ISA 444: Business Forecasting

14 - Autocorrelation and Seasonality

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Outline

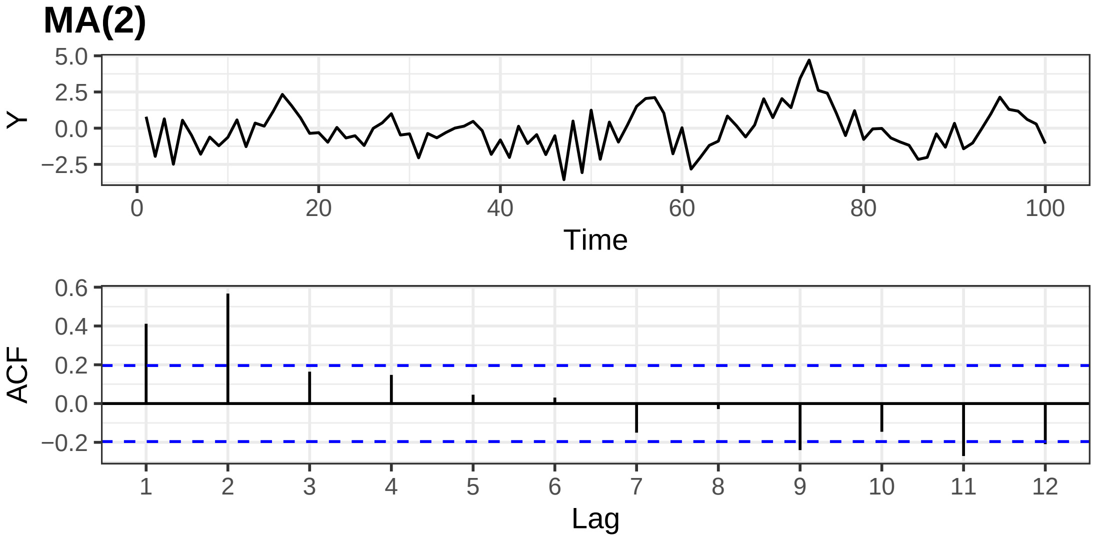
1. **Preface**
2. Partial Autocorrelation
3. Stationarity
4. Recap

Quick Refresher on What we Covered in Chapter 06 so Far

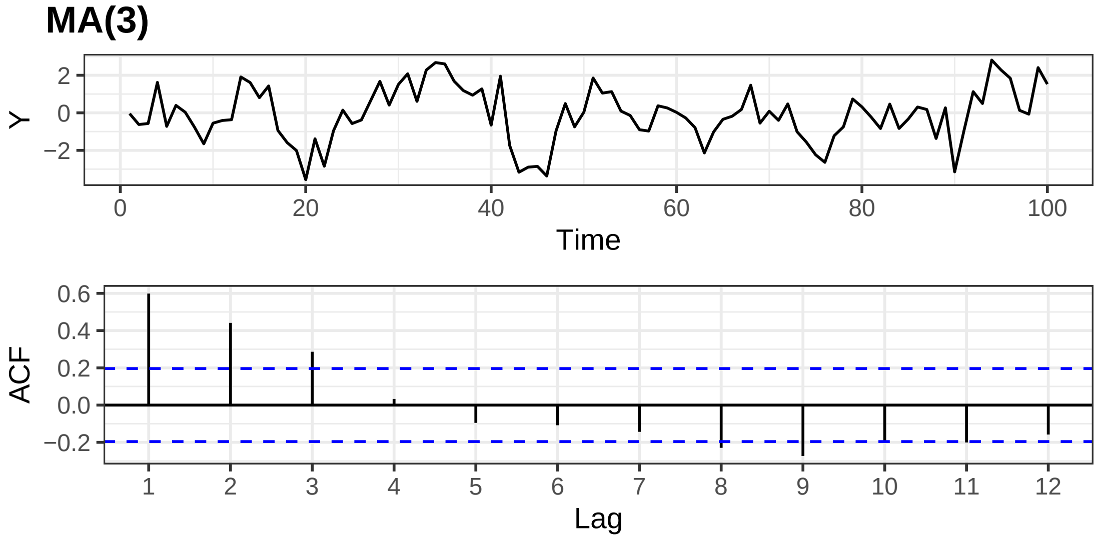
Main Learning Outcomes Discussed in Chapter 06

