TIME SERIES CASE STUDY

SUBMISSION

Group Name:
1. Ria Nag
2. Piyush Gaur
3. Sanjana Rao
4. Priya Chopra

Background | Goal

Background

"Global Mart" is an online store super giant having worldwide operations. It takes orders and delivers across the globe and deals with all the major product categories - consumer, corporate & home office.
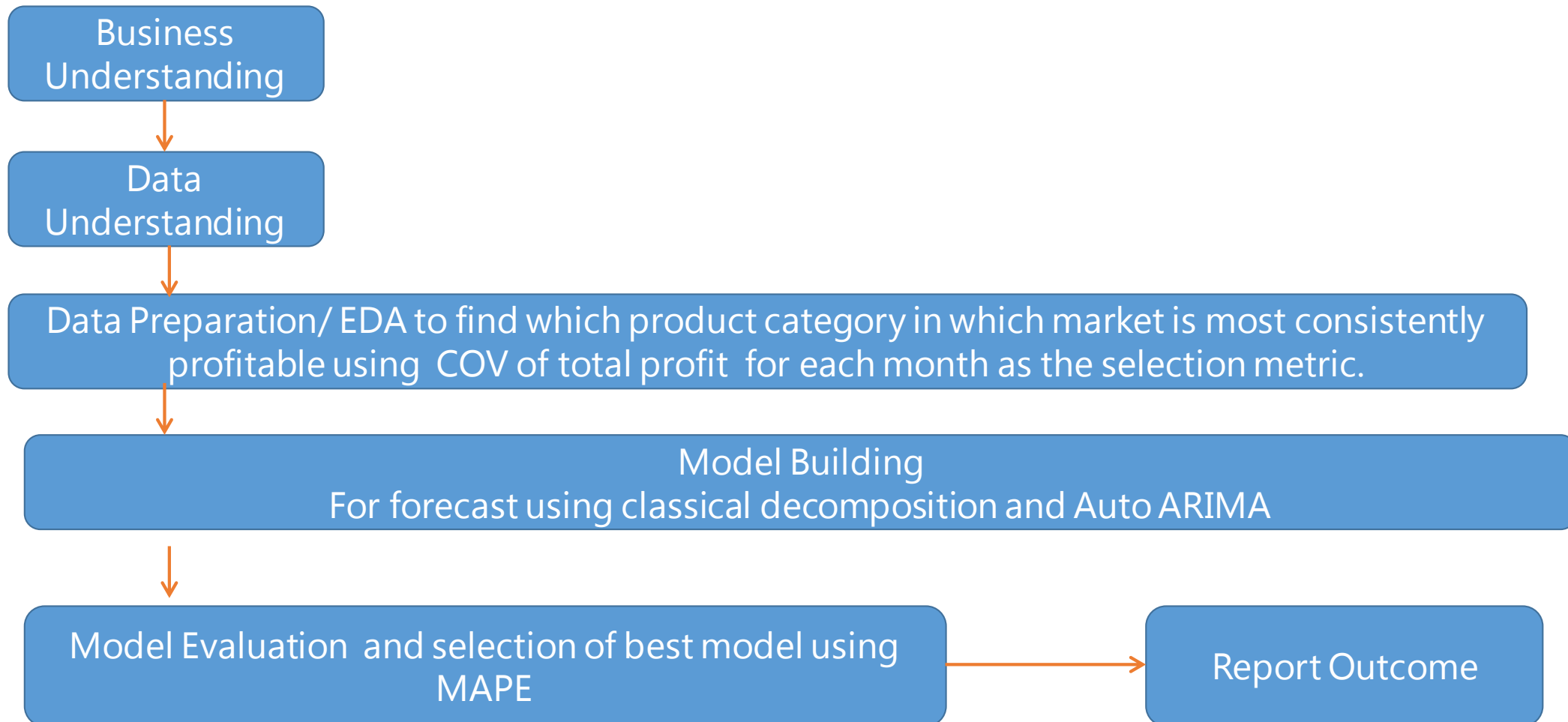
As a sales operation manager, business plan is required to be finalized for next 6 months to manage revenue and demand .

The store has 7 different market segments in 3 major product categories .T hus there are a total of 21 segments of market in different product categories. The company strategy is to find out 2 most consistently profitable segments and focus on them.
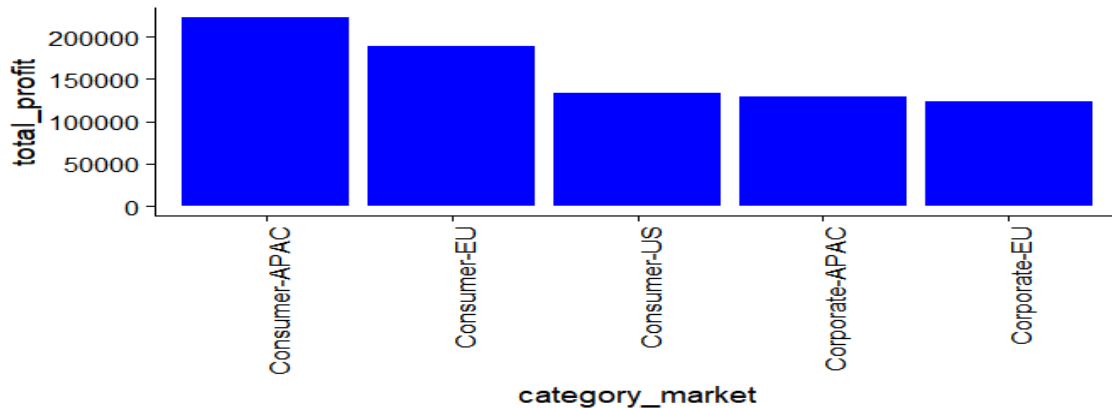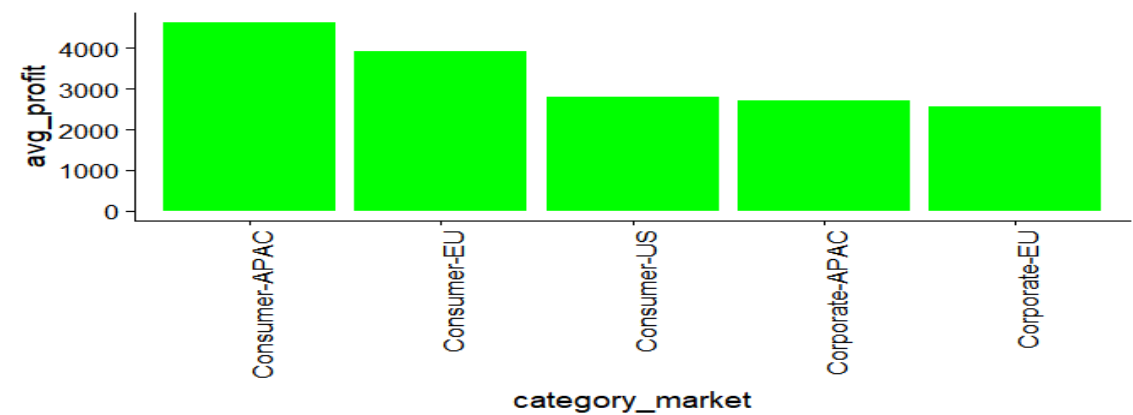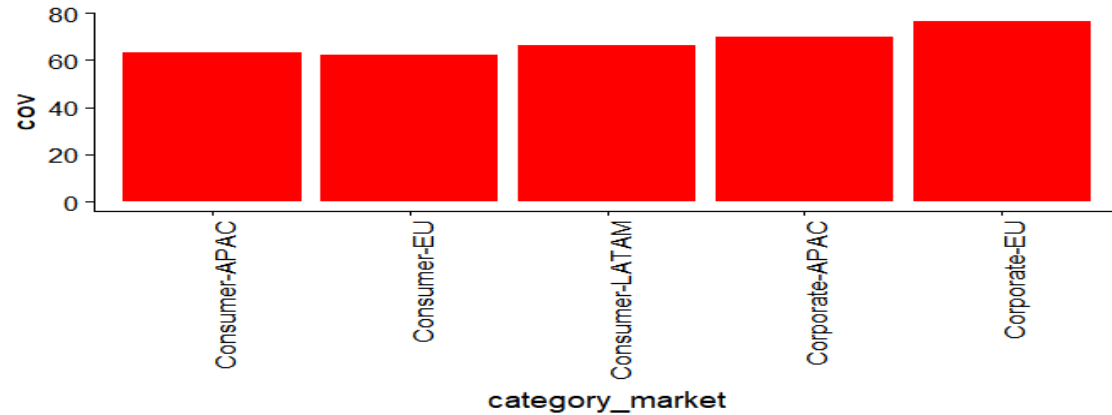
Goal

