

Cultour—an AI-powered smart tourism application

Group 5: deptrAI

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Phạm Tiến Đạt

December 14, 2025

Abstract

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1 Group Information

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2 Introduction

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3 Data Storage

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4 Project Architecture

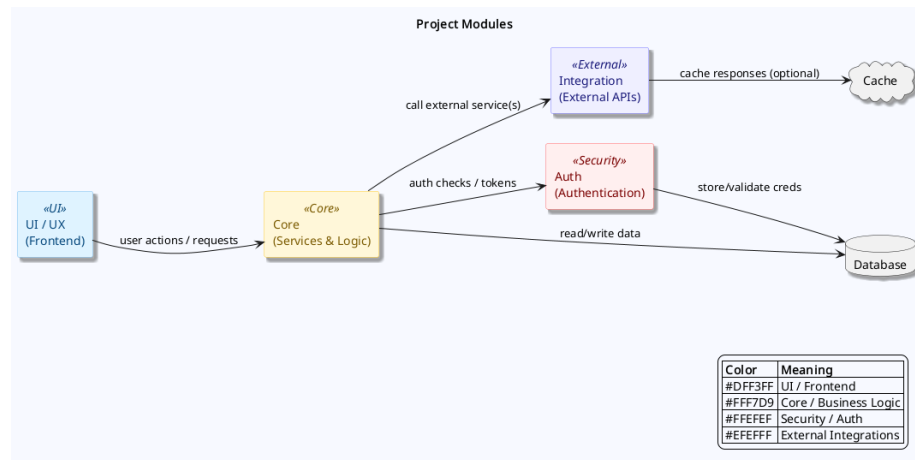
The project, in its core, is a Flutter mobile application that utilizes a NodeJS backend with assistance from Python backend servers that form into a single clean API that the frontend can use. The project's overall architecture can be split into three main architecture styles: the system-level architecture, the client architecture and the backend architecture.

System level architecture. The interaction between the frontend and the backend is a classic three-tier client-server architecture. More specifically, the Flutter client, which we call the *presentation*, utilizes the Node and Python API (the *application*). The backend then utilizes the database and external services to parse upstream data and pass it to the downstream clients. This

is the simplest architecture for an MVP achievable within a reasonable time frame.

Client architecture. The frontend is primarily developed vertically via a feature-first architecture. The codebase can be grouped by separate features (including but not limited to login, map screen, trips, saved place, location searching), each has its own logic and UI implementation. We choose this architecture because it is a simple and intuitive architecture primarily derived from the user flow. This ensures ease of development and understanding from the team.

Backend architecture. The backend is a NodeJS express app comprising of multiple endpoints grouped into categories callable from the frontend via dio. In its core, it is an MVC architecture. An endpoint is structured by the core logic's within its service function, express handling and parameters fetching within its controller functions, and routing via an express's Router object. Middlewares for authorization checking are also included, allowing decoupling and reducing code duplication. Other minor backend servers are also made for training AIs and AI-based searching, and the main backend calls these servers via Cloudflare tunnels. This allows for separation of duties and dependency decoupling.



5 Frontend

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6 Backend

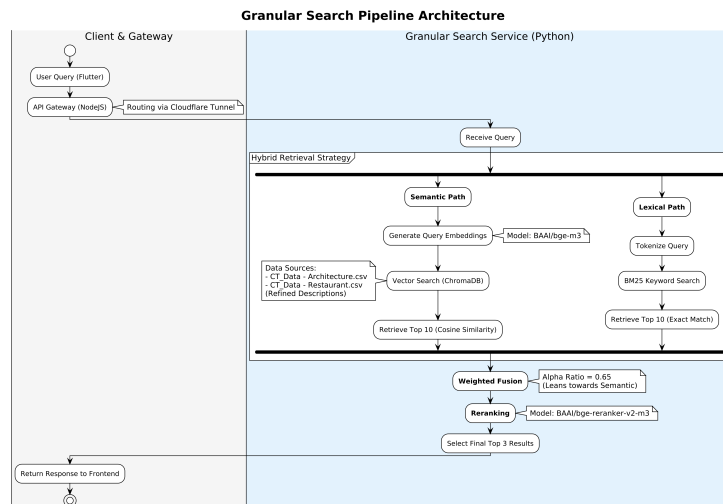
6.1 Granular Search Service

The search pipeline is built upon a hybrid architecture that combines semantic search and lexical search techniques to optimize both relevance and precision in results. The key components of this pipeline are as follows:

1. **Data Embedding and Indexing:** The system utilizes **ChromaDB** as a vector database. To enhance retrieval accuracy, raw data from architecture and restaurant CSVs is pre-processed into descriptively refined documents before being embedded. We utilize the state-of-the-art **BAAI/bge-m3** sentence transformer model to generate these vector embeddings.
2. **Hybrid Retrieval:** The retrieval phase fuses two distinct methodologies.
 - *Semantic Search:* Calculates **cosine similarity** between the user’s query vector and stored document vectors to find the top 10 conceptually relevant results.
 - *Lexical Search:* Utilizes the **BM25** algorithm to identify the top 10 results based on exact keyword matching.

These results are combined using a weighted fusion mechanism with an alpha ratio (α) of 0.65. This weighting prioritizes semantic search (understanding user intent) while retaining the precision of keyword matching for specific entity names.

3. **Reranking:** The combined pool of candidates undergoes a final filtering stage using the **BAAI/bge-reranker-v2-m3** model. This cross-encoder assesses the relevance of each candidate pair deeply, adding precision and selecting the final top 3 results to be returned to the client.



7 Feature Demonstration

8 Conclusion