Time Series = Trend + Seasonality + Error → 0

1. Stationarity
2. ACF and PACF

} Foundations of Models like AR, MA, ARMA "ARIMA, SARIMA"

1. Stationarity

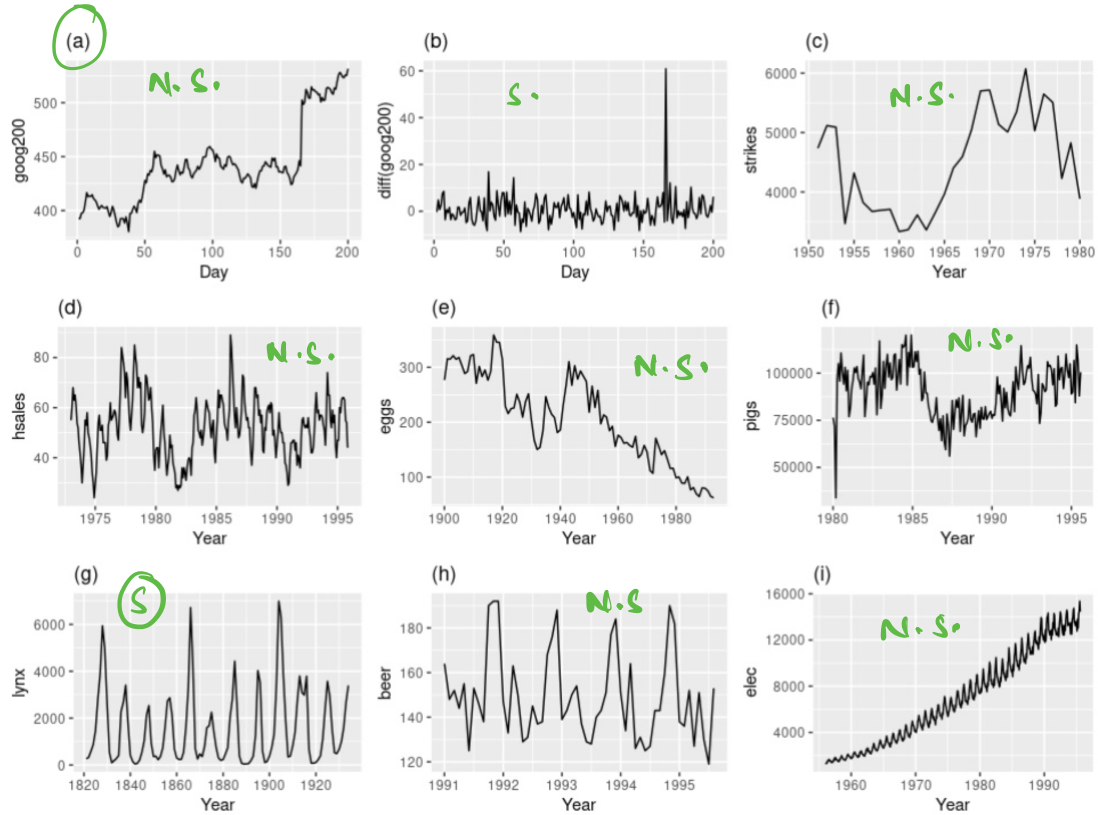
↳ T.S. is stationary if it's statistical behaviour does not change over time.

→ Average level (mean) stays roughly the same
→ The spread (variance) stays roughly the same.
→ The patterns of ups & downs is consistent.

T.S. forecasting is based on assumption:

↳ what happened in the past will repeat in future.

* Stationarity ensures that 'past' is meaningful




ADF → "Augmented Dickey - Fuller Test"

→ Tests

→ Statistical method designed for testing of 'stationarity'

p-value < 0.05 → S

≥ 0.05 → N.S

Sales Data : p-value ≃ 0.94 ≥ 0.05

T.S. → Non-stationary

Q. How do we convert Non-Stationary T.S to a Stationary T.S?

Ans: We can remove

↳ trend
↳ seasonality

} one-by-one

Removal of trend & seasonality is steps is called as ~

- De-trending
- De-seasonaling

$$\boxed{\hat{Y}_t = m * x_t + c + s(t) + r(t)}$$

where, $m * x_t + c \longrightarrow$ TREND

(i) Differentiating by 't'

$$\frac{d}{dt}(\hat{Y}_t) = m$$ , which is a constant.

$$\boxed{\text{value}(t+1) \simeq y(t+1) - y(t)}$$

Also, called as differencing

$$Y(t) = b(t) + s(t) + e(t)$$

$\downarrow$ Differentiating

$$y'(t) = \text{cons.} + s'(t) + e'(t)$$

↳ Trend is gone

(ii) De-seasonaling (m-differencing)

