Capstone project Report

1. Project Overview

This project simulates a real-time intelligent parking pricing system. Using a live stream of parking data, it implements multiple pricing strategies that react to demand signals such as occupancy, queue length, traffic conditions, and special events. The project leverages:

- Pathway for streaming computation
- Bokeh for real-time visualization

2. Objectives

- Implement 2 models:
  - Model 1: Baseline Linear Pricing
  - Model 2: Dynamic Pricing
- Use real-time data simulation
- Produce visual dashboards justifying pricing behavior

3 . Logic

In Model 1, I implemented a simple linear pricing strategy where the price increases proportionally to the occupancy-to-capacity ratio. The formula used was:

$\text{price}_{t+1} = \min(\text{price}_t + \alpha \times (\text{occupancy} / \text{capacity}), 20)$

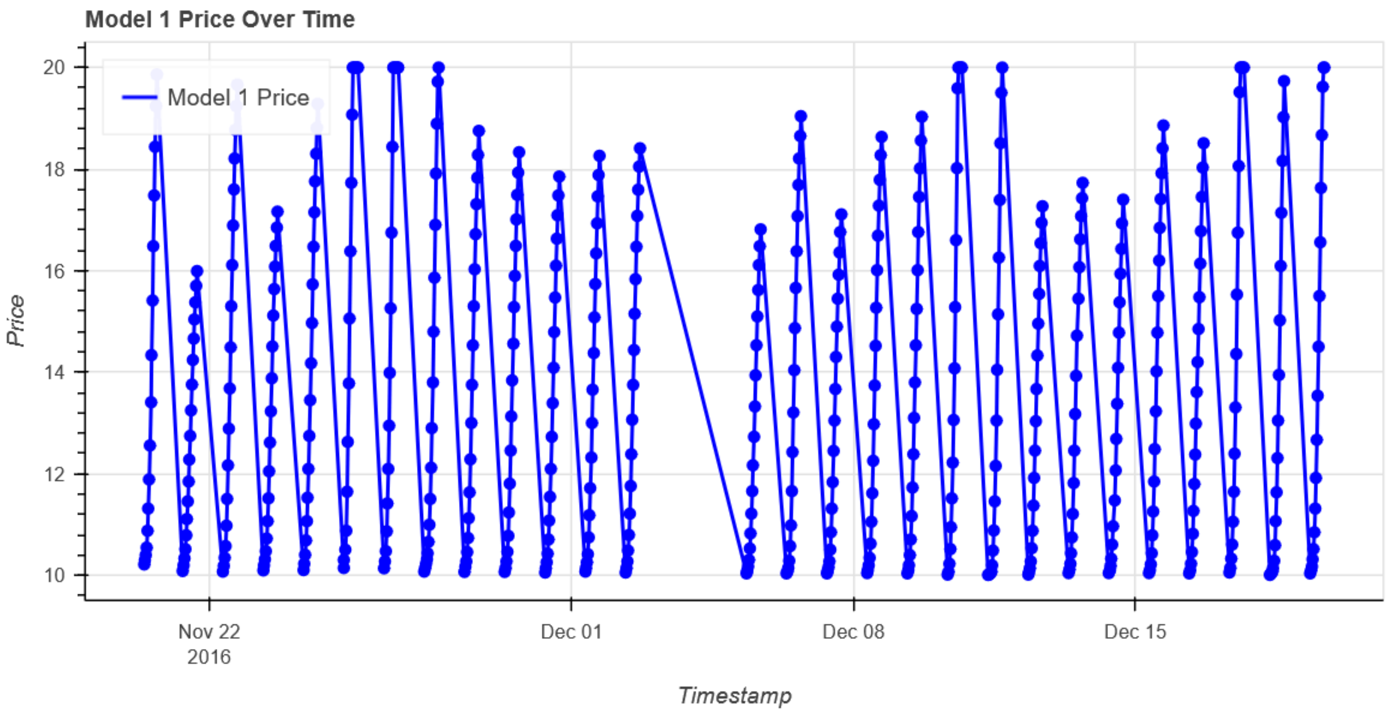
The price resets to a base value of 10 at the start of each day to avoid carry-over and ensure day-wise independence. I used Pathway to read the dataset in streaming mode and applied the pricing logic to each row in real time. The output was streamed to a CSV file, which was then visualized using Bokeh. I created a combined line and scatter plot to track the price progression over time. To show competition between lots, I also generated a separate scatter plot where each point represented the average daily price of a parking lot, colored uniquely. Since the same logic was applied to all lots in Model 1, the pricing curves across lots appeared similar, often reaching the 20 cap early in the day.

