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المرحلة ألرابعة
Lecture Title
عنوان المحاضرة
Time series
السلاسل الزمنية
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Time series

Time series are a series of observations made over a certain time interval. It is commonly used in economic forecasting as well as analyzing climate data over large periods of time. The main idea behind time series analysis is to use a certain number of previous observations to predict future observations.

This time series consists of two variables: the independent variable (represents time), and the dependent viable (represents the values of the phenomenon).

Components for Time Series Analysis

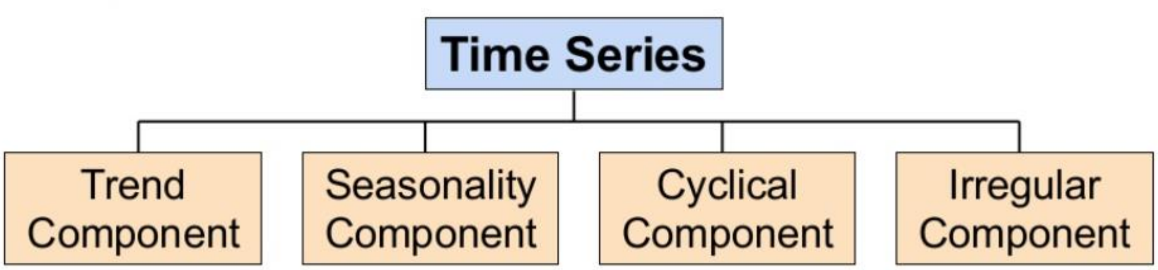
The various reasons or the forces which affect the values of an observation in a time series are the components of a time series. The four categories of the components of time series are

1-Trend

2-Seasonal Variations

3-Cyclic Variations

4-Random or Irregular movements



Seasonal and Cyclic Variations are the periodic changes or short-term fluctuations.

1- Trend

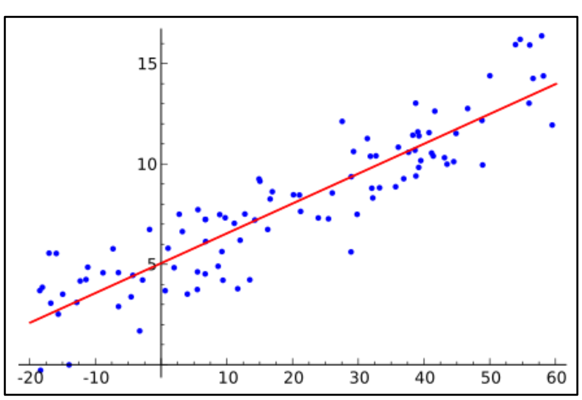
The trend shows the general tendency of the data to increase or decrease during a long period of time.

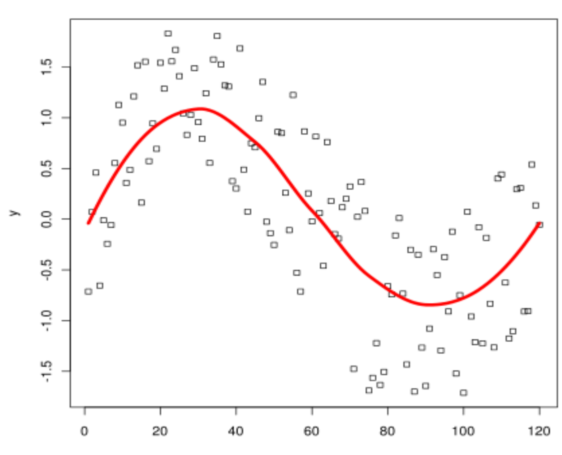
It is observable that the tendencies may increase, decrease or are stable in different sections of time. But the overall trend must be upward, downward or stable.

Rainfall, drought, the population, agricultural production, number of births and deaths, number of schools or colleges are some of its example showing some kind of tendencies of movement.

