Time Series Analysis

Homework of week 6

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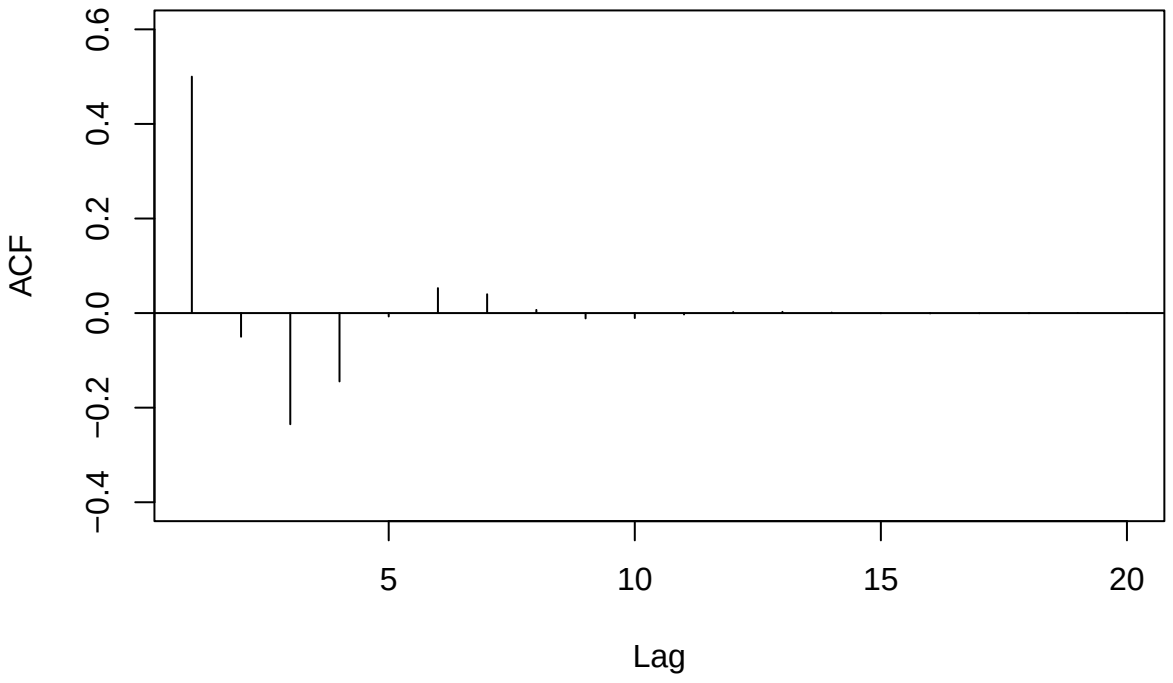
6.27

```
set.seed(996)
series <- arima.sim(n = 72, list(ar = c(0.7, -0.4)))
```

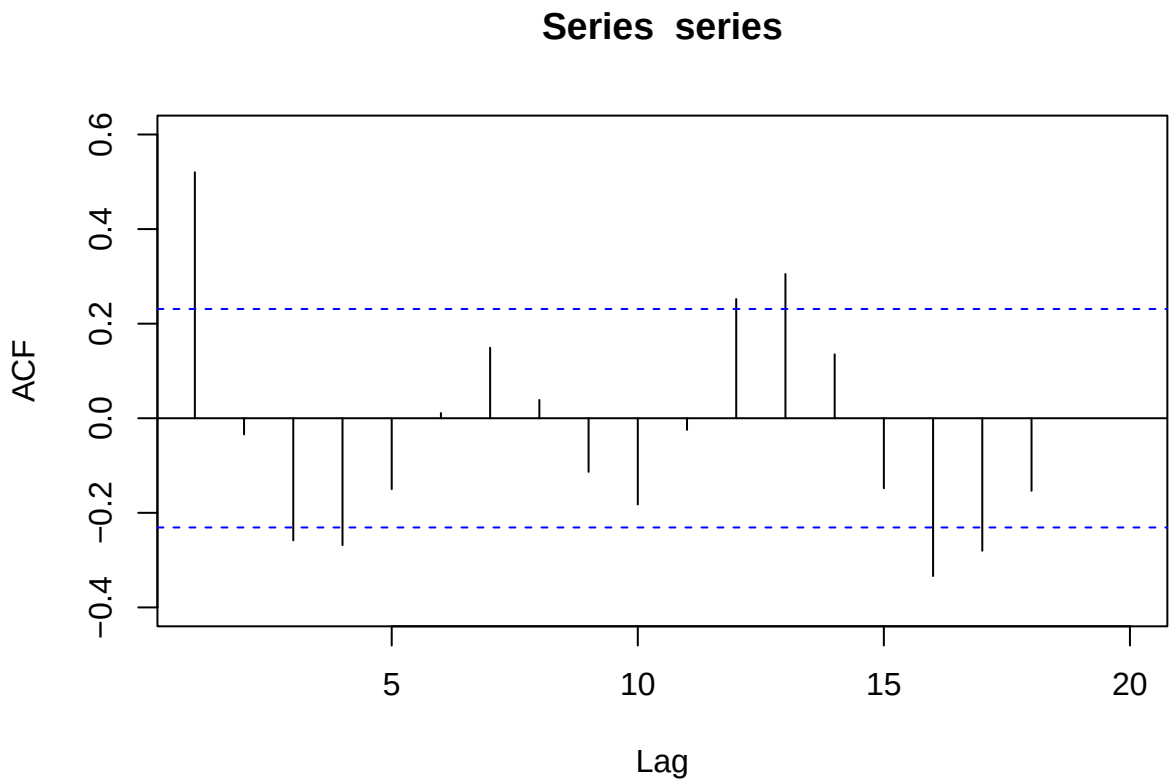
(a)

```
ACF <- ARMAacf(ar = c(0.7, -0.4), lag.max = 20)
plot(y = ACF[-1], x = 1:20, xlab = 'Lag', ylab = 'ACF', type = 'h', ylim = c(-0.4, 0.6))
abline(h = 0)
```



