Geospatial Analysis for Food Delivery Optimization

This project analyzes food delivery patterns using location-based data to help stakeholders (restaurants, delivery managers, and city planners) optimize operations. The goal is to understand delivery hotspots, route efficiency, and delivery time variations across different areas.

Part 1: Geospatial Analysis

1. Stakeholder Needs

Different stakeholders benefit from spatial data in various ways:

- **Restaurants & Delivery Managers**
  - Need to identify high-demand areas to plan resources.
  - Want to reduce delivery delays by optimizing routes.
  - Use heatmaps to see order density and common delivery routes.
- **Customers**
  - Interested in faster deliveries and better service availability.
  - Affected by traffic conditions in their area.
- **City Planners & Traffic Authorities**
  - Need to analyze delivery congestion and improve urban planning.
  - Can use geospatial data to optimize road networks.

2 Data Assessment

- **How is location represented?**
  - Latitude & Longitude of restaurant and delivery locations.
  - Routes connecting pickup and drop-off points.
- **What's the geographic coverage?**
  - Covers multiple cities, possibly regional or country-wide.
  - Focuses on urban areas with high food delivery activity.
- **What additional data might be useful?**
  - Traffic conditions (to analyze delays).
  - Weather data (to see if rain impacts delivery time).
  - Demographic data (to understand customer preferences in different areas).

3. Initial Design Exploration

Visualization 1: Heatmap of Delivery Demand

Purpose:

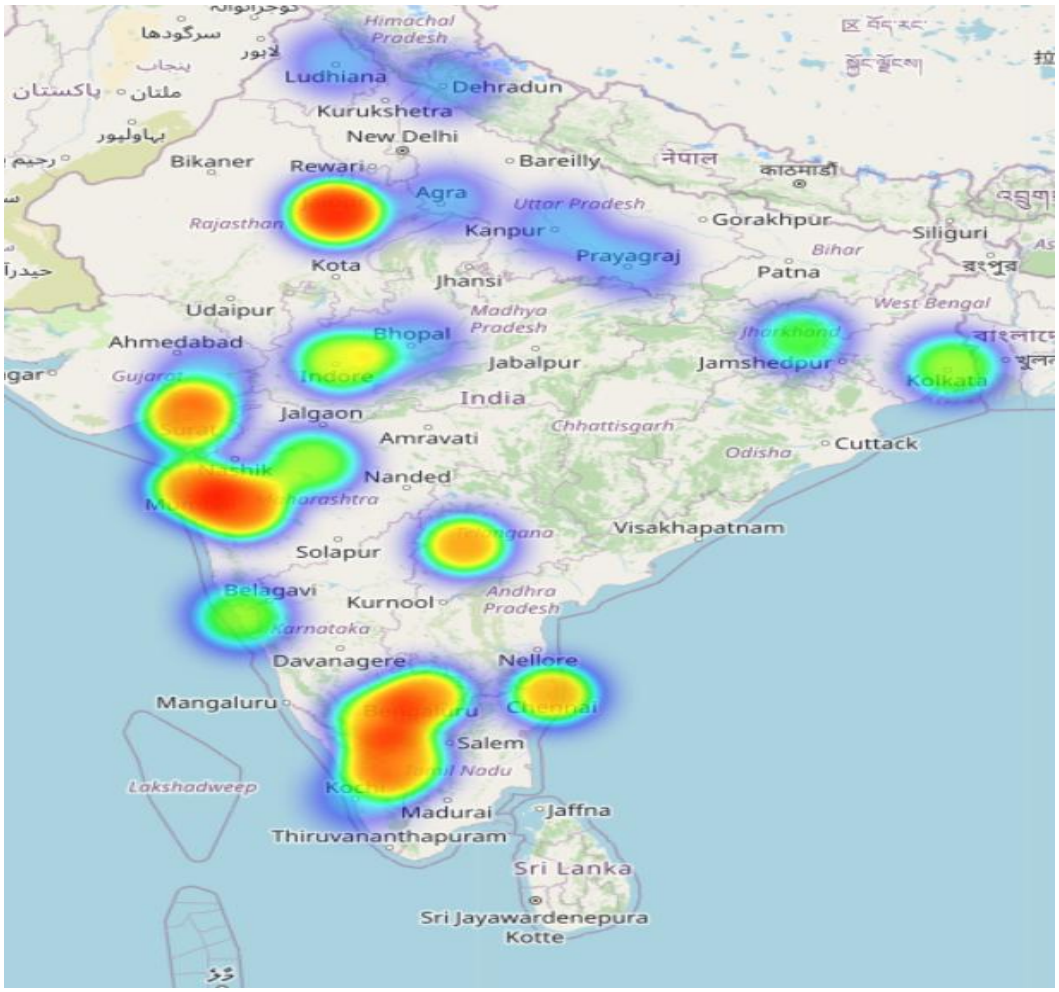
- Shows areas with the highest concentration of food deliveries.
- Helps identify demand hotspots where more delivery drivers are needed.

