Retail Giant Sale Forecast using Time Series Modelling techniques

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Business Objective

Global Mart is an online supergiant store that has worldwide operations. This store caters to **7 different geographical market segments** and **3 major customer segments**, i.e. consumer, corporate and home.

The **aim** is to **forecast the sales of the products for the next 6 months**, so that a proper estimate is obtained to plan the inventory and business processes accordingly.

Problem Solving Methodology

1. Data Understanding and Data Preparation
2. Finding Most Profitable Segment
3. Forecasting Sales of the Profitable Segment
4. Results of Forecasting and Observations

Data Understanding and Data Preparation

Data Understanding

The store dataset has the following **5 attributes** and their data description is as given below:

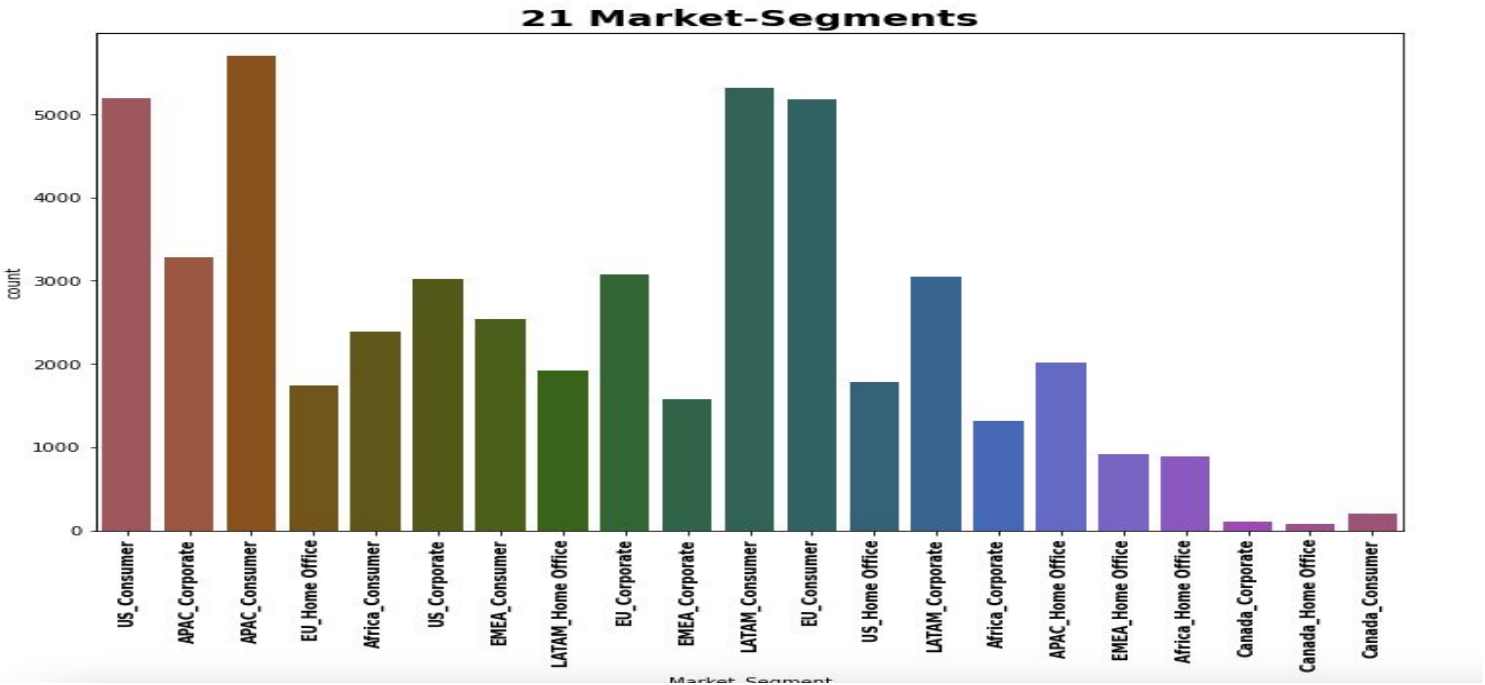
Attributes	Description
Order-Date	The date on which the order was placed
Segment	The segment to which the product belongs
Market	The market to which the customer belongs
Sales	Total sales value of the transaction
Profit	Profit made on the transaction

The store caters to:

- **7 different geographical market segments** - Africa, APAC (Asia Pacific), Canada, EMEA(Middle East), EU (European Union), LATAM (Latin America), US (United States)
- **3 major customer segments** - Consumer, Corporate, Home Office

Data Preparation

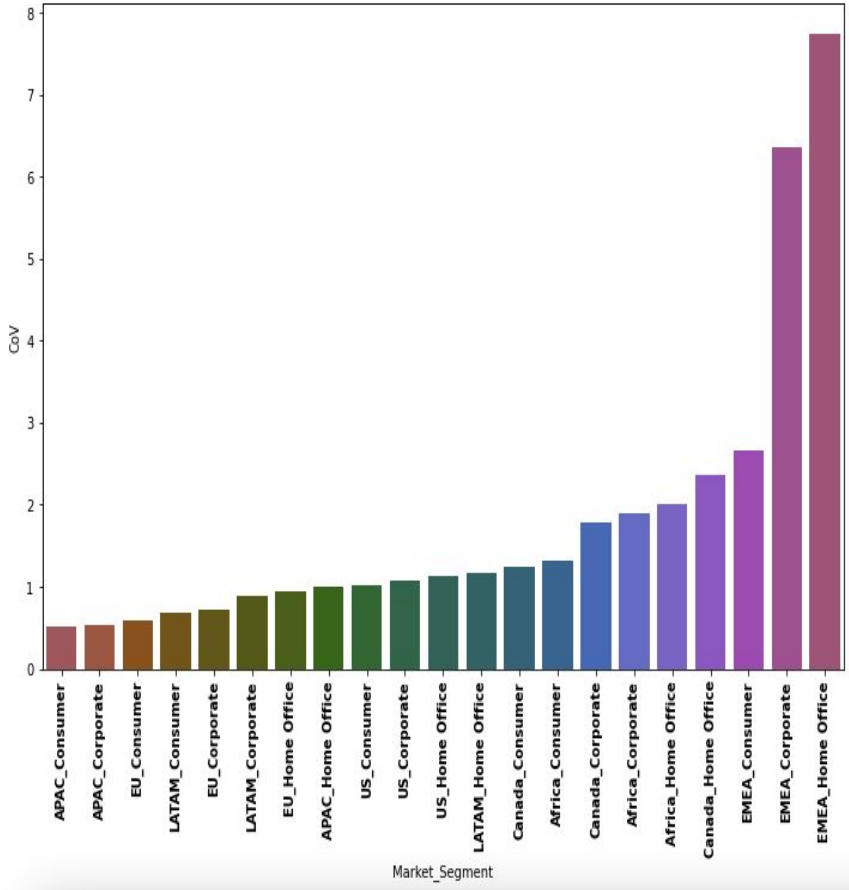
The entire dataset can be categorized into **21 (7*3) unique market segments** for which sales forecast can be made.



