SQL Project

Group: COMCEH24.

Participants : Batyr Batyrov, Askarali Ibragimdzhanov, Nurbek Amatzhanov.

Project name : Coffee Shop Management System.

Roles : Batyr - DB Architect & DB Analyst, Askar - SQL Developer, Nurbek - AI Engineer.

Github : https://github.com/SergioMavrodi/CoFFeeShop

Technical Report

Coffee Shop Management System

(Database & AI-Integrated Project)

Abstract

This project presents a Coffee Shop Management System designed to simulate real-world business operations of a modern café. The system combines a relational database with AI-powered natural language querying. A structured dataset was created to represent customers, products, orders, staff, and payments. The project integrates MySQL as the database engine and an AI-powered text-to-SQL agent using LangChain and Gemini to enable intuitive data analysis. The system demonstrates how traditional databases and modern AI tools can work together to generate business insights automatically.

Problem & Dataset

Small coffee shops often struggle to understand customer behavior, product demand, and overall business performance due to the lack of structured data systems. Our project addresses this problem by designing a synthetic, non-real dataset that models a realistic coffee shop environment.

The dataset includes structured information about customers, menu items, orders, order details, staff members, and payment transactions. The data was artificially generated to simulate real transaction volumes and patterns suitable for meaningful SQL analysis and AI-based querying.

