Lab4

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1. Fit a cubic polynomial (centered) model to the chicken data and see if it improves the fit. Have the data and the cubic fit in one plot.

```
library(astsa)
ck  <- chicken - mean(chicken)  # centered
ck.lm <- lm( chicken ~ poly(ck, 3, raw=TRUE))
summary(ck.lm)
```

```
## Warning in summary.lm(ck.lm): essentially perfect fit: summary may be
## unreliable
```

```
##
## Call:
## lm(formula = chicken ~ poly(ck, 3, raw = TRUE))
##
## Residuals:
##        Min         1Q     Median         3Q        Max
## -3.978e-14 -6.080e-15 -1.210e-15  1.130e-15  6.505e-13
##
## Coefficients:
##                             Estimate Std. Error    t value Pr(>|t|)
## (Intercept)                8.567e+01  5.423e-15  1.580e+16   <2e-16 ***
## poly(ck, 3, raw = TRUE)1   1.000e+00  6.542e-16  1.529e+15   <2e-16 ***
## poly(ck, 3, raw = TRUE)2   1.823e-17  1.780e-17  1.024e+00    0.307
## poly(ck, 3, raw = TRUE)3 -4.215e-19  1.240e-18 -3.400e-01    0.734
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.963e-14 on 176 degrees of freedom
## Multiple R-squared:      1,  Adjusted R-squared:      1
## F-statistic: 6.424e+30 on 3 and 176 DF,  p-value: < 2.2e-16
```

```
AIC(ck.lm)
```

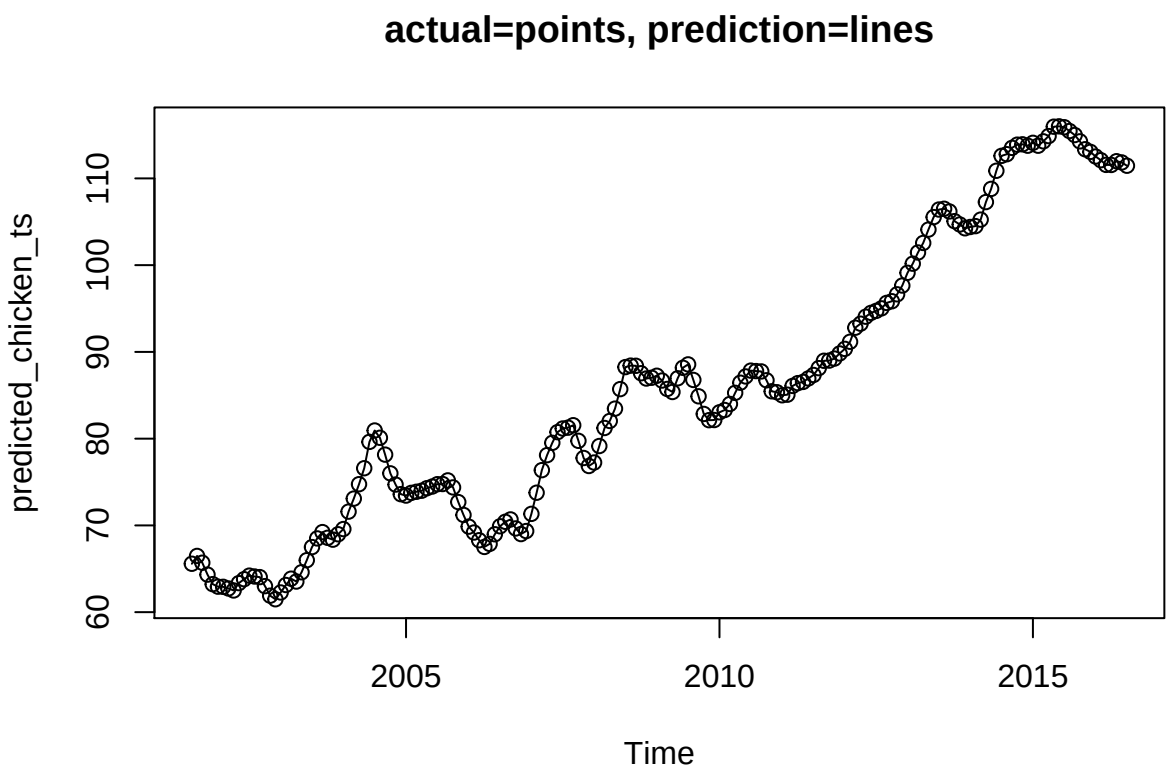
```
## [1] -10511.53
```

```
BIC(ck.lm)
```

