# Examples for acf and pacf
# (theoretical values and sample estimates)

# R code

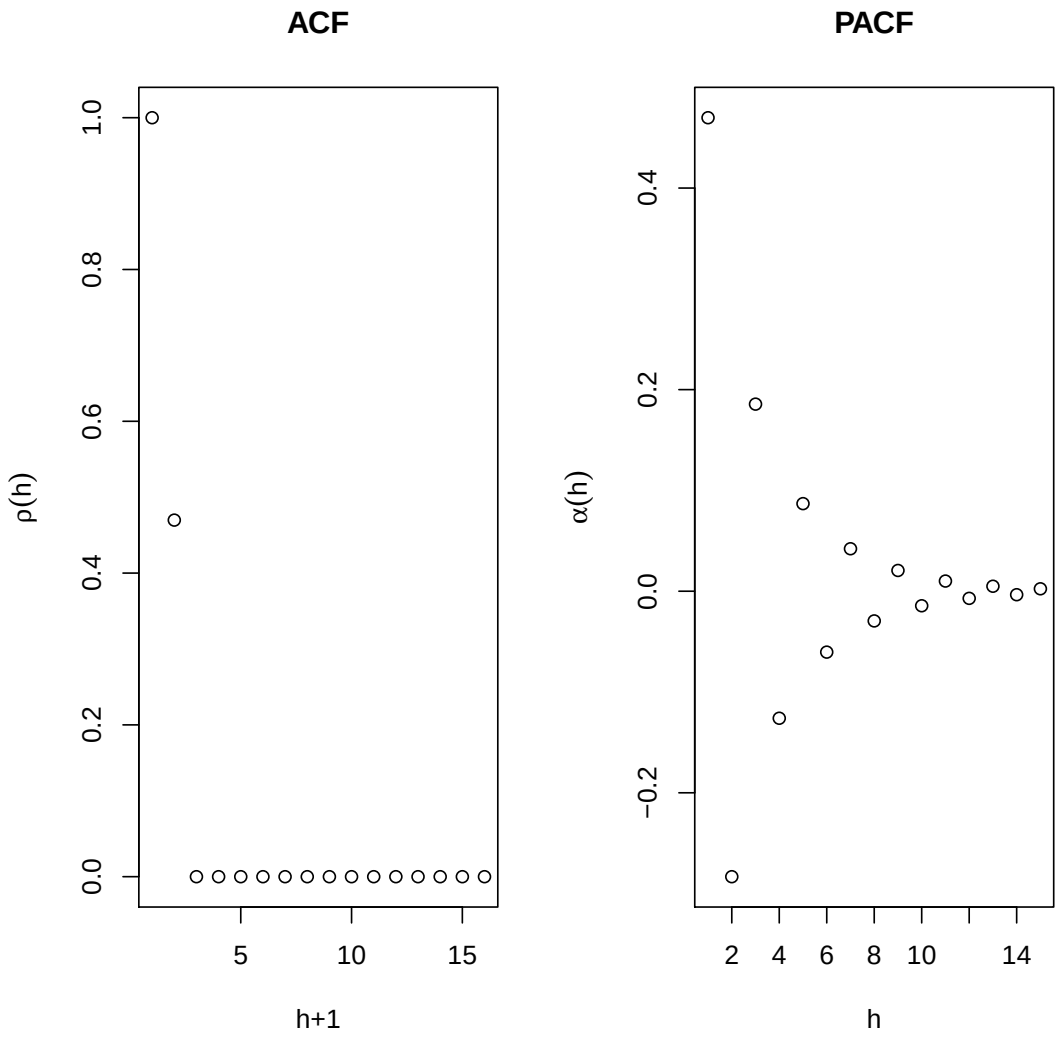
Actual acf of MA(2) with parameters $\theta_1 = 0.7,\ \theta_2 = -1$:

```
par(mfcol=c(1,2))

plot(ARMAacf(ar = numeric(0), ma = c(0.7, -1), lag.max = 15, pacf = F),xlab='h+1')

plot(ARMAacf(ar = numeric(0), ma = c(0.7, -1), lag.max = 15, pacf = T),xlab='h')
```

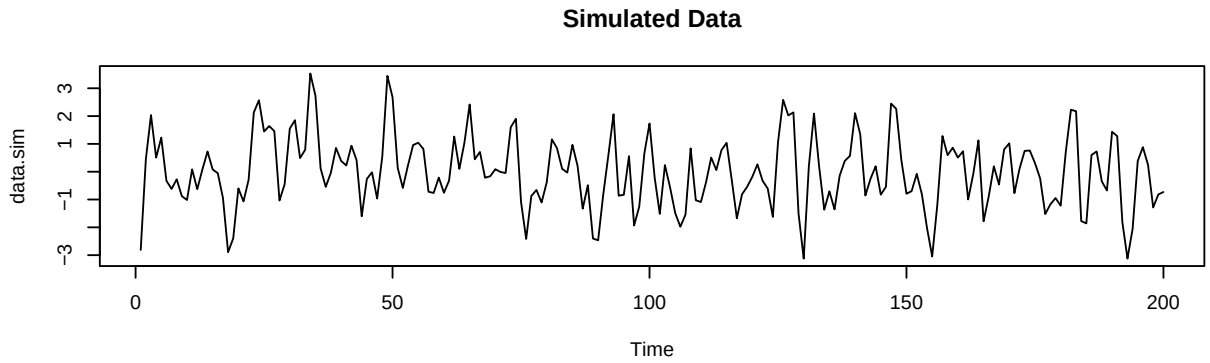
Sample acf of data from MA(2) with parameters $\theta_1 = 0.7,\ \theta_2 = -1$:

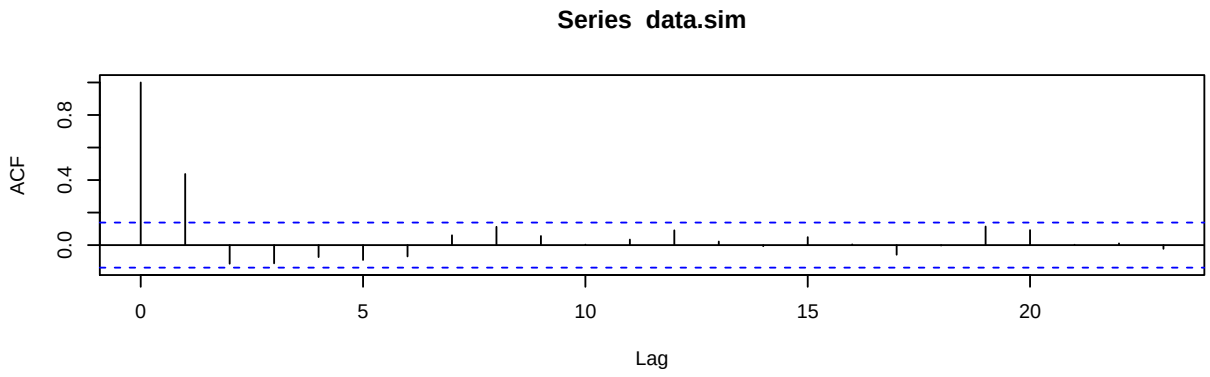
```
par(mfcol=c(3,1))

data.sim <- arima.sim(n = 200, list(ma = c(0.7,-1)), sd = sqrt(1))

plot(data.sim, main="Simulated Data")

acf(data.sim)

acf(data.sim, type="partial")
```

