exam_part2.R

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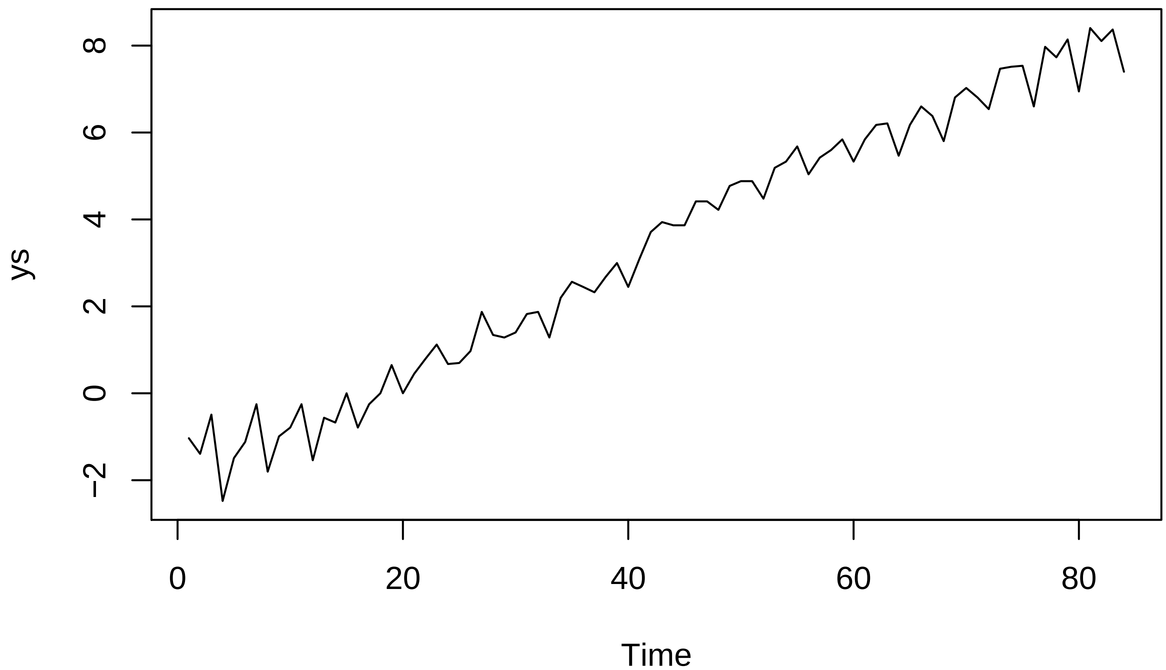
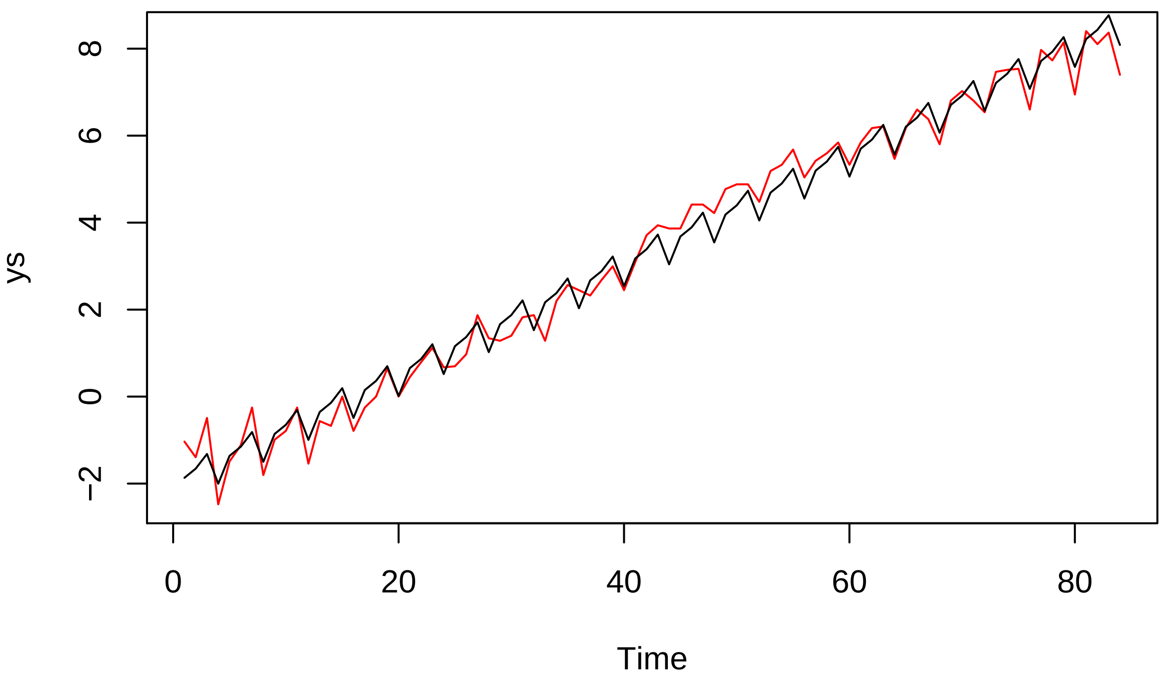
```
library(astsa)

# problem 1
# part (a)
tsdata <- ts(jj)
n <- length(tsdata)
ys <- exp((1/n)*sum(log(tsdata)))*log(tsdata)
plot(ys)
```




```
# part (b)
t <- 1:84
qt <- as.factor(rep(1:4,21))
q1 <- qt==1
q2 <- qt==2
q3 <- qt==3
m <- cbind(t,q1,q2,q3,ys)

# fit regression model to data
fit <- lm(ys~t+q1+q2+q3, data=m)

