TIME SERIES ANALYSIS

TIME SERIES DATA:

- A time series is a set of observations on the values that a variable takes at different times.
- Such data may be collected at regular time intervals, such as, monthly (eg. CPI), weekly (eg. Money supply), quarterly (eg. GDP) or annually (eg. Government Budget).
- Time series are used in statistics, econometrics, mathematical finance, weather forecasting, earthquake prediction and many other applications.

CROSS-SECTIONAL DATA:

- Such a type of data is collected by observing many subjects (such as individuals, firms, countries, or regions) at the same point of time or during the same time period.
- Example:-
    - Suppose an analyst wants to know the number of cars a household has bought in the past year. To do so, he collects data on a sample of, say, 500 families from the population and notes the data on how many cars they have bought in the past year.
- This cross-sectional sample provides a glimpse of the population for that duration.

PATTERNS EMERGING IN TIME SERIES DATA:

Depending on the frequency of the data (hourly, daily, weekly, monthly, quarterly, annually, etc) different patterns emerge in the data set which forms the component to be modeled. Sometimes the time series may just be increasing or decreasing over time with a constant slope or there may be patterns around the increasing slope.

COMPONENTS OF A TIME-SERIES:

The pattern in a time series is sometimes classified into trend, seasonal, cyclical and random components.

- **Trend**: A long term relatively smooth pattern that usually persists for more than one year.
- **Seasonal**: A pattern that appears in a regular interval wherein the frequency of occurrence is within a year or even short. for example, quarterly GDP series for India, transit data and monthly arrival of tourists to a town.
- **Cyclical**: The repeated pattern that appears in a time-series but beyond a frequency of one year. It is a wavelike pattern about a long-term trend that is apparent over a number of years. Cycles are rarely regular and appear in combination with other components. Example: business cycles that record periods of economic recession and inflation, cycles in the monetary and financial sectors.

- **Random**: The component of a time-series that is obtained after these three patterns have been 'extracted' out of the series is the random component. Therefore, when we plot the residual series then the scatter plot should be devoid of any pattern and would be indicating only a random pattern around a mean value.

IDEA BEHIND UNIVARIATE TIME SERIES MODELLING:

The need to use univariate modeling arises in situations where:
(a) An appropriate economic theory to the relationship between series may not be available and hence one considers only the statistical relationship of the given series with its past values.
(b) Sometimes even when the set of explanatory variables may be known it may not be possible to obtain the entire set of such variables required to estimate a regression model and one would then have to use only a single series of the dependent variable to forecast the future values.

APPLICATIONS OF UNIVARIATE TIME SERIES IN TERMS OF FORECASTING:

(a) Forecasting inflation rate or unemployment rates or the net inflow of foreign funds in the near future could be of interest to the government.
(b) Firms may be interested in demand for their product (e.g. two-wheelers, soft drinks bottles, or soaps etc.) or the market share of their product.
(c) Housing finance companies may want to forecast both the mortgage interest rate and the demand for housing loans.
(d) Forecasting gold or silver prices by the jewel merchant.

MODELS OF THE TIME SERIES ANALYSIS

There are two models of decomposition of time series:

i) The additive model
ii) The multiplicative model

THE ADDITIVE MODEL

This model is used where it is assumed that the four components are independent of one another. Independence is said to exist when the pattern of occurrences and the magnitude of movements in any particular components are not affected by the other components. Under this assumptions, the four components are arithmetically additive in the sense that the magnitudes of the time series are the sum of the separate influences of its four components. Thus, if it is taken to represent the magnitude of the time series data at time period t, the Y_t can be expressed as:

$$Y_t = T_t + C_t + S_t + R_t$$

Where Tt = Trend variation, C_t = Cyclical variations, S_t = Seasonal variations and R_t = Random variations.

THE MULTIPLICATIVE MODEL

This model is used where it is assumed that forces giving rise to the four types of variations are interdependent, so that overall pattern of variations in the time series is the combined result of the interaction of all the forces operating on the time series. According to this model, time series are the product of its four components, that is

$$Y_t = T_t * C_t * S_t * R_t$$