

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:** Thiruvaipati Lakshmi Navaneeth (**Project Manager & AI Specialist**)
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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.
 - `pyenv.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.

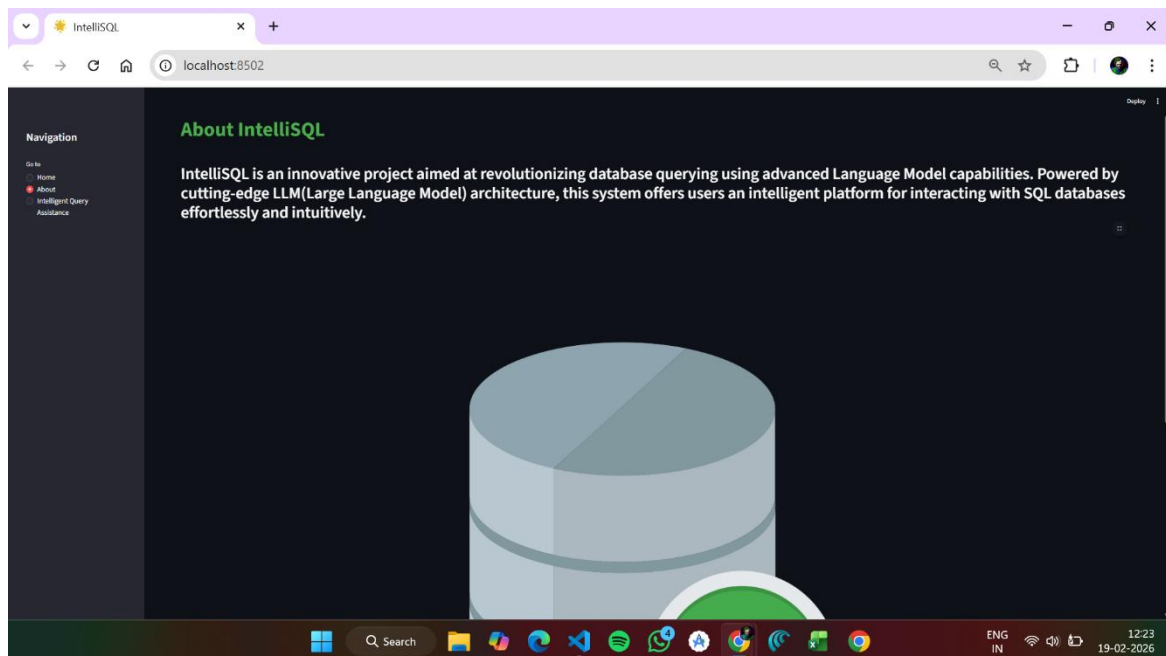
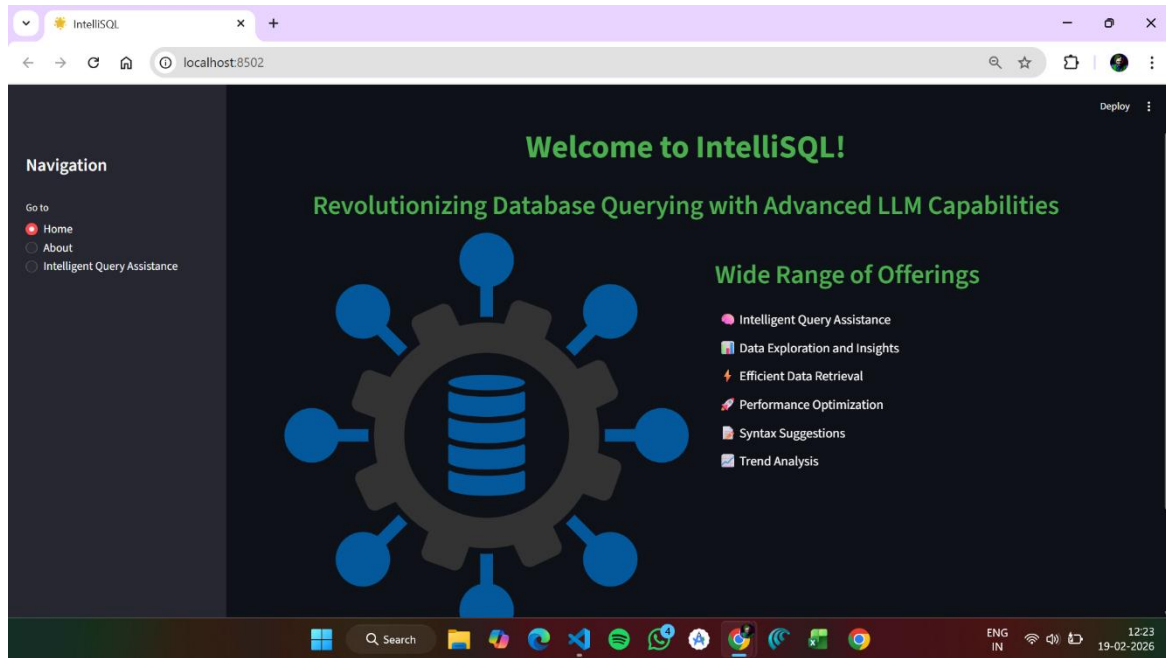
10. Testing