Linear and Non-Linear Trend

If we plot the time series values on a graph in accordance with time t. The pattern of the data clustering shows the type of trend. If the set of data cluster more or less round a straight line, then the trend is linear otherwise it is non-linear (Curvilinear).





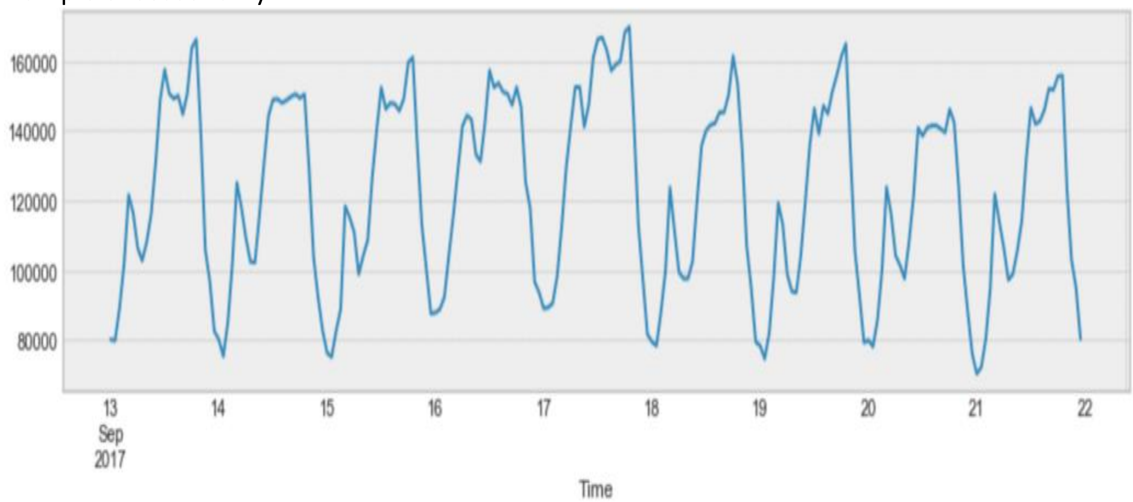
2- Seasonal Variations

Seasonality refers to periodic fluctuations. They have the same or almost the same pattern during a period of 12 months. This variation will be present in a time series if the data are recorded hourly, daily, weekly, quarterly, or monthly.

For example,

Production of crops depends on seasons, the sale of umbrella and raincoats in the rainy season, and the sale of electric fans in summer seasons., electricity consumption is high during the day and low during night, or sales increase during Ramadan month before slowing down again.

Example of seasonality



As you can see above, there is a clear daily seasonality. Every day, you see a peak towards the evening, and the lowest points are the beginning and the end of each day.

Simply look at the period, and it gives the length of the season.

3-Cyclic Variations

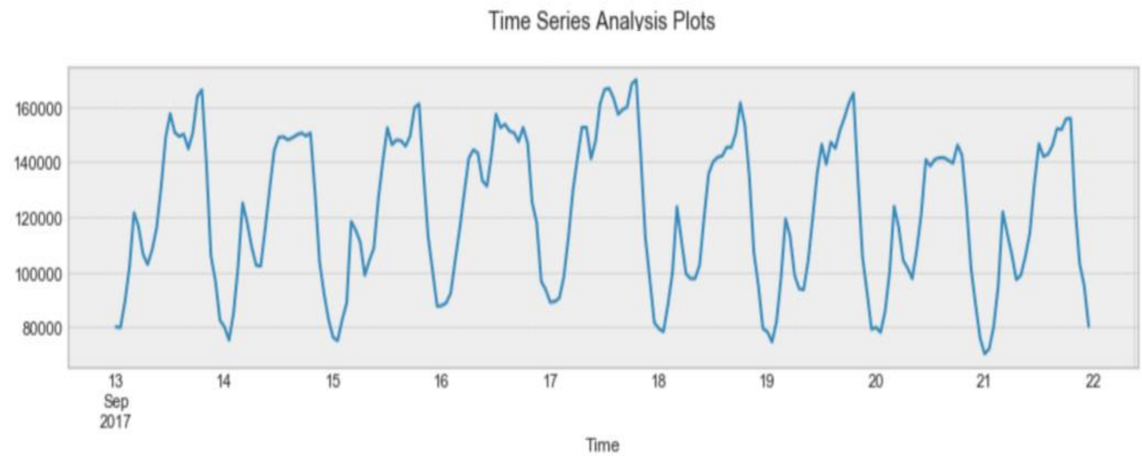
The variations in a time series which operate themselves over a span of more than one year are the cyclic variations. This oscillatory movement has a period of oscillation of more than a year. One complete period is a cycle. The cycles are not of fixed length – some last 8 or 9 years and others last longer than 10 years.