Finding Most Profitable Segment

Coefficient of Variation (CoV)

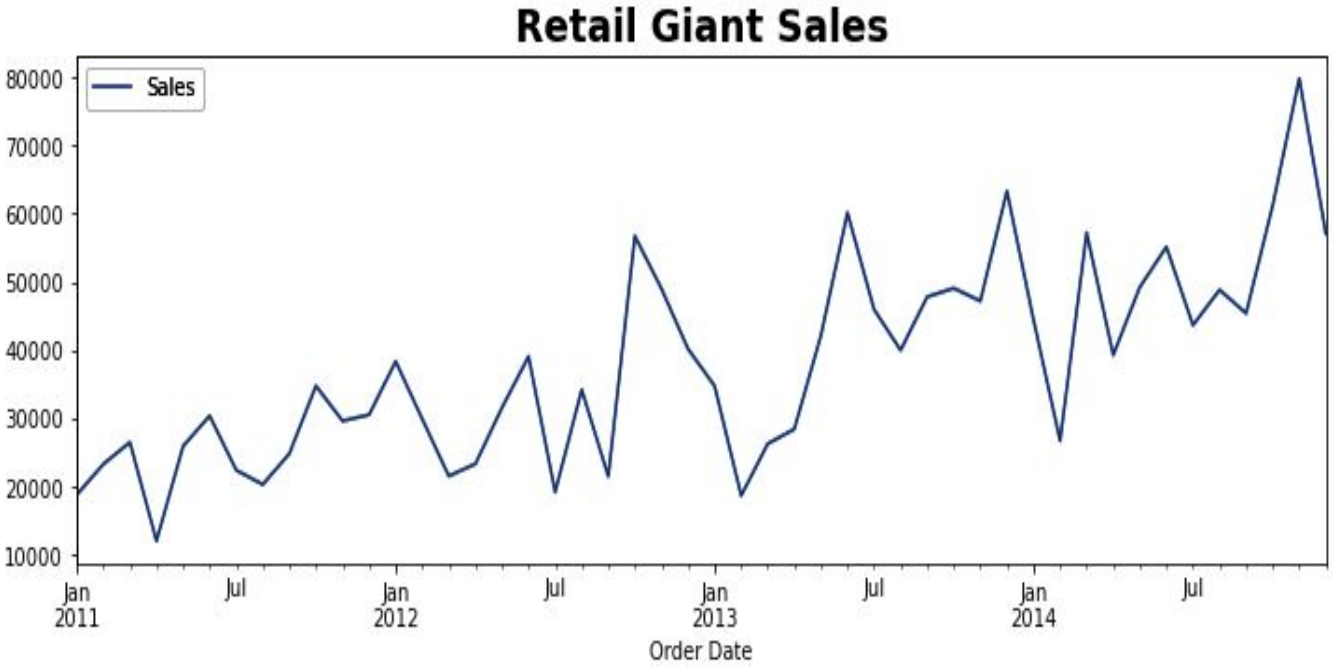
- The **Order Date** is converted to **Month-year** format.
- The transaction data is then **aggregated on monthly basis** such that we have data for **48 months** for the **21 market segments**.
- The data is split into **train (42 months)** and **test (6 months)** datasets.
- The **CoV (standard deviation/mean)** is calculated on the profit for each of the 21 market segments on the train data.
- The **CoV gives a comparative figure** on the basis of which we i**dentify the most profitable market segment**.
- Market Segment **APAC_Consumer** is the **most profitable** with the **lowest variation in the profits**.



