MAPÚA UNIVERSITY
SCHOOL OF ELECTRICAL, ELECTRONICS, AND COMPUTER ENGINEERING

Experiment 5: Data Modeling and Database

CPE106L (Software Design Laboratory)

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Section: **E01**

PreLab

Readings, Insights, and Reflection

At its essence, a database is an organized electronic collection of data that enables efficient storage, retrieval, and manipulation of information. In our digital age, databases are fundamental to the functioning of various applications, from straightforward mobile apps to intricate enterprise systems. This foundational role highlights the importance of understanding database concepts and their design principles, as they are critical for ensuring effectiveness in data management.

Each organization, such as TAL Distributors, Colonial Adventure Tours, and Solmaris Condominium Group, has distinct operational needs influencing their database requirements. For TAL Distributors, a relational database system is essential to manage inventory and orders effectively, allowing for swift queries on product stock and supplier details. On the other hand, Colonial Adventure Tours requires a flexible database to handle customer bookings and tour schedules, particularly due to seasonal variations. Solmaris Condominium Group needs a robust database solution to manage sensitive information related to property records and tenant data, with a strong emphasis on security and privacy.

The database design process involves recognizing crucial concepts like entities, attributes, and relationships, all of which contribute to accurately modeling real-world scenarios. Normalization is a vital aspect of effective database design that aims to minimize redundancy and enhance data integrity. Although the normalization process can make the structure more complex initially, its long-term benefits in terms of data integrity, scalability, and maintenance efficiency are invaluable. Understanding these fundamental principles equips organizations to build tailored databases that meet their unique needs, making continuous learning in database management essential as technology evolves.

METIS ebooks:
• A Guide to SQL. Philip J. Pratt; et al.9780357419830
• VBID: 9780357419830
• Chapter 1:
1) What is a Database
2) Database Requirements of TAL Distributors, Colonial Adventure Tours, and

Solmaris Condominium Group
Chapter 2:
1) Database Concepts
2) Database Design Fundamentals
3) Normalizatio

Answers to Questions

1. **What are DML and DDL statements in SQL? Provide examples of each.**
   - In SQL, Data Manipulation Language (DML) statements are used to handle data within existing schema objects, allowing you to insert, modify, or delete data. Examples of DML statements include INSERT INTO, UPDATE, and DELETE FROM. Data Definition Language (DDL) statements, on the other hand, are used to define or modify the structure of database objects. Common examples of DDL statements are CREATE TABLE, ALTER TABLE, and DROP TABLE.

2. **What are the categories of SQLite functions? Give three examples from each category.**
   - SQLite functions are grouped into categories such as aggregate functions, date & time functions, string functions, and math functions. Examples of aggregate functions include COUNT(), MAX(), and MIN(). Date & time functions include DATE(), TIME(), and DATETIME(). Examples of string functions are UPPER(), LOWER(), and LENGTH(), and examples of math functions are ABS(), ROUND(), and RANDOM().

3. **How do you verify if SQLite is installed on a Linux system using the terminal?**
   - To check if SQLite is installed, use the command sqlite3 --version in the Linux terminal. If SQLite is installed, this command will display the installed version. If it's not installed, you'll see a message indicating that the sqlite3 command was not found.

InLab

Procedure:

A popular lightweight relational database management system that gives users flexibility in how they interact with their databases is called SQLite. The DB Browser for SQLite and the Windows Command Prompt are two well-liked ways to access SQLite databases. Each approach has advantages and disadvantages that vary depending on the needs and preferences of the user.

For users who are accustomed to command-line activities, the Command Prompt interface offers a text-based environment. It does, however, necessitate a certain level of knowledge of SQLite syntax and operations, which can make the learning curve more challenging for novices. In spite of this, the Command Prompt has a lot to offer in terms of speed and effectiveness, especially when running individual queries on big databases. The SQLite3 executable's lightweight design also makes it very portable and simple to integrate into batch files or scripts for automation.

Users must explicitly type the'sqlite3' command and the location to the database file in order to connect to a database using Command Prompt. For seasoned users, this procedure is simple, although it may result in typographical errors. In this setting, query execution entails entering SQL commands straight into the prompt, with text-formatted results presented. This output is frequently faster than graphical alternatives, although it may be more difficult to read for large result sets.

On the other hand, many users find the graphical user interface offered by DB Browser for SQLite to be more user-friendly and intuitive. By enabling users to open database files using a recognizable file-selection window, this interface simplifies the database connection procedure. Writing and amending queries is made easier by the GUI's specialized SQL editor, which has syntax highlighting. Compared to the Command Prompt's text output, the results are typically easier to understand and evaluate because they are displayed in tabular form.

The DB Browser's visual depiction of the database schema is one of its best features; it makes it easy for users to examine table hierarchies and relationships. Furthermore, it offers flexibility in data interaction by enabling the execution of SQL commands and direct data manipulation via the interface.

Another area in which DB Browser shines is error handling. Particularly useful for people learning SQL or debugging complex queries, it usually offers more understandable error messages and displays syntax issues right in the SQL editor. On the other hand, especially for novices, error messages in the Command Prompt might be more confusing and difficult to understand. However, when working with very big databases or doing complicated queries, the graphical design of DB Browser may cause significant performance penalty that becomes apparent. Additionally, as comparison to the Command Prompt, it is typically less appropriate for automation activities.