Forecast the Sales and Demand for next 6 months for 2 most profitable segments, that would help you manage the revenue and inventory accordingly and also validate the model built to indicate the forecast is accurate.
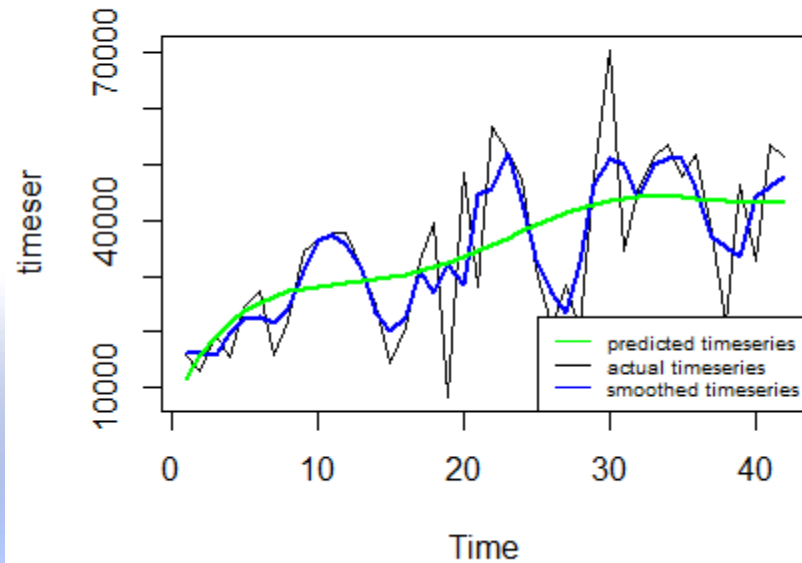
Problem Solving Methodology

Business Understanding

↓

Data Understanding

↓

Data Preparation/ EDA to find which product category in which market is most consistently profitable using COV of total profit for each month as the selection metric.

↓

Model Building
For forecast using classical decomposition and Auto ARIMA

↓

Model Evaluation and selection of best model using MAPE

→

Report Outcome

Data Preparation: Segment Selection

- **Data aggregated for Profit, Quantity, Sales in each Segment**
- **Based on Highest Profit, Highest Average Profit and Lowest COV - Consumer APAC and Consumer EU segments selected for next 6 months Sales and demand forecast**

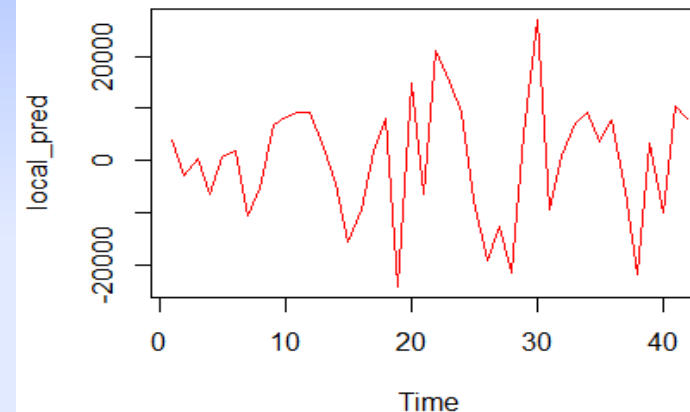# Classical Decomposition of APAC Sales- Methodology

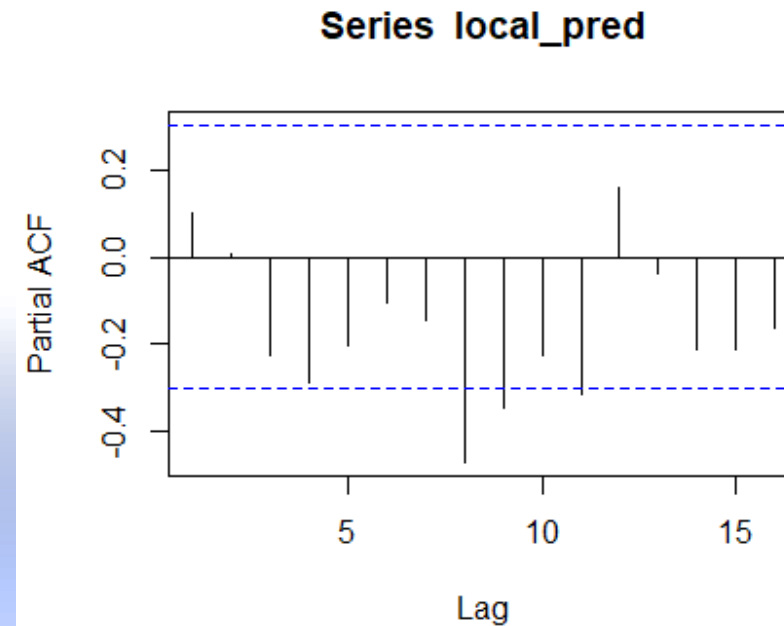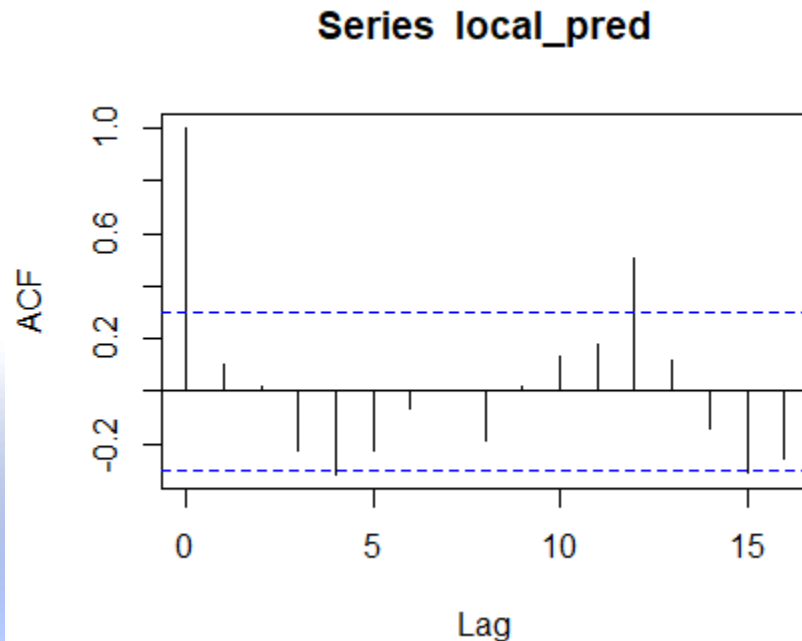On smoothing the data , applied Sinusoidal regression

