Dynamic Pricing for Urban Parking Lots

Capstone Project - Summer Analytics 2025

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1. Introduction

Urban parking spaces are limited and demand fluctuates heavily throughout the day. This project implements a dynamic pricing strategy for 14 urban parking lots using real-time data, economic principles, and machine learning techniques.

2. Data Overview

The dataset spans 73 days of 30-minute interval data for 14 parking lots. Features include: Capacity, Occupancy, Queue Length, Vehicle Type, Traffic Condition, Special Event Indicator, etc

3. Model 1 - Linear Baseline

This simple model increases the price proportionally to occupancy: Price_{t+1} = Price_{t} + alpha * (Occupancy / Capacity) ; Base Price = $10, Alpha = 2.0

4. Model 2 - Demand-Based Pricing

This model incorporates multiple factors into a demand function:
Demand = alpha * (Occupancy/Capacity) + beta * QueueLength - gamma * Traffic + delta * IsSpecialDay + epsilon * VehicleTypeWeight .
Price = Base * (1 + lambda * Normalized Demand)
Bounded between 0.5x and 2x the base price.

5. Model 3 - Competitive Pricing

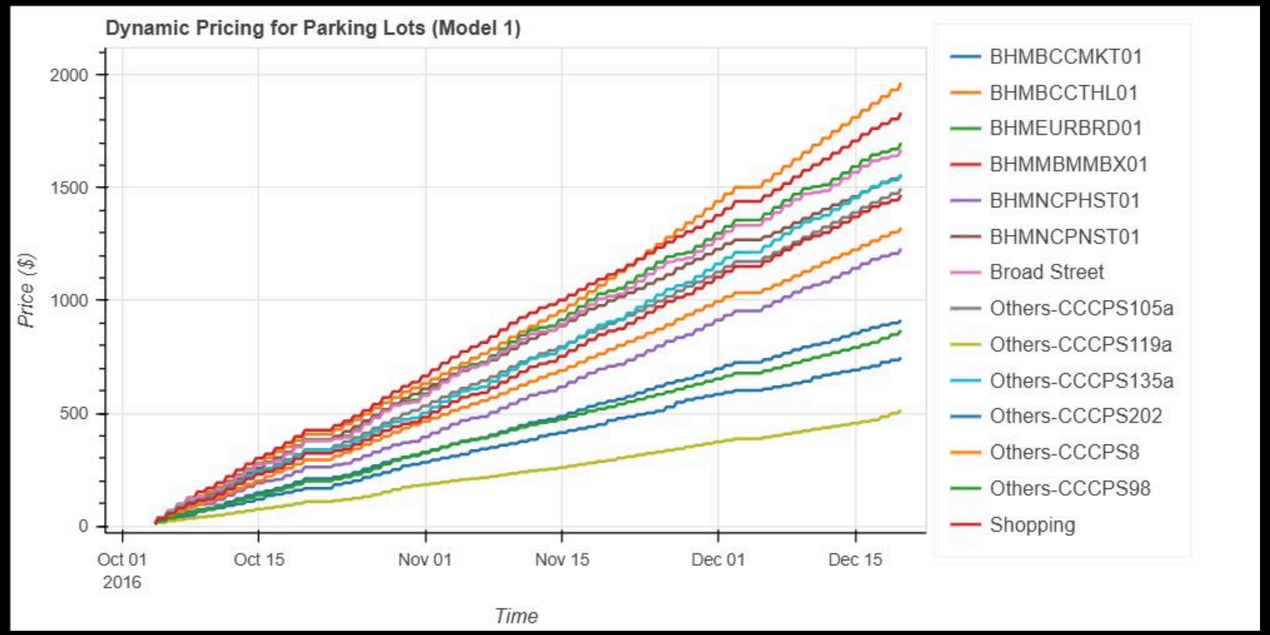
Uses geolocation to find nearby lots via haversine distance. If current lot is full and cheaper lots nearby, either reroute vehicles or reduce price to remain competitive..

6. Real-Time Simulation using Pathway

Streaming ingestion is handled using Pathway's streaming CSV reader. The pipeline computes occupancy ratio and outputs price prediction in real-time.

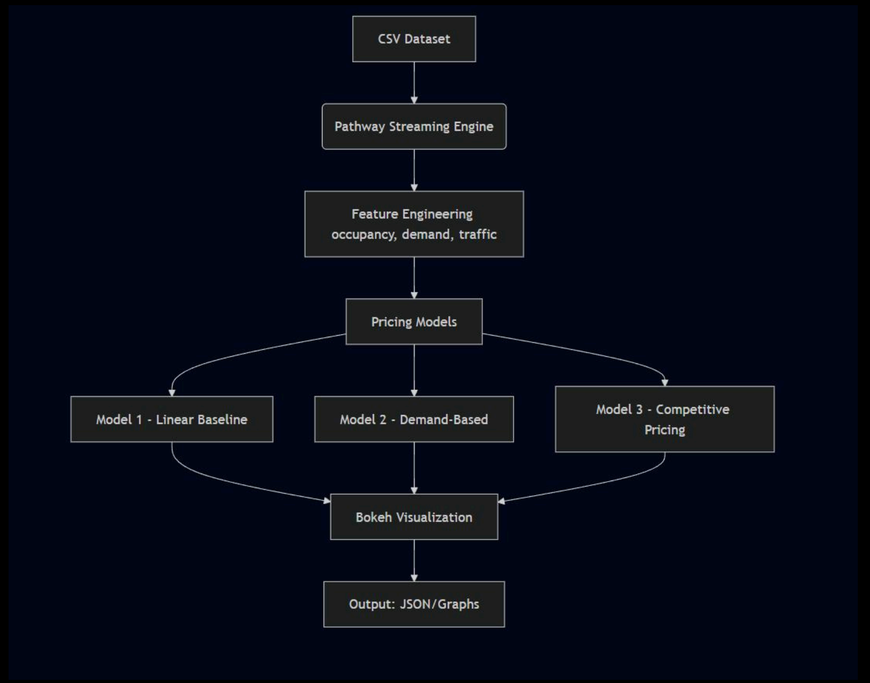
7. Visualization using Bokeh

Prices are visualized over time using Bokeh. Each lot has a separate colored line.



8. Assumptions

- Base price for all lots starts at $10
- Vehicle type weights: car=1.0, bike=0.5, truck=1.5
- Demand coefficients are chosen heuristically for demonstration



Conclusion

This pricing system helps balance parking demand across multiple lots using live data. Future improvements: fine-tuned coefficients, more real-time context (e.g., weather, bookings), feedback-based learning

Thankyou