(b)

```
acf(series, xlim = c(1, 20), ylim = c(-0.4, 0.6))
```

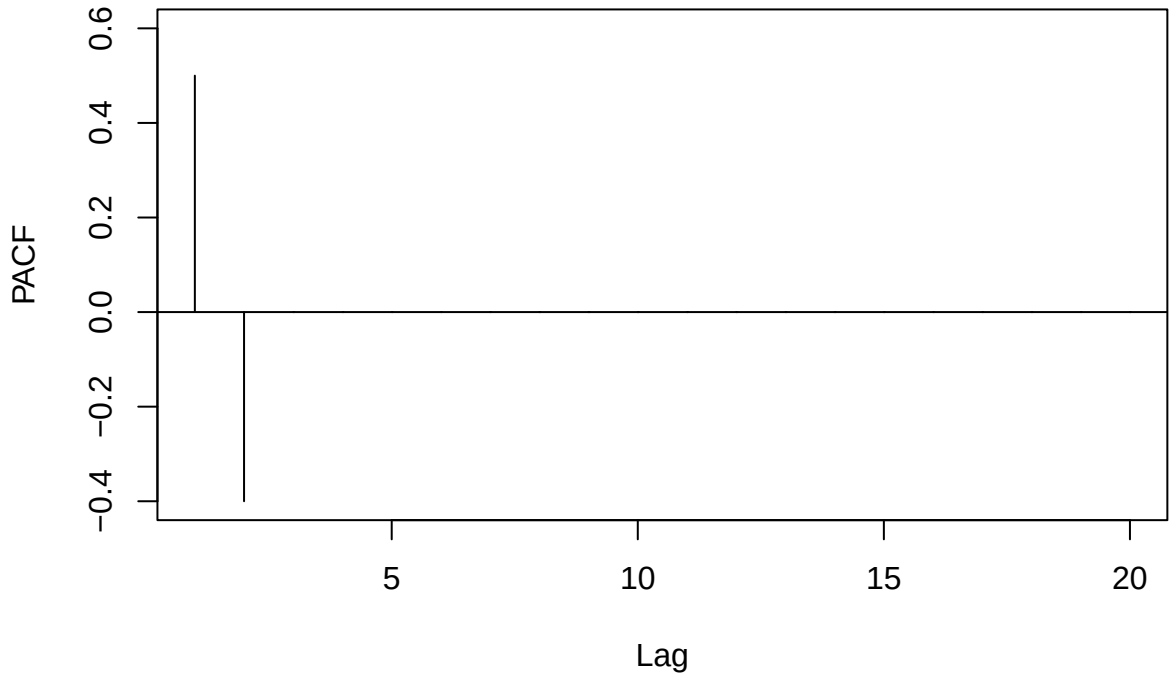


The lag 1 sample ACF matches well and the "damped sine wave" is somewhat apparent but the values at large lags do not die out like the theoretical ACF.

(c)

$\phi_{11} = Corr(Y_t, Y_{t-1}) = \rho_1 = 0.5$. $\phi_{22} = Corr(Y_t - \rho_1 Y_{t-1}, Y_{t-2} - \rho_1 Y_{t-1}) = \frac{\rho_2 - \rho_1^2}{1-\rho_1^2} = -0.4$. $\phi_{kk} = 0, \ k > 2$.

```
PACF <- c(0.5, -0.4, rep(0,18))
plot(y = PACF, x = 1:20, xlab = 'Lag', ylab = 'PACF', type = 'h', ylim = c(-0.4, 0.6))
abline(h = 0)
```

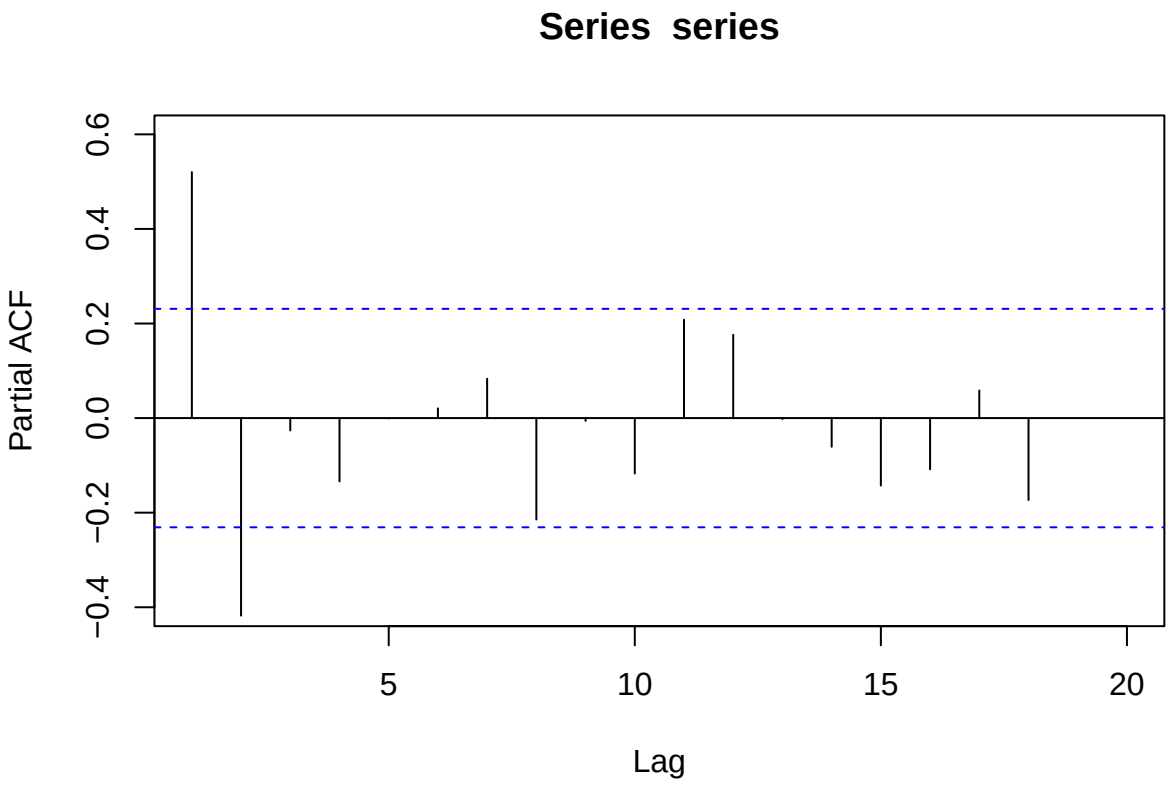


(d)

Same to (b).

