

Web API Mucar: A Solver for Optimal Multimodal Transportation Itineraries

Project Overview

The Web API Mucar project aims to develop a comprehensive solution for organizing dynamic global and public transportation services, including personal vehicles. This innovative system is specifically designed to address the challenges of fragmented transportation networks across various operators in the Franche-Comté region of France. The project focuses on territories such as PMA with EVOLITY, TADy, TER, and Karos, as well as the Belfort-Montbéliard area which additionally includes Optymo, TER Alsace, LongLine SNCF, TGV, and the Bale-Mulhouse airport. It also considers rural territories where only TAD (Transport à la Demande) or non-dynamic public carpooling options are available.

Our team, composed of HAMAILI Ahmed-Imad, MOURCELY Julien, MONNIER David, and ABIONA Boluwatife, has developed a modular architecture that integrates data visualization, API services, and database management to provide optimal multimodal itinerary calculations for users.

Technical Architecture

The Web API Mucar project is structured around three main components that work together to deliver a seamless transportation planning experience:

Data Visualization Module

The visualization component, implemented in Python, leverages libraries such as Folium, OSMnx, and NetworkX to create interactive maps displaying transportation data. This module processes various data sources including:

- SNCF API data for train stations, departures, and railway networks
- OpenStreetMap data for geographical information
- CSV files containing station information and schedules

The visualization script (Script.py) implements sophisticated algorithms for normalizing text, loading station data, processing railway information, and creating enhanced interactive elements on the map. It includes features such as:

- Dynamic display of transportation networks with color-coded routes
- Interactive popups showing detailed information about stations and routes
- Real-time departure information from the SNCF API
- Geographical filtering to focus on specific territories
- Caching mechanisms to optimize performance

The visualization module serves as the front-end interface for users to explore available transportation options and visualize potential routes across different modes of transport.

Transit API

The Transit API, built with Node.js and Express, provides a robust backend service for managing transportation data. It offers a RESTful interface with the following key features:

- JWT-based authentication system to secure access to protected routes
- CRUD operations for managing locations, modes, lines, and stops
- Swagger documentation for easy API exploration and testing
- MySQL database integration for persistent data storage
- Role-based access control for administrative functions

The API follows a modular architecture with separate route handlers for each data entity, middleware for authentication and authorization, and a structured database schema. This design ensures scalability and maintainability as the project evolves.

Vue.js Web Application

The front-end application, developed using Vue.js, provides an intuitive user interface for interacting with the transportation data. It includes components for:

- User authentication and session management
- Listing and detailed views for transportation entities (locations, modes, lines, stops)
- Navigation through a responsive drawer interface
- Data management through service modules that communicate with the API

The Vue.js application implements a state management pattern using Vuex to maintain application state and handle asynchronous operations. The component structure follows best practices for reusability and separation of concerns.

Integration and Workflow

The three components work together in a cohesive workflow:

1. The Transit API serves as the central data hub, providing authenticated access to transportation data stored in the MySQL database.
2. The Vue.js application consumes the API services, allowing users to browse, search, and manage transportation data through an intuitive interface.
3. The Python visualization module processes the transportation data to generate interactive maps that help users visualize routes and make informed decisions about their travel options.

This integrated approach enables the system to propose optimal multimodal itinerary calculations based on various input data sources, including:

- CSV/JSON/GPX data from data.gouv.fr for bus lines, stops, and real-time information
- CSV descriptions of students and calendars from universities
- Origin-to-destination matrices for all stops, pick-up, and delivery addresses
- OpenStreetMap geographical information

Future Perspectives

The Web API Mucar project is still under active development as our team continues to enhance its capabilities. We are currently planning several improvements to expand the system's functionality and user experience. Our ongoing work focuses on implementing advanced optimization algorithms for route planning, integrating additional transportation providers, and developing mobile applications for on-the-go access. We are also exploring machine learning components to predict transportation demand and optimize service allocation, along with real-time tracking and update features for dynamic transportation services. By addressing the challenges of fragmented transportation networks, the Web API Mucar project contributes to more efficient, accessible, and sustainable mobility solutions for diverse territories, from urban centers to rural areas.

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