IntelliSQL: Intelligent SQL Querying with LLMs Using Gemini Pro

Project Documentation format

1. Introduction

• **Project Title:** IntelliSQL: Intelligent SQL Querying with LLMs Using Gemini Pro

• **Team Members**: Jitendra Reddy Tamma **(Full Stack Developer & AI Integration)**

(Project Design, Backend Logic, Database Management, and UI Development)

2. Project Overview

• **Purpose:** To provide a seamless digital interface for non-technical users to interact with databases using natural language.

• **Features:**

- **NLP Interface**: Converts plain English into SQL commands via Gemini 1.5 Flash.
- **Secure Access**: Utilizes environment variables for API key masking.
- **Live Data Preview**: Displays database records in interactive tables.
- **Error Handling**: Implements Regex to clean AI responses for safe SQL execution.

3. Architecture

• **Frontend:**
• Built using **Streamlit**, which allows for rapid deployment of a data-driven web interface.
• The architecture is component-based, using a sidebar for multi-page navigation (Home, About, Query).

• **Backend:**
• Built with **Python** and the **Google Generative AI SDK** to handle LLM processing.
• Includes a logic layer that performs **Regex-based sanitization** to isolate raw SQL from AI responses.

• **Database:**
• Uses **SQLite** for lightweight, relational data storage (replacing MongoDB).
• The schema consists of a `STUDENTS` table with columns for **NAME**, **CLASS**, **SECTION**, **MARKS**, and **COMPANY**.

4. Setup Instructions

· **Prerequisites:**

- Python 3.9+
- Google Gemini API Key
- Pip (Python package manager)

· **Installation:**

1. **Clone the repository**: git clone [GitHub-URL]
2. **Install dependencies**: pip install streamlit google-generativeai python-dotenv
3. **Environment Variables**: Create a .env file in the root directory and add GOOGLE_API_KEY="your_api_key_here".

5. Folder Structure

- **Client:**
- **`app.py`:** Main entry point containing the Streamlit UI and AI integration logic.
- **`readme.md`**: Local documentation providing instructions on how to interact with the user interface.
- **`requirements.txt`**: List of dependencies required for the client-side libraries, such as `streamlit` and `google-generativeai`.

- **Server:**
- **`.env`**: The server configuration file that securely stores the `GOOGLE_API_KEY`.
- **`sql.py`**: The backend database engineering script used to initialize the server-side database and seed it with initial data.
- **`data.db`**: The SQLite database file where the server stores and retrieves all relational records.
- **`.gitignore`**: Server-side configuration to ensure sensitive files like `.env` are not exposed to version control.
- **pyvenv.cfg**: Server configuration file that manages the Python environment version and paths.

6. Running the Application

Step 1: Database Setup:

Bash

python sql.py

``` [cite: 148]
```

Step 2: Start Application:

