Facility Location Optimization Report

Introduction

This project tackles a facility location optimization problem, aiming to minimize costs and travel times for locating a central facility in Atlanta, GA. The analysis leverages geospatial techniques and Google Maps APIs to compare two approaches: Haversine distance (straight-line) and driving distance (actual travel).

Objectives

1. Identify the optimal location for a facility based on cost minimization.
2. Compare results using Haversine and driving distance methods.
3. Visualize the optimal location and routes on an interactive map.

Methodology

1. **Data Collection:**
    - Locations in Atlanta, GA with associated weights and fixed costs.
    - Geographic coordinates retrieved using the Google Maps API.
2. **Haversine Distance Optimization:**
    - Calculated "as-the-crow-flies" distances between points.
    - Used Scipy's `minimize` function to determine the optimal location.
3. **Driving Distance Optimization:**
    - Leveraged Google Maps Directions API to compute actual travel distances.
    - Used Scipy's `brute` function for integer-based optimization.
4. **Visualization:**
    - Mapped the optimal locations and routes using Folium and Google Maps.

Results

Haversine Distance Method

- **Optimal Location:** 618 Cresthill Ave NE, Atlanta, GA 30306, USA.
- **Coordinates:** [33.7837, -84.3674].
- **Minimum Cost:** $192,150.77.

Driving Distance Method

- **Optimal Location:** 1470 Ashwood Way, Lawrenceville, GA 30043, USA.
- **Coordinates:** [34.0, -84.0].
- **Minimum Cost:** $2,954,751.00.

Comparative Analysis

- The driving distance method accounts for real-world travel constraints, leading to higher costs compared to the Haversine approach.
- Both methods provide actionable insights for facility placement but differ in precision based on real-world constraints.

Discussion

- **Advantages:**
    - Haversine distance offers quick estimates for facility placement.
    - Driving distance provides realistic results suitable for practical implementation.
- **Challenges:**
    - Haversine distance ignores road networks and travel conditions.
    - Driving distance depends on API accuracy and incurs computational overhead.

Recommendations

1. Use Haversine distance for preliminary analysis to identify potential locations.
2. Apply driving distance optimization for final decision-making in practical scenarios.
3. Regularly update location data and parameters to reflect changes in road networks and demand patterns.

Conclusion

This project demonstrates the value of geospatial optimization in solving facility location problems. By combining mathematical models with real-world data, businesses can make informed decisions to minimize costs and improve operational efficiency.

References

- Google Maps API for geocoding and driving distances.
- Python libraries: Pandas, Scipy, Folium.