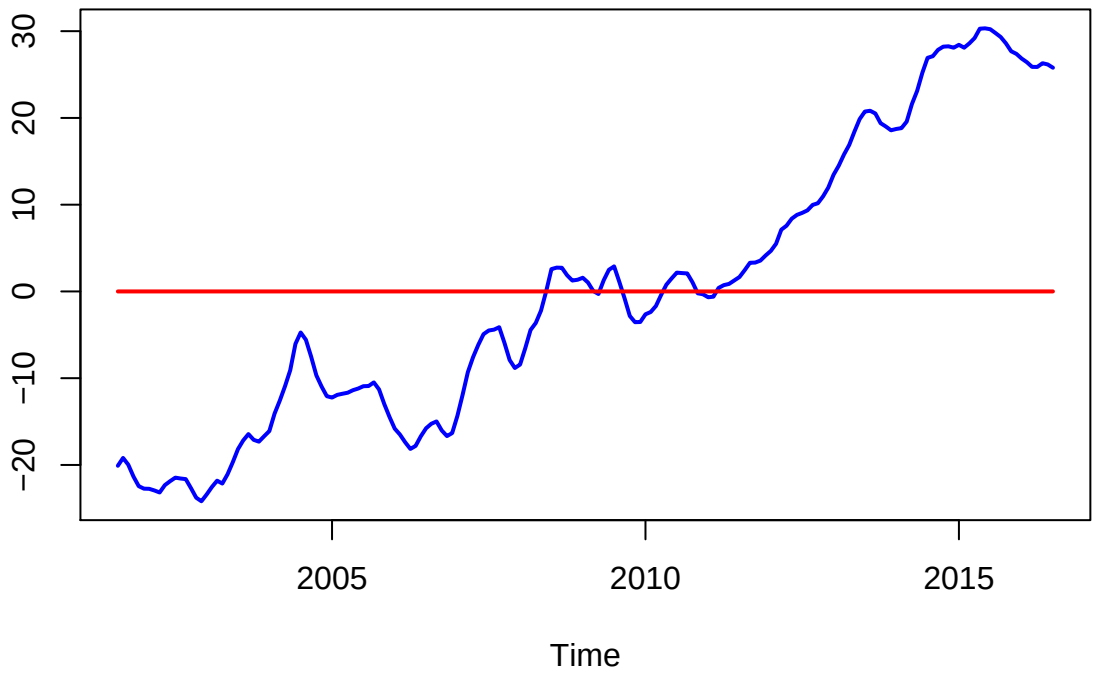
```
## [1] -10495.56
```

```
predicted_chicken <- predict(ck.lm)
predicted_chicken_ts <- ts(predicted_chicken
                           ,start(chicken)
                           ,end(chicken)
                           ,frequency(chicken))
```

```
plot(predicted_chicken_ts,main="actual=points, prediction=lines")
points(chicken)
```




```
ts.plot(ck, resid(ck.lm), gpars = list(col = c("blue", "red"), lwd = 2))
```



2. Generate a signal

$$x_t = 1 + 3t + e_t$$

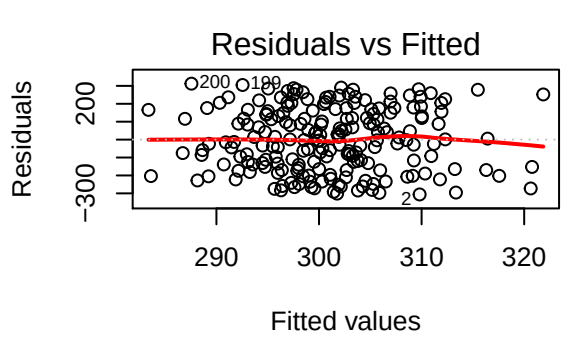
, with n = 200 and where 1)

