

RELATIONAL DATABASES & DATABASE QUERIES IN SQL

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COURSE DESCRIPTION

This course is an open access, self-study course introducing relational database systems and database queries in SQL. It consists of lecture notes, videos, and exercises. The course also incorporates AI tools like ChatGPT into the learning process to improve the learning experience.

This course is designed as a self-contained course. It may be incorporated into a database management course, the first course on structured data management in a data analytics course, or an IT professional whose job requires the knowledge and skill in relational databases.

PREREQUISITE

Basic knowledge about information technology including computing, operating systems, and computer programming.

LEARNING OBJECTIVES

Upon completion of the course, student should be able to:

- Understand the database technology evolution and trend
- Comprehend the fundamentals of the relational data model
- Develop the technical skill in database queries in SQL
- Build critical thinking and problem-solving skill through exercises
- Leverage the power of AI tools like ChatGPT in continuing learning and study.

PEDAGOGY

This class followed the experiential learning philosophy, which is characterized as an iterative, circular process of learn-act-reflect¹ as illustrated in the diagram on the right. Students study the fundamentals first (learn), apply the concepts to solve problems by completing specified learning activities (act), and, finally, reflect on the knowledge and skills learned.



¹ Kolb, D. A. (1984). *Experiential learning: experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall, Inc.
McCarthy, Mary (2016). “Experiential Learning Theory: From Theory to Practice.” *Journal of Business & Economics Research*, Volume 14, Number 3.

COURSE OUTLINE

Topics	Videos, Readings, & Exercises
Module 1: Database Evolution & Trend	
What are Databases?	Video: Database Tutorial - What are databases? Additional links: What Are Databases? – What is a Database? Microsoft Azure Sample Database: <i>Chinook database</i> SQLite Sample Database And Its Diagram(in PDF format)
Hierarchical databases & network databases	Video link: 05 Hierarchical Databases Video link: 06 Network Databases Additional links: Hierarchical data (SQL Server) - SQL Server Microsoft Learn Hierarchical database model - Wikipedia
Relational databases	Video link: 07 Relational Databases Additional links: Databases - SQL Server Microsoft Learn
Unstructured databases (NoSQL database) & Data schema	Video link: monday sales CRM is the CRM you'll actually want to use Video link: What is a database schema? Additional links: What Is Unstructured Data? - Palo Alto Networks Structured Data vs Unstructured Data - Difference Between Collectible Data - AWS
Cloud databases	Video link: What is Cloud Database? Why we need it? Its advantages, disadvantages and list Video link: What are Cloud Databases? Example: Google Cloud Database Google Cloud Databases Golden Demo
Exercise	<p>Open ChatGPT Ask following questions</p> <ol style="list-style-type: none"> 1. “What is the Chinook Database?” 2. “Is it a relational database?” 3. “How is data stored in this database?” <p>Instructions to download Chinook Database and SQL Lite into the learner’s system.</p> <p>Download SQLite Software download: SQLite Download Page</p> <p>Database to use: Chinook [SQLite Sample Database And Its Diagram(in PDF format)] [See installation instructions in “How to connect to SQLite sample database”]</p> <p>Installing Chinook Database on your computer:</p> <ol style="list-style-type: none"> 1. Download Chinook database from https://www.sqlitetutorial.net/wp-content/uploads/2018/03/chinook.zip 2. Unzip the file and make note of the location. 3. Open SQLite on your computer. 4. Then click “Open Database” to open the chinook file in step # 2 5. Look at the tables along with the Chinook Database Diagram: https://www.sqlitetutorial.net/wp-content/uploads/2018/03/sqlite-sample-database-diagram-color.pdf

