732A62 Lab 1

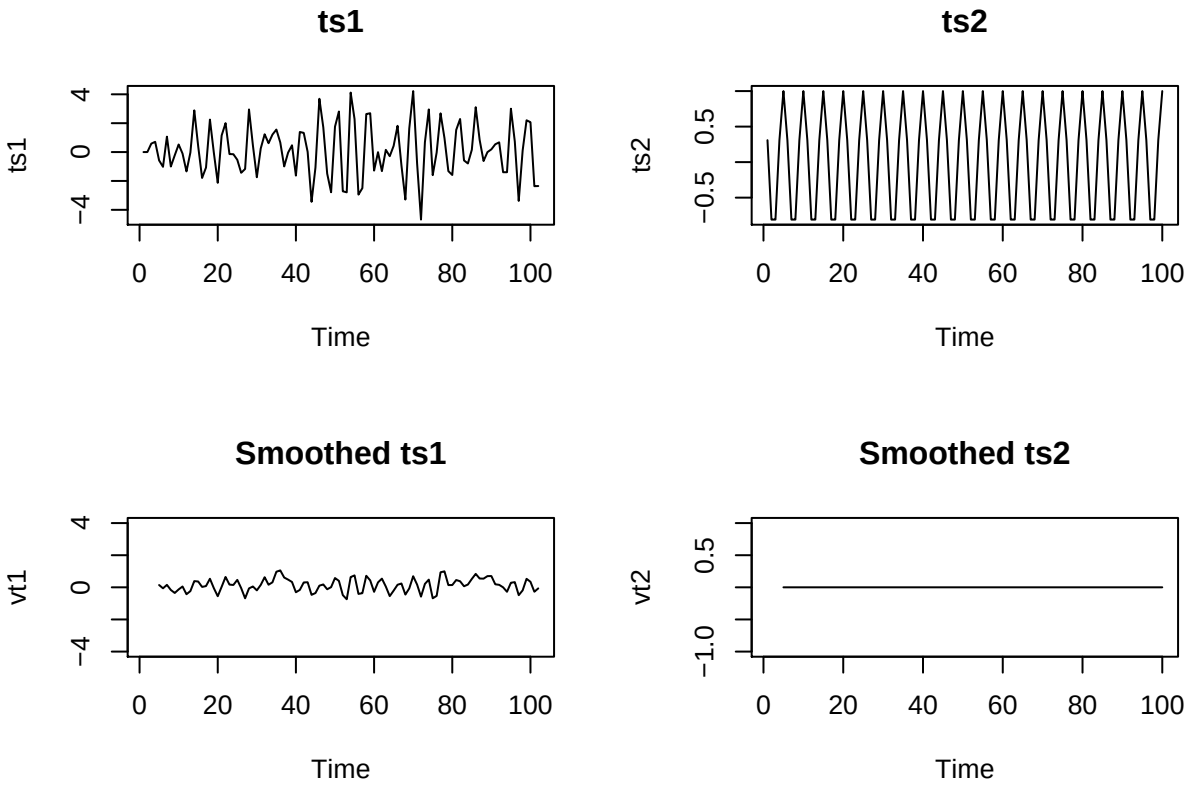
Emil K Svensson & Rasmus Holm

2017-09-11

Assignment 1

a)

```
set.seed(12345)
t1 <- c(0, 0, rnorm(100, 0, 1))
ts1 <- filter(t1, filter = c(0, -0.8),
              method = "recursive", sides = 1)

t2 <- 1:100
ts2 <- cos(2 * pi * t2 / 5)

vt1 <- filter(ts1, filter = c(rep(0.2, times = 5)),
              method = "convolution", sides = 1)

vt2 <- filter(ts2, filter = c(rep(0.2, times = 5)),
              method = "convolution", sides = 1)
```



Time series 1 (ts1) show no noticable change in its random pattern except the scale which is transformed in to a smaller scale. Time series 2 (ts2) is flatened by the soothing filter and all values are now basicly 0. This

is because the average of ts2 lies around zero it is also resonable to expect that a moving average smoother would generate the same (or similar) result.

b)

```
leftside <- c(1, -4, 2, 0, 0, 1) # the x's
rightside <- c(1, 0, 3, 0, 1, 0, -4) # The w's

causal <- polyroot(leftside) #Not causal
invertible <- polyroot(rightside) #Non invertible

complex_dist <- function(x) {
    sqrt(Re(x)^2 + Im(x)^2)
}

print("The causal")
```

```
## [1] "The causal"
```

```
sapply(causal, complex_dist)
```

```
## [1] 0.2936658 1.6793817 1.0000000 1.4239626 1.4239626
```

```
print("The invertible")
```

```
## [1] "The invertible"
```