Both methods offer unique features in terms of storage and query history. While the DB Browser lets users save queries, keeps a thorough query history, and provides the option to export queries for later use, the Command Prompt depends on the terminal's built-in command history function, which can be limiting.

Both approaches allow for data editing via SQL commands. On the other hand, DB Browser makes things more convenient by enabling direct data editing via its interface, which is useful for making quick changes or exploring data.

The decision between utilizing SQLite using the DB Browser or the Command Prompt ultimately comes down to the requirements, degree of knowledge, and particular tasks of the user. Because of its speed, effectiveness, and scripting features, the Command Prompt is perfect for automation tasks and seasoned users. On the other hand, DB Browser offers a more user-friendly interface with visual aids, which makes it more appropriate for novices, data exploration, and scenarios where graphical data representation is useful.

Both approaches have a role in the SQLite ecosystem, and many users think that knowing how to utilize both is helpful. Because of their adaptability, they may use the advantages of each strategy based on the work at hand, which eventually results in more effective and efficient database administration.

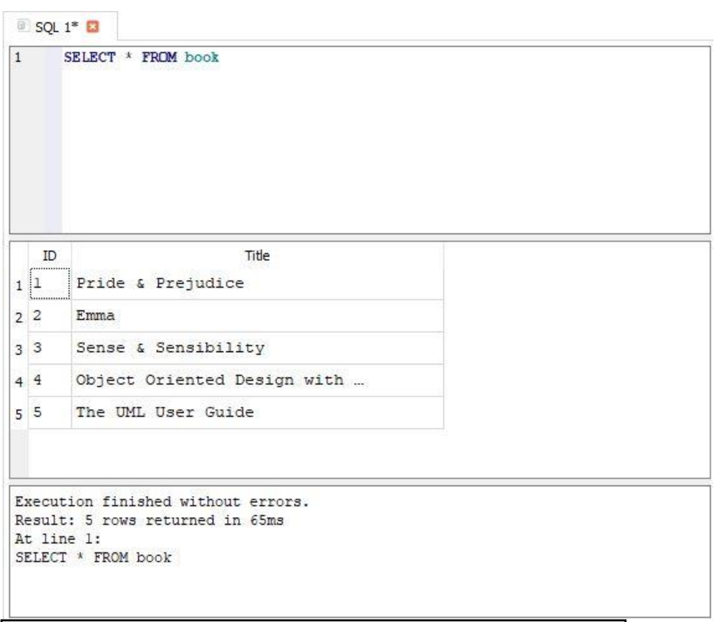
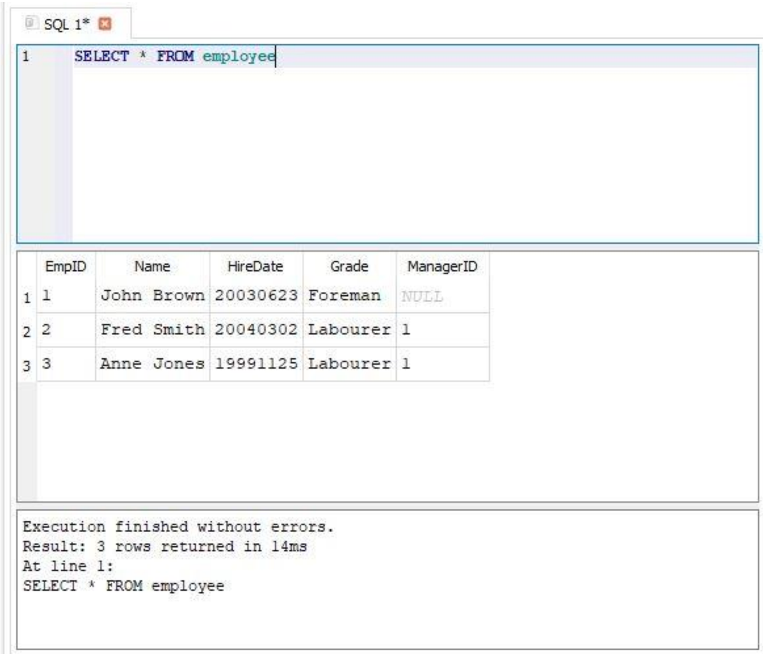


