Time Series Management

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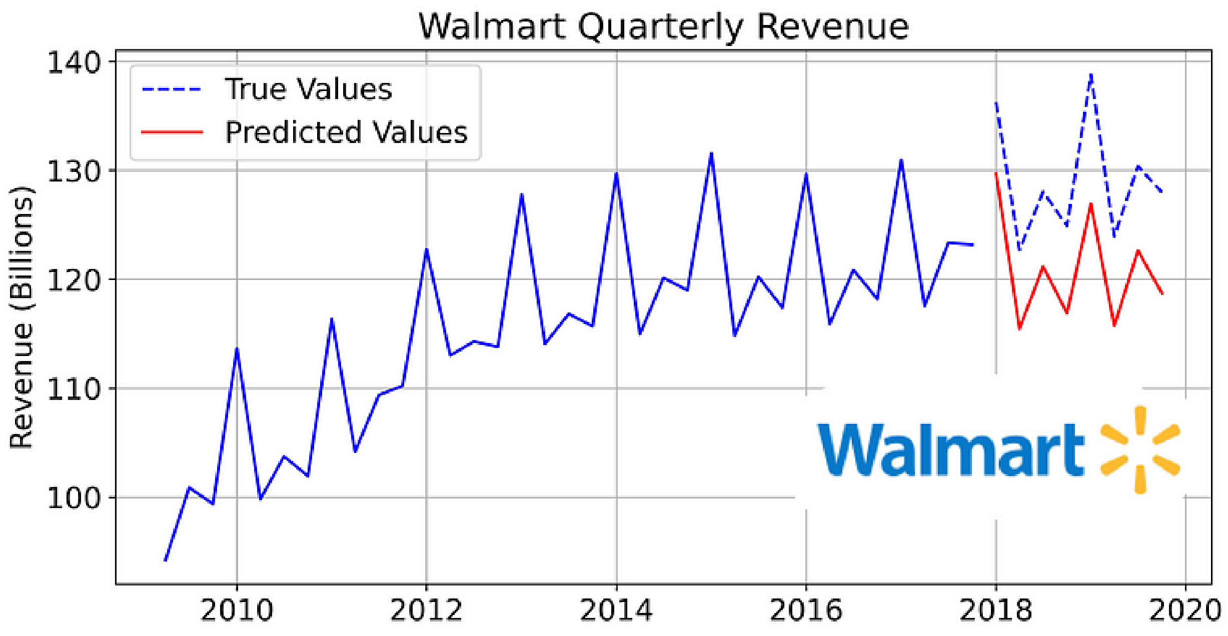
Syllabus

- Time series data
- Trend, seasonality, cycles and residuals
- Stationary processes
- Autoregressive processes.
- Moving average processes.
- ACF & PACF
- Fitting AR(p) MA(q) models

Time series data

- A **univariate time series** is a sequence of measurements of the same variable collected over time. Most often, the measurements are made at regular time intervals.