- ☑ Define the population mean, and variance of a random variable.
- ☑ Define the population covariance, and correlation between two random variables.
- ☑ Define the population autocovariance and autocorrelation of a random variable.
- ☑ Use sample estimates of the population mean, variance, covariance, and correlation.
- ☑ Explain the properties of the large sample distribution of the sample ACF.
- ☑ Use the large sample distribution of the sample ACF to identify significant autocorrelation in a time series.
- ☒ Determine if a sample ACF plot "cuts off" or "dies down".

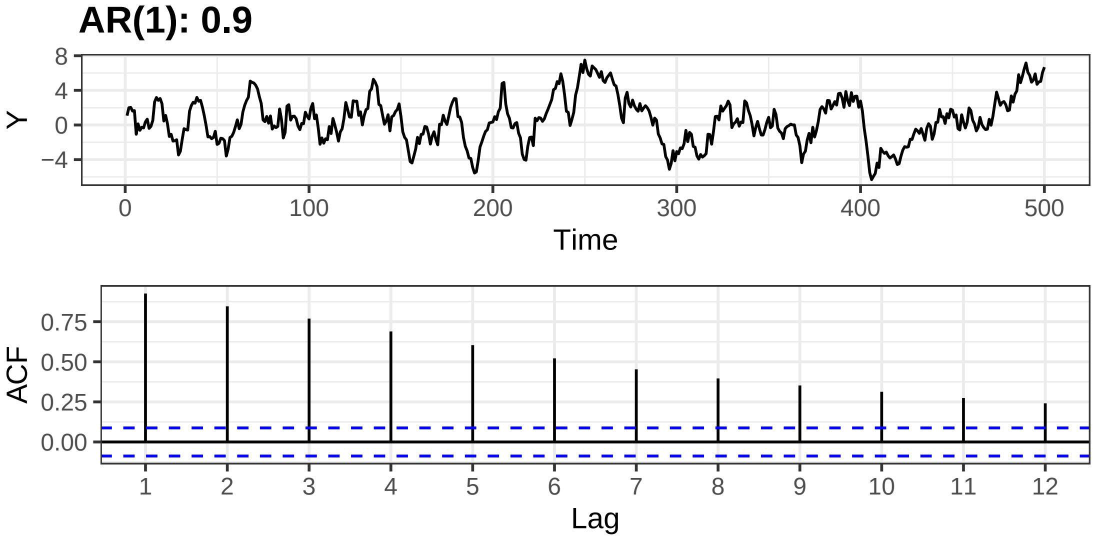
Some Time Series and their ACF Plots [1]



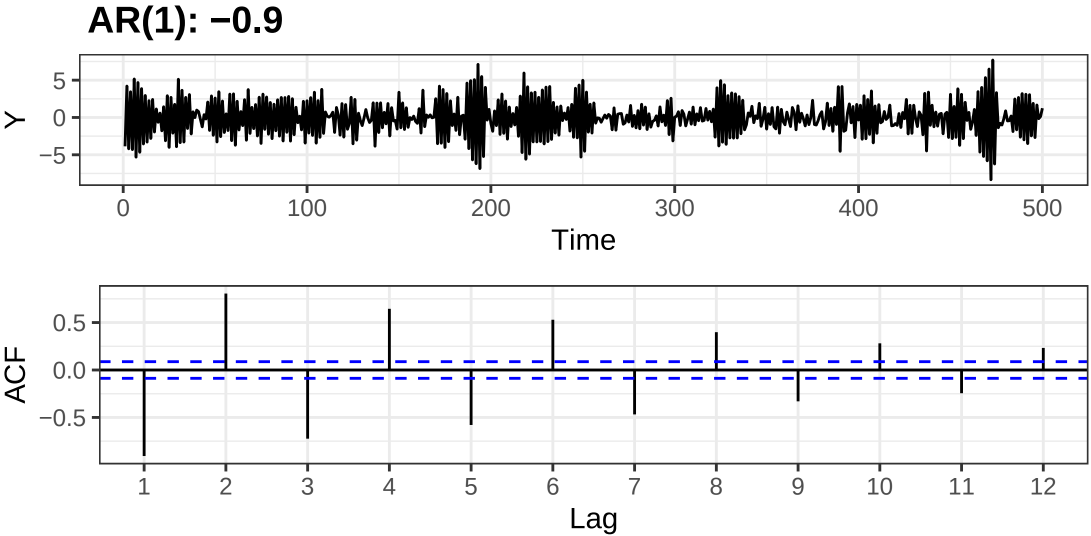
Some Time Series and their ACF Plots [2]