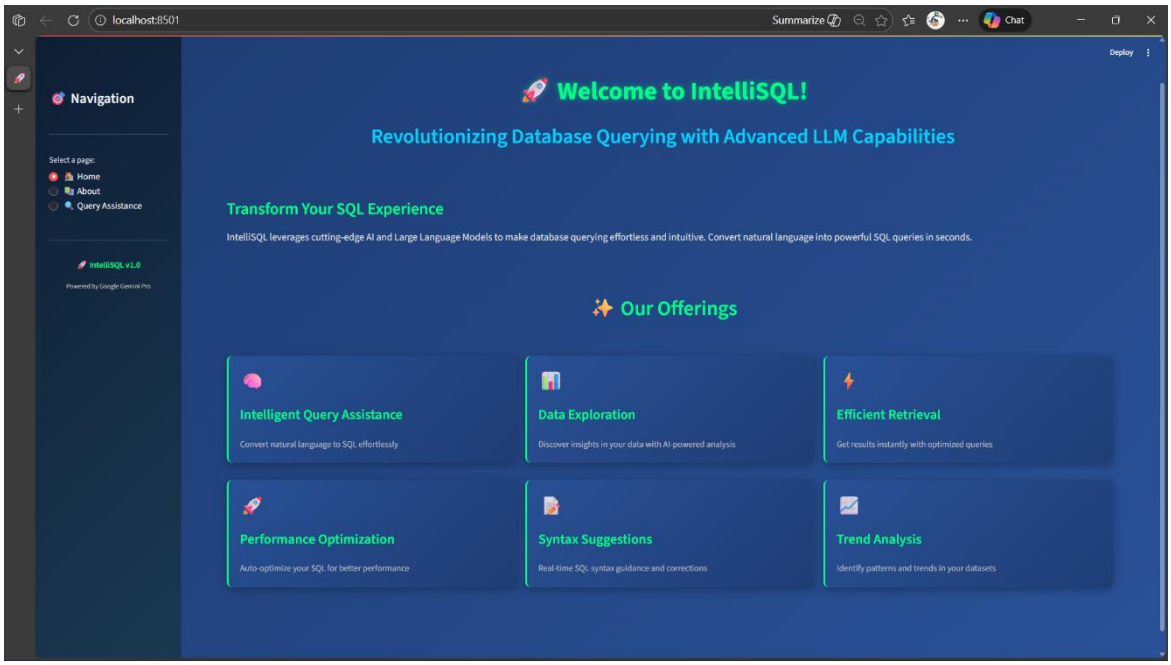
Bash

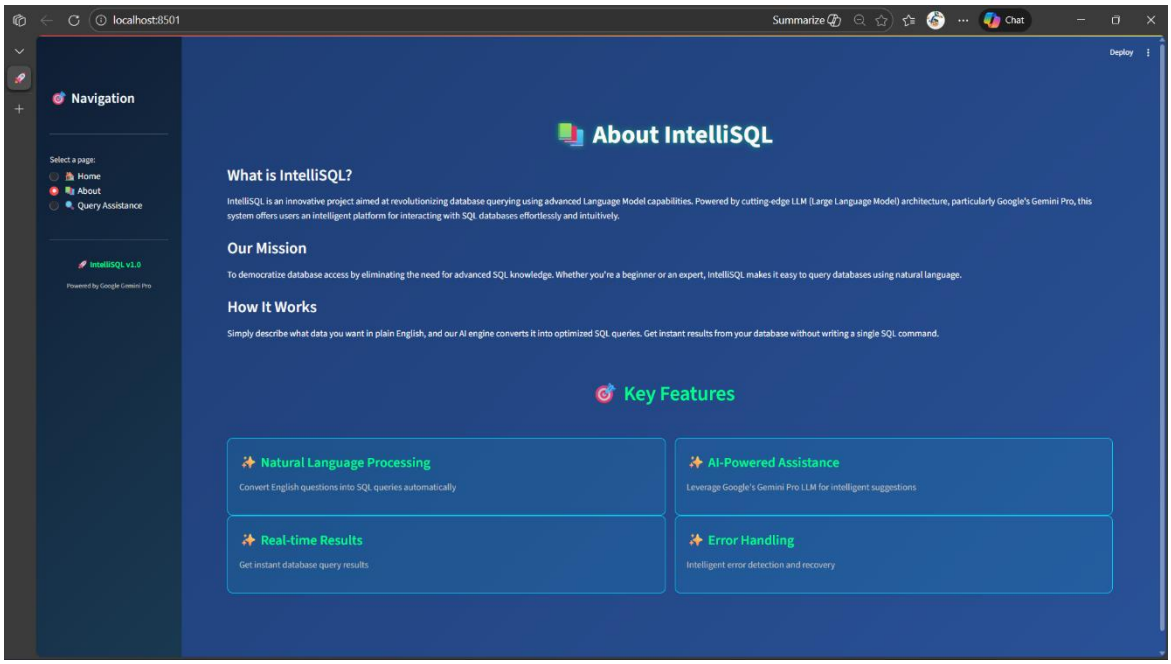
streamlit run app.py

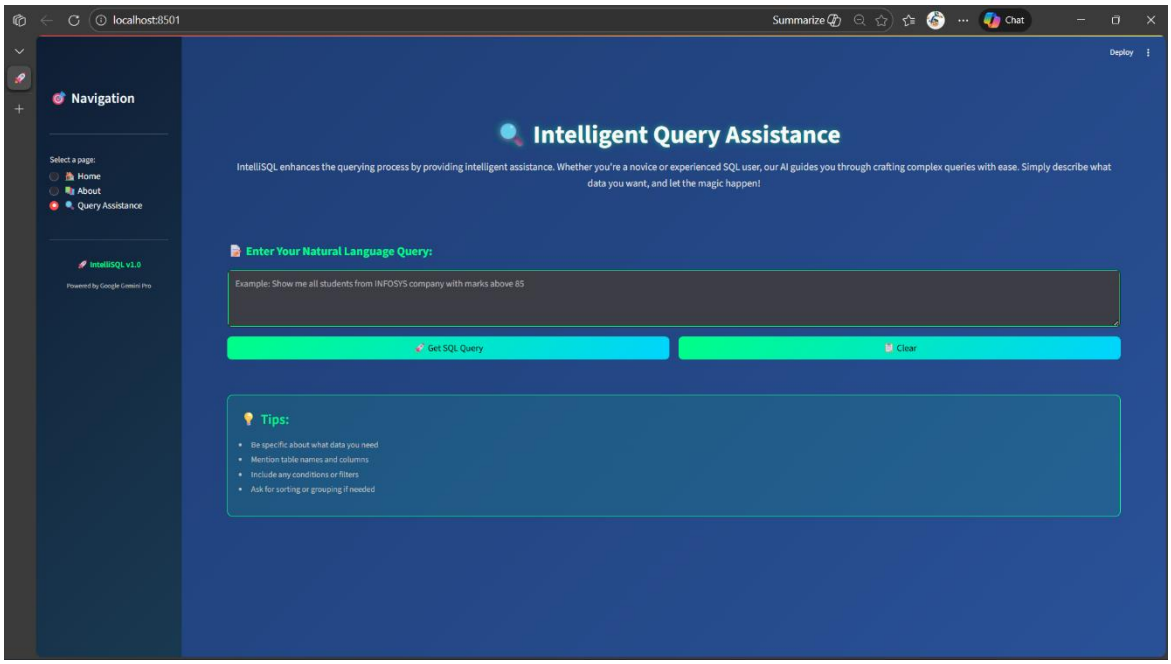
``` [cite: 146]

**App URL:** The dashboard is accessible at **http://localhost:8501**

## 7. API Documentation

**SQL Generation**:

- **Method**: Internal POST to Gemini 1.5 Flash.
- **Parameters**: prompt_context, user_question.
- **Response**: A SQL string (e.g., SELECT * FROM STUDENTS;).

**Database Execution**:

- **Function**: read_query(sql, db).
- **Parameters**: Cleaned SQL string and database path.

## 8. Authentication

- **API Authentication**: Handled via **API Key-based authentication** using the Google Generative AI SDK.
- **Security**: Keys are stored in an encrypted/masked .env file and loaded into the environment at runtime using python-dotenv.

## 9. User Interface

- **Registration/Login**: Simplified via API key validation upon app startup.
- **Query Interface**: A professional text-input area where users type natural language questions.
- **Data Visualization**: Real-time rendering of results in interactive data tables.

## 10. Testing

- **Strategy**: Functional testing was performed on diverse natural language phrasings to ensure SQL accuracy.
- **Tools**: **Manual UAT** and **Python Debugger** were used to verify that Regex correctly strips AI conversational text.
```

