Stationarity Of Time Series

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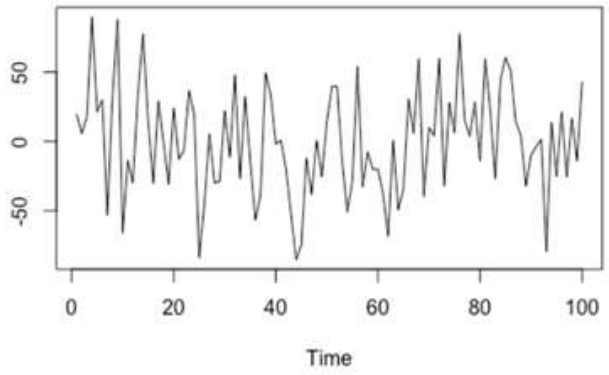
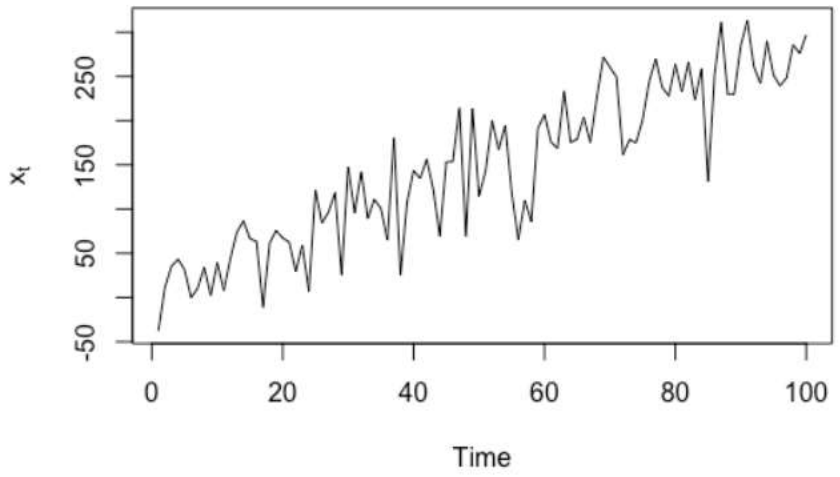
Stationary Series And their importance

- The concept of stationary series is based on the concept of consistency.
- Intuitively, stationarity means that the statistical properties of a process generating a time series do not change over time.
- It does not mean that the time series does not change (or is constant!!), just the way it changes does not itself change over time.
- It can also be thought as a time series in which there is no trend in the underlying structure.
- **Importance:** Without stationarity in the time series, most of the methods and models of time series cannot be used because they are built on the stationarity assumptions

Conditions For Stationarity

1. The first moment of x_i is constant, and should not depend on time; i.e. $\forall t$, $E[x_i]=\mu$.





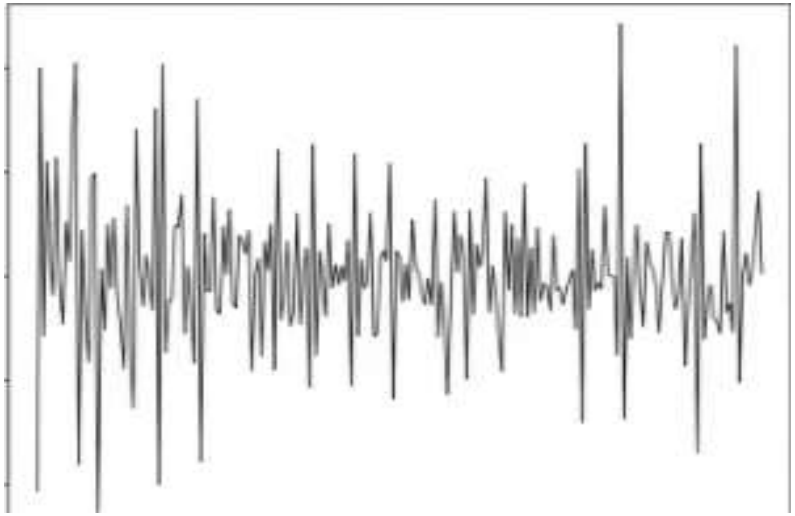
Conditions For Stationarity

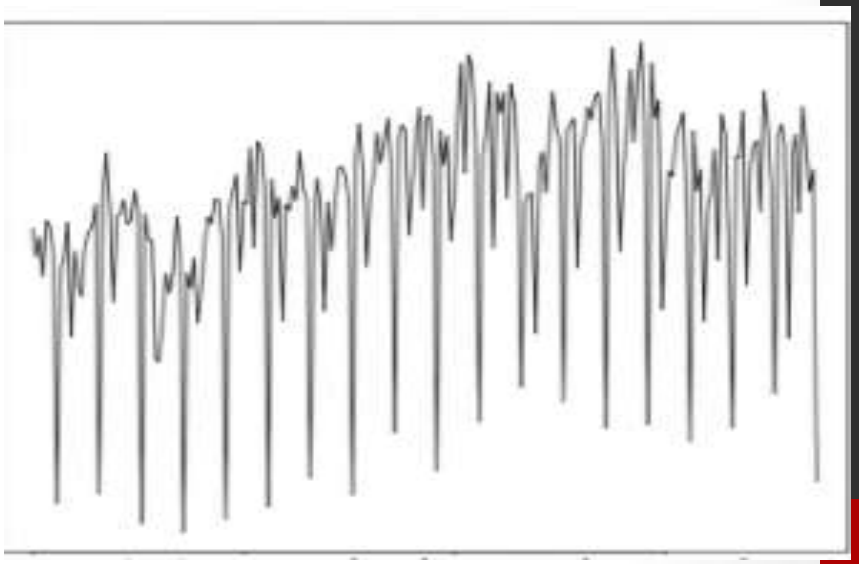
2. The second moment of x_i is finite and constant for all t; i.e. $\forall t$, $E[x_i^2]<\infty$ (which also implies of course $E[(x_i-\mu)^2]<\infty$; i.e. that variance is finite for all t).

