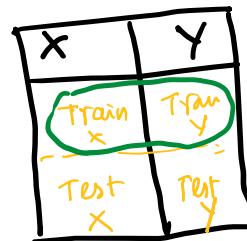


Time Series Analysis

26/08/2023

(Forecasting)

- Problem Statement ✓ Predict ?
- Why Time Series ✓ Future sales
- Missing values / anomalies ✓ Supervised ✓ | unsupervised
- Breakdown of TS



X

Supervised

X Y

Trade Price of a Car

make model year ^{input} Odo.R Fmn.

Target
Y
Independent

dependent

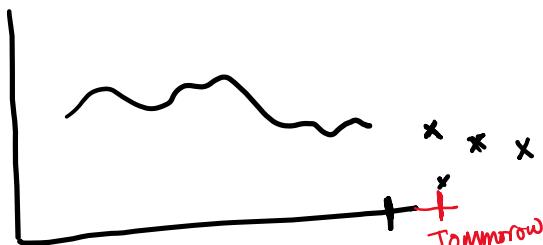
deterministic ✓

Cross Sectional
20000
O.R Charge 20400

(Car)

'y'
Y

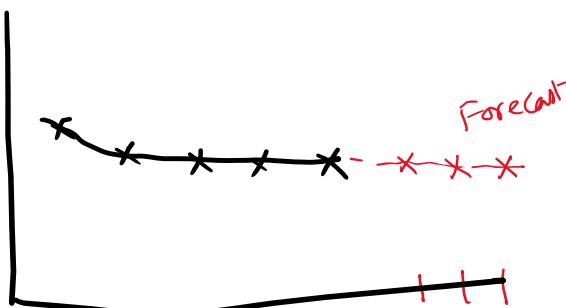
Stock



prev day closing value
performance in last quarter
News
hiddenburg-report
market condition.

Time Series key, value

Period	Quantity (metric)
Jan 2023	100
Feb 2023	986
Mar 2023	1024



Time Series forecasting

Time Series

Period: month, day, year, Quarter, Second, minute

(Regular interval) X

NSE

Problem statement

Imagine you are a Data Scientist at MobiPlus, a mobile manufacturing company

You need to forecast their future sales for better planning and revenue.

- ✓ • Agenda 1: We want to understand the patterns in demand to be able to better plan for factory maintenance / staffing requirements.
- Agenda 2: We need a certain level of accuracy. The management requires that the Mean Absolute Percentage Error (MAPE) is not more than 5%.
- Agenda 3: Need a range forecast to supplement the point forecast to make educated trade-off wherever needed.

Over the next few lectures, we will be completing these tasks.

Operations

'Point, Prediction'

Resale price \$ 210gb - Point

Range forecast 20000 - 22000

✓ Range

360 - 325 runs ✓
200 - 350 runs ✗

Pitch report

Prediction 300 per pitch

321 runs

Time Series

Period

Metric

Measured at regular intervals of time.

→ NSE, stock, sale by month /

TimeSeries

$y_0, y_1, y_2, \dots, y_{t-1}, y_t, y_{t+1}, y_{t+2}$

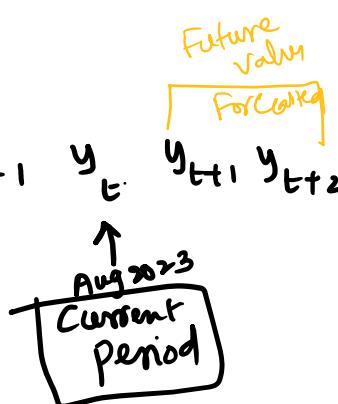
Future value

Forecasted

Missing data

2001 01 01	100
2001 02 01	220
2001 03 01	240
2001 04 01	6
2001 05 01	300

2001 01 01	100
2001 02 01	220
2001 03 01	240
2001 05 01	300



① Missing value Imputation

② outlier handling

→ IQR

→ Z-score

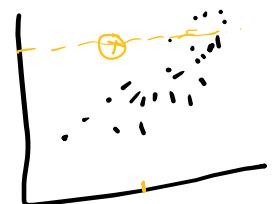
→ Percentile

$> 99\%$. }
 $< 1\%$.

what do we do
shall we drop?
(Bad idea)

ISolation | eel | lof

X multivariate



→ clipping / capping

when a value is $> 99\%$.

Cap (Replace) $\rightarrow 99\%$.

when a value $< 1\%$.

