ARMA Process

Bruno Pereira, Economist and Data Scientist

Contents

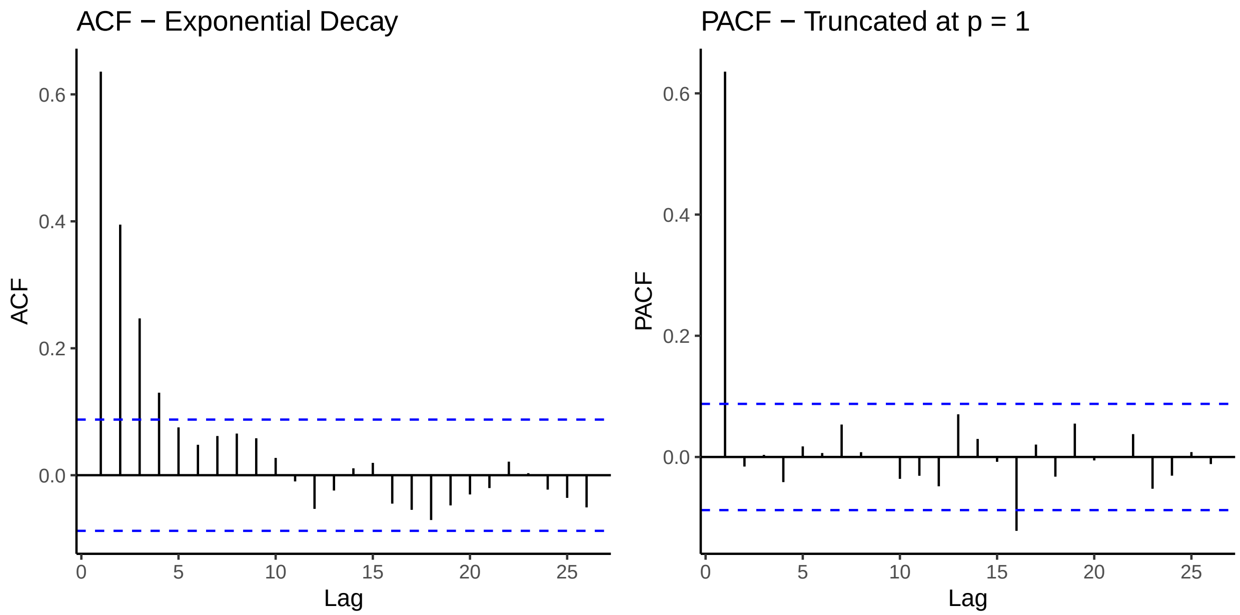
Type	ACF	PACF
AR(p)	Exponential or oscillating decay	Truncated at lag p
MA(q)	Truncated at lag q	Exponential or oscillating decay
ARMA(p,q)	Truncated at q	Truncated at p

```r
library(forecast)
library(ggplot2)
library(tidyverse)
library(gridExtra)
library(knitr)
library(kableExtra)
library(dplyr)
```