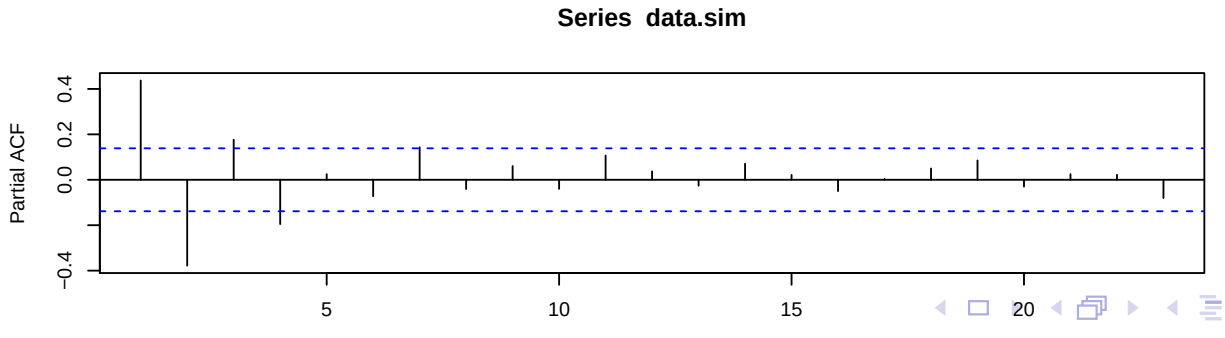
# Example: $MA(1)$: $\theta_1 = 0.7$



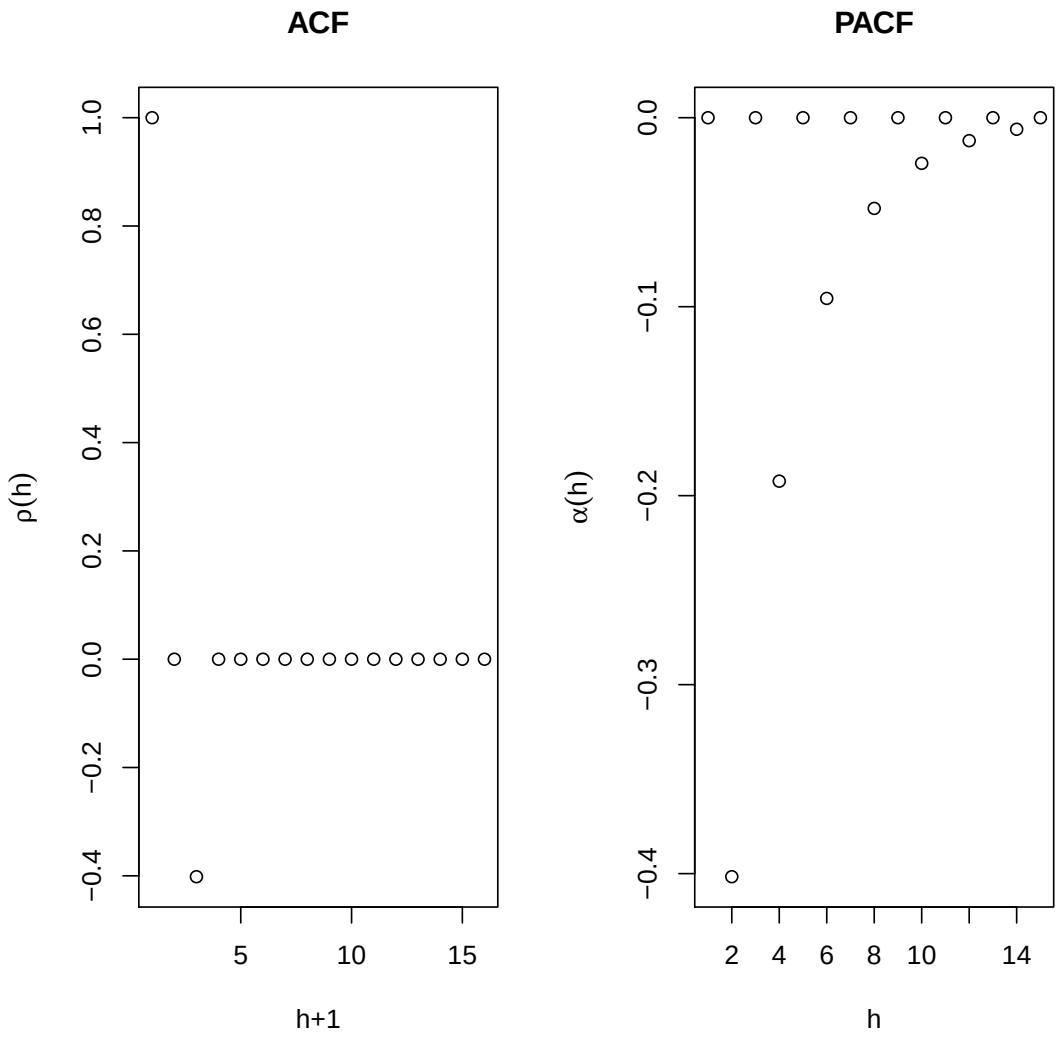
# Example: simulated data from $MA(1)$: $\theta_1 = 0.7$



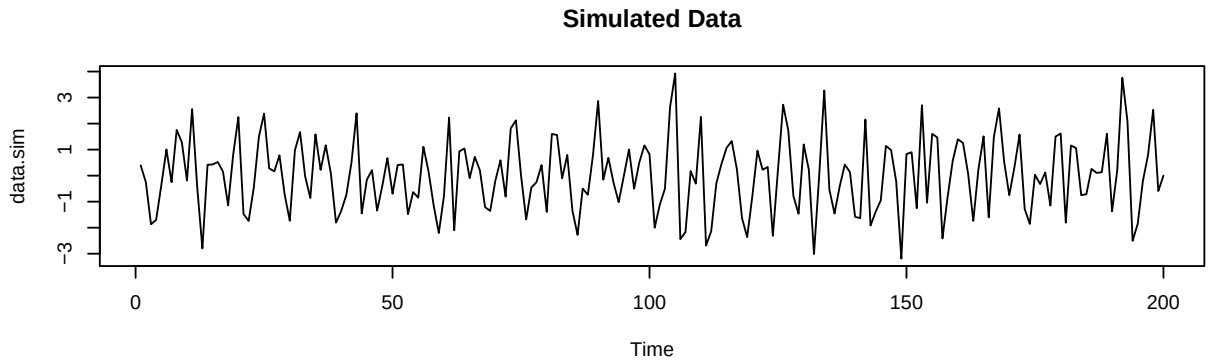



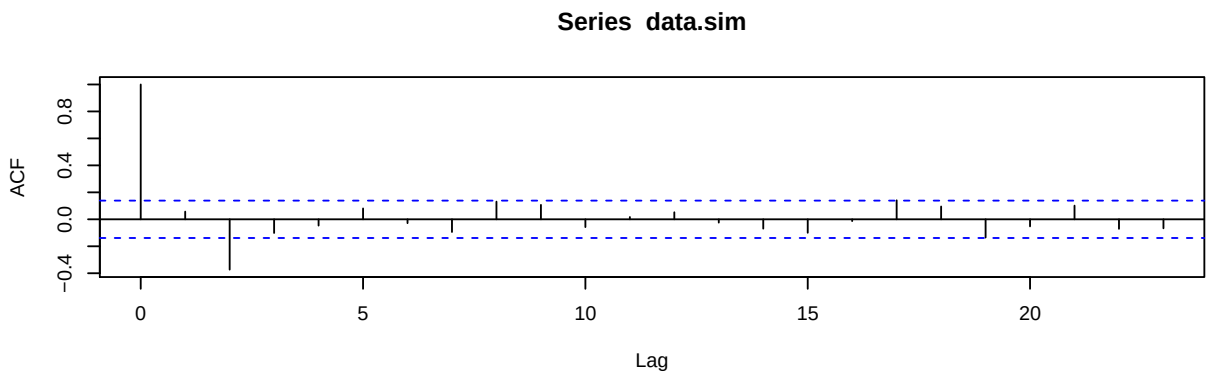



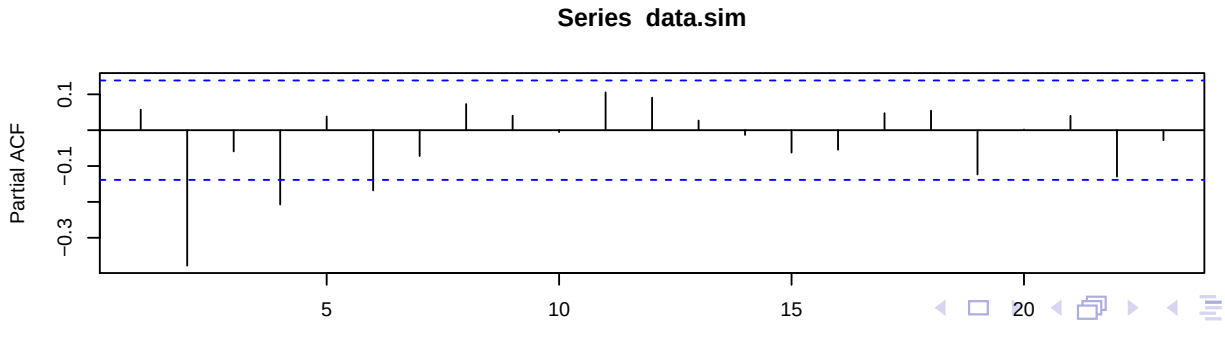
# Example: $MA(2)$: $\theta_1 = 0.7,\ \theta_2 = -1$



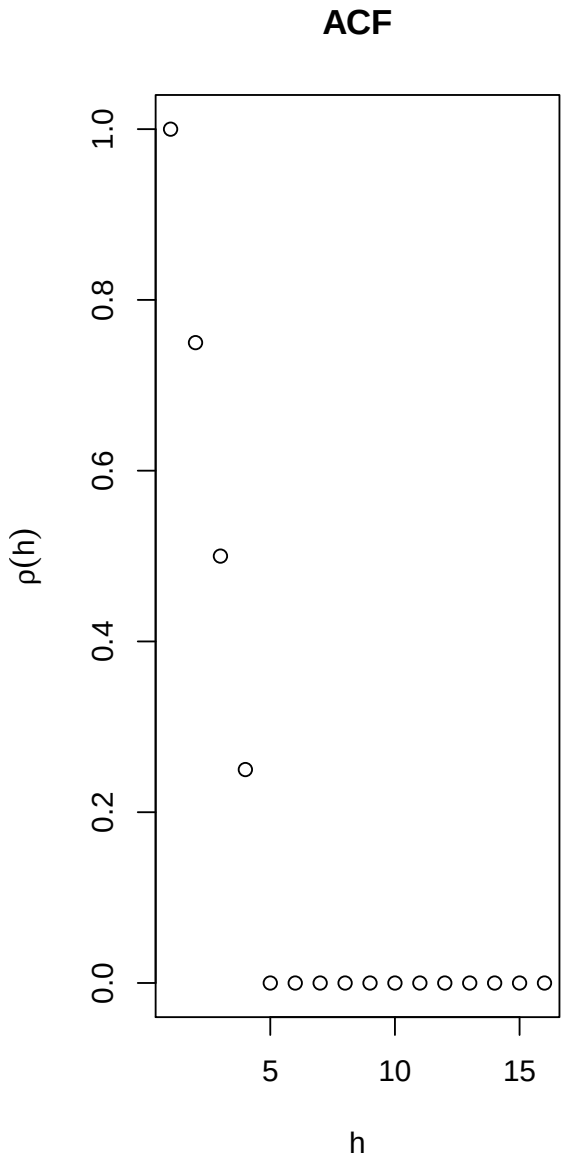
# Example: simulated data from $MA(2)$: $\theta_1 = 0.7,\ \theta_2 = -1$