Module 2: Relational Data Model	
Relational Data Model	<p>Video link: 01 What is a Data Model</p> <p>Video link: 02 Types of Data Models</p> <p>Video link: 07 Relational Databases</p> <p>Sample data model: SQLite Sample Database And Its Diagram(in PDF format)</p>
Tables, Rows, Fields & Data types	<p>Video link: Entities, Rows, and Columns - Databases tutorial</p> <p>Video link: SQL Server Tutorial - Understanding data types</p>
Primary Keys	Video link: SQL Server Tutorial - One-to-many and many-to-many table relationships
Foreign Keys	Video link: SQL Server Tutorial - One-to-many and many-to-many table relationships
Exercises	<p>Exercise #1 Open ChatGPT and ask the following questions: 1. Identify the entities in the Chinook database 2. How many tables are in this database? 3. Provide the meta data in table format for the Chinook database 4. List some of the primary keys for Chinook database 5. Identify the foreign keys and relationships in Chinook database</p> <p>Refer to the database diagram @ SQLite Sample Database And Its Diagram(in PDF format) to better understand ChatGPT response.</p> <p>(additional) Exercise #2 For the following set of relations, ask ChatGT to populate the relations with a set of “dummy data.” Then verify the correct use of foreign keys in the populated database. Reservation: (<u>Res#</u>, start-date, end-date, date-of-res, cust#) Customer: (<u>Cust#</u>, type, name) Vehicle: (<u>Tag#</u>, size, type, make) Reserve-Vehicle: (<u>Res#</u>, <u>Tag#</u>)</p>
Module 3: Single Table Queries	
Database Queries & SQL	Video link: SQL Tutorial- Running QUERIES and sorting results
Simple single table queries	<p>Video link: SQL Tutorial- Running QUERIES and sorting results</p> <p>Lecture Notes: open file named “SQL Single Table Queries”</p> <p>Lecture Videos: Introduction, Pre-Work, Creating Solutions, SQL Syntax, Aggregate Data and Group Aggregates, Takeaways</p>
Derived data fields	<p>Lecture Notes: open file named “SQL Single Table Queries”</p> <p>Lecture video Creating Solutions</p>
Pattern matching queries	<p>Video link: SQL Tutorial- Filter with regular expressions.</p> <p>Lecture Notes: open file named “SQL Single Table Queries”</p> <p>Lecture video: Creating Solutions, SQL Syntax</p>
Aggregate data queries using Group & Having	<p>Lecture Notes: open file named “SQL Single Table Queries”</p> <p>Lecture Video: Aggregate Data and Group Aggregates</p> <p>Video link: SQL Aggregate Functions: What You Need to Know</p> <p>Additional links: SQL Aggregate Functions SQL GROUP BY Statement SQL HAVING Clause</p>

Exercises	<p>Exercise # 1:</p> <ol style="list-style-type: none"> Following the link @ SQLite SELECT Statement With ChatGPT's help write the SQL select statement for getting all customers in Chinook database. The statement should retrieve the customer's first and last name, address, phone number, and email. <p>[sample prompt: provide me with the SQL statement should retrieve the customer's first and last name, address, phone number, and email in the chinook database]</p> <ol style="list-style-type: none"> Now retrieve the customers whose country is listed as "USA" [See SQLite WHERE - Filter Rows in a Result Set to understand where clause] Also retrieve the customers sorted in ascending order of last name. [See SQLite Order By - Sorting Result Set in Various Orders] Write SQL statement to get the number of customers in each country [See SQLite Group By] <p>(additional) Exercise #2:</p> <p>open file named "Exercise SQL Order Management DB Instructions"</p> <p>open file named "Exercise DB SQL Script Zipped File"</p> <p>open file named "SQL Single Table Exercise"</p>
Module 4: Multi-Table Queries	
Cartesian product	<p>Lecture Notes: open file named "SQL Single Table Queries"</p> <p>Lecture Video: SQL Cartesian Product Video</p>
Natural joins (Equi-Join)	Video link: SQL Tutorial- Utilizing JOINS
Outer joins	Video link: SQL Tutorial- Utilizing JOINS
Aggregate data queries in multi-tables	Video link: SQL Aggregate Functions: What You Need to Know
Exercises	<p>Exercise # 1:</p> <ol style="list-style-type: none"> Using ChatGPT, write the query to select the albumtitle and associated artist name from the Chinook database <p>[see A Visual Explanation of SQLite Joins]</p> <ol style="list-style-type: none"> Using ChatGPT, write the query using inner join to select all the tracks in an album in the Chinook database [see SQLite INNER JOIN with Examples] Using ChatGPT, write a query to identify all artists who do not have an album in the Chinook database [see SQLite Left Join & SQLite RIGHT JOIN Clause] Ask ChatGPT to explain the difference between an inner join and full outer join using Chinook database [see SQLite FULL OUTER JOIN Clause & SQLite INNER JOIN with Examples] <p>(additional) Exercise # 2:</p> <p>Consider the following set of relations for a Chef Database:</p> <p>Dish: (<u>DishName</u>, description, cuisine_type)</p> <p>Chef: (<u>Emp#</u>, name, email, kitchen_where_trained, specialty)</p> <p>Creates: (<u>DishName</u>, <u>Emp#</u>, expertise_level)</p> <p>Restaurant: (<u>RestaurantID</u>, name, address, size)</p> <p>RestaurantChef: (<u>RestaurantID</u>, <u>Emp#</u>)</p>

