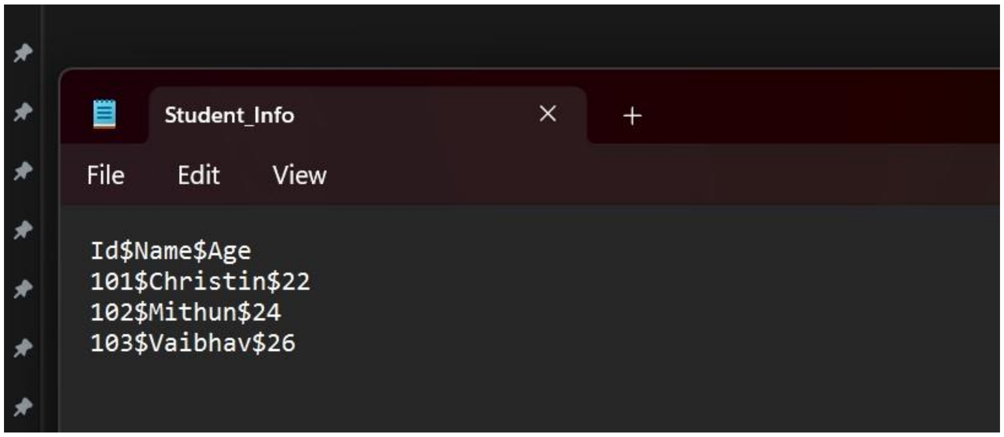
Query: UPDATE Student_Info SET Age = 24 WHERE Id = 102;

After a successful operation, it updates the data file.



```
Enter your SQL query (or 'exit' to log out):
INSERT INTO Student_Info (Id, Name, Age) VALUES (101, 'Christin', 22);

Data inserted successfully into table Student_Info

Enter your SQL query (or 'exit' to log out):
INSERT INTO Student_Info (Id, Name, Age) VALUES (102, 'Mithun', 25); INSERT INTO Student_Info

Data inserted successfully into table Student_Info

Data inserted successfully into table Student_Info

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Student_Info;
Id             Name           Age
101            Christin       22
102            Mithun         25
103            Vaibhav        26

Enter your SQL query (or 'exit' to log out):
SELECT Name, Age FROM Student_Info;
Name           Age
Christin       22
Mithun         25
Vaibhav        26

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Student_Info WHERE Id = 102;
Id             Name           Age
102            Mithun         25

Enter your SQL query (or 'exit' to log out):
UPDATE Student_Info SET Age = 24 WHERE Id = 102;

Table Student_Info updated successfully.

Enter your SQL query (or 'exit' to log out):
```

Figure 27 UPDATE operation into Student_Info table



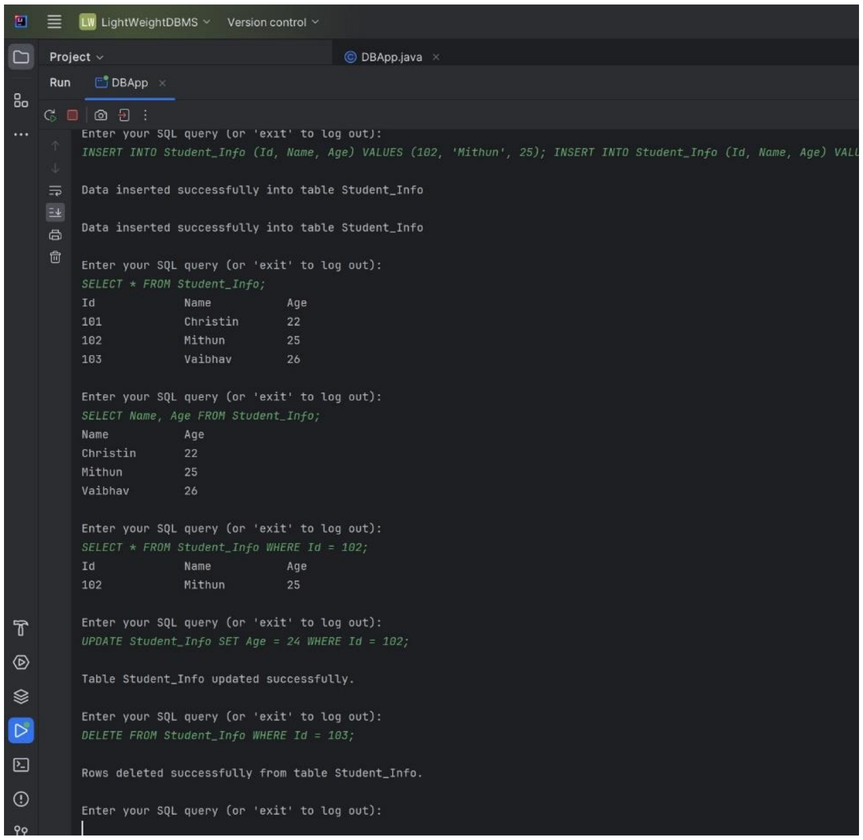
```
Id$Name$Age
101$Christin$22
102$Mithun$24
103$Vaibhav$26
```

Figure 28 Updated data in Student_Info

DELETE

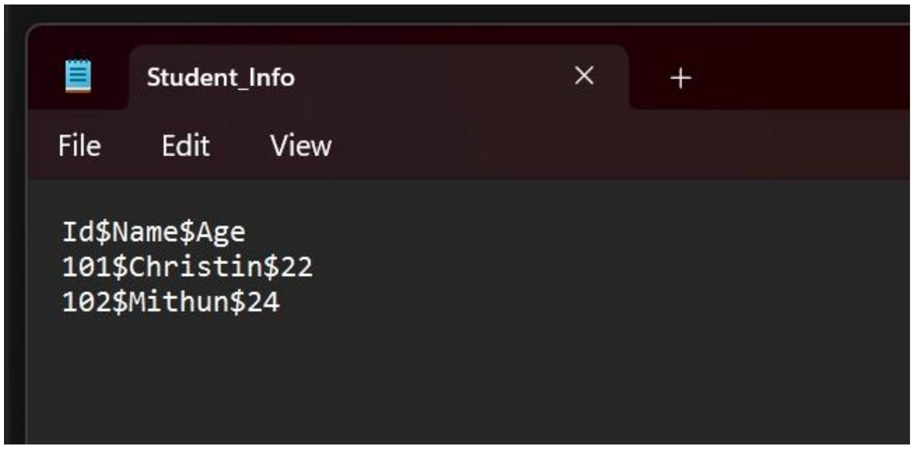
Query: DELETE FROM Student_Info WHERE Id = 103;