- Seasonal behavior is present
- Seasonal variation is expanding with time
- Amplitude is also expanding

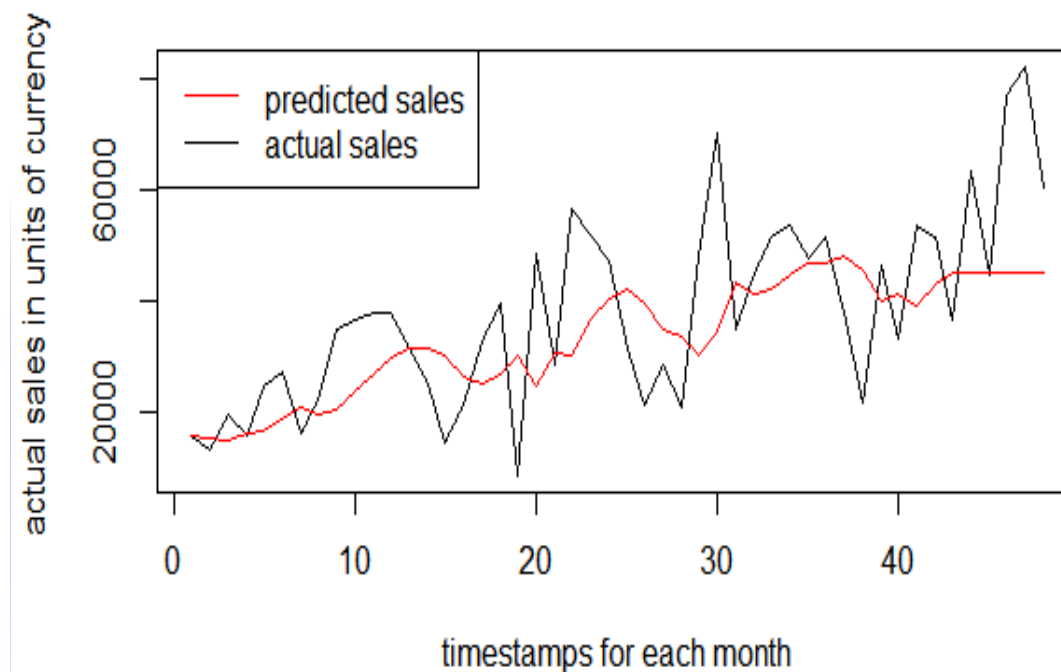Residue after removing global Trend
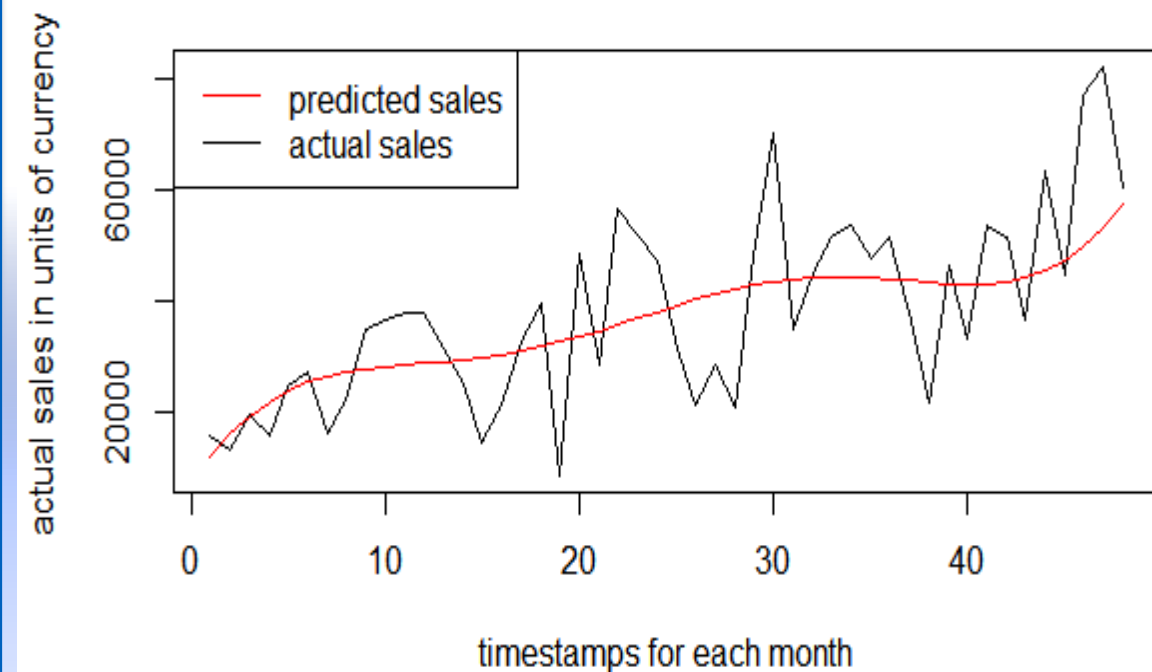
Is this White Noise ?

Classical Decomposition of APAC Sales- Methodology

Series local_pred

Series local_pred

- **ACF is good, with 1 peak at 0 and rest within acceptable band. PACF is within acceptable range.**
- **ARMA model Fit using ARIMA**
  - **Best fit – ARIMA(0,0,0) – no differencing required**
  - **Order 0 AR and order 0 MA- no auto regressive behavior left in time series**
- **Residue seems to be white noise**
  - **p-value for dicky-fuller is 0.01(below 0.05 – which indicates null hypothesis cannot be supported and series is stationary)**
  - **p-value for kpss is 0.1(above 0.05 – null hypothesis is fair and series is stationary)**
    residual is white noise

Results: APAC Sales

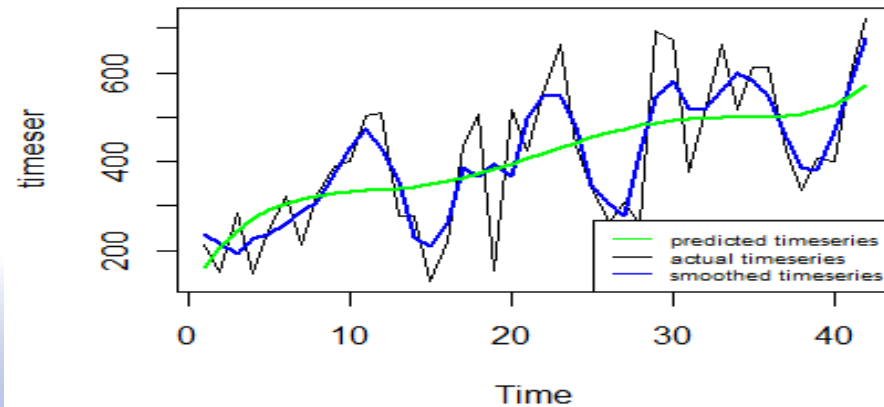| APAC SALES FOR CLASSICAL DECOMPOSITION | APAC SALES FOR auto ARIMA |

