HW3 Jin Kweon (3032235207)

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2/6/2018

Problem 1

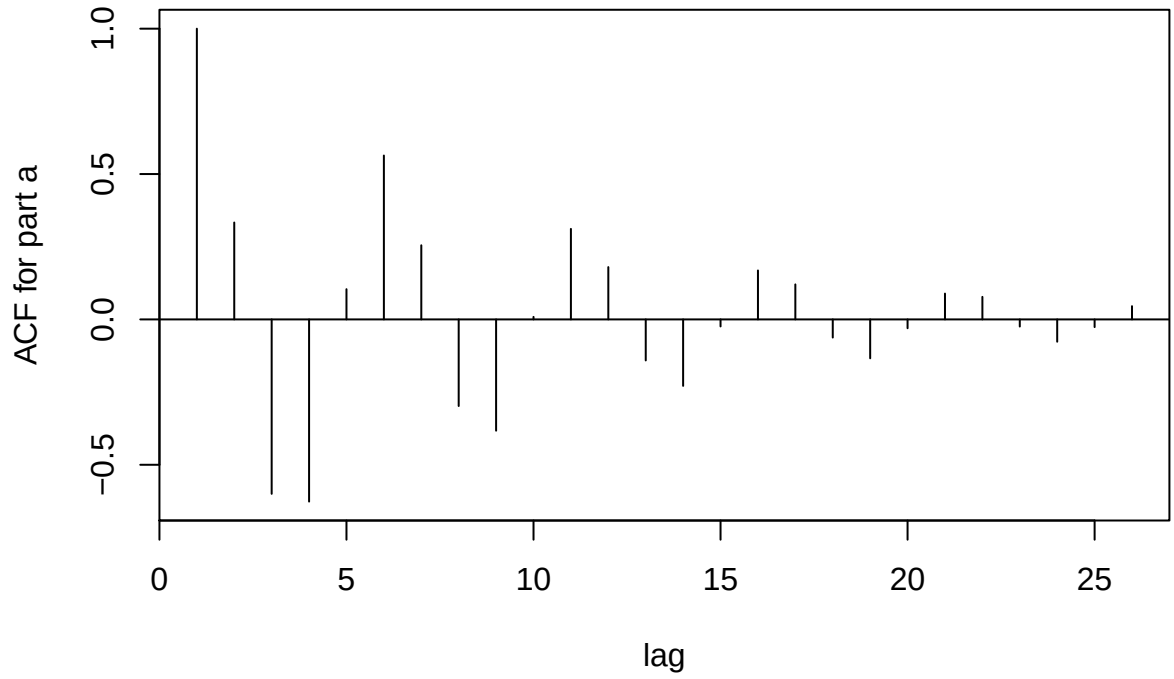
```
#Check answers
ARMAtoMA(ar= -0.5, ma = 1.5, 7)
```

```
## [1]  1.000000 -0.500000  0.250000 -0.125000  0.062500 -0.031250  0.015625
```

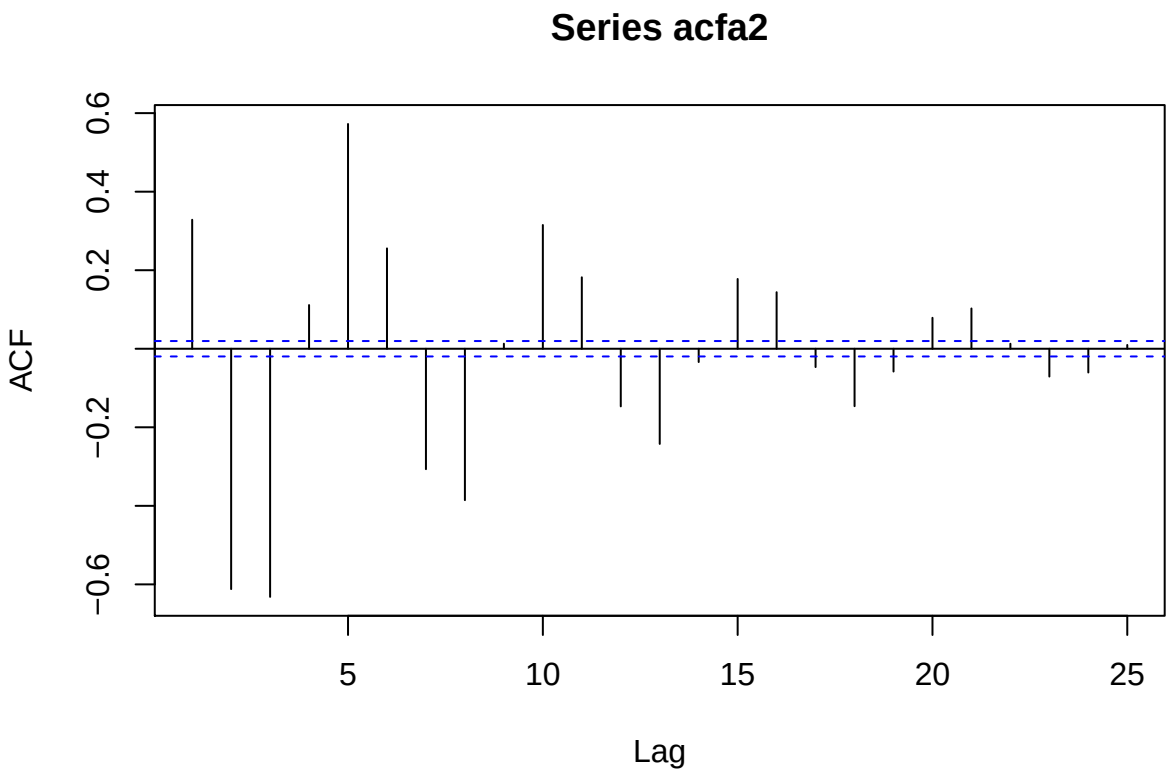
Problem 4

Part a

```
#Check invertibility/causality
abs(polyroot(c(1, (-3/5), (4/5)))[1])
abs(polyroot(c(1, (-3/5), (4/5)))[2])

#Plot Series
# set.seed(100)
# plot.ts(arima.sim(list(order = c(2, 0, 0), ar = c((3/5), (-4/5))), n = 10000), ylab = "x",
#       main = (expression(AR(2)~~~phi_1==(3/5)~~~phi_2==(-4/5))))
# set.seed(100)
# plot(arima.sim(list(order = c(2, 0, 0), ar = c((3/5), (-4/5))), n = 10000), ylab = "x",
#       main = (expression(AR(2)~~~phi_1==(3/5)~~~phi_2==(-4/5))))
# set.seed(100)
# tsplot(arima.sim(list(order = c(2, 0, 0), ar = c((3/5), (-4/5))), n = 10000), ylab = "x",
#       main = (expression(AR(2)~~~phi_1==(3/5)~~~phi_2==(-4/5))))



#ACF
set.seed(100)
acfa <- ARMAacf(ar = c((3/5), (-4/5)), ma = 0, lag.max = 25)
acfa
plot(acfa, type = "h", xlab = "lag", ylab = "ACF for part a")
abline(h = 0)
```