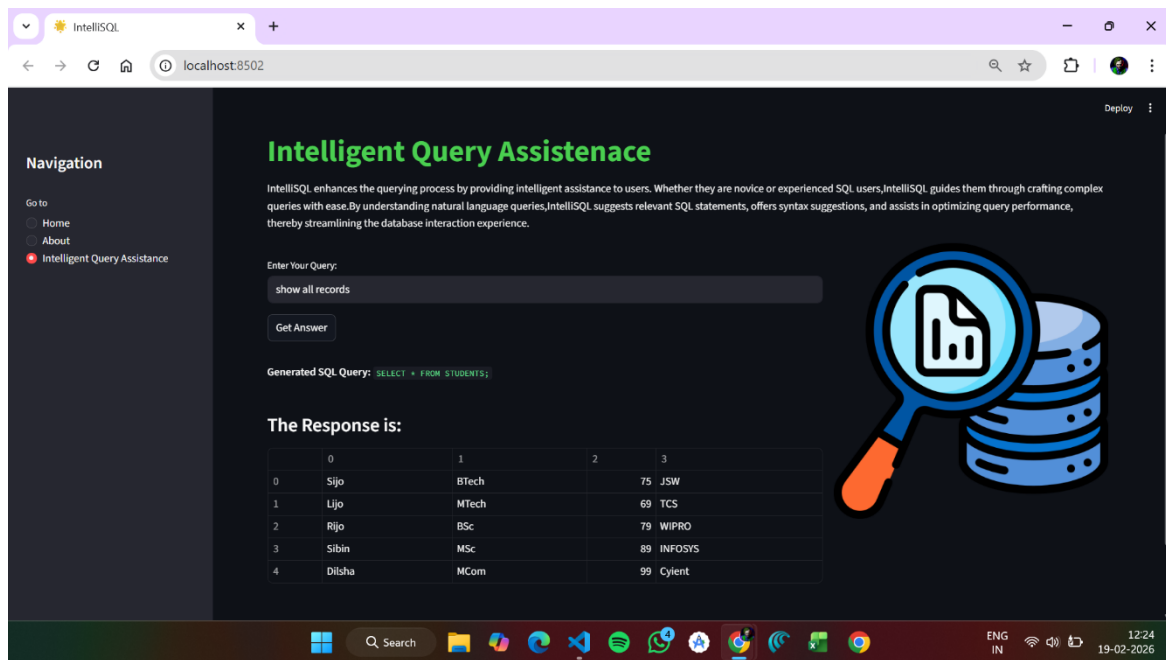
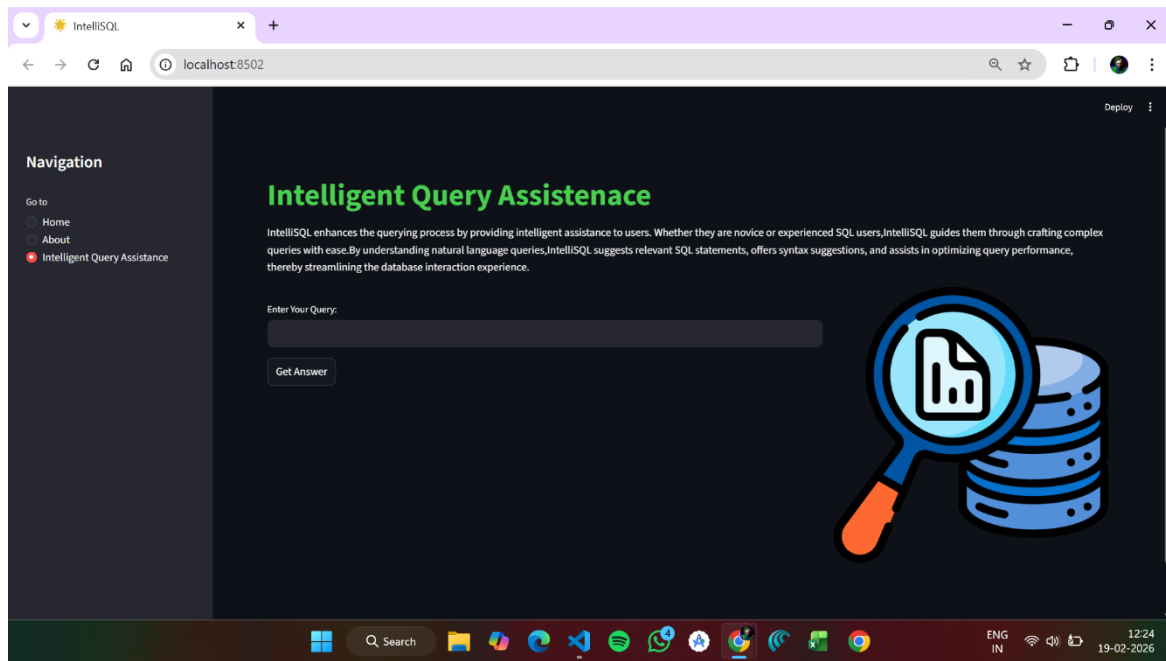
- **Strategy:** Functional testing was performed on diverse natural language phrasings to ensure SQL accuracy.