summary(fit)
```

```
##
## Call:
## lm(formula = ys ~ t + q1 + q2 + q3, data = m)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.8847 -0.2735 -0.0356  0.2553  0.8342
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) -2.508319   0.111529 -22.490  < 2e-16 ***
## t            0.126112   0.001704  73.999  < 2e-16 ***
## q1           0.514570   0.116866   4.403 3.31e-05 ***
## q2           0.599431   0.116803   5.132 2.01e-06 ***
## q3           0.810985   0.116766   6.945 9.50e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3783 on 79 degrees of freedom
## Multiple R-squared:  0.9859, Adjusted R-squared:  0.9852
## F-statistic:  1379 on 4 and 79 DF,  p-value: < 2.2e-16
```

```
plot(ys,col="red")
lines(fitted.values(fit),type="l")
```



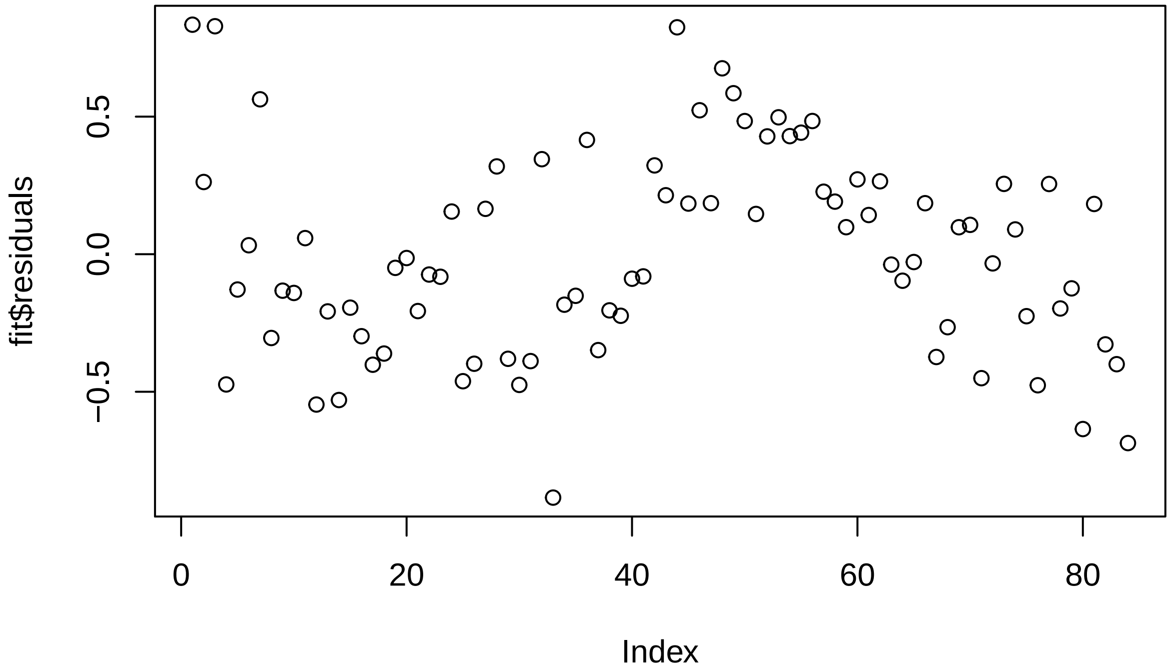

```
# part (c)
df <- 5
print("mse:")
```

```
## [1] "mse:"
```