1 Identification Table

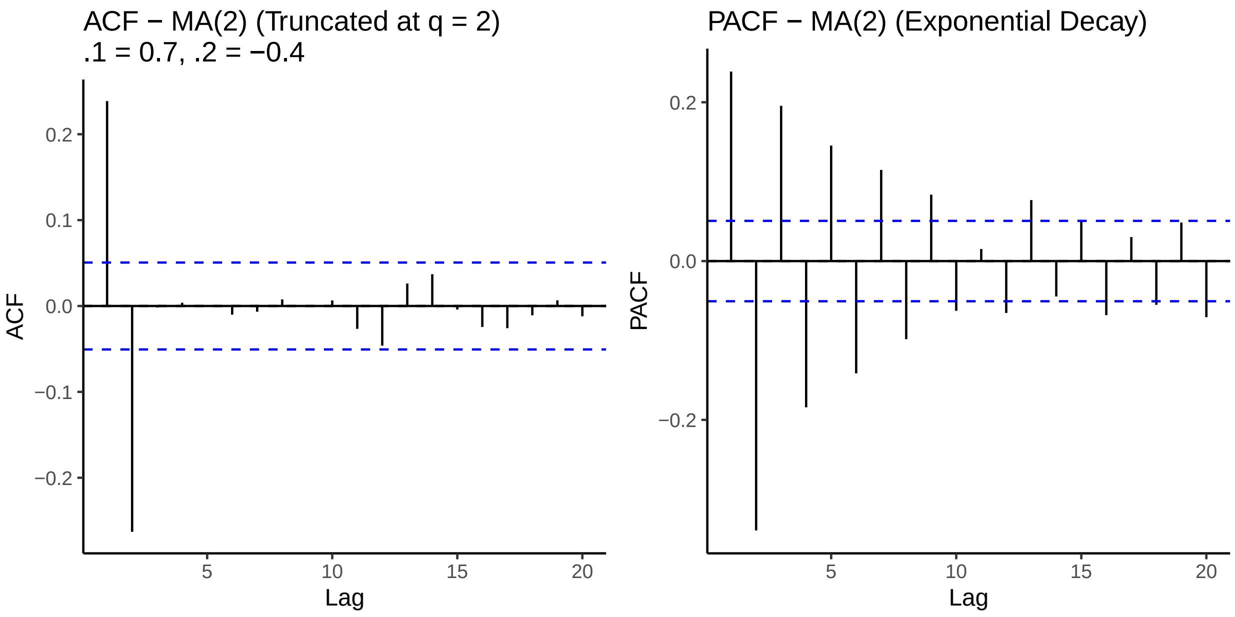
2 AR(p) Process

```r
# Simulation of the AR(1) process
set.seed(123)

ar1 <- arima.sim(model = list(ar = 0.7), n = 500)

#
g1 <- ggAcf(ar1) +
  ggtitle("ACF - Exponential Decay") +
  theme_classic()

#
g2 <- ggPacf(ar1) +
  ggtitle("PACF - Truncated at p = 1") +
  theme_classic()

grid.arrange(g1, g2, ncol = 2)
```



# MA(Q) Process

```
# MA(2) Simulation: X_t = _t +  _{t-1} +  _{t-2}
set.seed(123)
ma2 <- arima.sim(n = 1500, model = list(ma = c(0.7, -0.4)))

# ACF: truncated after lag 2
g1 <- ggAcf(ma2, lag.max = 20) +
  ggtitle("ACF - MA(2) (Truncated at q = 2)\n  = 0.7,   = -0.4") +
  geom_hline(yintercept = 0, linetype = "dashed") +
  theme_classic()

# PACF: exponential decay
g2 <- ggPacf(ma2, lag.max = 20) +
  ggtitle("PACF - MA(2) (Exponential Decay)") +
  geom_hline(yintercept = 0, linetype = "dashed") +
  theme_classic()

# Display both plots side by side
grid.arrange(g1, g2, ncol = 2)
```

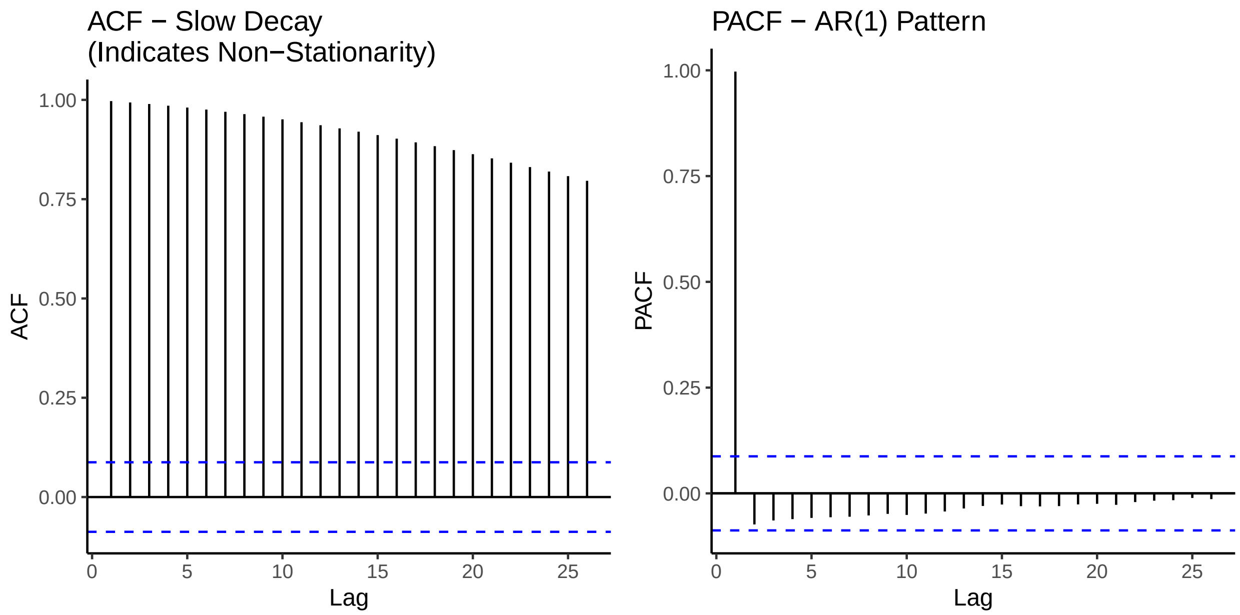


ACF − MA(2) (Truncated at q = 2)
.1 = 0.7, .2 = −0.4

PACF − MA(2) (Exponential Decay)