After successful execution, the particular information that is selected is removed from the data file.



```
Enter your SQL query (or 'exit' to log out):
INSERT INTO Student_Info (Id, Name, Age) VALUES (102, 'Mithun', 25); INSERT INTO Student_Info (Id, Name, Age) VALU

Data inserted successfully into table Student_Info

Data inserted successfully into table Student_Info

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Student_Info;
Id              Name            Age
101             Christin        22
102             Mithun          25
103             Vaibhav         26

Enter your SQL query (or 'exit' to log out):
SELECT Name, Age FROM Student_Info;
Name            Age
Christin        22
Mithun          25
Vaibhav         26

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Student_Info WHERE Id = 102;
Id              Name            Age
102             Mithun          25

Enter your SQL query (or 'exit' to log out):
UPDATE Student_Info SET Age = 24 WHERE Id = 102;

Table Student_Info updated successfully.

Enter your SQL query (or 'exit' to log out):
DELETE FROM Student_Info WHERE Id = 103;

Rows deleted successfully from table Student_Info.

Enter your SQL query (or 'exit' to log out):
```

Figure 29 Delete operation on Student_Info table



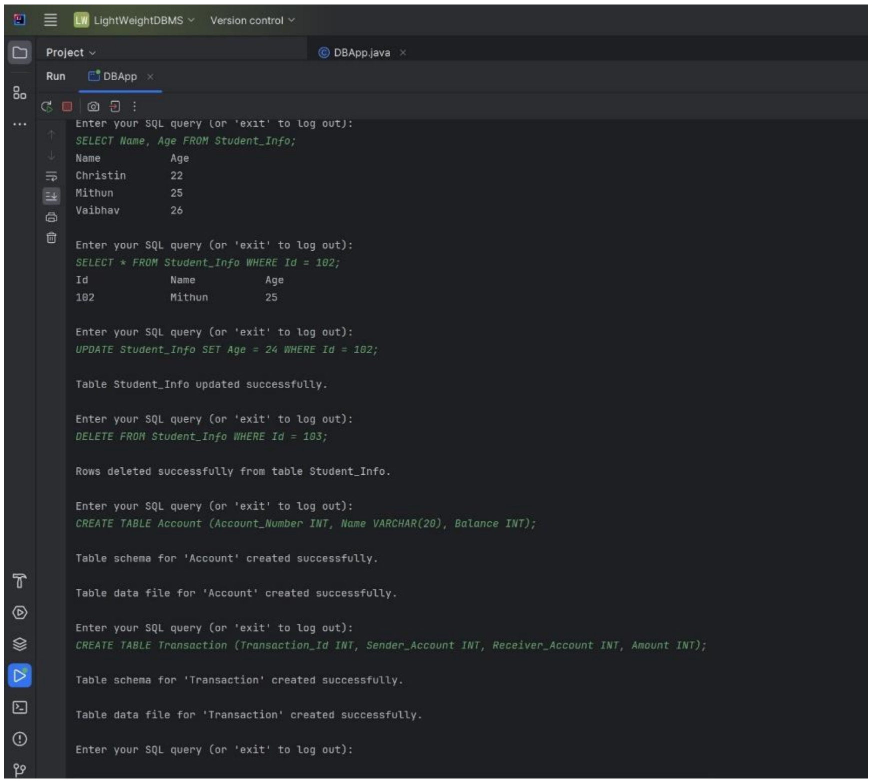
```
Id$Name$Age
101$Christin$22
102$Mithun$24
```

Figure 30 Update data in Student_Info table after delete operation

Task 4: Implementation of Transaction

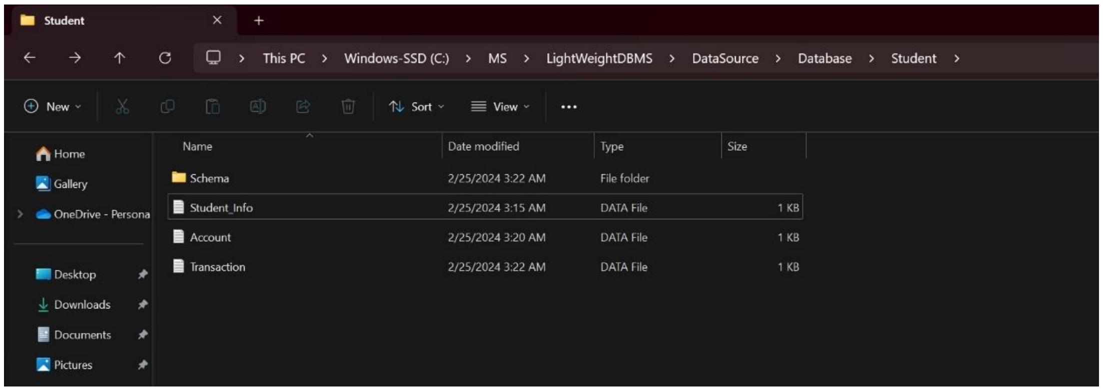
Setup

I created two tables, Account and Transaction, which I will use as base tables to run transaction operations on them. This will create `Account.data` and `Transaction.data` files, along with their respective metadata files in the Schema folder.



```
Enter your SQL query (or 'exit' to log out):
SELECT Name, Age FROM Student_Info;
Name          Age
Christin      22
Mithun        25
Vaibhav       26

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Student_Info WHERE Id = 102;
Id            Name          Age
102           Mithun        25

Enter your SQL query (or 'exit' to log out):
UPDATE Student_Info SET Age = 24 WHERE Id = 102;

Table Student_Info updated successfully.

Enter your SQL query (or 'exit' to log out):
DELETE FROM Student_Info WHERE Id = 103;

Rows deleted successfully from table Student_Info.

Enter your SQL query (or 'exit' to log out):
CREATE TABLE Account (Account_Number INT, Name VARCHAR(20), Balance INT);

Table schema for 'Account' created successfully.

Table data file for 'Account' created successfully.

Enter your SQL query (or 'exit' to log out):
CREATE TABLE Transaction (Transaction_Id INT, Sender_Account INT, Receiver_Account INT, Amount INT);

Table schema for 'Transaction' created successfully.

Table data file for 'Transaction' created successfully.

Enter your SQL query (or 'exit' to log out):
```