Conditions For Stationarity

3. The covariance of the ith term and the (i + m)th term should not be a function of time.

Cov(Yt,Yt+k) depends only on lag k, not on t

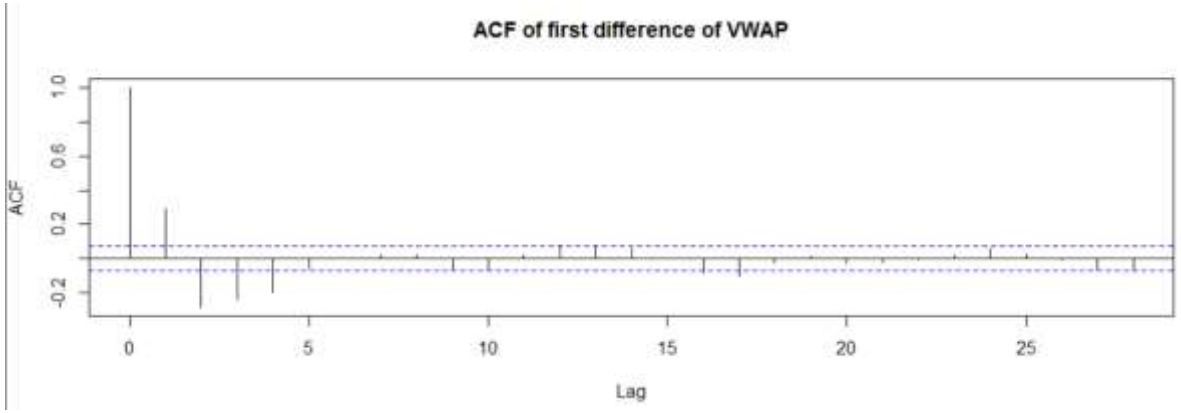




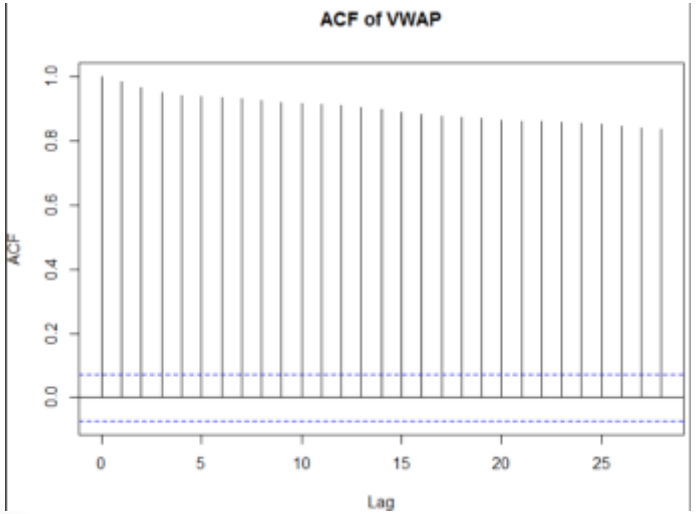
Test for stationarity

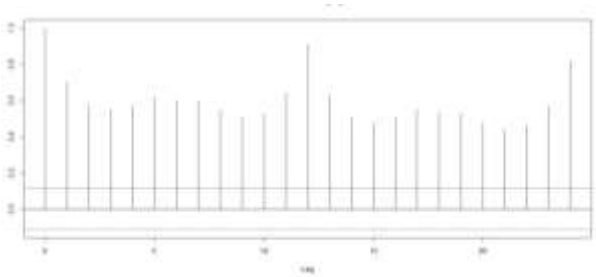
- Checking for the stationarity :
  - We look at the autocorrelation function of our data.
  - Autocorrelation function is just a function that calculates the autocorrelation of the time series at different lags.
  - In R, we can also get a graph of this function.

ACF of stationary time series



non-stationarity time series ACF





Statistical tests

- ADF test – Augumented Dickey Fuller test
  - Test of hypothesis used especially to test stationarity
    - $P < 0.25$, we say series is stationary
- KPSS test

We have non-stationary series?

- If we have non-stationary series, we will have to perform some transformations to convert it stationary series before proceeding with our analysis.

- Most common transformation that is done is differencing:

  difference(t) = observation(t) - observation(t-1)

- Sometimes, different lag is taken:

  difference(t) = observation(t) - observation(t-k)

- If these methods are not sufficient, then other methods can be used like log transformation, etc.

Thank you