(e)

```
pacf(series, xlim = c(1, 20), ylim = c(-0.4, 0.6))
```



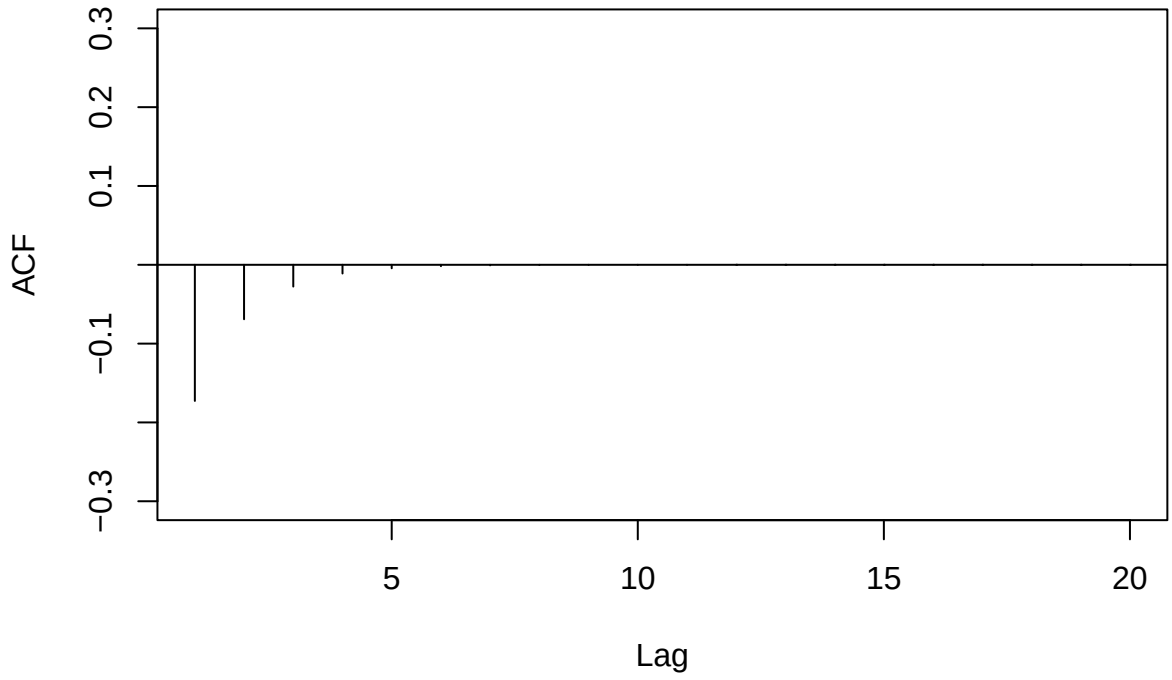
This sample pacf matches the theoretical pacf quite well.

6.29

```
set.seed(555)
series <- arima.sim(n = 60, list(ar = 0.4, ma = -0.6))
```

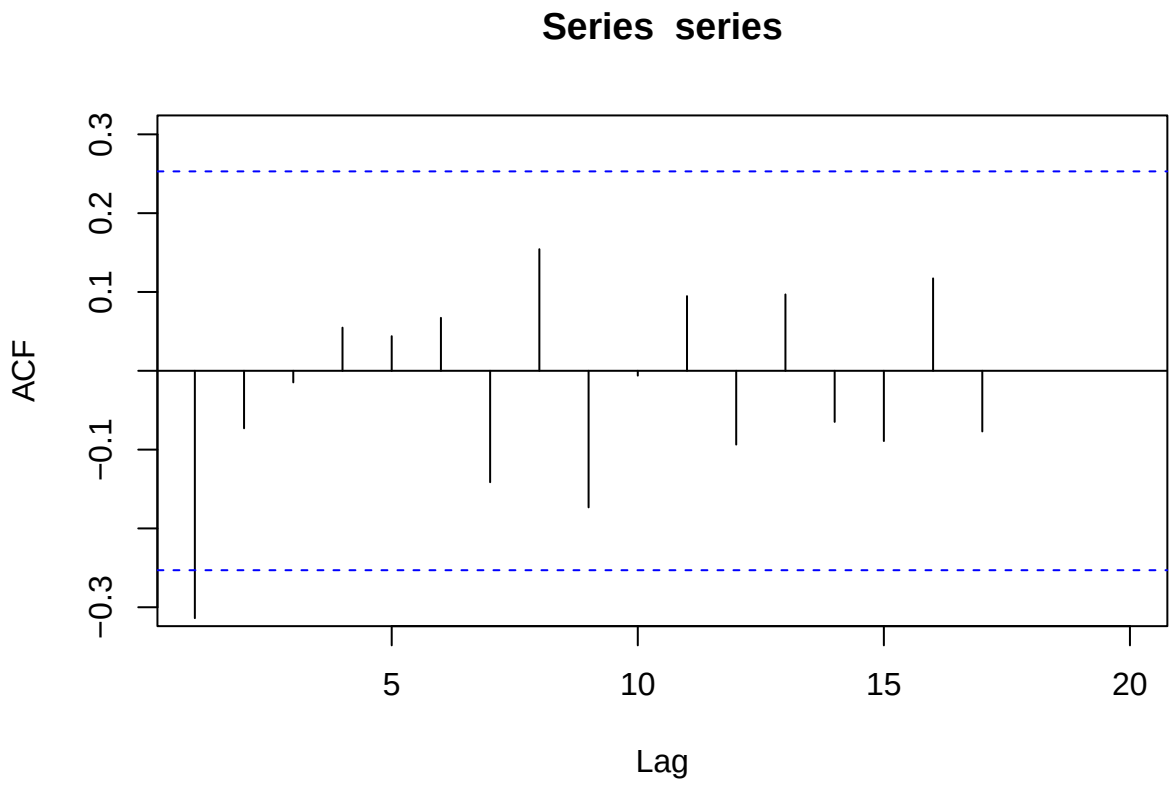
(a)

```
ACF <- ARMAacf(ar = 0.4, ma = -0.6, lag.max = 20)
plot(y = ACF[-1], x = 1:20, xlab = 'Lag', ylab = 'ACF', type = 'h', ylim = c(-0.3, 0.3))
abline(h = 0)
```



(b)

```
acf(series, xlim = c(1, 20), ylim = c(-0.3, 0.3))
```



The pattern matches somewhat at the first few lags but there is a lot of spurious autocorrelation at higher lags.

