Future Cart

AI Driven Demand Prediction

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Introduction

- Retail businesses today face challenges in accurately predicting demand due to constantly changing market conditions & consumer behaviors.
- Traditional forecasting methods often struggle to keep up, leading to inefficiencies in inventory management and missed business opportunities.
- This project, aims to leverage AI to enhance demand forecasting accuracy and support better decision-making in the retail industry.

Problem Statement

In the realm of E-Commerce, demand forecasting plays a pivotal role in ensuring business success. This project aims to develop a demand forecasting model in an E-commerce business that predicts future product demand leveraging time series analysis and multivariate regression based on historical sales data, along with Google Analytics KPIs such as Google clicks and Facebook impressions, which are valuable indicators of customer interest.

Our Goals

Key objectives of this project

1

Improved Inventory Management

More accurate demand forecasts lead to better inventory decisions, potentially reducing stock-outs.

2

Enhanced Marketing Efficiency

Identify periods of high demand for targeted marketing campaigns, optimizing resource allocation.

3

Data-Driven Decision Making

Reliable forecasts provide a basis for business decisions, such as pricing adjustments or product promotions.

4

Accurate Demand Predictions

Implement a forecasting model that achieves high accuracy in predicting future demands

5

Scalable Solution

Develop a solution that can scale to handle large datasets and varying demand patterns

Project Methodology

1. Data Collection
2. EDA & Data Processing
3. Time Series Modelling
4. Multivariate Analysis
5. Model Evaluation & Forecasting

Data Processing

Objective

To preprocess and prepare data for accurate demand forecasting by ensuring data quality, consistency, and relevance.

Steps

- Merging the Data
- Handle missing values
- remove duplicates
- align data by date
- normalize data etc..

Merging datasets

	Day Index	Quantity	Clicks	Impressions
0	2021-12-01	14	445	620
1	2021-12-02	10	433	890
2	2021-12-03	13	424	851
3	2021-12-04	22	427	881
4	2021-12-05	33	451	678

Handling missing values

```
Day Index      0
Quantity       0
Clicks         0
Impressions    0
dtype: int64
```