Figure 1: Using DB broswer to Execute a Select Command book.db



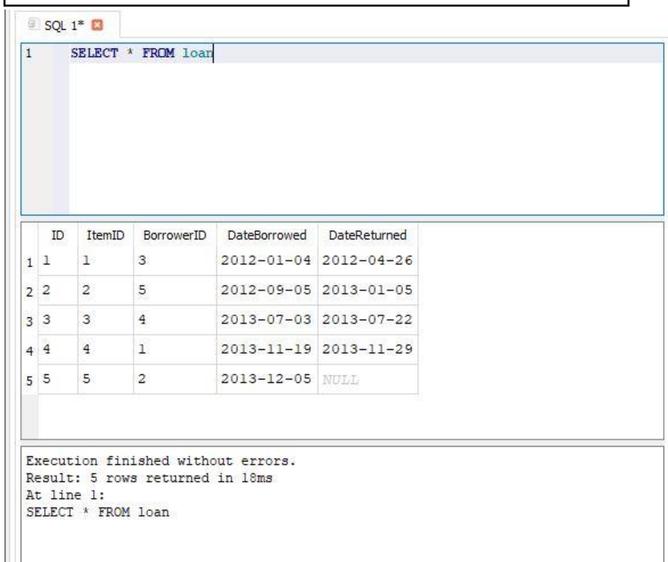
SQL 1*

```
SELECT * FROM employee
```

	EmpID	Name	HireDate	Grade	ManagerID
1	1	John Brown	20030623	Foreman	NULL
2	2	Fred Smith	20040302	Labourer	1
3	3	Anne Jones	19991125	Labourer	1

```
Execution finished without errors.
Result: 3 rows returned in 14ms
At line 1:
SELECT * FROM employee
```

Figure 2: Using DB broswer to Execute a Select Command employee.db



SQL 1*

```
SELECT * FROM loan
```

	ID	ItemID	BorrowerID	DateBorrowed	DateReturned
1	1	1	3	2012-01-04	2012-04-26
2	2	2	5	2012-09-05	2013-01-05
3	3	3	4	2013-07-03	2013-07-22
4	4	4	1	2013-11-19	2013-11-29
5	5	5	2	2013-12-05	NULL

```
Execution finished without errors.
Result: 5 rows returned in 18ms
At line 1:
SELECT * FROM loan
```

Figure 3: Using DB broswer to Execute a Select Command lendy.db

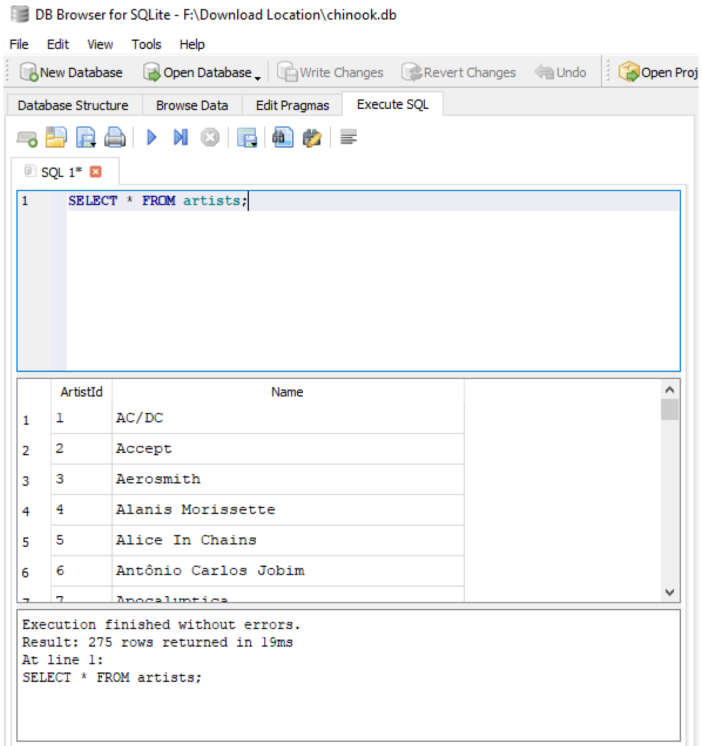


Figure 4: Using DB browser to Execute command: SELECT * FROM artists; (chinook.db)

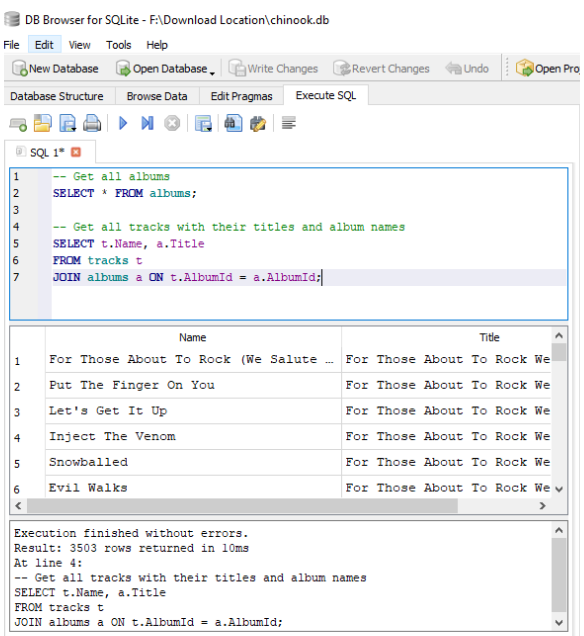


Figure 5: Using DB browser to Execute command: SELECT * FROM artists; SELECT t.Name, a.Title FROM tracks t JOIN albums a ON t.AlbumId = a.AlbumId;