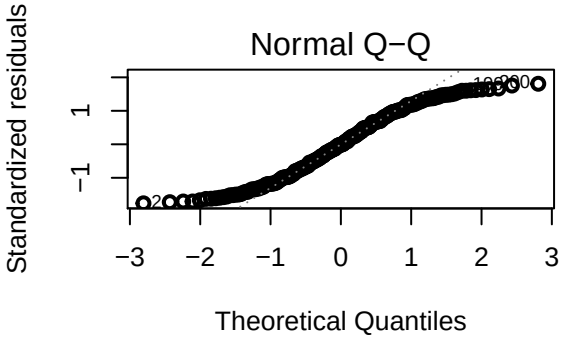
$$e_t = N(0, 1)$$

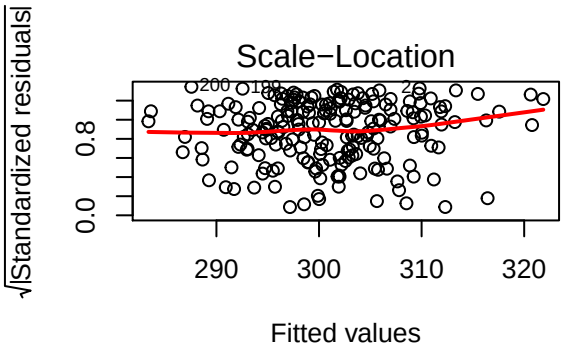
2)

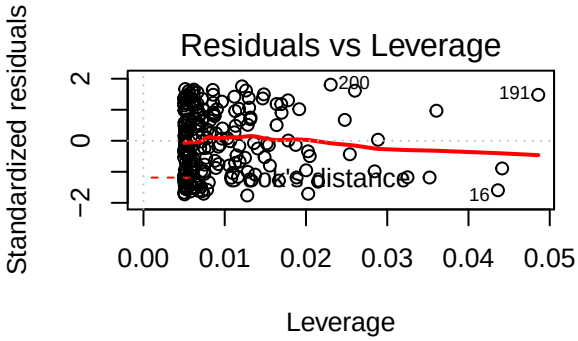
$$e_t = 0.3w_t - 0.3w_{(t-1)} + 0.4w_{(t-2)}$$

```
set.seed(123)
T <- seq(0, 200, length = 200)
sig1 <- 1 + 3*T + rnorm(200,0,1)

x200 <- rnorm(200)
coeffs <- c(0.3, -0.3, 0.4)
et2 <- filter(x200, sides = 1, filter = coeffs)
sig2 <- 1 + 3*T + et2

par(mfrow=c(2,2))
sig1.lm <- lm(sig1 ~ rnorm(200,0,1))
plot(sig1.lm, col=1, lwd=2)
abline(sig1.lm)
```

