TIME SERIES ANALYSIS –

* Time series will used for the forecasting the model using AR,MA,ARMA,ARIMA
* We have done forecasting in regression when we are using regression for forecasting then why we required time series
* What happen in regression also isn’t it, you have independent variable (X) to forecast y using formula ( y = mx+c)
* Number of cases x variable is not available all the time even though variable is available then there is some restriction in order to do the forecasting
* Univariate timeseries we have only one variable , this variable keep changes this is called Auto Regression (Yt = Yt-1 + epsilon)
* Data is collected from regular time interval, t1,t2,t3 till tn, when I am talking about interval then t2-t1, t3-t2 would be exactly same , interval would be monthly,weekly,annualy,daily basis,hourly basis, that is the time series data
* Lets say the stock period like period1, period 2, period 3 till period n or stock returns
* Cross-section data is nothing but (when you use no. of variable at one time) but in time series (1 variable we have no. of time)
* Firms- what happened to the company in 2011 that is the area of study, you collected number of emp,revenue, total profit of the company, these are the variables and these variables are collect at one time period. (Multiple variable in 1 time – time series you have 1 varaible multiple time like- stock period profit in 2011 profit in 2012,profit in 2013)
* This is the difference b/w (CROSS-SECTIONAL DATA vs TIME SERIES DATA)
* In cross-sectional data we will use multi variate analysis & we use univariate analysis in time-series data
* Lets say one examply we are using gdp data for TN state & this is upward sloping trend were the slope is going upward & its keep increasing over time, some time you will get upward trending, downward trending & sometime you will get mix of both
* Let’s check other case initialy there was downward slope and then there is a upward slope , these are the different type of scenario you will come across
* Time-series classified into – TREND,SEASONAL,CYCLICAL,RANDOM COMPONENTS
* What is TREND PATTERN – not a reliance trend.what is trend means in English language, when we talk about trend it will come as either it would be upward trend, downward trend. I can say that this is the long term pattern for more then a year
* What is SEASONALPATTERN – normal when I am talking about season normally short period of time, like summer,winter,raining. If I take the sales data every December year end sales. We called the seasonal data or when winter comes you buy the winter jacket that is also one of the seasonal data & when we use as umbrella then we can use as rainy or summer also, that is also one of the seasonal data .
* What is CYCLICAL PATTERN – I would take example as budget or economy, budget can not say that budgest can be one year budget & also depend upon the country, budget doesnot happen in particular month or year , I can say that it could be change and go beyond the year & you might see wave like pattern. Cyclical is not regular approach but you find as rarely regular method, one more example is festival – festival is fixed or pre-decided but budgets are not decided & if you consider the festival budgest for the last 10 year then definitely you will get as wave graph
* What is RANDOM PATTERN – random cannot have any particular pattern that means you cannot extract any pattern from the data that is called Random
* Idea behind univariate time series is that to use the past value of the series data to forecast the future , variables are stock price, gdp , sales and so on & it can be use for variety of purposes.
* Most central bank use ARIMA forecasting or Time-series forecasting like unemployment rate, inflation rate, stock exchange rate etc
* We will see some termilogy before we go into modelling part,
* Different Time Series Process –
* 1> White Series –
* series is nothing but a series of numbers, stock price of tata motors e.g - rs.100 in day1, rs.120 in day2, rs.125- day3, rs,19 in day4 ) this is known as series, this is series of no
* Now when we called as white Noise – white noise is purely random number in nature, were the mean is 0 and the variance is constant, when you say 50% positive& 50% is negative then on that condition you will get 0 mean
* If you do a scatter plot you won’t find any pattern in the data & if the time series data source is white noise feature then you should stop doing time series analysis , there is no point doing time series forecasting
* Random series cannot do for the forecasting that’s why white noise are cannot use for forecasting & white noise is simply take the average and that’s the best forecast available for series, so simply you take the average of the series then that is best forecast avaialable for the series & that average series you will give for the next figure.