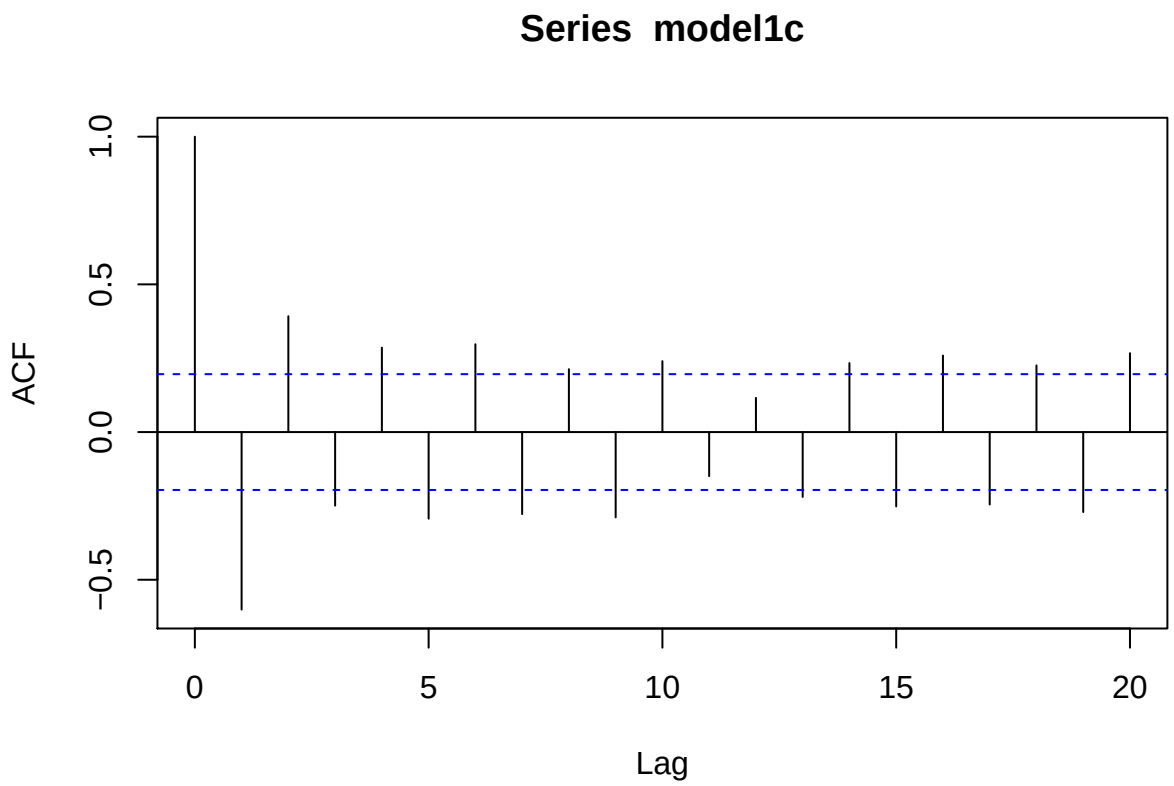
```
sapply(invertible, complex_dist)
```

```
## [1] 0.6874372 0.6874372 0.6874372 0.6874372 1.0580446 1.0580446
```

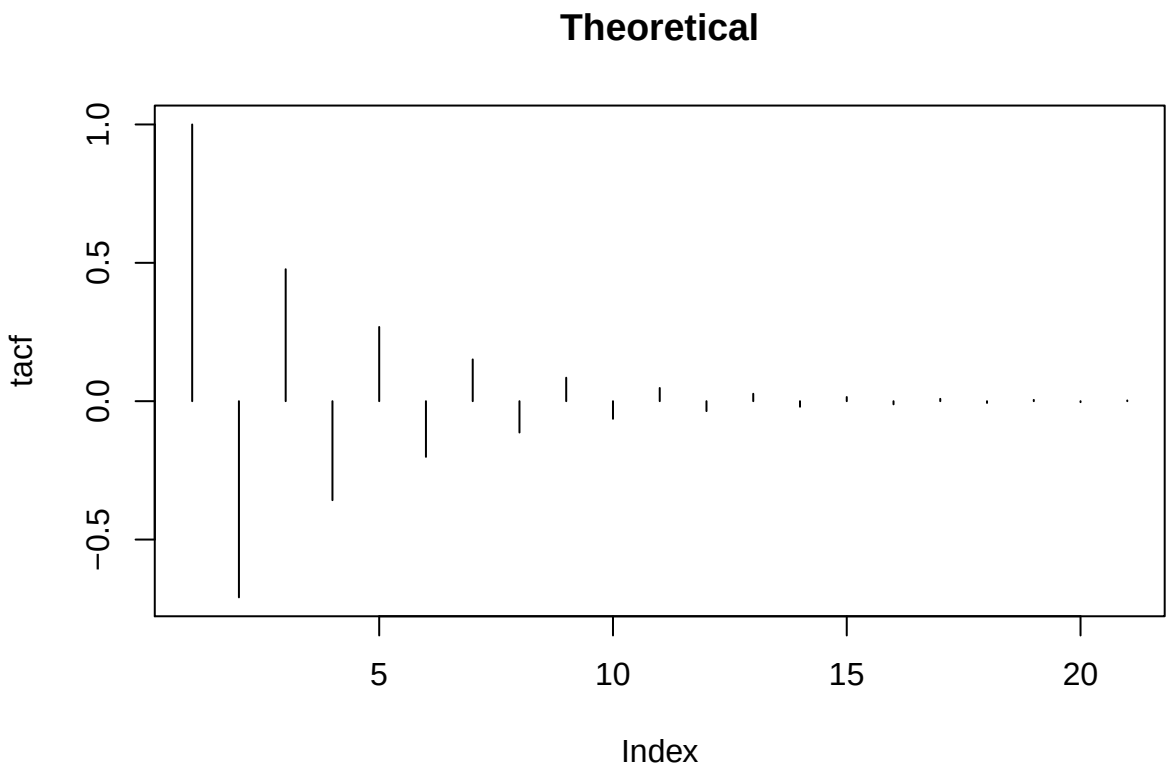
Since both parts contains values below 1 they are inside the unit circle and therefor are not causal nor invertible.

c)

```
set.seed(54321)
model1c <- arima.sim(n = 100, list(ar = c(-3 / 4), ma = c(0, -1 / 9) ))

acf(model1c)
```