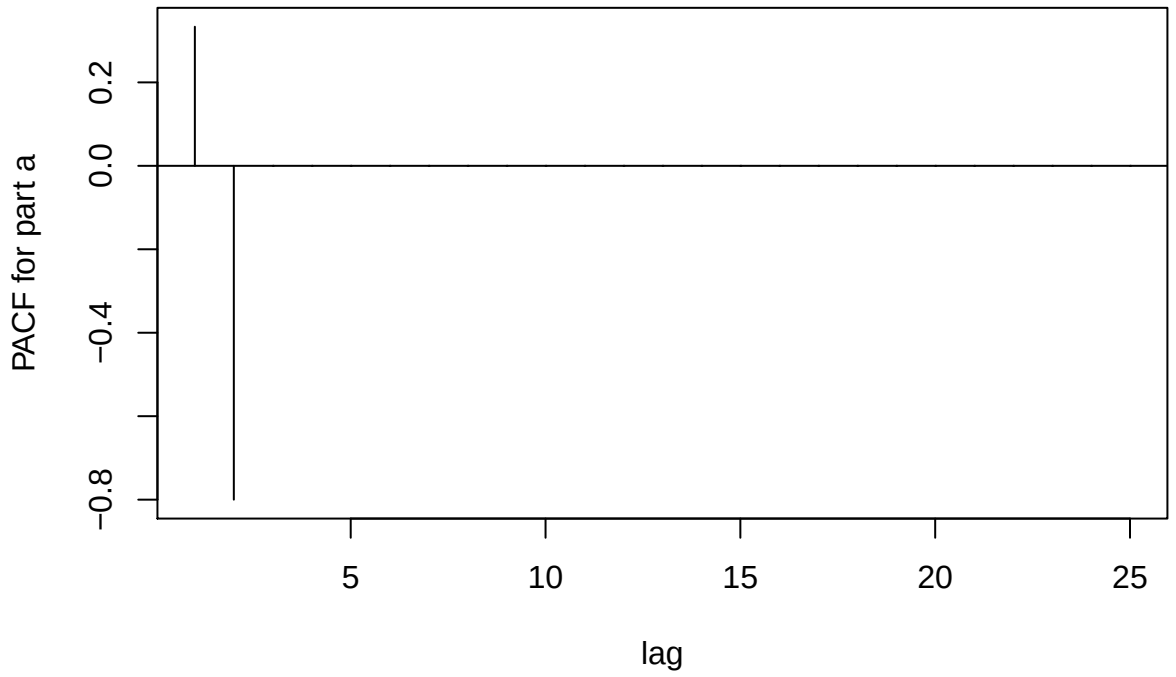



```r
#ACF2
set.seed(100)
acfa2 <- arima.sim(list(order = c(2, 0, 0), ar = c((3/5), (-4/5))), n = 10000)
acf(acfa2, lag.max = 25, plot = T)
```

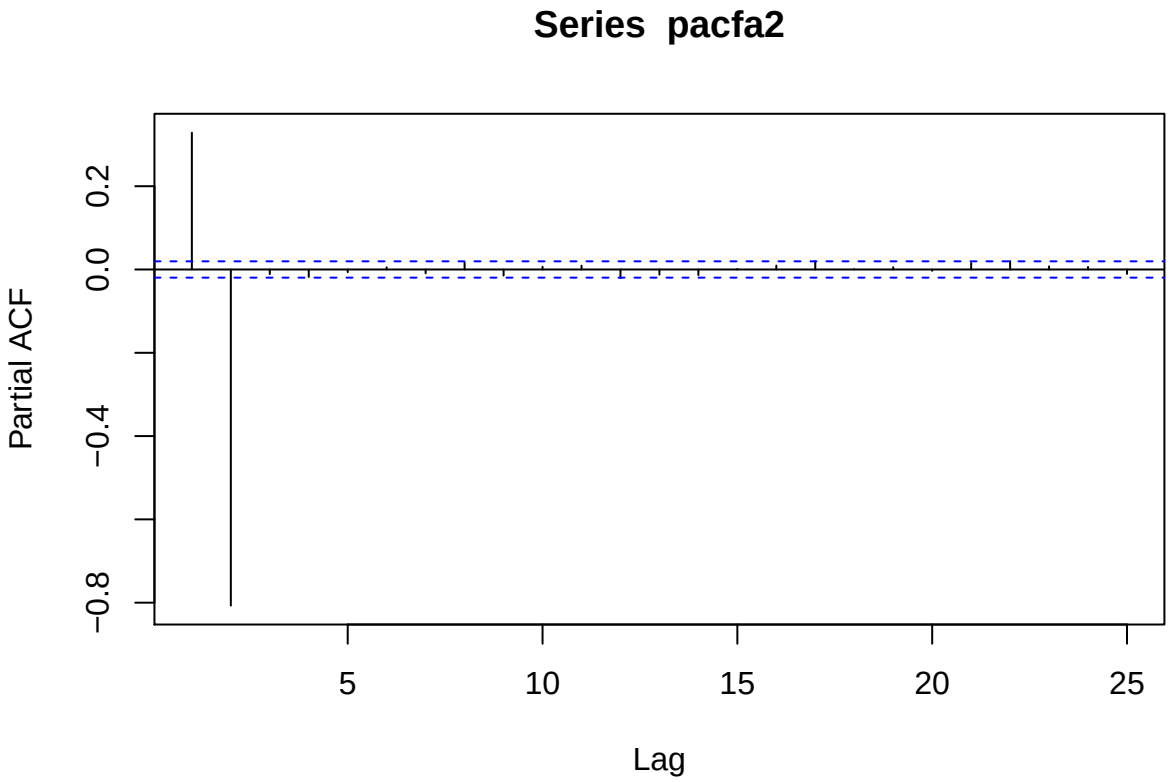



```r
#PACF theoretical
set.seed(100)
pacfa <- ARMAacf(ar = c((3/5), (-4/5)), ma = 0, lag.max = 25, pacf = T)
```