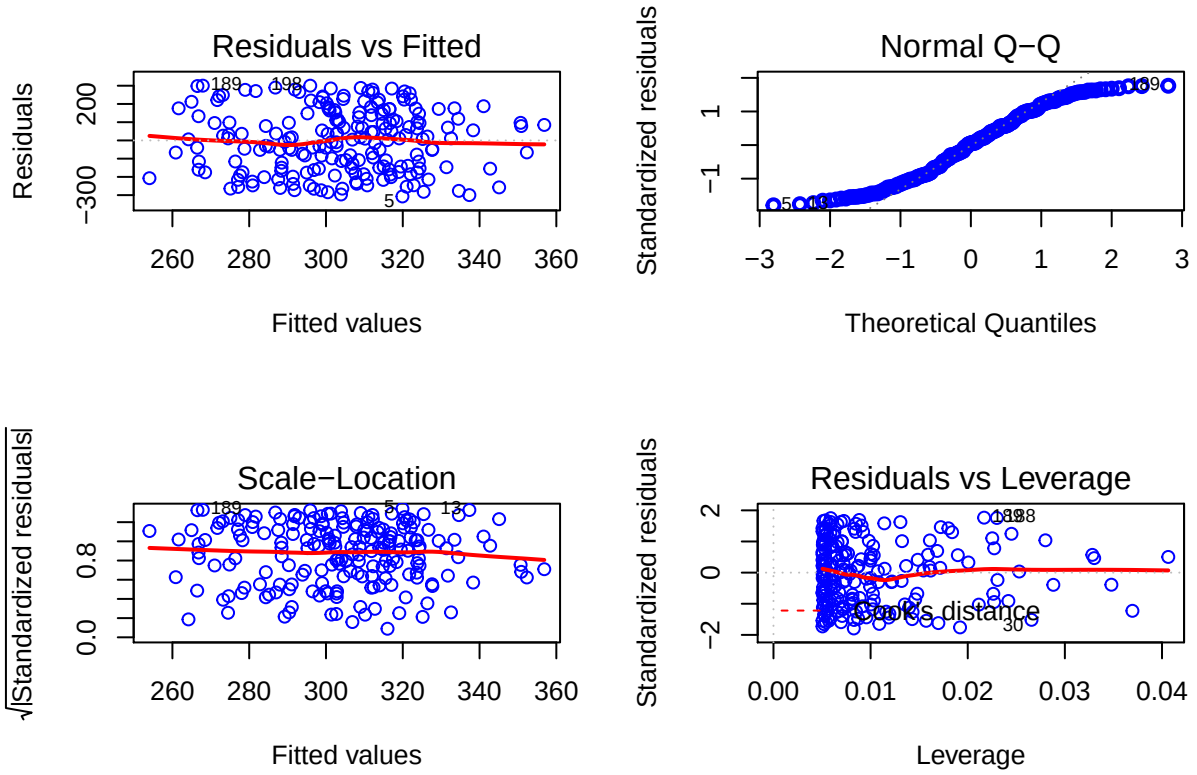









```r
sig2.lm <- lm(sig2 ~ rnorm(200,0,1))
plot(sig2.lm, col=4, lwd=2)
abline(sig2.lm)
```