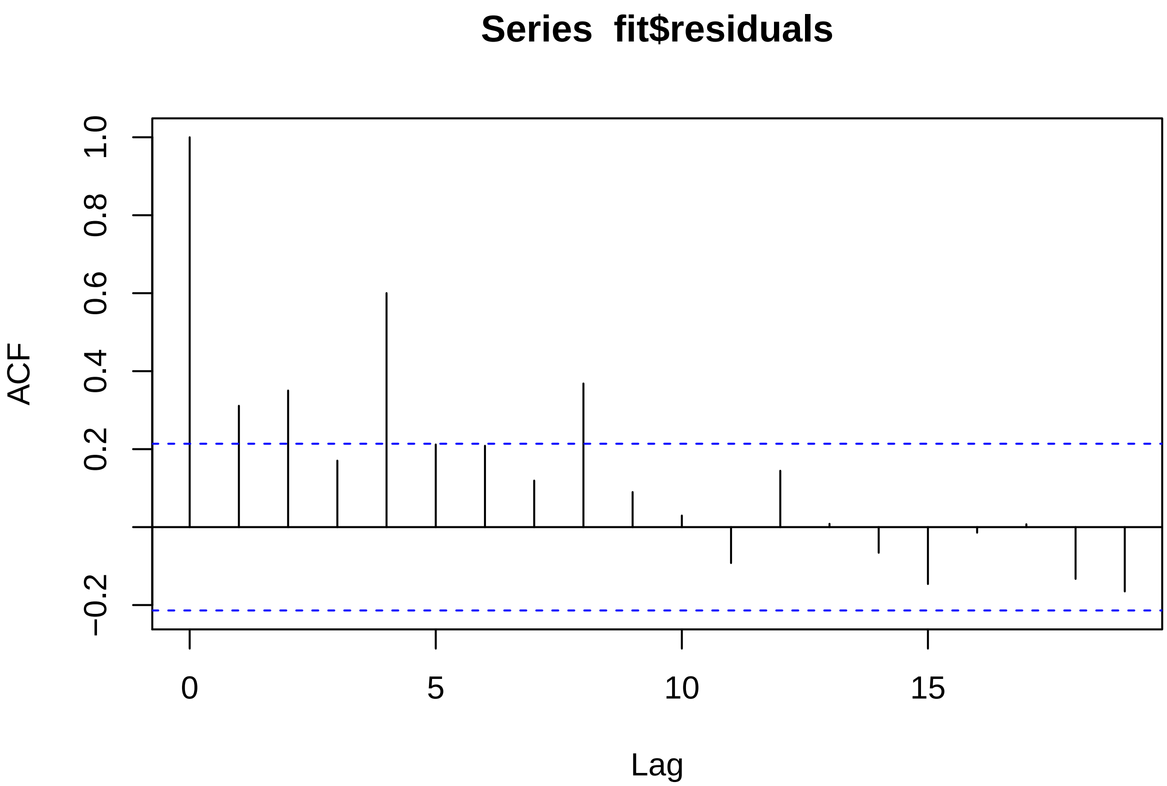
```
print(summary(fit)$sigma^2)
```

```
## [1] 0.14313
```

```r
plot(fit$residuals)
```



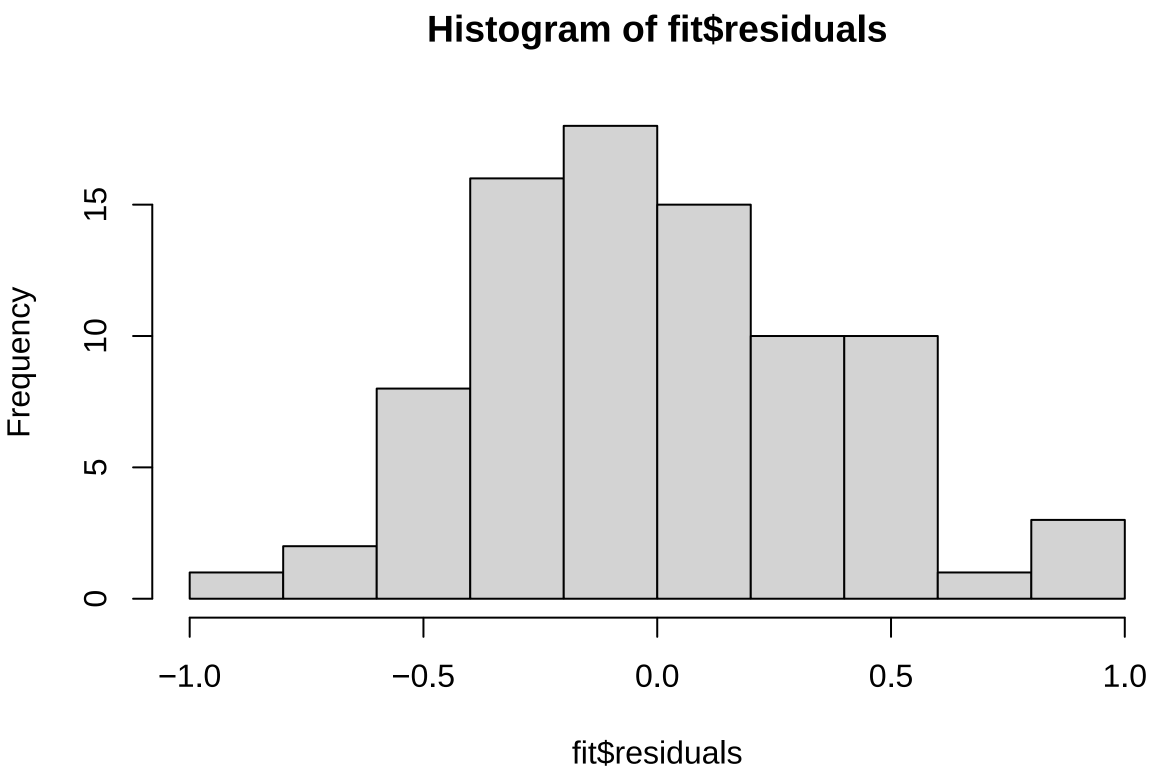

```r
acf(fit$residuals)
```




```r
hist(fit$residuals)

# The residuals do not look like white noise. according to the ACF, there
# seems to be some correlation. Particularly, the periods seem to be correlated,
```

```
# i.e., lags 4 and 8 are correlated.

