**Formulas and Theoretical Logic Documentation**

1. Profitability Margin Analysis

**Logarithmic Transformations**  
Used to normalize skewed data and analyze relationships in a linearized form:

* Log\_Price=log (Price)
* Log\_Demand=log (Demand)
* Log\_Competitor\_Price=log (Competitor\_Price)

**Price Elasticity of Demand**  
Elasticity measures sensitivity of demand (Q) to changes in price (P):  
  
A higher absolute value of elasticity indicates greater price sensitivity.

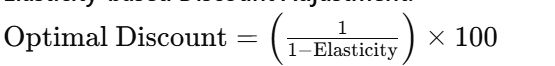
**Profit Margin Calculation**  
Profitability is analysed per price bin to suggest optimal discounting strategies:  
Profit Margin=Revenue−Cost

**Optimal Discount Model**

This section provides optimal discounting by geography and product.

**Key Concepts:**

**Optimal Discount Calculation**  
Optimal discount is determined using price elasticity and profit maximization strategies:

1. **Revenue Maximization Equation:**  
   R=P×QR   
   Where P is price and Q is quantity demanded.
2. **Profit Maximization Condition:**  
     
   Solving this equation determines the discount level that maximizes profit.
3. **Elasticity-based Discount Adjustment:**  
     
   This formula ensures the discount is aligned with demand response to pricing.

**Price Segmentation**  
Different price bins indicate the optimal price range for a product.

1. Final Simulation Table (Optimized)

This section simulates the impact of discount percentages across various price segments.

**Demand Simulation Across Price Bins**  
Evaluates how demand varies for different discount levels.

**Revenue Forecasting**  
Estimates revenue changes for different discount percentages.

**Simulation Calculation**  
Simulation is performed by iterating through various discount percentages and analyzing their effects on demand and profitability using historical data. The key steps are:

1. **Define the Discount Range:** Various discount levels (e.g., 0% to 50%) are tested.
2. **Apply Price Elasticity Formula:**  
     
   Where Q′Q' is the new demand after applying the discount.
3. **Calculate Revenue and Profit for Each Scenario:**  
   P′=P−DiscountP'   
   R′=P′×Q′R'   
   Where R′R' is the simulated revenue.
4. **Optimize for Maximum Profit:**  
   The discount level that results in the highest profitability is selected.

Simulation ensures optimal discount strategies by predicting real-world effects based on historical trends and elasticity values.

1. Demand Forecast with Confidence Intervals

Predicts demand and provides a confidence range.

**Forecasting Demand**  
A time-series forecasting approach such as ARIMA or Exponential Smoothing is used.

**Confidence Interval for Forecasts**  
  
Where σ\sigma is the standard deviation of residual errors.

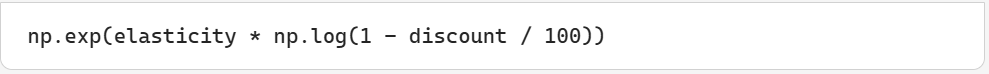
The standard Demand Formula:



this is the formula for new demand based on elasticity, so we converted this to a python function.

**But one Important thing to consider is - elasticity values (from SARIMAX) are already negative (generally), because price ↑ should → demand ↓.**

So to apply a **discount** and want to simulate **new demand**, then this part of our code



as per macroeconomics theory.

**References:**

* <https://en.wikipedia.org/wiki/Price_elasticity_of_demand>
* <https://corporatefinanceinstitute.com/resources/accounting/profit-margin/>
* <https://www.investopedia.com/terms/e/elasticity.asp>
* <https://otexts.com/fpp3/>
* <https://en.wikipedia.org/wiki/Exponential_smoothing>
* <https://en.wikipedia.org/wiki/ARIMA>