	<p>1. write an SQL query to identify the names of the restaurants and the names of their chefs for restaurants that have chefs who have an expertise level of novice for making a seasoned rice dish.</p> <p>2. Identify two different scenarios for which the results of this query might be useful.</p> <p>3. Select restaurant.name, chef.name From restaurant, restaurantChef, creates, chef, dish Where RestaurantChef.restaurantID = Restaurant.RestaurantID AND RestaurantChef.Emp# = Chef.Emp# AND Creates.Emp#=RestaurantChef.Emp# AND expertise_level = 'novice' AND creates.DishName = Dish.DishName AND description= 'seasoned rice';</p> <p>a. As a manager of a restaurant, you know that you can provide the dish to your patrons. Therefore, you can include it in your menu. You might also assume that this dish does not require a great deal of expertise in order to be able to offer it.</p> <p>b. You want to increase the capabilities of your chef and move them up towards an expert level for this dish, perhaps because you offer it frequently at your restaurant.</p> <p>Now, run the same query using ChatGPT and compare the outputs. What are the implications of the real-world application for such a database?</p>
Module 5: Advanced Database Queries	
Divide-and-Conquer problem solving strategy	<p>Lecture note: open file named "SQL Subqueries"</p> <p>Lecture video link: SQL Subqueries Video</p>
Subqueries (nested queries)	<p>Lecture note: open file named "SQL Subqueries"</p> <p>Lecture video link: SQL Subqueries Video</p> <p>Video link: When to Use a Subquery in SQL</p>
Stored procedures & functions	<p>Video link: SQL Tutorial - Using functions</p> <p>Video link: SQL Server Stored Procedure - How To</p> <p>Additional Link SQL Stored Procedures</p>
Exercises	<p>Exercise # 1:</p> <ol style="list-style-type: none"> Using ChatGPT, write the subquery to get all the titles in the album containing "Let there be rock" in the Chinook database. Also get the artist's name for that album. [See SQLite Subquery: An Ultimate Guide for SQLite The Novices] Ask ChatGPT for other ways to answer question 1. Ask ChatGPT about stored procedures in SQL database Ask ChatGPT about functions in SQL database As ChatGPT about the difference between functions and stored procedures in SQL database <p>(additional) Exercise #2</p> <p>Explain how a relational database and SQL can help create and maintain some of the data integrity needed for effective databases. Consider database constraints (domain integrity, entity integrity, referential integrity) and data constraints (domain, range, intrarelation, interrelation). Define these using ChatGPT. Then verify the definitions.</p>