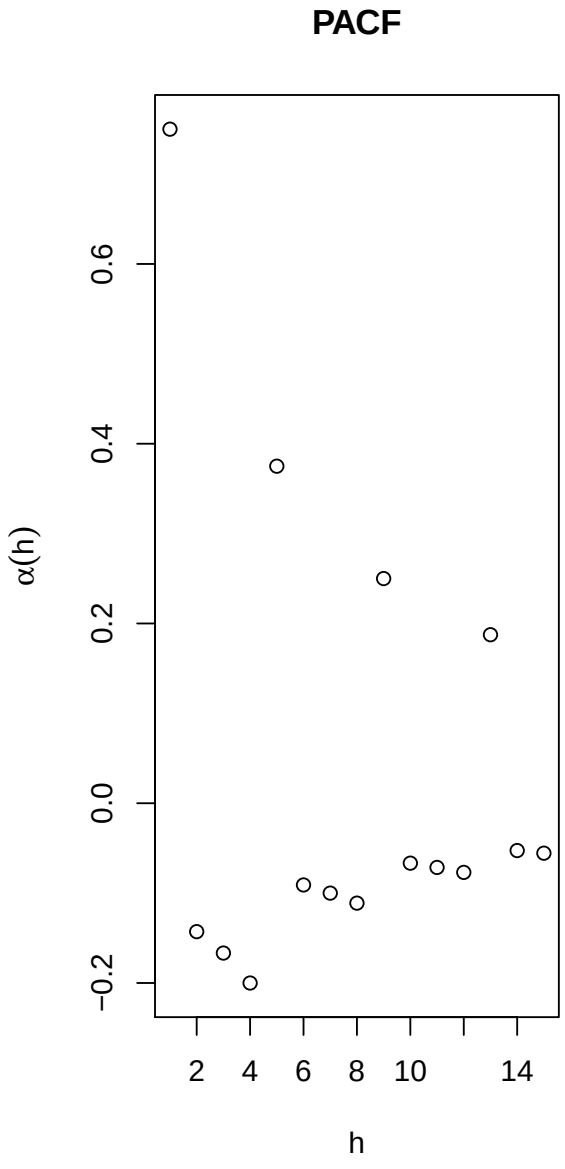


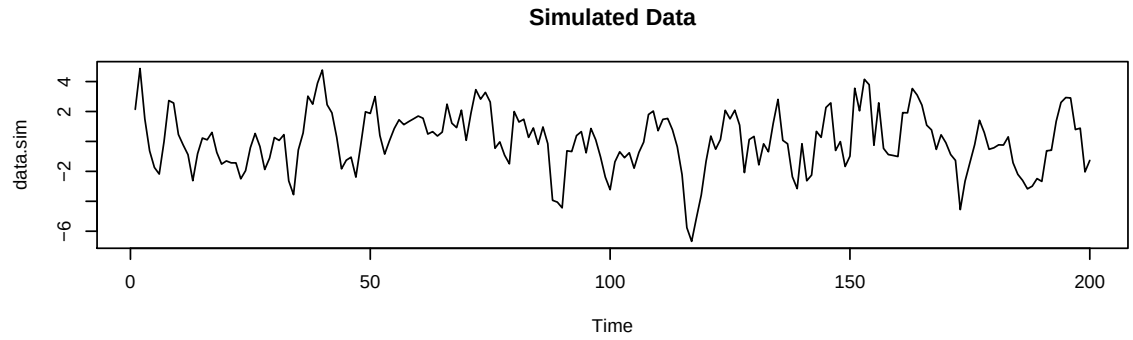



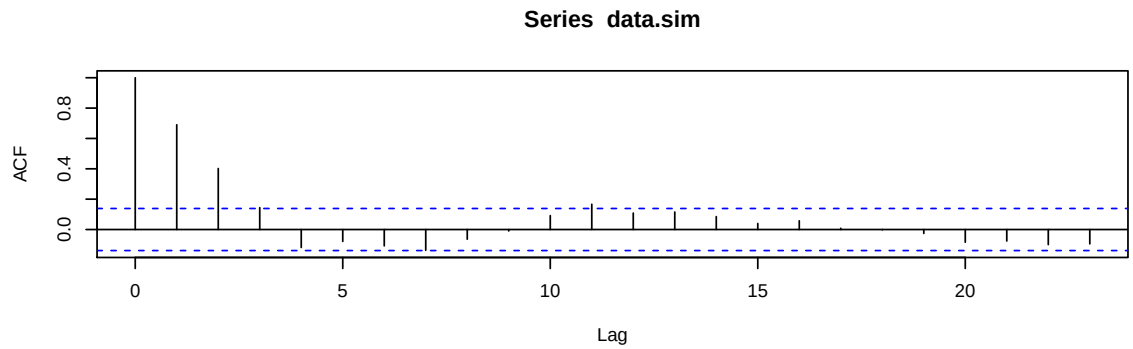
# Example: $MA(3)$: $\theta_1 = \theta_2 = \theta_3 = 1$

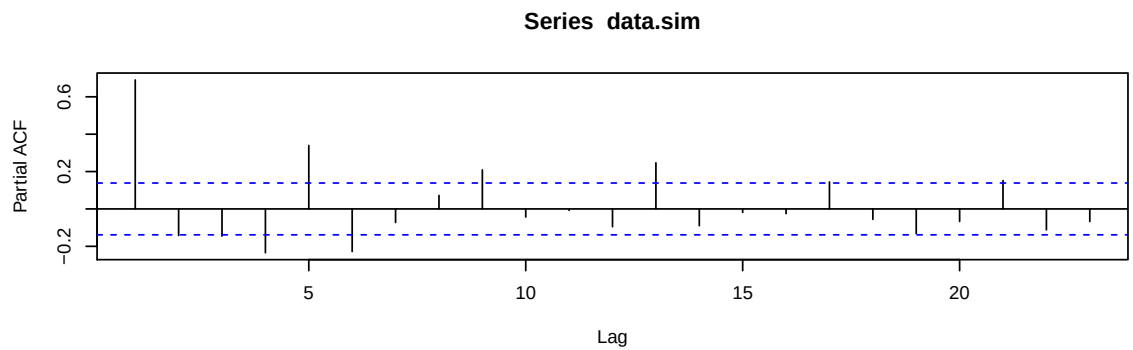


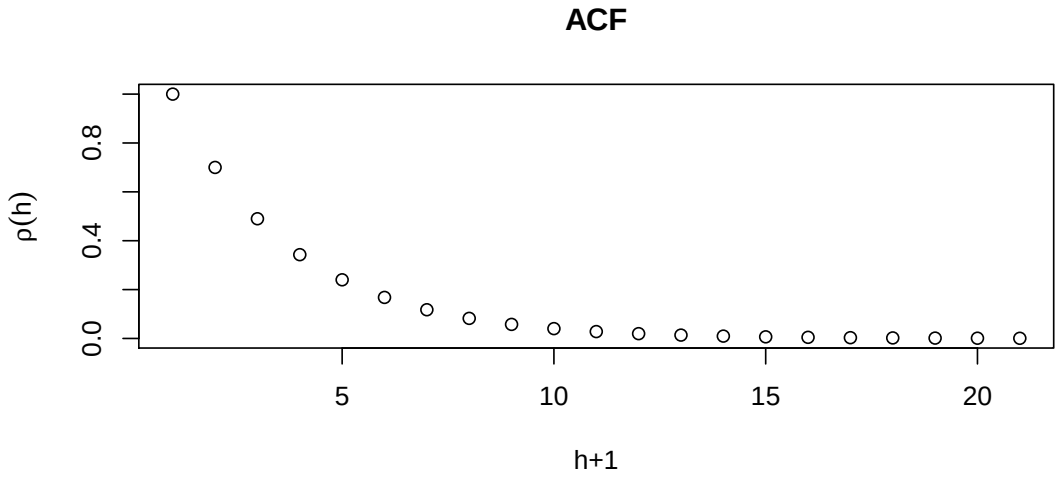
# Example: simulated data from $MA(3)$: $\theta_1 = \theta_2 = \theta_3 = 1$

