### **Capstone Project Report**

### **Objective:**

To analyze product demand using features given and build a dynamic pricing model that adjusts prices based on demand and competitor pricing.

### **1. Dataset Overview:**

The dataset consists of multiple product-related attributes such as:

* Product id, product name
* Category,sub category
* Units sold, price, competitor price
* rating, stock, discount

These features are used to predict demand and optimize pricing.

### **2. Demand Function:**

I have define demand as a function of several variables, primarily:

Based on exploratory data analysis, a multiple linear regression (or tree-based models like Random Forest) is suitable to approximate this demand function:

I have also experimented with regularized regression (Ridge, Lasso) and tree-based models (Random Forest, Gradient Boosting).

### **3. Assumptions:**

* Price elasticity is linear within the range of values in the dataset.
* Competitor price is considered constant in the short term.
* Product quality is inferred from ratings and reviews.
* Demand is only partially influenced by promotions and discounts.
* The relationship between variables is assumed to be stable during the analysis period.

### **4. Pricing Strategy:**

To determine dynamic pricing, I have adjust the price using a rule-based logic:

* **High demand, low competition:** Increase price by 5-10%
* **Low demand, high competition:** Decrease price by 10-15%
* **Average demand, high competition:** Match competitor price +/- 5%
* **Low stock:** Slightly increase price to avoid stock-out

This price adjustment logic is implemented after training the demand model. The final price is:

Where is based on demand class and competitor comparison.

**5. Tech Stacks Used:**

1. Numpy
2. Pandas
3. Pathway
4. Matplotlib
5. Datetime
6. Bokeh
7. Panel

### **6. Visualizations:**

Implemented using **Bokeh**:

* Bar chart of predicted vs actual demand
* Line chart for price vs units sold
* Interactive scatter plots to explore correlation (price vs demand)
* Histograms of demand class distribution

All graphs are dynamic and interactive, enhancing understanding of trends and model behavior.

### **8. Conclusion:**

* Machine learning models successfully predicted demand with good accuracy.
* Pricing strategy aligned with demand signals increases potential revenue.
* Future enhancements could include live data streams and reinforcement learning for real-time pricing.