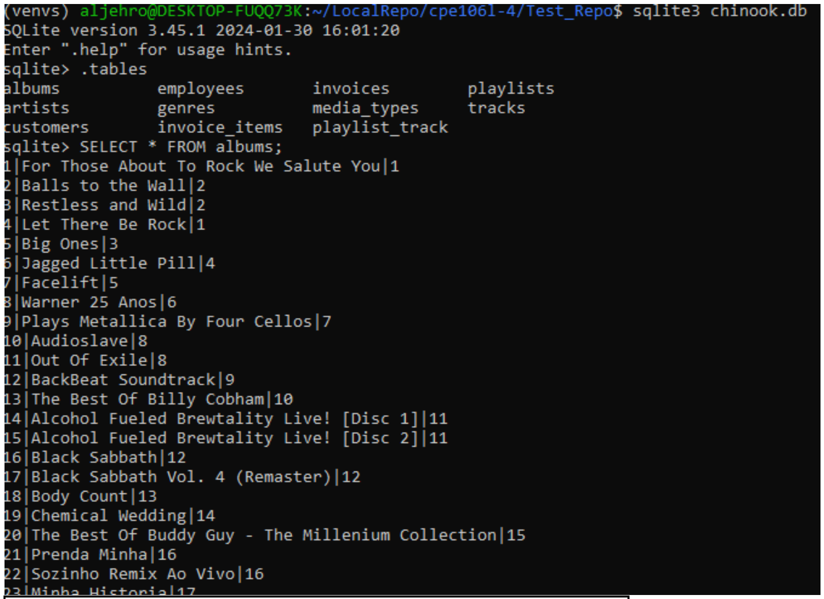


Figure 6: Using WSL Linux terminal to open database “chinook.db”: SELECT * FROM artists; SELECT t.Name, a.Title FROM tracks t JOIN albums a ON t.AlbumId = a.AlbumId;

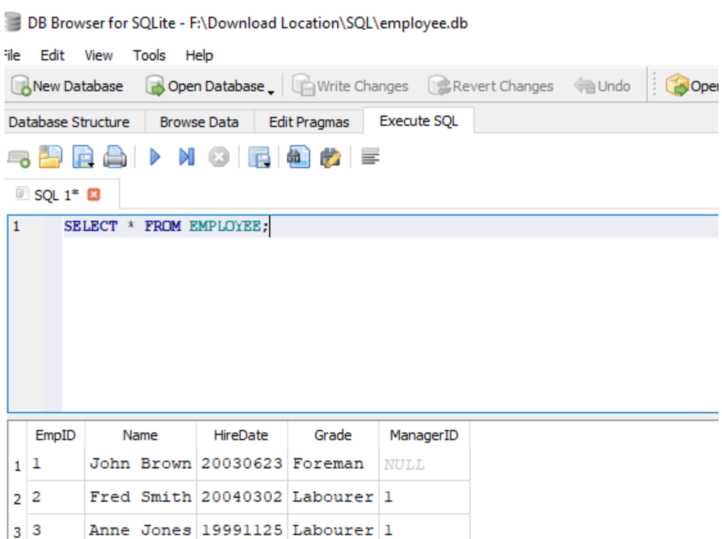


Figure 7: Using DB browser to browse data of Employee.DB

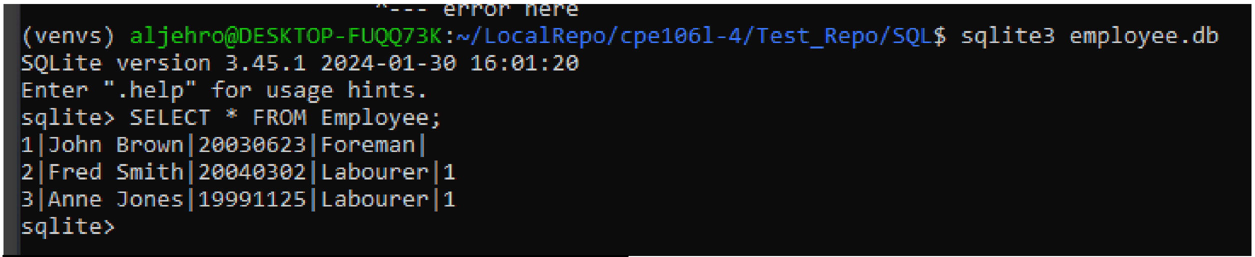


Figure 8: Using WSL sqlite3 to browse data of Employee.DB

PostLab

Machine Problems

Discussion:

Colonial Adventure Tours focuses on providing a variety of outdoor adventure classes, and our database design is tailored to track participants, their enrollments, and class offerings. We established three main entities: **Participants**, **AdventureClasses**, and **Enrollments**. The **Participants** table holds essential information about each participant, including their name, address, and contact details. The **AdventureClasses** table captures class descriptions, maximum participant limits, and associated fees. The **Enrollments** table functions as a junction, facilitating a many-to-many relationship that enables participants to enroll in multiple classes and vice versa. This structure allows for easy retrieval of class rosters and individual schedules, ensuring a seamless experience for both participants and administrators.

