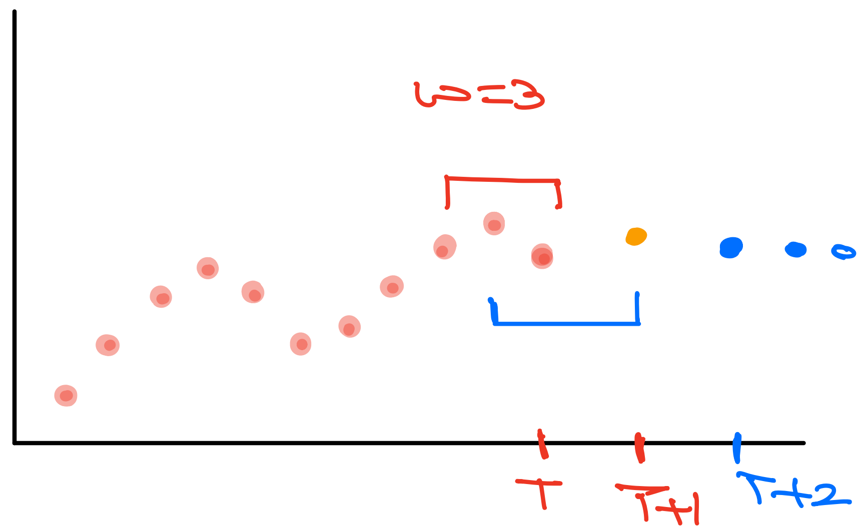
Agenda

Drift Method

- Smoothing Family
  - Moving Average for forecasting
  - Exponential Smoothing Family
    - SES
    - DES
    - TES
- Stationarity in Time-series
- ACF and PACF for determining seasonality window

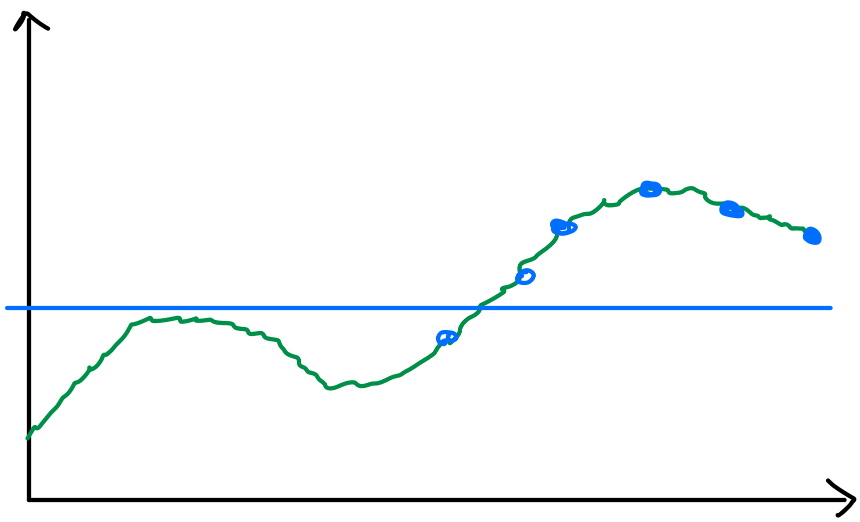
Moving Average

We need window_size



Exponential Smoothing

* SES = Simple Exponential Smoothing
    - ⇒ It consider all the data points
    - ⇒ It gives more weightage to recent points



$$\hat{y}_{t+h} = \alpha y_t + (1-\alpha)\hat{y}_{t-1}$$

$$\downarrow$$

$$[\alpha y_{t-1} + (1-\alpha)\hat{y}_{t-2}]$$

$$\Rightarrow \alpha y_t + (1-\alpha)[\alpha y_{t-1} + (1-\alpha)\hat{y}_{t-2}]$$