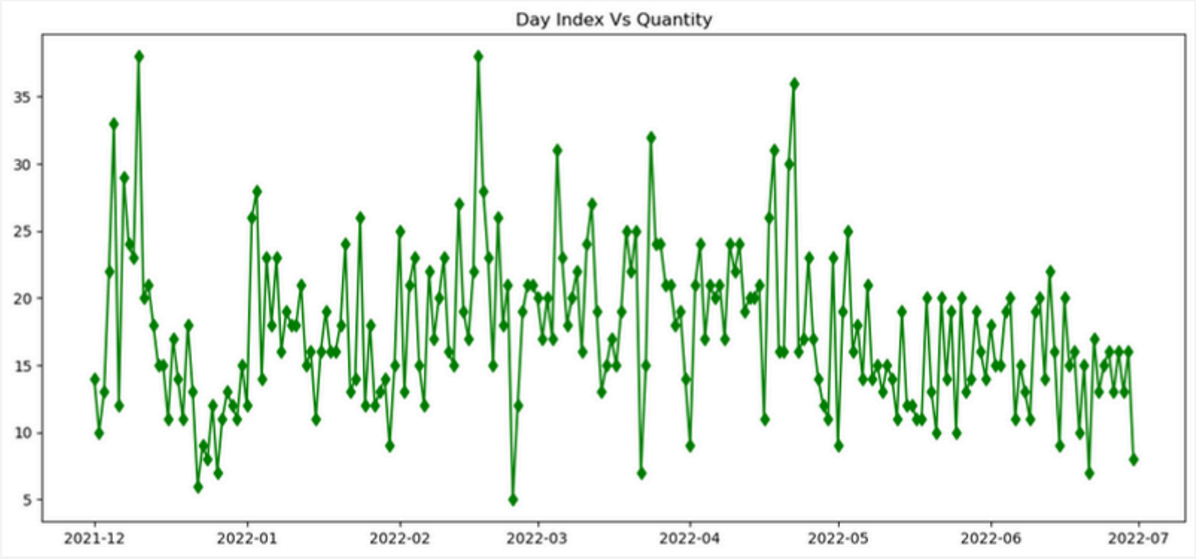
Exploratory Data Analysis

Objective

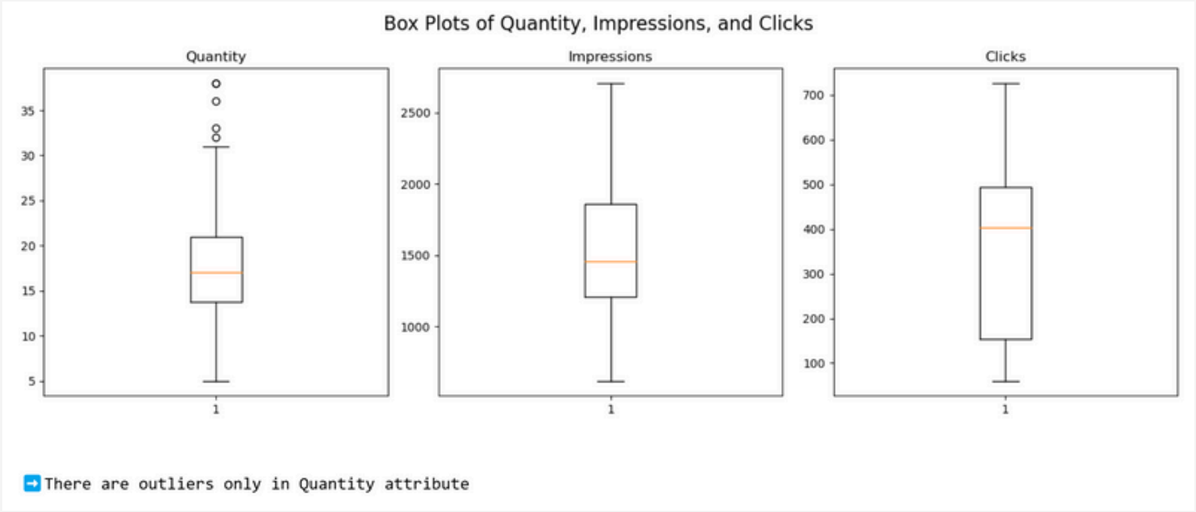
To understand the structure, patterns, and relationships within the data, ensuring it is ready for modeling and analysis.

Steps

- Visualize data with time series plots and scatter plots
- analyze seasonality
- detect outliers.



