Demand Forecasting Project Summary

This project presents a complete Demand Forecasting pipeline designed for real-world supply chain optimization.

I utilized both machine learning and time series modeling techniques to capture product sales patterns and generate forecasts.

1. Dataset Overview

- Total Records: 2,400

- Features: Product ID, Category, Price, Promo Flag, Month, Units Sold, Year, Seasonality, Holiday Flag

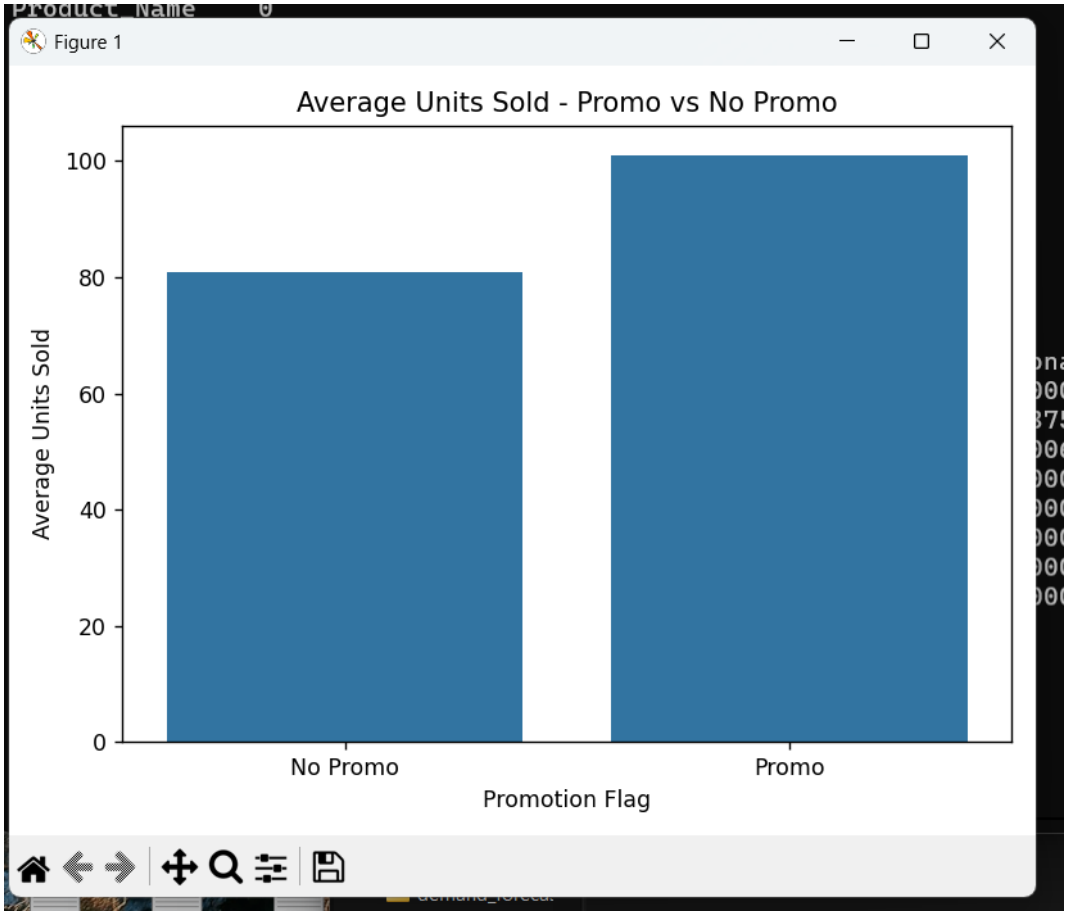
- Target Variable: Units_Sold

- No missing data. Data spans 2023-2024.

2. Exploratory Data Analysis

I analyzed product seasonality, the effect of promotions on sales, and monthly sales trends.

Promotional offers were found to increase sales by approximately 25% (from avg. 81 to 101 units sold).



3. Machine Learning Model (XGBoost)

I trained an XGBoost regressor using features like price, category, promo, seasonality, and holidays.