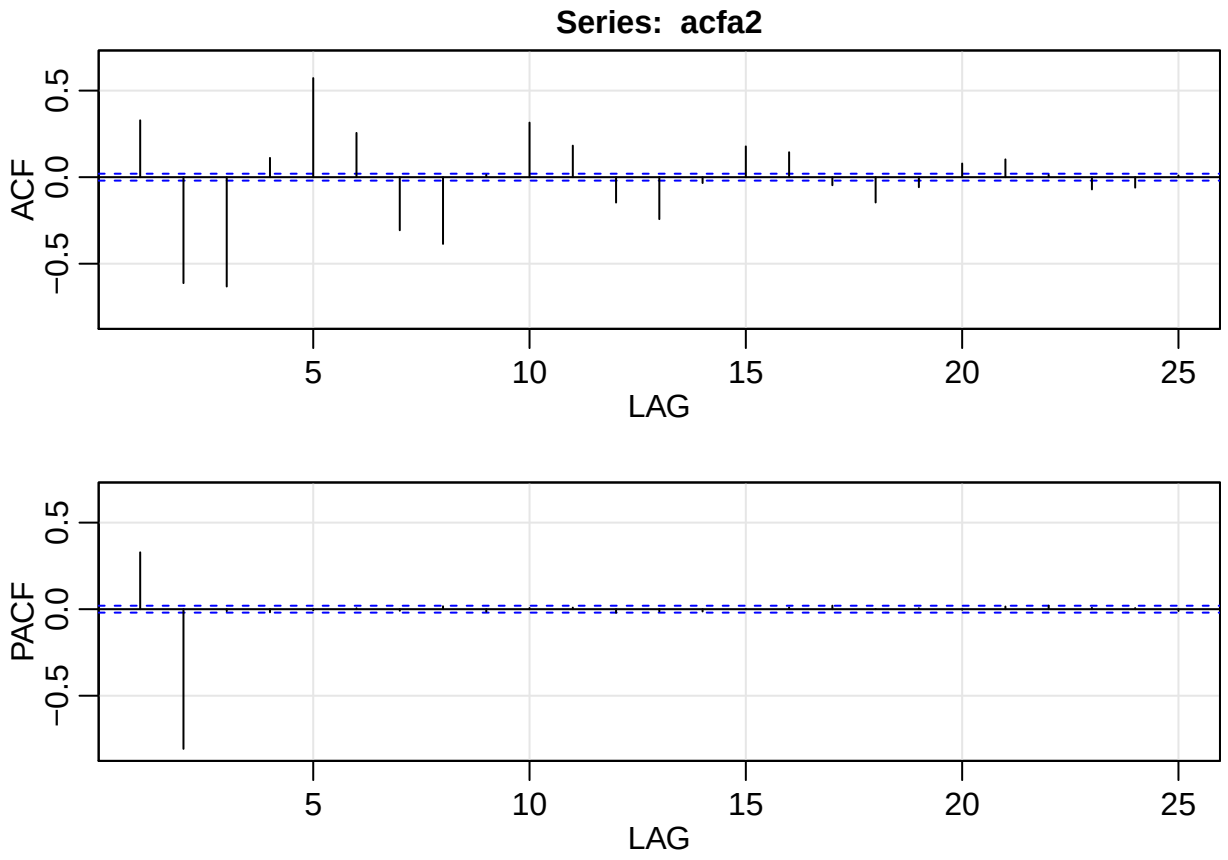
```r
pacfa
plot(pacfa, type = "h", xlab = "lag", ylab = "PACF for part a")
abline(h = 0)
```




```r
#PACF2 simulation
set.seed(100)
pacfa2 <- arima.sim(list(order = c(2, 0, 0), ar = c((3/5), (-4/5))), n = 10000)
pacf(pacfa2, lag.max = 25, plot = T)
```




```
#Do both acf and pacf
acf2(acfa2, max.lag = 25, plot = T)
```



Comment: My time series model is $x_t = \frac{3}{5}x_{t-1}$ - $\frac{4}{5}x_{t-2} + w_t$. So, ϕ_1 will be $\frac{3}{5}$ and ϕ_2 will be $\frac{-4}{5}$. And, this is both causal and invertible. And, by the definition, this is AR(2) process.

The most important thing I can notice from AR(2) process is that ACF is tailing off, and PACF cuts off after lag 2.

PACF starts at lag 1 and ACF starts at lag 0. Since this is AR(2) process, PACF should cut off at h = 2.

Part b

```
#Check invertibility/causality
abs(polyroot(c(1, 0.8, 1.1))[1])
```

```
## [1] 0.9534626
```

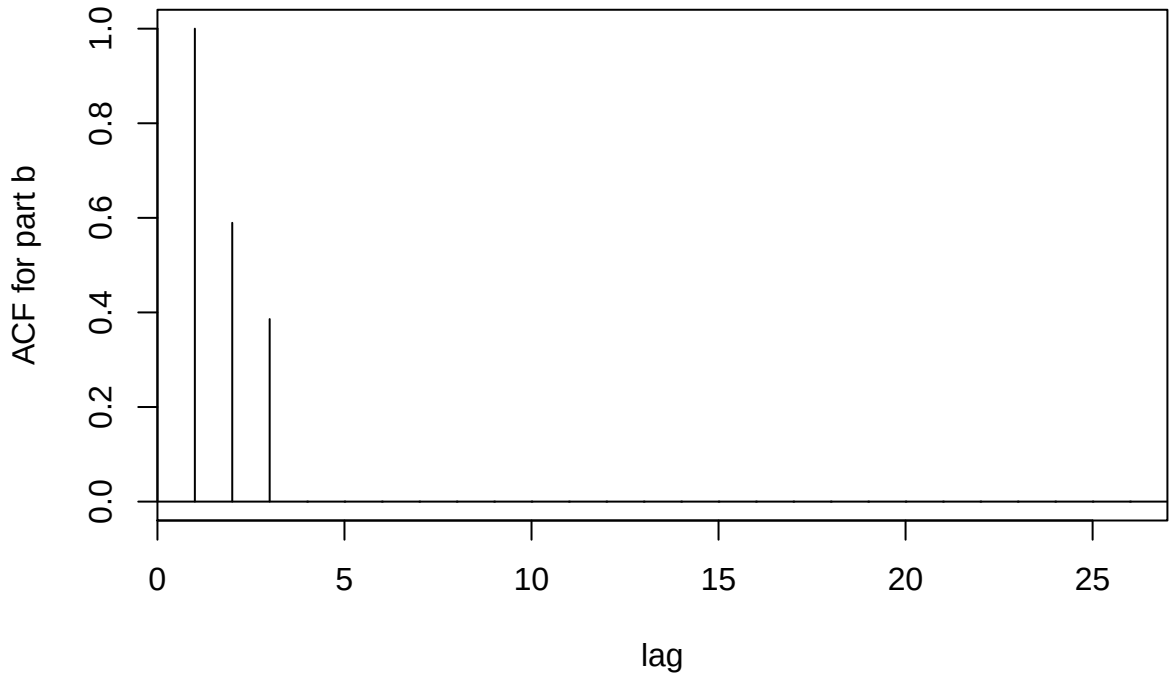
```
abs(polyroot(c(1, 0.8, 1.1))[2])
```

```
## [1] 0.9534626
```