(c)

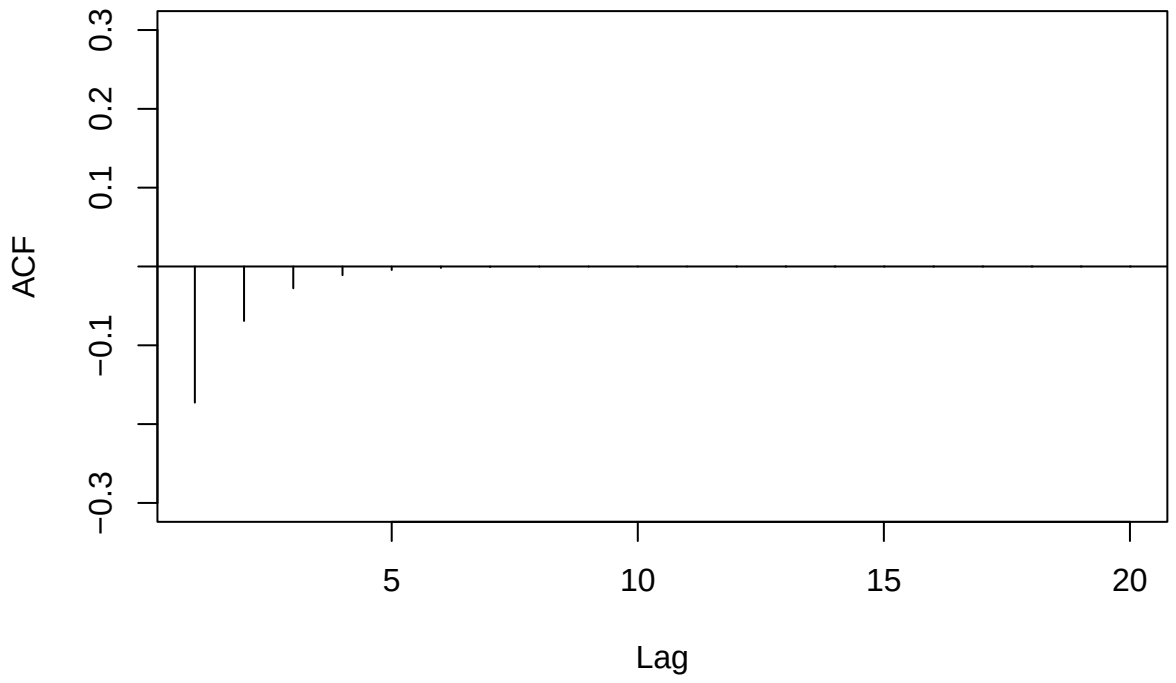
```
library(TSA)
eacf(series)
```

```
## AR/MA
##   0 1 2 3 4 5 6 7 8 9 10 11 12 13
## 0 x o o o o o o o o o o  o  o  o
## 1 x o o o o o o o o o o  o  o  o
## 2 x o o o o o o o o o o  o  o  o
## 3 o o x o o o o o o o o  o  o  o
## 4 o o o o o o o o o o o  o  o  o
## 5 x o o o o o o o o o o  o  o  o
## 6 o x o o o o o o o o o  o  o  o
## 7 o x o o o o x o o o o  o  o  o
```

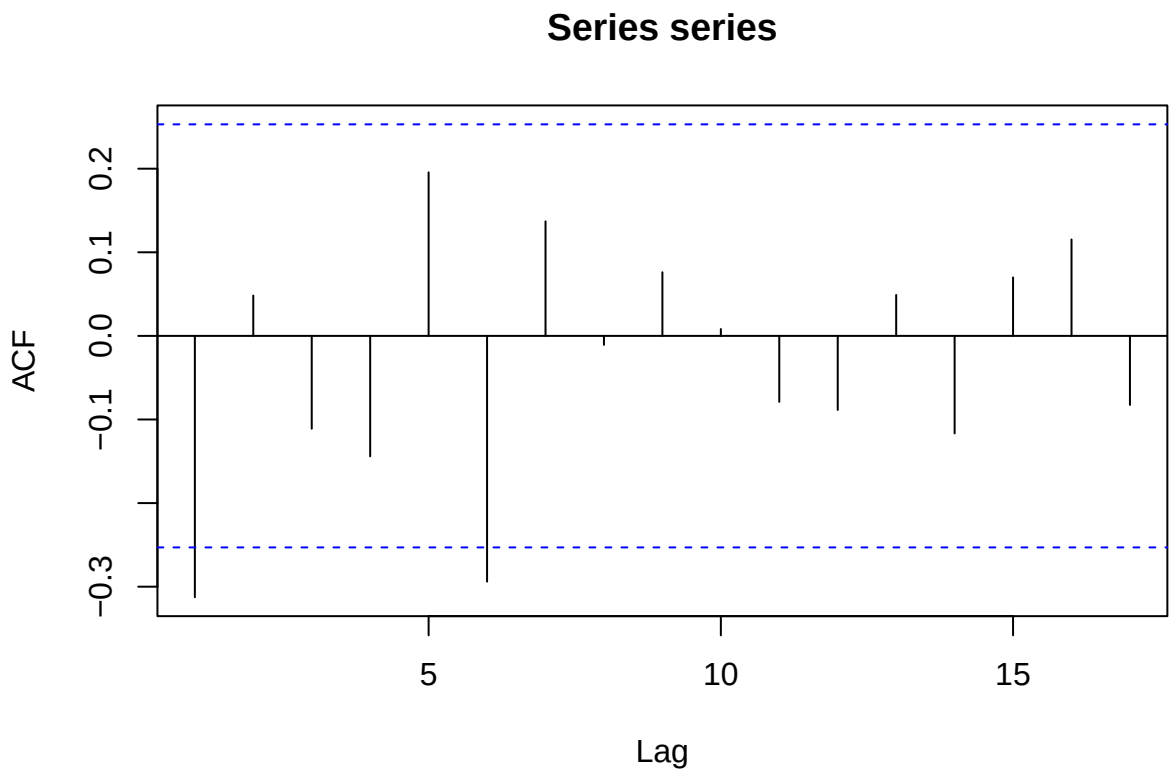
This sample EACF seems to point the mixed ARMA(1,1). Yes.

(d)

```
set.seed(777)
series <- arima.sim(n = 60, list(ar = 0.4, ma = -0.6))
#
ACF <- ARMAacf(ar = 0.4, ma = -0.6, lag.max = 20)
plot(y = ACF[-1], x = 1:20, xlab = 'Lag', ylab = 'ACF', type = 'h', ylim = c(-0.3, 0.3))
abline(h = 0)
```




```
#
acf(series)
```




```
#
eacf(series)
```

