



< Previous	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Next >
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3. Autoregressive model

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Exercises due Nov 10, 2021 17:29 IST Completed

A time series $\{X_t\}_t$ is an **autoregressive process** of order p , denoted **AR** (p), if:

$$X_t = \phi_1 X_{t-1} + \phi_2 X_{t-2} + \cdots + \phi_p X_{t-p} + W_t$$

where $\{W_t\}_t$ is a white noise process, and W_t is uncorrelated with X_s for $s < t$.

Note that the definition of the model is recursive, meaning that we can relate X_t to any previous term of the series X_{t-h} by substituting the above expression for X_{t-1} on the right side of the equation, then for X_{t-2} and so on until we obtain a formula that relates X_t and X_{t-h} . So, X_t depends on X_{t-1} , and X_{t-1} depends on X_{t-2} , and X_{t-2} depends on X_{t-3} , etc. Because of this recursive nature of the model, **all** terms of the series are **dependent**. This fact is reflected formally in the autocovariance function. The acf $\gamma_X(h)$ of a **stationary** autoregressive process is non-zero for all time shifters h and decays to zero exponentially as h increases.

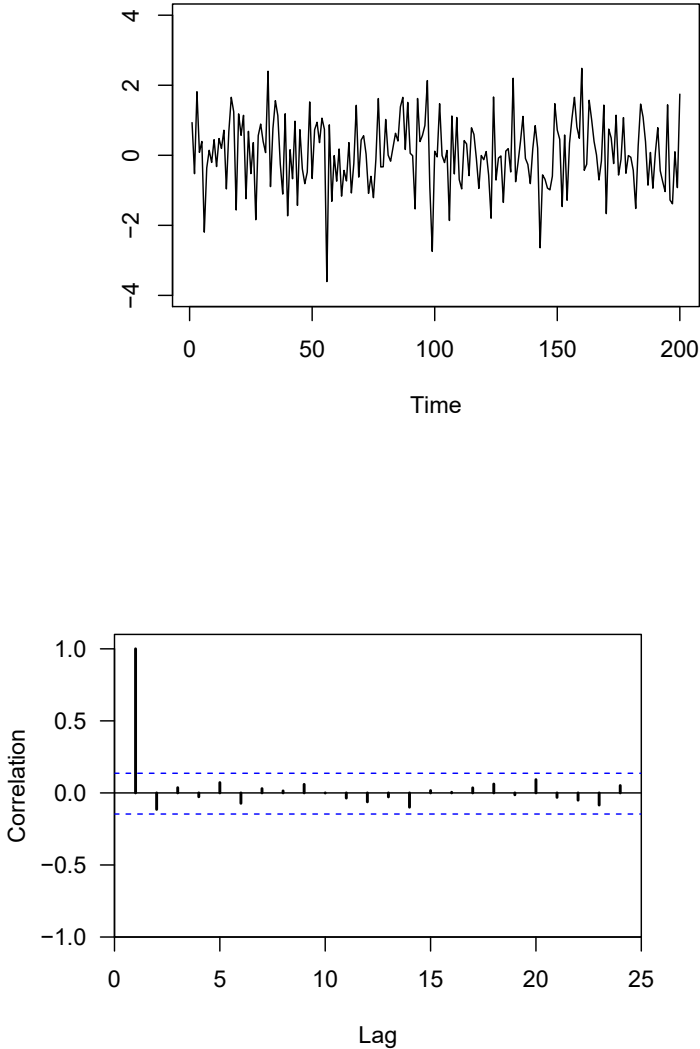
What does autoregressive process look like

1/1 point (graded)

Which plot shows the path of a stationary autoregressive process and its acf?

☐

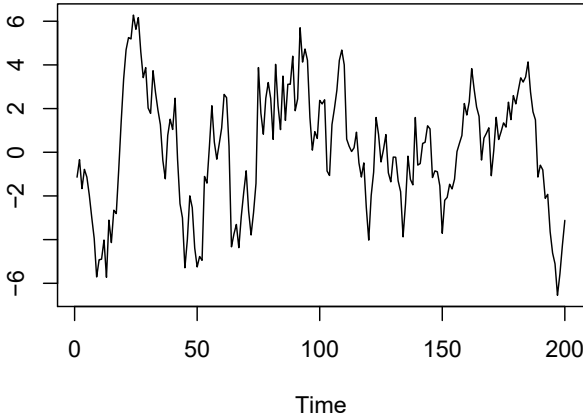
(a):



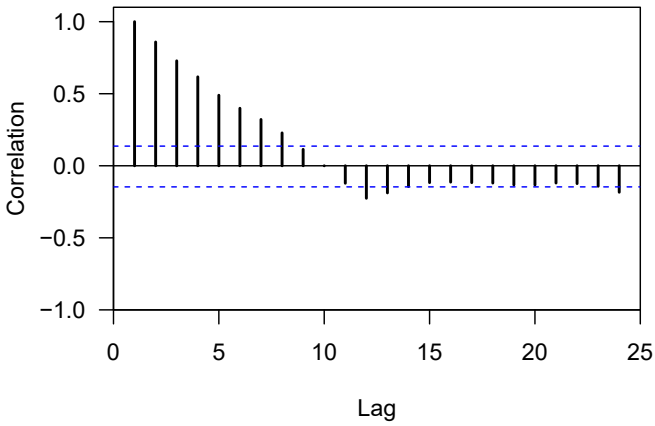
The figure consists of two vertically stacked plots. The top plot is a time series plot with 'Time' on the x-axis (0 to 200) and values on the y-axis (-4 to 4). It shows a highly volatile, random-looking signal fluctuating around zero. The bottom plot is an Autocorrelation Function (ACF) plot with 'Lag' on the x-axis (0 to 25) and 'Correlation' on the y-axis (-1.0 to 1.0). The correlation starts at 1.0 for lag 0 and decays exponentially towards zero, with dashed blue lines indicating the confidence interval.

☐

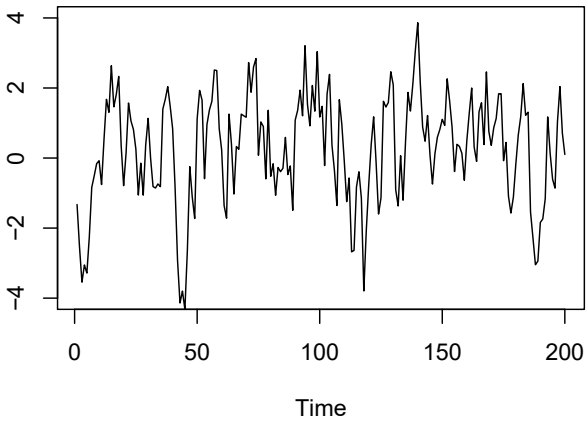
(b):



The figure consists of two vertically stacked plots. The top plot is a time series plot with 'Time' on the x-axis (0 to 200) and values on the y-axis (-6 to 6). It shows a signal that exhibits a clear upward trend and increasing variance over time, characteristic of a non-stationary process. The bottom plot is an ACF plot with 'Lag' on the x-axis (0 to 25) and 'Correlation' on the y-axis (-1.0 to 1.0). The correlation starts at 1.0 for lag 0 and decays very slowly, remaining significantly above the zero line for most lags, which is typical for non-stationary data.



(c):



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