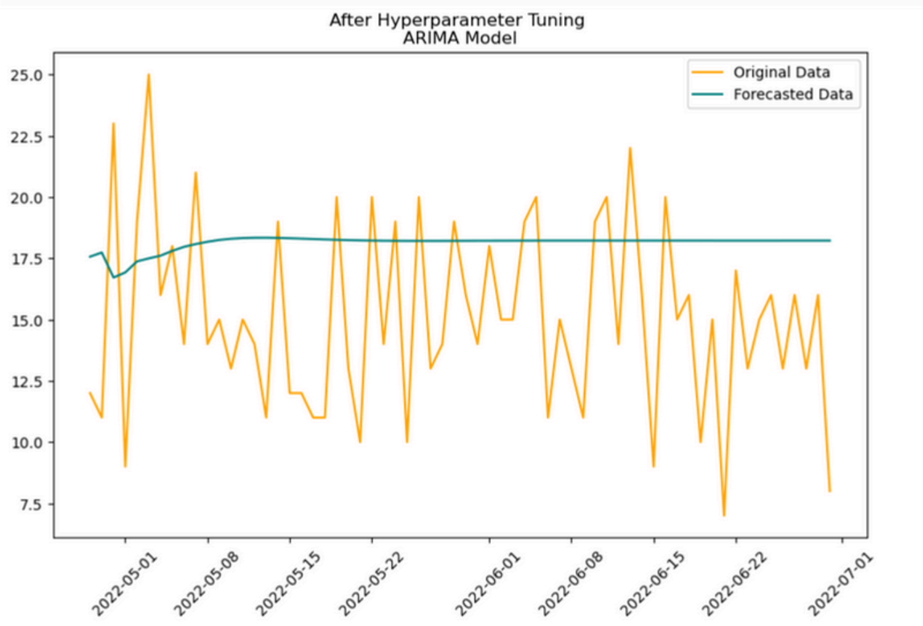
Detecting Outliers

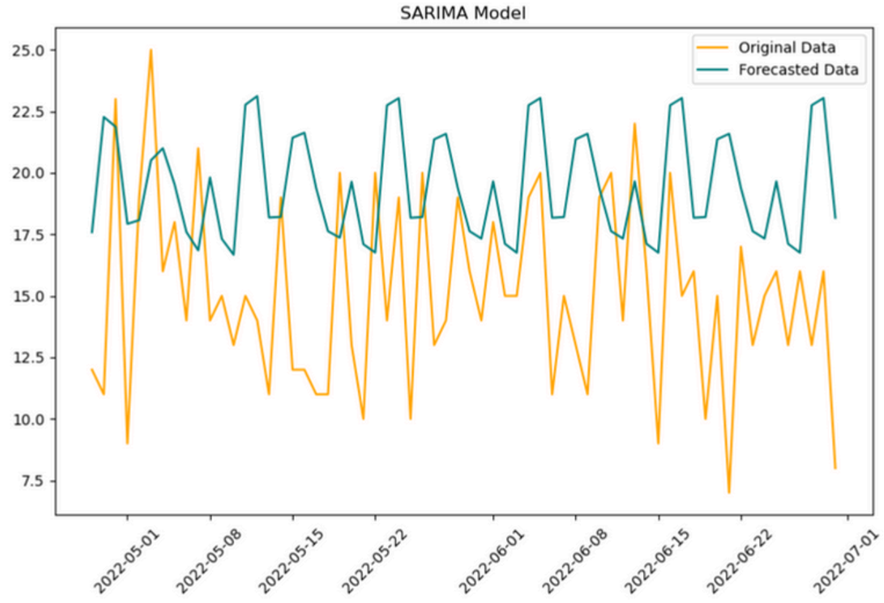


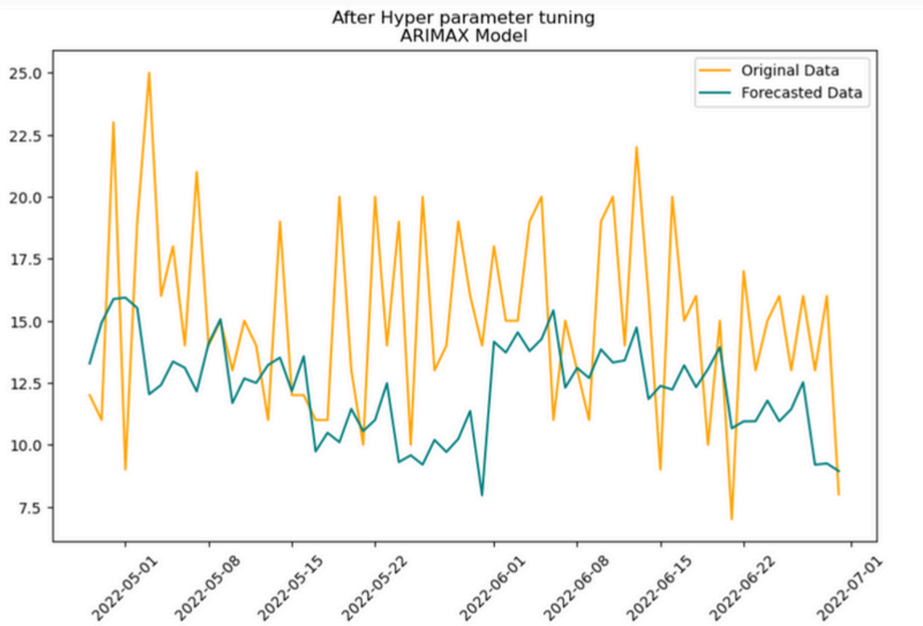
Time Series Modelling

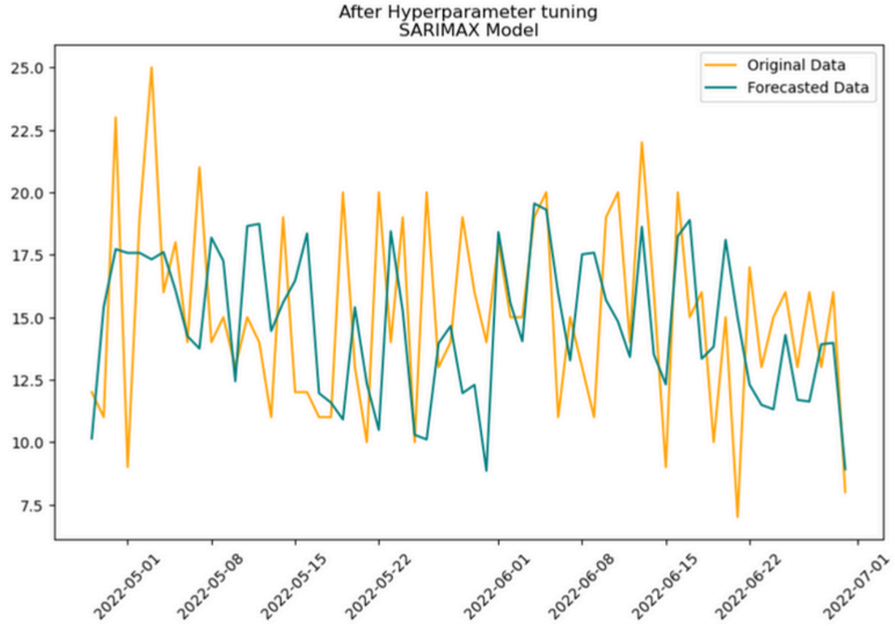
- **AR (Auto Regressive) :** Models the current value as a linear combination of its past values (parameter p)
- **MA (Moving Average) :** Models the current value as a function of past error terms (parameter q)
- **ARIMA (AR Integrated MA) :** Combines AR and MA models with an additional differencing step (parameter d) to handle non-stationary time series.
- **SARIMA (Seasonal ARIMA) :** Extends ARIMA by adding seasonal components to account for repeating patterns
- **ARIMAX (ARIMA with Exogenous Variables) :** Enhances ARIMA by including external predictors or exogenous variables
- **SARIMAX (Seasonal ARIMAX) :** Combines SARIMA and ARIMAX, incorporating both seasonal components and exogenous factors

