Price Elasticity Analysis and Sales Optimization in Retail Using Historical Transaction Data

Sanjana Vashisth, Vinay Rawat, Harsh Gupta

Abstract
Effective pricing is a critical factor in maximizing revenue and profitability for retail businesses. Understanding price elasticity helps retailers determine optimal price points by analyzing how demand varies with price changes. This project aims to develop a price recommendation system using historical transaction data to assess the elasticity of demand for different products and recommend pricing adjustments to increase both revenue and profitability.

Keywords: Machine learning, price elasticity, Constraint optimization.

1. Introduction

In a competitive retail environment, price elasticity[1]—the measure of demand response to price changes—plays a crucial role in setting optimal pricing strategies. Retailers often rely on trial and error to adjust prices, potentially missing opportunities to maximize revenue or inadvertently driving away demand-sensitive customers. This project focuses on developing a predictive model to analyze price elasticity across products and optimize pricing. Using transactional data, we will examine historical sales and item-level pricing to recommend price adjustments tailored to profitability and demand sensitivity.

The project will leverage price elasticity to help make informed decisions on price increases that align with revenue and profitability goals. We will also account for seasonality, trends, and external factors that may influence purchasing behavior, aiming to deliver a comprehensive solution for retail price optimization.

2. Methods

Our approach consists of two main components: (1) Price Elasticity Estimation and (2) Revenue and Profit Optimization.

Price Elasticity Estimation:
Using historical transaction data, we will estimate demand elasticity by analyzing the relationship between price changes and sales quantities. To account for varying elasticity across categories, we'll first apply clustering techniques to group similar items, allowing us to calculate elasticity within each category. Statistical and machine learning methods[2], such as linear and log-log regression, will then be used to determine elasticity coefficients, identifying which items are price-sensitive or inelastic. We will incorporate seasonality, category-specific elasticity.

Revenue and Profit Optimization:
With elasticity coefficients, we will develop an optimization model to recommend price adjustments that maximize revenue and/or profitability. Using mathematical programming

techniques, we will balance trade-offs between price increases for revenue-maximizing items and demand sensitivity to prevent volume loss in price-sensitive items. By targeting profit maximization for products[3], we aim to create a balanced pricing strategy. We will also incorporate practical constraints[4], such as minimum/maximum price changes and the common strategy of ending prices in 9 or 0[5], to refine these recommendations.

3. References

Research Papers Relevant to Price Optimization and Elasticity Analysis:

1. https://conjointly.com/guides/understanding-price-elasticity-of-demand/
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3. https://towardsdatascience.com/optimization-newtons-method-profit-maximization-part-3-applied-profit-maximization-23a8c16167cd
4. "Price Optimization with Practical Constraints"
5. Demand Impact for Prices Ending with “9” and “0” in Online and Offline Consumer Goods Retail Trade Channels
6. https://mavenanalytics.io/data-playground?accessType=open&order=date_added%2Cdesc&tags=Retail