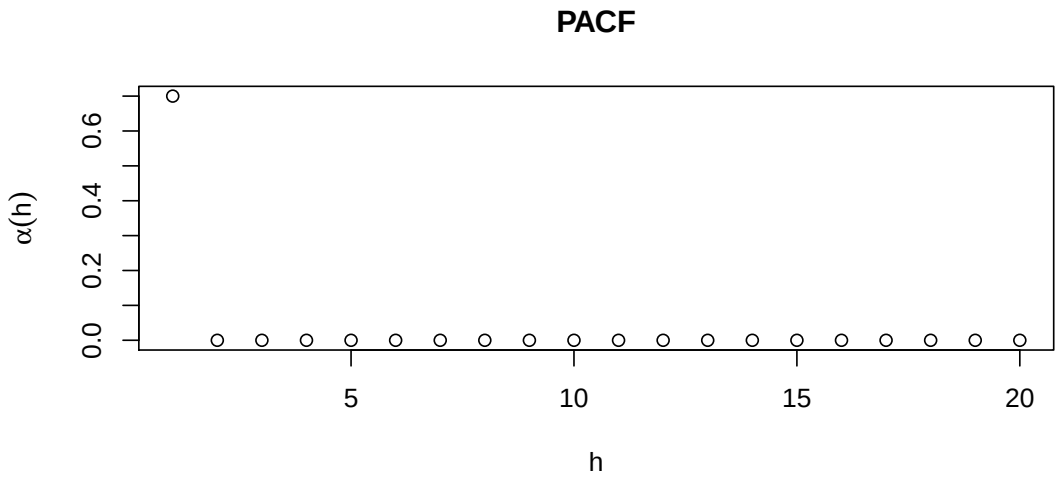


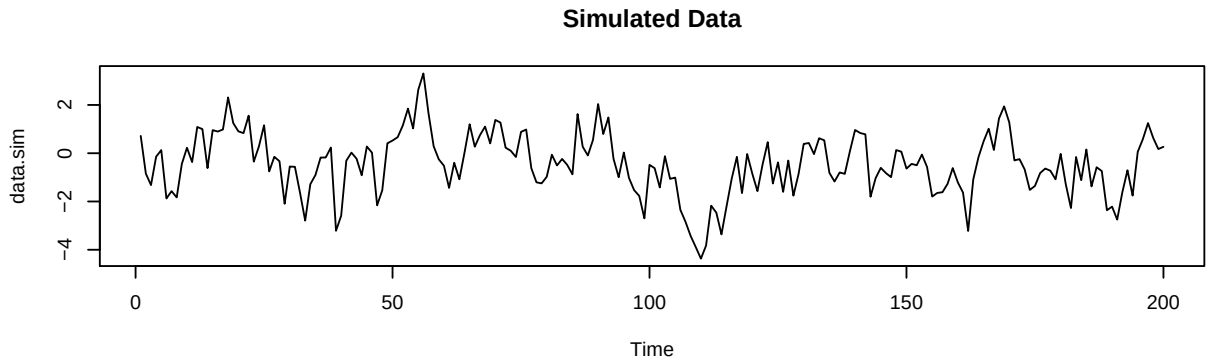



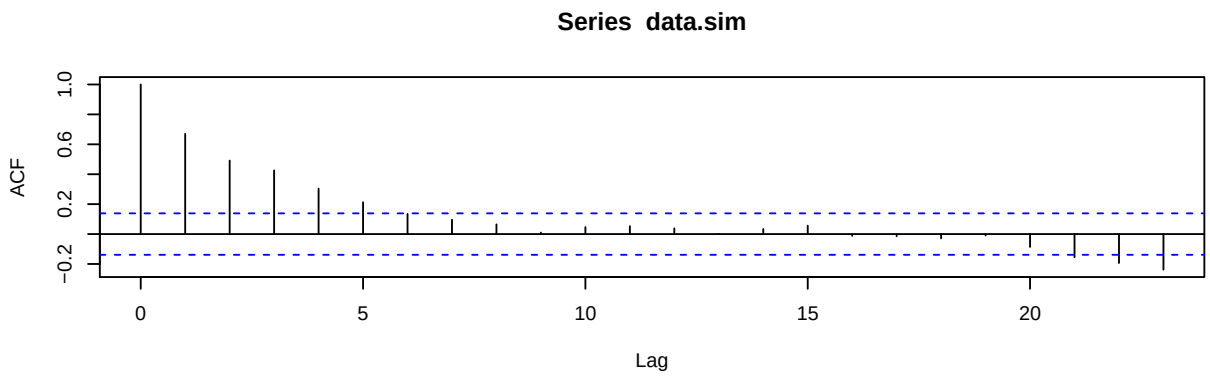
# Example: $AR(1)$: $\phi_1 = 0.7$

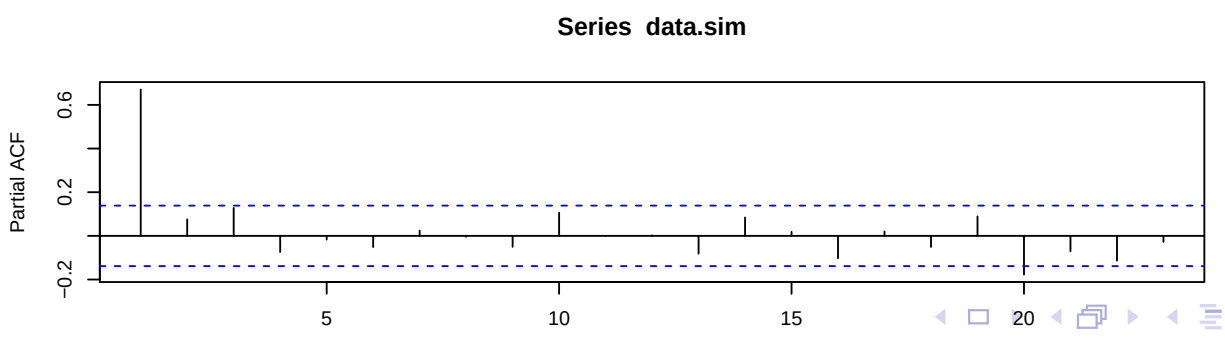


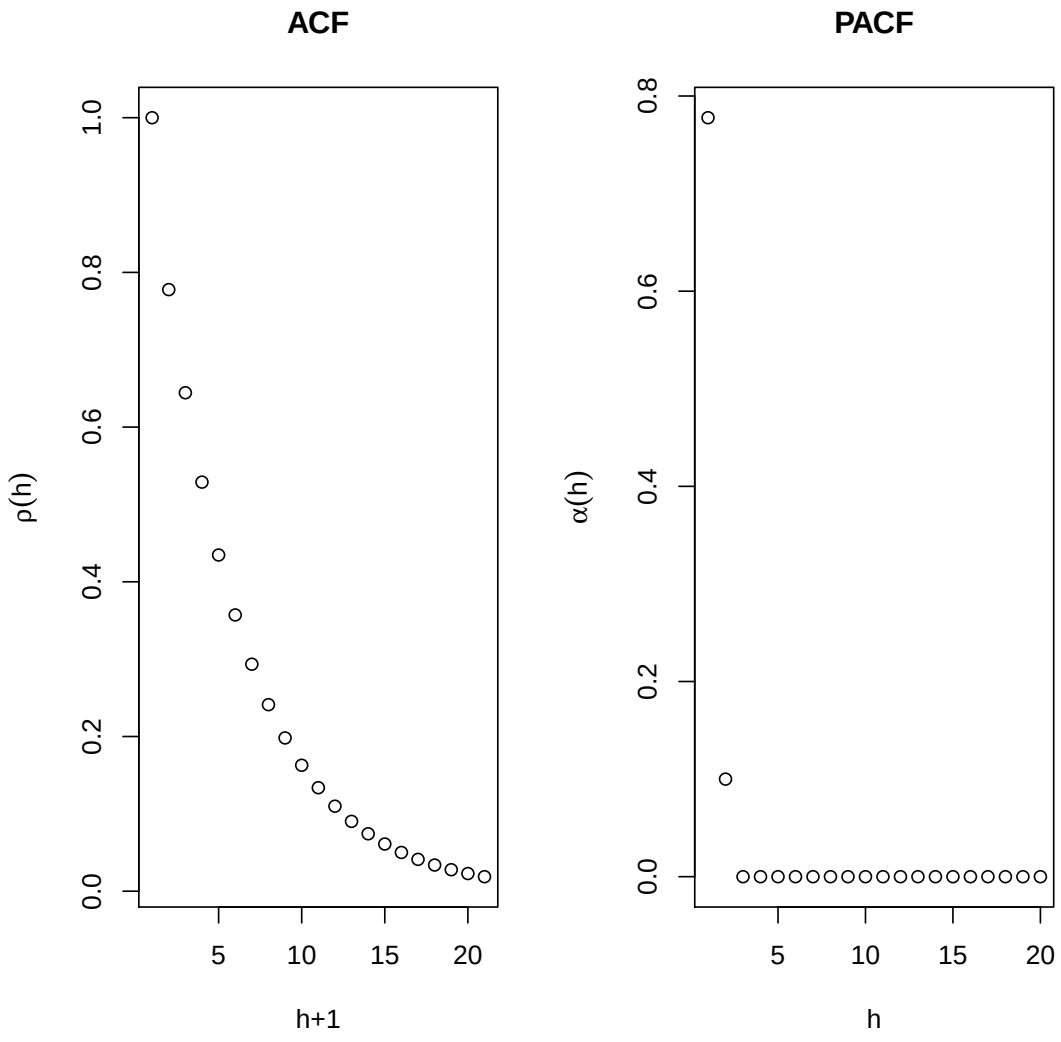
# Example: simulated data from $AR(1)$: $\phi_1 = 0.7$