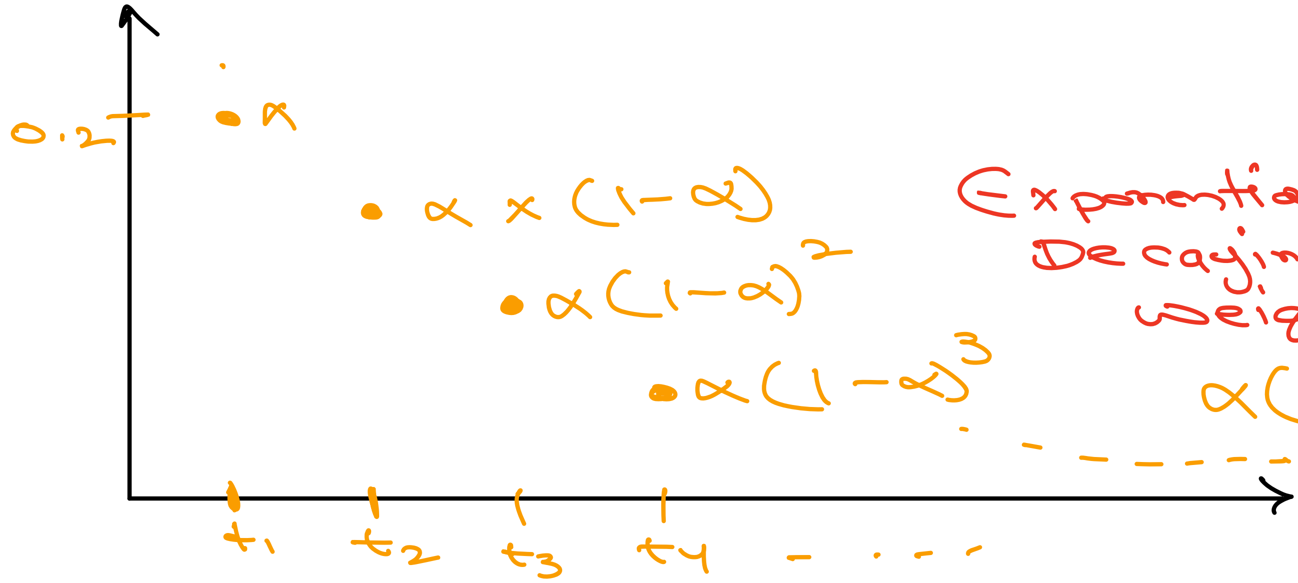
$$\Rightarrow \alpha y_t + (1-\alpha)\times\alpha\cdot y_{t-1} + (1-\alpha)^2\hat{y}_{t-2}$$

$$\downarrow$$

$$\alpha(y_{t-2}$$

$$\Rightarrow \alpha \cdot y_t + (1-\alpha)\times\alpha\cdot y_{t-1} + (1-\alpha)^2\alpha\, y_{t-2}$$

(recent) Second recent " " "



