**TIME SERIES FORECASTING FOR PRODUCT DEMAND PREDICTION**

**Step 1: Data Acquisition and Preprocessing**

***1.1 Dataset Information***

The dataset, labeled as dataset.csv, was sourced from [Kaggle](https://www.kaggle.com/datasets/chakradharmattapalli/product-demand-prediction-with-machine-learning).

It contains 4750 rows and 5 columns: Id, store id, total price, base price, and unit sold.

***1.2 Handling Missing Values***

A thorough examination of each column was performed to identify any missing or incomplete data.

Records with Null values in the "Total Price" column were removed to ensure data integrity and accuracy.

***1.3 Libraries Used***

Pandas for data manipulation

Installation command: pip install pandas

Numpy for numerical operations

Installation command: pip install numpy

Plotly for interactive plots

Installation command: pip install plotly

Seaborn for statistical data visualization

Installation command: pip install seaborn

Matplotlib for static plots

Installation command: pip install matplotlib

Scikit-learn (sklearn) for machine learning tasks

Installation command: pip install scikit-learn

**Step 2: Exploratory Data Analysis (EDA)**

***2.1 Analyzing Price-Demand Relationship***

A scatter plot was used to visualize how demand changes with price variations.

This helps in understanding the relationship between product price and demand.

***2.2 Correlations in the Dataset***

Correlation analysis was performed to identify relationships between different features and demand.

Understanding these correlations is crucial for predicting product demand accurately.

**Step 3: Time Series Forecasting**

***3.1 Importance of Time Series Forecasting***

**Time Series Forecasting** is a critical technique for making predictions based on historical data that is indexed in time order. In the context of product demand prediction, this means that we use past demand data to predict future demand patterns.

This is particularly crucial because demand for products tends to follow specific temporal patterns. For example, some products may have seasonal demand spikes (e.g., winter coats in winter), while others may have long-term trends (e.g., electronics becoming more popular over time). Understanding and capturing these patterns allows for more accurate predictions.

***3.2 Libraries Required for Time Series Forecasting***

To perform time series forecasting for product demand prediction, we'll be using two key libraries:

**Statsmodels**: This library provides a wide range of models and tools for time series analysis. It's particularly known for its implementation of the ARIMA (AutoRegressive Integrated Moving Average) model, which is a widely used method for time series forecasting.

**Installation command**: **pip install statsmodels**

**Elaboration**: The ARIMA model is capable of capturing different aspects of time series data, including trends, seasonality, and autocorrelation. By using ARIMA, we can model and predict demand patterns effectively.

**Prophet**: Prophet is an open-source forecasting tool developed by Facebook. It's designed to handle time series data with strong seasonal patterns, as well as data that may have missing or irregularly spaced observations.

**Installation command**: **pip install prophet**

**Elaboration**: Prophet is particularly useful for product demand prediction because it can handle data with daily or seasonal fluctuations. It also allows for the inclusion of additional external factors (holidays, promotions, etc.) that might affect demand.

Application to Product Demand Prediction:

In the context of predicting product demand, let's consider an example:

Imagine we're dealing with a retail business that sells winter jackets. Using time series forecasting, we can analyze past data of jacket sales over several years. By applying a model like ARIMA or Prophet, we can capture the seasonal patterns (higher sales in winter, lower in summer), trends (increasing or decreasing popularity of jackets over time), and any irregularities in the data.

This analysis helps us make accurate predictions about future demand for jackets. For instance, it can guide decisions on how much inventory to stock for the upcoming winter season. If the forecast predicts a particularly cold winter, the business might choose to stock more jackets than in a milder year.

**Step 4: Model Training for Demand Prediction**

***4.1 Selecting Features and Labels***

For training the machine learning model, 'Total Price' and 'Base Price' columns were chosen as features.

'Units Sold' column was selected as the labels for the model.

***4.2 Regression Metrics for Model Evaluation***

Mean Absolute Error (MAE), Mean Squared Error (MSE), or R-squared (R2) can be used to assess the model's performance.

In summary, time series forecasting is a powerful tool for making informed decisions about inventory management and production planning based on historical demand patterns. The choice of library (Statsmodels, Prophet, or others) will depend on the specific characteristics of the data and the desired level of detail in the forecasting model.