4-Random or Irregular Movements

There is another factor that causes the variation in the variable under study. They are not regular variations and are purely random or irregular. These fluctuations are unforeseen, uncontrollable, unpredictable, and are erratic. These forces are earthquakes, wars, flood, and any other disasters.

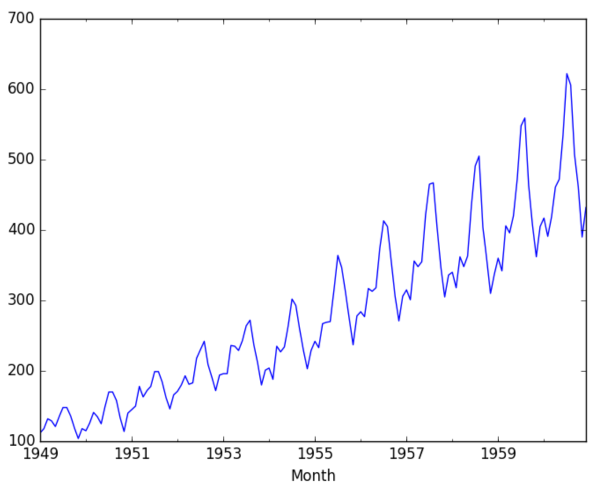
Stationarity

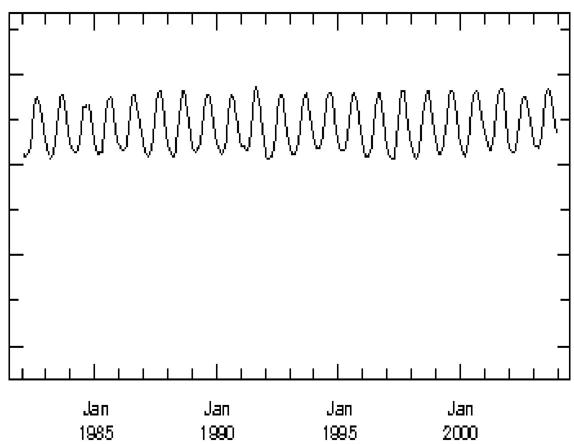
Stationarity is an important characteristic of time series. A time series is said to be stationary if its statistical properties do not change over time. In other words, it has constant mean and variance, is independent of time.



Looking again at the same plot, we see that the process above is stationary. The mean and variance do not vary over time.

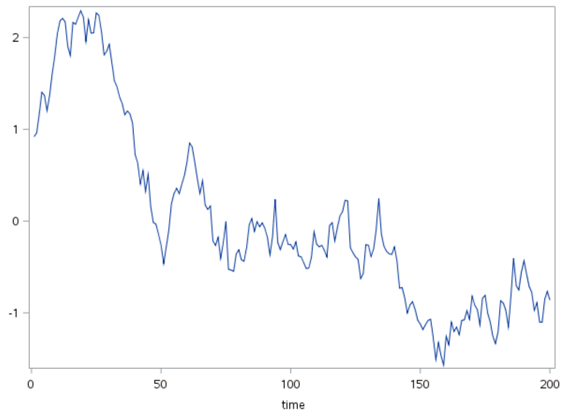
Ideally, we want to have a stationary time series for modeling. Of course, not all of them are stationary.





