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**: Kukkala Naga Tulasi**(Project Manager & AI Specialist)**
Macharla Meghana **(Backend Developer & Data Engineer)**
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Mekala Vasantho**(QA Engineer)**

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.

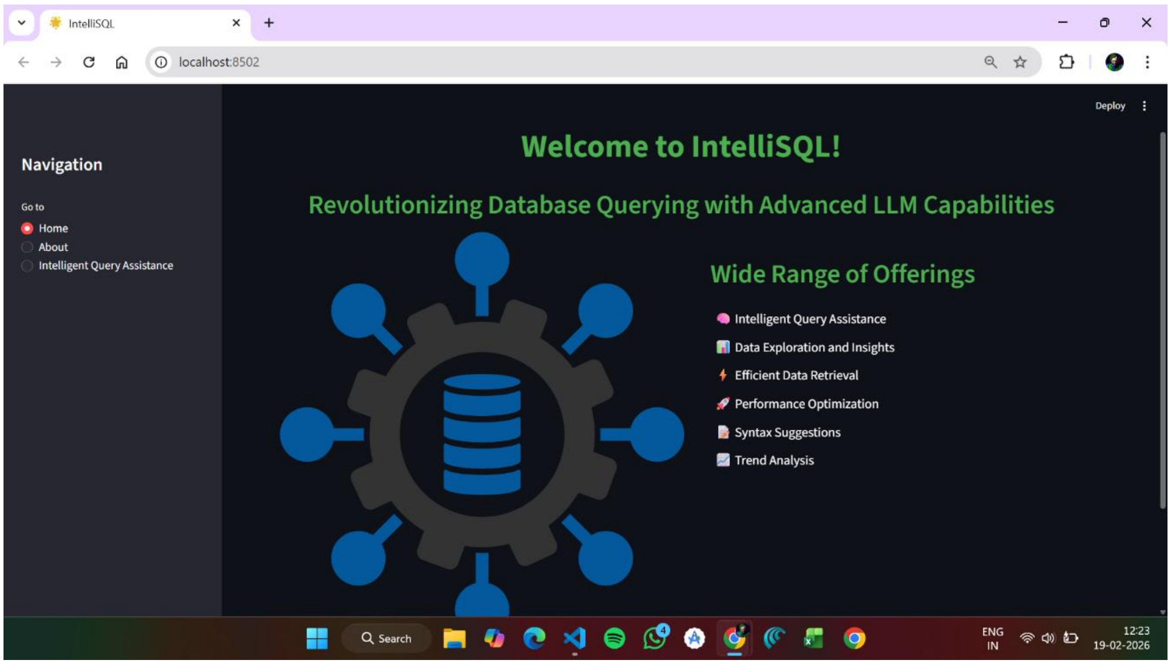
10. Testing

- **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:



Navigation

Go to

● Home

○ About

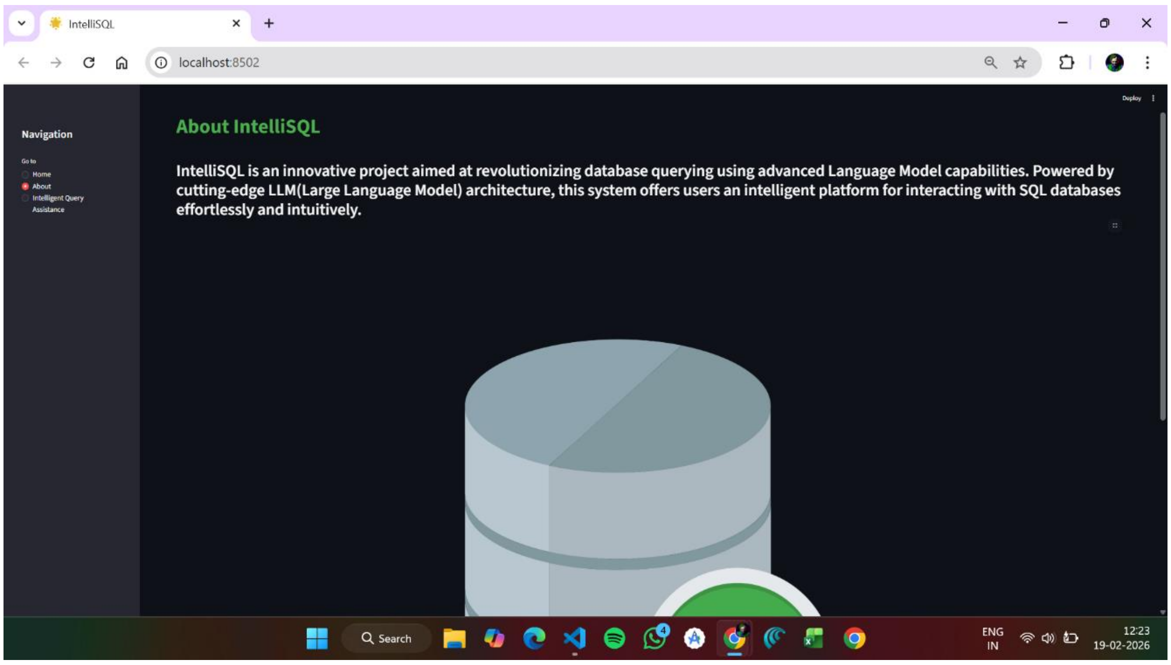
○ Intelligent Query Assistance

Welcome to IntelliSQL!

Revolutionizing Database Querying with Advanced LLM Capabilities

Wide Range of Offerings

- Intelligent Query Assistance
- Data Exploration and Insights
- Efficient Data Retrieval
- Performance Optimization
- Syntax Suggestions
- Trend Analysis



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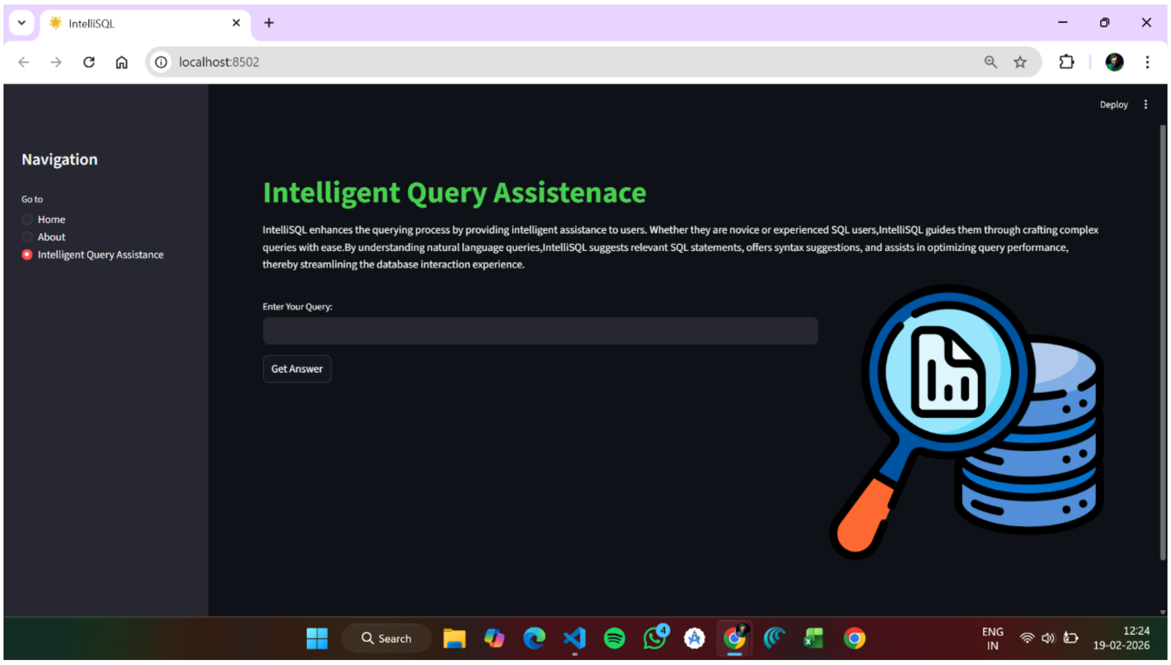
About IntelliSQL