# furthermore, when we plot the residuals, time units 40-65 seem to have a
# non-zero positive expectation. they should hover above and below more or
# less equally, but they seem to be above zero there.


# part (d)



# part (e)
library(forecast)
```

```
## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo

##
## Attaching package: 'forecast'

## The following object is masked from 'package:astsa':
##
##     gas
```

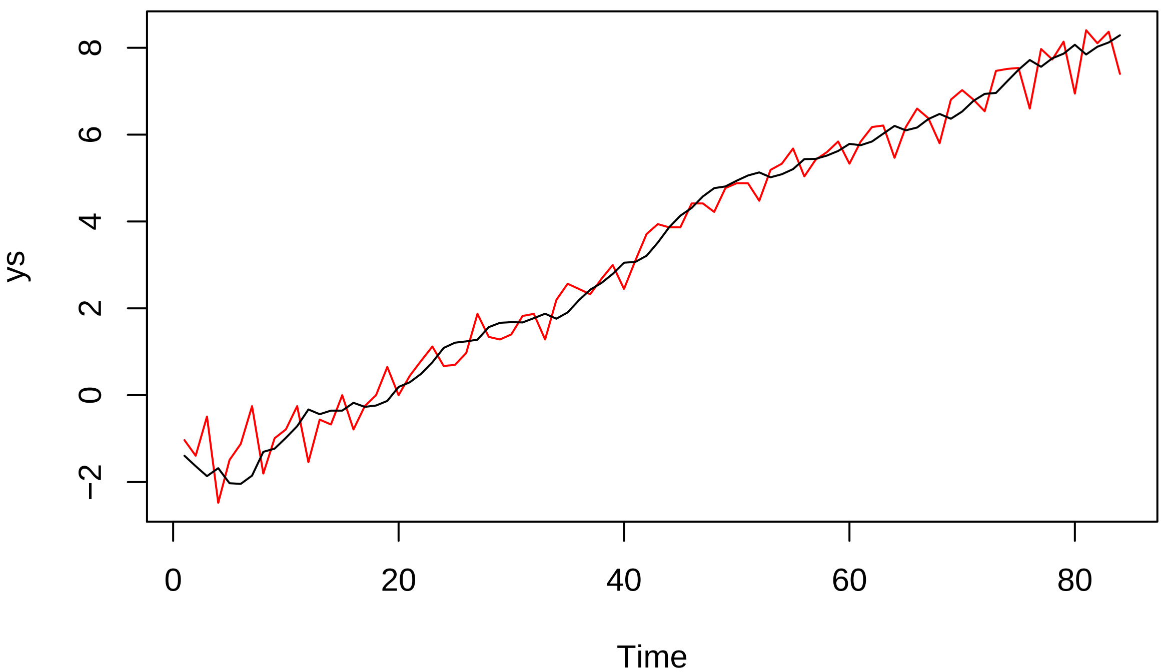



```
dEMA <- holt(ys,h=1,level=c(95),initial="simple")
summary(dEMA)
```

```
##
## Forecast method: Holt's method
##
```

```
## Model Information:
## Holt's method
##
## Call:
##  holt(y = ys, h = 1, level = c(95), initial = "simple")
##
##   Smoothing parameters:
##     alpha = 0.1922
##     beta  = 0.7383
##
##   Initial states:
##     l = -1.0335
##     b = -0.3607
##
##   sigma:  0.4987
## Error measures:
##                      ME      RMSE       MAE MPE MAPE      MASE       ACF1
## Training set 0.02957531 0.4987013 0.3840707 NaN  Inf 0.7636477 -0.1033669
##
## Forecasts:
##    Point Forecast    Lo 95    Hi 95
## 85       8.108907 7.131471 9.086344
```

```
plot(ys,col="red")
lines(dEMA$fitted)
```




```
#plot(tsdata,col="red")
#lines(exp((1/alpha)*dEMA$fitted))

# part (g)

# from the summary output in party (a), the forecast using holt-winters double
# exponential method is: 8.108907 with a 95% prediction interval (7.131471 9.086344).
```

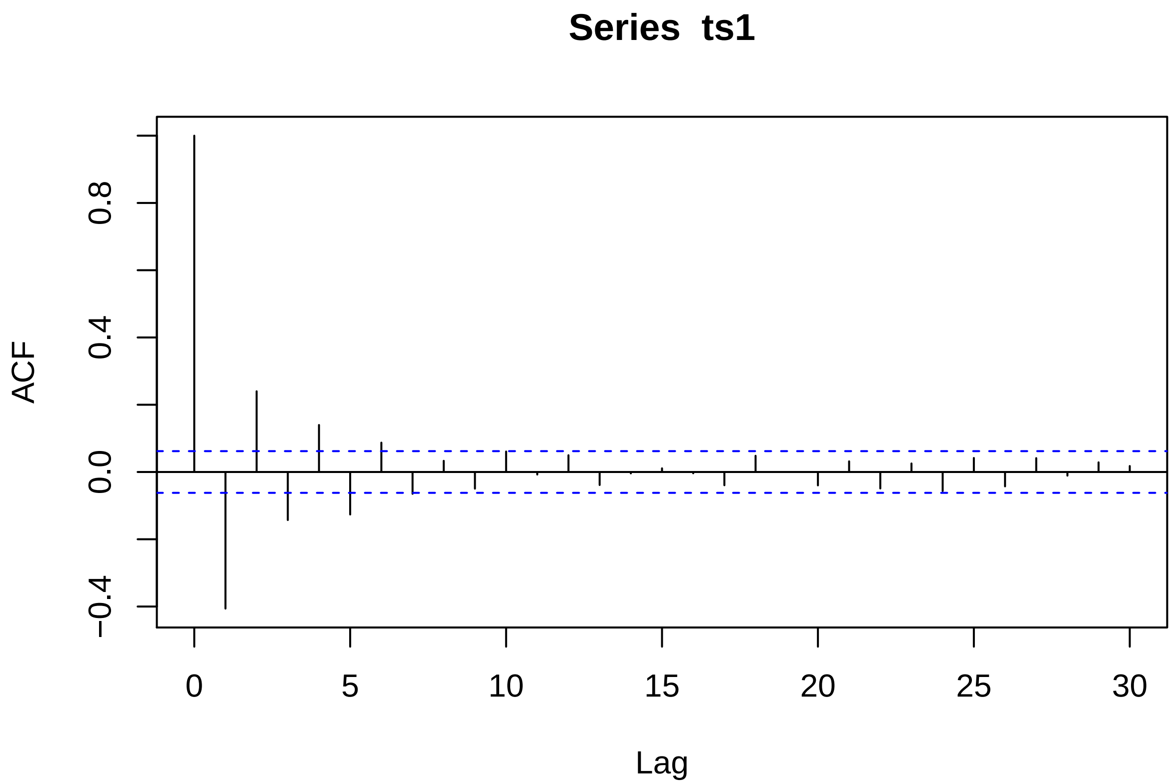
```r
# problem 2

# part (b)

# Y(t) = -0.4 Y(t-1) + e(t)
# AR(1), stationary and invertible
# rho(k) = (-0.4)^k
ARMAacf(ar=c(-.4),lag.max=12,pacf=F)
```

```
##              0              1              2              3              4
##  1.000000e+00 -4.000000e-01  1.600000e-01 -6.400000e-02  2.560000e-02