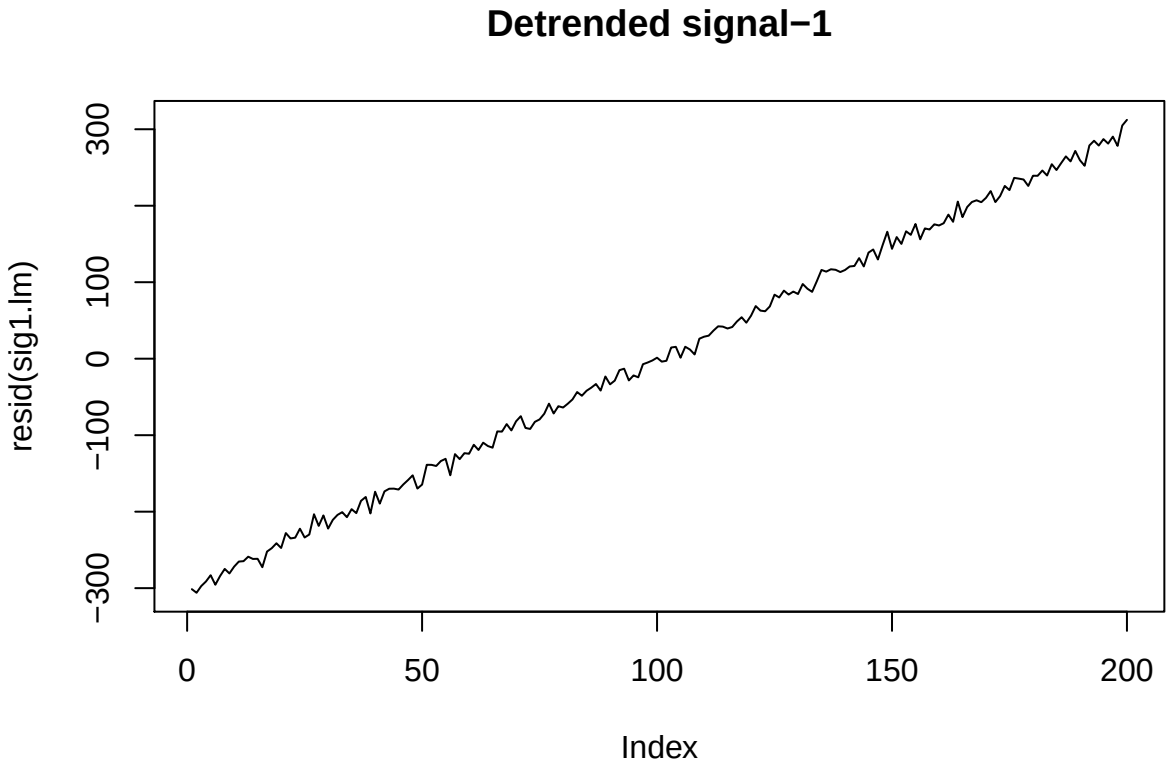


3. For 1 and 2 above, estimate and remove the trend. Examine the acf of the residuals

```
summary(sig1.lm)
```

```
##
## Call:
## lm(formula = sig1 ~ rnorm(200, 0, 1))
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -306.023 -152.441   -2.526  151.586  312.250
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)       301.225     12.364  24.362   <2e-16 ***
## rnorm(200, 0, 1)   -7.344     12.841  -0.572    0.568
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 174.8 on 198 degrees of freedom
## Multiple R-squared:  0.00165,    Adjusted R-squared:  -0.003393
## F-statistic: 0.3271 on 1 and 198 DF,  p-value: 0.568
```

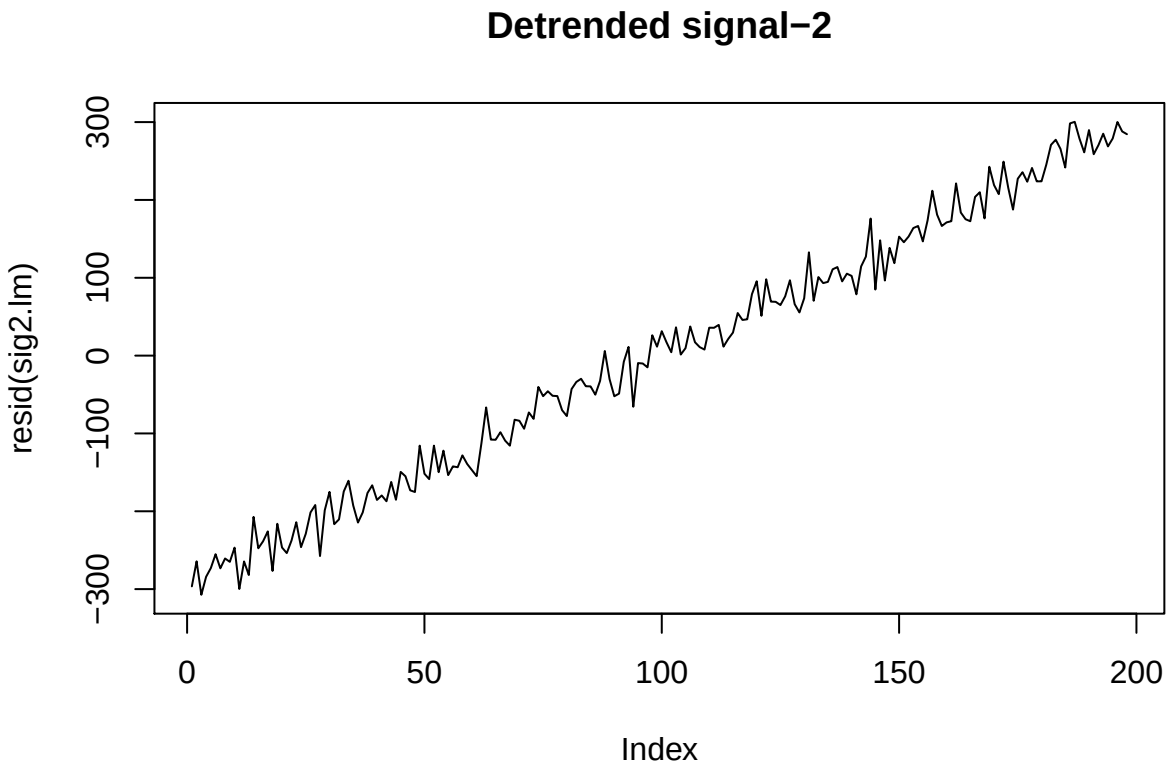
```r
plot(resid(sig1.lm), type="l", main="Detrended signal-1")
```