Exponentially Decaying weights

$\alpha(1-\alpha)^{n-1}$

$\alpha \to 1 \longrightarrow$ Naive mode

$\alpha \to 0 \longrightarrow$ 0 will remove impact of latest point

Similar to mean model

Recommended Value for alpha

$$\alpha \Rightarrow \frac{1}{2\times \text{Seasonality\_window}}$$

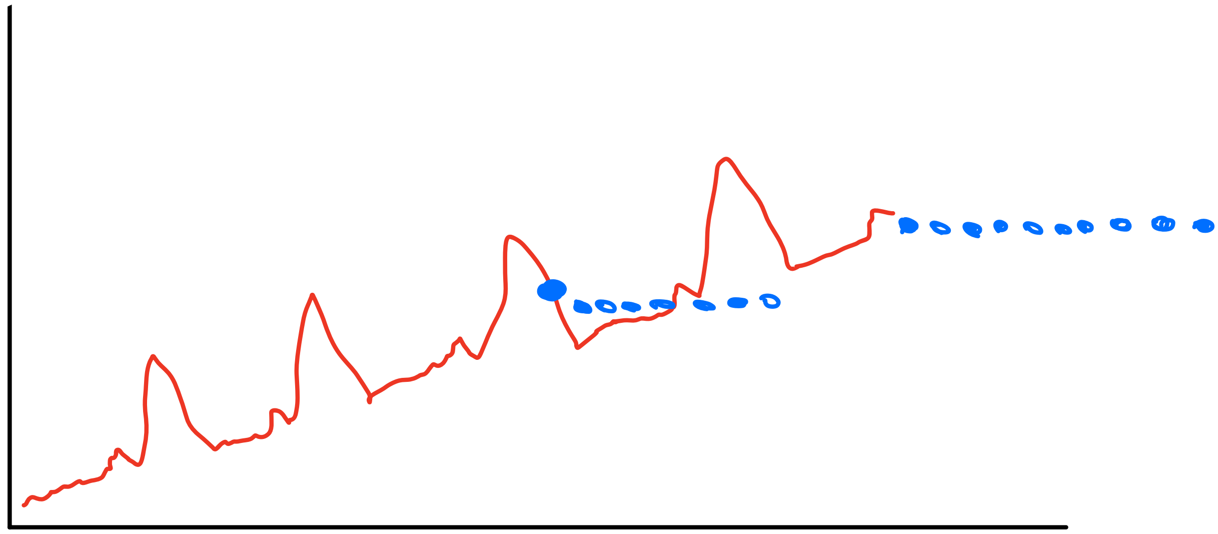
$\alpha(1-\alpha)$

$(0.2)\times 0.8\times 0.8$

Ex: $\alpha = 0.2$

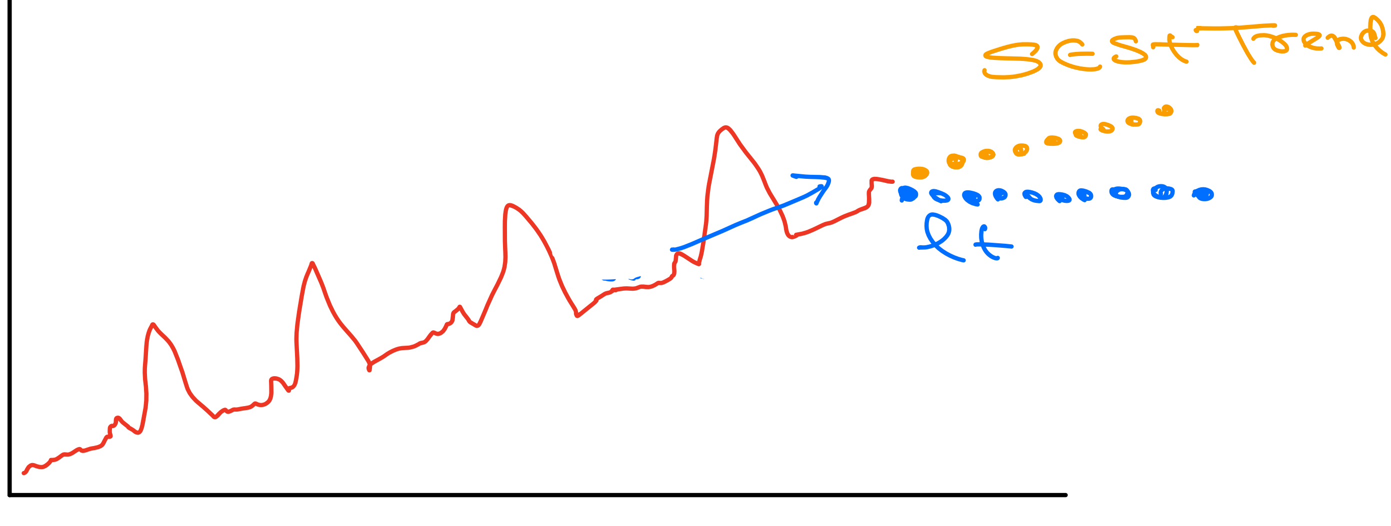
y_t	y_{t-1}	y_{t-2}	
0.2	0.16	0.128	......