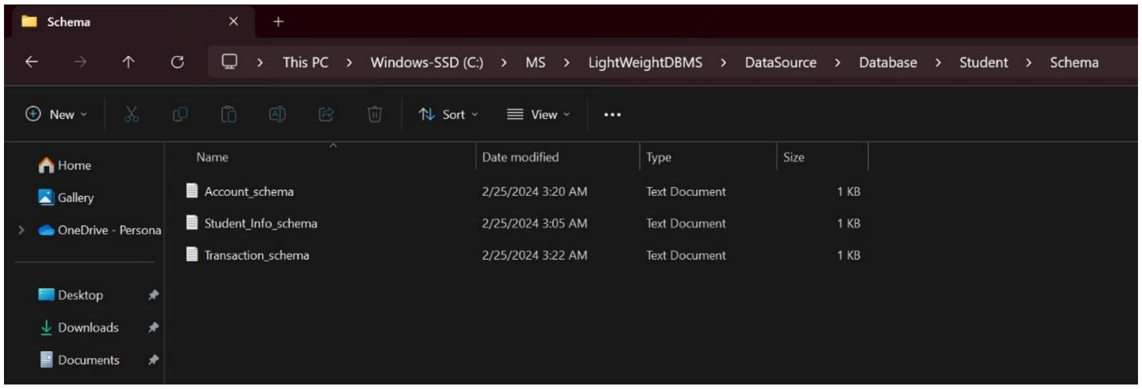
Figure 31 Created Account and Transaction table



This PC > Windows-SSD (C:) > MS > LightWeightDBMS > DataSource > Database > Student >

Name	Date modified	Type	Size
Schema	2/25/2024 3:22 AM	File folder	
Student_Info	2/25/2024 3:15 AM	DATA File	1 KB
Account	2/25/2024 3:20 AM	DATA File	1 KB
Transaction	2/25/2024 3:22 AM	DATA File	1 KB

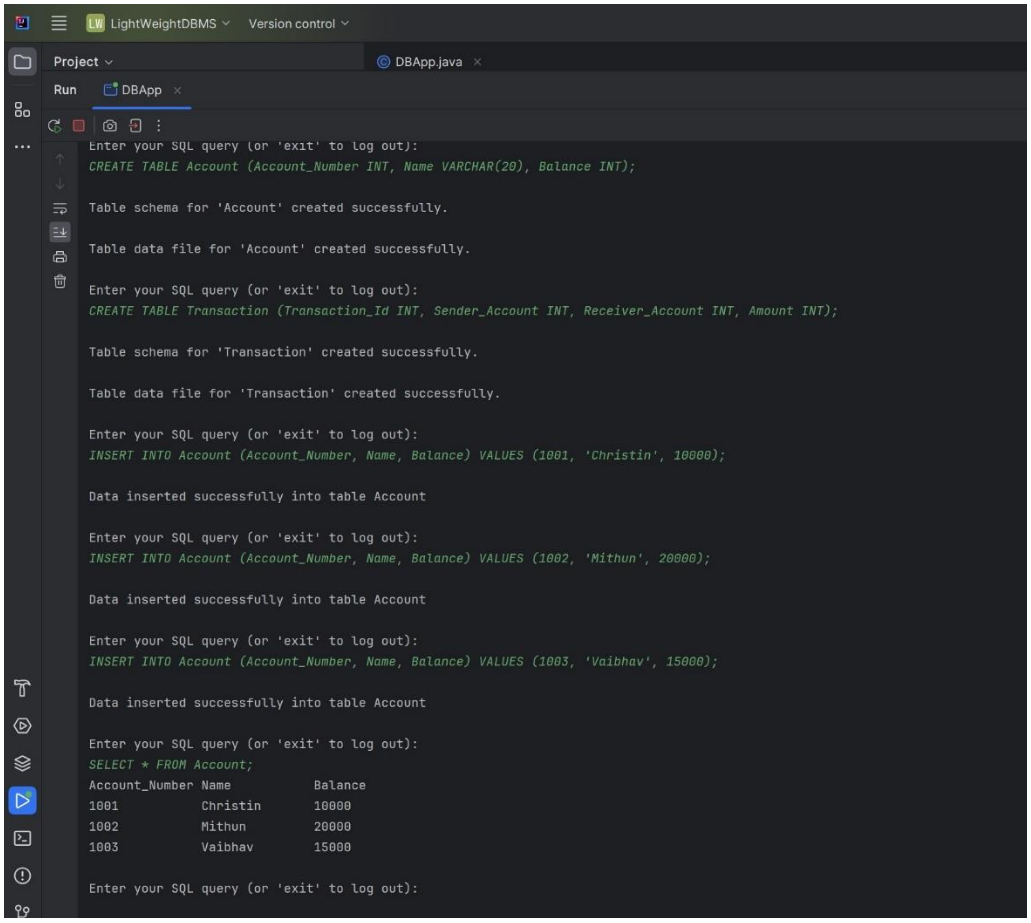
Figure 32 Account.data and Transaction.data generated


Schema
This PC > Windows-SSD (C:) > MS > LightWeightDBMS > DataSource > Database > Student > Schema
New
Sort
View
Home
Gallery
OneDrive - Persona
Desktop
Downloads
Documents

Name	Date modified	Type	Size
Account_schema	2/25/2024 3:20 AM	Text Document	1 KB
Student_Info_schema	2/25/2024 3:05 AM	Text Document	1 KB
Transaction_schema	2/25/2024 3:22 AM	Text Document	1 KB