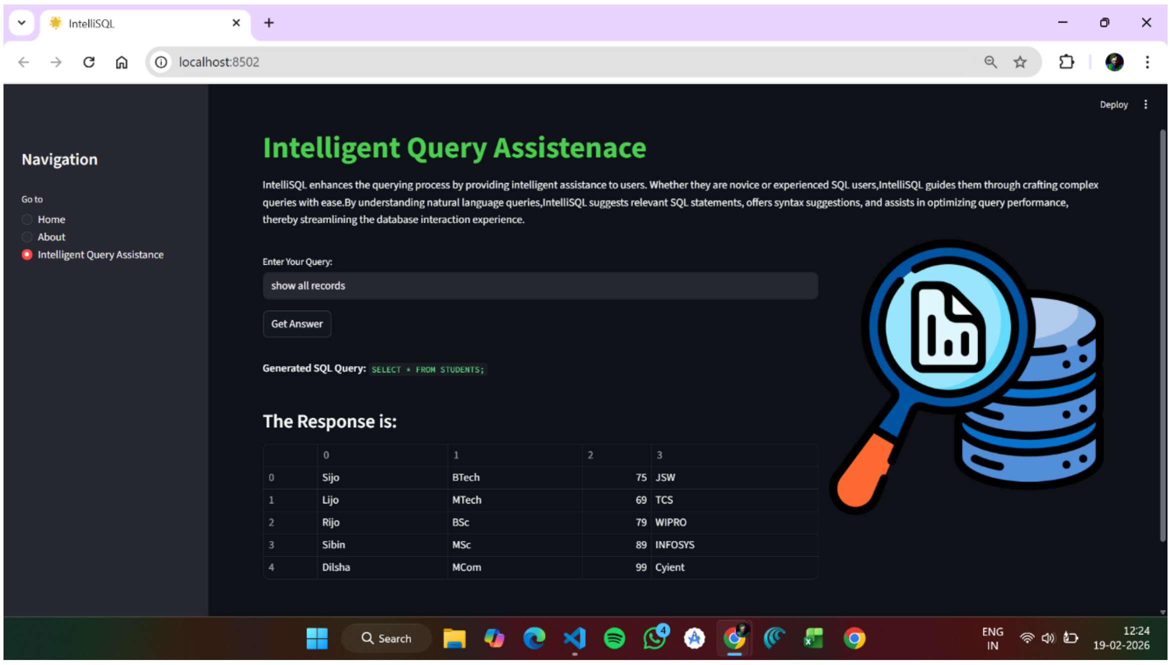
IntelliSQL is an innovative project aimed at revolutionizing database querying using advanced Language Model capabilities. Powered by cutting-edge LLM(Large Language Model) architecture, this system offers users an intelligent platform for interacting with SQL databases effortlessly and intuitively.



Intelligent Query Assistenace

IntelliSQL enhances the querying process by providing intelligent assistance to users. Whether they are novice or experienced SQL users,IntelliSQL guides them through crafting complex queries with ease.By understanding natural language queries,IntelliSQL suggests relevant SQL statements, offers syntax suggestions, and assists in optimizing query performance, thereby streamlining the database interaction experience.

Enter Your Query:



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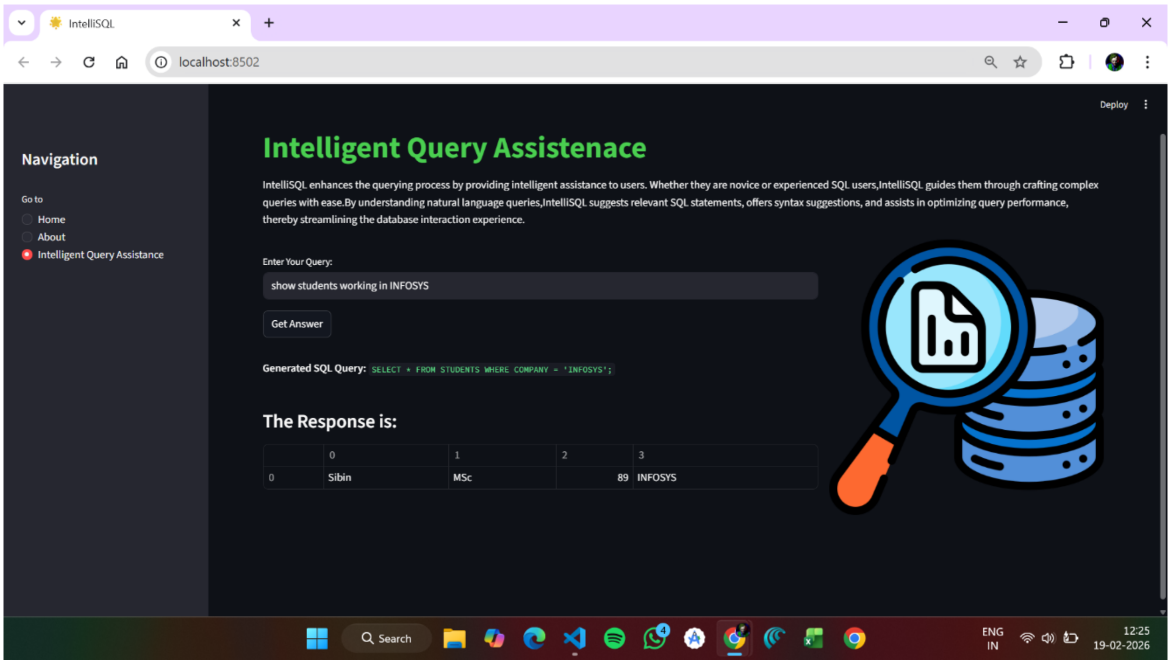
Enter Your Query: show all records