Time Series Model Predictions



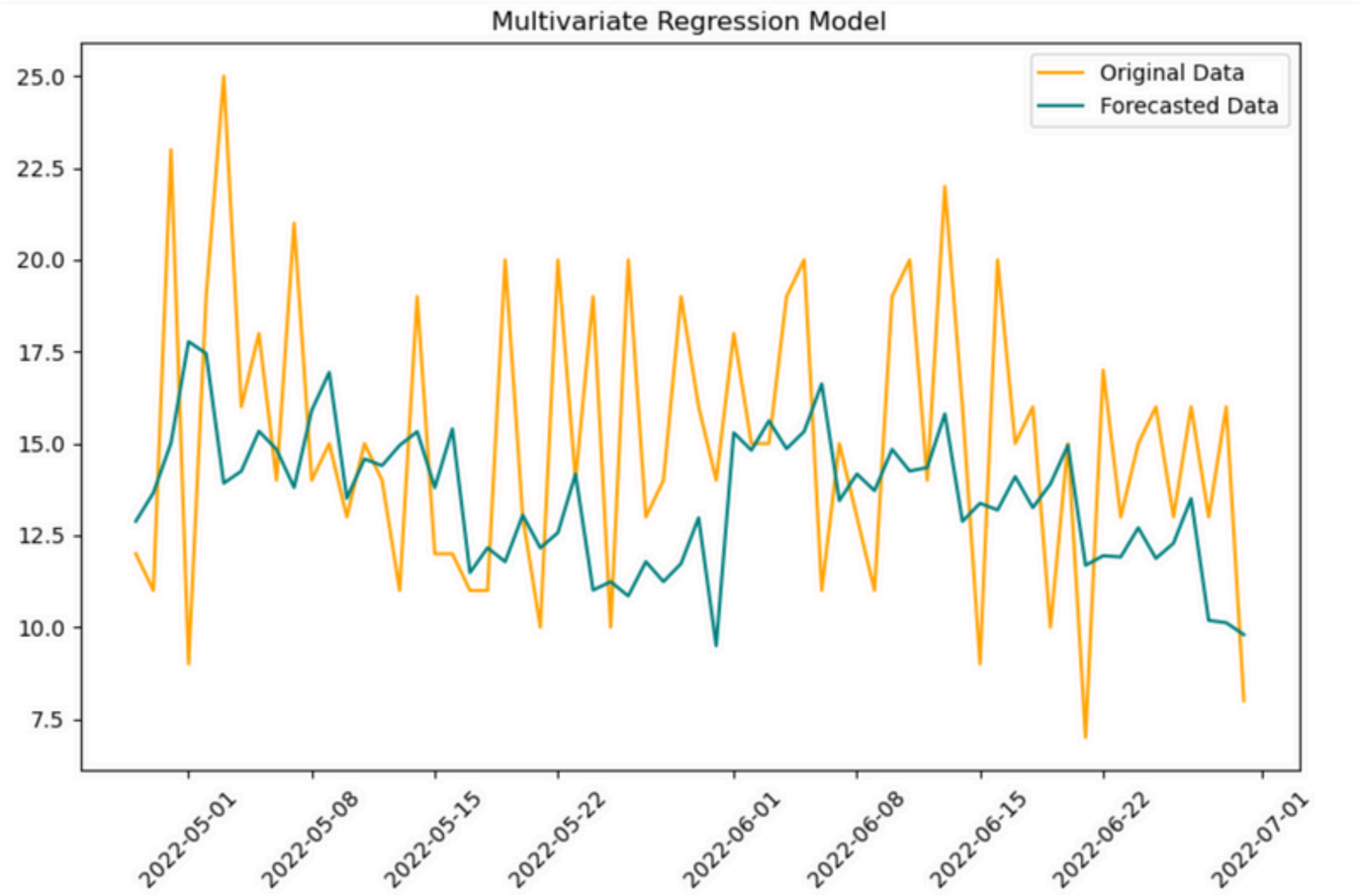






Multivariate Regression

Multivariate regression helps model the relationship between a dependent variable and multiple independent variables, providing a more comprehensive understanding of how different factors influence the outcome.