##              5              6              7              8              9
## -1.024000e-02  4.096000e-03 -1.638400e-03  6.553600e-04 -2.621440e-04
##             10             11             12
##  1.048576e-04 -4.194304e-05  1.677722e-05
```

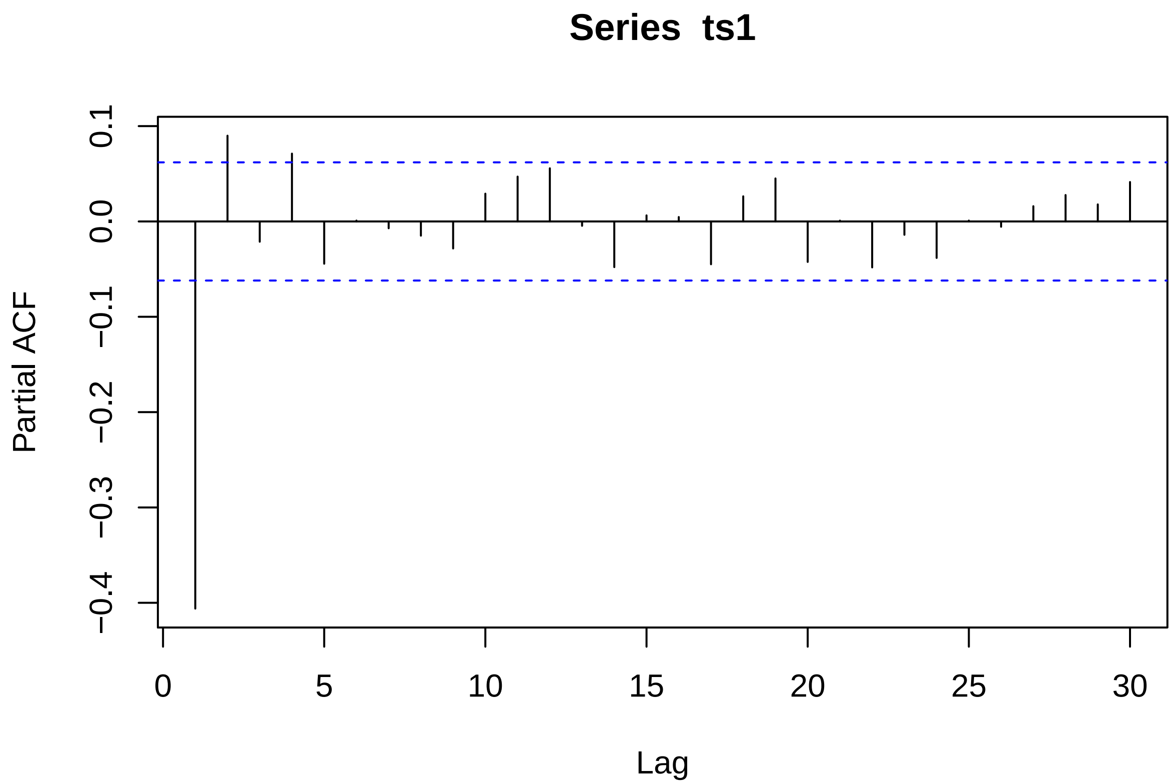
```r
# Y(t) = .9Y(t-1) + e(t) + .5e(t-1)
# ARMA(1,1), stationary and invertible
# rho(t) = .6984(.9)^t
ARMAacf(ar=c(.9),ma=c(-.5),lag.max=12,pacf=F)
```

```
##         0         1         2         3         4         5         6         7
## 1.0000000 0.6285714 0.5657143 0.5091429 0.4582286 0.4124057 0.3711651 0.3340486
##         8         9        10        11        12
## 0.3006438 0.2705794 0.2435215 0.2191693 0.1972524
```

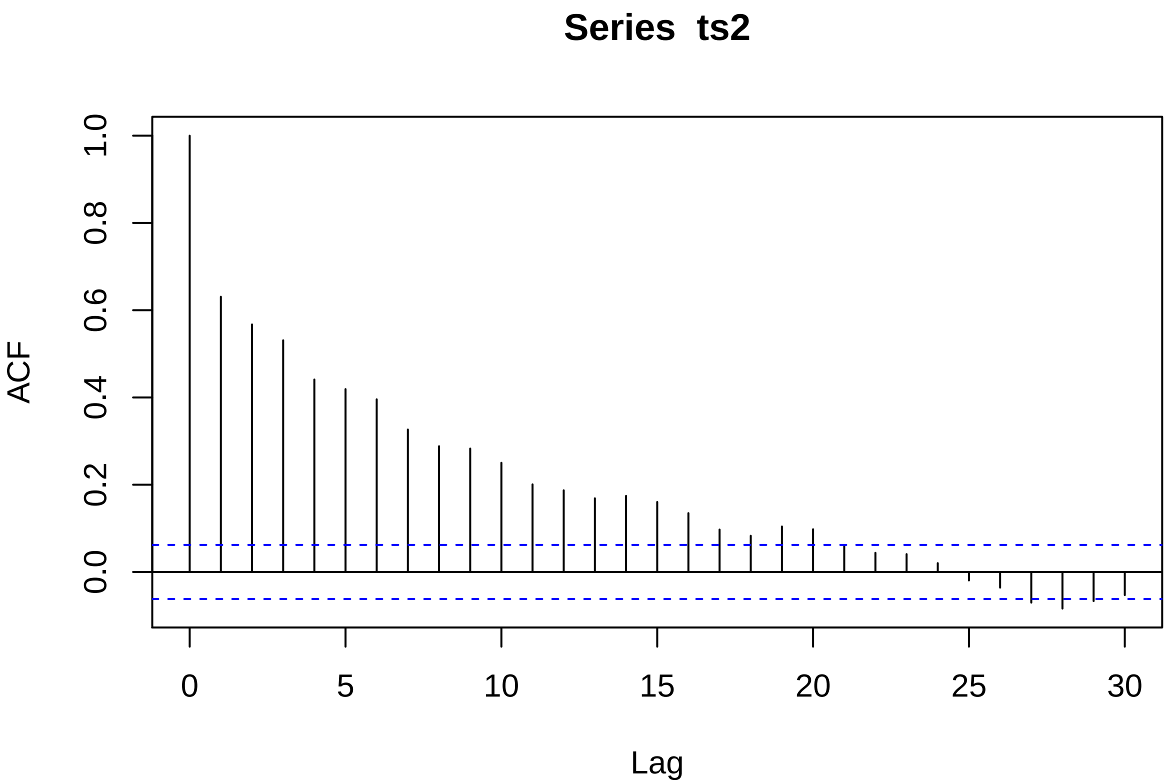
```r
# part (c)

#(i) Y(t) = -0.4 Y(t-1) + e(t)
ts1 <- arima.sim(n = 1000,
          list(ar = c(-0.4)),
          sd = 1)