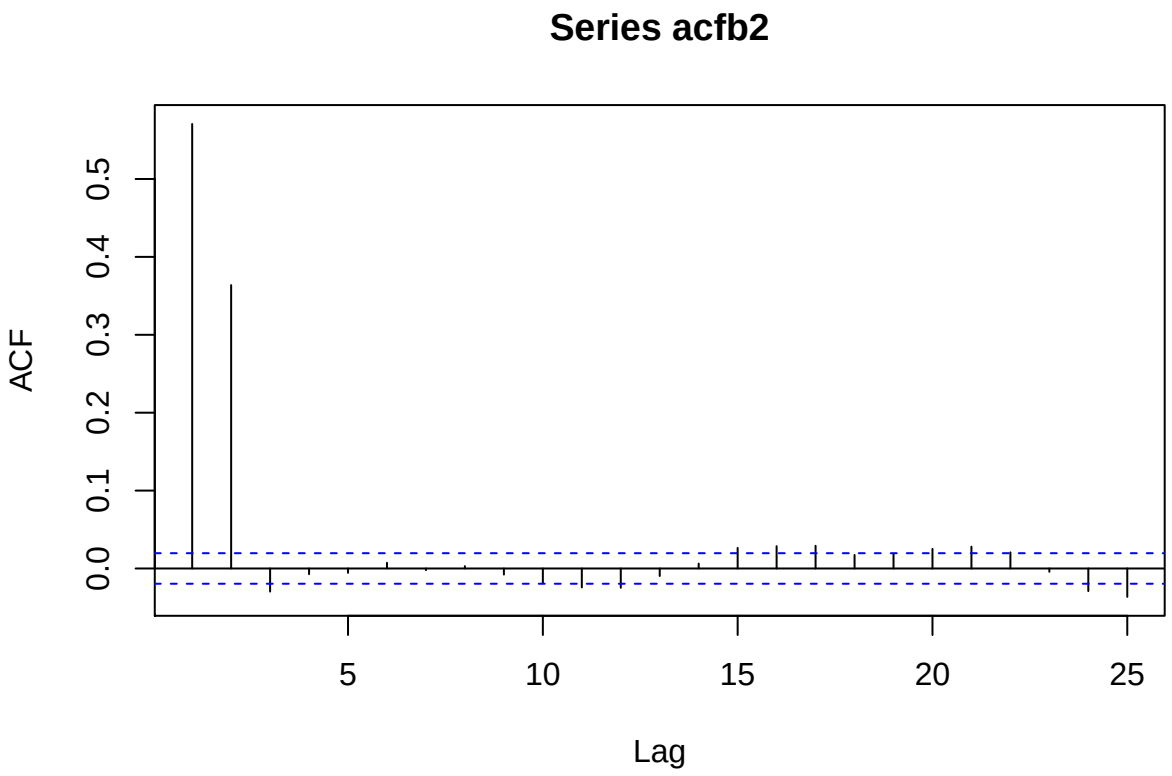
```
#Plot Series
# set.seed(100)
# plot.ts(arima.sim(list(order = c(0, 0, 2), ma = c(0.8, 1.1)), n = 10000), ylab = "x",
#       main = (expression(MA(2)~~~theta_1==(0.8)~~~theta_2==(1.1))))
# set.seed(100)
# plot(arima.sim(list(order = c(0, 0, 2), ma = c(0.8, 1.1)), n = 10000), ylab = "x",
#       main = (expression(MA(2)~~~theta_1==(0.8)~~~theta_2==(1.1))))
# set.seed(100)
# tsplot(arima.sim(list(order = c(0, 0, 2), ma = c(0.8, 1.1)), n = 10000), ylab = "x",
#       main = (expression(MA(2)~~~theta_1==(0.8)~~~theta_2==(1.1))))


#ACF theoretical
set.seed(100)
acfb <- ARMAacf(ar = 0, ma = c(0.8, 1.1), lag.max = 25)
acfb
```

```
##         0         1         2         3         4         5         6
## 1.0000000 0.5894737 0.3859649 0.0000000 0.0000000 0.0000000 0.0000000
##         7         8         9        10        11        12        13
## 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
##        14        15        16        17        18        19        20
## 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
##        21        22        23        24        25
## 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000
```

```
plot(acfb, type = "h", xlab = "lag", ylab = "ACF for part b")
abline(h = 0)
```




```r
#ACF2 simulation
set.seed(100)
acfb2 <- arima.sim(list(order = c(0, 0, 2), ma = c(0.8, 1.1)), n = 10000)
acf(acfb2, lag.max = 25, plot = T)
```

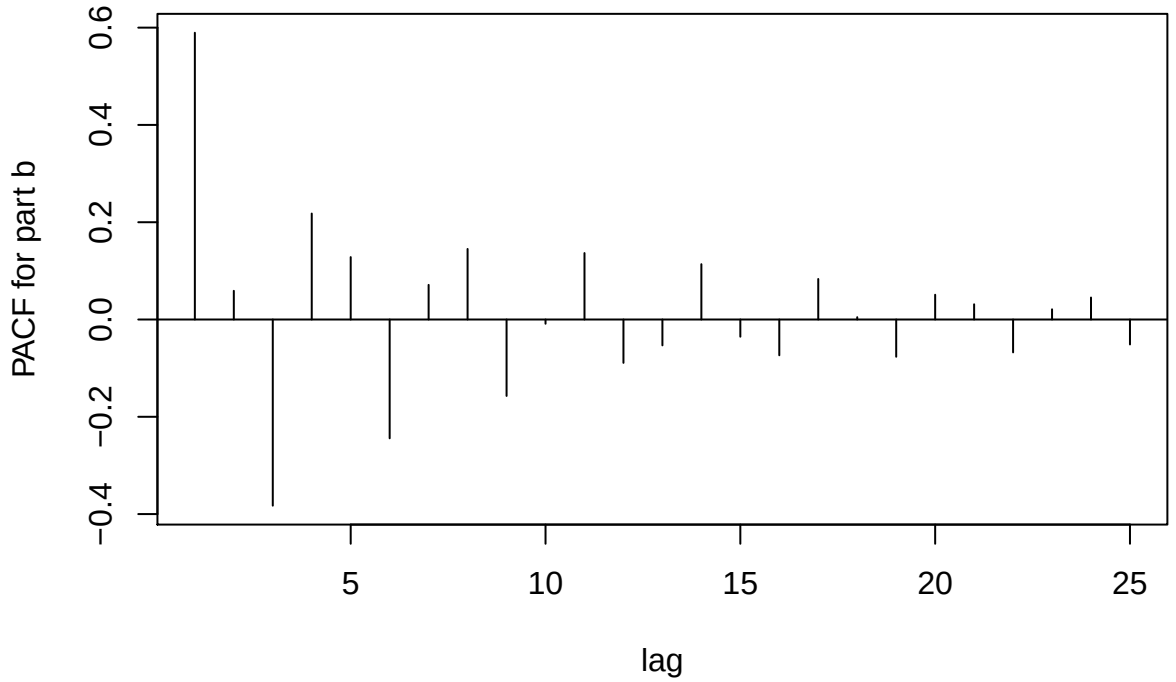



```r
#PACF
set.seed(100)
pacfb <- ARMAacf(ar = 0, ma = c(0.8, 1.1), lag.max = 25, pacf = T)
```