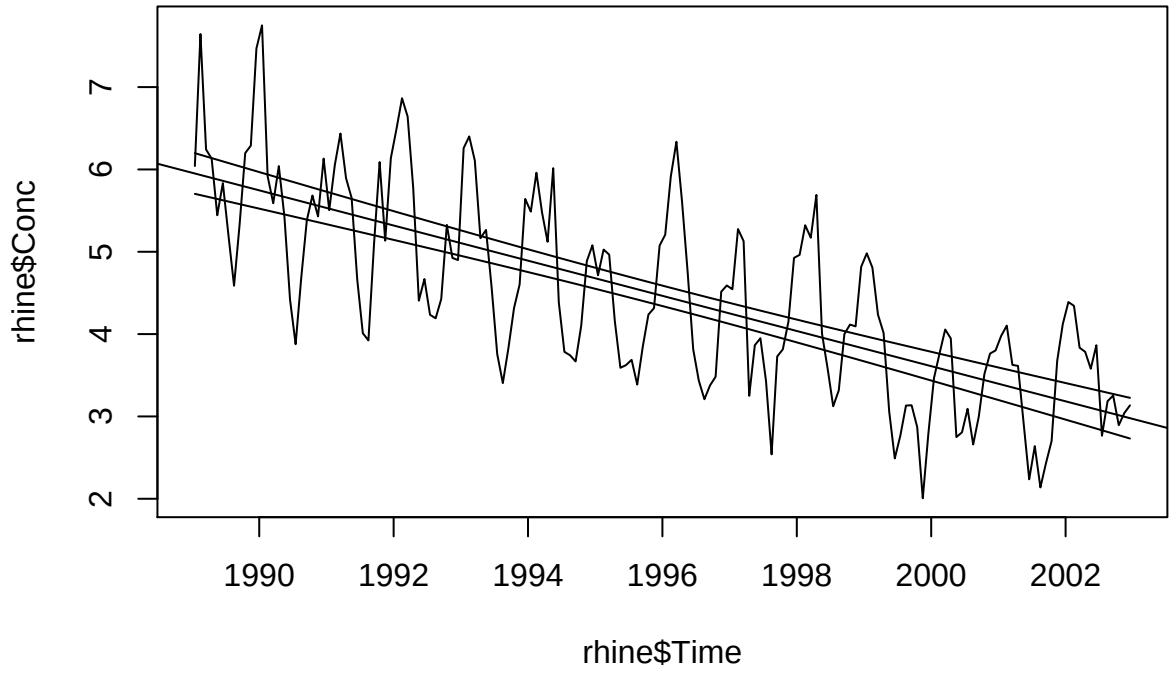



```
tacf <- ARMAacf(ar=c(-3 / 4), ma=c(0, -1/9), lag.max=20)
plot(tacf, type="n", main="Theoretical")
segments(1:length(tacf), rep(0, length(tacf)), 1:length(tacf), tacf)
```

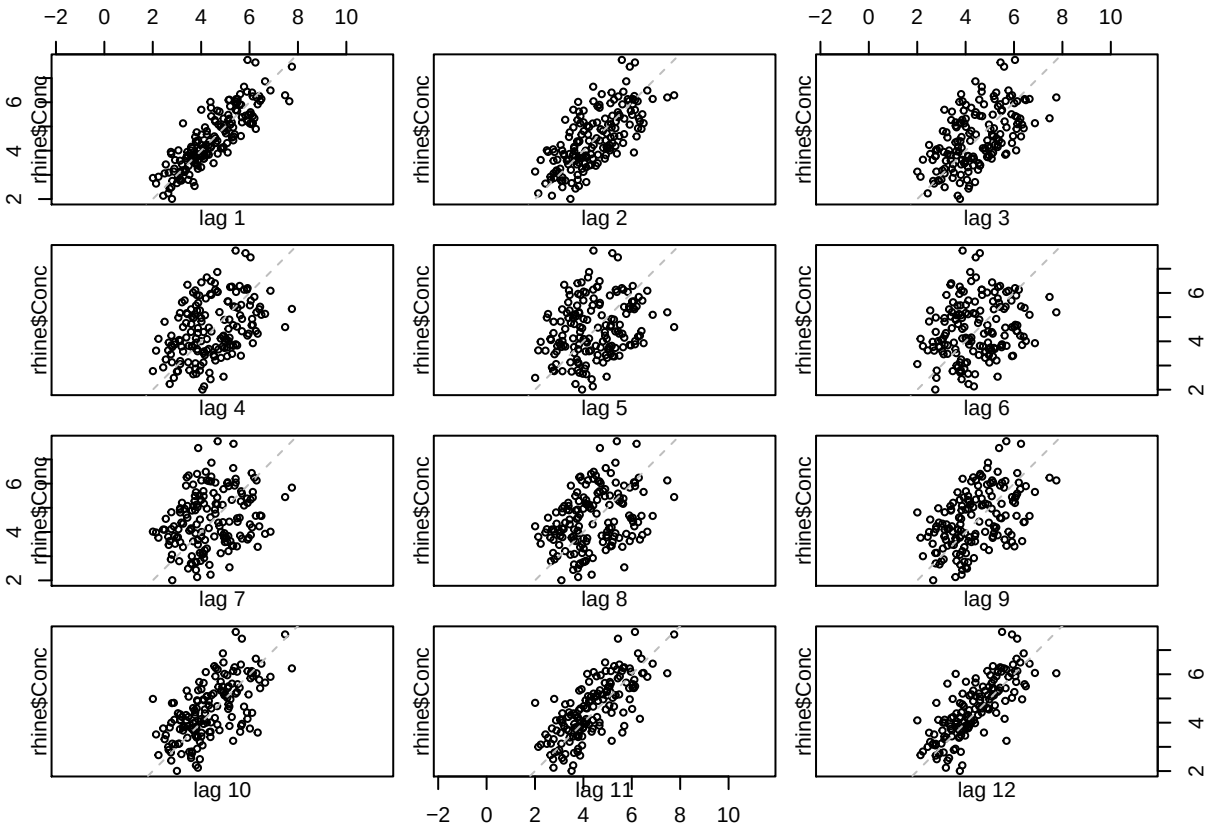


Assignment 2

```
rhine <- read.csv2("../data/Rhine.csv")
colnames(rhine)[4] <- "Conc"

rhine_ts <- ts(rhine)

plot(y = rhine$Conc, x = rhine$Time, type = "l")
abline(lm(Conc ~ Time, data = rhine))
lines(predobj$fit + 1.96 * predobj$se.fit ~ as.numeric(rhine$Time))
lines(predobj$fit - 1.96 * predobj$se.fit ~ as.numeric(rhine$Time))
```



