

Product Demand Analysis

Abstract:

Supply and demand are two fundamental concepts of sellers and customers. Predicting demand accurately is critical for organizations in order to be able to make plans. The main aim of our project is to develop machine learning model(Linear Regression, Decision Tree Regression, K-Means Regression and Random Forest Regression) that forecasts product demand based on historical sales data.

Problem Statement:

Create a machine learning model that forecasts product demand based on historical sales and external factors, helping businesses optimize inventory management and production planning to meet customer needs efficiently.

Problem Definition:

The problem is to create a machine learning model that forecasts product demand based on historical sales data and external factors. The goal is to help businesses optimize inventory management and production planning to efficiently meet customer needs. This project involves data collection, data pre-processing, feature engineering, model selection, training, and evaluation.

Design Thinking :

The model enables any product company to prepare for the holiday seasons and plans to offer discounts on its product. The project's objective is to determine product demand based on historical sales data and to determine optimal price at which its product can outperform its competitors in the market.

To achieve this goal, I have gathered a dataset containing historical sales data based on different price points. My aim to train a predictive model that can forecast product demand under various pricing scenarios.

Dataset Information:

The dataset provided for this task includes the following key information:

- **Product ID:** Each product in the company's inventory is assigned a unique identifier, allowing us to distinguish between different items.
- **Store ID:** This represents the specific store or location where the product was sold. It helps in understanding regional variations in demand.
- **Total Price:** This is the actual price at which the product was sold to customers during the sales transaction. It includes any discounts or promotions applied.
- **Base Price:** The base price is the original or standard price at which the product is typically sold before any discounts or promotions are applied.

- **Units Sold (Quantity Demanded):** This is the quantity of the product that was purchased by customers at a given price point. It reflects the demand for the product at that particular price.

The primary goal of this project is to create a predictive model that can estimate the demand for the product in the market under different pricing strategies. By analysing historical sales data, the project aims to identify the price point at which the product is perceived as a better deal compared to competitors, leading to increased sales.

Design:

To achieve this objective, the project will likely use machine learning techniques and statistical analysis. I will train a predictive model using the provided dataset, which includes features like product price and units sold. This model can then be used to make demand predictions for various price segments, helping the company make informed pricing decisions for the upcoming holiday season.

1. **Data Collection:** Historical sales data

Dataset Link: <https://www.kaggle.com/datasets/chakradharmattapalli/product-demand-prediction-with-machine-learning>

2. **Data Pre-processing:** Clean and pre-process the data, handle missing values, and convert categorical features into numerical representations
3. **Feature Engineering:** Create additional features that capture seasonal patterns, trends, and external influences on product demand.
4. **Model Selection:** Choose suitable regression algorithms (e.g., Linear Regression, Random Forest, XGBoost) for demand forecasting.
5. **Model Training:** Train the selected model using the pre-processed data.
6. **Evaluation:** Evaluate the model's performance using appropriate regression metrics (e.g., Mean Absolute Error, Root Mean Squared Error).

The project aims to use a variety of machine learning algorithms to train a predictive model for product demand forecasting. Some popular algorithms include:

- **Linear regression:** This is a simple but effective algorithm that can be used to model the relationship between the product price and units sold.
- **Decision trees:** This algorithm can learn complex relationships between the features in the dataset and the target variable (units sold).
- **Gradient boosting machines:** This algorithm combines the predictions of multiple decision trees to produce a more accurate forecast.
- **Random forests:** This algorithm is similar to gradient boosting machines, but it uses a different method for constructing the decision trees.

Once the model is trained, the model uses it to predict the demand for the product at different price points. This information can then be used to set the optimal price for the product during the holiday season.

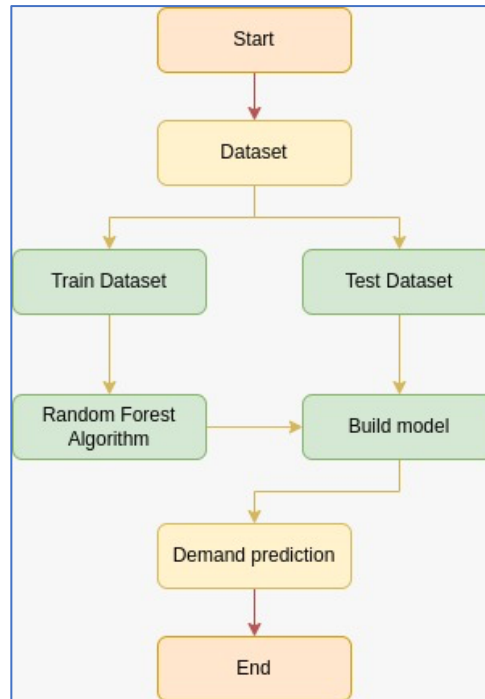


Figure 1

Benefits of Using Machine Learning for Product Demand Prediction

There are several benefits to using machine learning for product demand prediction:

- **Accuracy:** Machine learning models can be trained to produce highly accurate demand predictions, especially when they are trained on large datasets of historical sales data.
- **Speed:** Machine learning models can make predictions very quickly, which is essential for businesses that need to make pricing decisions in real time.
- **Flexibility:** Machine learning models can be adapted to account for changes in market conditions and consumer preferences.

Conclusion

By using machine learning to forecast product demand, the company can gain a competitive advantage in the market. By setting the optimal price for its products, the company can increase sales and profitability.