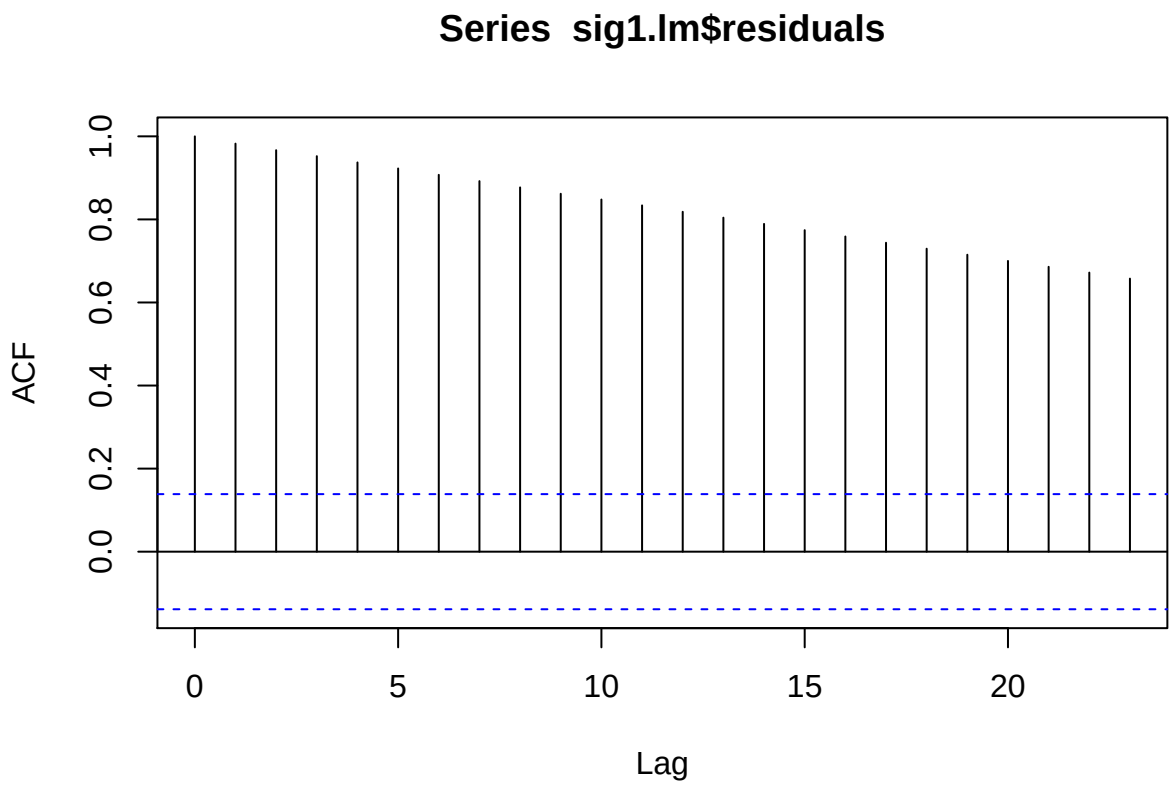

```r
summary(sig2.lm)
```

```
##
## Call:
## lm(formula = sig2 ~ rnorm(200, 0, 1))
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -307.253 -153.098    8.643  146.499  300.307
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)        304.56      12.23  24.902   <2e-16 ***
## rnorm(200, 0, 1)    19.43      11.94   1.627    0.105
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 172 on 196 degrees of freedom
##   (2 observations deleted due to missingness)
## Multiple R-squared:  0.01333,    Adjusted R-squared:  0.0083
## F-statistic: 2.649 on 1 and 196 DF,  p-value: 0.1052
```