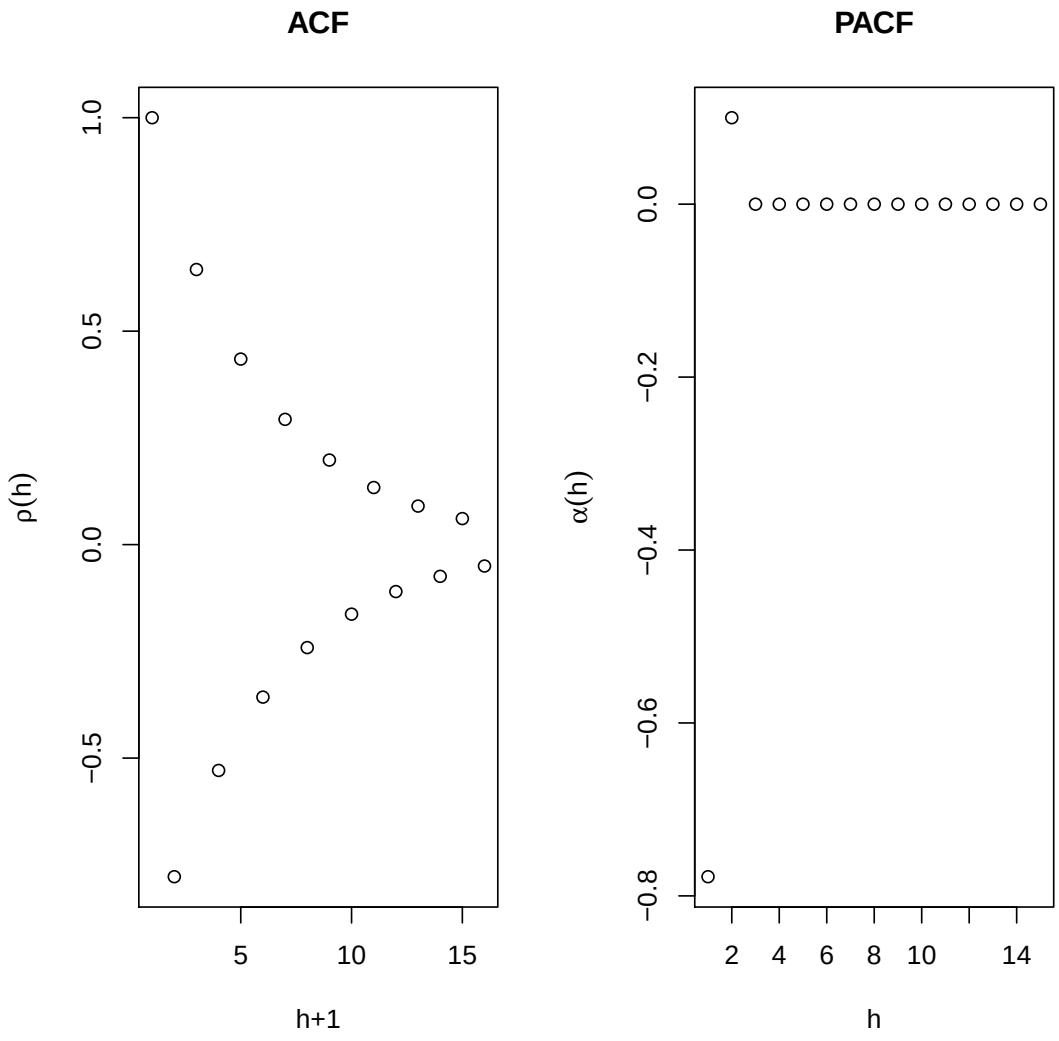



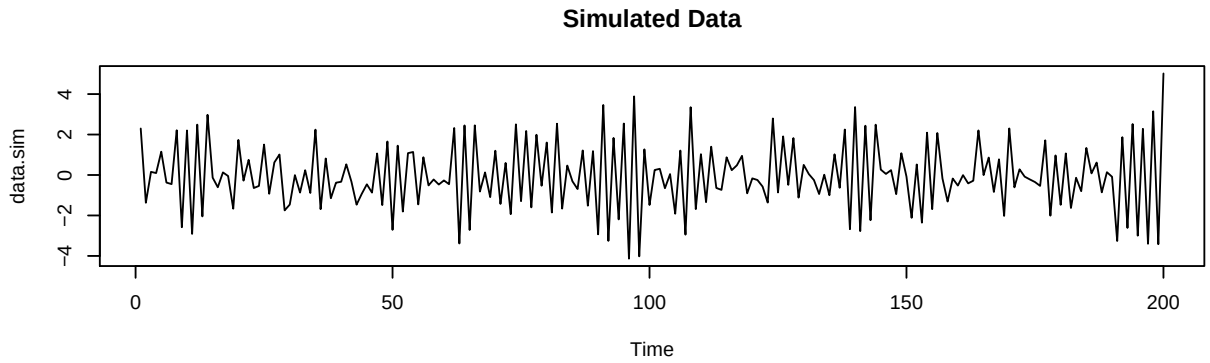
# Example: $AR(2)$: $\phi_1 = 0.7$, $\phi_2 = 0.1$

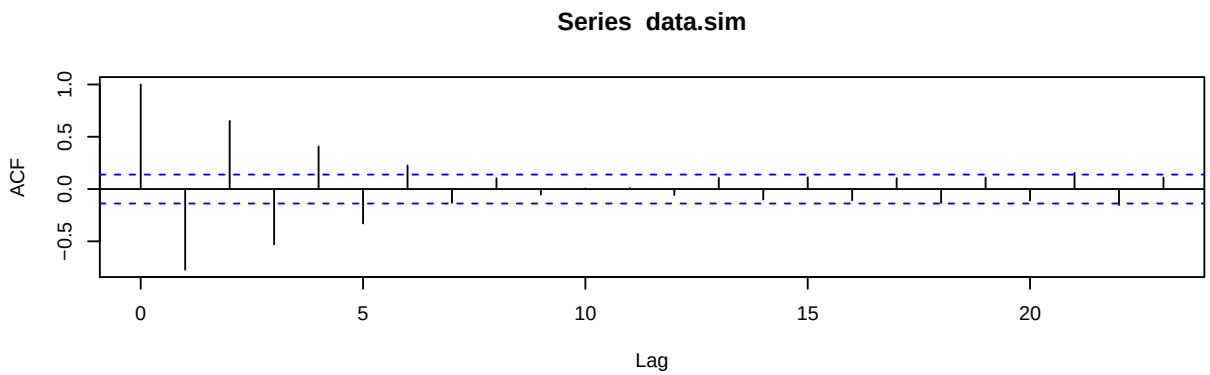


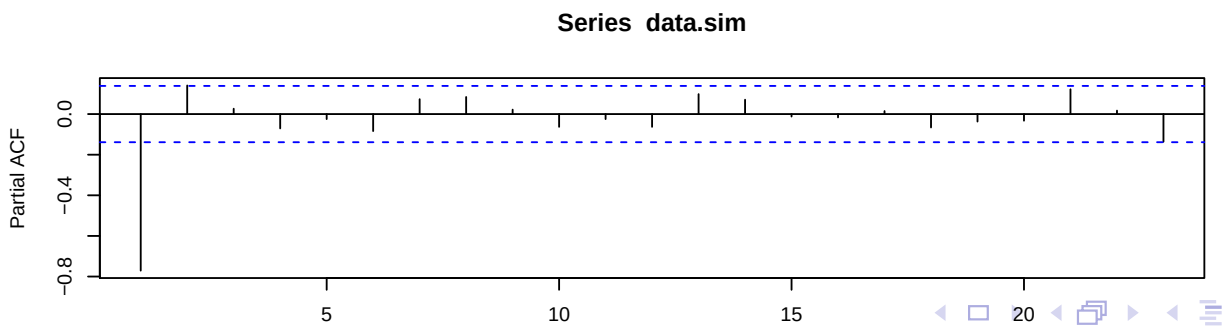
# Example: $AR(2)$: $\phi_1 = -0.7$, $\phi_2 = 0.1$



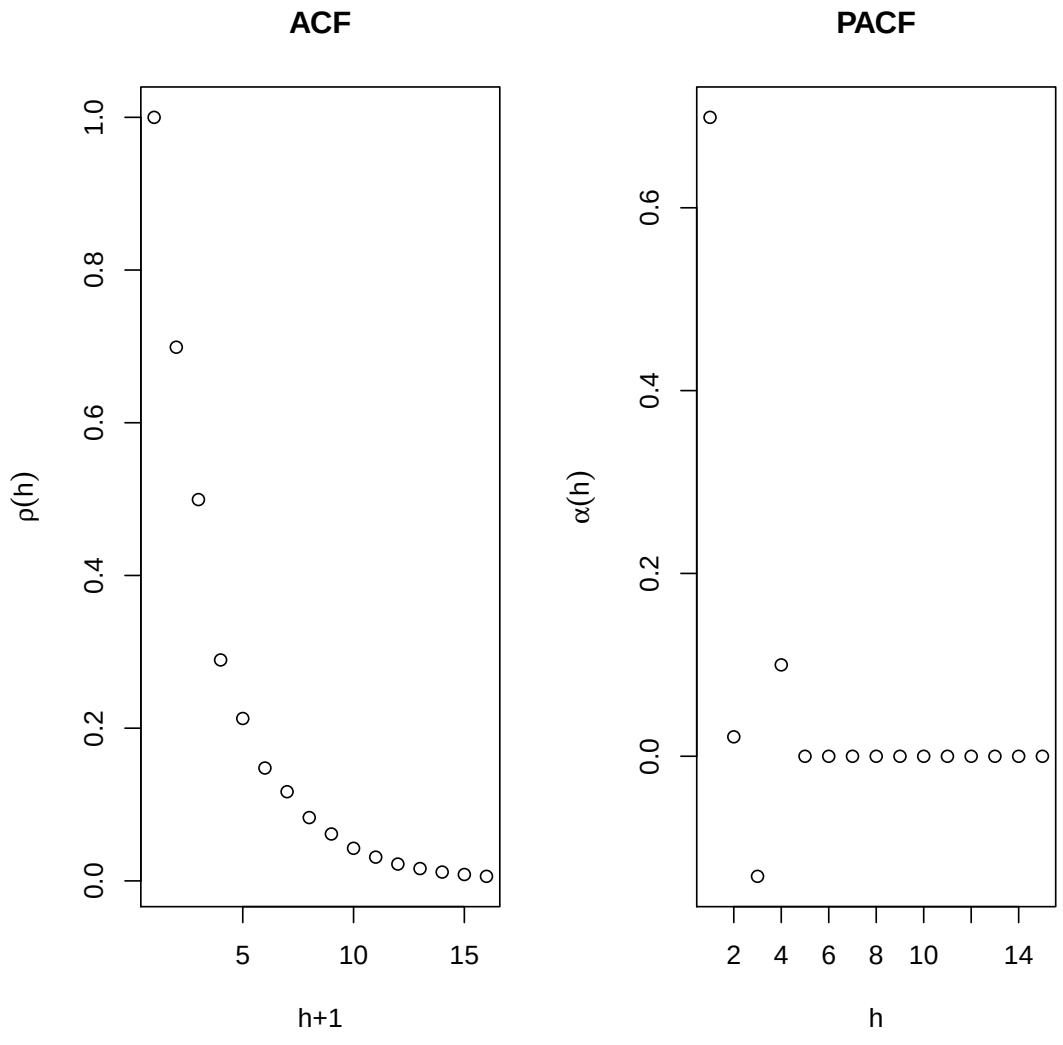
# Example: simulated data from $AR(2)$: $\phi_1 = -0.7, \phi_2 = 0.1$