Forecasting Sales of the Profitable Segment

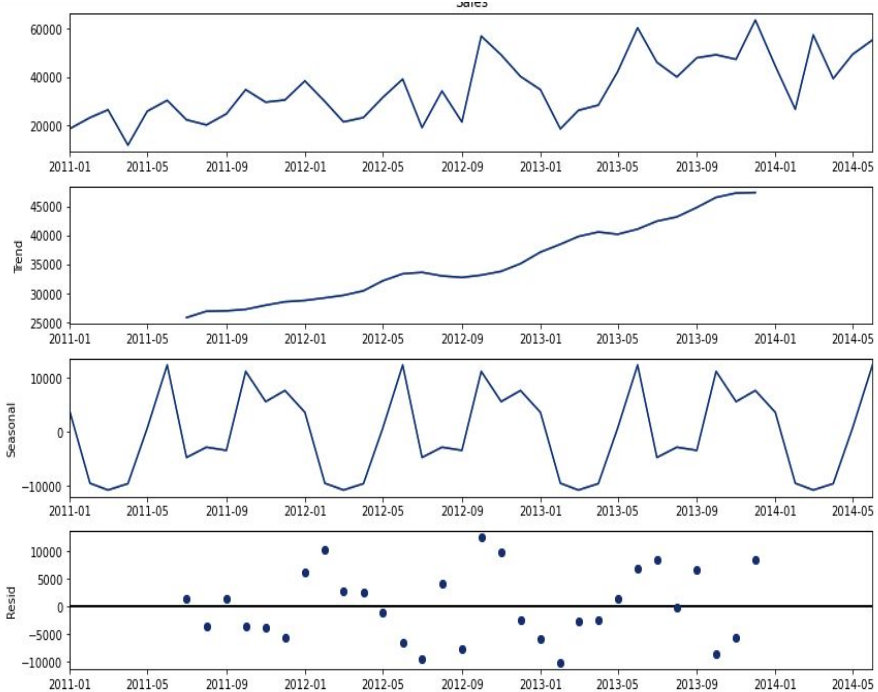
Time Series Analysis

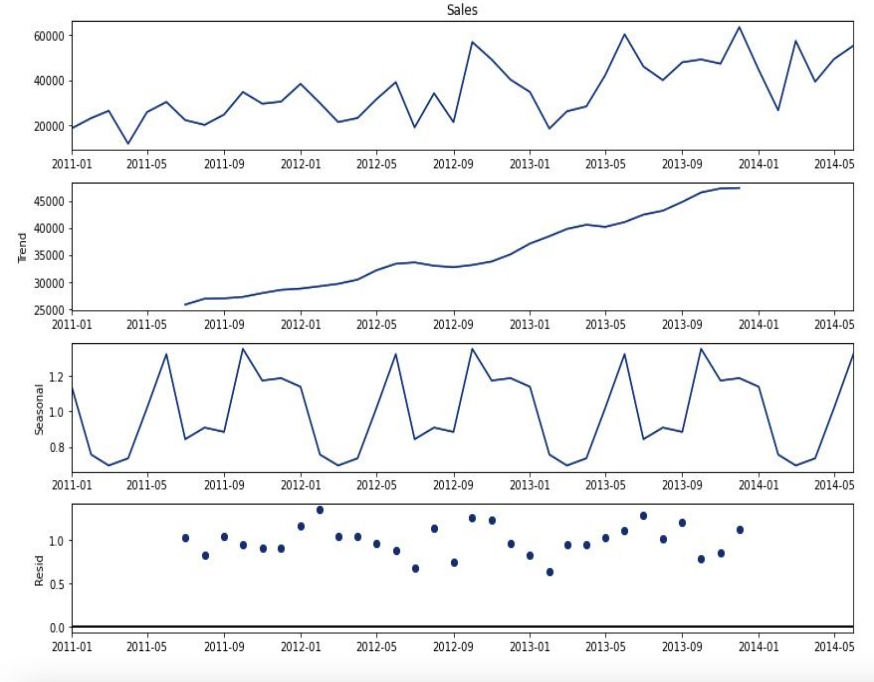
- Data for the most profitable Market Segment- **APAC Consumer** is kept in the dataframe and remaining market segments are dropped to forecast the future sales.
- The data is **aggregated based on Order Date** to find the **total Sales**.



Time Series Decomposition

- The below respective Additive and Multiplicative decomposition of the Time Series data shows that it has both **trend and seasonality**.

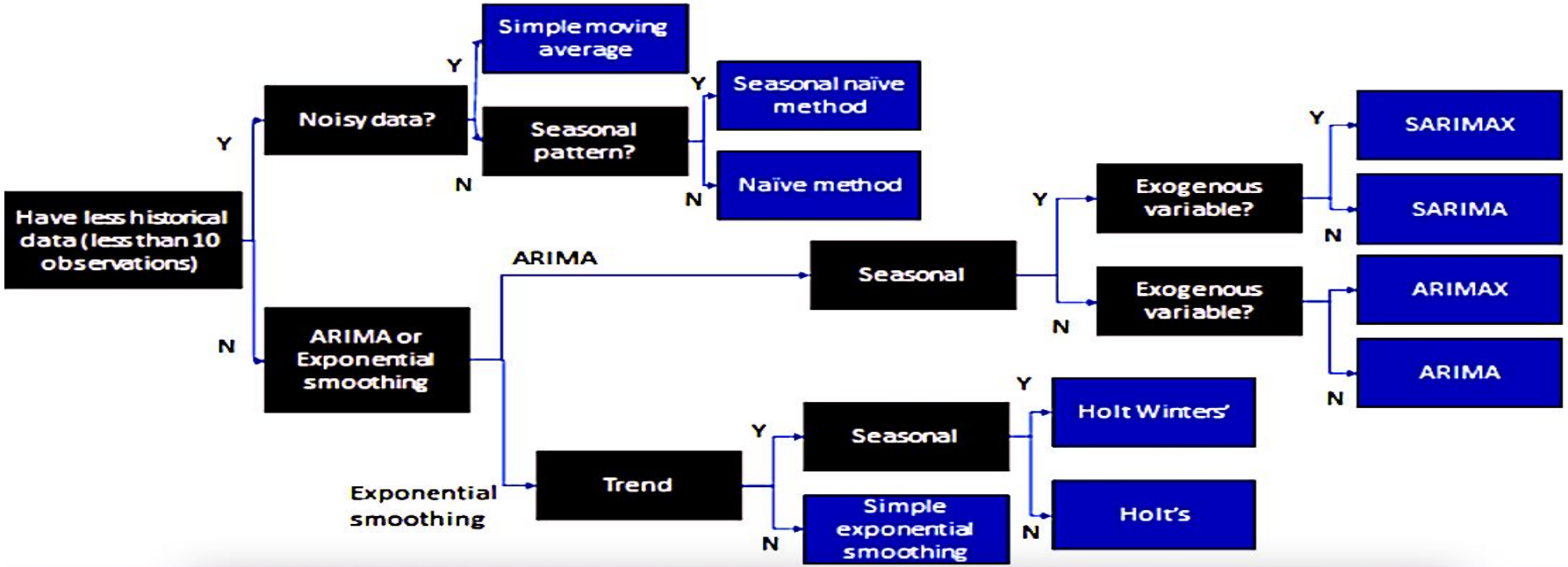




Choosing the Right Time Series Method

The series has both trend and seasonality. Hence, based on the below flow chart the optimum technique that might work best for the sales forecast are:

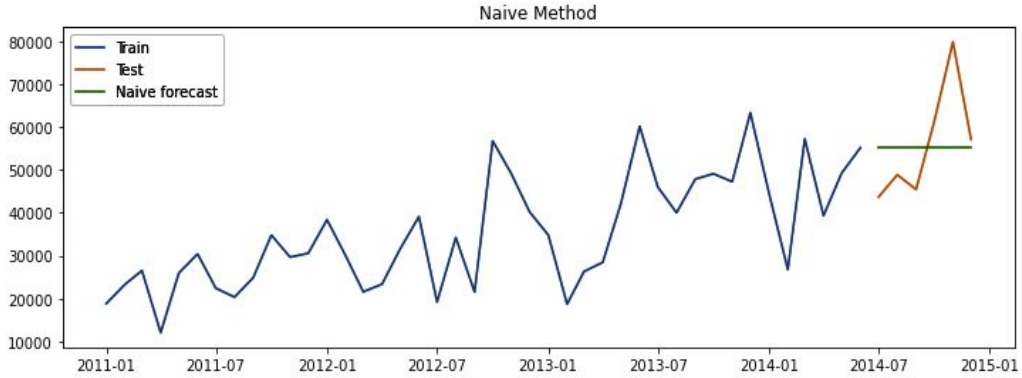
- Smoothing technique - **Holt Winters' Method**
- ARIMA set of techniques - **Seasonal Autoregressive Integrated moving average (SARIMA)**



Results of Forecasting and Observations

Naive Method

- To forecast the sales from month 2014-07 to 2015-01 we consider the last or previous month data which is 2014-06. Thus, the forecast for the next six months is the same value (green line) as the last observation of the blue line.

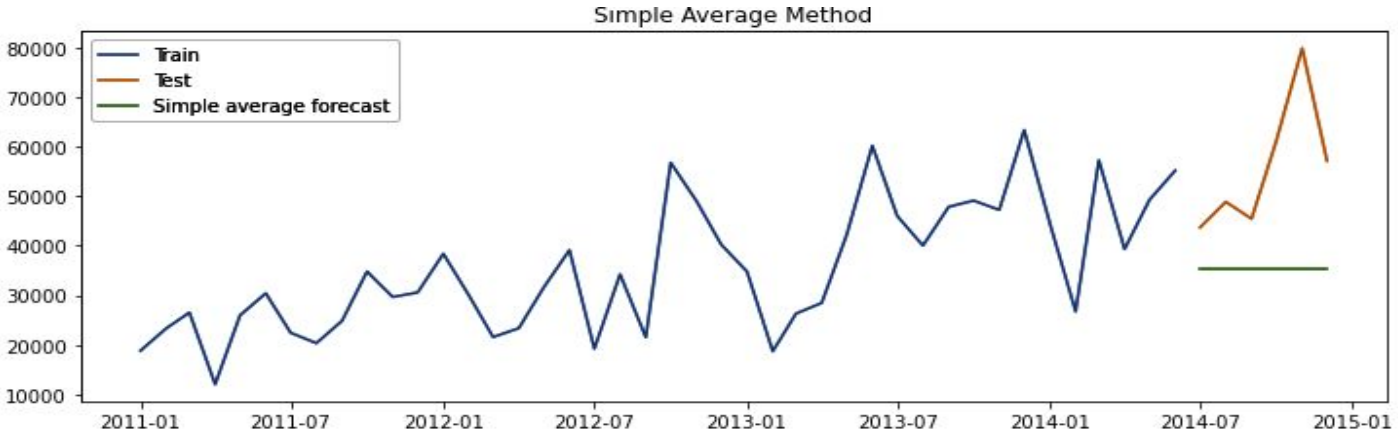


- The RMSE and MAPE values are calculated in order to compare with other methods.

	Method	RMSE	MAPE
0	Naive method	12355.97	17.47

Simple Average Method

- The Forecast of months from 2014-07 to 2015-01 equals Average of all past months' sales, indicated by the green line as the average of all the 42 months sales data.



- The RMSE and MAPE values are calculated in order to compare with other methods.

	Method	RMSE	MAPE
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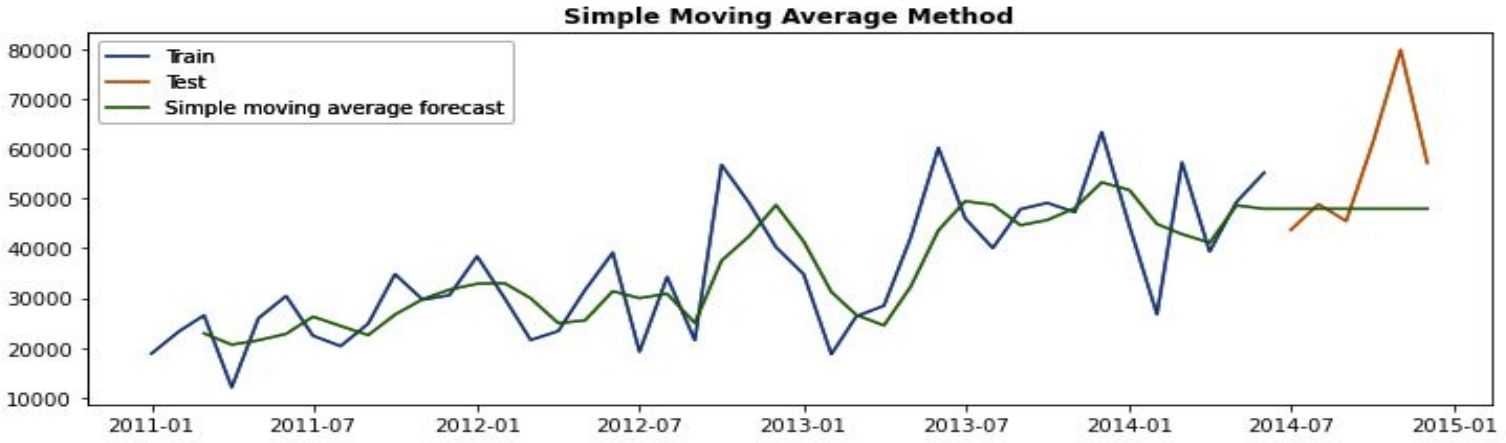
Simple Moving Average Method

- The Forecast equals Average of only last few months' sales, indicated by the green line.