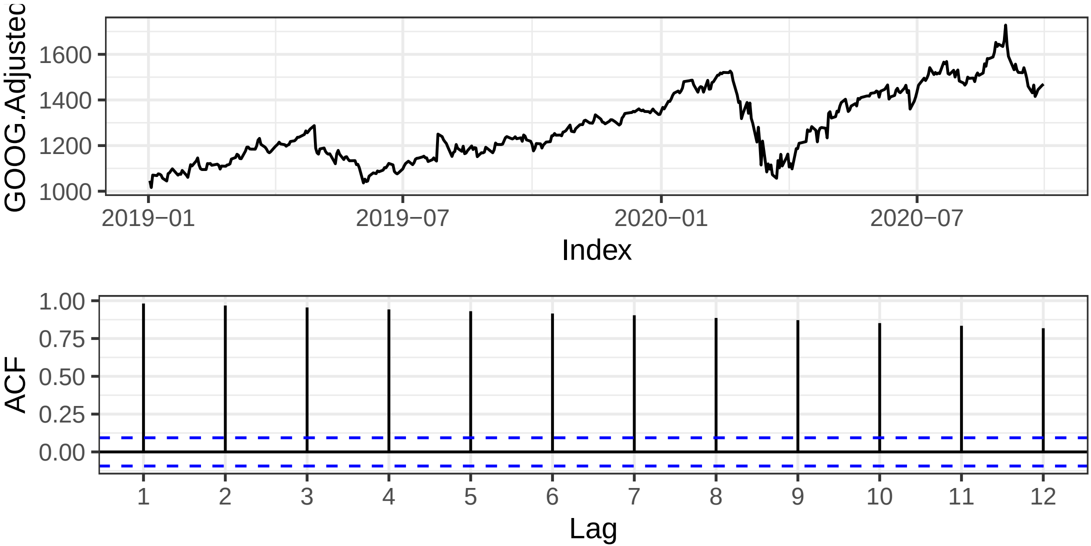
Some Time Series and their ACF Plots [3]



Some Time Series and their ACF Plots [4]



Some Time Series and their ACF Plots [5]



Learning Objectives for Today's Class

Main Learning Outcomes

- Determine if a sample ACF plot "cuts off" or "dies down".
- Explain how sample partial autocorrelation is calculated.
- Define the term "weakly stationary" and recognize time series that do not fit this definition.
- Use the sample ACF plot to identify a nonstationary time series.

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Definition: General

Statistical Definition: Let us say that we have three variables, X, Y, and Z, all correlated, and we want to know how X and Y are correlated after we remove the effects of Z on each.

Computation Approach:

$$\hat{X} = a_1 + b_1 Z; \qquad X^* = X - \hat{X}$$

$$\hat{Y} = a_2 + b_2 Z; \qquad Y^* = Y - \hat{Y}$$

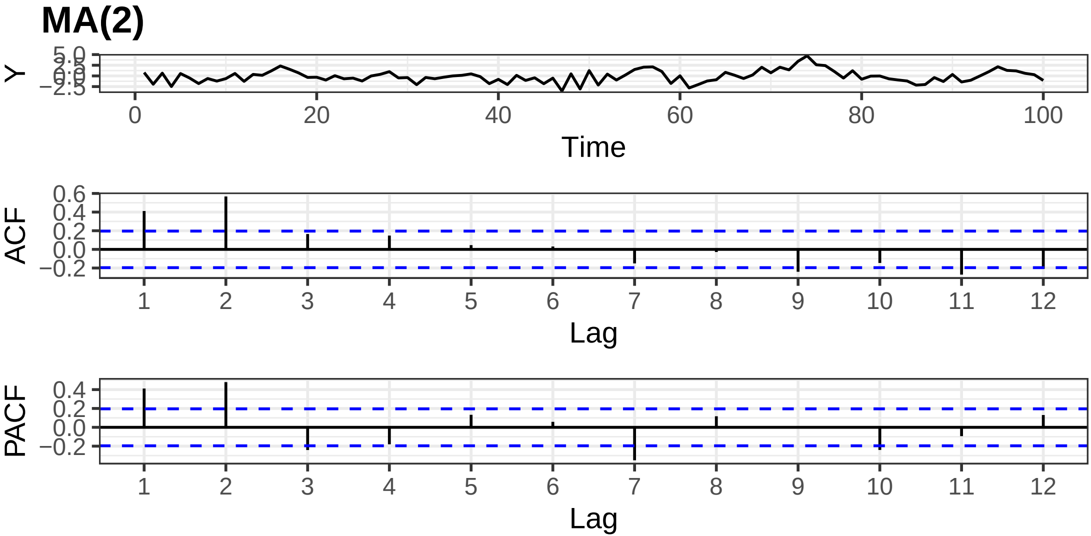
$Corr(X^*, Y^*)$ is the Partial Autocorrelation between X and Y. It is the correlation that remains after we remove the effect of Z.

PACF in the Context of Time-Series Analysis

The Partial Autocorrelation between Y_t and Y_{t+k} is the correlation between Y_t and Y_{t+k} after removing the effects of Y_{t+1}, Y_{t+2}, Y_{t+3}, $\ldots$, Y_{t+k-1}.

- We plot the partial autocorrelation over multiple lags just like the autocorrelation function (ACF).
- We refer to the plotted partial autocorrelations as the PACF.

Some Time Series and their PACF Plots [1]



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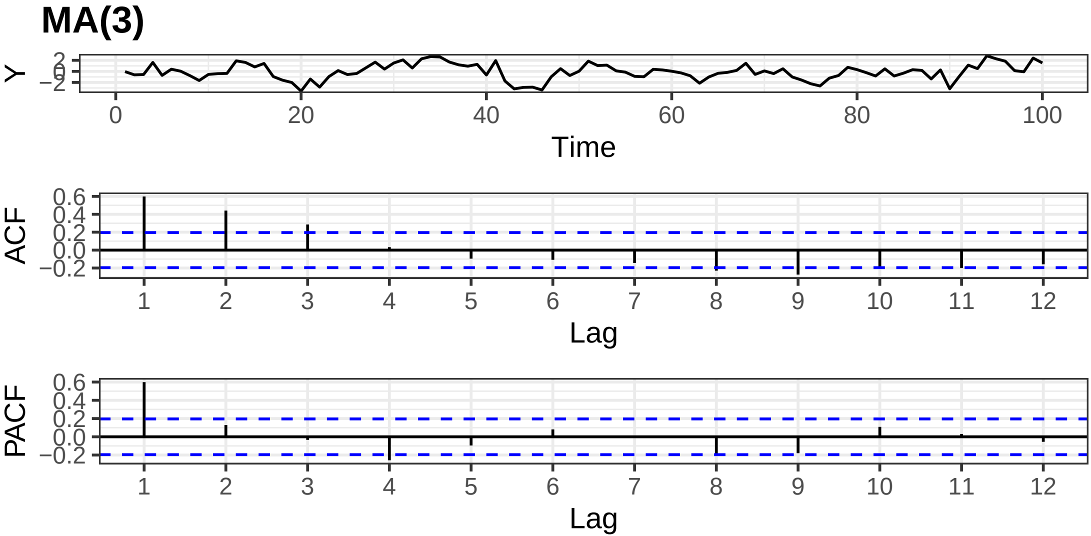

