

System Requirements

This is an evacuation decision-support system built using Python as a programming language. It functions as an interactive web application, created with the Streamlit library.

The system's core purpose is to calculate the optimal evacuation route from various barangays to a central evacuation center. It uniquely combines the A* pathfinding algorithm (using heapq) with a fuzzy logic model (using skfuzzy). Instead of just finding the shortest path, it determines the "best" path by calculating a "cost" based on real-world road characteristics like slope, travel time, and curvature, which are loaded from Excel files (pandas).

The application loads geographic path data from a .kml file and uses Folium to display an interactive satellite map, highlighting the calculated optimal route in red for the user.

1. Functional Requirements

- **FR-1:** The system **must** load geographic path data from a single .kml file located in a data/ folder.
- **FR-2:** The system **must** load road attribute data from one or more .xlsx or .xls files located in the data/ folder.
- **FR-3:** The system **must** parse Excel filenames to associate data with a specific barangay (e.g., ...to_BarangayName.xlsx).
- **FR-4:** The system **must** read "Slope" and "Travel_Time_min" columns from the Excel files.
- **FR-5:** The system **must** provide a web interface for user interaction.
- **FR-6:** Users **must** be able to select a starting barangay from a dropdown list.
- **FR-7:** The system **must** display an interactive map with a satellite imagery base layer.
- **FR-8:** The system **must** display markers for all predefined barangays and the central evacuation center ("Poblacion").
- **FR-9:** The system **must** calculate the optimal evacuation route from the selected barangay to "Poblacion."
- **FR-10:** The optimal path **must** be determined using the A* pathfinding algorithm.
- **FR-11:** The A* cost function ($g(n)$) **must** be calculated using a fuzzy logic model based on road slope, travel time, and path curvature.
- **FR-12:** The A* heuristic function ($h(n)$) **must** be the Haversine (straight-line) distance.
- **FR-13:** The system **must** visually highlight the calculated optimal path on the map (e.g., in red).
- **FR-14:** The system **must** display all other available KML paths (e.g., in gray).

- **FR-15:** The system **must** display the total distance (km) and total estimated travel time (minutes) for the optimal path.
- **FR-16:** The system **must** display a clear error message if the data/ folder or required files are not found on startup.

2. Software Requirements (Python Libraries)

- streamlit: For the web application framework.
- folium: For generating the interactive map.
- streamlit-folium: For embedding Folium maps in Streamlit.
- xml.etree.ElementTree: (Python Standard Library) For parsing the .kml file.
- numpy: For numerical operations required by scikit-fuzzy.
- scikit-fuzzy (as skfuzzy): For all fuzzy logic operations (membership functions, rules).
- pandas: For reading and processing .xlsx (Excel) files.
- heapq: (Python Standard Library) For the priority queue in the A* algorithm.
- math: (Python Standard Library) For Haversine distance calculations.
- os: (Python Standard Library) For file and path operations.

3. Data Requirements

- **DR-1:** A folder named data/ **must** exist in the root directory of the project, alongside the main Python script.
- **DR-2 (KML):** The data/ folder **must** contain exactly **one** .kml file.
 - This file must contain Placemark elements.
 - Each Placemark must have a <name> tag (e.g., Poblacion to Bobon) and a <coordinates> tag containing a list of longitude,latitude pairs.
- **DR-3 (Excel):** The data/ folder **must** contain one or more .xlsx or .xls files.
 - Each filename **must** follow the convention [Origin]_to_[Destination].xlsx (e.g., Poblacion_to_Bacolod.xlsx, Poblacion_to_Gines2.xlsx). The system parses the string after _to_ and capitalizes it.
 - Each Excel file **must** contain a sheet with, at minimum, one column containing "Slope" in its header and one column containing "Travel_Time_min" in its header.