Cap (Replace) \rightarrow deleted

Imputation

How to Impute?

mean } X
median }

① previous record value / after value

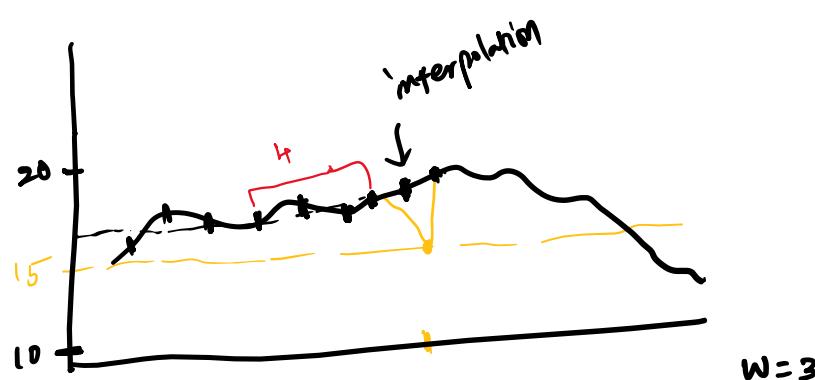
② group by month and mean

③ average of previous

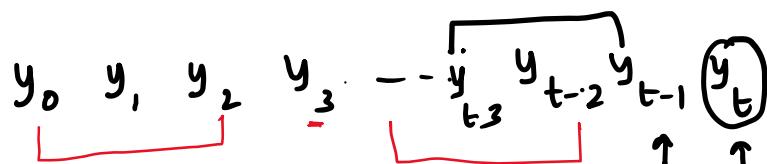
① Interpolation

② moving average

moving average (Window = p)



Rolling Window



Moving average

- Forward
- centred

Forward

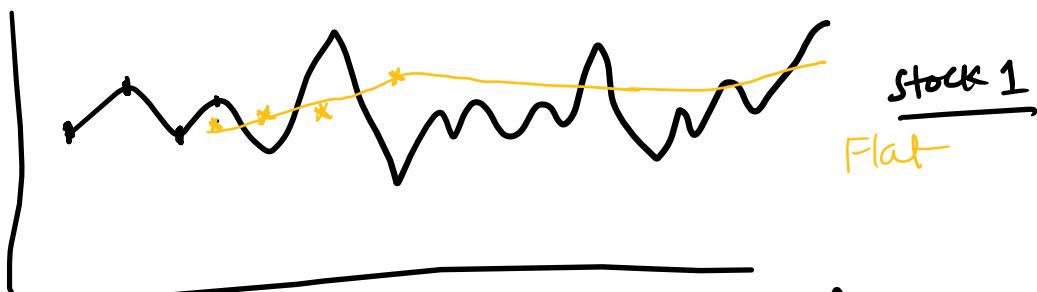
$y_0 \ y_1 \ y_2 \ y_3 \dots$ $y_{t-3} \ y_{t-2} \ y_{t-1} \ y_t$