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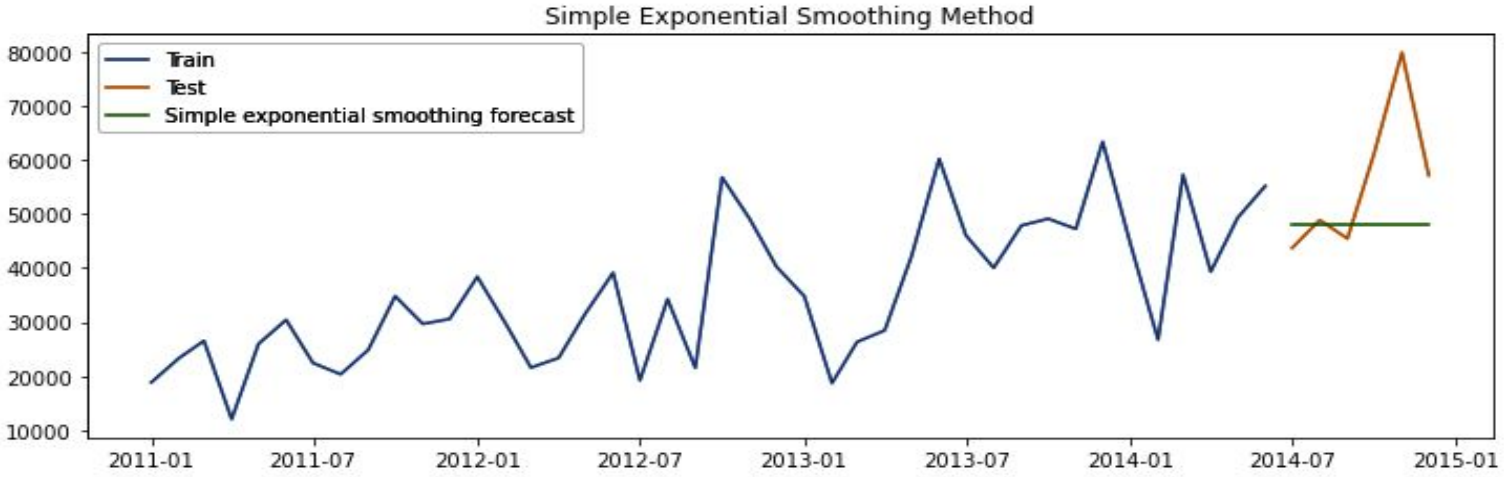
Simple Exponential Smoothing Method

- The simple exponential model captured the level of a time series.



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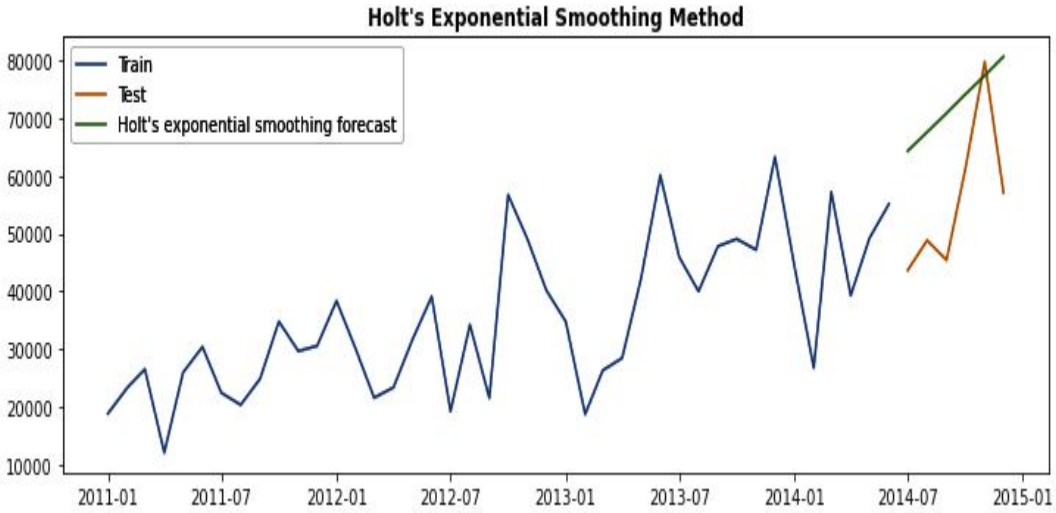
Holt’s Exponential Smoothing Method

- The forecast is a straight line, sloping upwards as Holt's method captured both level and trend.
- The RMSE and MAPE values are calculated in order to compare with the other methods.



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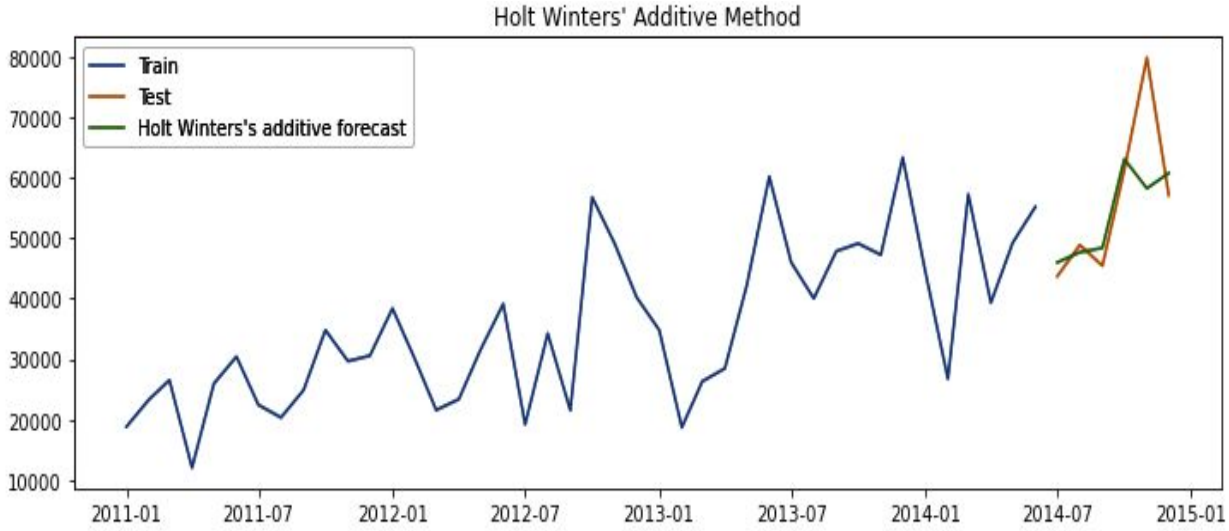
Holt Winters' Additive Method

- Forecast is based on level, trend and seasonality of a time series.
- The RMSE and MAPE values are calculated in order to compare with other methods. It has the lowest RMSE and MAPE values, i.e., error measures are very less.



