Capstone Project Report: Real-Time Dynamic Pricing for Urban Parking

1. Introduction

This project presents a solution for dynamic pricing of parking spaces based on real-time data. With rising urban congestion, optimal pricing helps manage traffic, reduce search times, and maximize space utilization.

2. Data Description

The dataset consists of fields like:

- LastUpdatedDate & LastUpdatedTime
- Capacity & Occupancy
- QueueLength
- VehicleType
- TrafficConditionNearby

These features are used to derive intermediate metrics such as occupancy ratio, vehicle weight factor, and traffic score.

3. Data Preprocessing

- Combined and cleaned date/time fields to generate unified timestamps.
- Handled missing values using domain-relevant defaults.
- Mapped categorical variables (`VehicleType`, `TrafficConditionNearby`) to numeric scores.
- Calculated Occupancy Ratio = Occupancy / Capacity.

4. Feature Engineering

- Derived `VehicleWeight` and `TrafficScore`.

- Sorted data chronologically to simulate live stream behavior.

5. Modeling Approaches

Three models were built and evaluated:

- Model 1: Baseline Linear Regression

- Model 2: Decision Tree Regression

- Model 3: Advanced Model with Time-Window Aggregates

6. Real-Time Simulation

Post-model predictions are written in JSONL format to mimic real-time stream output.

This stream can be visualized or ingested by a dynamic dashboard.

7. Conclusion

This project demonstrates a robust pipeline for urban parking price optimization using real-time data streams. Future improvements may include geo-embedding, anomaly detection, and reinforcement learning for adaptive pricing.