- **MAPE value for APAC Sales for Classical Decomposition = 21.92**
- **MAPE value for APAC Sales for ARIMA = 27.69**

Based on Lowest value of MAPE Classical Decomposition for APAC sales was chosen

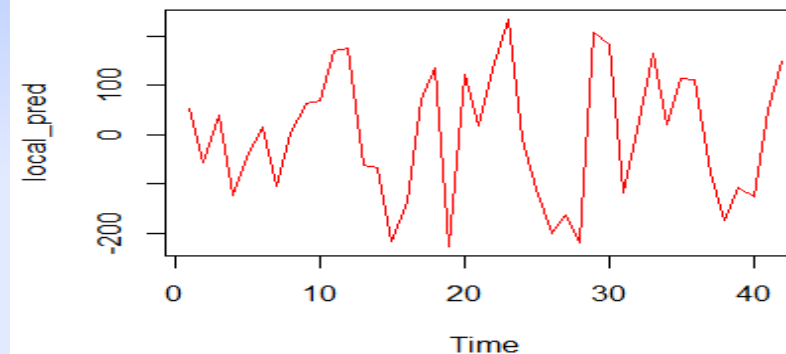# Classical Decomposition of APAC Quantity- Methodology

On smoothing the data , applied Sinusoidal regression

- Seasonal behavior is present
- Seasonal variation is expanding with time
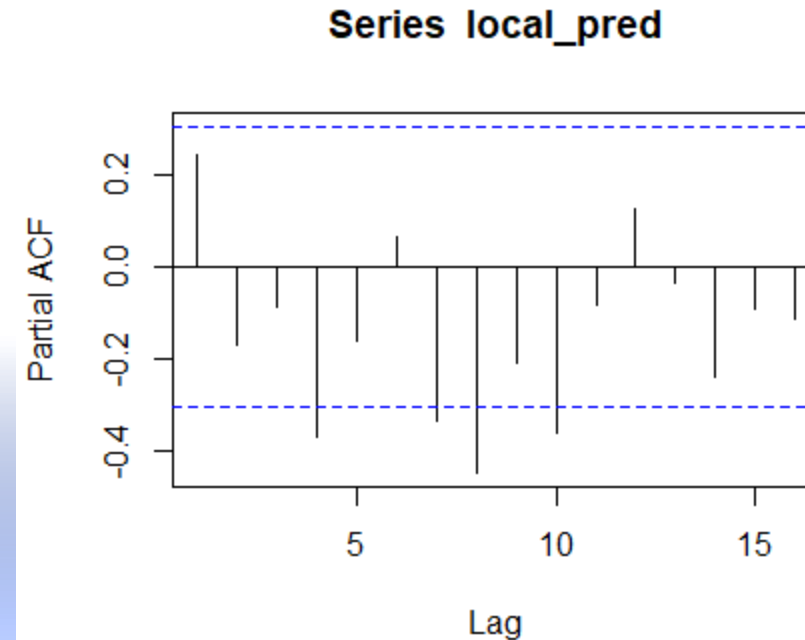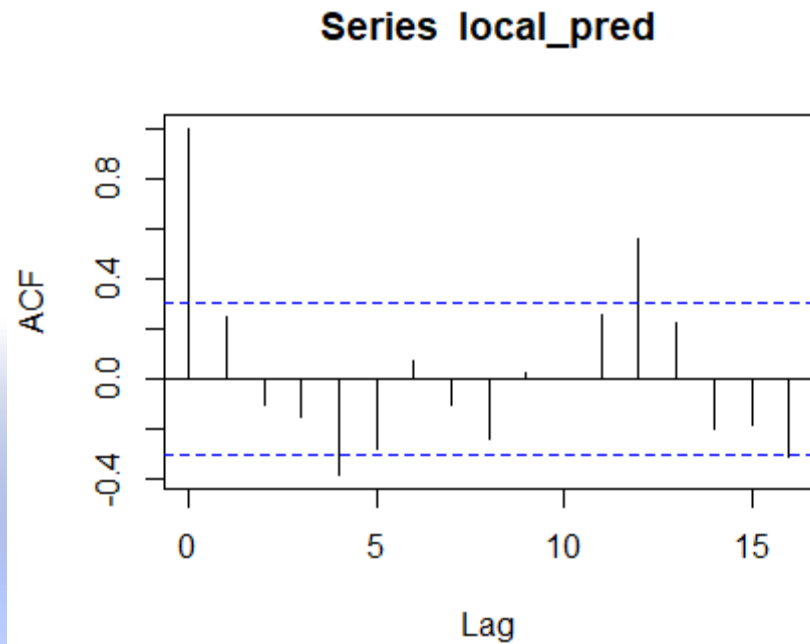- Amplitude is also expanding

Residue after removing global Trend

Is this White Noise ?

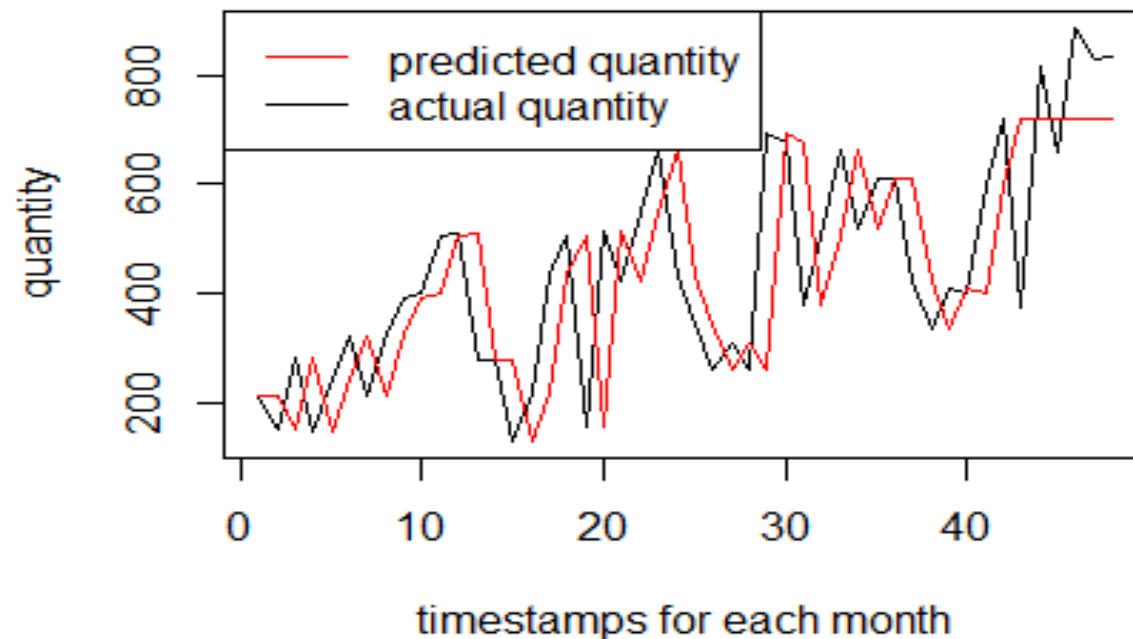# Classical Decomposition of APAC Quantity- Methodology