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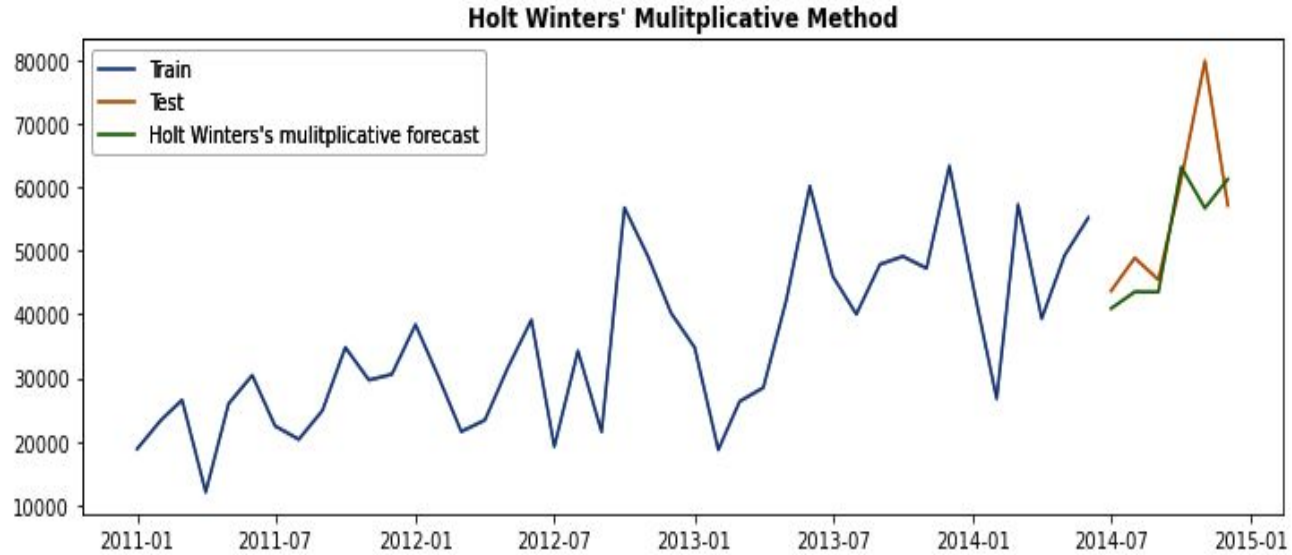
0	Holt Winters' additive method	9124.30	8.44

Holt Winters' Multiplicative Method

- Forecast equals the trend forecast multiplied by the seasonality.
- The RMSE and MAPE values are calculated in order to compare with other methods. It has low RMSE and MAPE values, after the Holt Winters' Additive Method.



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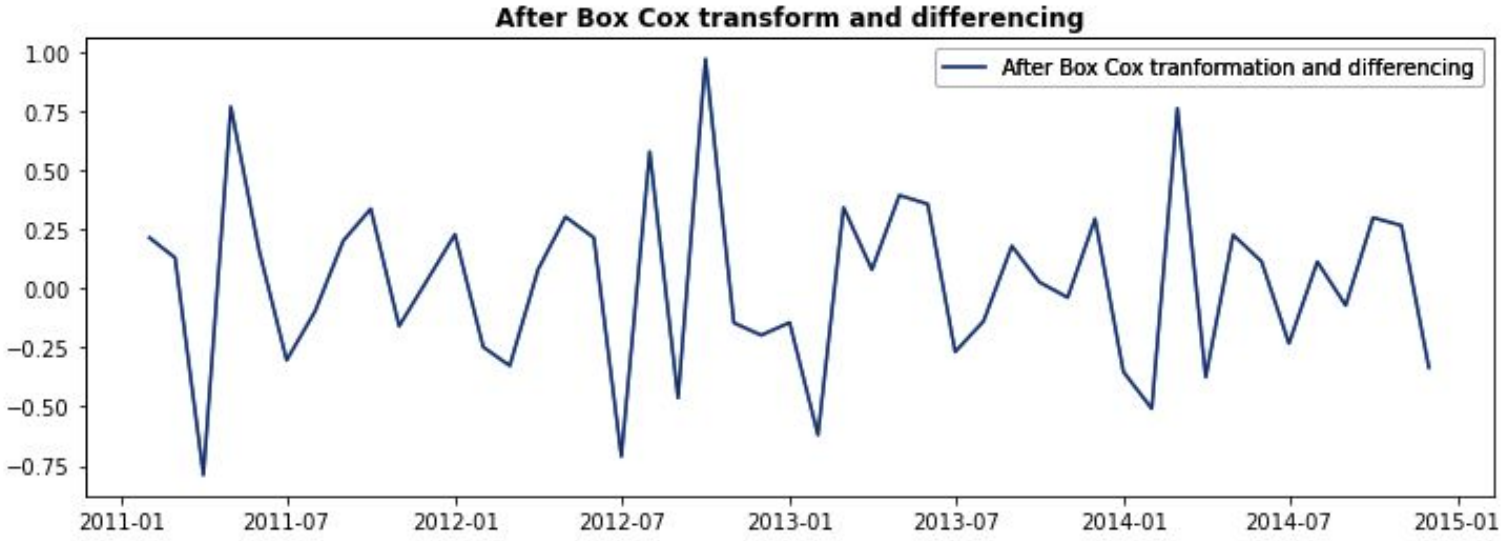
0	Holt Winters' multiplicative method	9972.29	10.15