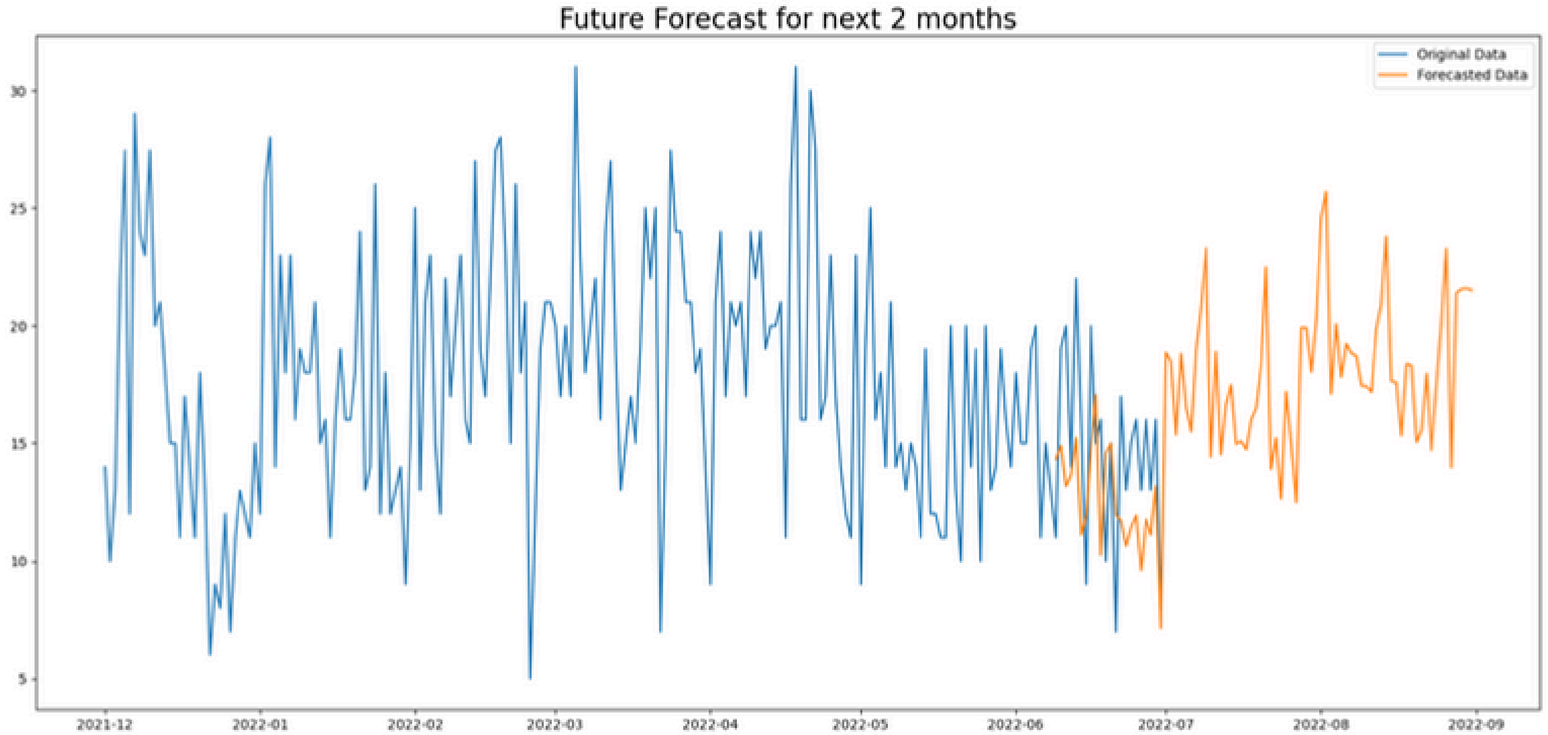
Model Evaluation :

Evaluation Metrics:

Model	MAE	MSE	RMSE	MAPE
AR	4.12672	23.815	4.88006	33.8592
MA	4.23222	24.9789	4.99789	34.8093
ARIMA	4.21108	24.6325	4.96312	34.4588
SARIMA	3.9831	22.7098	4.76548	32.7936
ARIMAX	3.857	23.8653	4.88521	24.2364
SARIMAX	3.40091	17.7544	4.2136	23.9086
MultiVariate	3.32606	18.0982	4.2542	21.9756