Figure 33 Account_schema and Transaction_schema generated

I added some sample data to the Account table to run the operation on.



```
Enter your SQL query (or 'exit' to log out):
CREATE TABLE Account (Account_Number INT, Name VARCHAR(20), Balance INT);

Table schema for 'Account' created successfully.

Table data file for 'Account' created successfully.

Enter your SQL query (or 'exit' to log out):
CREATE TABLE Transaction (Transaction_Id INT, Sender_Account INT, Receiver_Account INT, Amount INT);

Table schema for 'Transaction' created successfully.

Table data file for 'Transaction' created successfully.

Enter your SQL query (or 'exit' to log out):
INSERT INTO Account (Account_Number, Name, Balance) VALUES (1001, 'Christin', 10000);

Data inserted successfully into table Account

Enter your SQL query (or 'exit' to log out):
INSERT INTO Account (Account_Number, Name, Balance) VALUES (1002, 'Mithun', 20000);

Data inserted successfully into table Account

Enter your SQL query (or 'exit' to log out):
INSERT INTO Account (Account_Number, Name, Balance) VALUES (1003, 'Vaibhav', 15000);

Data inserted successfully into table Account

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Account;
Account_Number Name           Balance
1001           Christin       10000
1002           Mithun         20000
1003           Vaibhav        15000

Enter your SQL query (or 'exit' to log out):
```

Figure 34 Sample data in Account Table

COMMIT

Query:

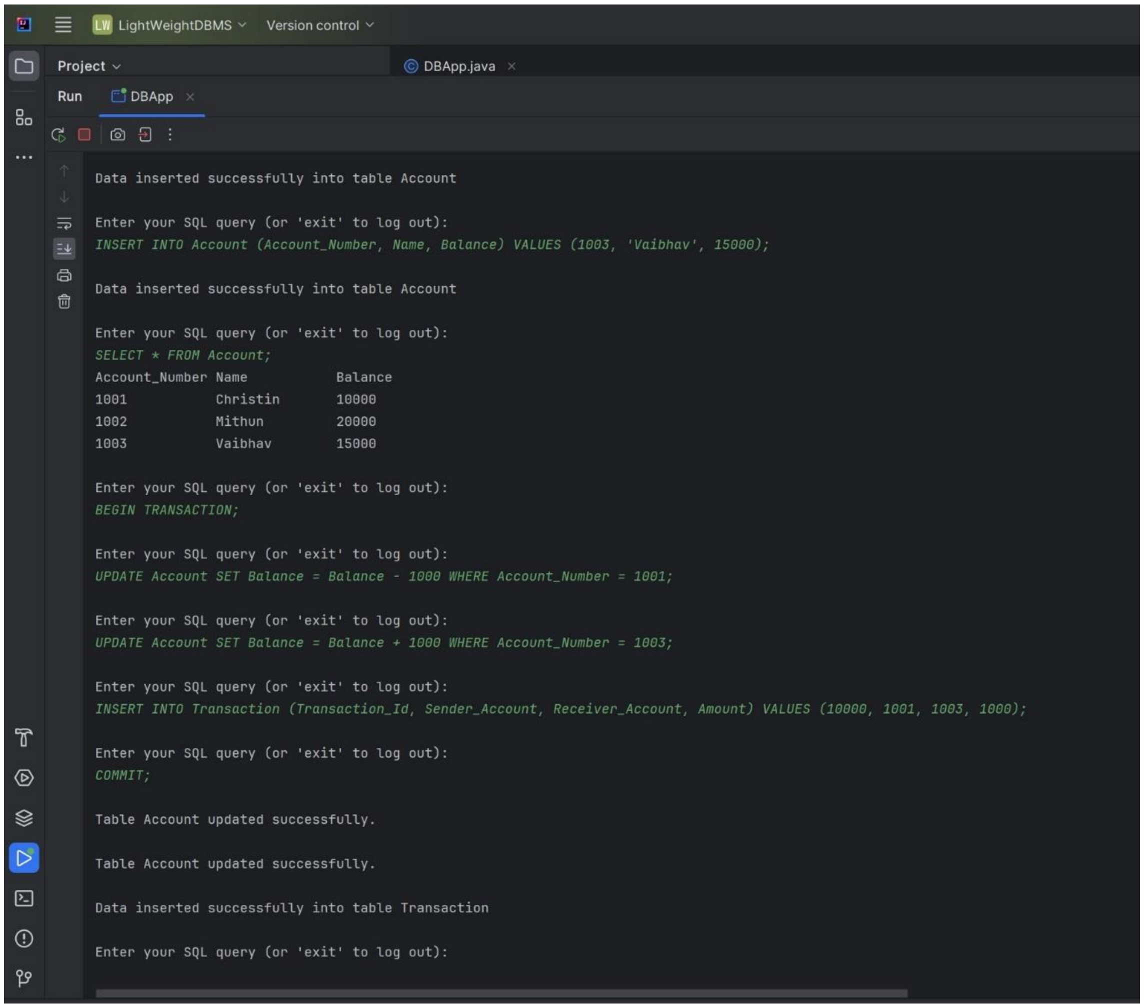
BEGIN TRANSACTION;

UPDATE Account SET Balance = Balance – 1000 WHERE Account_Number = 1001;

UPDATE Account SET Balance = Balance + 1000 WHERE Account_Number = 1002;

INSERT INTO Transaction (Transaction_Id, Sender_Account, Receiver_Account, Amount) VALUES (10000, 1001, 1003, 1000);