$\frac{1}{2\times 12} \Rightarrow \frac{1}{24}$



SES gives us a reasonable level of the series

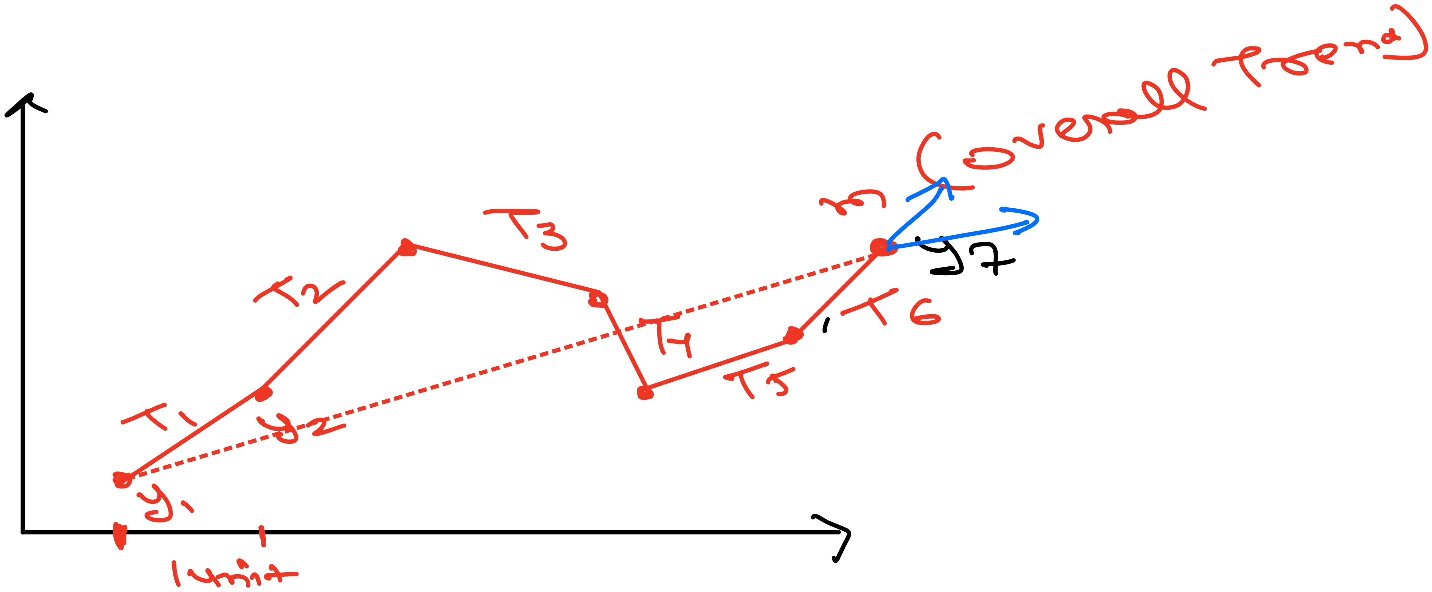
Double Exp Smoothing
DES



* Additive Model

m x

$$\hat{y}_{t+h} \Rightarrow l_t + h(b_t)$$



Trend ⇒ Slope (rate of change)

$$\Delta y = \frac{(y_2 - y_1)}{1}$$

Which Trend shall we pick

(a) Overall Trend ⇒ m

(b) Take only recent trend ⇒ T_6

* Can we calculate a reasonable estimate of trend?