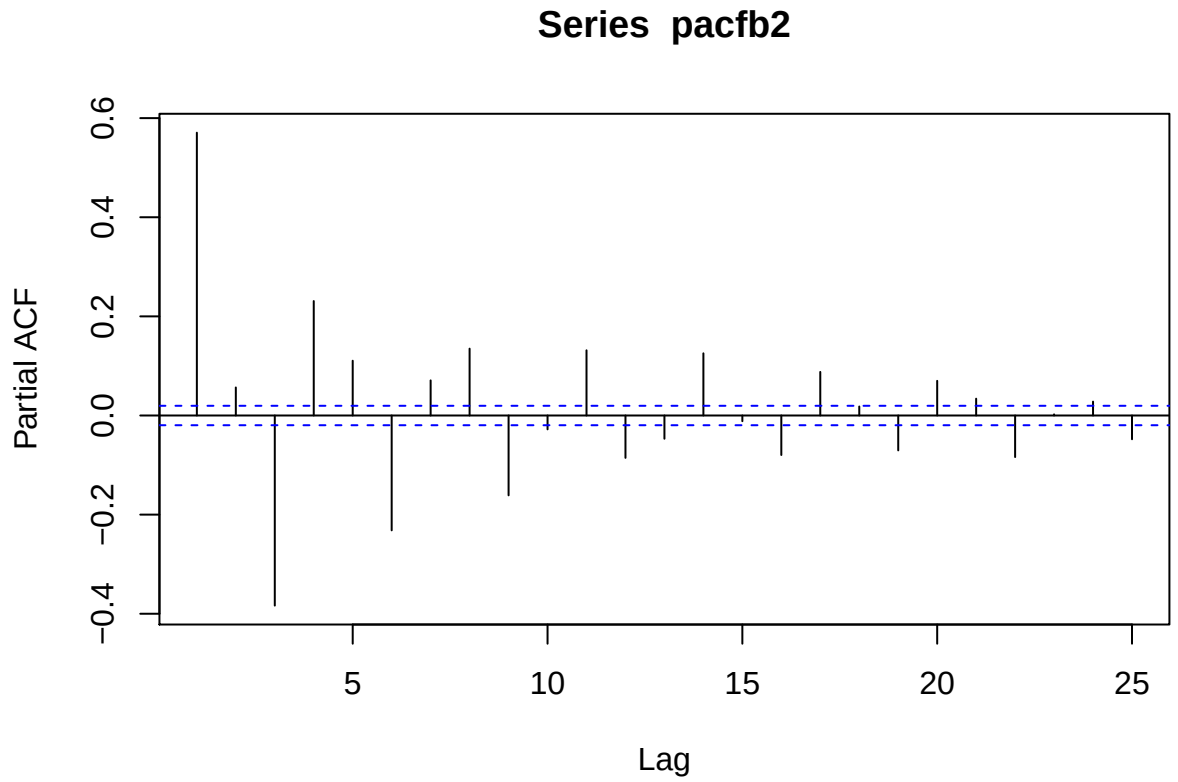
```
pacfb
```

```
##  [1]  0.589473684  0.058980019 -0.382720616  0.217835887  0.128330078
##  [6] -0.244251517  0.071180617  0.145039704 -0.157116800 -0.008742490
## [11]  0.136624078 -0.089176853 -0.053172237  0.113727343 -0.035367317
## [16] -0.073569931  0.083295264  0.004730005 -0.076611983  0.050895955
## [21]  0.031261115 -0.067609762  0.020970722  0.045192089 -0.051331754
```

