ARMA

Auto-Regressive with Moving Average

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ARMA

- Auto-regressive moving average (ARMA) is a combination auto-regressive and moving average process.
- ARMA is applied for a stationary time series
- ARMA(p, q) process combines AR(p) and MA(q) processes.
- How much of p and q to take for a dataset can be guessed from the autocorrelation and partial autocorrelation plots

How to find Stationarity?

- Dickey-Fuller Test can be used to test the stationarity of any time series
- Consider the expression of auto-regressive model

$$y_t = \beta y_{t-1} + \epsilon_t$$

Dickey–Fuller test checks whether the β in the expression above is 1 or less than 1

*H*0: β = 1 (the time series is non-stationary)

*H*A: β < 1 (the time series is stationary)

Dickey-Fuller Test in Python

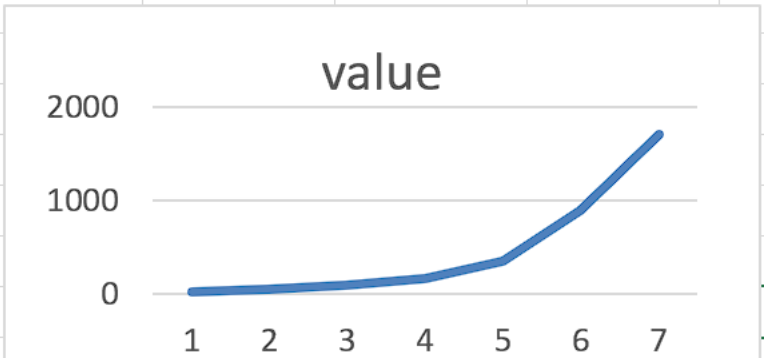
- *statsmodels.tsa.stattools.adfuller* is a Dicky–Fuller test and returns test statistics and p-value for the test of the null hypothesis.
- If the p-value is less than 0.05, the time series is stationary.

```
In [28]: result = adfuller(df['GasProd'], maxlag=10)
    ...: print("P-Value =", result[1])
    ...: if result[1] < 0.05:
    ...:     print("Time Series is Stationary")
    ...: else:
    ...:     print("Time Series is not Stationary")
P-Value = 0.9981674130928889
Time Series is not Stationary
```

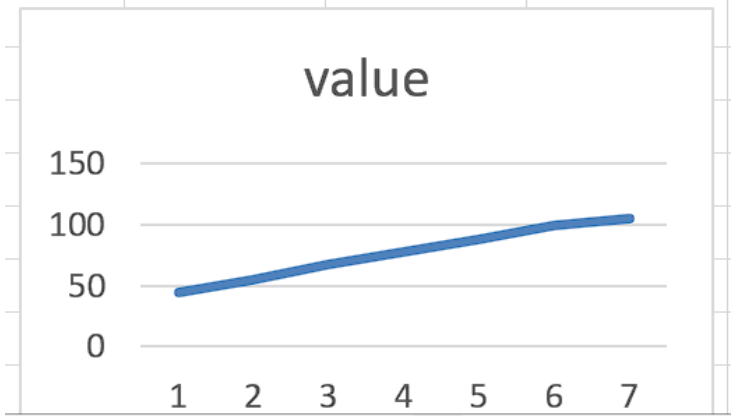
What can be done for stationarity?

- We can difference the time series

value	diff 1st	2nd	3rd
23			
44	21		
89	45	24	
157	68	23	-1
350	193	125	102
890	540	347	222
1706	816	276	-71



	value	diff 1st
	45	
	55	10
	67	12
	78	11
	88	10
	100	12
	105	5



ARIMA

- If the time series is not stationary, then we can difference by making it stationary and then apply ARMA
- But, how much order of differencing also needs to be examined
- ARIMA model is an integration of both these things, differencing and ARMA
- ARIMA stands for Auto-Regressive Integrated with Moving Average
- The parameters of ARIMA are:
  - p: order of Auto-Regressive Model
  - d: order of differencing
  - q: order of Moving Average Model

SARIMA

- Seasonal ARIMA considers not only the past values of the same season period but also the past values of earlier season period
- For Example,
  - Past Values: Today's (3rd Feb 2024), Yesterday's(2nd Feb 2024), etc
  - Past Seasonal Values: Today's seasonal(3rd Feb 2023, 3rd Feb 2022, etc.)

SARIMA Parameters

- p: order of Auto-Regressive Model
- d: order of Differencing
- q: order of Moving Average Model
- P: order of Seasonal Auto-Regressive Model
- D: order of Seasonal Differencing
- Q: order of Seasonal Moving Average Model
- m: Seasonal Time period = 12 monthly
  = 4 quart
  = 7 daily

Tuning SARIMA

- It requires lot of guess work for knowing the best parameter set
- There is an automated option from package *pmdarima* which searches the best model with a criterion called AIC

Questions?