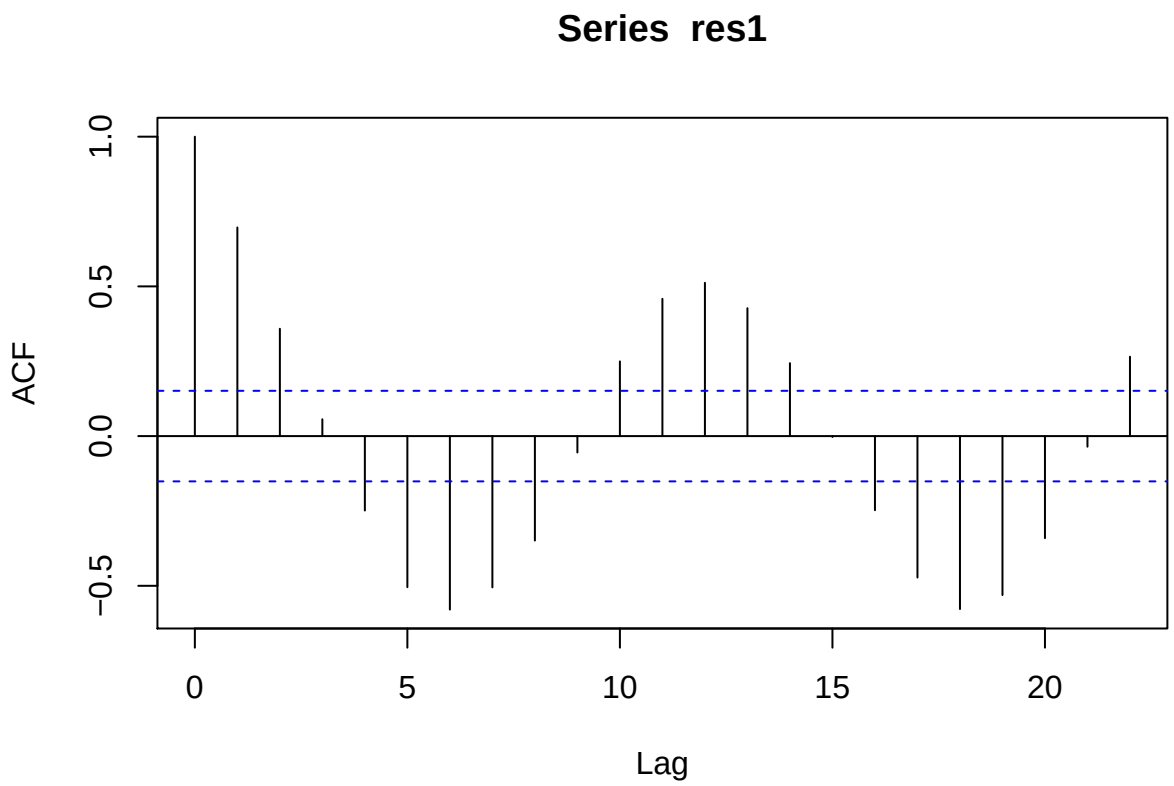

```
lag.plot(rhine$Conc, lags = 12)
```



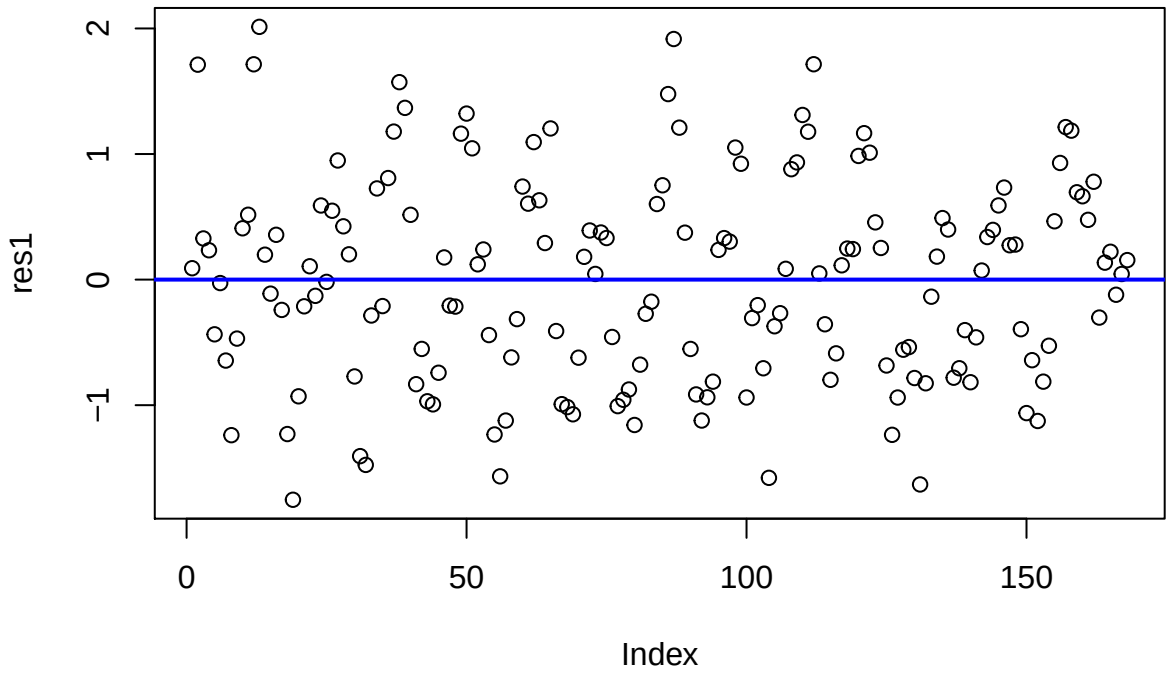

```
lmobj <- lm(Conc ~ Time, data = rhine)
res1 <- residuals(lmobj)
summary(lmobj)
```

```
##
## Call:
## lm(formula = Conc ~ Time, data = rhine)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.75325 -0.65296  0.06071  0.52453  2.01276
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 430.70725   31.26570   13.78   <2e-16 ***
## Time         -0.21355    0.01566  -13.63   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.8205 on 166 degrees of freedom
## Multiple R-squared:  0.5282, Adjusted R-squared:  0.5254
## F-statistic: 185.9 on 1 and 166 DF,  p-value: < 2.2e-16
```

```
acf(res1)
```