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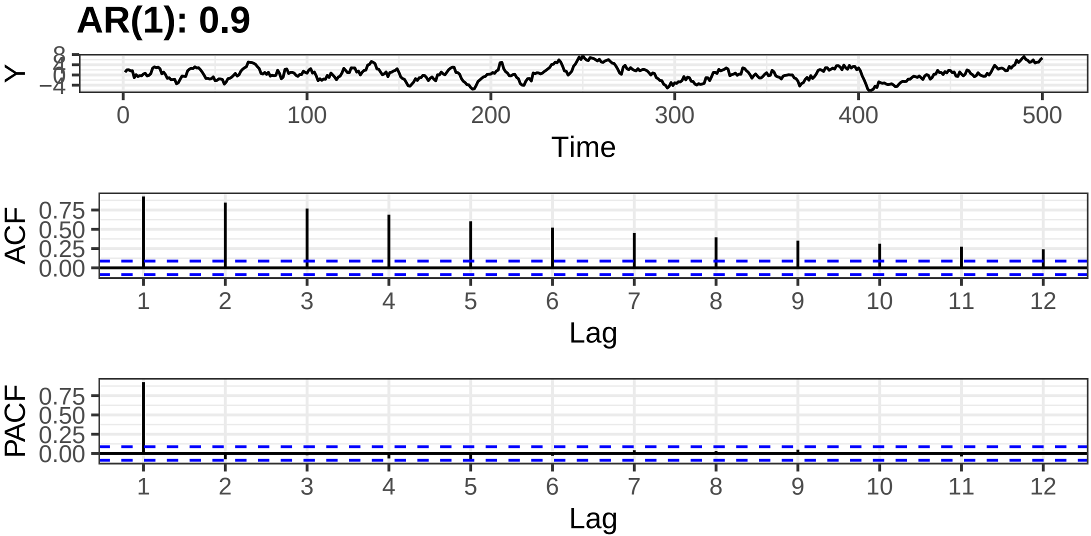

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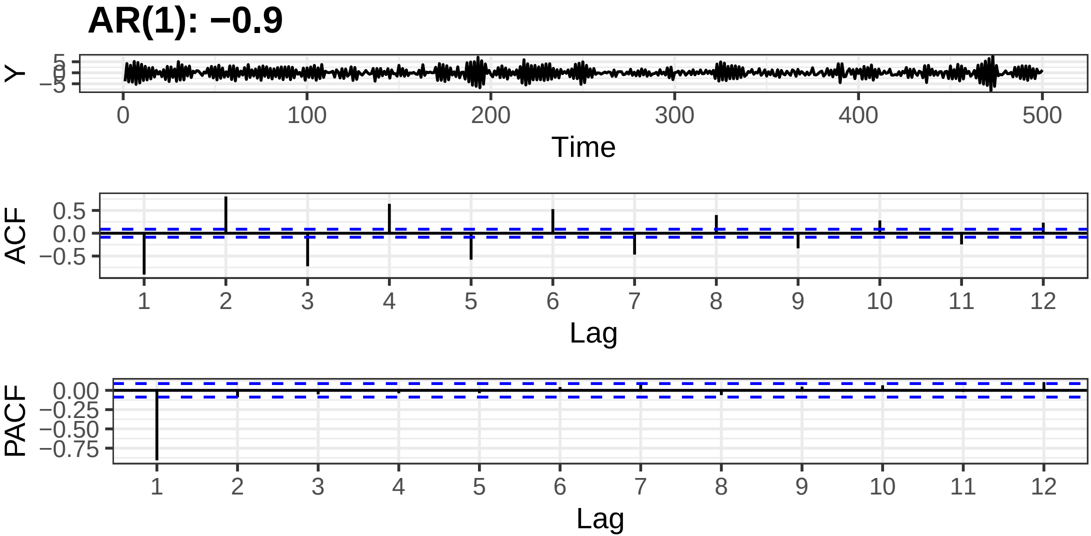