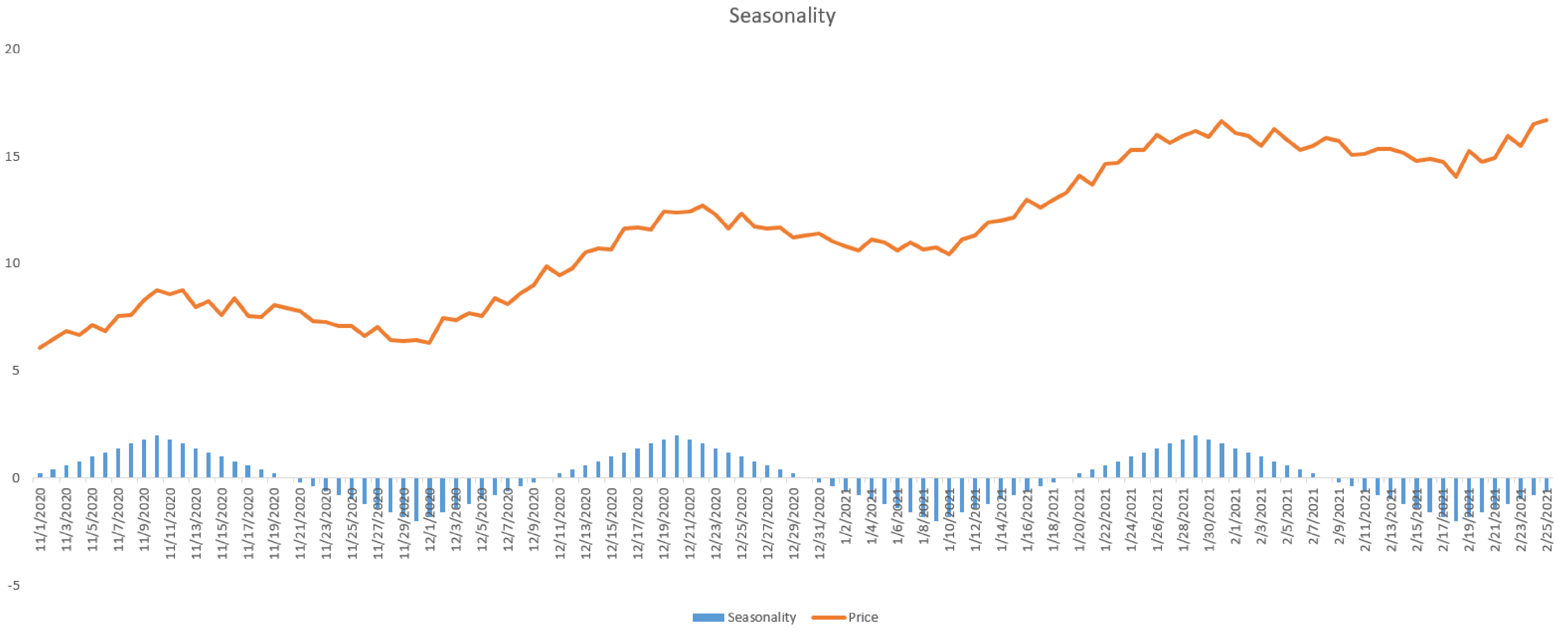


https://www.kaggle.com/code/anushkaml/walmart-time-series-sales-forecasting

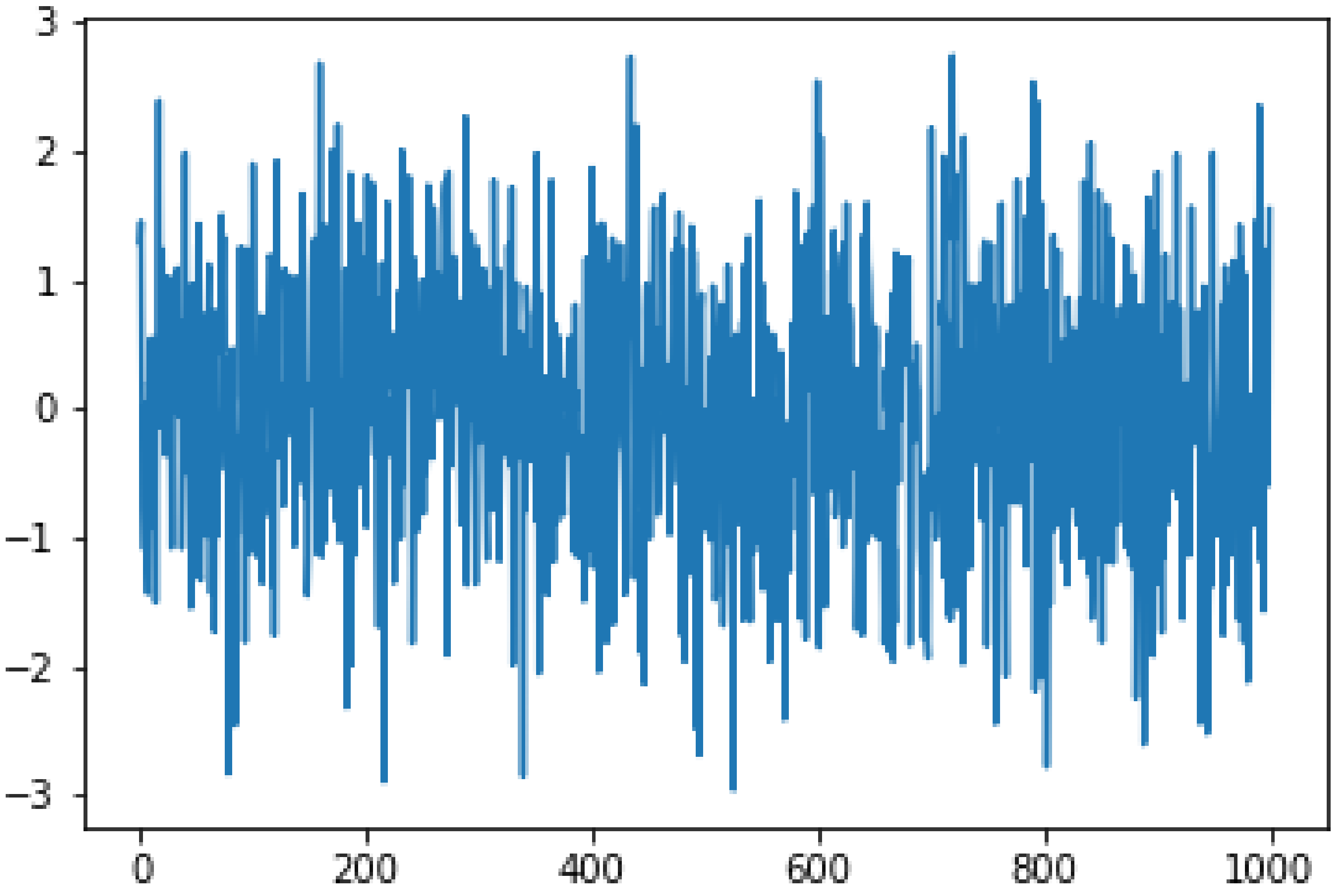
TS Trend


divyant published on TradingView.com, Apr 10, 2022 21:19 UTC+5:30
BAJAJ AUTO LTD, 1W, NSE 3776.20 +70.45 (+1.88%)
Higher tops
Higher lows
Uptrend
INR
3000.00
2830.55
2600.00
2400.00
2200.00
2000.00
1800.00
1650.00
1530.00
1410.00
1290.00
1190.00
1090.00
1010.00
935.00
Jun
2011
Jun
2012
Jun
2013
Jul
2014
Jul
2015
Jul
2016
Jun
2017
TradingView