$w=3$
 $(ma)^t$
 \downarrow
 ma_{t-1}
 $w=3$

ma Smoothen a time series

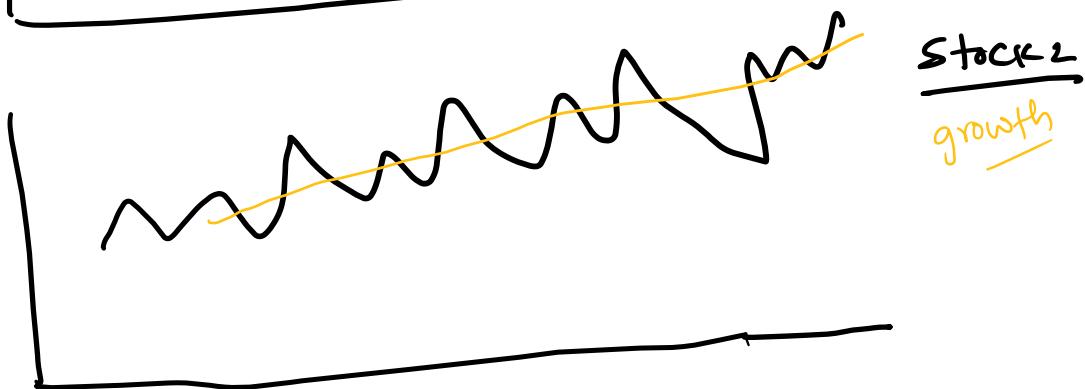
Rolling window

stock

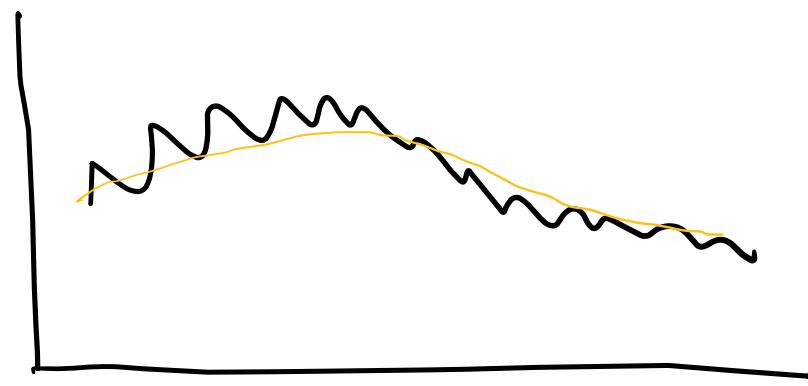


Stock 1
Flat

which
stock
will
you
invent

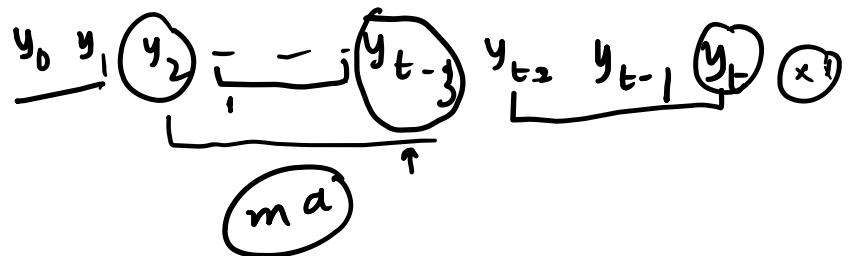


Stock 2
growth



w=3 ⑦

Centred moving average



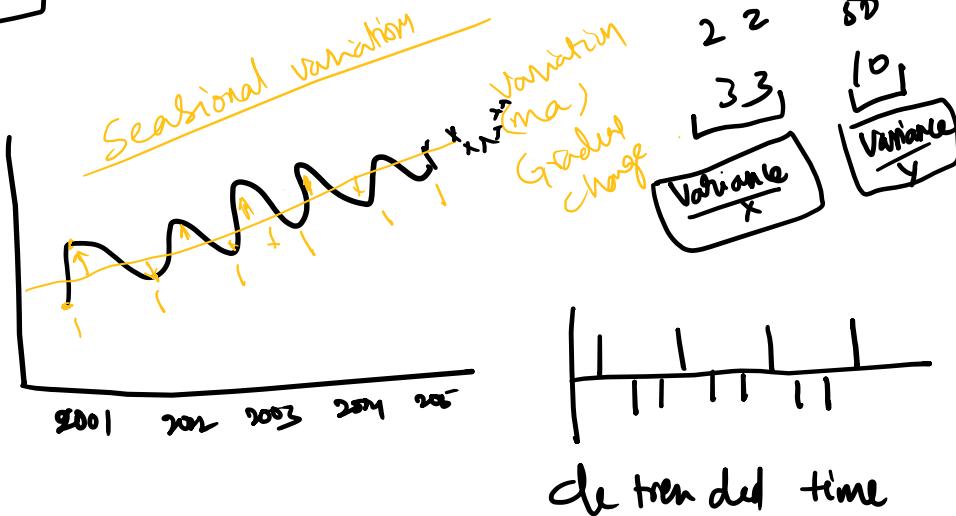
Decomposition of a time series

$y_0, y_1, y_2, \dots, y_{t-1}, y_t$

↓
Variation over time in y

y_{t+1}, y_{t+2} → forecast
to predict y future values

- ① Trend ✓
- ② Seasonality ✓
- ③ error (residual)



→ additive decomposition

→ multiplicative decomposition

$b(t)$ - trend at t

$s(t)$ - Seasonality at t

$e(t)$ - error residual

additive

$$y_t = b(t) + s(t) + e(t) \quad \checkmark$$

$y_0, y_1, y_2, y_3, \dots, y_t$

ma ($w=12$)

$\frac{m_1}{b_2}, b_3, \dots, (b_t)$

(centred ma)

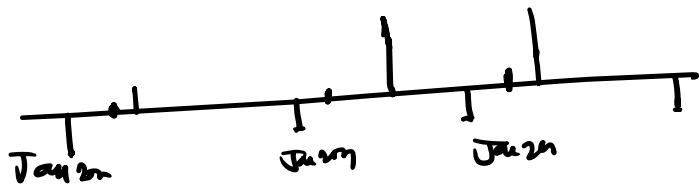
detrend

$y_{0-b_0}, y_{1-b_1}, y_{2-b_2}, \dots, y_{t-b_t}$

Subtracting trend from the time series

	Jan 2020	—	Jan 2021	—	Jan 2022	Feb 2022	Mar	—	Jan 2023
Trend	30	—	31	- 40	31	—	33	- 34	- 41
frend	33	—	33	33	33	—	33	33	33
	(-3)	—	(-2)	+7	(-2)	—	0	+8	(-3)

detrended



Jan ~~Sea~~ ~~-2.5~~ Feb = 0, Mar +1, Apr +3, May +7, Jun -14
Dec -3

$$y_t - b(t) - s(t) = e(t)$$

May 2023

$$\underline{33+7} = 40$$

$$41 \quad 41-40=1$$

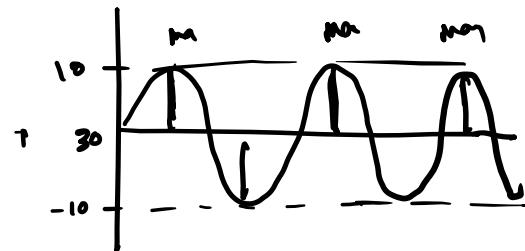
Multiplicative

$$y_t = b(t) * s(t) * e(t)$$

Additive

Constant
variance

Multiplicative
Non constant variance



frequency : How many data points in a year

Monthly data = $f = 12$

Quarterly = $f = 4$

weekly data = 52 weeks