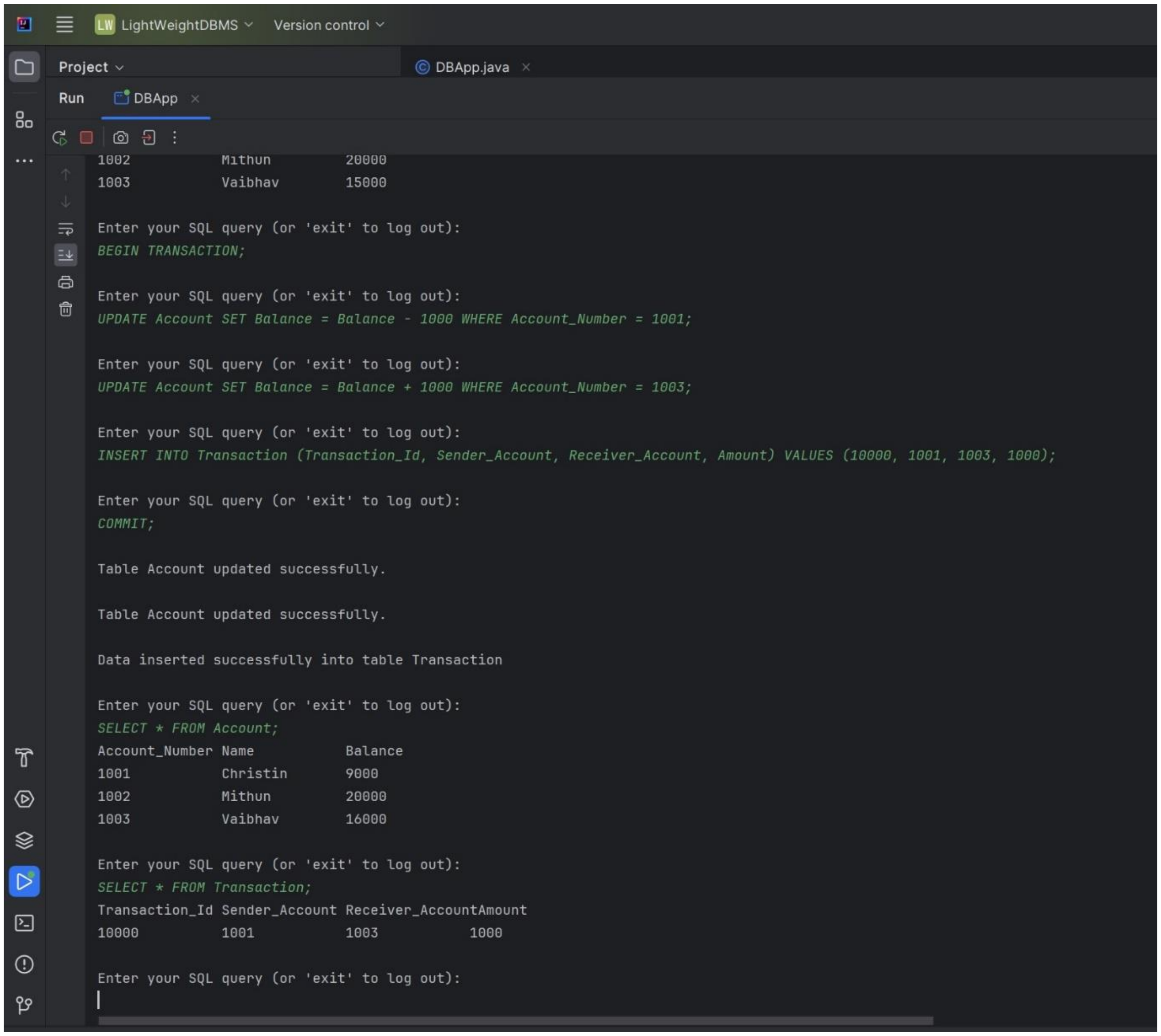
COMMIT;



```
Data inserted successfully into table Account

Enter your SQL query (or 'exit' to log out):
INSERT INTO Account (Account_Number, Name, Balance) VALUES (1003, 'Vaibhav', 15000);

Data inserted successfully into table Account

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Account;
Account_Number Name           Balance
1001           Christin       10000
1002           Mithun         20000
1003           Vaibhav        15000

Enter your SQL query (or 'exit' to log out):
BEGIN TRANSACTION;

Enter your SQL query (or 'exit' to log out):
UPDATE Account SET Balance = Balance - 1000 WHERE Account_Number = 1001;

Enter your SQL query (or 'exit' to log out):
UPDATE Account SET Balance = Balance + 1000 WHERE Account_Number = 1003;

Enter your SQL query (or 'exit' to log out):
INSERT INTO Transaction (Transaction_Id, Sender_Account, Receiver_Account, Amount) VALUES (10000, 1001, 1003, 1000);

Enter your SQL query (or 'exit' to log out):
COMMIT;

Table Account updated successfully.

Table Account updated successfully.

Data inserted successfully into table Transaction

Enter your SQL query (or 'exit' to log out):
```

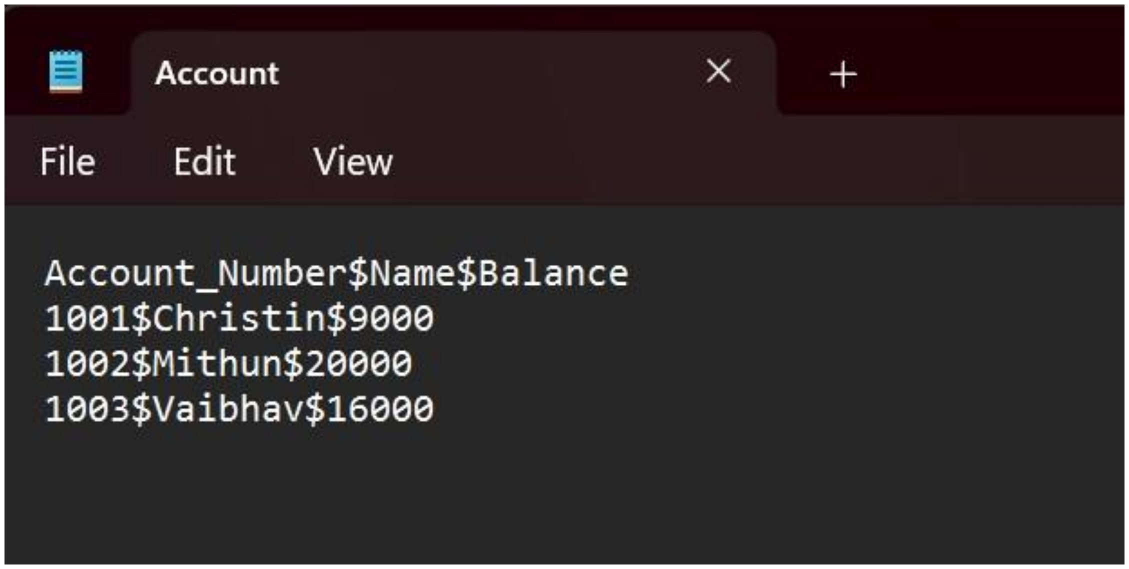
Figure 35 COMMIT operation for the transaction

After the COMMIT command, all the transactions are updated and reflected in the database file.