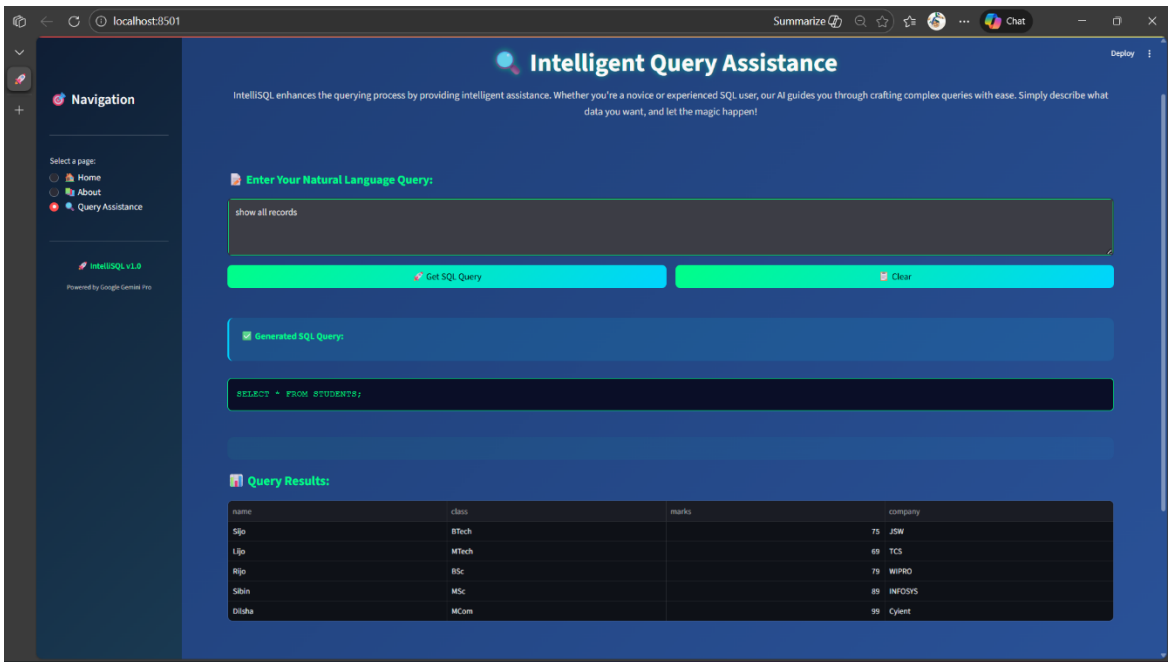
11. Screenshots of project

GitHub Repository: https://github.com/TammaReddy123/IntelliSQL-Intelligent-SQL-Querying-with-LLMs-Using-Gemini-Pro-main