Often, stock prices are not a stationary process, since we might see a growing trend, or its volatility might increase over time (meaning that variance is changing).

Example of non-stationary time series:



Modeling time series:

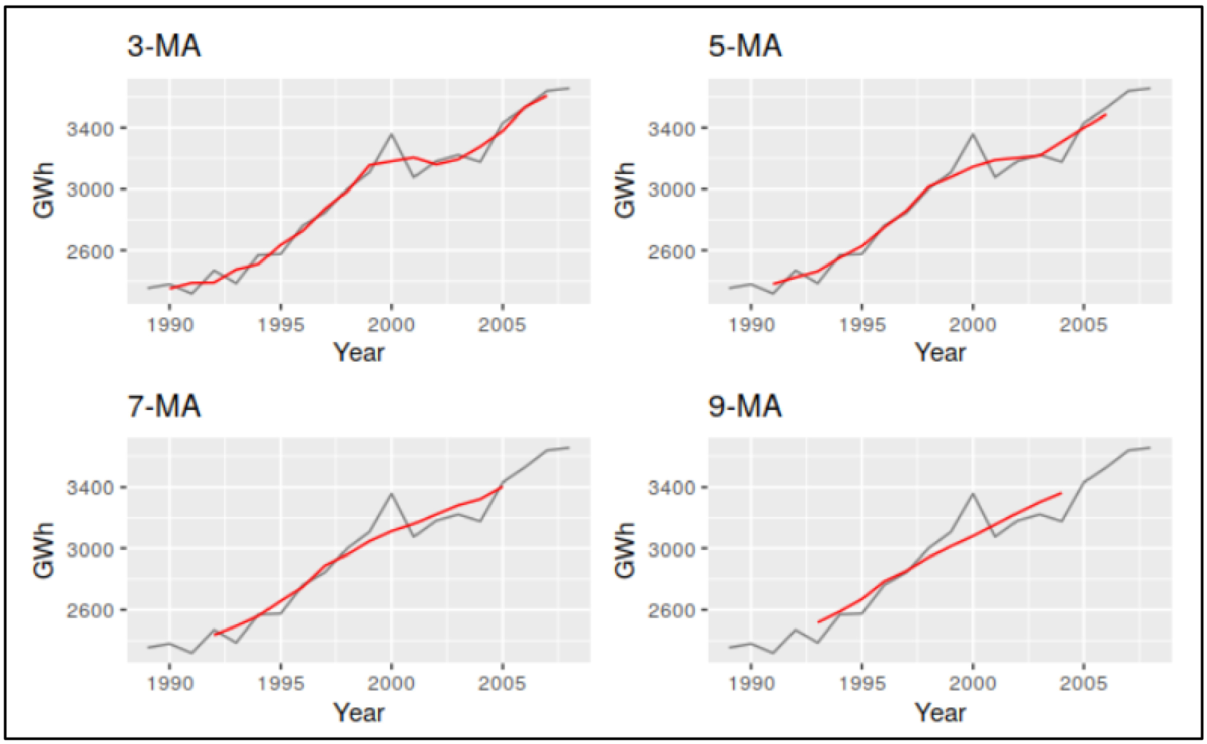
There are many ways to model a time series in order to make predictions:
1-moving average
2-exponential smoothing
3-ARIMA

1- Moving average

A moving average is a technique to get an overall idea of the trends in a data set; it is an average of any subset of numbers. The moving average is extremely useful for forecasting long-term trends. You can calculate it for any period of time.

For example, if you have sales data for a twenty-year period, you can calculate a five-year moving average, a four-year moving average, a three-year moving average and so on.