* If series not white noise then we will use for forecasting.
* 2> AutoRegressive Model (AR Model) –
  + AR model are the model forecasting done based on the past values, if Yt value is the current value then Yt-1, Yt-2, Yt-3 is my past value & I can say that Yt is the function of past values [[ Yt = f ( Yt-1, Yt-2, Yt-3, \_ \_ \_, Et) /// E- Error rate
  + How many past value you can use, common representation of AR model where it depends on p of its past value called as << AR(p) – [P is called parameter] >>
  + AR(0) // AR(zero) model (Yt = B0) && if AR(1) model = Y t-1, AR(2) then Y t-2 & so on
  + Most of the time we will stop AR(3) & AR(4)
  + We will see what is actual P – value for forecast , how many number of past value we will take
* 3> Moving Average Model –
* We will do the forecast based on error term , if you check the regression (Yt = Yt-1) & if you add (( Yt = B1Yt-1 + Bo + E1 )), then you get Error 1 // similarly if you do (( Y t-1 = B1Yt-2 + B0 + E2 )), then you get Error term 2
* Every regression series you will get Epsilon1, Epsilon2,Epsilon3 \_ \_ EpsilonN, instead of past value you in moving average model you can use as only ERROR TERM for forecasting & we had replaced past value with error term & we don’t have Yt-1,Yt-2 instead of error term used as E t-1
* Remember Et are the white noise because if you take the mean then you will get 0 but if you take the variance of Et then you will get as 1
* 4>AutoRegressive Moving Average Model –
  + They know as ARMA model they are both AR & MA model refered as ARMA(p,q) – combination of past value & also error terms
  + AR + MA = ARMA
  + Normally people will say more accurate in many of the cases
* Stationary of a Time Series –
  + Time series said to be stationary if the marginal distribution of Y at any time [p(Yt)] is same at any other point of time
  + Slightly difficult to understand but let’s understand what is marginal distribution mean - stationarity means the series of value are not correlated that means , series has constant mean, variance , the basic statistic like mean, variance are Time invariant that means they do not change over the time
  + Stationary is one of the important criteria in Time series , all the model we have seen like, AR, MA, ARMA the condition series would be stationary other wise we cannot build this model, many time your series not be stationary in that case you have to make it to stationary . in that case you have to use differentiate method to convert timeseries
  + We will see why we have to differentiate from non stationary to stationary , now stationary also different type called as WEAKLY STATIONARY or COVARIANCE STATIONARY so far we learned as STRICTLY STATIONARY
  + In weakly stationary Mean is constant, Variance is constant & if you take the covariance for different 2 series then it only depends on difference in the time
  + E.g. if I take the time from T1 – T5, then the difference is 5-1 = 4, that means the covariance of the series depends on LAG K but do not depend on time explicitely this is called COVARIANCE STATIONARY
  + After differentiation non-stationary can be made to stationary after differenting
  + Differentiating is nothing but – d f(y1) / dy1 (you have take derivative)
  + If you heard about ARIMA model I – stands for integrated , I terms means Integrated that means differentiated
  + If we differentiate once then we called as integrated of 1 series, if we differentiated twice then we called as integrated of 2 series and so on
  + If you are not doing any differentiated then I(0) & Its already stationary then we use as I(0)
  + This is all about ARIMA model
* Necessity of the assumption of stationary –
  + Why it has to be stationary , stationar is very important from theortical point of view & if you trying to do the estimation of time series model like AR,MA,ARMA,ARIMA stationary is one of the basic assumpation
  + If this stationar assumation is not met then the forecast is not reliable, that’s for theoretical point of view Checking stationary in a series is very important
* Estimation and forecasting of univariate time-series model is carried out using BOX-JENKIN (B-J) methodology which has to followed by 3 steps –
  + Idientification
  + Estimation
  + Diagnostic Checking
* They are the 2 statistians who formulated this methodology which is very important to time series forecasting & this B-J is applicable only for stationary variables
  + If you want to do the modelling first you have to see WHITE NOISE – if it white noise you cannot do any forecasting, then check if it is stationary then start with modelling & if its non-stationary then make it stationary and then apply time series modelling
  + 1> IDENTIFICATION –
    - **A> AutoCorelation Function (ACF) –**