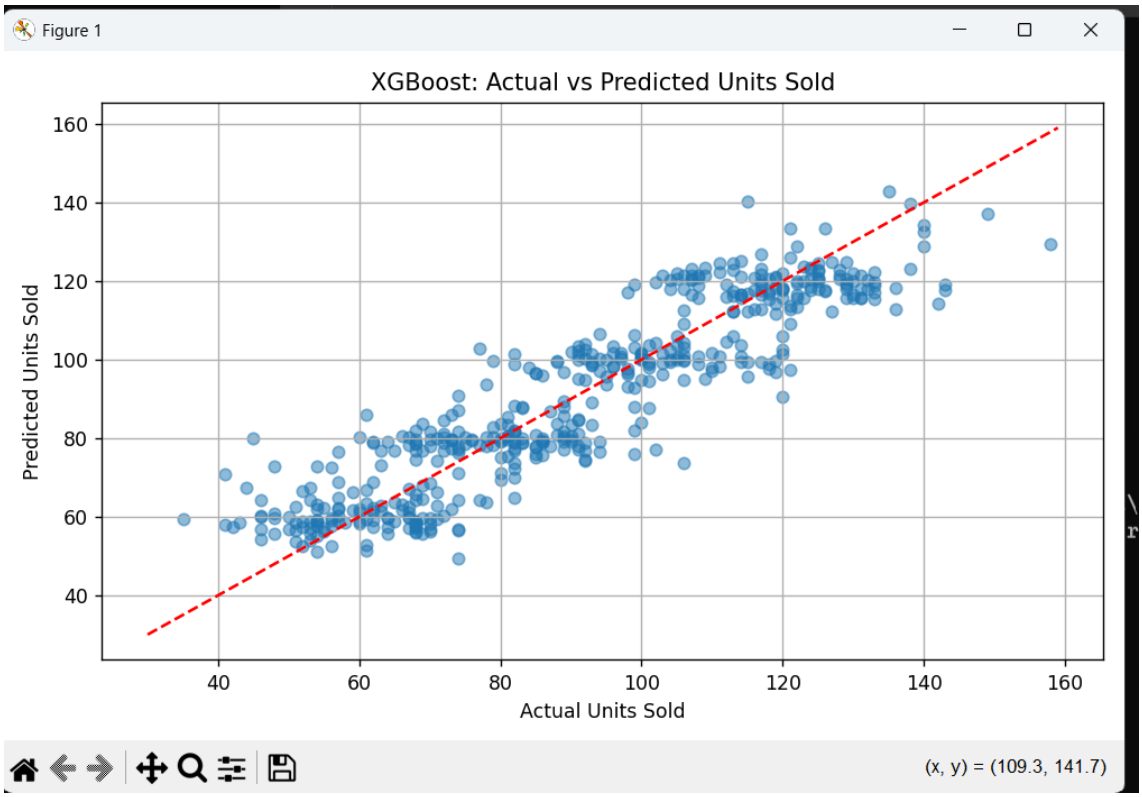
The model achieved strong performance:

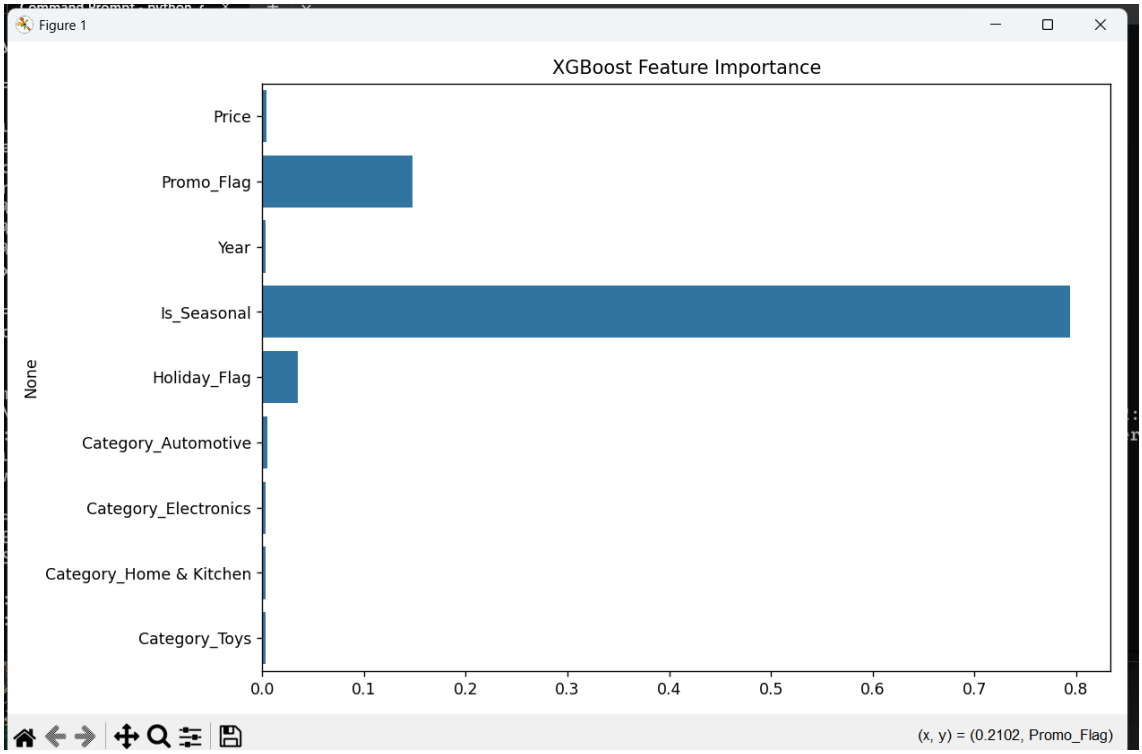
- MAE: 8.47

- RMSE: 10.56

- R2 Score: 0.83

```
y = df_encoded['Units_Sold']
from sklearn.model_selection import train_test_split
from xgboost import XGBRegressor
from sklearn.metrics import mean_absolute_error, mean_squared_error, r2_score
from prophet import Prophet
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
xgb_model = XGBRegressor(n_estimators=100, learning_rate=0.1, random_state=42)
xgb_model.fit(X_train, y_train)
y_pred = xgb_model.predict(X_test)
mae = mean_absolute_error(y_test, y_pred)
rmse = mean_squared_error(y_test, y_pred, squared=False)
r2 = r2_score(y_test, y_pred)
print(f"\n=== XGBoost Model Performance ===")
print(f"MAE: {mae:.2f}")
print(f"RMSE: {rmse:.2f}")
print(f"R² Score: {r2:.2f}")
product_df = df[df['Product_ID'] == 'P1000'].copy()
product_df.rename(columns={"Month": "ds", "Units_Sold": "y"}, inplace=True)
product_df = product_df[["ds", "y"]]
model = Prophet()
model.fit(product_df)
future = model.make_future_dataframe(periods=6, freq='MS')
forecast = model.predict(future)
import matplotlib.pyplot as plt  # Ensure this is imported
```