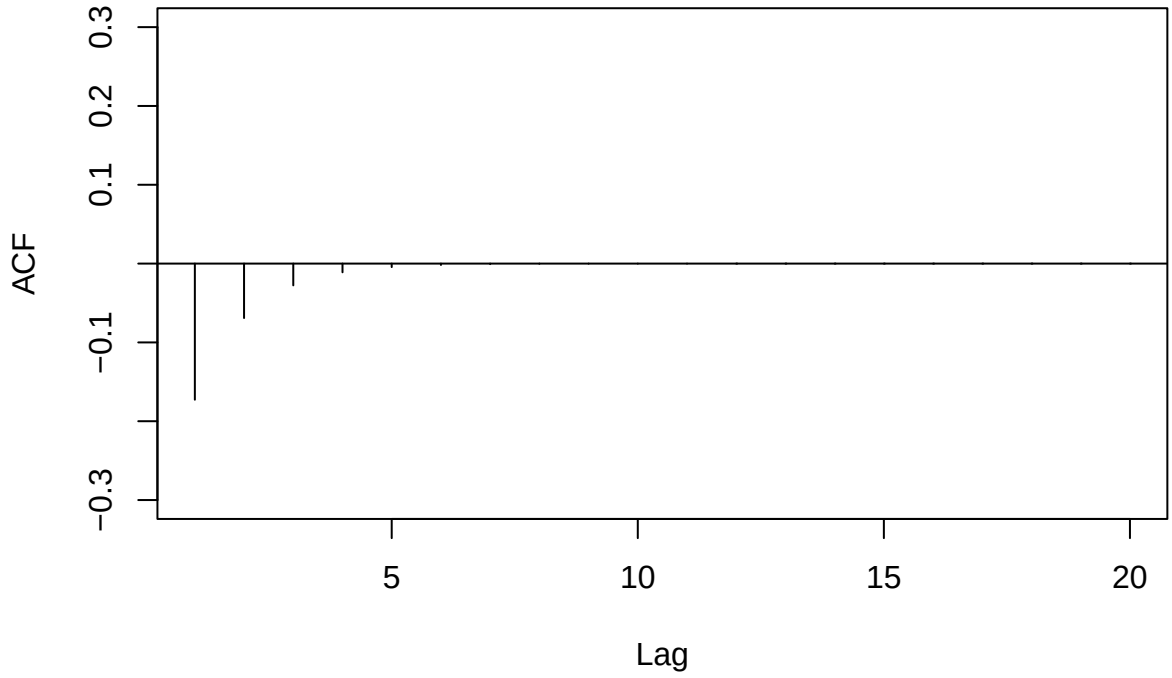
```
## AR/MA
##   0 1 2 3 4 5 6 7 8 9 10 11 12 13
## 0 x o o o o x o o o o o  o  o  o
## 1 o o o o o o o o o o o  o  o  o
## 2 x o o o o o o o o o o  o  o  o
## 3 x o x o o o o o o o o  o  o  o
## 4 x x x o o x o o o o o  o  o  o
## 5 o x x o o o o o o o o  o  o  o
## 6 x o o o o o o o o o o  o  o  o
## 7 o o o o o o o o o o o  o  o  o
```

part(b): the pattern matches somewhat at the first few lags but there is a lot of spurious autocorrelation at higher lags. \ part(c): this sample EACF seems to point to an MA(1) or AR(1) model rather than the mixed ARMA(1,1).

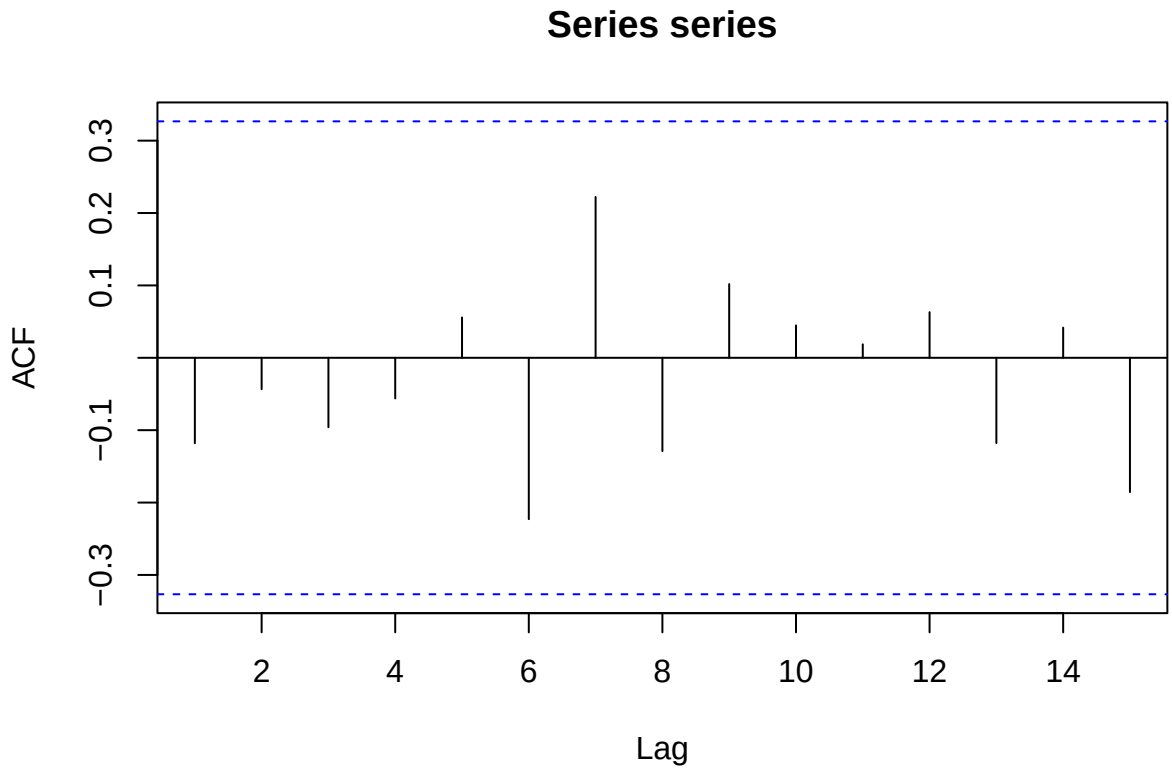
(e)

```
set.seed(1234)
series <- arima.sim(n = 36, list(ar = 0.4, ma = -0.6))
#
```

```r
ACF <- ARMAacf(ar = 0.4, ma = -0.6, lag.max = 20)
plot(y = ACF[-1], x = 1:20, xlab = 'Lag', ylab = 'ACF', type = 'h', ylim = c(-0.3, 0.3))
abline(h = 0)
```




```r
#
acf(series)
```




```
#
eacf(series, ar.max = 7, ma.max = 10)
```