DES

$$\boxed{b_t = \beta\,[l_t - l_{t-1}] + (1-\beta)\, b_{t-1}}$$

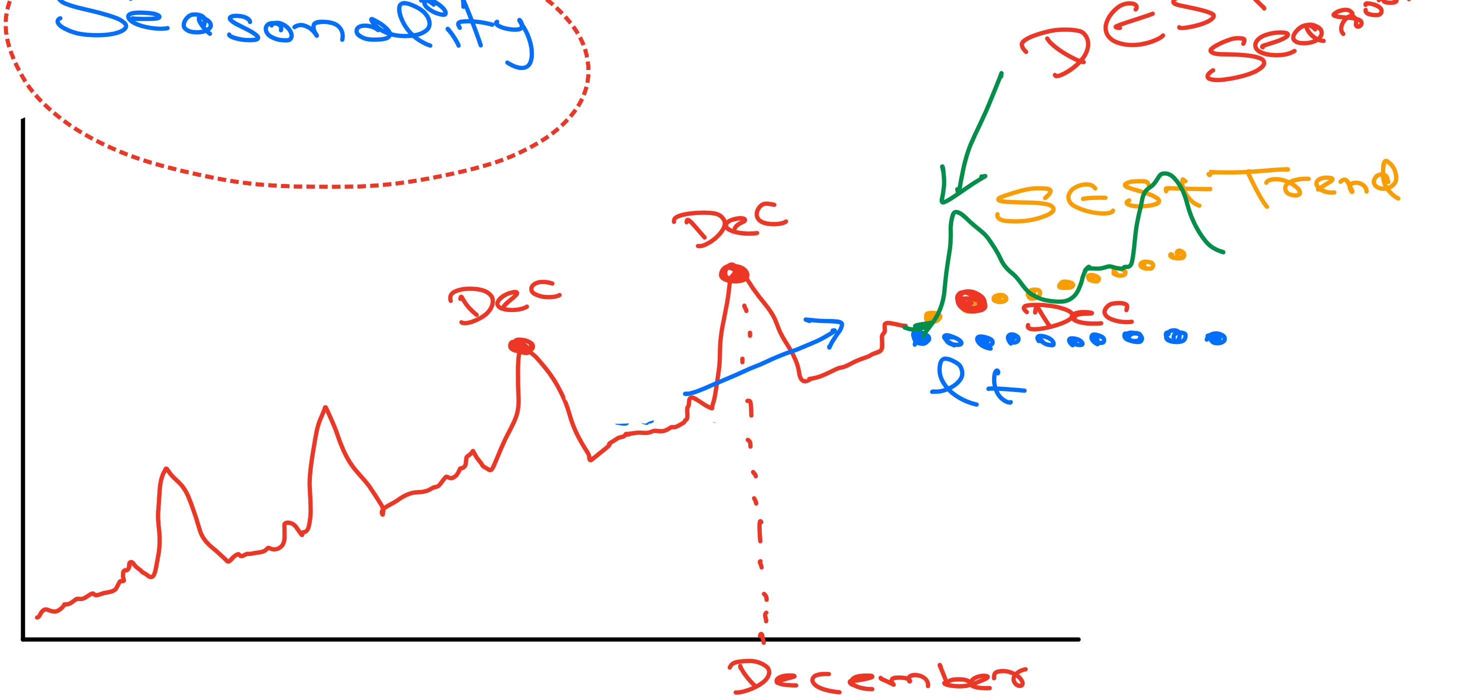
$$\hat{y}_{t+h} = l_t + h\, b_t$$

$$l_t = \alpha(y_t) + (1-\alpha)\underbrace{(l_{t-1} + b_{t-1})}_{\hat{y}_{t-1}}$$

Level ✓

Trend ✓

Seasonality

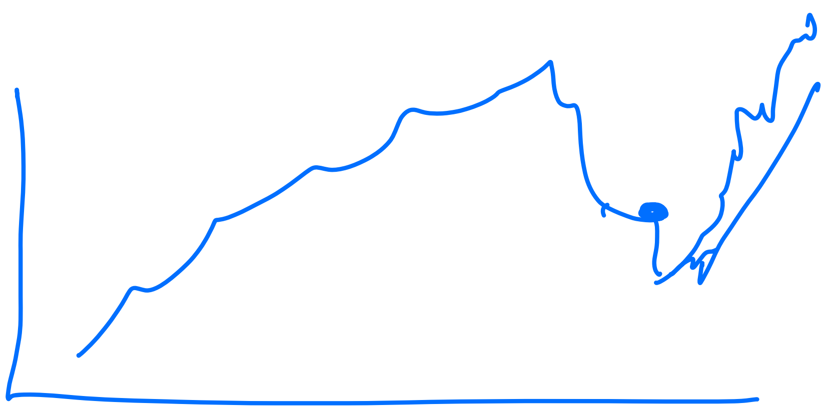


$\hat{y}_{Dec}$

Can we take all Dec sales and use Exponential Smoothing to decide impact of Seasonality

$$\hat{y}_{Dec_{2020}} \Rightarrow DES + \gamma(Dec2019) + \gamma(1-\gamma)(Dec2018) + \gamma(1-\gamma)^2(Dec2017) + \ldots + ---$$