Solmaris Condominium Group's database design is centered on managing rental properties and agreements efficiently. We identified three core entities: **Renters**, **Properties**, and **RentalAgreements**. The **Renters** table stores vital information about each renter, including their contact details and demographic information. The **Properties** table catalogs various rental units, including specifications such as location, size, and rental rates. Finally, the **RentalAgreements** table links renters to properties, capturing details about rental periods and associated costs. This organization allows for effective management of vacation rentals, helping to streamline the process of booking and maintaining rental units.

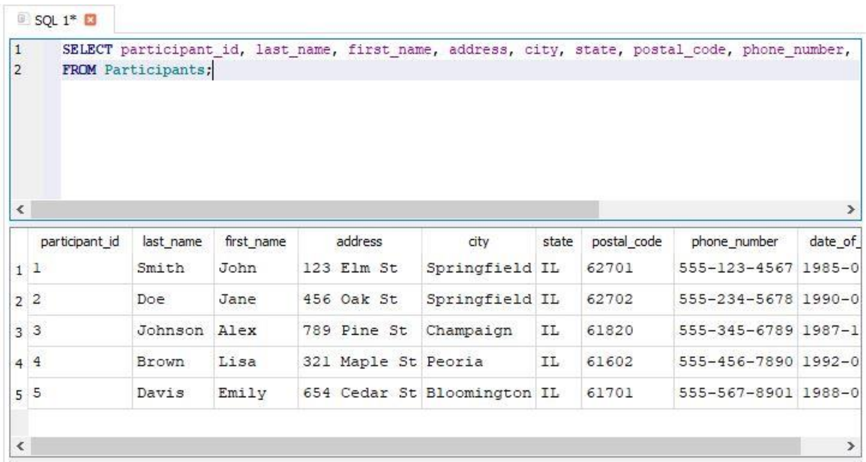
The initial step in our project involved a thorough analysis of the requirements for both Colonial Adventure Tours and Solmaris Condominium Group. By employing Entity-Relationship (ER) modeling, we were able to visualize the data structure and identify the relationships among various entities.

During the implementation phase, we opted for SQLite due to its portability and simplicity, making it ideal for small to medium-sized applications. The process involved creating tables, defining constraints, and populating the database with sample data. Some challenges encountered included adapting data types for SQLite’s flexible system, defining constraints, and modifying SQL scripts originally designed for SQL Server to ensure compatibility with SQLite.

To illustrate the practical application of our databases, we developed a Python script utilizing the sqlite3 module. This integration enables real-time interactions with the database, allowing functionalities like searching for available properties, enrolling participants in classes, and generating reports.

This project exemplifies the significance of meticulous planning and adaptability in database design and implementation. Through a clear understanding of business requirements and effective use of ER modeling, we successfully created efficient database structures. The integration with Python not only highlights the functionality of the databases but also serves as a practical demonstration of how strategic database development can lead to effective solutions for managing participants in adventure classes and vacation rentals.

1. Colonial Adventure Tours

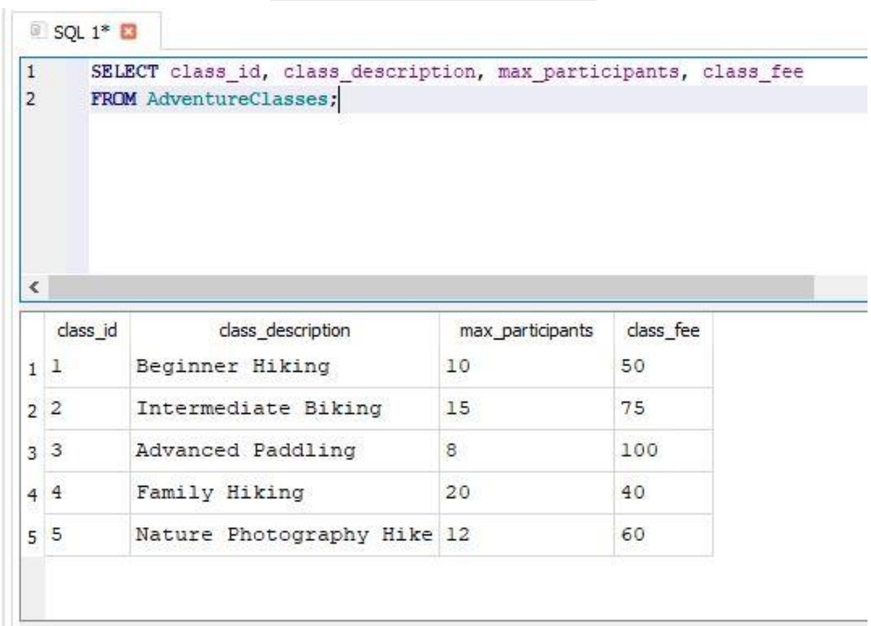


SQL 1*

```sql
SELECT participant_id, last_name, first_name, address, city, state, postal_code, phone_number,
FROM Participants;
```

	participant_id	last_name	first_name	address	city	state	postal_code	phone_number	date_of_
1	1	Smith	John	123 Elm St	Springfield	IL	62701	555-123-4567	1985-0
2	2	Doe	Jane	456 Oak St	Springfield	IL	62702	555-234-5678	1990-0
3	3	Johnson	Alex	789 Pine St	Champaign	IL	61820	555-345-6789	1987-1
4	4	Brown	Lisa	321 Maple St	Peoria	IL	61602	555-456-7890	1992-0
5	5	Davis	Emily	654 Cedar St	Bloomington	IL	61701	555-567-8901	1988-0

