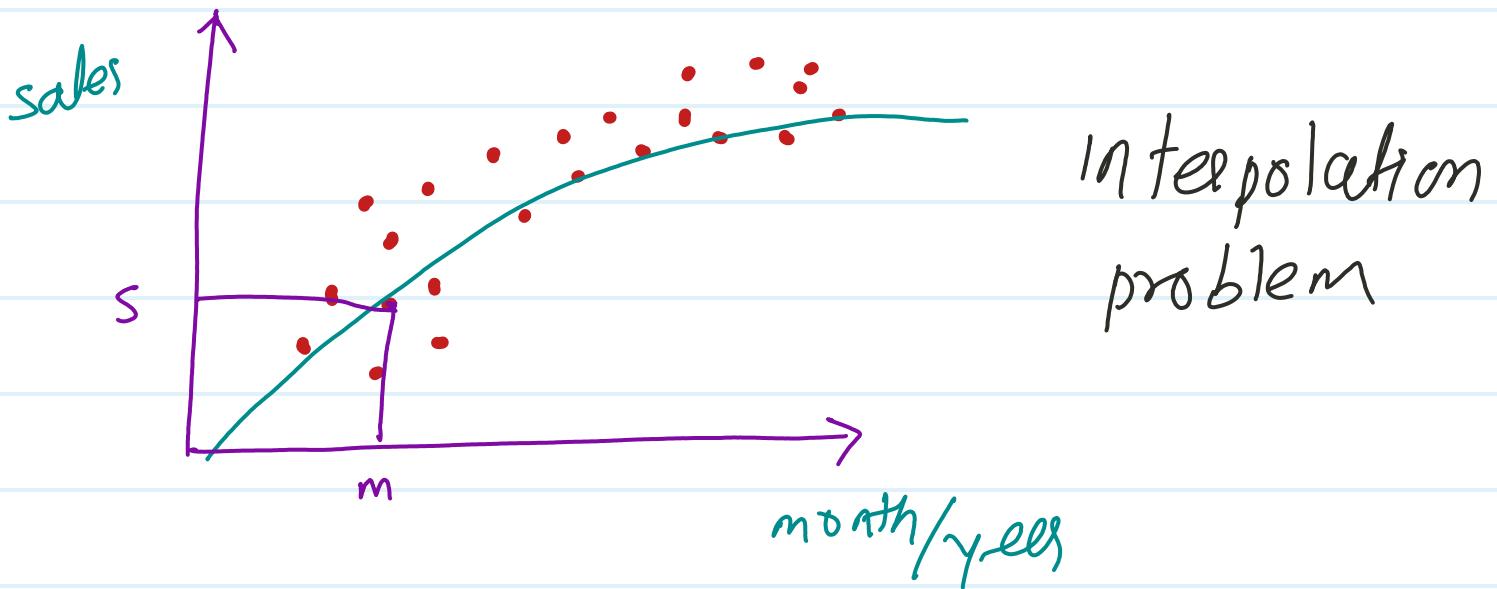


# Time Series

what Time series and non-Time series problem

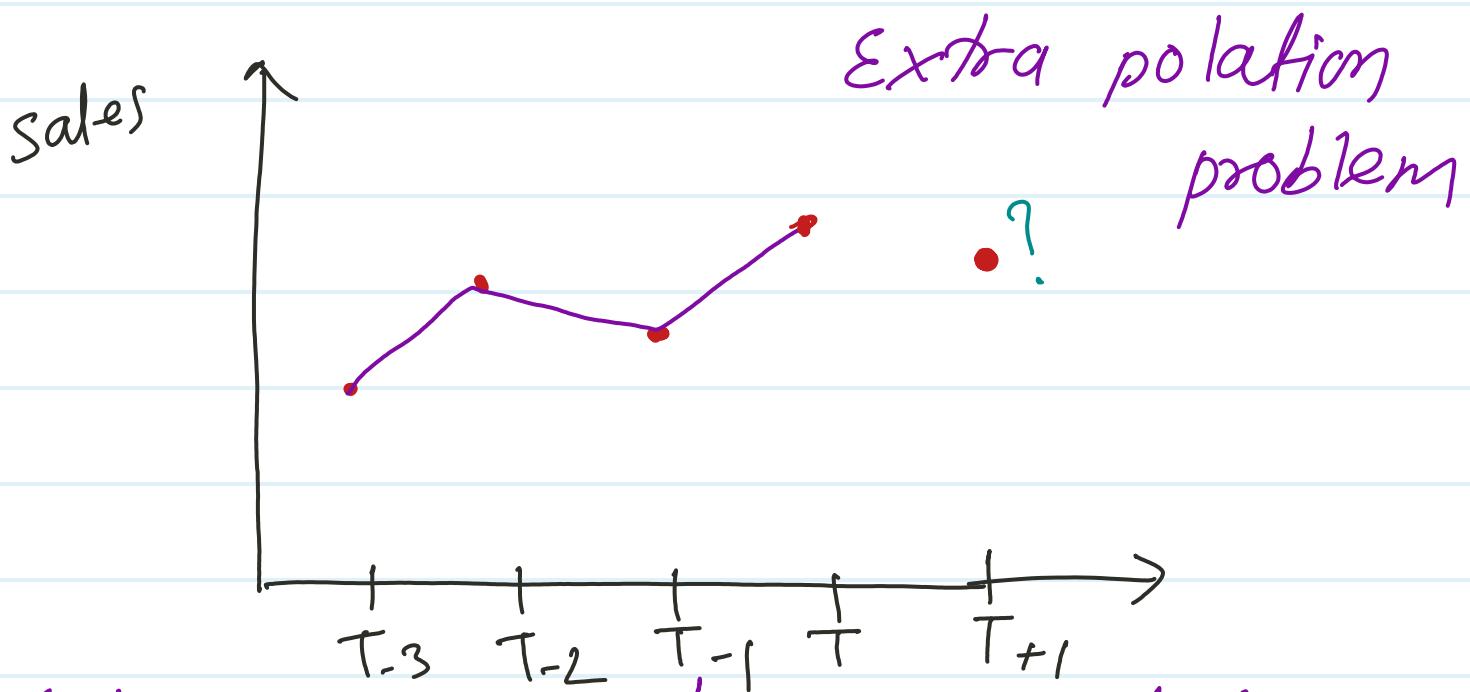
## ① Non - Time - Series



Here, we are predicting sales value on the basis on previous data like we did in regression problem it is called Interpolation problem

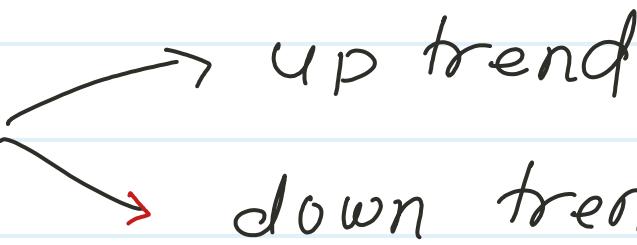
It is basically supervised ML problem

## ② Time series -



When we are forecasting future price based on current or may be past lag it called extrapolation problem.

① Level - calculate the avg of data.

② Trend -  up trend  
down trend

③ Seasonality - for example sales depends on season

④ Cyclic pattern - Repeat trend after a long period like after a year.

⑤ Noise - where no pattern and trend identified in the data.

SARIMA

ARIMA (Auto Regressive Integrated moving Average)

① AR Auto Regressive P

predict the current value using a weighted sum of past observation.

$$Y_t = C + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \dots + \phi_p Y_{t-p} + \epsilon_t$$

$\epsilon_t$

here

$Y_t$  = current value

$Y_{t-1}, Y_{t-2}$  = past value (lags)

$\phi_1, \phi_2$  = coefficients (weight)

$\epsilon_t$  = error term / Residual