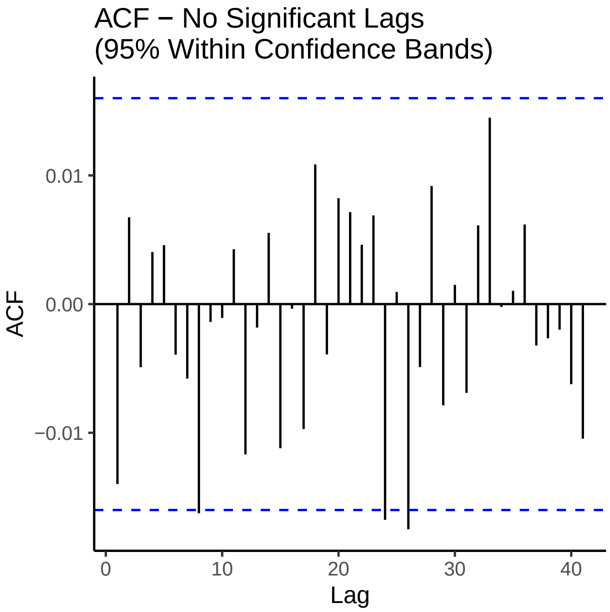
3 Non-Stationary Process: Slow, Linear Decay

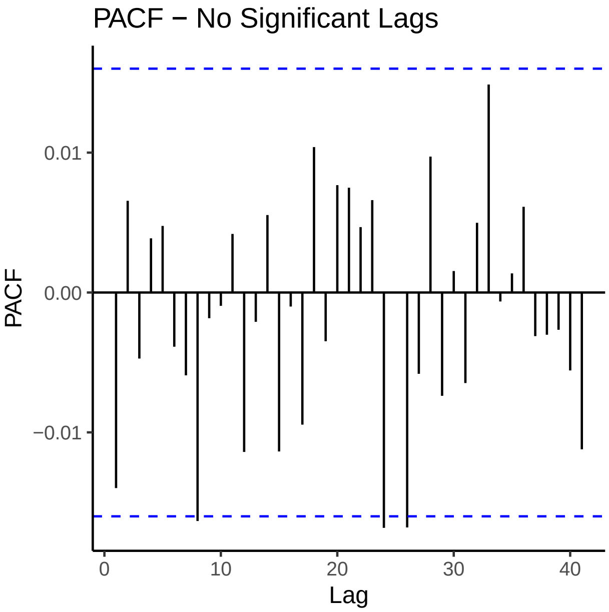
```
# Simulation of an ARIMA(1,1,0) Process - Non-Stationary
set.seed(123)
non_stationary <- arima.sim(
  model = list(
    order = c(1, 1, 0),
    ar = 0.98
  ),
  n = 500
)

# ACF: Slow decay suggests non-stationarity
g1 <- ggAcf(non_stationary) +
  ggtitle("ACF - Slow Decay\n(Indicates Non-Stationarity)") +
  theme_classic()

# PACF: AR(1) pattern
g2 <- ggPacf(non_stationary) +
  ggtitle("PACF - AR(1) Pattern") +
  geom_hline(yintercept = 0) +
  theme_classic()

#
grid.arrange(g1, g2, ncol = 2)
```



4 White Noise

```
set.seed(123)

n <- 15000

noise <- scale(rnorm(n))

#
g1 <- ggAcf(noise) +
  ggtitle("ACF - No Significant Lags\n(95% Within Confidence Bands)") +
  theme_classic()

#
g2 <- ggPacf(noise) +
  ggtitle("PACF - No Significant Lags") +
  theme_classic()

#
grid.arrange(g1, g2, ncol = 2)
```


ACF − No Significant Lags
(95% Within Confidence Bands)
ACF
0.01
0.00
−0.01
0
10
20
30
40
Lag


PACF − No Significant Lags
PACF
0.01
0.00
−0.01
0
10
20
30
40
Lag