Figure 1: Participant Table



SQL 1*

```sql
SELECT class_id, class_description, max_participants, class_fee
FROM AdventureClasses;
```

	class_id	class_description	max_participants	class_fee
1	1	Beginner Hiking	10	50
2	2	Intermediate Biking	15	75
3	3	Advanced Paddling	8	100
4	4	Family Hiking	20	40
5	5	Nature Photography Hike	12	60

Figure 2: AdventureClasses Table

SQL 1*

```sql
SELECT p.participant_id, p.last_name, p.first_name,
       ac.class_id, ac.class_description, e.class_date
FROM Participants p
JOIN Enrollments e ON p.participant_id = e.participant_id
JOIN AdventureClasses ac ON e.class_id = ac.class_id;
```

	participant_id	last_name	first_name	class_id	class_description	class_date
1	1	Smith	John	1	Beginner Hiking	2023-06-01
2	1	Smith	John	2	Intermediate Biking	2023-06-10
3	2	Doe	Jane	1	Beginner Hiking	2023-06-02
4	2	Doe	Jane	3	Advanced Paddling	2023-06-15
5	3	Johnson	Alex	4	Family Hiking	2023-06-05
6	4	Brown	Lisa	2	Intermediate Biking	2023-06-12
7	4	Brown	Lisa	5	Nature Photography Hike	2023-06-20

Figure 3

SQL 1*

```sql
SELECT e.class_date, ac.class_id, ac.class_description,
       p.participant_id, p.last_name, p.first_name
FROM Enrollments e
JOIN AdventureClasses ac ON e.class_id = ac.class_id
JOIN Participants p ON e.participant_id = p.participant_id;
```

	class_date	class_id	class_description	participant_id	last_name	first_name
1	2023-06-01	1	Beginner Hiking	1	Smith	John
2	2023-06-10	2	Intermediate Biking	1	Smith	John
3	2023-06-02	1	Beginner Hiking	2	Doe	Jane
4	2023-06-15	3	Advanced Paddling	2	Doe	Jane
5	2023-06-05	4	Family Hiking	3	Johnson	Alex
6	2023-06-12	2	Intermediate Biking	4	Brown	Lisa
7	2023-06-20	5	Nature Photography Hike	4	Brown	Lisa

Figure 4

2. Solmaris Condominium Group

SQL 1*

```sql
    city AS "City",
    state AS "State",
    postal_code AS "Postal Code",
    phone_number AS "Telephone Number",
    email_address AS "Email Address"
FROM
    Renters;
```

	Renter Number	First Name	Middle Initial	Last Name	Address	City	State	Postal Code	Telep
1	1	Alice	B	Johnson	123 Main St	Orlando	FL	32801	555-
2	2	Bob	NULL	Smith	456 Oak St	Miami	FL	33101	555-
3	3	Catherine	D	Evans	789 Maple St	Tampa	FL	33601	555-
4	4	David	NULL	Brown	101 Pine St	Jacksonville	FL	32201	555-
5	5	Emma	X	Taylor	202 Birch St	St. Petersburg	FL	33701	555-

Figure 1: Renter Table

SQL 1*

```
        square_footage AS "Square Footage",
        num_bedrooms AS "Number of Bedrooms",
        num_bathrooms AS "Number of Bathrooms",
        max_persons AS "Maximum Number of Persons",
        base_weekly_rate AS "Base Weekly Rate"
    FROM
        Properties;
```

	Condo Location Number	Condo Location Name	Address	City	State	Postal Code	Condo Unit Numb
1	101	Sunset Cove	100 Coastal Rd	Fort Myers	FL	33901	1A
2	102	Ocean View	200 Ocean Blvd	Naples	FL	34101	2B
3	103	Palm Oasis	150 Palm St	Key West	FL	33040	3C
4	104	Tropical Paradise	250 Island Dr	Destin	FL	32541	4D
5	105	Serene Shores	75 Bayside Ave	Sarasota	FL	34236	5E