How it was created:

- Latitude & Longitude of deliveries plotted on a map.
- Color gradient:
    - **Red** = High delivery density
    - **Blue** = Low delivery density

Insights:

- Helps **restaurants and delivery partners** focus on **high-demand areas**.
- City planners can **improve infrastructure** in areas with heavy congestion.



Visualization 2: Delivery Routes & Time Analysis

Purpose:

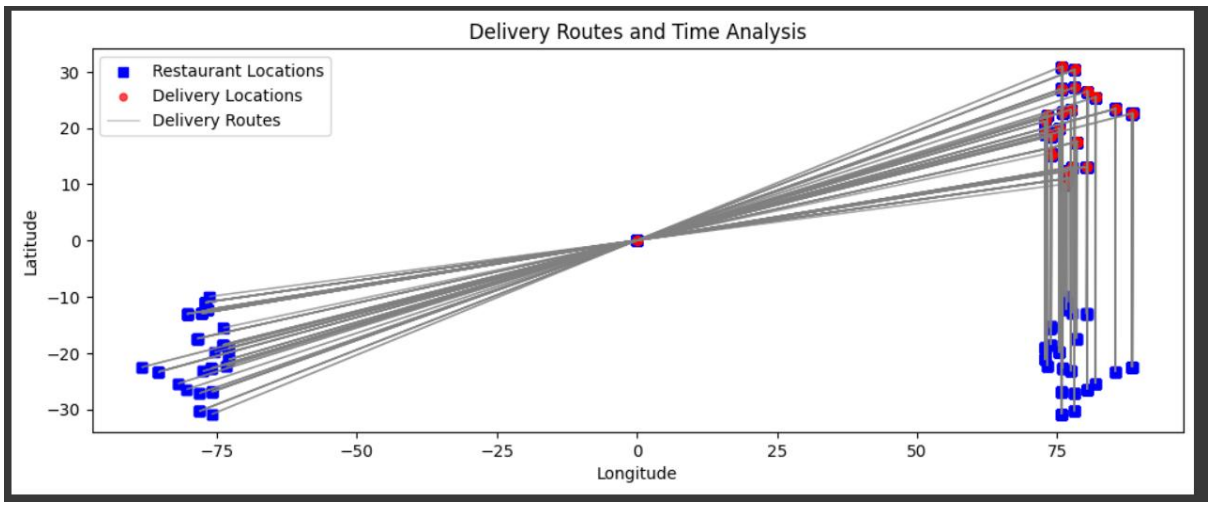
- Connects restaurant locations (blue) to delivery locations (red) with lines.
- Shows how far food needs to travel and delivery time variations.

How it was created:

- Lines drawn between pickup & drop-off locations.
- Markers used to distinguish restaurants (blue) and delivery spots (red).

Insights:

- Identifies long-distance orders that take too much time.
- Helps optimize routes to make deliveries more efficient.



Part 2: AI-Assisted Design Process

1. How AI Helped in the Design Process

- **AI Used:** ChatGPT (Version 4o)
- **Prompts Used:**
  - "Suggest geospatial visualizations for food delivery optimization."
  - "What are the best ways to visualize delivery demand on a map?"

Implementation Plan

- **Data Preparation:**
    - Clean missing values in latitude/longitude columns.
- **Tools/Libraries Used:**

  Python Libraries:

    - **Folium** – To generate interactive heatmaps of delivery locations.
    - **Geopandas** – To handle spatial data and create route visualizations.
    - **Matplotlib** – Used to plot delivery routes and analyze travel patterns.
    - **Shapely** – To create lines connecting restaurant locations to delivery destinations for route mapping.

- **Interactive Features:**
    - Allows users to analyze delivery demand in specific locations.
    - Helps identify peak demand zones and traffic congestion areas.
    - Toggle between Heatmap and Route Map for insights
        - **Heatmap**: Identifies high-demand delivery regions.
        - **Route Map**: Shows connections between restaurants and delivery locations, helping optimize delivery routes.
    - **Zoom and Pan on the Map**
        - Allows users to explore different geographic areas dynamically.
        - Useful for comparing delivery activity in multiple regions.
    - **Adjust Heatmap Intensity**
        - In Folium, heatmap intensity is automatically adjusted based on delivery density.
        - This helps delivery managers allocate resources efficiently.

3. Evaluation of AI Suggestions

- **Helpful AI Suggestions:**
    - Recommended heatmaps and route maps as best visualization choices.
- **Limitations of AI:**
    - Did not account for real-time data processing challenges.
    - Suggested some complex GIS techniques that are not easy in Power BI.