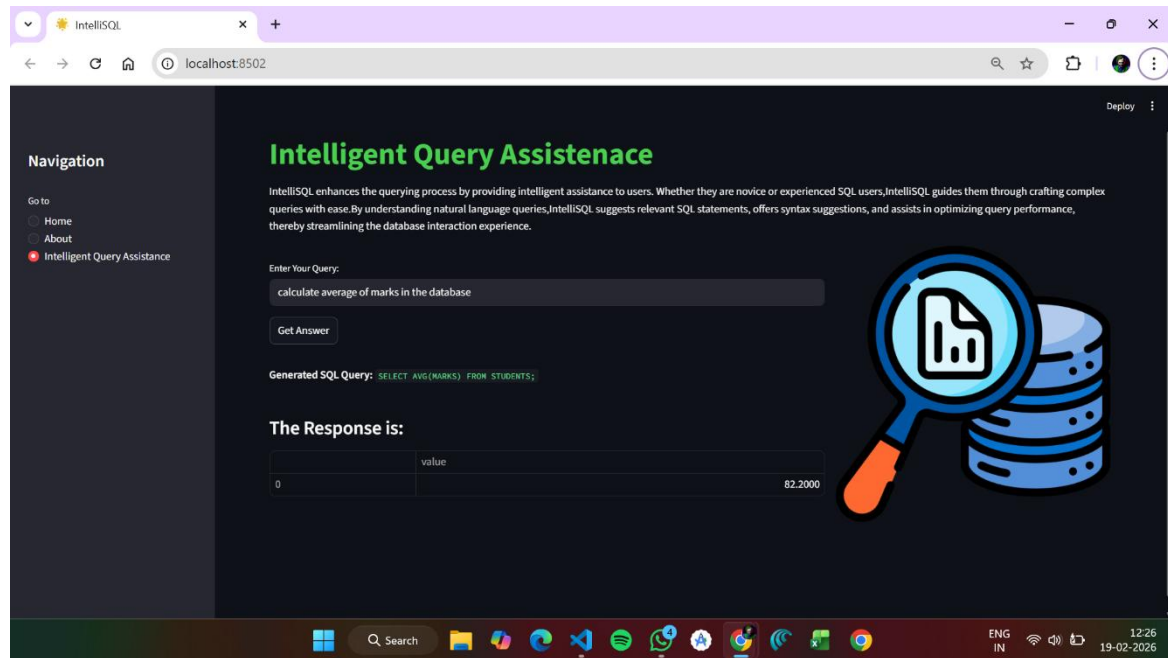
- **Tools: Manual UAT and Python Debugger** were used to verify that Regex correctly strips AI conversational text.

11. Screenshots of project

GitHub Repository:







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.