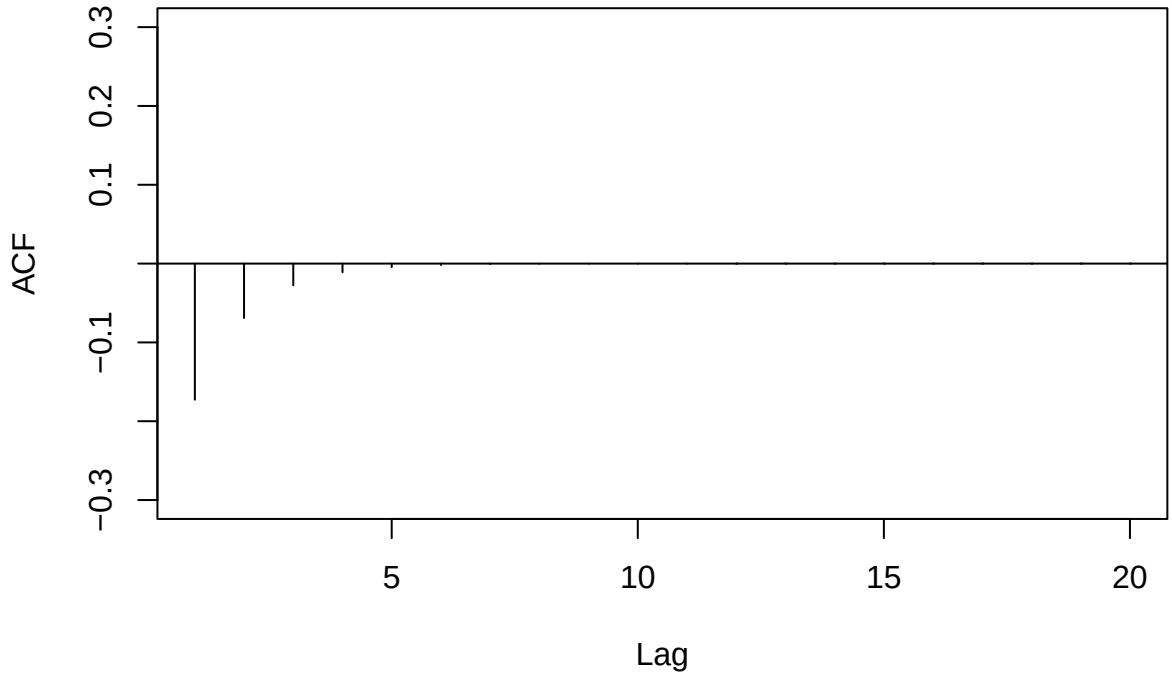
```
## AR/MA
##   0 1 2 3 4 5 6 7 8 9 10
## 0 o o o o o o o o o o o
## 1 x o o o o o o o o o o
## 2 x x o o o o o o o o o
## 3 x o o o o o o o o o o
## 4 x o o o o o o o o o o
## 5 o o o o o o o o o o o
## 6 x o o o o o o o o o o
## 7 x o o o o o o o o o o
```

part(b): the pattern matches somewhat at the first few lags but there is a lot of spurious autocorrelation at higher lags. \ part(c): this sample EACF seems to point to an ARMA(0,0) model(white noise) rather than the mixed ARMA(1,1).

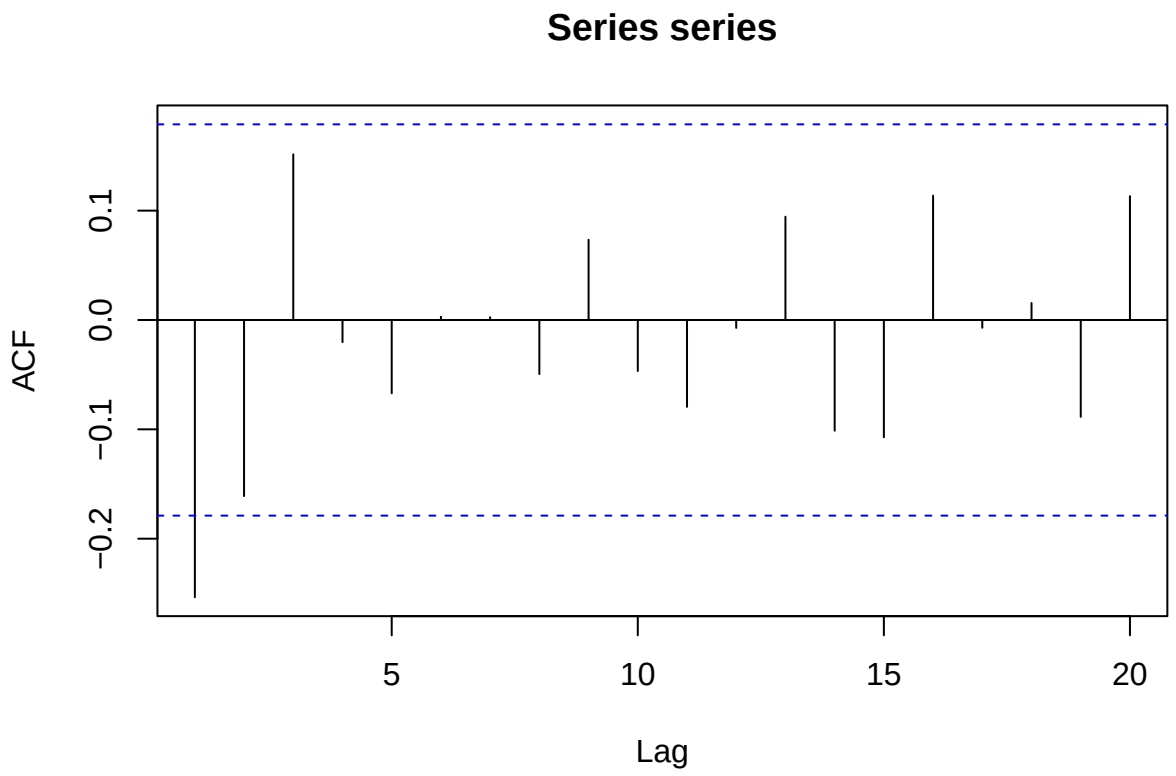
(f)

```
set.seed(105)
series <- arima.sim(n = 120, list(ar = 0.4, ma = -0.6))
#
```

```r
ACF <- ARMAacf(ar = 0.4, ma = -0.6, lag.max = 20)
plot(y = ACF[-1], x = 1:20, xlab = 'Lag', ylab = 'ACF', type = 'h', ylim = c(-0.3, 0.3))
abline(h = 0)
```




```r
#
acf(series)
```




```
#
eacf(series)
```