Figure 2: Property Table

SQL 1*

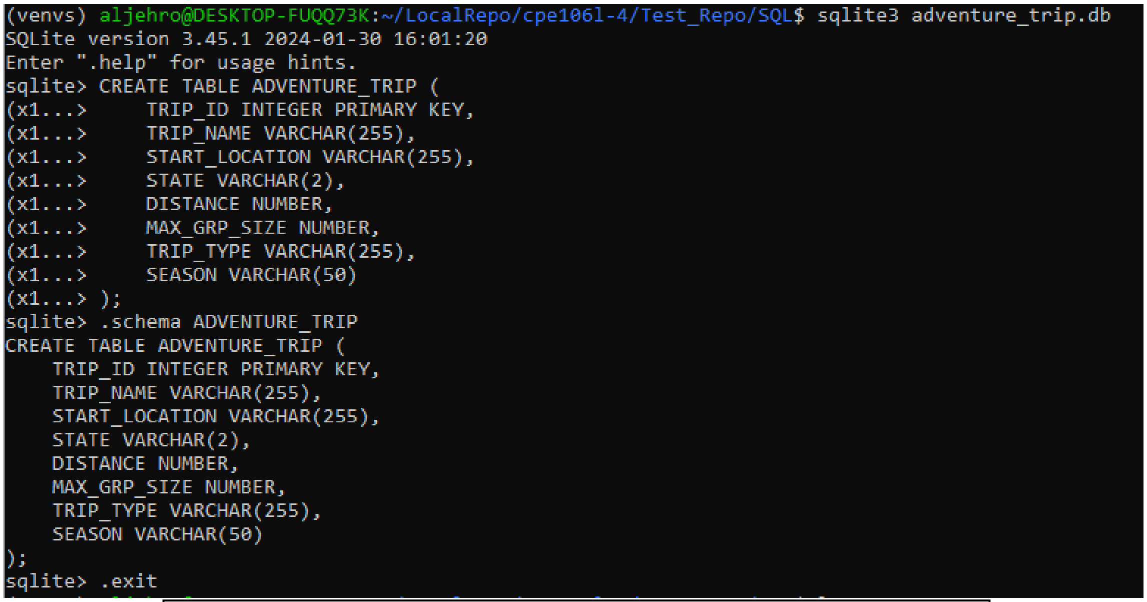
```
        RA.start_date AS "Start Date of Rental",
        RA.end_date AS "End Date of Rental",
        RA.weekly_rental_amount AS "Weekly Rental Amount"
    FROM
        RentalAgreements RA
    JOIN
        Renters R ON RA.renter_id = R.renter_id;
```

	Renter Number	First Name	Middle Initial	Last Name	Address	City	State	Postal Code	Telep
1	1	Alice	B	Johnson	123 Main St	Orlando	FL	32801	555-
2	2	Bob	NULL	Smith	456 Oak St	Miami	FL	33101	555-
3	3	Catherine	D	Evans	789 Maple St	Tampa	FL	33601	555-
4	4	David	NULL	Brown	101 Pine St	Jacksonville	FL	32201	555-
5	5	Emma	X	Taylor	202 Birch St	St. Petersburg	FL	33701	555-

Figure 3: RentAgreement Table

3.

a. Create a table named ADVENTURE_TRIP. The table has the same structure as the TRIP table shown in Figure 3-2 below except the TRIP_NAME column should use the VARCHAR data type and the DISTANCE and MAX_GRP_SIZE columns should use the NUMBER data type. Execute the command to describe the layout and characteristics of the ADVENTURE_TRIP table.



```
(venvs) aljehro@DESKTOP-FUQQ73K:~/LocalRepo/cpe106l-4/Test_Repo/SQL$ sqlite3 adventure_trip.db
SQLite version 3.45.1 2024-01-30 16:01:20
Enter ".help" for usage hints.
sqlite> CREATE TABLE ADVENTURE_TRIP (
(x1...>     TRIP_ID INTEGER PRIMARY KEY,
(x1...>     TRIP_NAME VARCHAR(255),
(x1...>     START_LOCATION VARCHAR(255),
(x1...>     STATE VARCHAR(2),
(x1...>     DISTANCE NUMBER,
(x1...>     MAX_GRP_SIZE NUMBER,
(x1...>     TRIP_TYPE VARCHAR(255),
(x1...>     SEASON VARCHAR(50)
(x1...> );
sqlite> .schema ADVENTURE_TRIP
CREATE TABLE ADVENTURE_TRIP (
    TRIP_ID INTEGER PRIMARY KEY,
    TRIP_NAME VARCHAR(255),
    START_LOCATION VARCHAR(255),
    STATE VARCHAR(2),
    DISTANCE NUMBER,
    MAX_GRP_SIZE NUMBER,
    TRIP_TYPE VARCHAR(255),
    SEASON VARCHAR(50)
);
sqlite> .exit
```

Figure 4: adventure_trip.db (creating ADVENTURE_TRIP via Linux sqlite3)

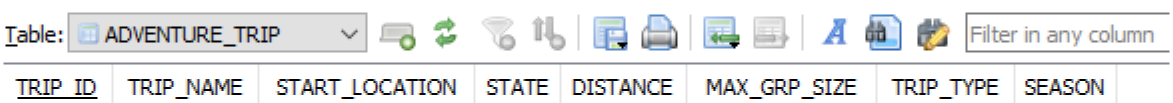


Figure 5: adventure_trip.db (ADVENTURE_TRIP Table)

- The `adventure_trip.db` database contains a table named `ADVENTURE_TRIP`, which is structured to capture detailed information about various adventure trips, including attributes such as trip ID, trip name, start location, state, distance, maximum group size, trip type, and season. The `TRIP_ID` serves as the primary key, while the `TRIP_NAME` column uses the VARCHAR data type, and `DISTANCE` and `MAX_GRP_SIZE` columns employ the NUMBER data type, ensuring flexibility in storing textual and numerical data.