- **ACF is good, with 1 peak at 0 and rest within acceptable band. PACF is within acceptable range.**
- **ARMA model Fit using ARIMA**
  - **Best fit – ARIMA(0,0,0) – no differencing required**
  - **Order 0 AR and order 0 MA- no auto regressive behavior left in time series**
- **Residue seems to be white noise**
  - **p-value for dicky-fuller is 0.01(below 0.05 – which indicates null hypothesis cannot be supported and series is stationary)**
  - **p-value for kpss is 0.1(above 0.05 – null hypothesis is fair and series is stationary)**
    residual is white noise

Results: APAC Quantity
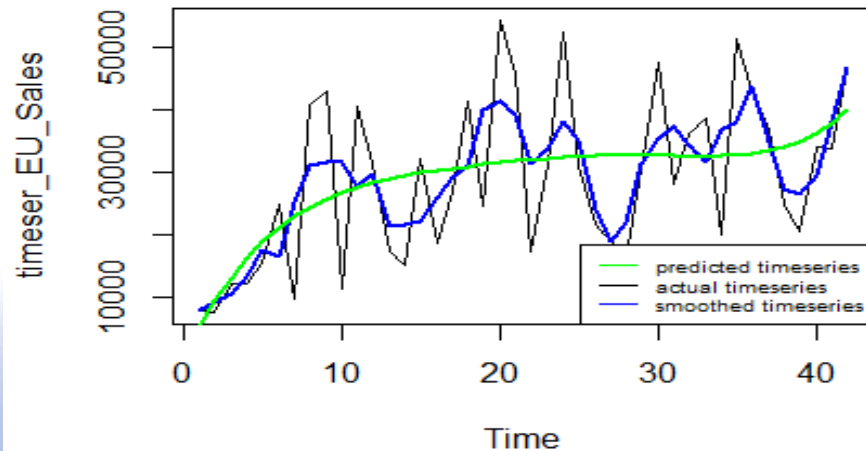
APAC QUANTITITY FOR CLASSICAL DECOMPOSITION
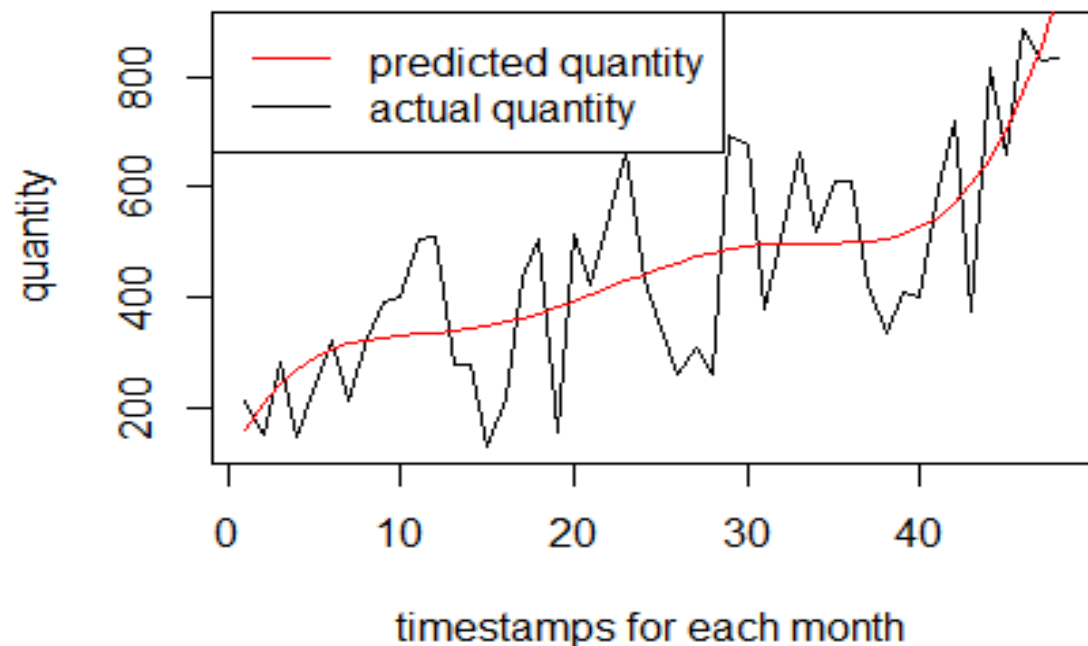
APAC QUANTITITY FOR ARIMA

- MAPE value for APAC Quantity for Classical Decomposition = 19.67
- MAPE value for APAC Quantity for ARIMA = 26.24

Based on Lowest value of MAPE, Classical Decomposition for APAC quantity was chosen
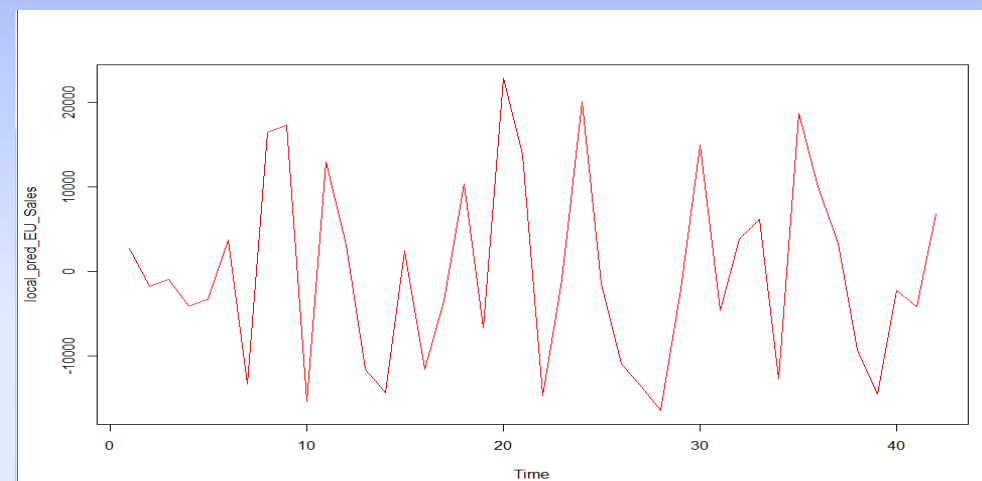
Classical Decomposition of EU Sales- Methodology

On smoothing the data , applied Sinusoidal regression

- Seasonal behavior is present
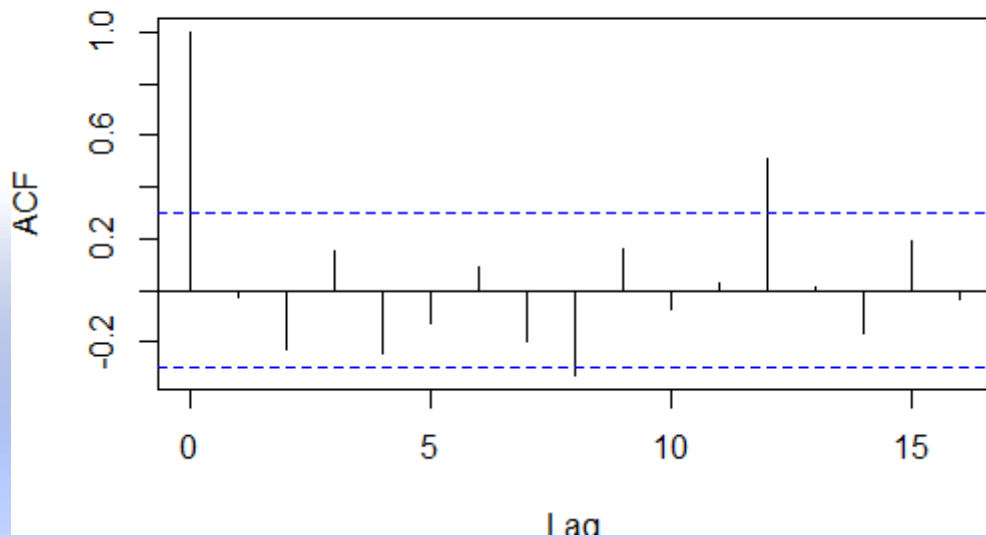- Seasonal variation is expanding with time
- Amplitude is also expanding

Residue after removing global Trend

Is this White Noise ?