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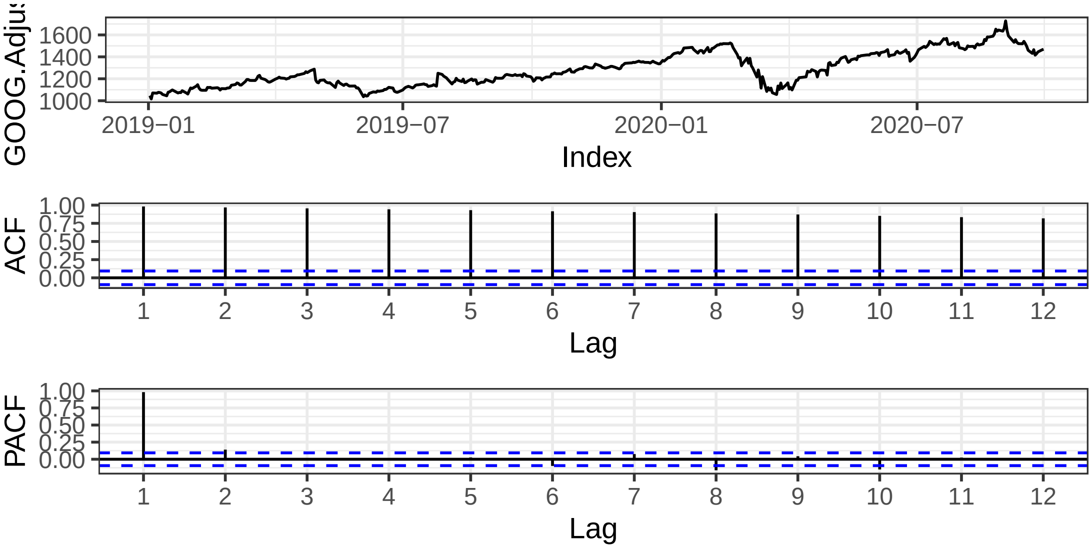
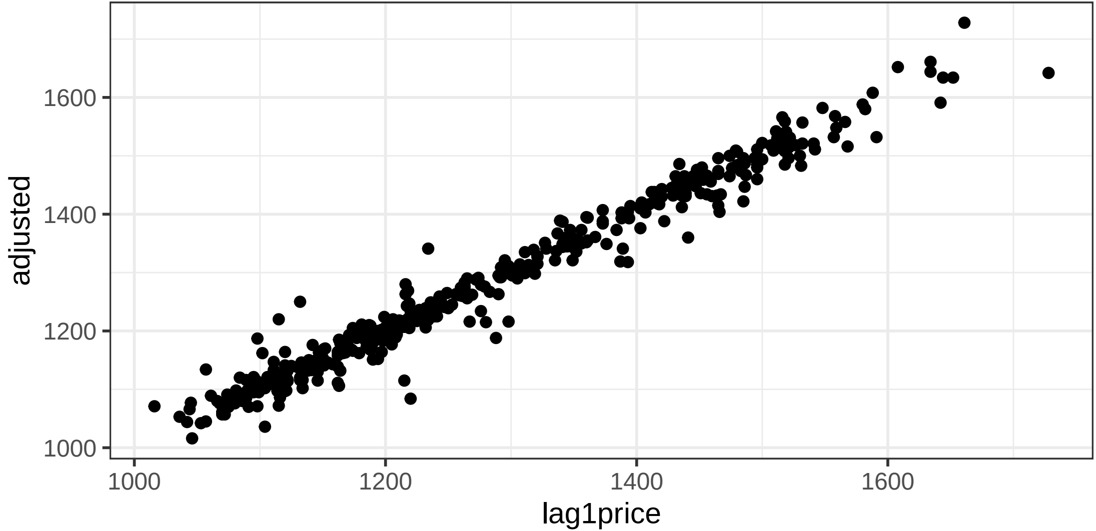


What we have learned from the GOOG Example [1]



What we have learned from the GOOG Example [2]

	Dependent variable:
	adjusted
lag1price	0.985***
	(0.008)
Constant	20.607**
	(10.390)
Observations	439
R^2	0.972
Adjusted R^2	0.972
Residual Std. Error	25.897 (df = 437)
F Statistic	15,001.350*** (df = 1; 437)
Note:	*p<0.1; **p<0.05; ***p<0.01

