Product Demand prediction with machine learning

Problem Definition:

The problem of product demand prediction with machine learning involves developing a predictive model that accurately forecasts the future demand for specific products. The primary objective is to assist businesses in optimizing their inventory management and production planning processes by providing accurate insights into the expected quantity of products that will be required over a given time period.

Design Thinking:

Data Collection:

- Collect historical sales data, including product sales, timestamps, and relevant features (e.g., price, promotions, seasonality).
- Gather external data sources, such as economic indicators, holidays, and weather data, that may influence demand.
- Preprocess the data by handling missing values, outliers, and encoding categorical variables.

Feature Engineering:

- Create relevant features that can enhance the predictive power of the model, such as lag features, rolling statistics, and holiday indicators.
- Perform time-series decomposition to extract trends, seasonality, and residuals.

Data Splitting:

- Split the data into training and testing sets to evaluate model performance effectively. Consider time-based splitting to preserve temporal dependencies.

Model Selection:

- Experiment with various machine learning models suitable for time-series forecasting, such as:
  - ARIMA(AuroRegresive Integrated Moving Average)
  - Exponential Smoothing methods (e.g., Holt-Winters)
  - Machine learning Algorithms (e.g.,Random Forest, Gradient Boosting, LSTM)
- Tune hyperparameters and select the model with the best performance on the validation set.

Model Training:

- Train the selected model on the training dataset, using appropriate training techniques for each model type.
- Fine-tune hyperparameters to optimize model performance.

Model Evaluation:

- Evaluate the model's performance on the testing dataset using relevant metrics like Mean Absolute Error (MAE), Mean Squared Error (MSE), and Root Mean Squared Error (RMSE).
- Visualize the model's predictions against actual demand to assess accuracy and reliability.