In Model 2, I developed a more dynamic and realistic pricing model that responds to several real-world factors. The pricing was based on a weighted combination of:

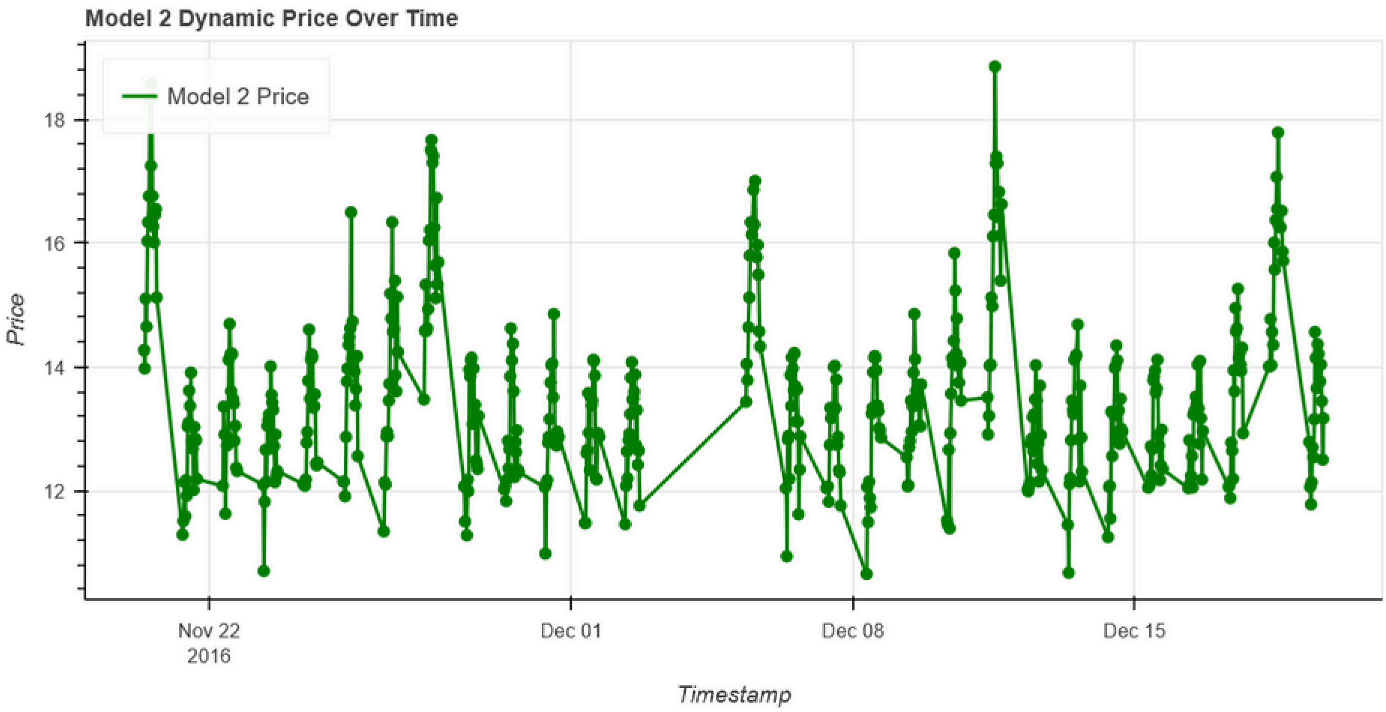
- Occupancy-to-capacity ratio
- Queue length
- Traffic conditions
- Special day indicator
- Vehicle type (converted to weight)

These inputs were mapped and scaled using helper functions (@pw.udf) in Pathway and plugged into a formula that computes a demand score. The score was normalized and scaled to yield a price between ₹5 and ₹20.