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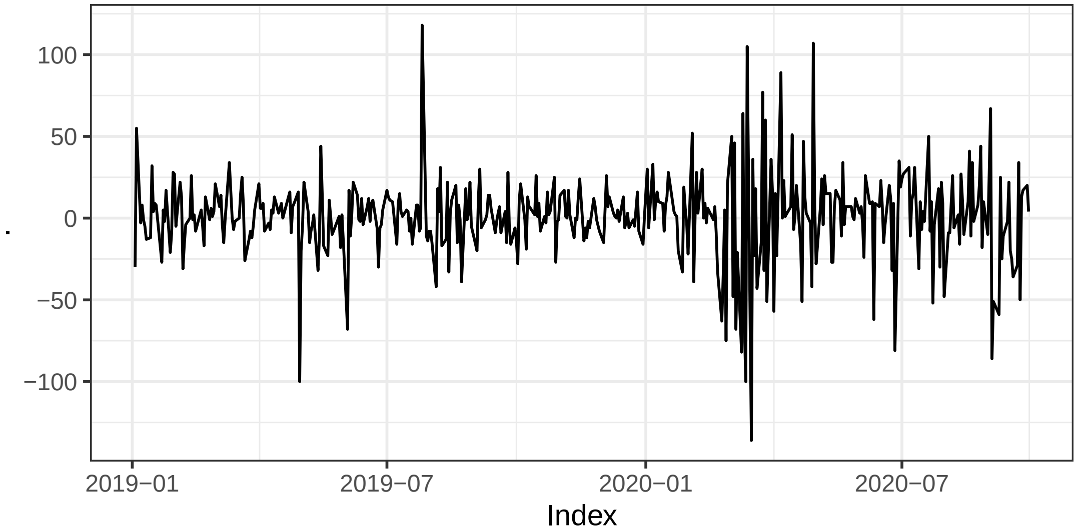

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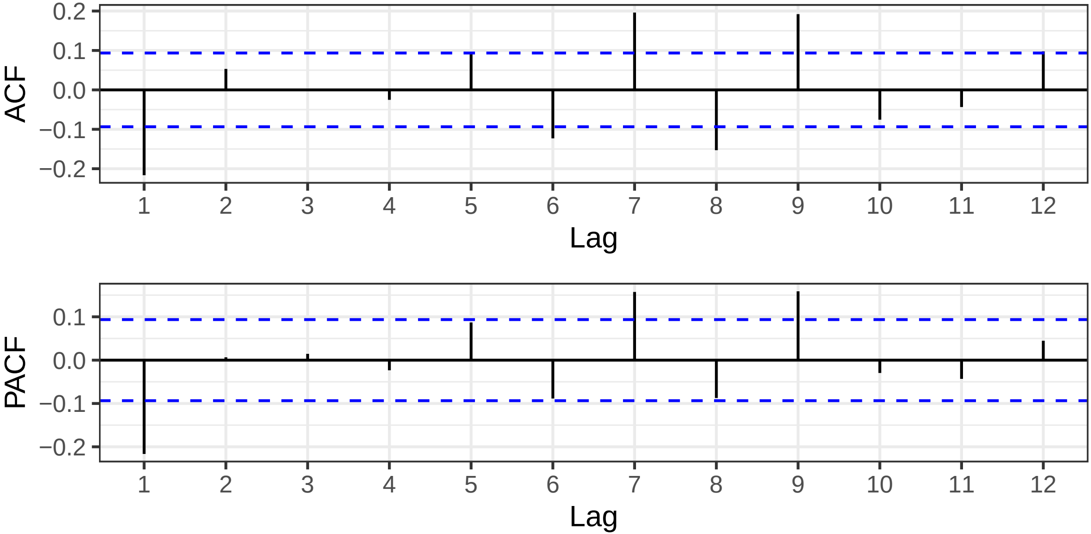

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Stationarity: A Formal Definition