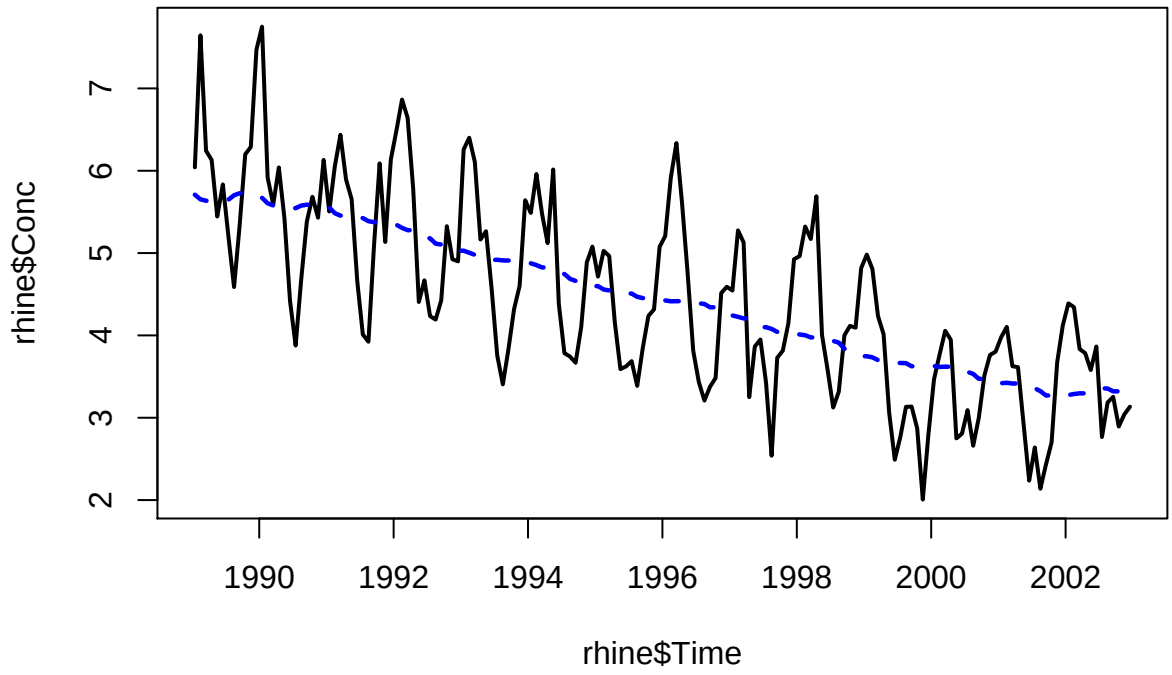



```
plot(res1)
abline(h = 0, col = "blue", lwd =2)
```

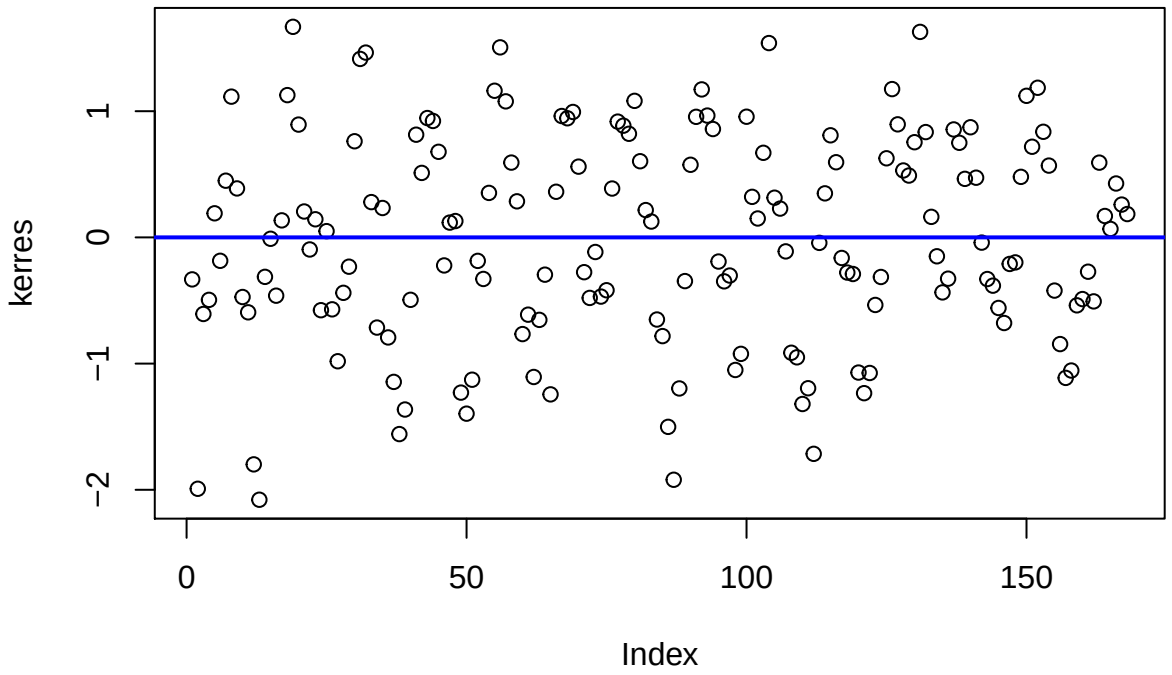



```
predobj <- predict(lmobj, se.fit = TRUE)
```