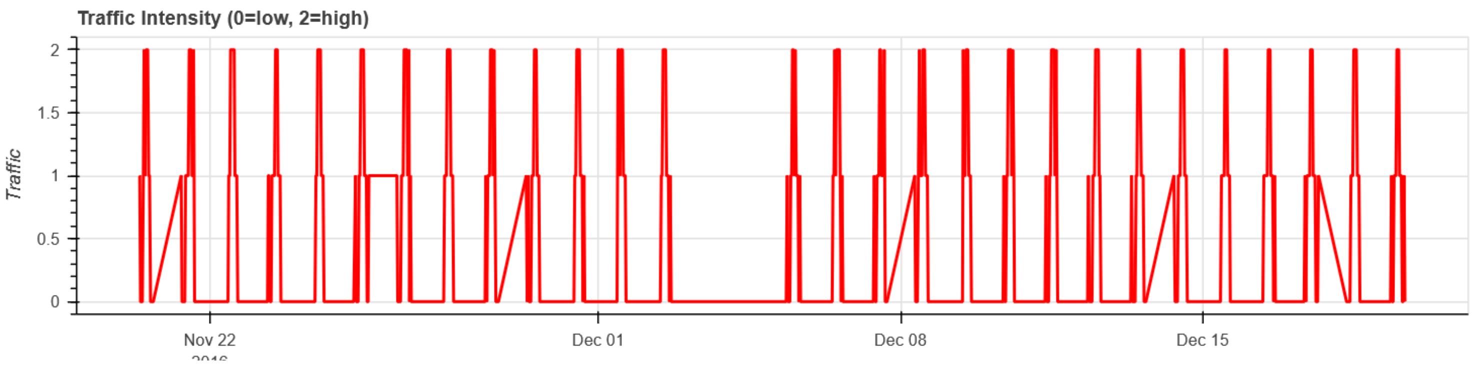
For visualization, I again used Bokeh to create a main pricing plot (line + scatter) and added additional plots showing occupancy ratio, queue length, and traffic intensity to explain pricing behavior. I reused the competition scatter plot here as well. Unlike in Model 1, the daily average prices varied significantly across lots due to the additional influencing factors. This model better captured fluctuations and reflected more adaptive, context-aware pricing.