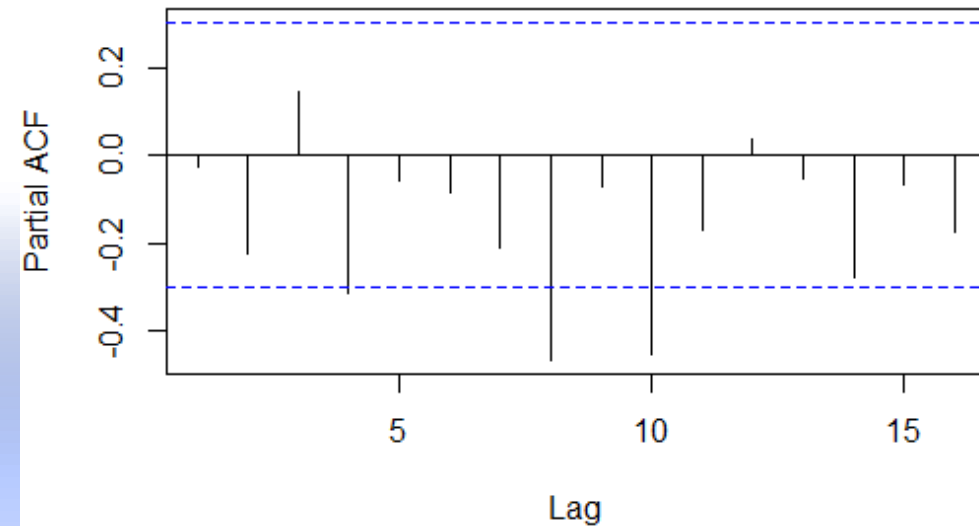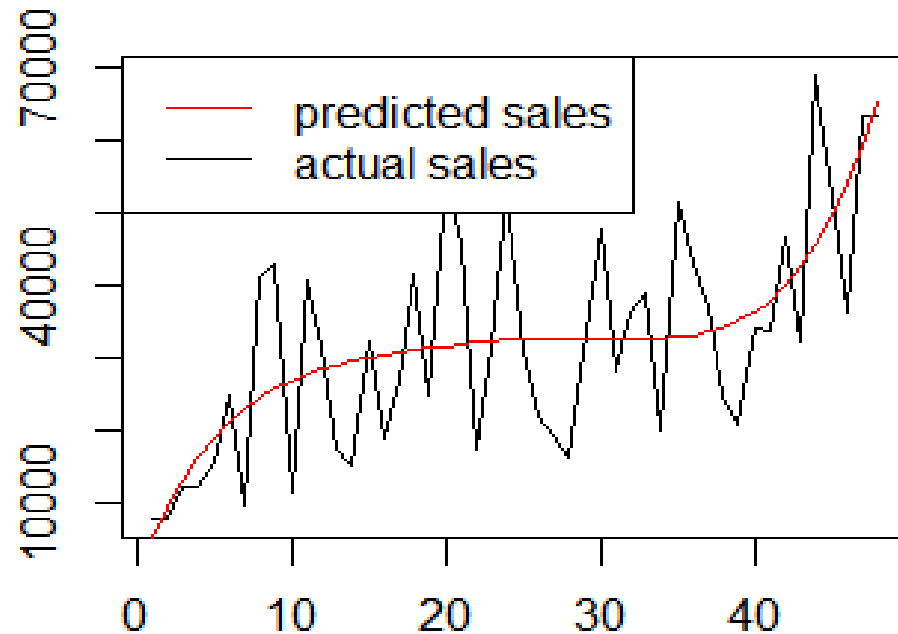# Classical Decomposition of EU Sales- Methodology

Series local_pred_EU_Sales (ACF plot) and Series local_pred_EU_Sales (Partial ACF plot)

- ACF is good, with 1 peak at 0 and rest within acceptable band. PACF is within acceptable range.
- ARMA model Fit using ARIMA
  - Best fit – ARIMA(0,0,0) – no differencing required
  - Order 0 AR and order 0 MA- no auto regressive behavior left in time series

- Residue seems to be white noise
  - p-value for dicky-fuller is 0.019(below 0.05 – which indicates null hypothesis cannot be supported and series is stationary)
  - p-value for kpss is 0.1(above 0.05 – null hypothesis is fair and series is stationary)
    residual is white noise

Results: EU Sales

EU SALES FOR CLASSICAL DECOMPOSITION

EU SALES FOR ARIMA

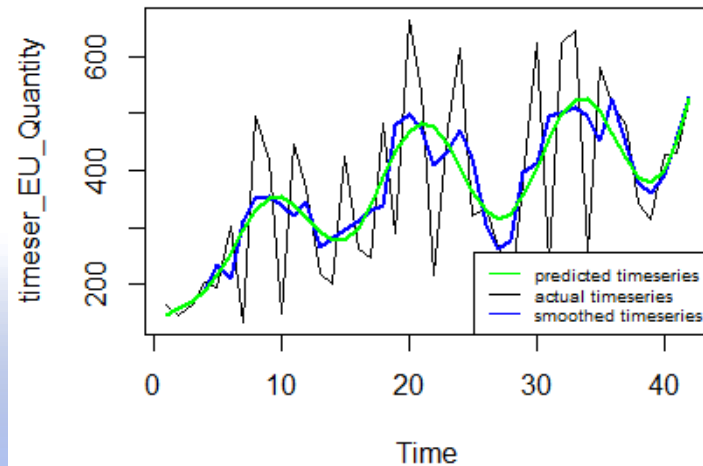actual sales in units of currency
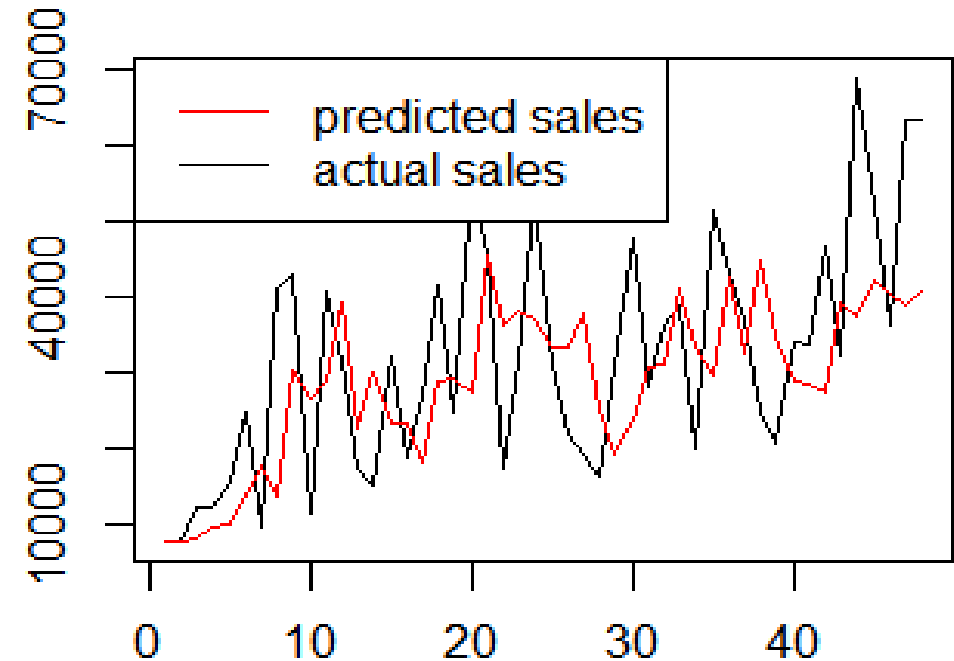
timestamps for each month