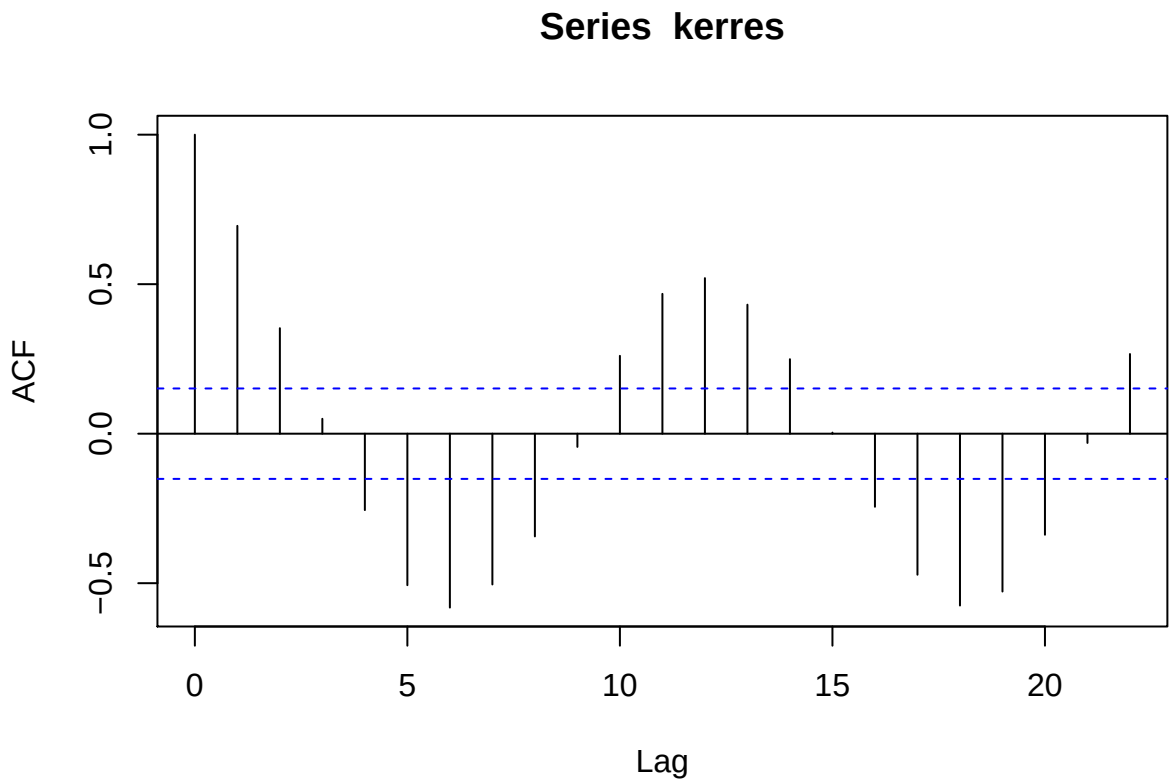
```
plot(x = rhine$Time, y = rhine$Conc, type = "l", lwd =2)
lines(ksmooth(y = rhine$Conc, x = rhine$Time, bandwidth = 5), col = "blue", lwd = 2.25, lty =2)
```



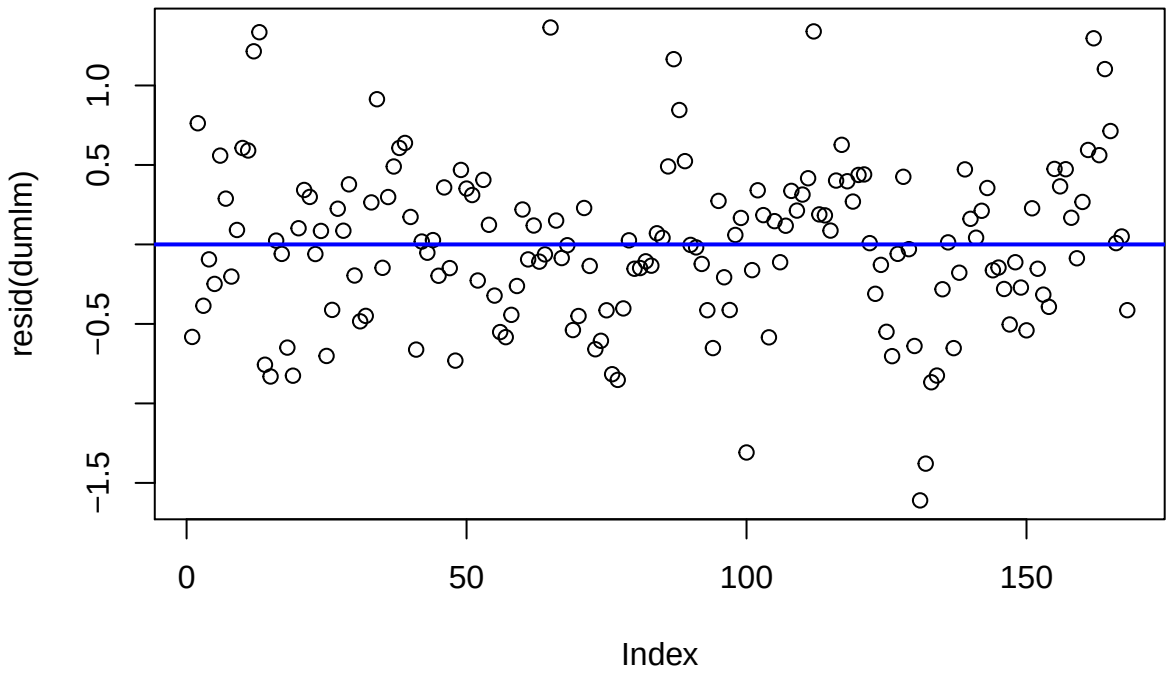

```
kersmo <- ksmooth(y = rhine$Conc, x = rhine$Time, bandwidth = 5)
kerres <- kersmo$y - rhine$Conc

plot(kerres, type = "p")
abline(h = 0, col = "blue", lwd = 2)
```