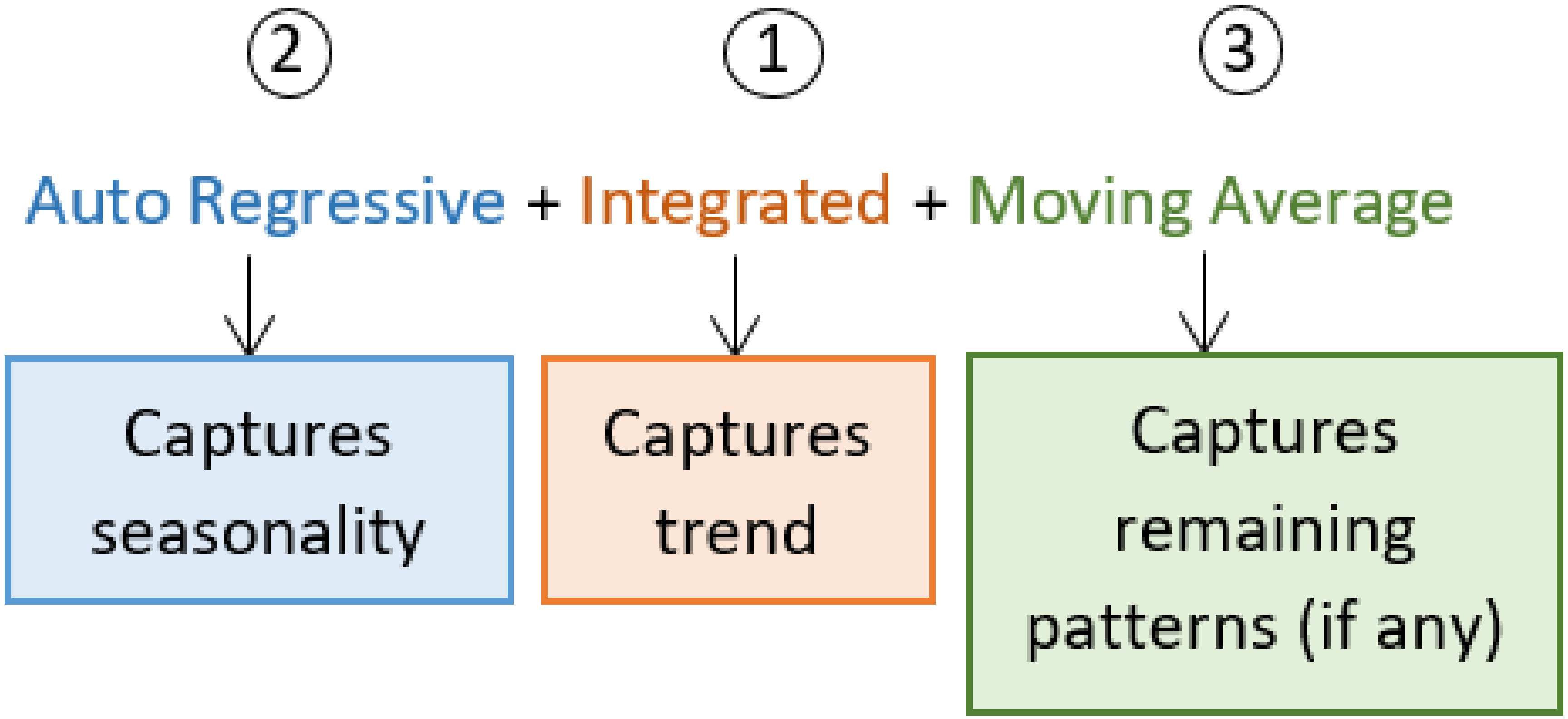
TS Seasonality and Ciclicality



TS Noise



Predictive models



https://www.linkedin.com/pulse/time-series-part-2-introduction-arima-models-using-excel-agarwal

ACF – Autocorrelation function

- **The sample autocorrelation function (ACF)** for a series gives correlations between the series $X_{[t]}$ and lagged values of the series for lags of 1,2,3 and so on. We represent a lagged series with $X_{[t-h]}$, where h := lag.

- Example: $X_{[t]}$ = [1,2,3,4,…] , $X_{[t-1]}$ = [2,3,4,…], $X_{[t-2]}$ = [3,4,…], …

$$\frac{Covariance(X_{[t]}, X_{[t-h]})}{Std.Dev.(X_{[t]})Std.Dev.(X_{[t-h]})}$$

PACF – Partial Autocorrelation function

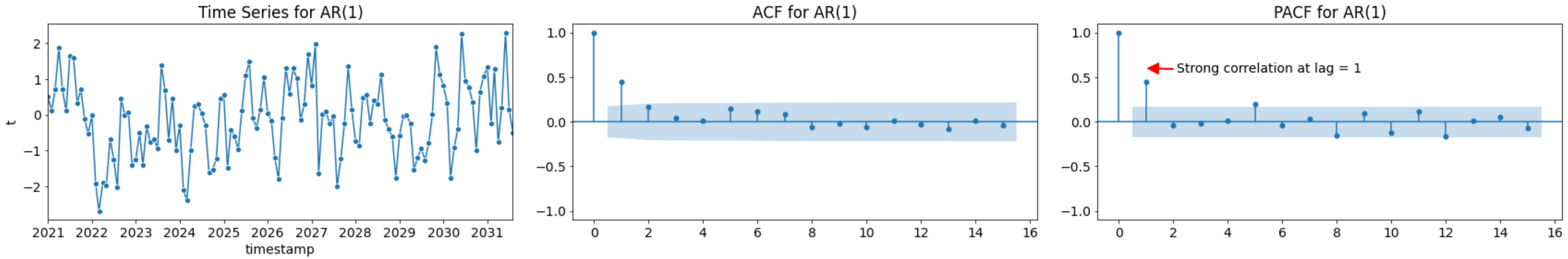
In general, a partial correlation is a conditional correlation, namely the correlation between two variables under the assumption that we know and take into account the values of some other set of variables.

If we assume that $\boldsymbol{X_t = C + \varphi_1 X_{t-1} + \varphi_2 X_{t-2}}$ **+ …**

We may want to consider the (partial) dependency between $\boldsymbol{X_{t-3}}$ to $\boldsymbol{X_t}$. Hence, PACF of order 3:

$$\frac{Covariance(X_{[t]}, X_{[t-3]} | X_{[t-2]}, X_{[t-1]})}{\sqrt{Variance(X_{[t]} | X_{[t-1]}, X_{[t-2]}) Variance(X_{[t-3]} | X_{[t-1]}, X_{[t-2]})}}$$

