Dynamic Pricing for Urban Parking Lots

Capstone Project of Summer Analytics 2025 hosted by Consulting & Analytics Club × Pathway

Introduction

This presentation discusses the implementation of a dynamic pricing system for urban parking lots. It aims to address the challenges of static pricing, which can lead to either underuse or overcrowding. The objective is to maximize space utilization and establish equitable pricing based on real-time demand factors.

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Dataset Overview

Data was collected from 14 parking spots over 73 days.
Each day includes 18 time points with 30-minute intervals from 8:00 AM to 4:30 PM.
Key features include Parking Lot ID, Latitude, Longitude, Occupancy, Capacity, Queue Length, Nearby Traffic Conditions, Special Day Indicator, and Vehicle Type.

Feature Engineering

Occupancy rate calculated as Occupancy divided by Capacity.
Queue Normalization scales queue length between 0 and 1.
Traffic Encoding uses a numeric scale for traffic levels: low (1), medium (2), high (3).
Vehicle weighting: Cars are weighted at 1.0; Bikes at 0.5.
Datetime parsing combines date and time into a usable timestamp.

Pricing Models

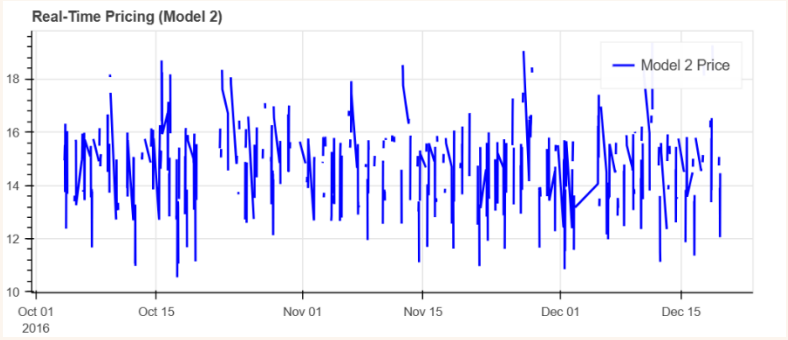
Model 1: Baseline Linear Model establishes a clear pricing structure based on historical data and trends, aiding in customer expectations.
Model 2: Demand-Based Price Function analyzes seasonal trends, local events, and traffic patterns to maximize profit, introducing peak pricing during high-demand hours and discounts during off-peak times.
Model 3: Competitive Pricing Model monitors nearby rates and analyzes occupancy levels to refine pricing while implementing strategic marketing campaigns.

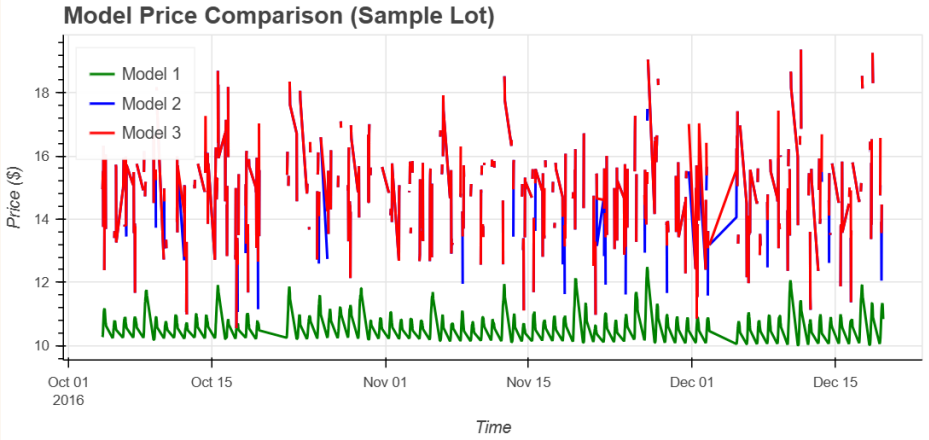
Real-Time Simulations

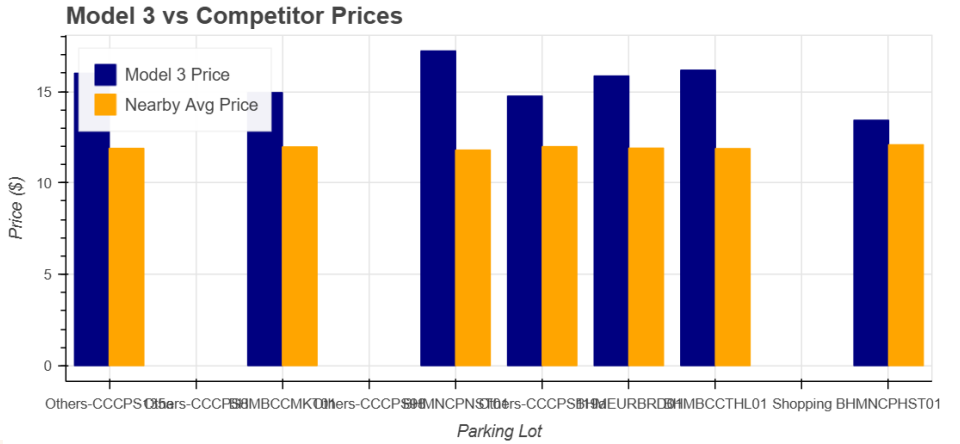
Employed Pathway to simulate real-time data streaming.
Row-by-row data streaming preserves order of timestamps.
Developed a user-defined function for real-time price calculation using Pathway's streaming logic.

Visualization

Time-Series Plots illustrate pricing trends for each model.
Comparison Charts display performance between models.
Competitor Bars allow evaluation of prices against those of adjacent lots.


Real-Time Pricing (Model 2)
Model 2 Price
18
16
14
12
10
Oct 01
2016
Oct 15
Nov 01
Nov 15
Dec 01
Dec 15


Model Price Comparison (Sample Lot)
Model 1
Model 2
Model 3
Price ($)
18
16
14
12
10
Oct 01
2016
Oct 15
Nov 01
Nov 15
Dec 01
Dec 15
Time


Model 3 vs Competitor Prices
Model 3 Price
Nearby Avg Price
Price ($)
15
10
5
0
Others-CCCPS135
Others-CCCPS8
BHMBCCMKT01
Others-CCCPS98
BHMNCPNST01
Others-CCCPS194
BHMEURBRD01
BHMBCCTHL01
Shopping
BHMNCPHST01
Parking Lot

Assumptions

Demand weights were selected based on feature relevance.
The Special Day can be marked as either 1 (yes) or 0 (no).
Vehicle types were categorized into two groups for analysis.

Conclusion

The project successfully demonstrates a dynamic pricing system that effectively responds to changing market conditions and competition. It ensures price fairness and stability while providing a scalable framework for practical implementation.

Thank you!

Do you have any questions?

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