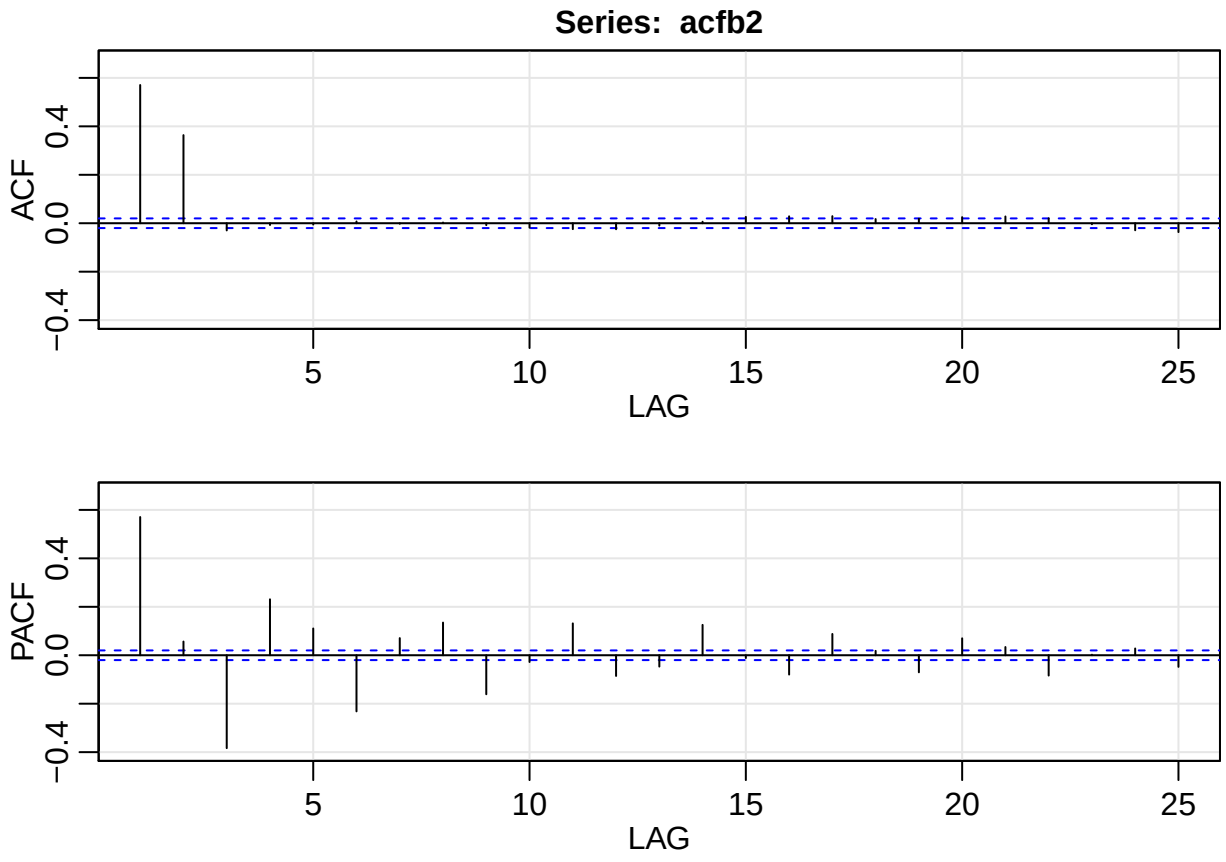
```
plot(pacfb, type = "h", xlab = "lag", ylab = "PACF for part b")
abline(h = 0)
```




```
#PACF2
set.seed(100)
pacfb2 <- arima.sim(list(order = c(0, 0, 2), ma = c(0.8, 1.1)), n = 10000)
pacf(pacfb2, lag.max = 25, plot = T)
```




```
#Do both acf and pacf
acf2(acfb2, max.lag = 25, plot = T)
```



```
##          ACF  PACF
##  [1,]  0.57  0.57
##  [2,]  0.36  0.06
##  [3,] -0.03 -0.38
##  [4,] -0.01  0.23
##  [5,] -0.01  0.11
##  [6,]  0.01 -0.23
##  [7,]  0.00  0.07
##  [8,]  0.00  0.13
##  [9,] -0.01 -0.16
## [10,] -0.02 -0.03
## [11,] -0.02  0.13
## [12,] -0.02 -0.09
## [13,] -0.01 -0.05
## [14,]  0.01  0.13
## [15,]  0.03 -0.01
## [16,]  0.03 -0.08
## [17,]  0.03  0.09
## [18,]  0.02  0.02
## [19,]  0.02 -0.07
## [20,]  0.03  0.07
## [21,]  0.03  0.03
## [22,]  0.02 -0.08
## [23,]  0.00  0.00
## [24,] -0.03  0.03
## [25,] -0.04 -0.05
```

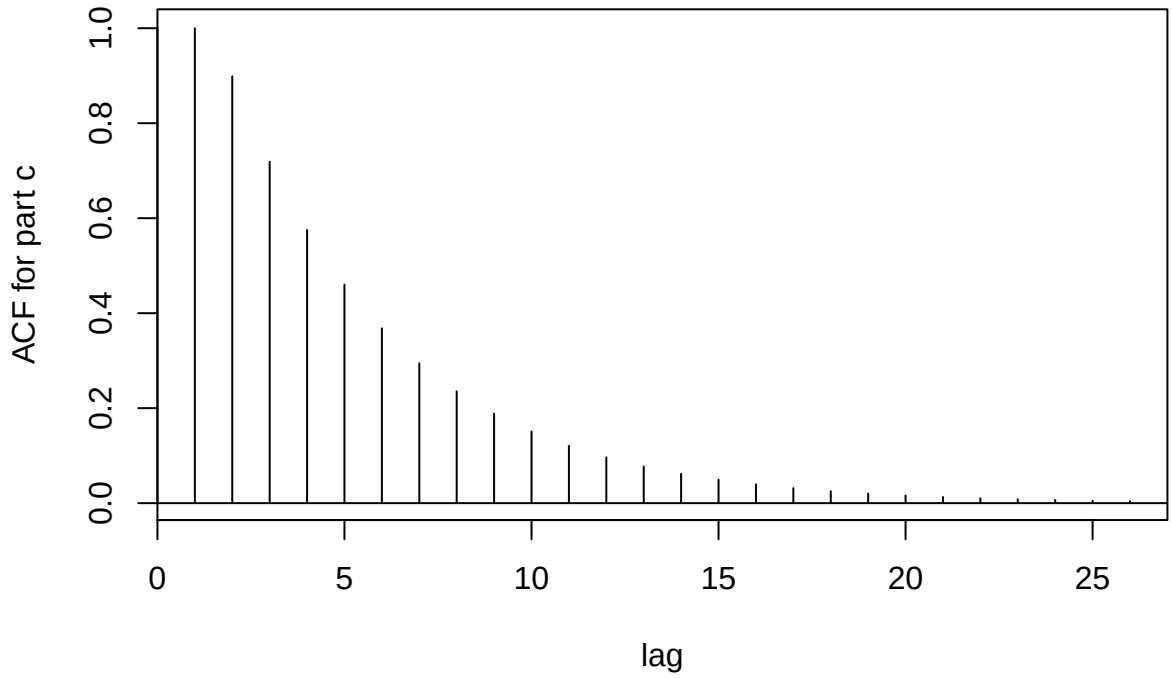
Comment: My time series model is $x_t = w_t$ - $0.8w_{t-1} + 1.1w_{t-2}$. So, θ_1 will be 0.8 and θ_2 will be 1.1. And, this is causal but not invertible. And, by the definition, this is MA(2) process.

MA(2) process has an ACF of cutting off at lag 2, and has an PACF with tailing off.