An average represents the “middling” value of a set of numbers. The moving average is exactly the same, but the average is calculated several times for several subsets of data. For example, if you want a two-year moving average for a data set from 2000, 2001, 2002 and 2003 you would find averages for the subsets 2000/2001, 2001/2002 and 2002/2003. Moving averages are usually plotted and are best visualized.

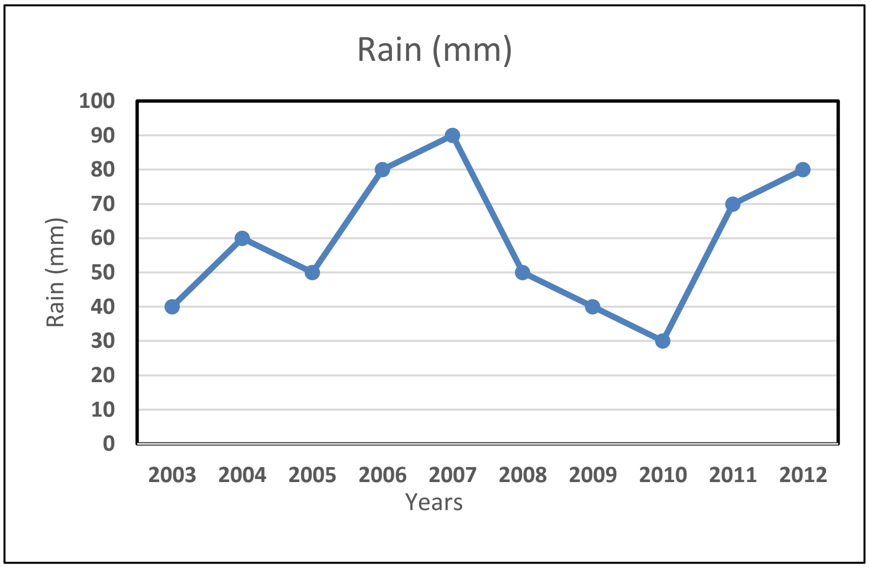


Residential electricity sales (black line) along with different moving averages applied to the data (red line).

Year	Rain(mm)
2003	40
2004	60
2005	50

2006	80
2007	90
2008	50
2009	40
2010	30
2011	70
2012	80

Example, calculating a 5-Year Moving Average from the following data set:



The mean (average) for the first five years (2003-2007) is calculated by finding the mean from the first five years (i.e. adding the five sales totals and dividing by 5). This gives you the moving average for 2005 (the center year) = 64 mm:

Year	Rain(mm)
2003	40
2004	60
2005	50
2006	80
2007	90

- First average: $$= \frac{X_1 + X_2 + X_3 + X_4 + X_5}{5}$$

$$1 \text{ Moving Average}(2003 - 2007) = \frac{(40 + 60 + 50 + 80 + 90)}{5} = 64\ mm$$

The average for the second subset of five years (2004 – 2008), centered around 2006, is 66 mm:

Year	Rain(mm)
2004	60
2005	50
2006	80
2007	90
2008	50

- Second average: $= \dfrac{X_2 + X_3 + X_4 + X_5 + X_6}{5}$

$$2 \text{ Moving Average}(2004 - 2008) = \frac{(60 + 50 + 80 + 90 + 50)}{5} = 66\ mm$$

The average for the third subset of five years (2005 – 2009), centered around 2007, is 62 mm:

Year	Rain(mm)
2005	50
2006	80
2007	90
2008	50
2009	40

$$3 \text{ Moving Average}(2005 - 2009) = \frac{(50 + 80 + 90 + 50 + 40)}{5} = 62\ mm$$

Continue calculating each five-year average, until you reach the end of the set (2009-2013). This gives you a series of points (averages) that you can use to plot a chart of moving averages.

Year	Rain(mm)	Moving Average
2003	40	
2004	60	
2005	50	64
2006	80	66
2007	90	62
2008	50	58
2009	40	56
2010	30	54
2011	70	
2012	80