Dynamic Pricing for Urban Parking Lots
Architecture Report

This report provides a detailed explanation of the system architecture of the Dynamic Pricing for Urban Parking Lots project, developed as a Capstone Project for Summer Analytics 2025 hosted by Consulting & Analytics Club x Pathway.

Overview:

The architecture is designed to process real-time data streams, compute pricing dynamically based on demand, competition, and external factors, provide smooth and explainable pricing decisions, and optionally recommend rerouting vehicles when lots are full.

Workflow Stages:

1. Input Data:

Historical dataset of 18,368 records over 73 days covering 14 parking lots, including features like occupancy, capacity, queue length, vehicle type, traffic conditions, special day indicator, and geo-coordinates.

2. Ingestion Layer:

Pathway streaming engine simulates real-time feed preserving timestamp order.

3. Feature Engineering:

Live computation of occupancy ratio, queue length, traffic weight, special day indicator, and vehicle type weight.

4. Pricing Engine:

- Model 1: Baseline Linear Pricing - price increases linearly with occupancy.

- Model 2: Demand-based Pricing - weighted features determine demand and adjust price.

- Model 3: Competitive Pricing - considers competitor proximity, prices, and suggests rerouting if needed.

5. Output & Visualization:

Real-time price streams per lot, interactive Bokeh dashboard, optional rerouting recommendations.

Design Principles & Assumptions:

- Real-time and low-latency performance using Pathway.

- Smooth pricing bounded between $5-$20.

- No external ML libraries, only Python, Pandas, Numpy, and Pathway.

- Scalable and modular.

This architecture ensures real-time performance, explainable decisions, and scalability while integrating with monitoring dashboards.