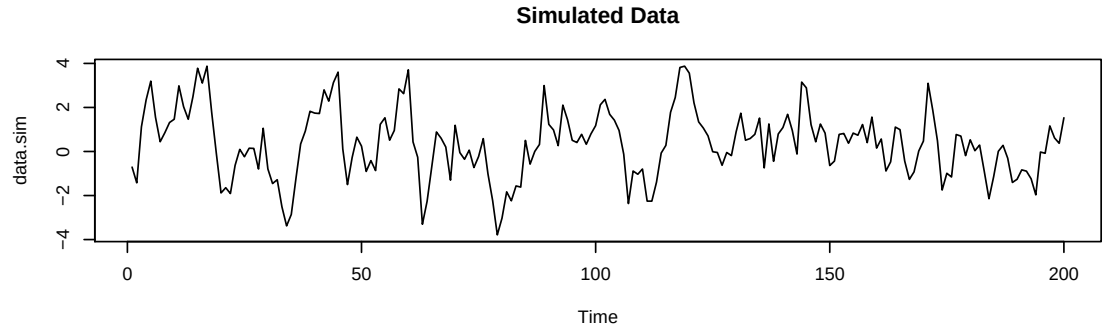



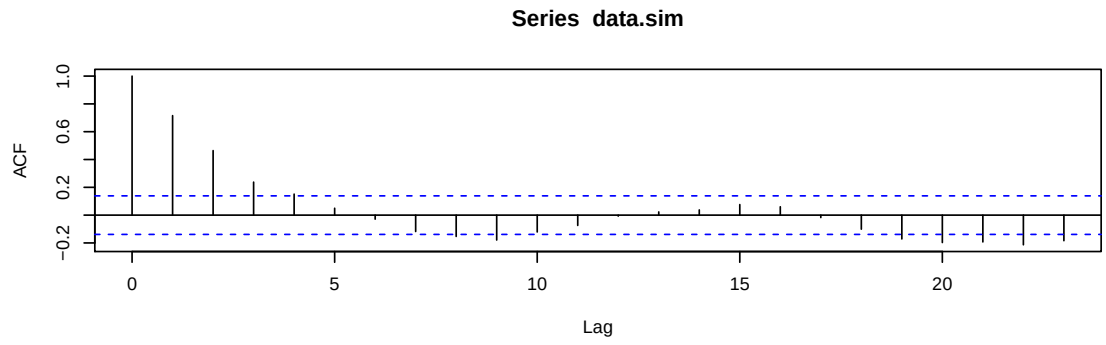



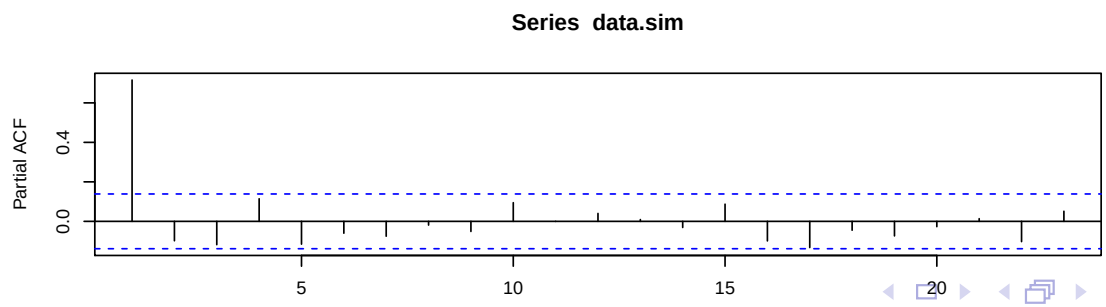
# Example: $AR(4)$: $\phi_1 = 0.7$, $\phi_2 = 0.1$, $\phi_3 = -0.2$, $\phi_4 = 0.1$



# Example: simulated data from $AR(4)$: $\phi_1 = 0.7$, $\phi_2 = 0.1$, $\phi_3 = -0.2$, $\phi_4 = 0.1$



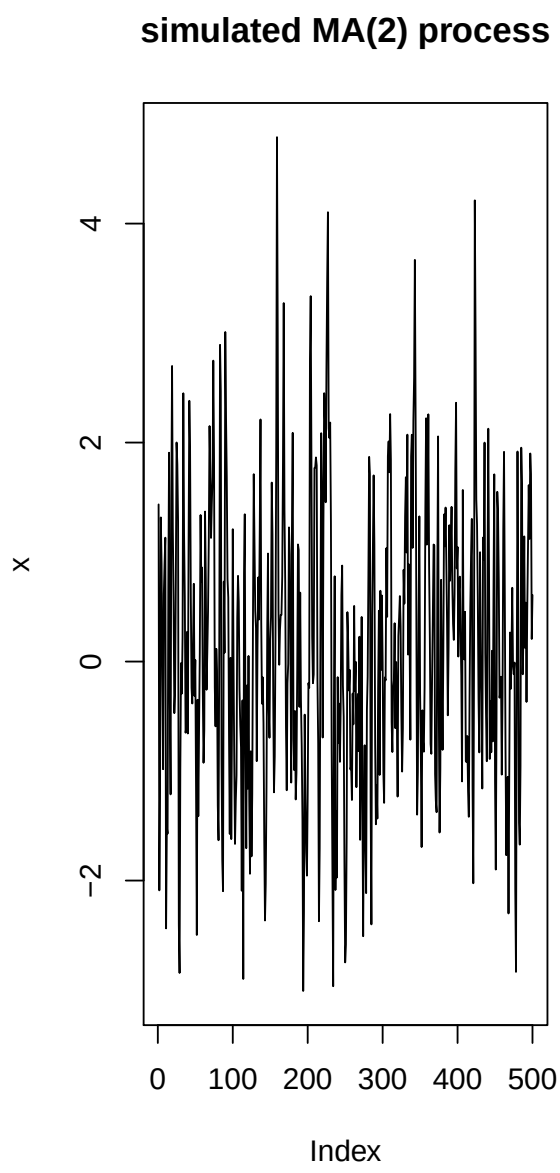



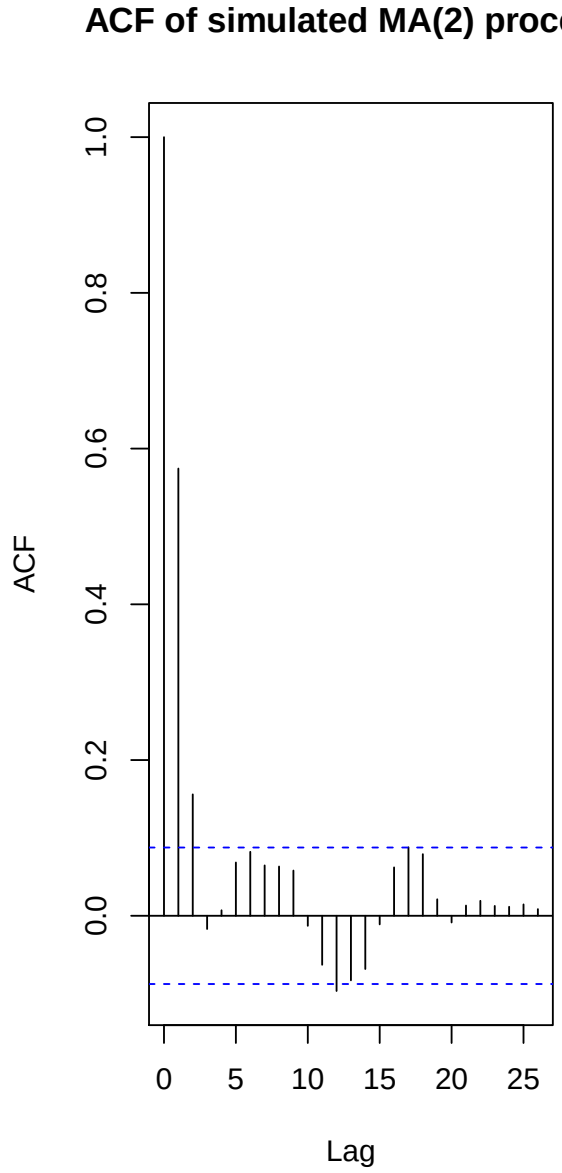



# R code: simulating *MA*(2)

```
##################
#ma(2) basic simulation
####################
theta1 <- 0.75 #define parameters
theta2 <- 0.26
n <- 500 #sample size
z <- rnorm(n) #Innovations
x <- seq(0, length=n)
x[1] <- z[1] #initial values
x[2] <- z[2]
for(i in 3:n) #generating output
{
x[i] <- z[i] + theta1*z[i-1]+ theta2*z[i-2]
}


#plotting
par(mfcol=c(1,2))
plot(x, type='l', main="simulated MA(2) process")
acf(x, main="ACF of simulated MA(2) process")
```