- MAPE value for EU Sales for Classical Decomposition = 21.72
- MAPE value for EU Sales for ARIMA = 28.92

Based on Lowest value of MAPE Clasical Decomposition for EU Sales was chosen

Classical Decomposition of EU Quantity- Methodology
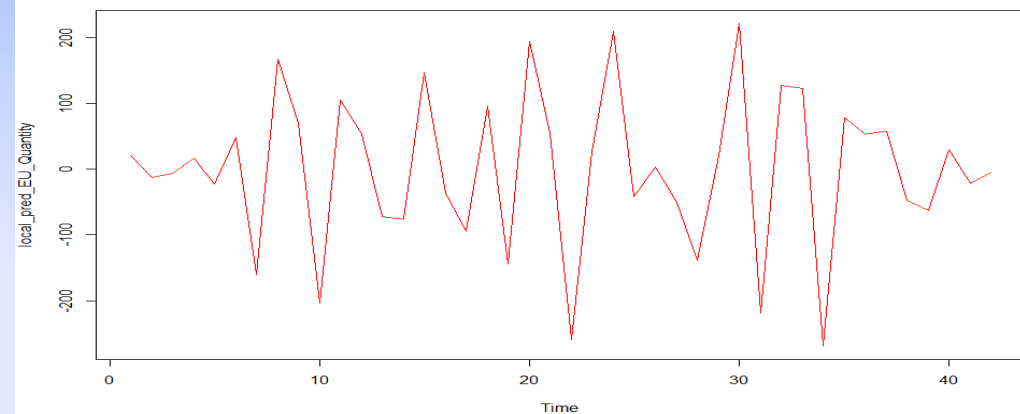

On smoothing the data , applied Sinusoidal regression

- Seasonal behavior is present
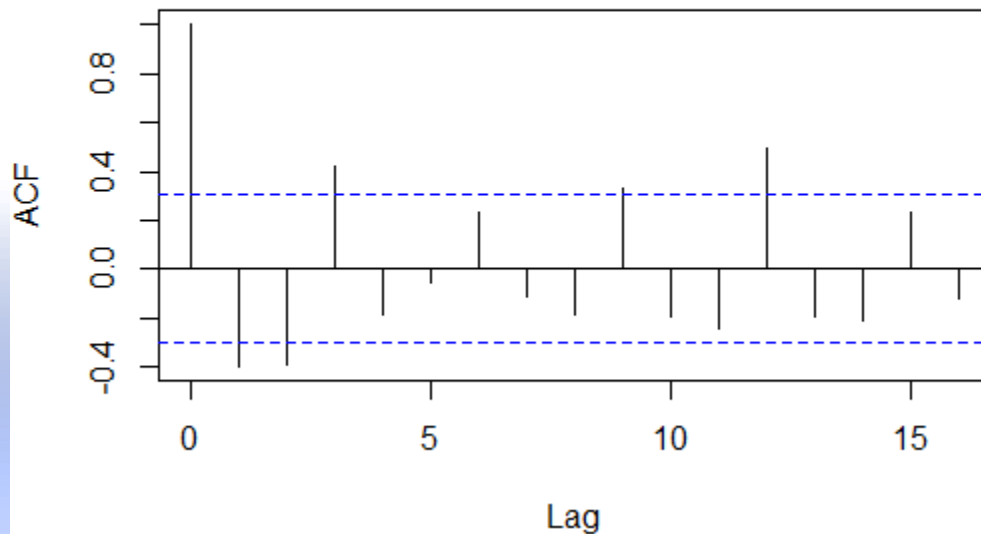- Seasonal variation is expanding with time
- Amplitude is also expanding

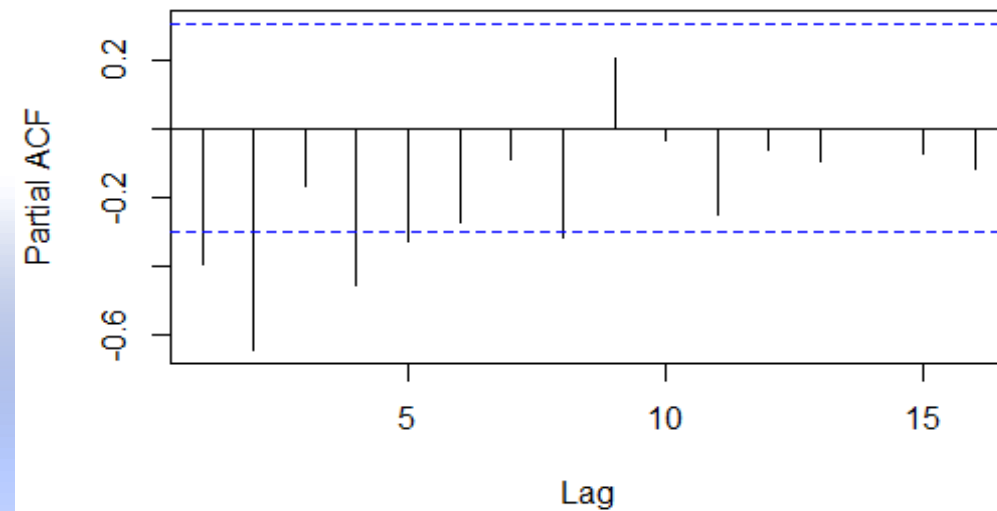Residue after removing global Trend

Is this White Noise ?