acf(ts1)
```



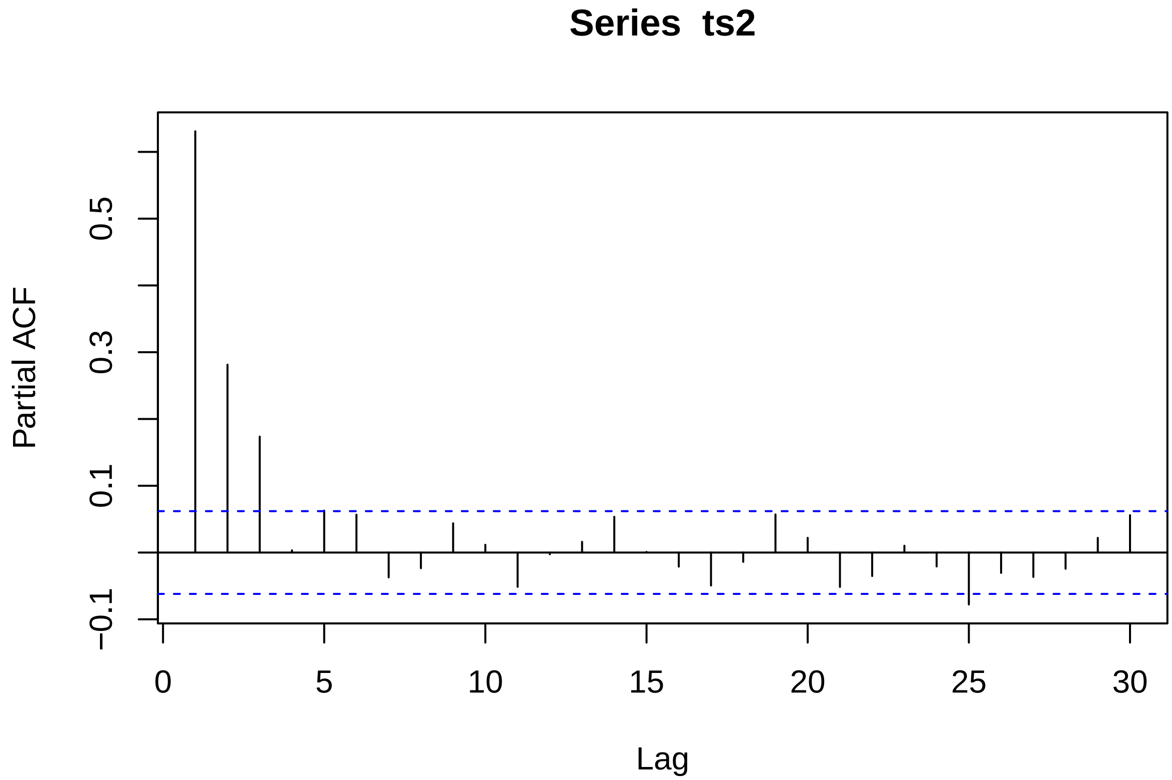

```
# we see that the ACF of AR(1) model:
#     (1) oscillates as expected since it has a negative coefficient -0.4.
#     (2) exponentially decays, as expected of an AR model

pacf(ts1)
```




```r
# the partial acf shows that only lag 1 is compatible with a non-zero value.
# specifically, -0.4, as expected.


#
#(iii) Y(t) = .9Y(t-1) + e(t) - (-.5)e(t-1)
# ARMA(1,1)
ts2 <- arima.sim(n = 1000,
                 list(ar = c(0.9),
                      ma = c(-0.5)),
                 sd = 1)

acf(ts2)
```




```
# we see that the ACF of ARNA(2,2) model:
#     (1) oscillates as expected since it has a negative coefficient -0.4.
#     (2) exponentially decays, as expected of an AR model

pacf(ts2)
```




```
# the partial acf shows that only lag 1 is compatible with a non-zero value.
# specifically, -0.4, as expected.
```