Module 6: Data Definition & Manipulations in SQL DDL/DML	
Table Creation & Changes	Video link: SQL Table Creation Changes Video link: SQL Table Update Lecture notes: open file named “SQL DDL & DML” Lecture video: SQL DDL & DML Video
Row insertions & deletions	Video link: SQL Table Creation Changes , SQL Table Update Lecture notes: open file named “SQL DDL & DML” Lecture video: SQL DDL & DML Video
Data changes – Update	Lecture notes: open file named “SQL DDL & DML” Lecture video: SQL DDL & DML Video
Exercises	<p>Exercise #1</p> <ol style="list-style-type: none"> 1. Using ChatGPT, create a table in SQLite for students. The table should contain Name, Date of Birth, Major. [See SQLite Create Table with Examples] 2. Run the query from question 1 in SQLite (under “Execute SQL”) and view the table under “Data Structure” 3. Using ChatGPT alter the table to add StudentID as a non-primary column to the table created in SQLite. [See SQLite ALTER TABLE & How To Overcome Its Limitations] 4. Using ChatGPT, try to add a record with your name, your date of birth, major as "IS", StudentID as "007" to the table. [See SQLite Insert Into - Inserting New Rows Into a Table] View the record under “Browse Data”. 5. Using ChatGPT, try to update the record with StudentID as “007”. Change the major to “Marketing”. [See Learn SQLite UPDATE Statement with Examples] 6. Using ChatGPT, try to delete the record with StudentID as “007”. [See SQLite DELETE Statement Step By Step with Examples] View the record under “Browse Data”. <p>(additional) Exercise # 2</p> <p>For the following relation use ChatGPT to write the corresponding data definition language. Assess the output.</p> <p>XTwitter: (<u>XTwitter#</u>, date_posted, description)</p>
Module 7: Relational Database Design	
Relational database design approaches (<i>bottom-up/reverse engineering, top-down, etc.</i>)	Lecture Notes: open file named “RDB Design Approaches” Video link: RDB Design Approaches Video
Relation normalization design method	Video link: Database Tutorial - First normal form (1NF) Video link: SQL Server Tutorial - How to plan your database
Entity-relationship design method	Lecture Notes: open file named “ER Modeling” Lecture Video: ER Modeling Video

Model 8: Relational Database Management	
Data security	<p>Video link: What is Database Security?</p> <p>Video link: Data Security: Protect your critical data (or else)</p> <p>Video link: SQL Stored Procedures - What They Are, Best Practices, Security, and More...</p>
User management	Video link: SQL Server Tutorial - Creating user-defined server roles
Data mining	Video link: What is Data Mining?
Visualization	<p>Video link: Data Visualization Tutorial - Overview of data visualization in Processing</p> <p>View Hans Rosling's famous <i>200 Countries, 200 Years, 4 Minutes - The Joy of Stats - BBC Four</i>, available at: http://www.youtube.com/watch?v=jbkSRLYSojo.</p> <p>Visualization – provides a graphic representation of the world's populations growth by countries and time. Note source and quality of input data.</p>
Data analytics & Data Science	Video link: Data Analytics vs Data Science
Exercise	<p>Ask ChatGPT to explain clearly the role of data in data mining.</p> <p>Suppose you get an answer such as: “Data is the raw material that fuels the data mining process. The quantity, quality, and relevance of the data are crucial factors that determine the success and effectiveness of data mining projects.” Explain how you would modify this response to account for pattern identification and assessment.</p>
Model 9: Future Trends	
AI enabled RDBMS (Vector database)	<p>What is an LLM? How Large Language Models Work</p> <p>Video link: What is a Vector Database?</p>
Text to SQL	<p>Video link: Discover LlamaIndex: Joint Text to SQL and Semantic Search</p> <p>Additional link: How we built Text-to-SQL at Pinterest by Pinterest Engineering Pinterest Engineering Blog Medium</p>
Retrieval Augmented Generation (RAG)	<p>Video link: What is Retrieval-Augmented Generation (RAG)?</p> <p>Video link: RAG Explained</p> <p>Video link: Advanced RAG: Combining RAG with Text-to-SQL</p>
Exercise	Complete the free training @ Optimizing Foundation Models
To learn more, please visit the following links	
Solo Learn @ www.Sololearn.com	
W3School @ https://www.w3schools.com/sql/default.asp	