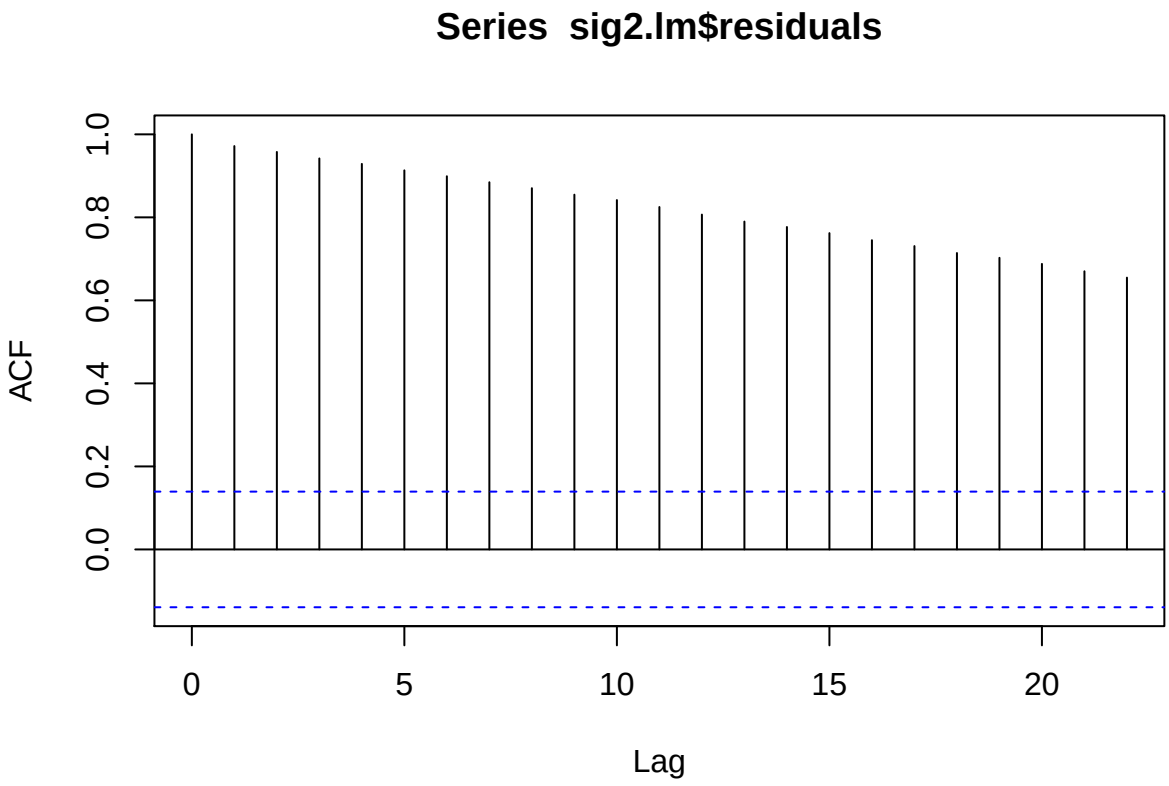
```r
plot(resid(sig2.lm), type="l", main="Detrended signal-2")
```




```r
acf(sig1.lm$residuals)
```




```
acf(sig2.lm$residuals)
```


Series sig2.lm$residuals
ACF
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
Lag