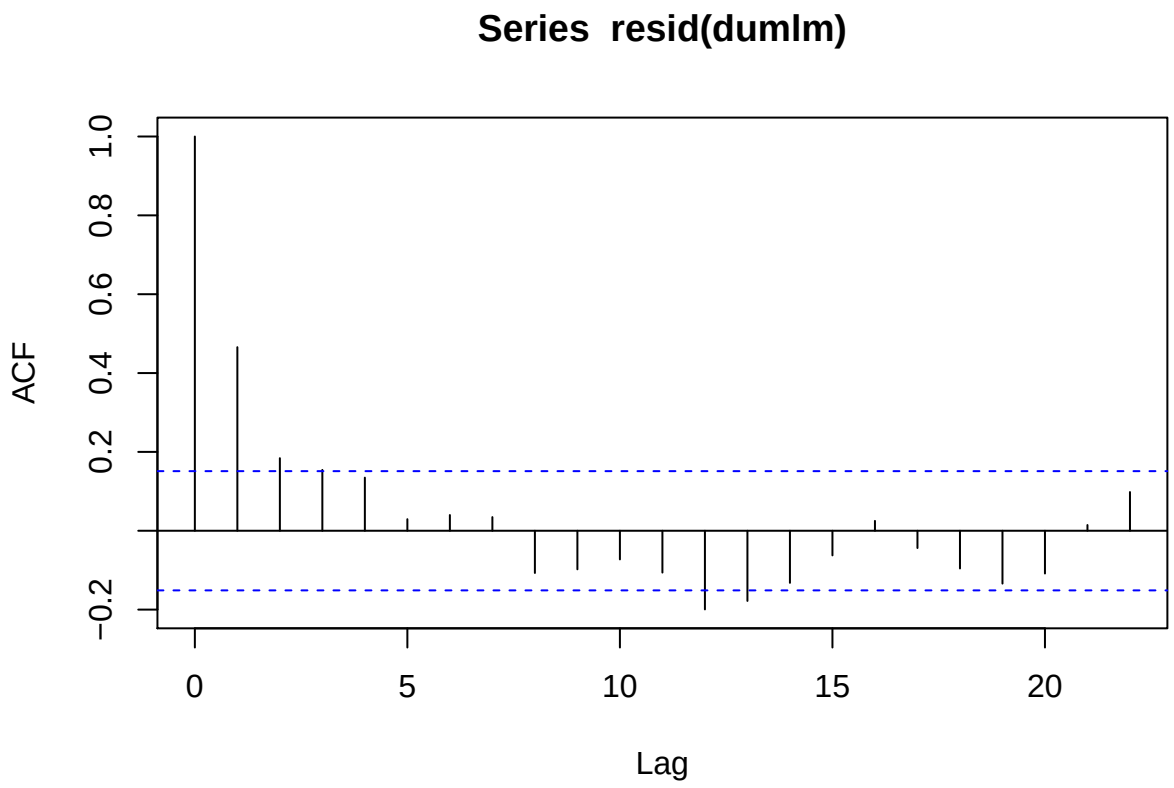

```
acf(kerres)
```




```
rhine$Month.f <- as.factor(rhine$Month)
dumlm <- lm(Conc ~ Time + Month.f, rhine)

plot(resid(dumlm))
abline(h = 0, col = "blue", lwd=2)
```



```r
acf(resid(dumlm))
```



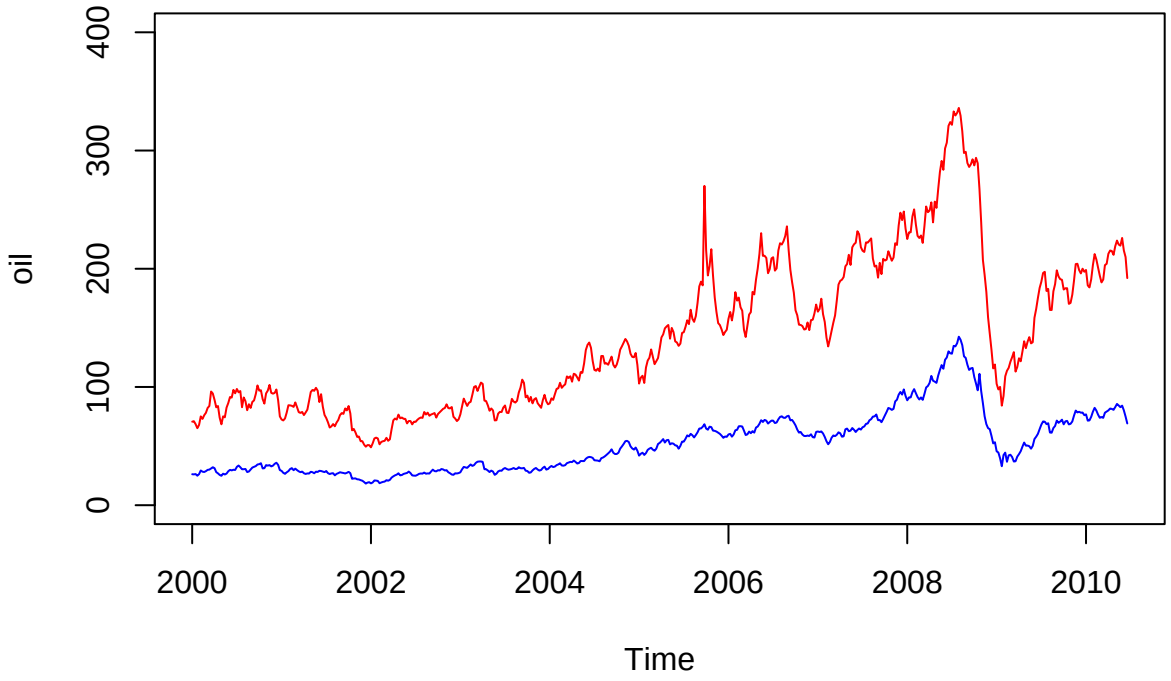

```r
library(MASS)
stepAIC(dumlm, direction = "backward", steps = 1000)
```

```
## Start:  AIC=-202.02
## Conc ~ Time + Month.f
##
##           Df Sum of Sq     RSS      AIC
## <none>                  43.237 -202.023
## - Month.f 11    68.524 111.761  -64.477
## - Time     1   118.387 161.624   17.499
```