Classical Decomposition of EU Quantity- Methodology

Series local_pred_EU_Quantity

Series local_pred_EU_Quantity

- **ACF is good, with 1 peak at 0 and rest within acceptable band. PACF is within acceptable range.**
- **ARMA model Fit using ARIMA**
  - **Best fit – ARIMA(2,0,0) – no differencing required**
  - **Order 0 AR and order 0 MA- no auto regressive behavior left in time series**

- **Residue seems to be white noise**
  - **p-value for dicky-fuller is 0.01(below 0.05 – which indicates null hypothesis cannot be supported and series is stationary)**
  - **p-value for kpss is 0.1(above 0.05 – null hypothesis is fair and series is stationary)**
    residual is white noise

UpGrad

EU QUANTITITY FOR CLASSICAL DECOMPOSITION
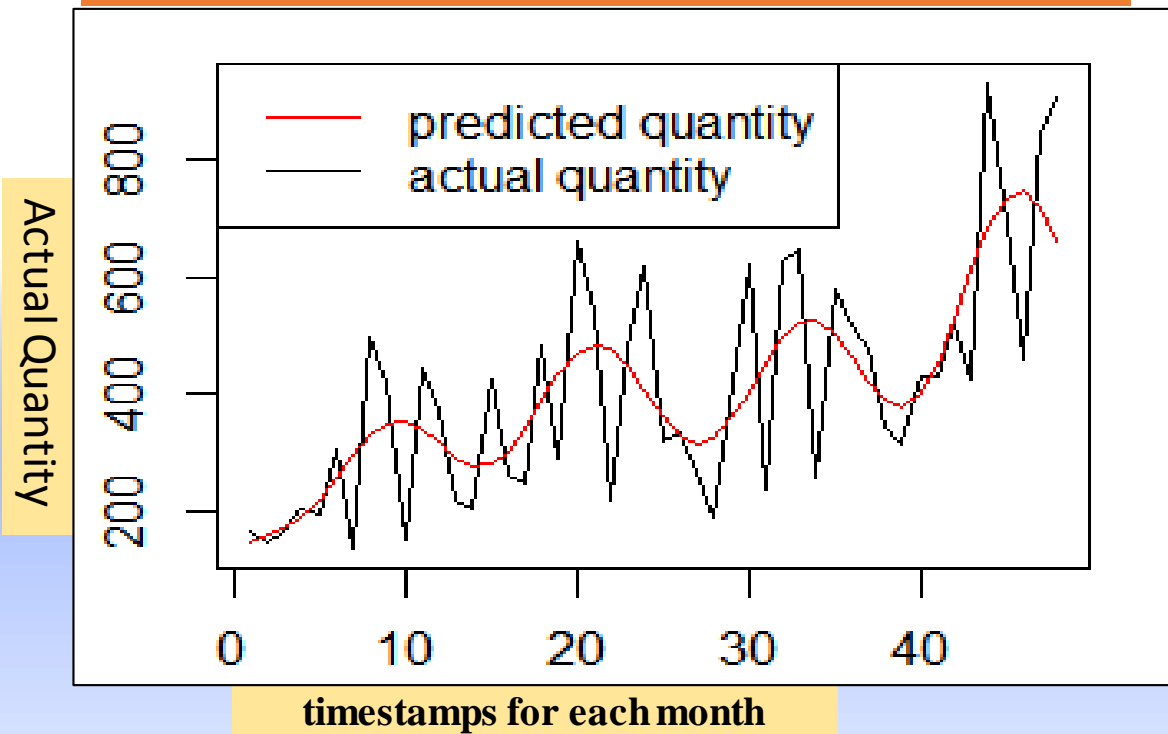
EU QUANTITITY FOR ARIMA
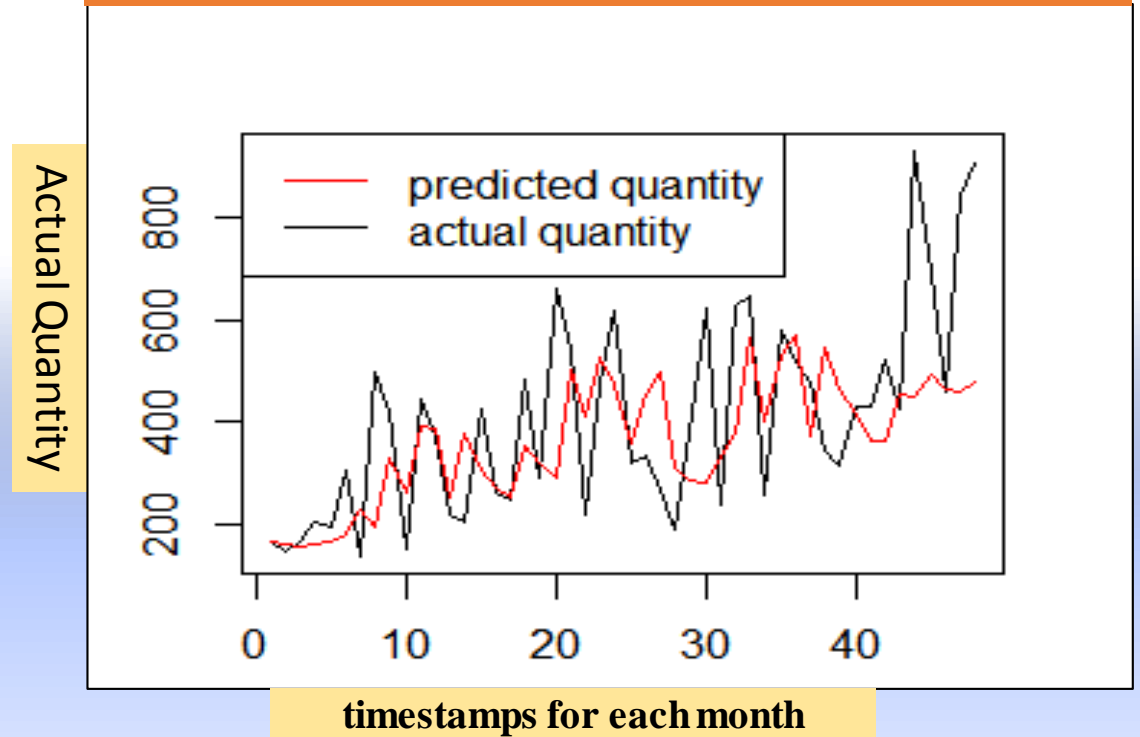
- MAPE value for EU Quantity for Classical Decomposition = 30.39
- MAPE value for EU Quantity for ARIMA = 30.133
- *Based on Lowest value of MAPE ARIMA for EU quantity was chosen*

Outcome

Market Segment	Classical Decomposition Model	ARIMA Model
APAC_Sales	MAPE=21.92	MAPE=27.69
APAC Quantity	MAPE=19.67	MAPE=26.24
EU Sales	MAPE=21.72	MAPE=28.92
EU Quantity	MAPE=30.39	MAPE=30.133

FORECAST FOR SALES AND QUANTITY REQUIREMENT IN FUTURE 6 MONTHS

MONTH / SEGMENT	1	2	3	4	5	6
APAC CONSUMER Sales	62,768.48	69,143.97	76,736.95	85,639.15	95,933.62	107,693.05
APAC CONSUMER QUANTITY	1,066.10	1,198.79	1,350.74	1,522.94	1,716.19	1,931.12
EU CONSUMER Sales	72,231.06	80,138.12	89,030.24	98,947.03	109,920.11	121,972.14
EU CONSUMER QUANTITY	466.25	463.74	472.95	467.65	466.14	470.37

CONCLUSION

From a business strategy planning perspective the sales manager is given the following recommendation

Out of the available 21 Market Segments
- Most consistently profitable segments are APAC and EU in consumer products category
- 6 months Sales and Demand forecast is done for these Segment which shows an increasing trends for next 6 months
- One of the Industry wide used Machine Learning modeling technique i.e. Time Series is used for Prediction
- Model is evaluated with Classical Decomposition and Auto ARIMA mechanism of Time Series to arrive at accurate prediction and effective forecast based on past data

Sales Manager now has good visibility to manage his demand and revenue for these segments and also knows that these 2 segments to be prioritized as they are most profitable

THANK YOU