    - Corelation with itself called as Auto correlation, if Yt is correlated with Y t-1 then (both are series) & you can actualy take correlation and its auto correlation because the same series has been taken use for calculating the correlation of past value of the same series .
    - Why do we need to measure this because it help us to determine the P-value (parameter – number of lags to be used in time series model)
    - We will compute ACF function while doing the time-series model & we will compute the Auto coreation using given formula b/w Y t & Y t-1 is -- @ CORR(Y t & Y t-1) = Covariance(Yt, Yt-p) / root of variance of Yt \* root of Y t-p)
    - E.g – if t = 5 & p =1 then my equation become y5 , y4 & now try to find out the correlation b/w (y5 & y4) & finally you get the ACF value
    - **B> Partial Autocorrelation Function ( PACF) –**
    - This is also some sort of correlation but slightly variation of that , partial auto correlation are known as (PACF)
    - All the time you removed different LAG b/w them , e.g. Y5,Y4,Y3,Y2,Y1.. so I removed Y4,Y3,Y2 to get the partial auto correlation & in this case we call this as PACF
    - PACF is some kind of ACF just that we remove intermediate LAGs & there is no effect of Y4,Y3,Y2 & only effect would be (Y5 & Y1) without taking consideration into Y4,Y3,Y2
    - **C> Inference from ACF & PACF –**
    - So why do we need to calculate ACF & PACF just to see what extend the current values of a series are related to the past values
    - If you are forecasting the series, logical if you are taking todays value are related to the past values but how many past values, is that next past value or next to last past value or next to next to past value , so how do you know that how many past value related.
    - Logicaly if you think todays value always related to yesterdays value, day before yesterday or may be couple of days back but after that there might not be relation b/w those values right.
    - E.g stock price of today is related to stock price of yesterday or day before yesterday , may be 2 days or 3 days beyond that there might be very less correlation
    - ACF & PACF will tell us how many LAGS or how many periods will consider for forecasting & there you have to find out the LAGS , LAGS means weather you have to consider as Y t-1 , Y t-2, Y t-3 & so on.
    - We can called that as CORRELOGRAMS – Correlograms is the plot of ACF function with respect to the LAGS
    - By looking at the ACF & PACF with respect to the LAGS we will select p & q values in ARIMA ( p values in AR & q values in MA)
    - Please check the following general characteristics of ACF & PACF, these are called as some of the pattern or standard pattern
    - By looking at the ACF & PACF you can tell that which is the best time series model
    - First step In the model is to check the stationary & then do the estimation and third do the diagonastic & 3 steps are very clear guys & these are the standard steps
    - We will start with diagonastic which model do we need to used & to check the dataseries is for perfect time series or not & you do the estimation . once you done with estimation sure that your model is good enough for prediction

2> Estimation :

* Different type of estimation are available – 1> Yule walker procedure estimation <2>method of moments estimation <3>Maximum likelihood method
* Not required to get in details about each estimation , no mater which estimation you have to used software is available to take by default values & these are the internal software calculation part

3> Diagnostic Checking –

* Once the model is builded then we will do the diagonastic step or statistics from the model and sure about these values are acceptable range like you saw like R2, adjusted R2 , in regression this kind for stuff.
* **Part -A**
* But hear to check the models performance AIC/BIC/SBIC - we can say that model with lowest value of above criteria is choosen to be the best model & actauly software do the calculation and tells you for better model
* Let me give you one example you will be worried weather I want to be AR(0) model,AR(1) model & you are sure that you are using AR model based on the criteria which we discussed on last slide
* Now you will confuse which model I have to use out of AR(0), AR(1),AR(2) ,AR(3) model.
* In this case if you are not sure which model is best model to be used simply you can fit all these models and you can check least AIC value or BIC value . finaly you can get the best fit model
* **Part –B :**
* Final step is to plot the residual or ACF of the residual , it should be random. Mean should be 0 and that should not by any pattern oriented
* Diagonistic is same what you have done in regression
* Once you are fine with diagonastic then you can use your model for forecasting & these are the steps