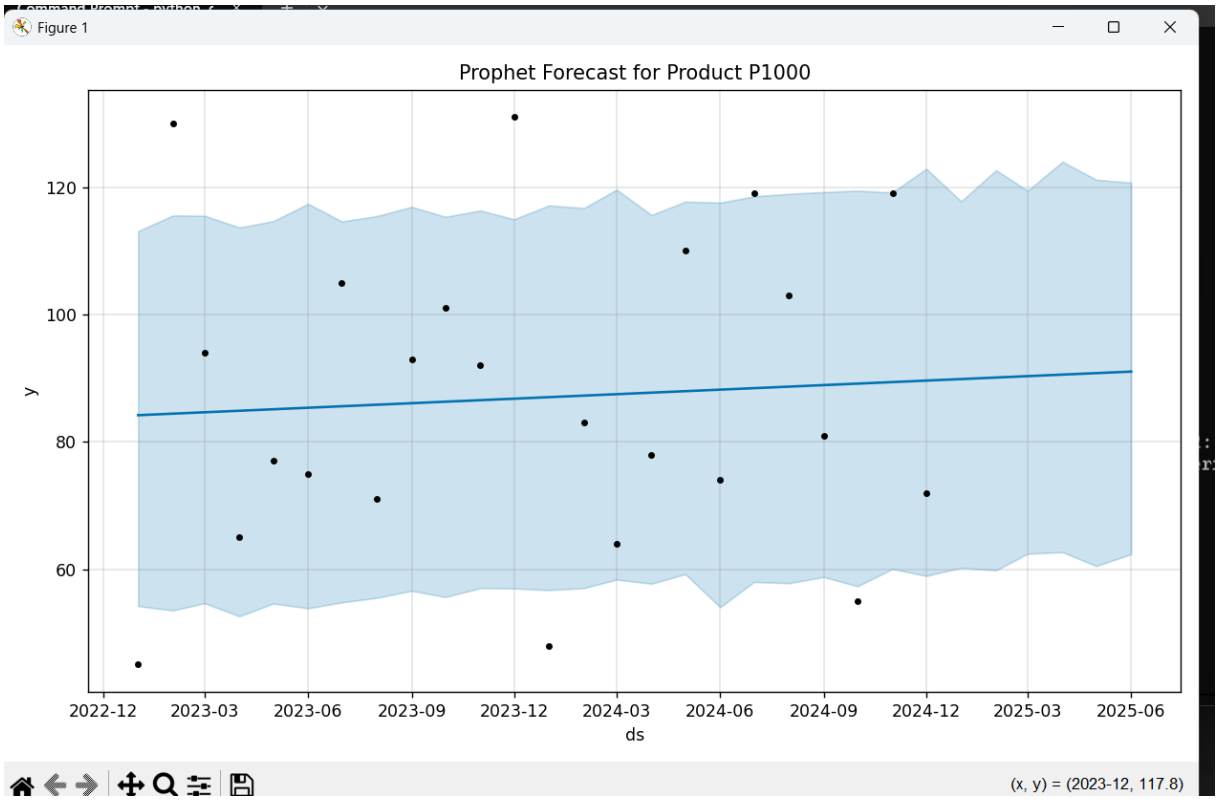


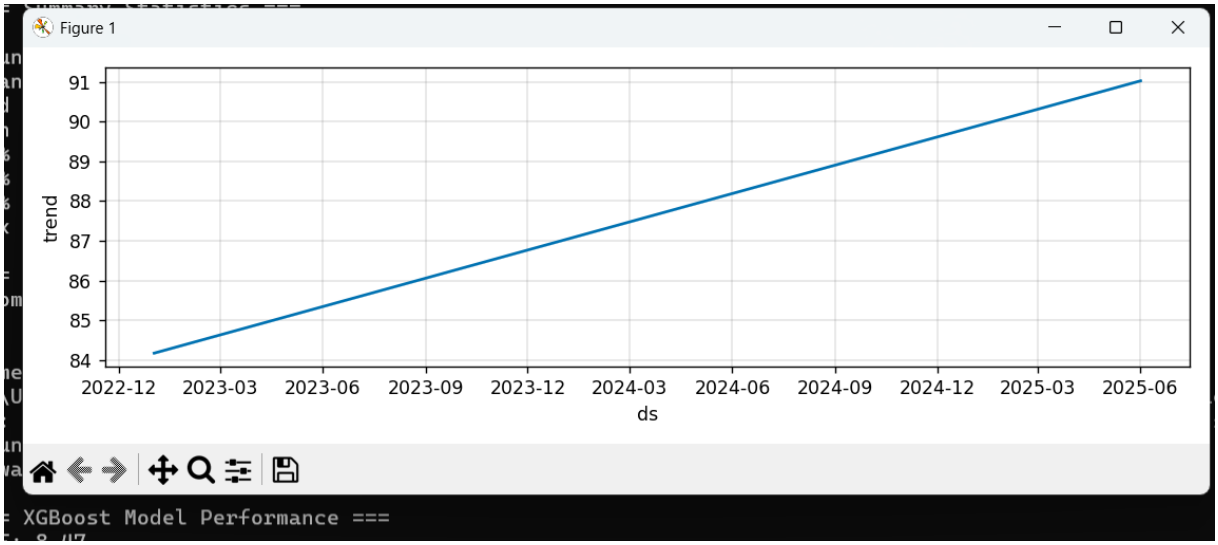


4. Time Series Forecasting (Prophet)

Using Prophet, I focused on forecasting demand for product 'P1000'. The model captured clear seasonal and trend-based signals.

I forecasted demand for 6 future months.





5. Key Takeaways

- Built a complete demand forecasting pipeline using XGBoost and Prophet.

- Demonstrated business impact of promotions and seasonality on sales.

- Visualized product trends, model accuracy, and future forecasts.

- Project applicable to retail, inventory, and supply chain optimization use cases.