localhost:8501
Summarize
Chat
Deploy
Navigation
Select a page:
Home
About
Query Assistance
IntelliSQL v1.0
Powered by Google Gemini Pro
Intelligent Query Assistance
IntelliSQL enhances the querying process by providing intelligent assistance. Whether you're a novice or experienced SQL user, our AI guides you through crafting complex queries with ease. Simply describe what data you want, and let the magic happen!
Enter Your Natural Language Query:
Example: Show me all students from INFOSYS company with marks above 85
Get SQL Query
Clear
Tips:
Be specific about what data you need
Mention table names and columns
Include any conditions or filters
Ask for sorting or grouping if needed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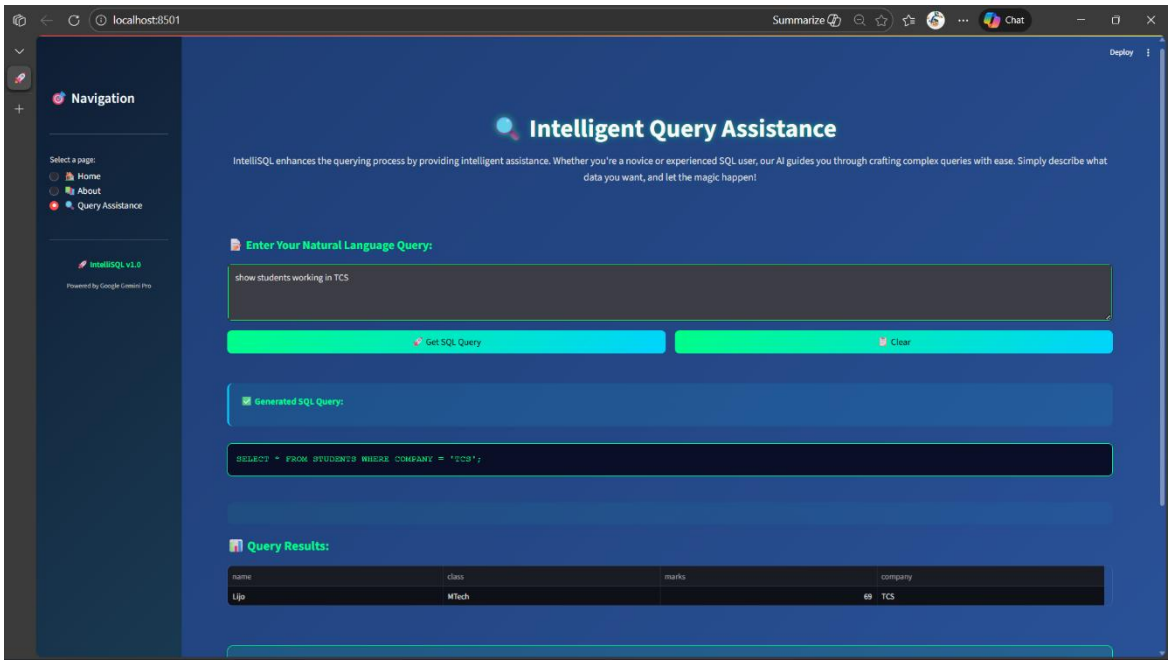
Intelligent Query Assistance
IntelliSQL enhances the querying process by providing intelligent assistance. Whether you're a novice or experienced SQL user, our AI guides you through crafting complex queries with ease. Simply describe what data you want, and let the magic happen!
Enter Your Natural Language Query:
show all records
Get SQL Query
Clear
Generated SQL Query:
SELECT * FROM STUDENTS;
Query Results:
name class marks company
Sijo BTech 75 JSW
Lijo MTech 69 TCS
Rijo BSc 79 WIPRO
Sibin MSc 89 INFOSYS
Dilsha MCom 99 Cyient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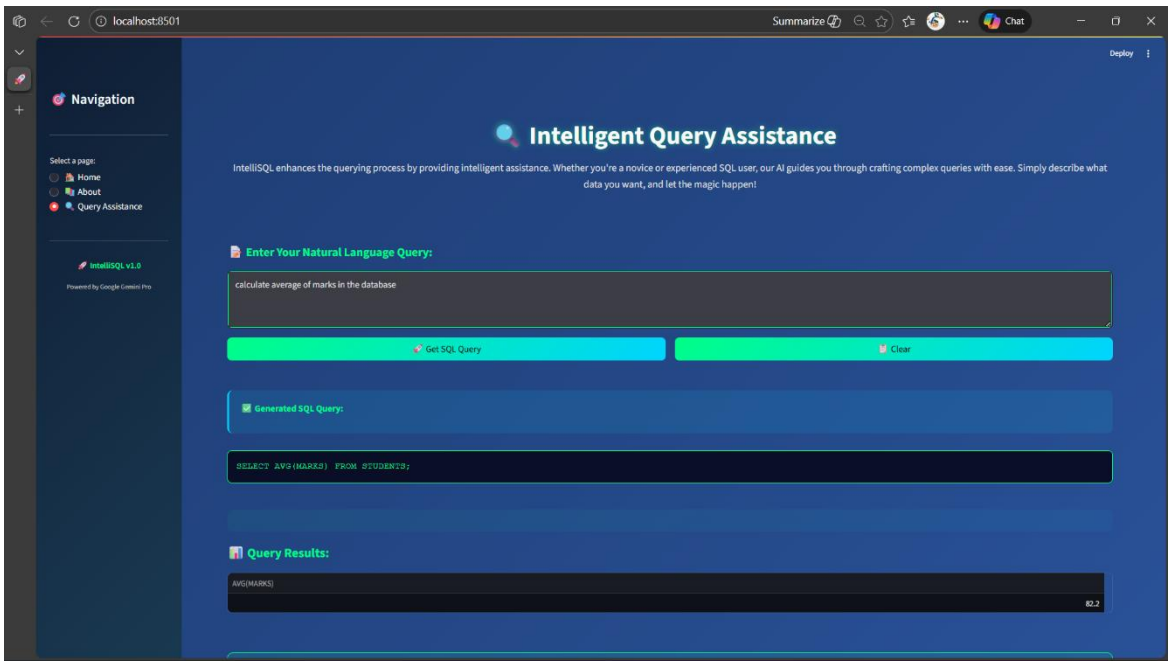
Enter Your Natural Language Query:
show students working in TCS
Get SQL Query
Clear
Generated SQL Query:
SELECT * FROM STUDENTS WHERE COMPANY = 'TCS';
Query Results:
name
class
marks
company
Lijo
MTech
69
TCS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Intelligent Query Assistance
IntelliSQL enhances the querying process by providing intelligent assistance. Whether you're a novice or experienced SQL user, our AI guides you through crafting complex queries with ease. Simply describe what data you want, and let the magic happen!
Enter Your Natural Language Query:
calculate average of marks in the database
Get SQL Query
Clear
Generated SQL Query:
SELECT AVG(MARKS) FROM STUDENTS;
Query Results:
AVG(MARKS)
82.2

12. Known Issues

- **Complex Joins**: The current model may struggle with multi-table queries if the schema isn't explicitly defined in the prompt.
- **Responsiveness**: Wide data tables may require horizontal scrolling on smaller mobile displays.

13. Future Enhancements

- **Voice-to-SQL**: Integration of a microphone icon to allow users to speak their queries.
- **AI Insights**: Using the AI to explain the data results in plain English below the table.
- **Multi-DB Support**: Adding connectors for PostgreSQL and MySQL.