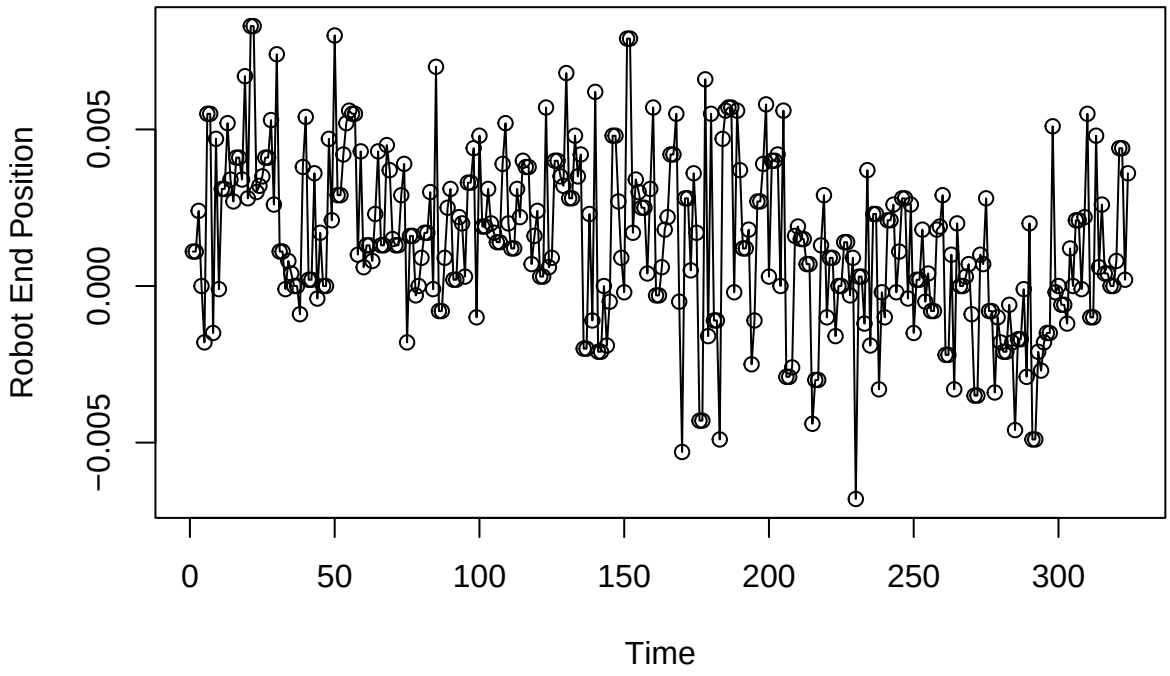
```
## AR/MA
##   0 1 2 3 4 5 6 7 8 9 10 11 12 13
## 0 x o o o o o o o o o o  o  o  o
## 1 x x o o o o o o o o o  o  o  o
## 2 o o o o o o o o o o o  o  o  o
## 3 o o o o o o o o o o o  o  o  o
## 4 o x o o o o o o o o o  o  o  o
## 5 x x o o o o o o o o o  o  o  o
## 6 x x o o o o o o o o o  o  o  o
## 7 x o o o o x o o o o o  o  o  o
```

part(b): the pattern matches somewhat at the first few lags(except lag = 3) but there is a lot of spurious autocorrelation at higher lags. \ part(c): this sample EACF seems to point to an MA(1) model rather than the mixed ARMA(1,1).

6.36

(a)

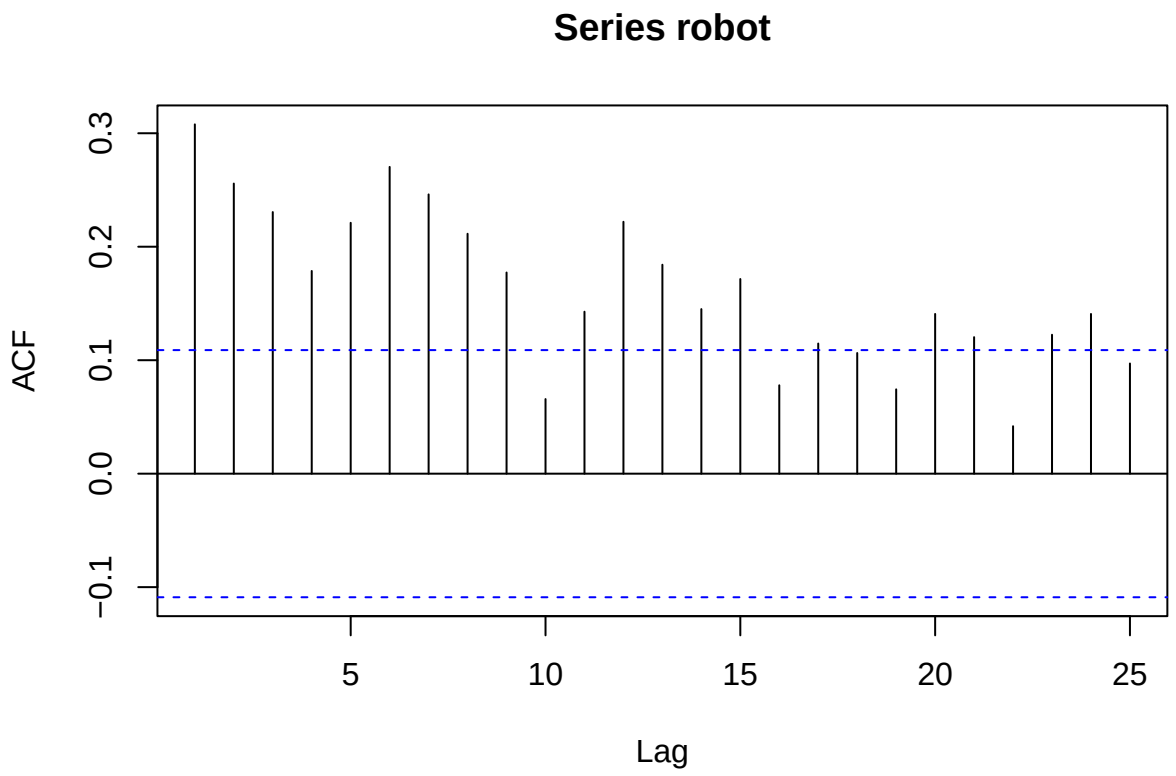
```
data(robot)
plot(robot, type = 'o', ylab = 'Robot End Position')
```