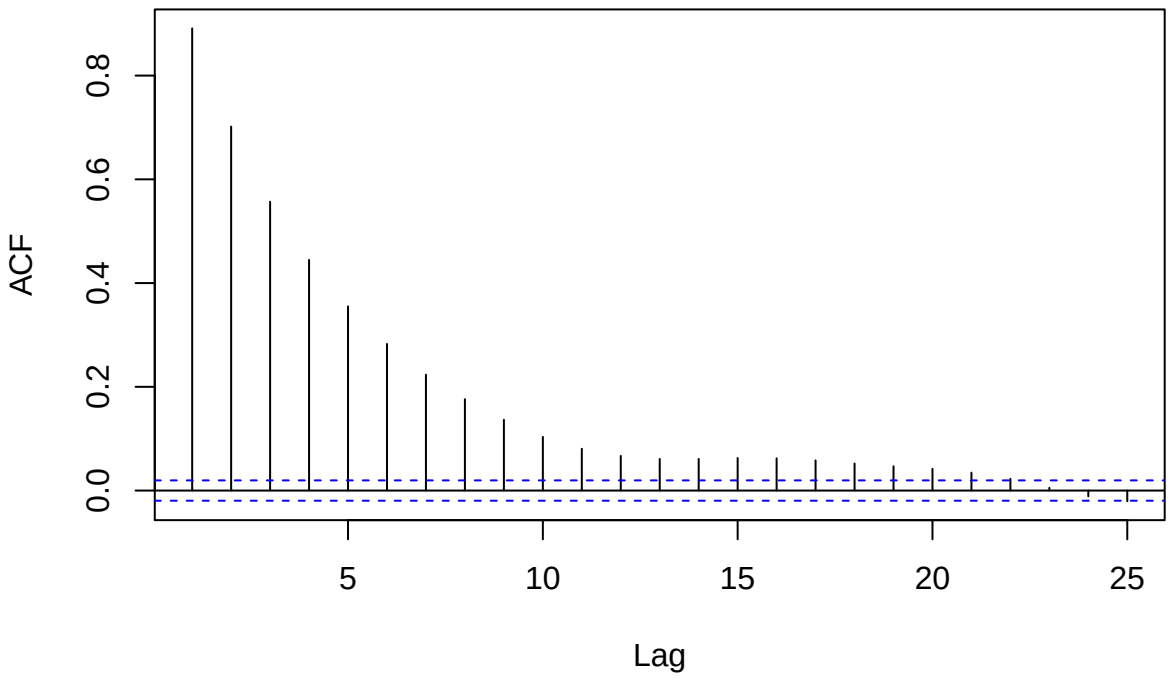
Part c

```
#Check invertibility/causality
abs(polyroot(c(1, (-4/5))))

abs(polyroot(c(1, (4/5))))


#Plot Series
# set.seed(100)
# plot.ts(arima.sim(list(order = c(1, 0, 1), ar = (4/5), ma = (4/5)), n = 10000), ylab = "x",
#      main = (expression(ARMA(1,1)~~~phi_1==(4/5)~~~theta_1==(4/5))))
# set.seed(100)
# plot(arima.sim(list(order = c(1, 0, 1), ar = (4/5), ma = (4/5)), n = 10000), ylab = "x",
#      main = (expression(ARMA(1,1)~~~phi_1==(4/5)~~~theta_1==(4/5))))
# set.seed(100)
# tsplot(arima.sim(list(order = c(1, 0, 1), ar = (4/5), ma = (4/5)), n = 10000), ylab = "x",
#      main = (expression(ARMA(1,1)~~~phi_1==(4/5)~~~theta_1==(4/5))))
```

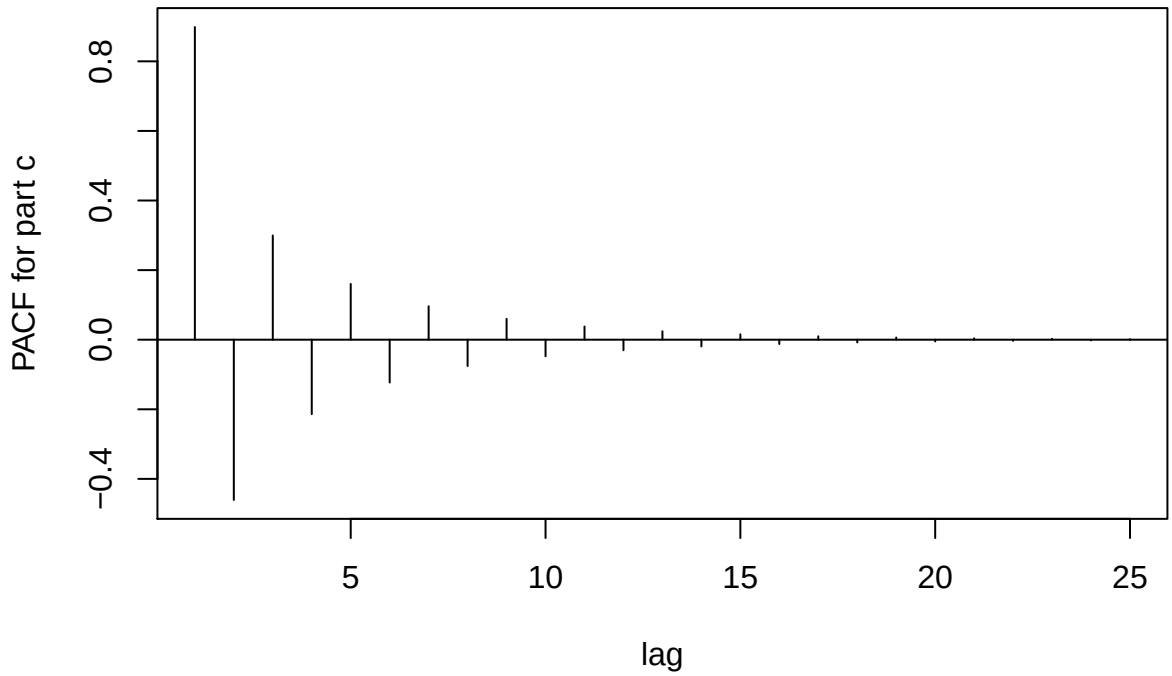
```r
#ACF theoretical
set.seed(100)
acfc <- ARMAacf(ar = (4/5), ma = (4/5), lag.max = 25)
acfc
plot(acfc, type = "h", xlab = "lag", ylab = "ACF for part c")
abline(h = 0)
```