ACF – PACF Examples

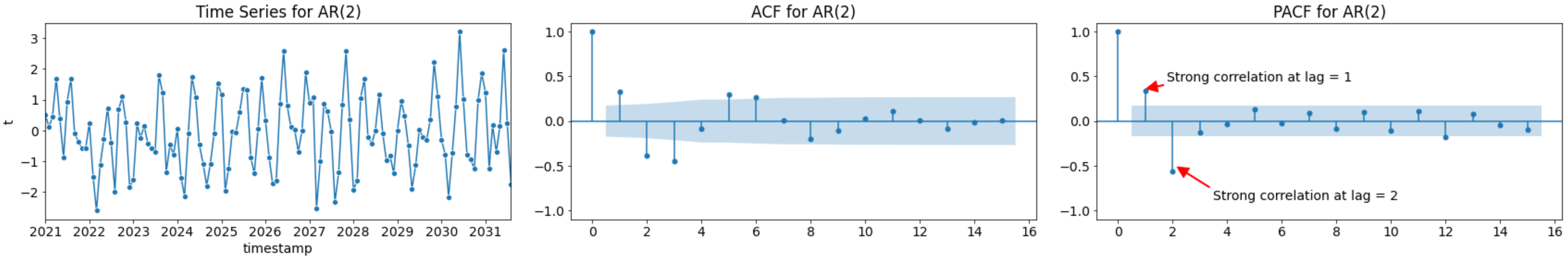


AR(p= 1)

ACF Tails off (Geometric decay)

PACF Significant at each lag p / Cuts off after lag p

ACF – PACF Examples

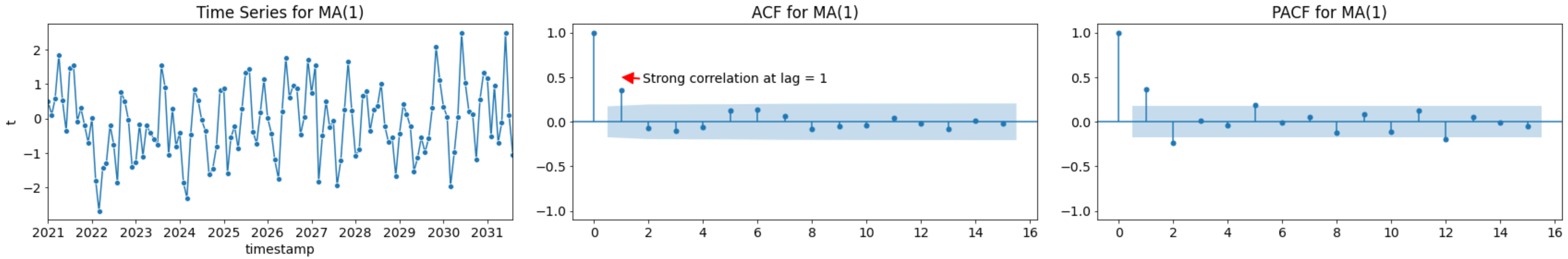


AR(p= 2)

ACF Tails off (Geometric decay)

PACF Significant at each lag p / Cuts off after lag p

ACF – PACF Examples

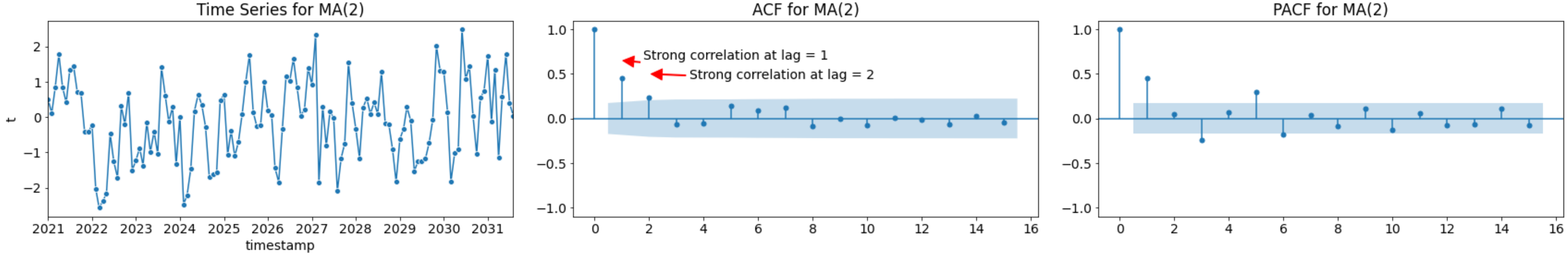


MA(q = 1)

ACF Significant at lag q / Cuts off after lag q

PACF Tails off (Geometric decay)