# MA(2)

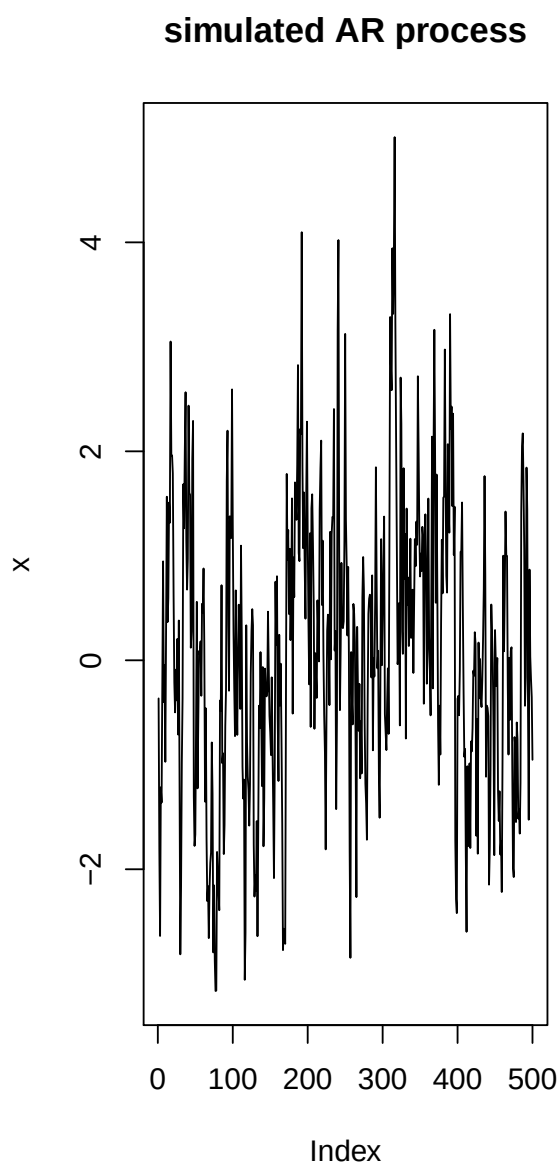

simulated MA(2) process
x
4
2
0
−2
0
100
200
300
400
500
Index

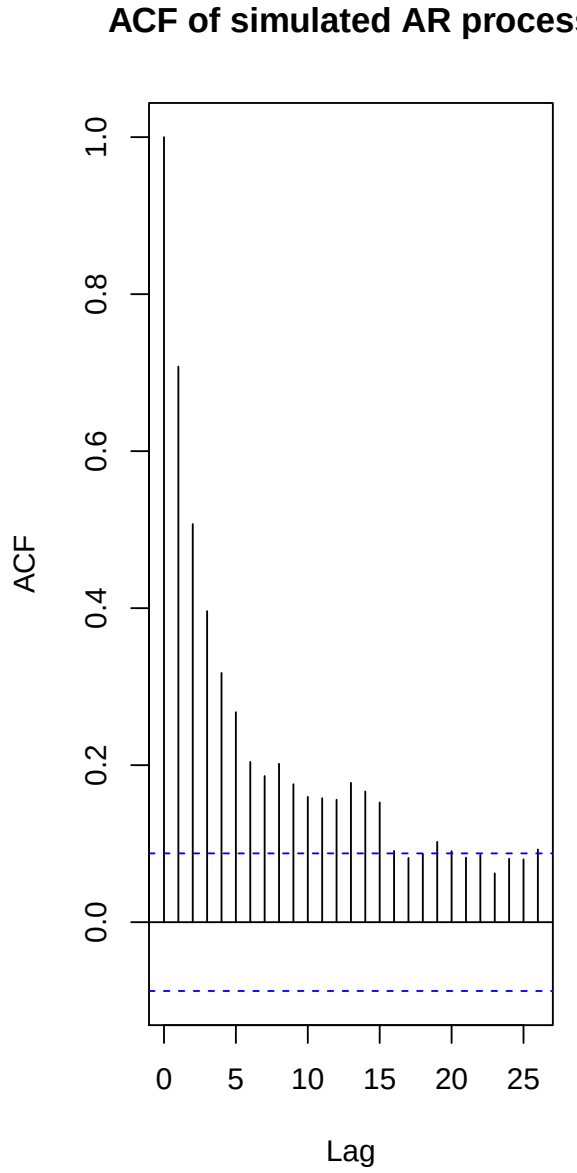

ACF of simulated MA(2) process
ACF
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
Lag

# R code: simulating $AR(1)$

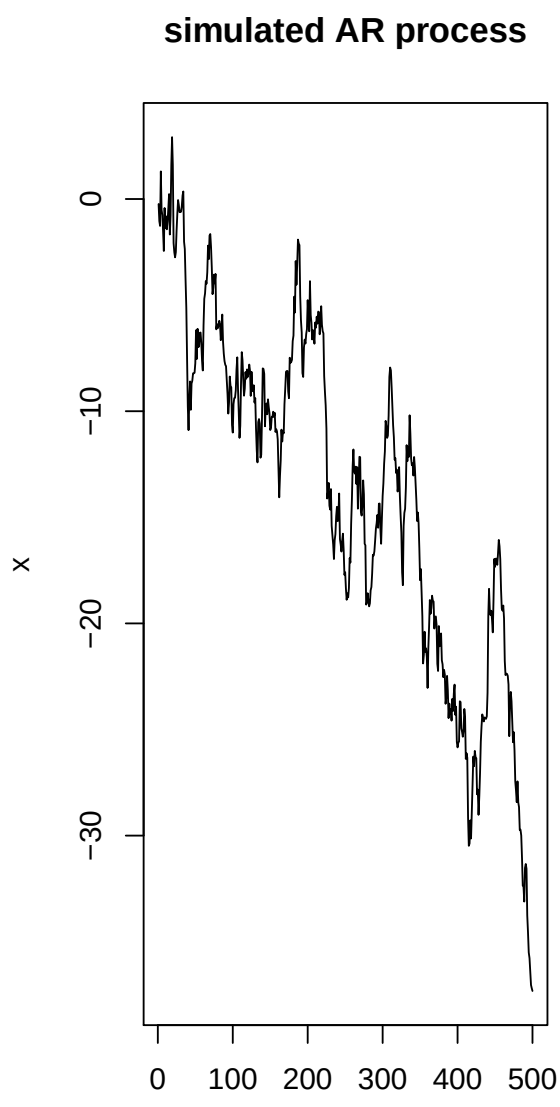
```
##################
#ar basic simulation
####################
phi <- 0.7 #define parameters
n <- 500 #sample size
z <- rnorm(n) #Innovations
x <- seq(0, length=n)
x[1] <- z[1] #initial values
for(i in 2:n)
{
x[i] <- phi*x[i-1]+ z[i]
}


## Plotting
par(mfcol=c(1,2))
plot(x, type='l', main="simulated AR process")
acf(x, main="ACF of simulated AR process")
```

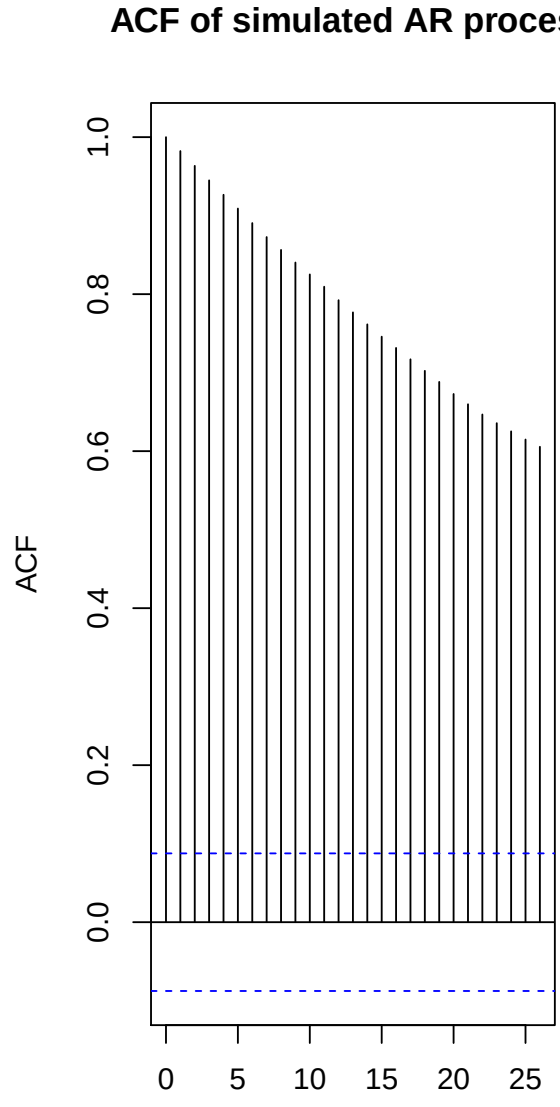
# AR(1): $\phi = 0.7$


simulated AR process
x
4
2
0
−2
0
100
200
300
400
500
Index

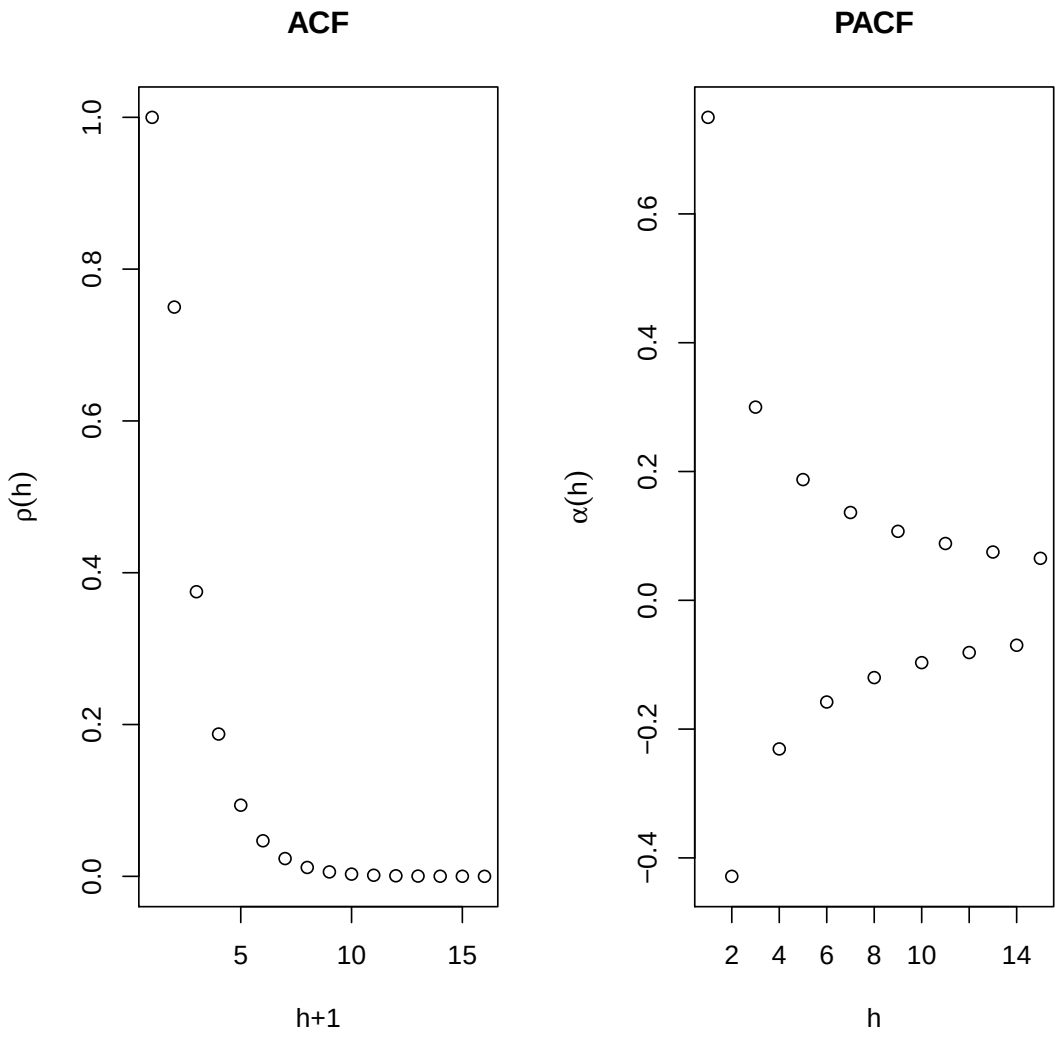

ACF of simulated AR process
ACF
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
Lag