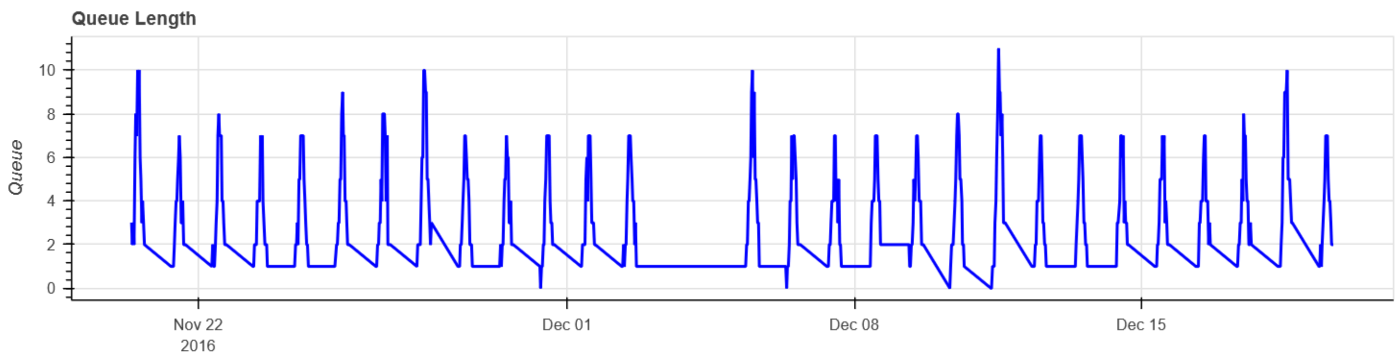


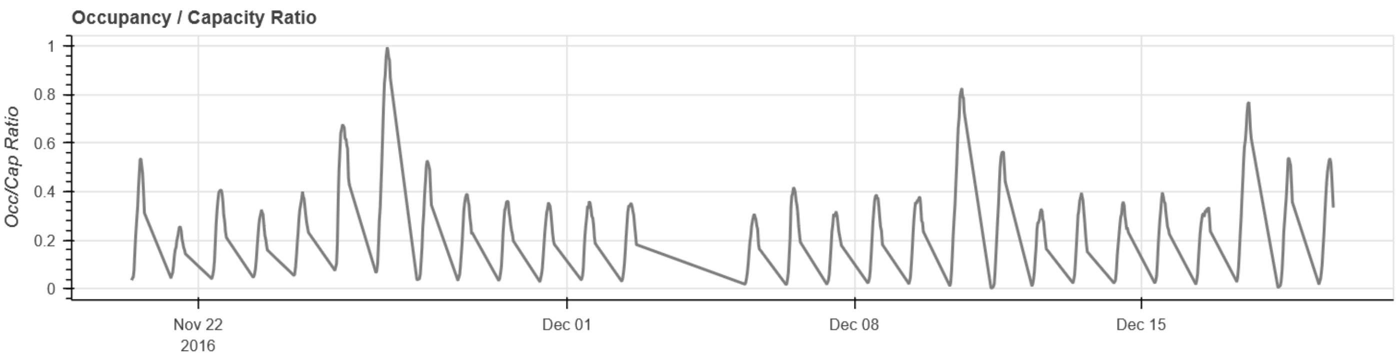
The model1 increases price linearly caps to 20 then resets to next day . we could see 13,14,15 dec had low prices while 25,26,27 nov were one of the highest . The steeper the curve is the faster it went up.



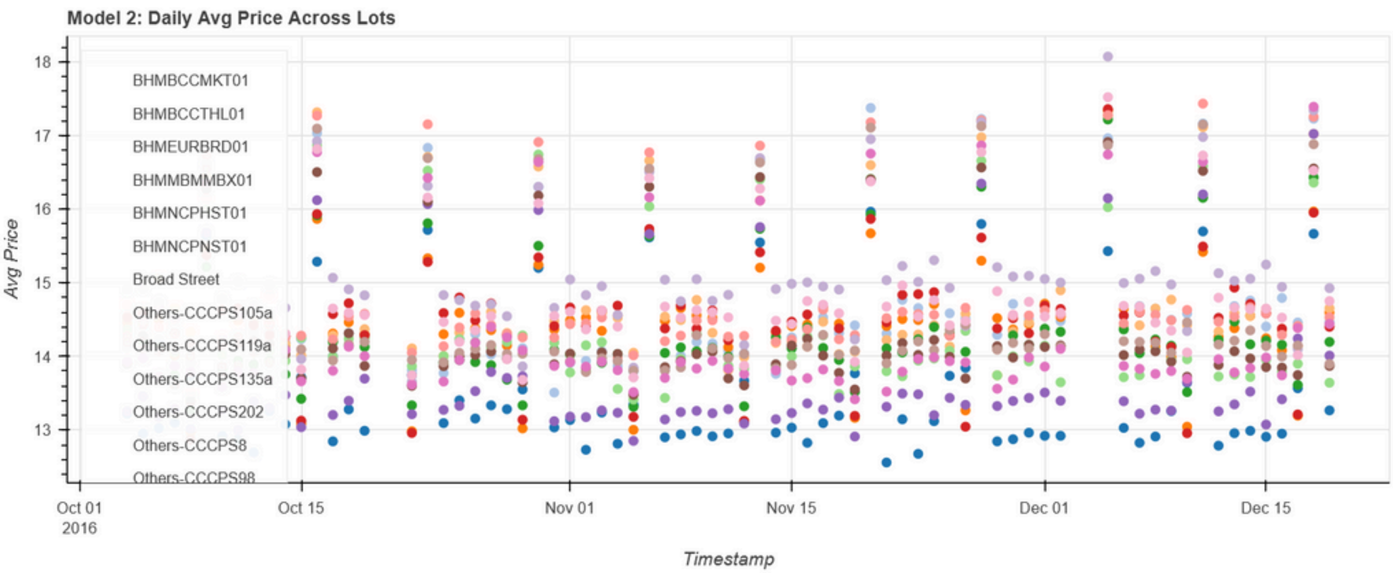
Model 2 depends on various coeff which make up the demand . we could see price for most of the time hovered around 13 . 17 > was only observed for 5 days .







The three of 5 coeff align perfectly with our model , the higher prices have atleast 2 of 3 coeff on higher range while other at mid range.



This plot shows the competitiveness between lots . price for alot largely hovered around same.