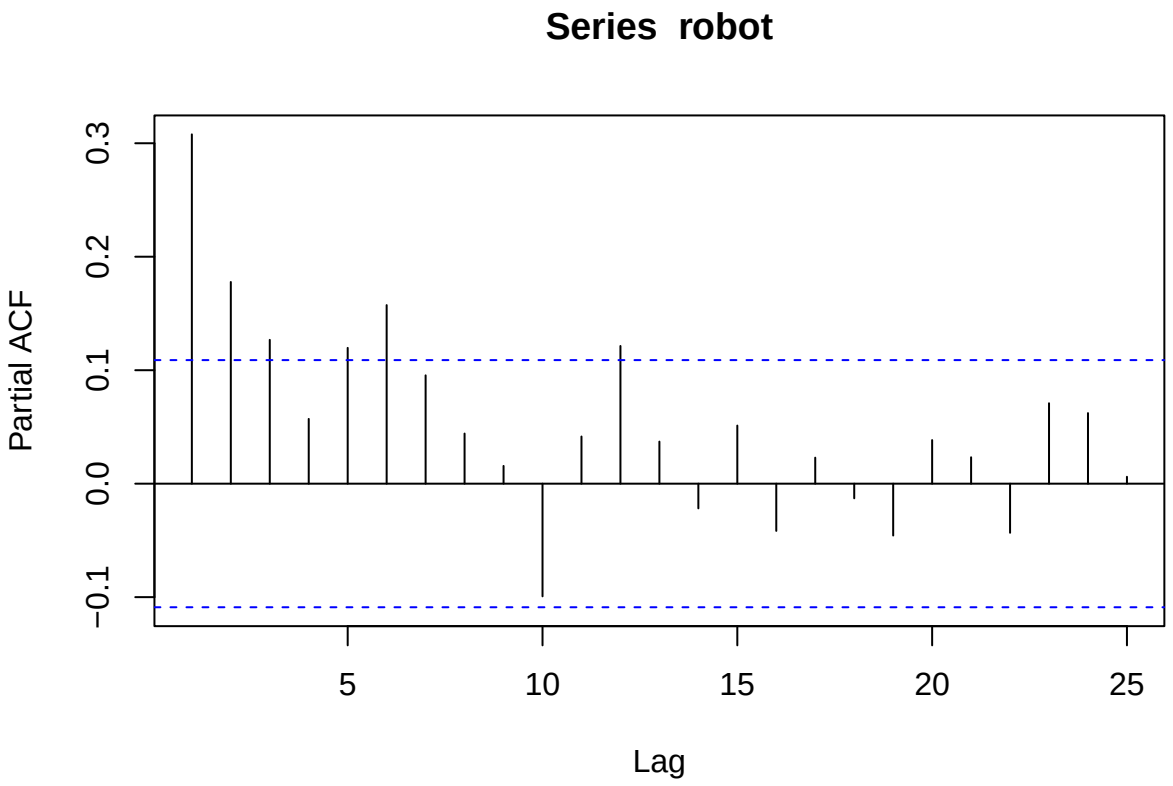
From this plot we might try a stationary model but there is also enough "drift" that we might also suspect nonstationarity.

(b)

```
acf(robot)
```




```
pacf(robot)
```



These plots are are not especially definitive, but the pacf suggests possibly an AR(3) or AR(6) model for the series.

(c)

```
eacf(robot)
```

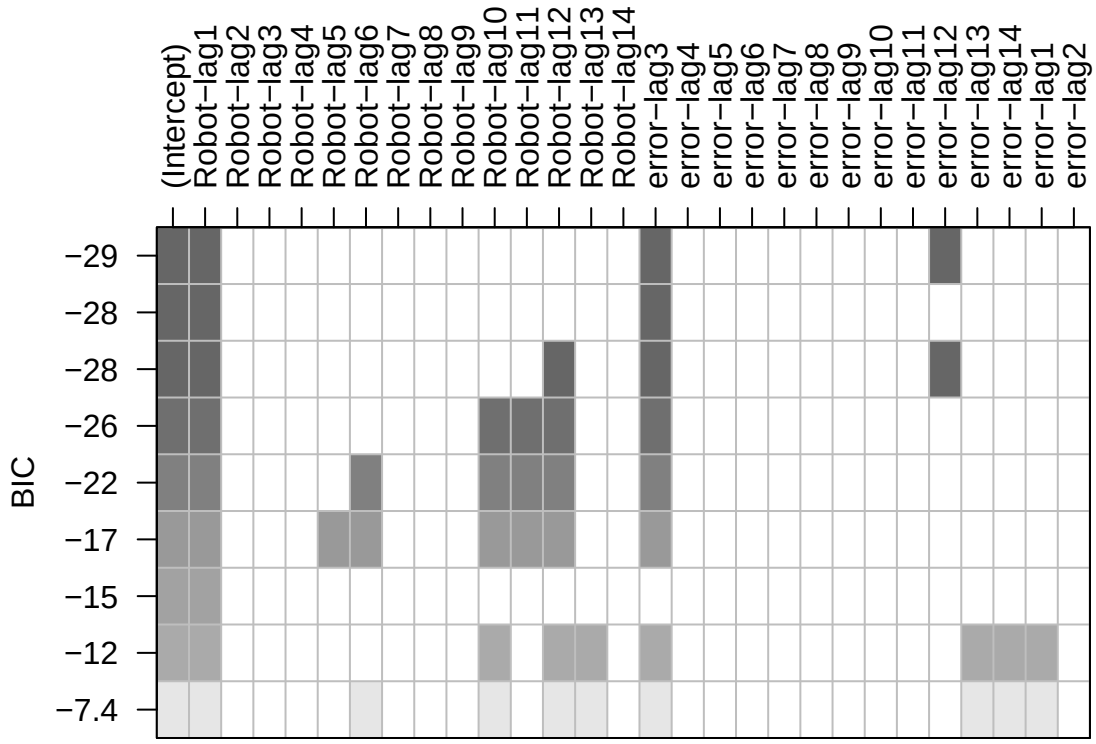
```
## AR/MA
##   0 1 2 3 4 5 6 7 8 9 10 11 12 13
## 0 x x x x x x x x x o x  x  x  x
## 1 x o o o o o o o o o o  o  o  o
## 2 x x o o o o o o o o o  o  o  o
## 3 x x o o o o o o o o o  o  o  o
## 4 x x x x o o o o o o o  o  x  o
## 5 x x x o o o o o o o o  o  x  o
## 6 x o o o o x o o o o o  o  o  o
## 7 x o o x o x x o o o o  o  o  o
```

The EACF suggests an ARMA(1,1) model.

(d)

```
plot(armasubsets(y = robot, nar = 14, nma = 14, y.name = 'Robot', ar.method = 'ols'))
```

```
## Reordering variables and trying again:
```



The best model here includes a lag 1 AR term but lags 3 and 12 in the MA part of the model.