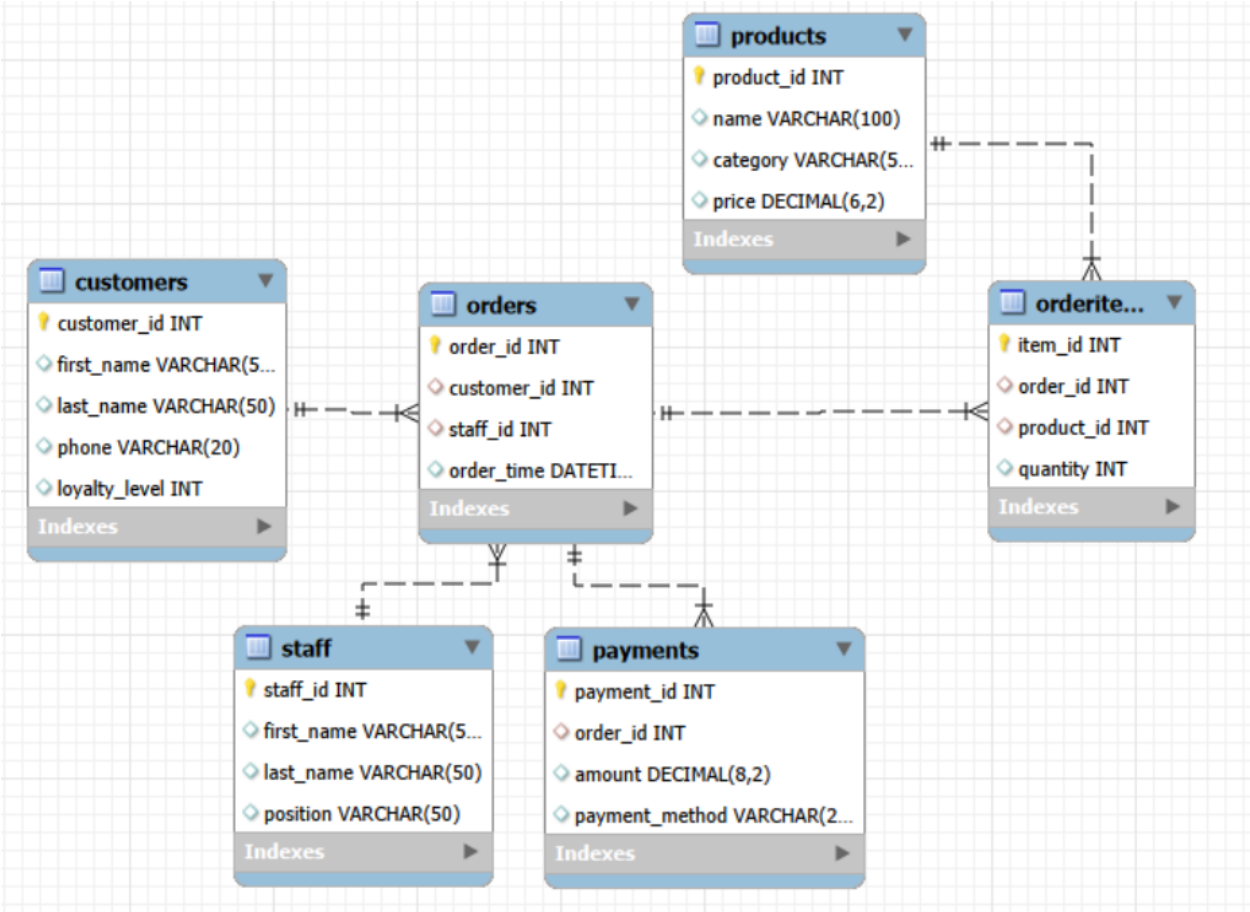
Database Design

The database was designed using relational modeling principles and normalized up to the Third Normal Form (3NF). Each table represents a single business entity, ensuring data integrity and reducing redundancy.

The core tables include:

- Customers
- Products
- Orders
- OrderItems
- Staff
- Payments

An Entity-Relationship (ER) diagram was developed to illustrate the relationships between these entities, including one-to-many and one-to-one associations. Primary and foreign keys were used to enforce referential integrity across related tables.



The ER diagram for the system is provided as Figure 1 in this report and illustrates all entities, attributes, primary keys, foreign keys, and relationships.

Implementation

The database was implemented using MySQL. A structured schema was created with strict data types and defined constraints, including primary keys, foreign keys, and NOT NULL rules.

Data population was achieved using automated scripts to generate a large volume of realistic records. These scripts simulated customer purchases, product popularity patterns, and different payment methods. Referential integrity was actively enforced through foreign key constraints.

SQL Analysis

Several analytical SQL queries were developed to extract insights from the system. These included:

- Multiple table joins to connect customers, orders, and payments.
- Aggregation queries using SUM, COUNT, and AVG functions.
- Subqueries to rank products and customers based on performance.

These SQL queries enabled the analysis of revenue, customer behavior patterns, and product performance.

Optimization

To improve performance, indexes were created on the most frequently queried columns such as foreign keys and date fields. Query execution plans were tested to evaluate performance improvements. The use of indexing significantly reduced query execution time, demonstrating the effectiveness of database optimization techniques.

The following indexes were created to optimize query performance:

CREATE INDEX idx_orders_time ON orders(order_time DESC);

CREATE INDEX idx_orders_customer ON orders(customer_id);

CREATE INDEX idx_orders_staff ON orders(staff_id);

CREATE INDEX idx_orders_time_customer ON orders(order_time, customer_id);

The EXPLAIN command was used to analyze query execution plans and confirm performance improvements.

AI Integration

An AI-powered natural language to SQL agent was implemented using LangChain and Gemini. This component allows users to type human-readable questions, which the AI translates into valid SQL queries. The agent connects directly to the MySQL database and returns live analytical results, making data analysis accessible without deep SQL knowledge.

Results

The system successfully generated several insights, including:

- Identification of top-selling products and most profitable categories.
- Recognition of repeat customers with the highest spending patterns.
- Performance comparisons between staff members.
- Detection of underperforming menu items.

These results demonstrate the value of combining structured databases with AI-driven querying.

Conclusion

The Coffee Shop Management System successfully demonstrates the integration of relational database design and artificial intelligence for business analytics. The project achieved structured data storage, optimized querying, and intelligent interaction through AI. Future improvements could include real-time dashboards, integration with web or mobile applications, and advanced predictive analytics.