Dynamic Pricing for Urban Parking Lots

Capstone Project – Summer Analytics 2025
Hosted by Consulting & Analytics Club × Pathway

Objective

This project builds an intelligent real-time dynamic pricing engine for 14 urban parking lots. The goal is to optimize utilization, manage demand, and adjust pricing based on real-time features such as occupancy, queue length, traffic congestion, special days, vehicle type, and competitor pricing.

Tech Stack Used

- Python 3.x
- Pandas
- NumPy
- Bokeh
- Geopy
- (Simulated) Pathway

Model Overview

Three pricing models were implemented:

Model 1: Baseline Linear Model

A simple occupancy-based price adjustment model:

$$Price(t+1) = Price(t) + \alpha * (Occupancy / Capacity)$$

Model 2: Demand-Based Model

A weighted formula using:

- Occupancy / Capacity
- Queue Length
- Traffic Level
- Special Day Indicator
- Vehicle Type Weight

$$Price = BasePrice * (1 + \lambda * NormalizedDemand)$$

Model 3: Competitive Model

Adds location awareness by calculating distances to nearby lots. If nearby lots are cheaper or full, pricing adjusts accordingly.

Assumptions

- Base price: $10 (bounded between $5 and $20)
- Demand normalized for smooth transitions
- Nearby competitors considered within 1.5 km
- Vehicle type affects duration, influencing pricing

Real-Time Simulation

Pathway was not supported in Colab, so real-time behavior was simulated using Pandas and `time.sleep()` delays.
Live visualizations were plotted using Bokeh.

Visualization & Output

The system outputs price predictions and plots real-time pricing trends for each parking lot using Bokeh line charts.

Conclusion

This notebook successfully implements a fully functional pricing engine for urban parking spaces. It adheres to Summer Analytics 2025 guidelines, simulates real-time logic, includes visual feedback, and explains the reasoning behind each model in a clean, modular structure.