b. Add the following row to the ADVENTURE_TRIP table: trip ID: 45; trip name: Jay Peak; start location: Jay; state: VT; distance: 8; maximum group size: 8; type: Hiking and sea- son: Summer. Display the contents of the ADVENTURE_TRIP table.

```
(venvs) aljehro@DESKTOP-FUQQ73K:~/LocalRepo/cpe106l-4/Test_Repo/SQL$ sqlite3 adventure_trip.db
SQLite version 3.45.1 2024-01-30 16:01:20
Enter ".help" for usage hints.
sqlite>
sqlite> SELECT * FROM ADVENTURE_TRIP;
sqlite> .schema ADVENTURE_TRIP
CREATE TABLE ADVENTURE_TRIP (
    TRIP_ID INTEGER PRIMARY KEY,
    TRIP_NAME VARCHAR(255),
    START_LOCATION VARCHAR(255),
    STATE VARCHAR(2),
    DISTANCE NUMBER,
    MAX_GRP_SIZE NUMBER,
    TRIP_TYPE VARCHAR(255),
    SEASON VARCHAR(50)
);
sqlite> INSERT INTO ADVENTURE_TRIP (TRIP_ID, TRIP_NAME, START_LOCATION, STATE, DISTANCE, MAX_GRP_SIZE, TRIP_TYPE, SEA
SON)
   ...> VALUES (45, 'Jay Peak', 'Jay', 'VT', 8, 8, 'Hiking', 'Summer');
sqlite> SELECT * FROM ADVENTURE_TRIP;
45|Jay Peak|Jay|VT|8|8|Hiking|Summer
sqlite>
```

Figure 6: adventure_trip.db (adding details at ADVENTURE_TRIP table)

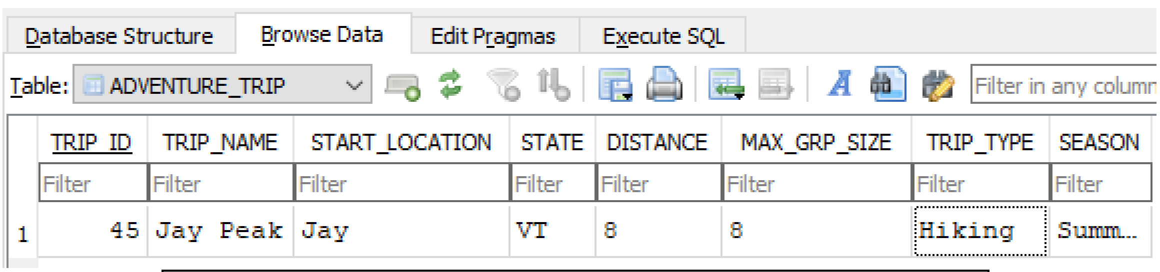


Figure 7: adventure_trip.db (table view)

- The steps demonstrate the process of creating a record in a SQLite database table, including the retrieval of the table's schema, which provides insights into the structure and constraints of the data being handled. The successful execution of the INSERT command followed by a SELECT confirms that the data insertion worked correctly, allowing for persistent data management within the SQLite database.

c. Delete the ADVENTURE_TRIP table.

```
sqlite> DROP TABLE ADVENTURE_TRIP;
sqlite> .exit
(venvs) aljehro@DESKTOP-FUQQ73K:~/LocalRepo/cpe106l-4/Test_Repo/SQL$
```

Figure 8: Deletes ADVENTURE_TRIP Table.

d. Open the script file (SQLServerColonial.sql) to create the six tables and add records to the tables. Revise the script file so that it can be run in the DB Browser.

```
aljehro@DESKTOP-FUQQ73K: ~/LocalRepo/cpe106l-4/Test_Repo/SQL
  GNU nano 7.2                                        SQLServerColonial.sql
CREATE TABLE my_tables (
    trip_id INTEGER PRIMARY KEY,
    trip_name TEXT,
    start_location TEXT,
    state TEXT,
    distance REAL,
    max_grp_size INTEGER,
    trip_type TEXT,
    season TEXT
);
```

Figure 9: nano SQLServerColonial.sql

e. Confirm that you have created the tables correctly by describing each table and comparing the results to the figures shown below. Confirm that you have added all data correctly by viewing the data in each table and comparing the results to Figures 1-4 through 1-8 shown below.

```
(venvs) aljehro@DESKTOP-FUQQ73K:~/LocalRepo/cpe106l-4/Test_Repo/SQL$ sqlite3 adventure_trip.db
SQLite version 3.45.1 2024-01-30 16:01:20
Enter ".help" for usage hints.
sqlite> SELECT * FROM my_tables;
sqlite> .schema my_tables
CREATE TABLE my_tables (
    trip_id INTEGER PRIMARY KEY,
    trip_name TEXT,
    start_location TEXT,
    state TEXT,
    distance REAL,
    max_grp_size INTEGER,
    trip_type TEXT,
    season TEXT
);
sqlite>
```

Figure 9: running adventure_trip.db and viewing created tables.

- It is confirmed that the tables have been created correctly by describing each table structure and comparing the results to the expected figures provided. The data was reviewed in each table and verified that all entries match the information outlined in Figures 1-4 through 1-8, ensuring that all data has been accurately inserted.