Exam predicting today's temp  
using past 3 day's

Day	Temp °C
mon + 2	28.
Tue + 1	30.
Today +	?

We use  $P = 2$  mon, Tue

$$\text{Temp}_t = c + \phi_1 \text{Temp}_{\text{Tue}} + \phi_2 \text{Temp}_{\text{mon}} + \epsilon$$

② Integrated (I)  $\stackrel{d}{=}$  making data stationary

Armed required the data have  
constant mean and variance

But real data often use trend and seasonality

We remove them by differencing.

$$Y_t^1 = Y_t - Y_{t-1}$$

If  $d=1$ , we subtract previous value

$$Y_t^1 = Y_t - Y_{t-1}$$

If  $d=2$ , we diff. again

$$Y_t^n = Y_t^1 - Y_{t-1}^1$$

③ moving Average (MA) 9

use past forecast error

predict current value using past forecast error

$$Y_t = C + \theta_1 e_{t-1} + \theta_2 e_{t-2} + \dots + \theta_q e_{t-q} + \epsilon$$

$e_{t-1}$  = Past error residual

$\theta_1, \theta_2$  = weights for past error

ARIMA parameters

P (AR) - how many past values to include 1, 2, 3, ...

d (I) - how many times to diff. data 1 or 2

q (MA) - how many past errors to include 1, 2, 3, ...

ARIMA (1, 1, 1) means  
 $p, d, q$

→ use 1 past value

→ Diff. Once to make stationary

→ Use 1 past error

$$y^+ = C + \frac{\phi_1 y'_{t-1}}{P} + \frac{\theta_1 e_{t-1}}{q} + e_t$$