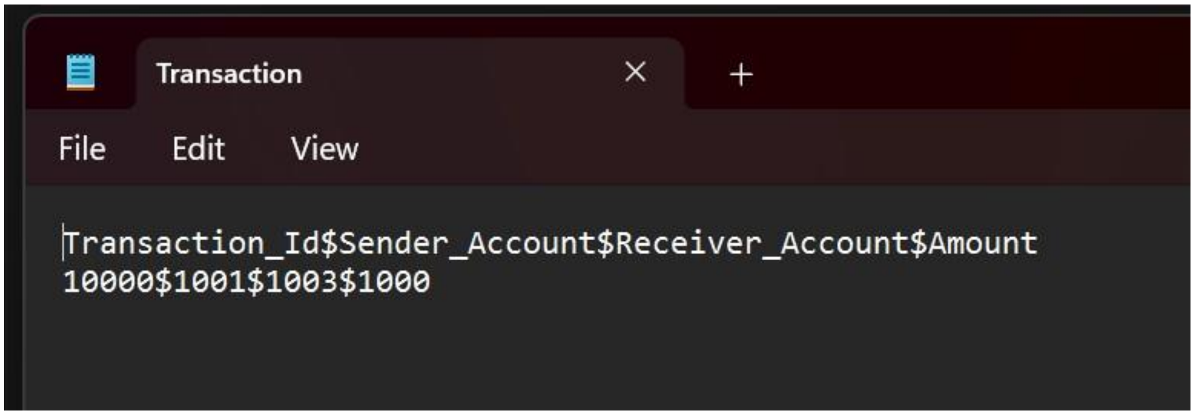
```
1002           Mithun         20000
1003           Vaibhav        15000

Enter your SQL query (or 'exit' to log out):
BEGIN TRANSACTION;

Enter your SQL query (or 'exit' to log out):
UPDATE Account SET Balance = Balance - 1000 WHERE Account_Number = 1001;

Enter your SQL query (or 'exit' to log out):
UPDATE Account SET Balance = Balance + 1000 WHERE Account_Number = 1003;

Enter your SQL query (or 'exit' to log out):
INSERT INTO Transaction (Transaction_Id, Sender_Account, Receiver_Account, Amount) VALUES (10000, 1001, 1003, 1000);

Enter your SQL query (or 'exit' to log out):
COMMIT;

Table Account updated successfully.

Table Account updated successfully.

Data inserted successfully into table Transaction

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Account;
Account_Number Name           Balance
1001           Christin       9000
1002           Mithun         20000
1003           Vaibhav        16000

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Transaction;
Transaction_Id Sender_Account Receiver_AccountAmount
10000          1001           1003           1000

Enter your SQL query (or 'exit' to log out):
```

Figure 36 Updated information in the table after successful commit



```
Account_Number$Name$Balance
1001$Christin$9000
1002$Mithun$20000
1003$Vaibhav$16000
```

Figure 37 Account table after commit operation



```
Transaction_Id$Sender_Account$Receiver_Account$Amount
10000$1001$1003$1000
```

Figure 38 Transaction table after commit operation

ROLLBACK

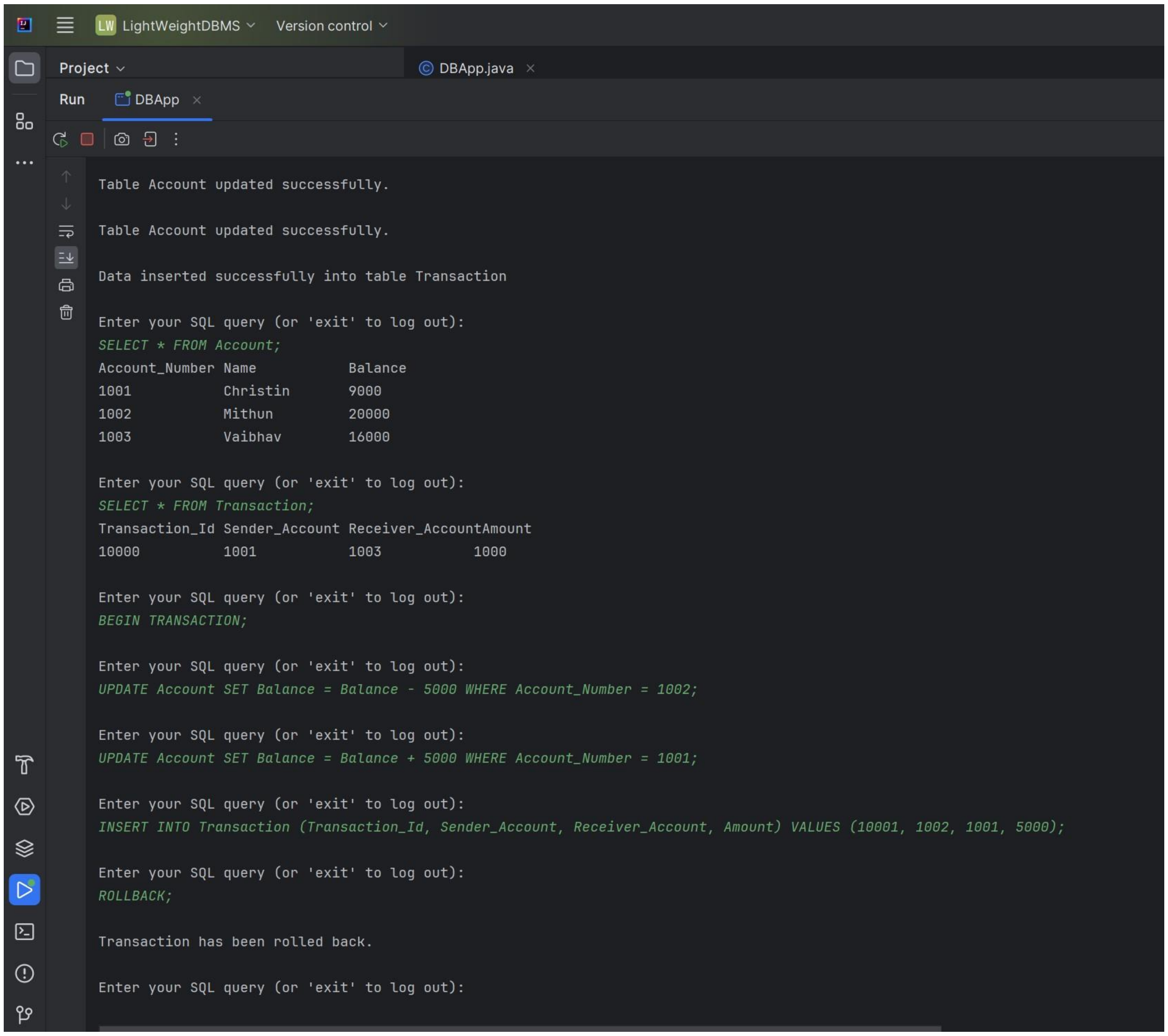
Query:

BEGIN TRANSACTION;

UPDATE Account SET Balance = Balance – 5000 WHERE Account_Number = 1002;

UPDATE Account SET Balance = Balance + 5000 WHERE Account_Number = 1001;

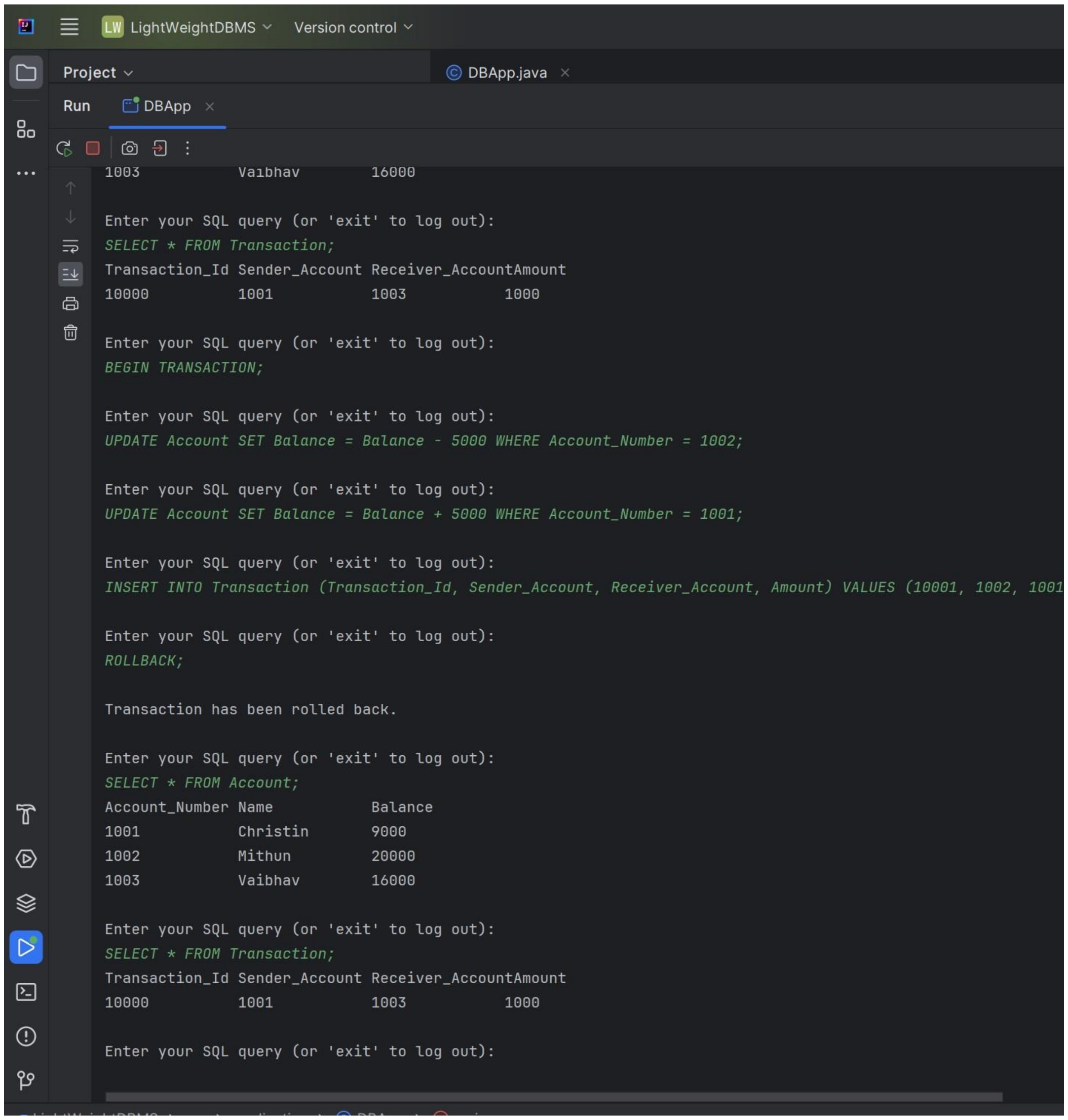
INSERT INTO Transaction (Transaction_Id, Sender_Account, Receiver_Account, Amount) VALUES (10001, 1002, 1001, 5000);



```
Table Account updated successfully.

Table Account updated successfully.

Data inserted successfully into table Transaction

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Account;
Account_Number Name           Balance
1001           Christin       9000
1002           Mithun         20000
1003           Vaibhav        16000

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Transaction;
Transaction_Id Sender_Account Receiver_AccountAmount
10000          1001           1003           1000

Enter your SQL query (or 'exit' to log out):
BEGIN TRANSACTION;

Enter your SQL query (or 'exit' to log out):
UPDATE Account SET Balance = Balance - 5000 WHERE Account_Number = 1002;

Enter your SQL query (or 'exit' to log out):
UPDATE Account SET Balance = Balance + 5000 WHERE Account_Number = 1001;

Enter your SQL query (or 'exit' to log out):
INSERT INTO Transaction (Transaction_Id, Sender_Account, Receiver_Account, Amount) VALUES (10001, 1002, 1001, 5000);

Enter your SQL query (or 'exit' to log out):
ROLLBACK;

Transaction has been rolled back.

Enter your SQL query (or 'exit' to log out):
```