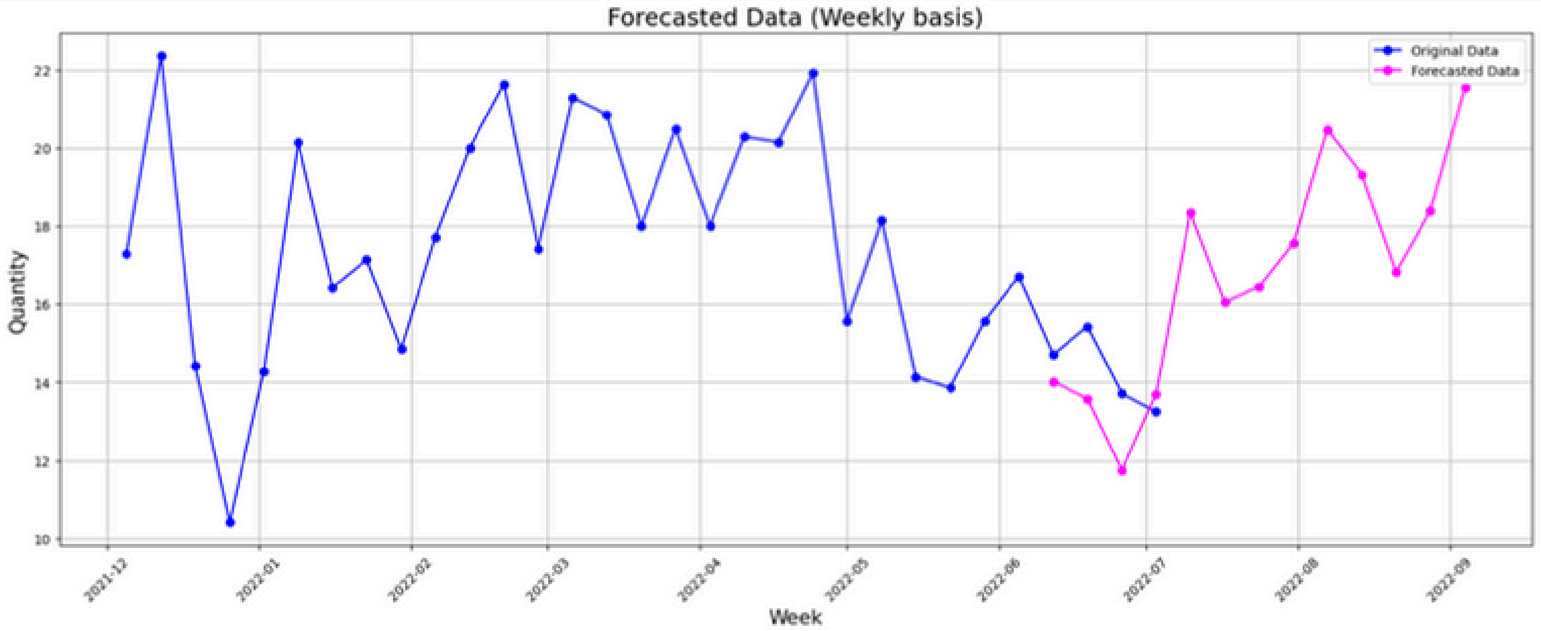
SARIMAX is the best model based on RMSE and other Metrics

Future Forecast



Daily Basis

Weekly Basis



Reasons for choosing SARIMAX model for forecasting

1. **Handles Exogenous Variables**: Includes external factors (e.g., holidays) to improve forecast accuracy.
2. **Seasonal and Non-Seasonal Modeling**: Captures both seasonal and trend components, offering flexibility in modeling
3. **Improved Forecasting**: Provides more accurate predictions by accounting for external influences and seasonality.
4. **Reduced Residuals**: Produces residuals with no patterns, indicating good model fit.
5. **Versatile for Complex Data**: Effective for data with multiple seasonalities or complex trends, ensuring reliable forecasts.
6. **Enhanced Interpretability**: The model provides insights into how external factors (exogenous variables) impact the forecast, aiding in understanding the drivers of demand.

Conclusion

Objective Achieved :

The SARIMAX model was used to forecast ‘Quantity’, with high accuracy by capturing seasonality and trends in the data

Key Insights :

- **Improved Inventory Management:** Predicts future sales trends, ensuring the right amount of inventory is stocked, reducing missed sales opportunities.
- **Reduced Stockouts:** Minimizes out-of-stock situations, leading to higher customer satisfaction and an improved shopping experience.
- **Optimized Ordering Process:** Informs decisions on order timing and quantities, preventing overstocking and reducing carrying costs.
- **Enhanced Supplier Relationships:** Enables effective communication with suppliers, ensuring timely restocking and better negotiation terms.

THANK YOU