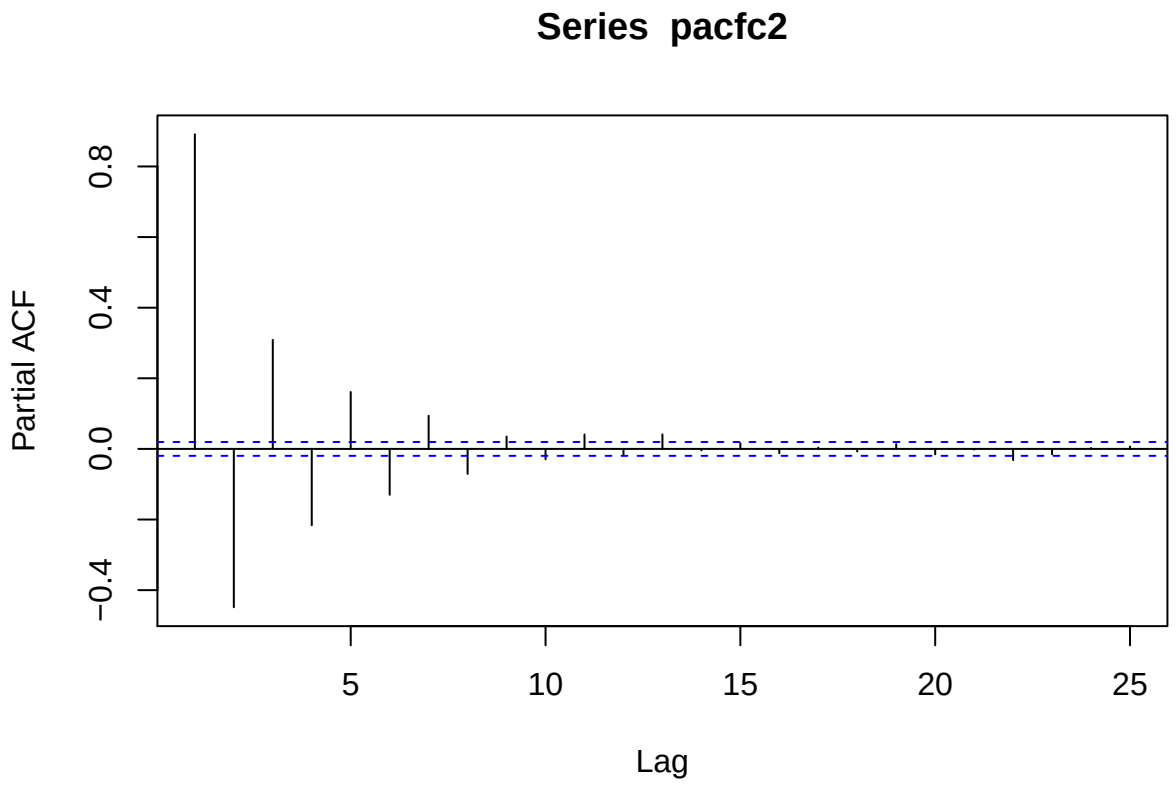

```r
#ACF2 simulation
set.seed(100)
acfc2 <- arima.sim(list(order = c(1, 0, 1), ar = (4/5), ma = (4/5)), n = 10000)
acf(acfc2, lag.max = 25, plot = T)
```



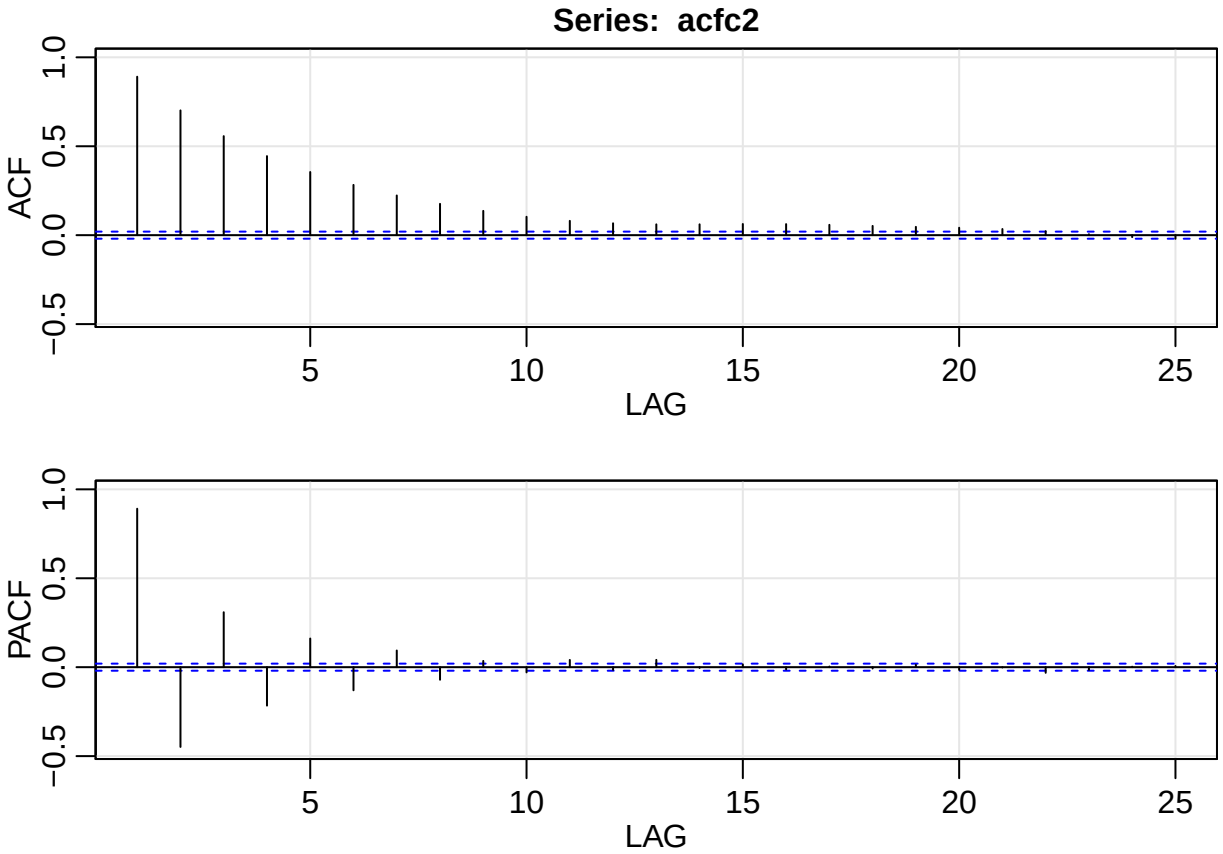

```
#PACF theoretical
set.seed(100)
pacfc <- ARMAacf(ar = (4/5), ma = (4/5), lag.max = 25, pacf = T)
pacfc
plot(pacfc, type = "h", xlab = "lag", ylab = "PACF for part c")
abline(h = 0)
```



```r
#PACF2 simulation
set.seed(100)
pacfc2 <- arima.sim(list(order = c(1, 0, 1), ar = (4/5), ma = (4/5)), n = 10000)
pacf(pacfc2, lag.max = 25, plot = T)
```




```r
#Do both acf and pacf
acf2(acfc2, max.lag = 25, plot = T)
```



Comment: My time series model is $x_t = w_t + \frac{4}{5}x_{t-1} + \frac{4}{5}w_{t-1}$. So, ϕ_1 will be $\frac{4}{5}$ and θ_1 will be $\frac{4}{5}$. And, this is both causal and invertible. And, by the definition, this is ARMA(1,1) process.

The ACF and PACF for the ARMA(1,1) process are both tailing off.