# AR(1): $\phi = 1$ (non-stationary)

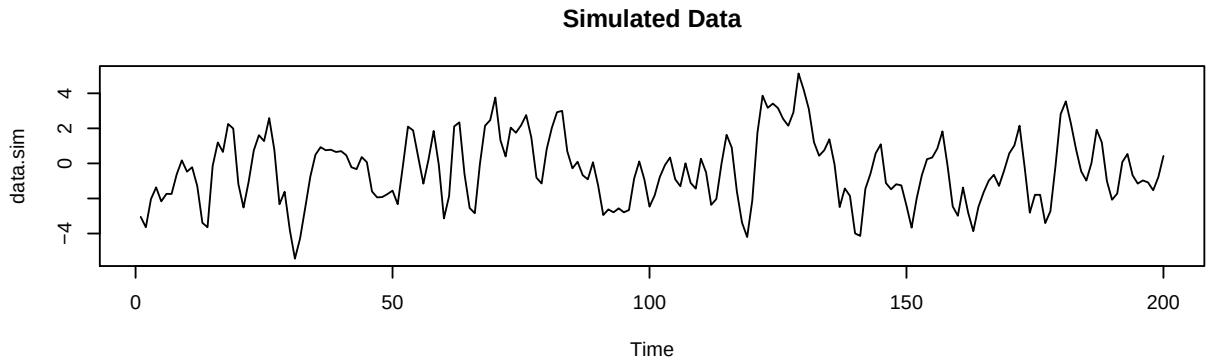


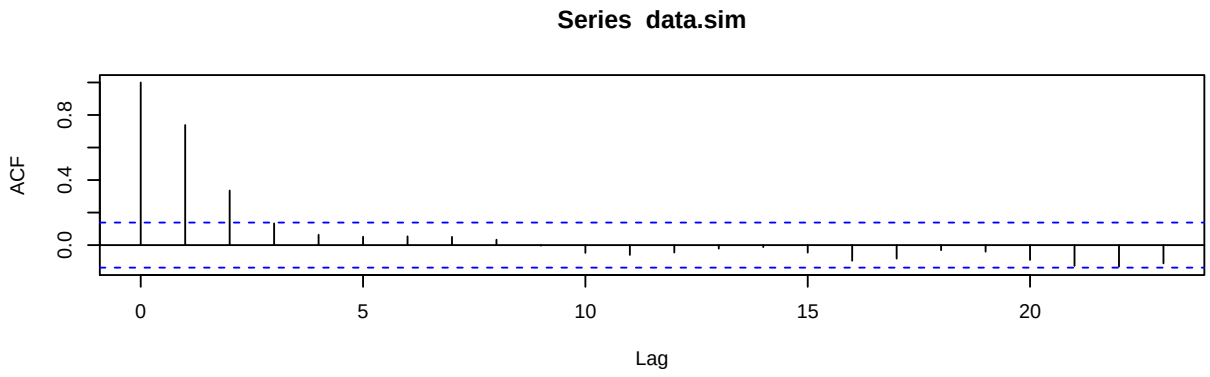



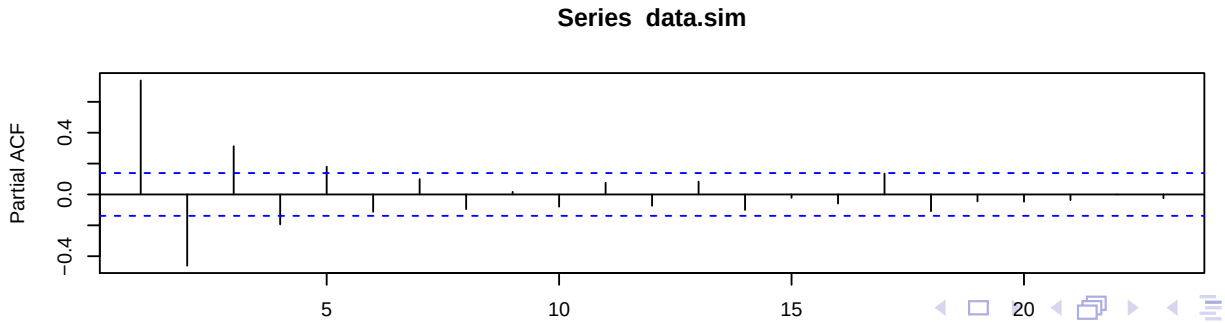
# Example: $ARMA(1,1)$: $\phi_1 = 0.5$, $\theta_1 = 1$



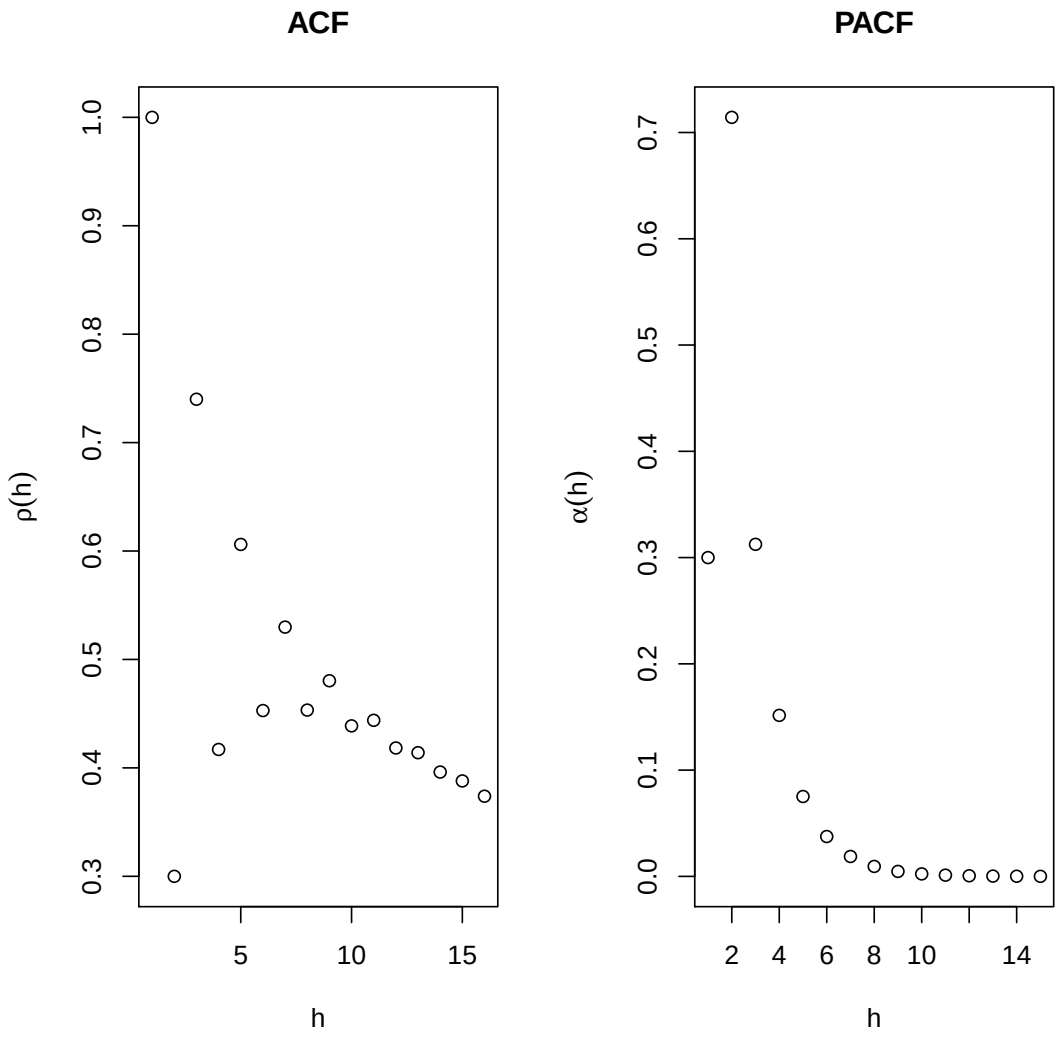
# Example: simulated data from $ARMA(1,1)$: $\phi_1 = 0.5$, $\theta_1 = 1$



# Example: $ARMA(2,1)$: $\phi_1 = 0.3$, $\phi_2 = 0.65$, $\theta_1 = -0.5$



# Simulated data from $ARMA(2,1)$: $\phi_1 = 0.3$, $\phi_2 = 0.65$, $\theta_1 = -0.5$