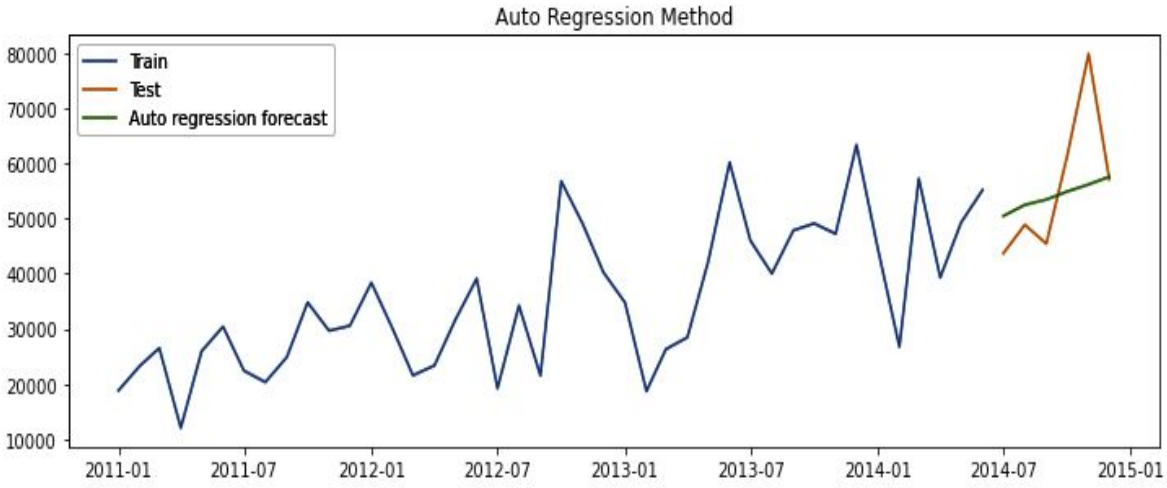
Auto Regressive Methods

- In Auto Regressive models, the future observations are forecasted using a linear combination of past observations of the same variable.
- The stationarity tests are performed on the time series.
- Box-Cox transformation is used to make the variance constant in time series.
- Differencing is performed to remove the trend and seasonality on the time series.
- Thus, the time series is made stationary to build an Auto Regressive model.



Autoregressive (AR) Method

- It models the future observation as a linear regression of one or more past observations.
- Forecast captures the trend not the seasonality.
- The RMSE and MAPE values are slightly high.



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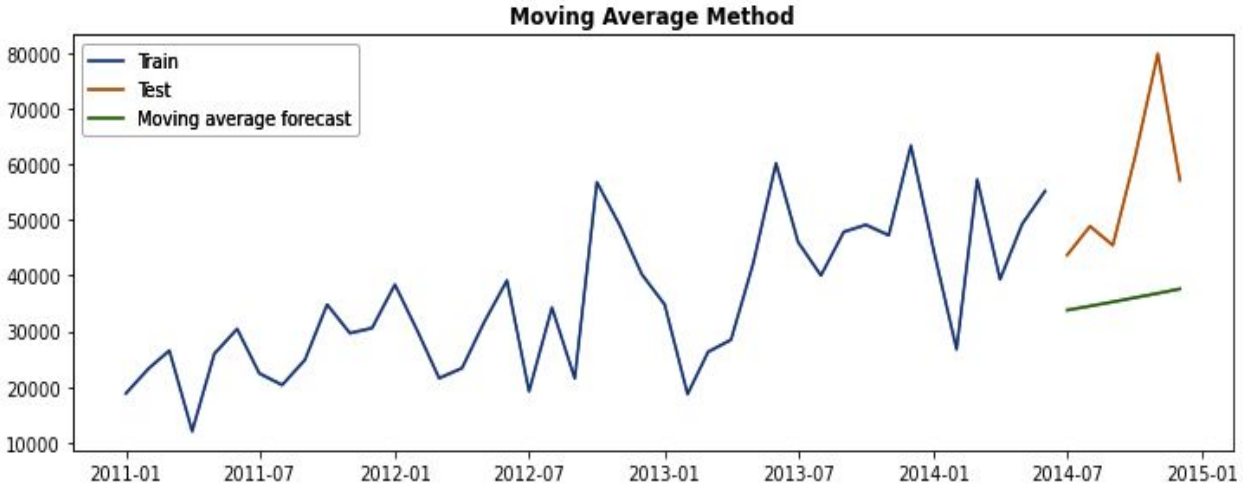
0	Autoregressive (AR) method	10985.28	13.56

Moving Average (MA) Method

- It models the future forecasts using past forecast errors in a regression-like model.
- Forecast captures the trend not the seasonality.
- The RMSE and MAPE values are high, which means too many errors.



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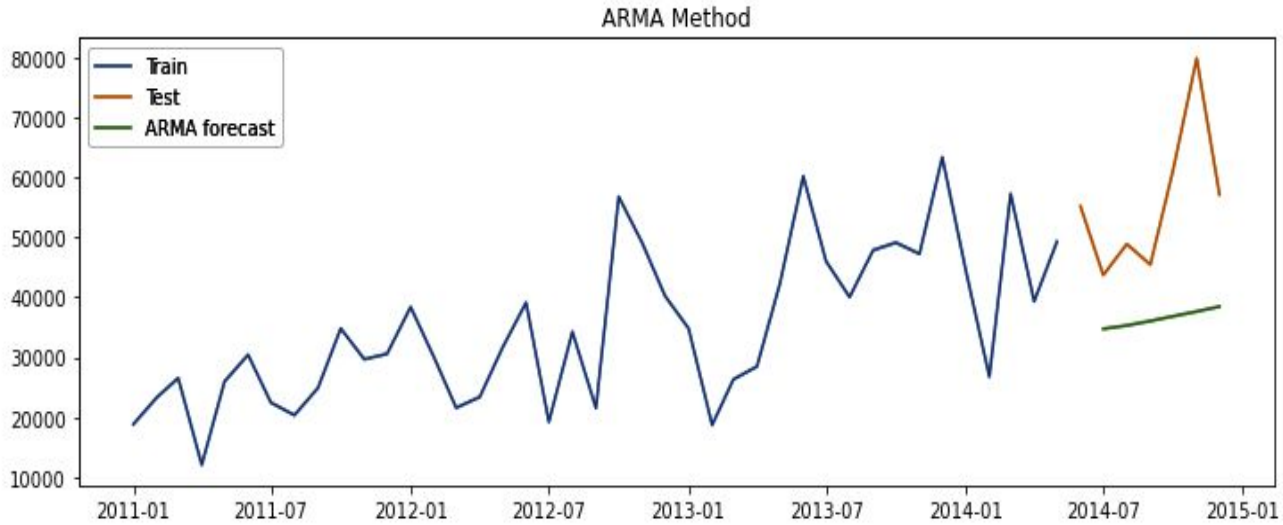
Autoregressive Moving Average (ARMA) Method

- It models the future forecasts using past forecast errors in a regression-like model.It models the future observation as linear regression of one or more past observations and past forecast errors.
- Forecast captures the trend not the seasonality.
- The RMSE and MAPE values are high.



