Title: Dynamic Pricing for Urban Parking Lots
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📌 Project Overview

This project implements a real-time dynamic pricing engine for 14 urban parking lots based on features such as occupancy, queue length, traffic congestion, special day indicators, vehicle type, and competitor pricing. The goal is to improve utilization and avoid over/underpricing by adjusting rates every 30 minutes.

📊 Data Description

- **73 days of data**
- **18 time points per day** (every 30 minutes from 8 AM to 4:30 PM)
- Key features:
    - Occupancy
    - Capacity
    - Queue Length
    - Traffic Condition (Low, Moderate, High)
    - Special Day Indicator
    - Vehicle Type (Car, Bike, Truck)
    - GPS Coordinates

⚙️ Models Implemented

Model 1: Baseline Linear Pricing

$P(t+1) = P(t) + \alpha \times (\text{Occupancy} / \text{Capacity})$

Model 2: Demand-Based Dynamic Pricing

Demand = α × (Occupancy / Capacity) + β × QueueLength − γ × Traffic + δ × IsSpecialDay + ε × VehicleWeight
Price = BasePrice × (1 + λ × NormalizedDemand)

Model 3 (Optional): Competitive Pricing

- Calculates geographic distance using latitude and longitude.
- Considers nearby parking lot prices (within 1 km).
- If competitors are cheaper and the lot is full → reduce price.
- If competitors are expensive → increase slightly.

📝 Assumptions

- Traffic mapped to integers: Low=0, Moderate=1, High=2
- Vehicle weight: Bike=0.5, Car=1.0, Truck=1.5
- Price is bounded: minimum $5, maximum $20
- Competitor radius: 1 km using `geopy`

📉 Visualization

The final output shows a matplotlib plot comparing:

- Model 1: Baseline price increase with occupancy
- Model 2: Smoothed price with demand function
- Model 3: Price modified by competitive pressure

✅ Conclusion

The project demonstrates a scalable approach to urban parking management using lightweight models and real-time simulation, improving both customer pricing and lot efficiency.

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