Generated SQL Query: `SELECT * FROM STUDENTS;`

The Response is:

	0	1	2	3
0	Sijo	BTech	75	JSW
1	Lijo	MTech	69	TCS
2	Rijo	BSc	79	WIPRO
3	Sibin	MSc	89	INFOSYS
4	Dilsha	MCom	99	Cyient



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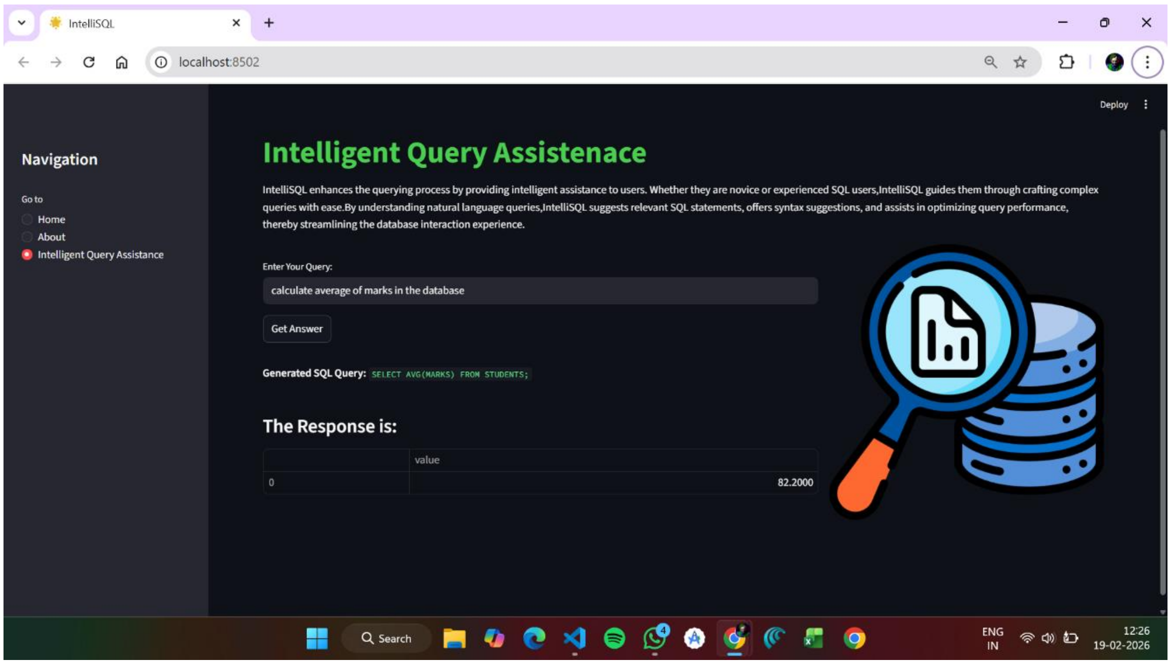
Enter Your Query: show students working in INFOSYS

Get Answer

Generated SQL Query: `SELECT * FROM STUDENTS WHERE COMPANY = 'INFOSYS';`

The Response is:

	0	1	2	3
0	Sibin	MSc	89	INFOSYS



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Enter Your Query: calculate average of marks in the database

Get Answer

Generated SQL Query: `SELECT AVG(MARKS) FROM STUDENTS;`

The Response is:

	value
0	82.2000

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.