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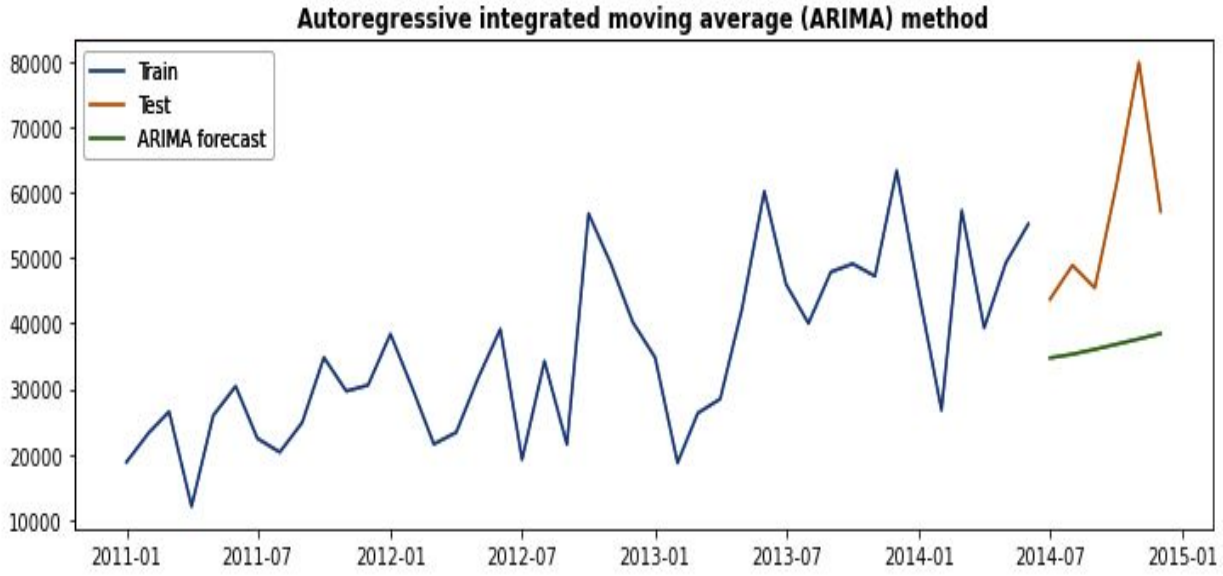
0	Moving Average (MA) method	23360.02	33.93
0	Autoregressive moving average (ARMA) method	22654.32	32.40

Autoregressive Integrated Moving Average (ARIMA) Method

- It models the future forecasts using three parameters - p (Highest lag included in the regression model); d (Degree of differencing to make the series stationary); q (Number of past error terms included in the regression model).

- The RMSE and MAPE values same as ARMA method.



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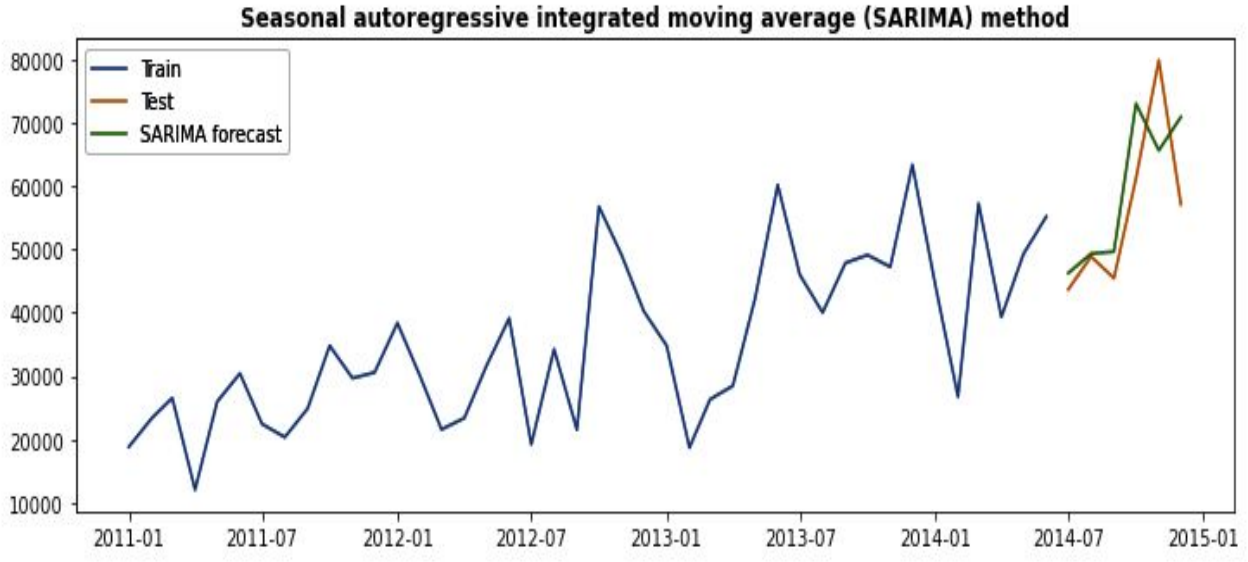
0	Autoregressive moving average (ARMA) method	22654.32	32.40
0	Autoregressive integrated moving average (ARIM...	22654.32	32.40

Seasonal Autoregressive Integrated Moving Average (SARIMA) Method

- It models both seasonal and non-seasonal elements.
- The forecast captures both trend and seasonality.
- The RMSE and MAPE values are the least among all the methods.



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0	(SARIMA) Seasonal autoregressive integrated mo...	9617.21	12.88

Conclusion

It can be concluded that the best forecasting methods as per the plots are those where **the predicted values are closest to the actual values** and have the **least error measure**, i.e., low MAPE values.

In this case, we have the best forecasting method for:

- Smoothing technique - **Holt Winters' Additive Method**
- ARIMA set of techniques - **Seasonal Autoregressive Integrated moving average (SARIMA)**