$\hat{y}_{Jan20} \Rightarrow$



TES

$$\boxed{\hat{y}_{t+h} = l_t + h\, b_{(t)} + S_{t+h-m}}$$

Season window

↓

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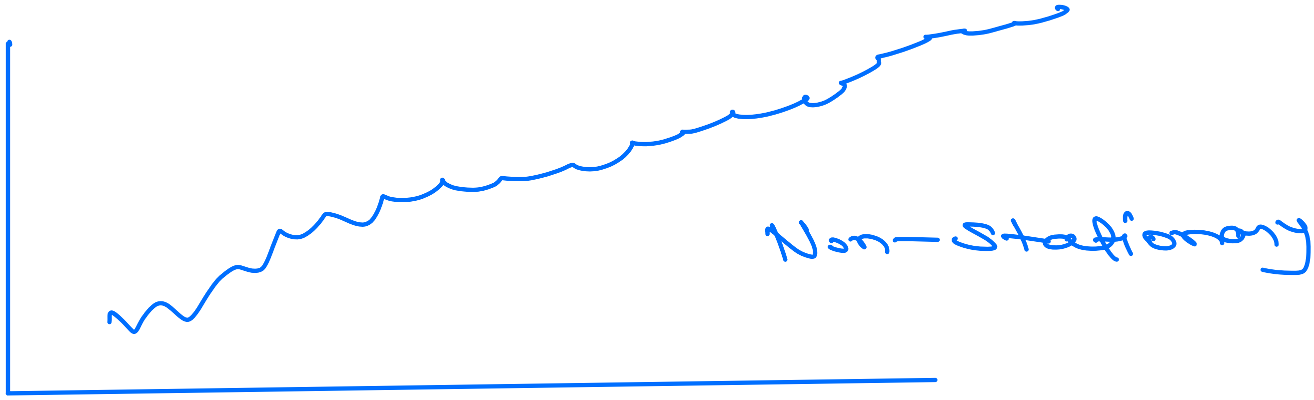
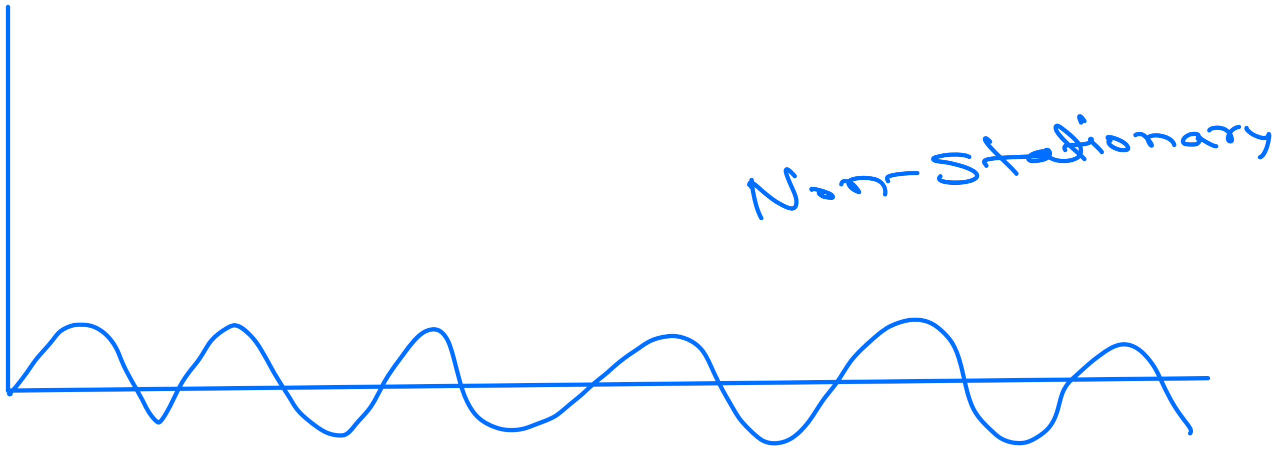
ACF and PACF

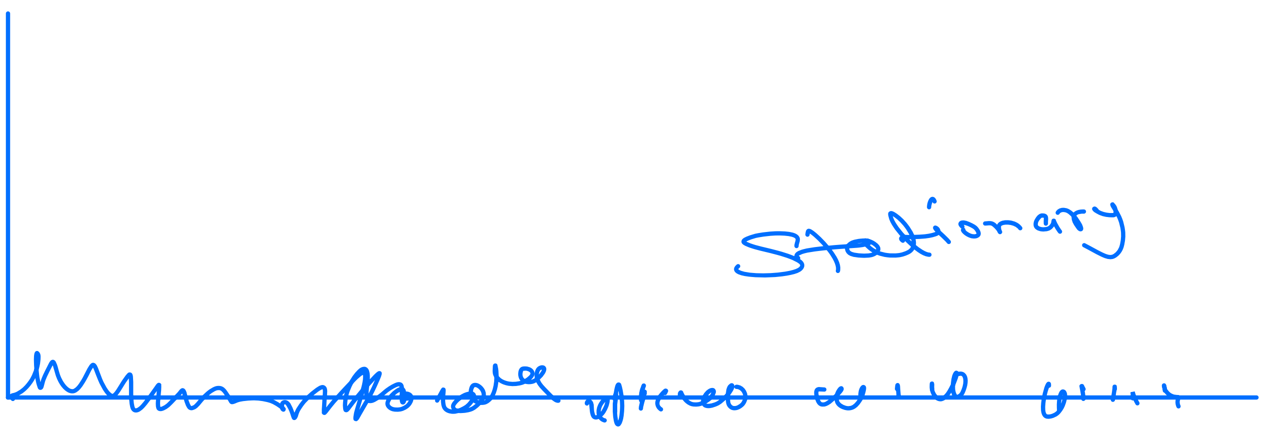
Stationarity

- The properties (mean, variance, amplitude, frequency) should be independent of Time
- i.e. time-series without trend and without seasonality is consider Stationary Time Series.

Ex







Test for Stationarity

- Dickey Fuller Test
- Returns a p-value score
- For time-series: P-value shall be less than 0.05

Topics Remaining

1) Make Time-Series Stationary

2) ACF and PACF.