Dec-2018 → Dec-2017 → Dec-2016

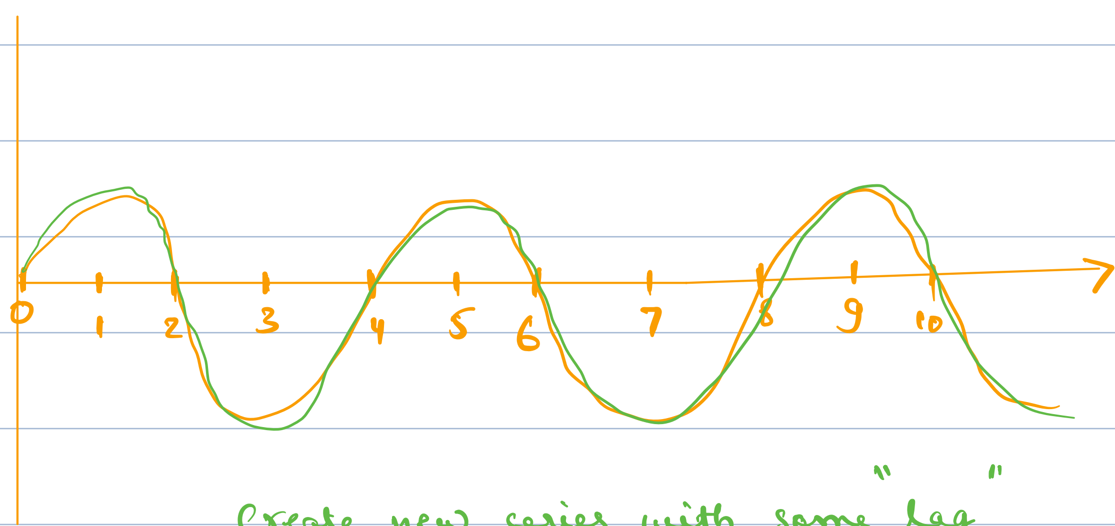
$$\Delta y = y_t - y_{t-m}$$

In our sales data, we have monthy data, $m = 12$

$$\Delta y = y_t - y_{t-12}$$

① ACF → Auto-correlation function

Q: How to get optimal value of m?




Create new series with some "lag"

lag = 1

lag = 2

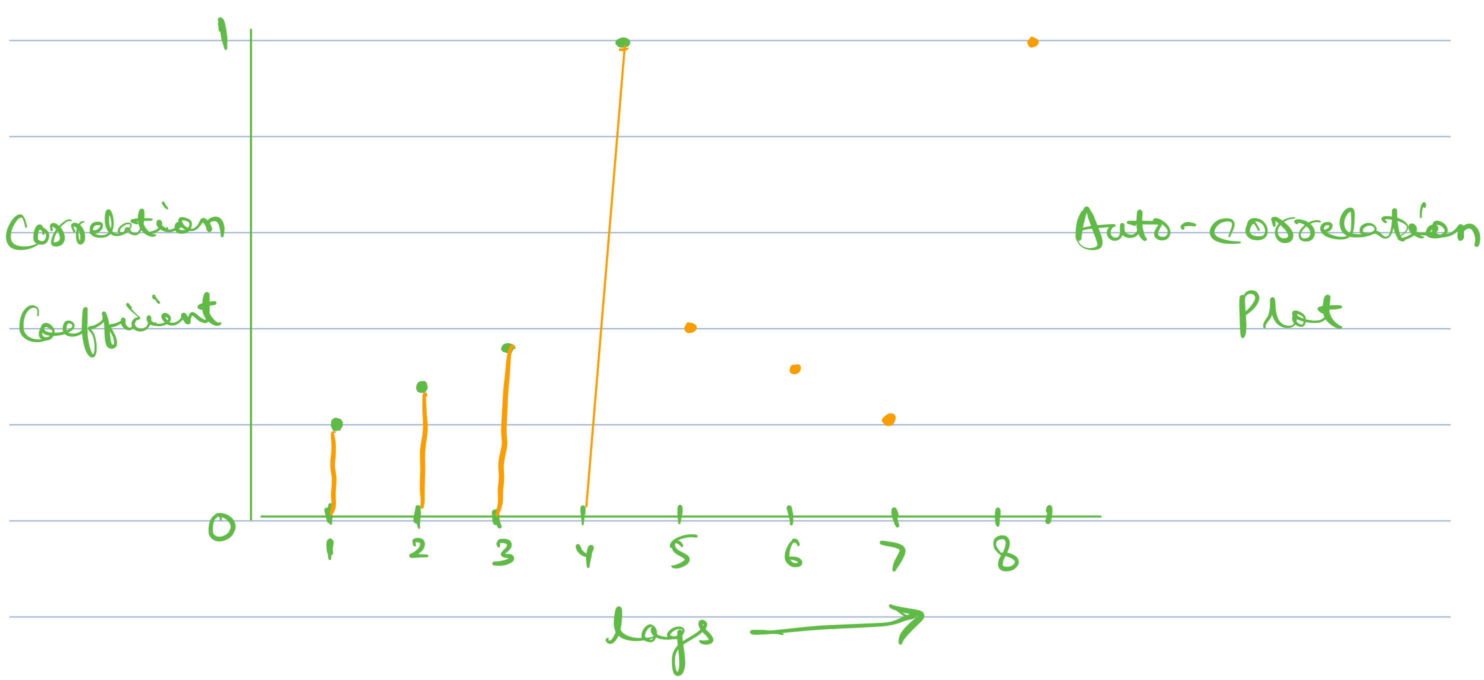
lag = 3

lag = 4 → OVERLAP

$\boxed{\text{lag} = 2}$

Approach:

1. Given our T.S $y(t)$
2. We consider another T.S where we introduce a lag of 1
   i.e. shift the T.S by 1 unit. $\longrightarrow y_1(t)$
3. Find the correlation coefficient between $y(t)$ & $y_1(t)$
4. Similarly, find CC between
   $y(t)$ and T.S lagged by 'i' units
   $i = 1, 2, 3, 4, \ldots$
5. By doing so, we would find a value of 'i'
   where lagged T.S. will roughly overlap over original. T.S



f (lags) = correlation coeff.

"ACF"

ACF Plot

↳ gives use CC. for all lags

↳ try with de-trending

↳ try with de-seasonaling

② PACF (Partial ACF)

↳ Similar to ACF, with a small difference.

↓

* All intermediate / indirect correlations are removed

Lets say, we consider $y(t)$ and $y^{12}(t)$

Then, we do not want this CC to get affected/corrupted by intermediate c.c. like $i = 1, 2, 3 \ldots$"