ACF – PACF Examples

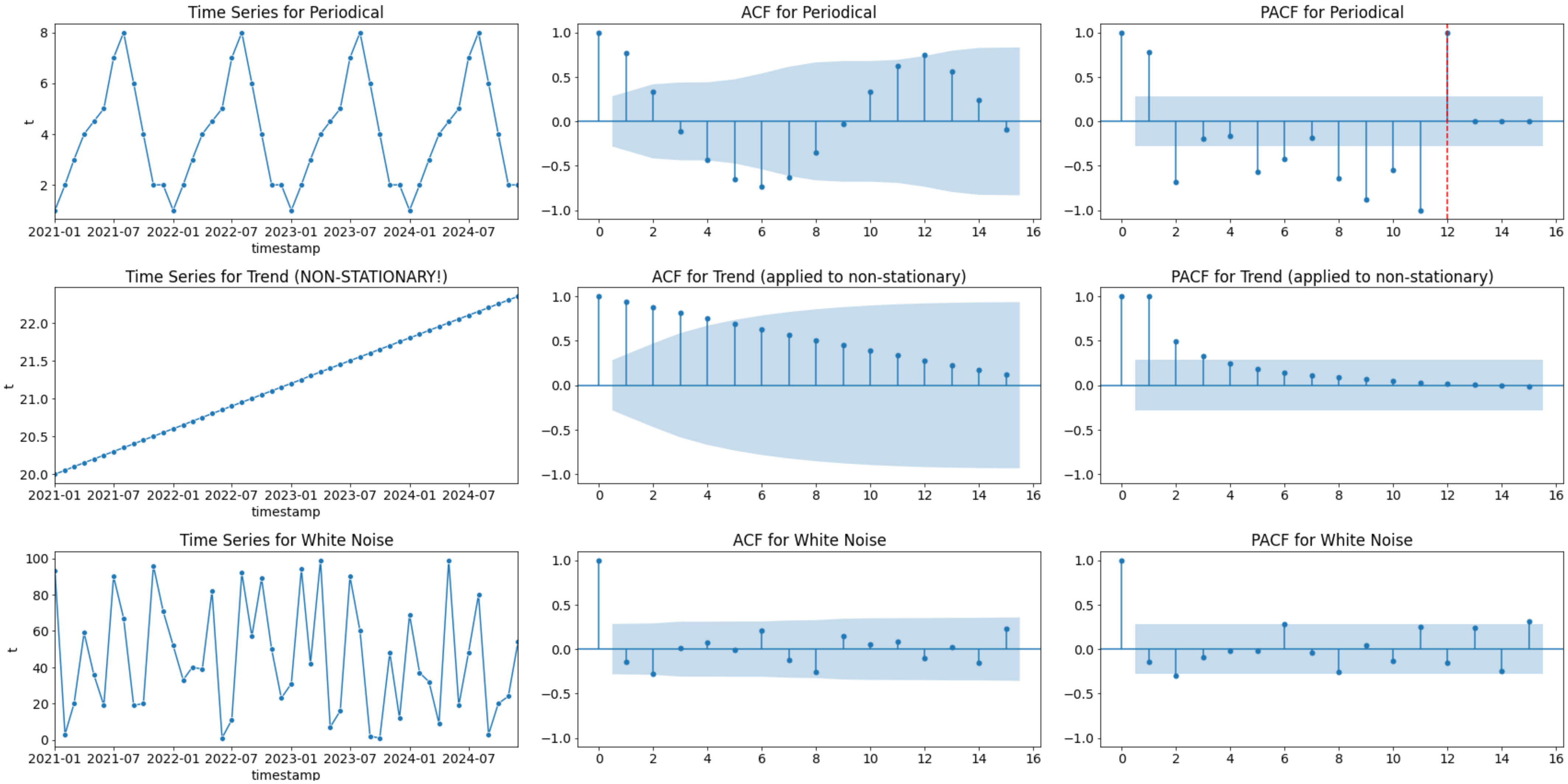


MA(q = 2)

ACF Significant at lag q / Cuts off after lag q

PACF Tails off (Geometric decay)

ACF – PACF Examples … continue



References

- Andrew V. Metcalfe, **Paul S.P. Cowpertwait, Introductory Time Series with R** (2009).

- Aileen Nielsen, **Practical Time Series Analysis: Prediction with Statistics and Machine Learning** (2019).