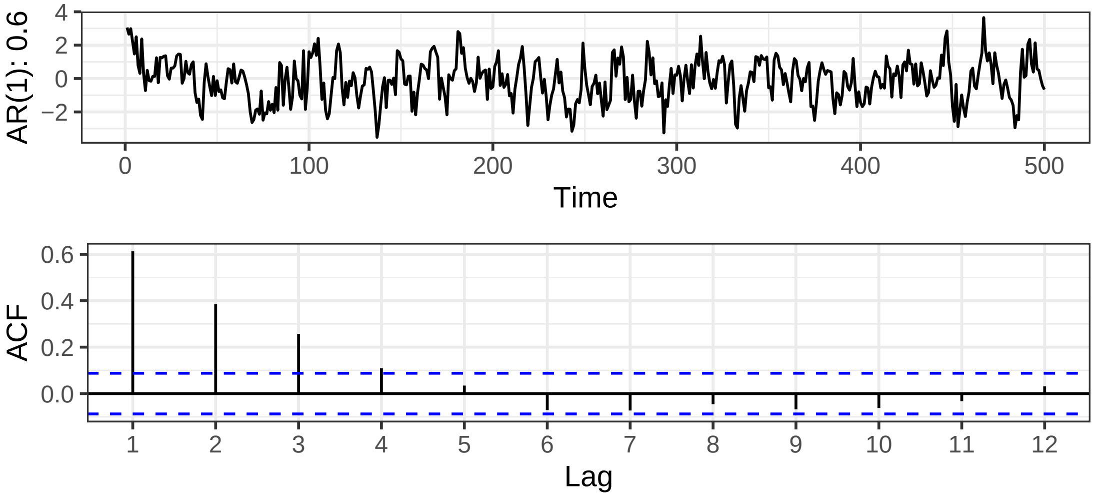
Weak Stationarity: A weakly stationary time series is a finite variance process such that:

1. The mean, μ_t, is constant and does not depend on the time t; and
2. The autocovariance function, $\gamma(s,t)$ depends on s and t only through their difference $|s-t|$.

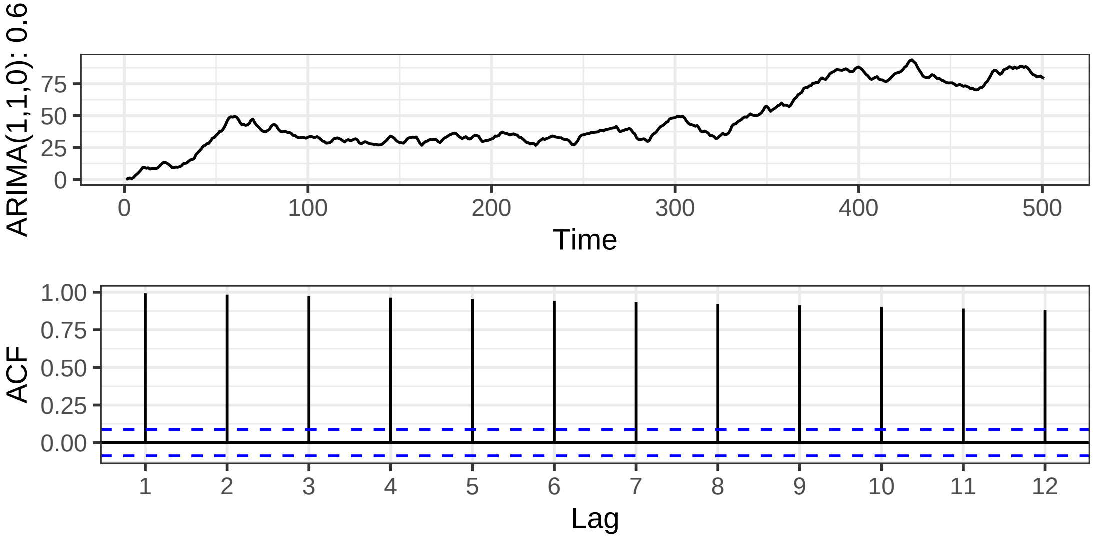
We will use the term "stationary" to refer to weak stationarity.

- The concept of weak stationarity forms the basis of much of the foundation for time series modeling.
- The fundamental properties (1 & 2) required for weak stationarity are satisfied by many of the models that are widely used.

Stationarity: A Visual Explanation



Non-Stationarity: A Visual Explanation



Stationarity: Some Thoughts??

Based on the five examples depicted in Slides $4-8$ (or alternatively $13-17$), please identify which of the five series are stationary and which are not!!

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Summary of Main Points

Main Learning Outcomes

- Determine if a sample ACF plot “cuts off” or “dies down”.
- Explain how sample partial autocorrelation is calculated.
- Define the term “weakly stationary” and recognize time series that do not fit this definition.
- Use the sample ACF plot to identify a nonstationary time series.

Things to Do for Next Class

- Thoroughly read Chapter 6.1 of our textbook.
- Go through the slides, examples and make sure you have a good understanding of what we have covered.

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