# Dynamic Pricing for Urban Parking Lots

Capstone Project — Summer Analytics 2025  
Organized by the Consulting & Analytics Club × Pathway

This project focuses on building a smart, real-time pricing engine for urban parking spaces that adapts to changing demand, traffic, and environmental conditions. Our goal is to avoid overcrowding or underutilization by using data-driven dynamic pricing techniques.

# Tech Stack

- Python (3.8+)  
- pandas, numpy for data manipulation  
- Pathway for real-time streaming  
- Bokeh for visualization  
- Git & GitHub for version control  
- Mermaid for diagramming (architecture)

# How It Works

We start with raw CSV data containing timestamps, occupancy, queue length, traffic levels, and vehicle types.

The workflow is:  
1. Preprocess data with pandas  
2. Stream data using Pathway's real-time engine  
3. Apply pricing logic via a user-defined Python function  
4. Output results as real-time predictions  
5. Optionally visualize the output using Bokeh charts

# Models Used

1. Baseline Linear Model: Price increases with occupancy  
2. Demand-Based Pricing: Considers queue, traffic, vehicle type, and events  
3. Competitive Pricing Model (Optional): Includes GPS and nearby lot comparisons

# Workflow Summary

1. Load and clean data  
2. Stream it in real time using Pathway  
3. Apply dynamic pricing logic  
4. Output to console or JSON  
5. Visualize with Bokeh

# Repository Contents

- dataset.csv: Raw data file  
- dynamic\_pricing.ipynb: Main code notebook  
- pricing\_logic.py: Python script for pricing  
- architecture.png: Diagram of the system flow  
- report.pdf: (Optional) Full write-up

# Assumptions

- Base price is $10  
- Price varies between 0.5x and 2x base  
- Vehicle type affects price  
- Traffic encoded as low=0, average=1, high=2  
- Demand is normalized between 0 and 1

# Sample Output

Time: 2025-07-06 08:00 — Lot ID: LOT\_01 — Price: $11.50  
Time: 2025-07-06 10:30 — Lot ID: LOT\_07 — Price: $17.20

# Report

The report explains the problem, modeling approach, assumptions, and insights. It also includes visuals and discussion of the results.

(Attach or link report.pdf if available.)

# Submission Checklist

- All code runs without errors  
- Dataset is included  
- README and report are complete  
- Repository is public or access is shared

# Final Thoughts

This project helped us understand the application of real-time analytics and how to balance technical modeling with business impact. We’ve implemented a dynamic, responsive system that reflects how real cities could handle parking demand in a smarter way.

We look forward to feedback and continued learning.