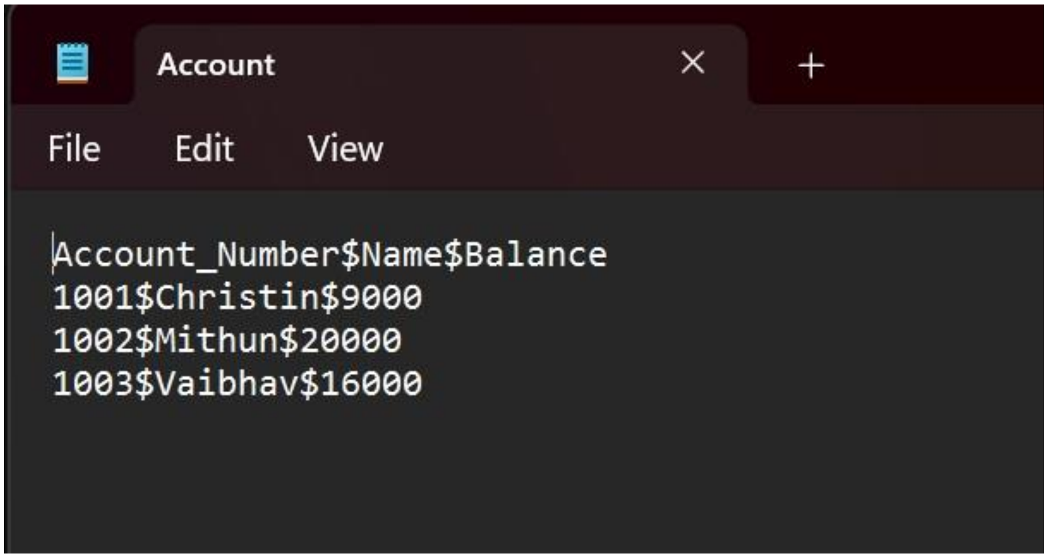
Figure 39 Rollback operation revert back the transaction

As soon as I enter ROLLBACK, all the operations from the point I started the transaction revert without updating the table.



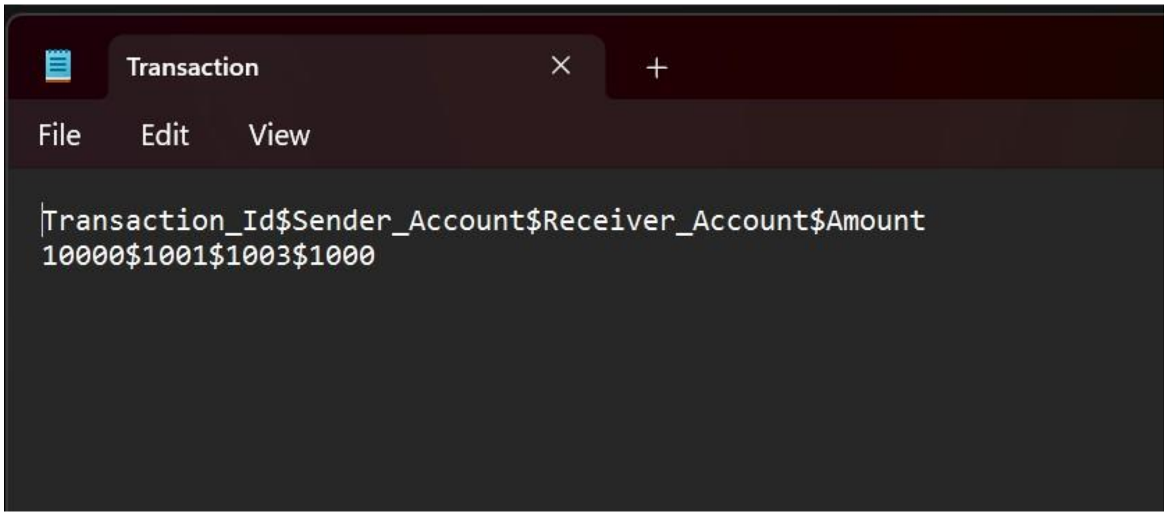
```
1003          Vaibhav       16000

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Transaction;
Transaction_Id Sender_Account Receiver_AccountAmount
10000          1001           1003           1000

Enter your SQL query (or 'exit' to log out):
BEGIN TRANSACTION;

Enter your SQL query (or 'exit' to log out):
UPDATE Account SET Balance = Balance - 5000 WHERE Account_Number = 1002;

Enter your SQL query (or 'exit' to log out):
UPDATE Account SET Balance = Balance + 5000 WHERE Account_Number = 1001;

Enter your SQL query (or 'exit' to log out):
INSERT INTO Transaction (Transaction_Id, Sender_Account, Receiver_Account, Amount) VALUES (10001, 1002, 1001

Enter your SQL query (or 'exit' to log out):
ROLLBACK;

Transaction has been rolled back.

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Account;
Account_Number Name          Balance
1001          Christin      9000
1002          Mithun        20000
1003          Vaibhav       16000

Enter your SQL query (or 'exit' to log out):
SELECT * FROM Transaction;
Transaction_Id Sender_Account Receiver_AccountAmount
10000          1001           1003           1000

Enter your SQL query (or 'exit' to log out):
```

Figure 40 No updates on the Account and Transaction table after rollback



```
Account_Number$Name$Balance
1001$Christin$9000
1002$Mithun$20000
1003$Vaibhav$16000
```

Figure 41 No update on Account table after rollback



```
Transaction_Id$Sender_Account$Receiver_Account$Amount
10000$1001$1003$1000
```

Figure 42 No update on Transaction table after rollback

References

[1] Sardar Mudassar Ali Khan, “Layered Architecture Used in Software Development,” *DEV Community*, [Online], June 14, 2023. Available: https://dev.to/sardarmudassaralikhan/layered-architecture-used-in-software-development-8jd [Accessed: February 24, 2024].

[2] Samuel Oloruntoba, “Solid: The First 5 Principles of Object Oriented Design,” *DigitalOcean*, November 30, 2021. Available: https://www.digitalocean.com/community/conceptual-articles/s-o-l-i-d-the-first-five-principles-of-object-oriented-design [Accessed: February 24, 2024].