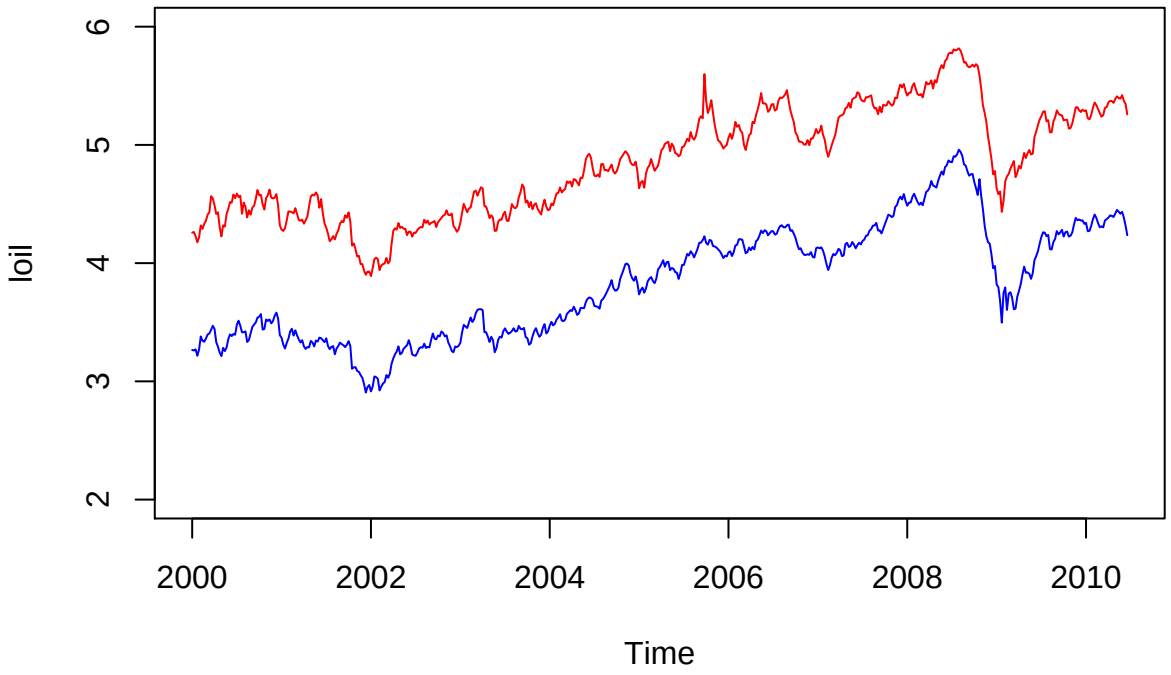
```
##
## Call:
## lm(formula = Conc ~ Time + Month.f, data = rhine)
##
## Coefficients:
## (Intercept)         Time     Month.f2     Month.f3     Month.f4
##   420.82746     -0.20824      0.27659      0.04006     -0.34643
##    Month.f5     Month.f6     Month.f7     Month.f8     Month.f9
##    -0.86165     -1.26114     -1.60808     -1.71242     -1.23669
##   Month.f10    Month.f11    Month.f12
##    -0.87446     -0.75127     -0.17745
```

Assignment 3

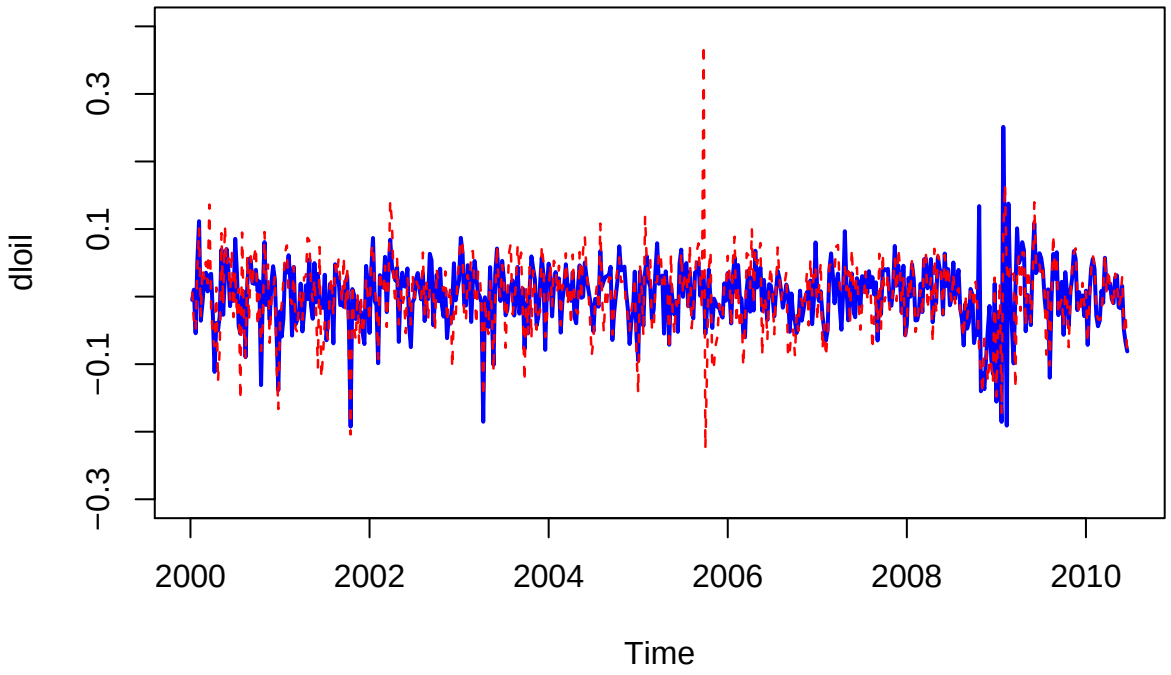
```
library(astsa)

plot(oil, col = "blue", ylim = c(0, 400))
lines(gas, col = "red")
```



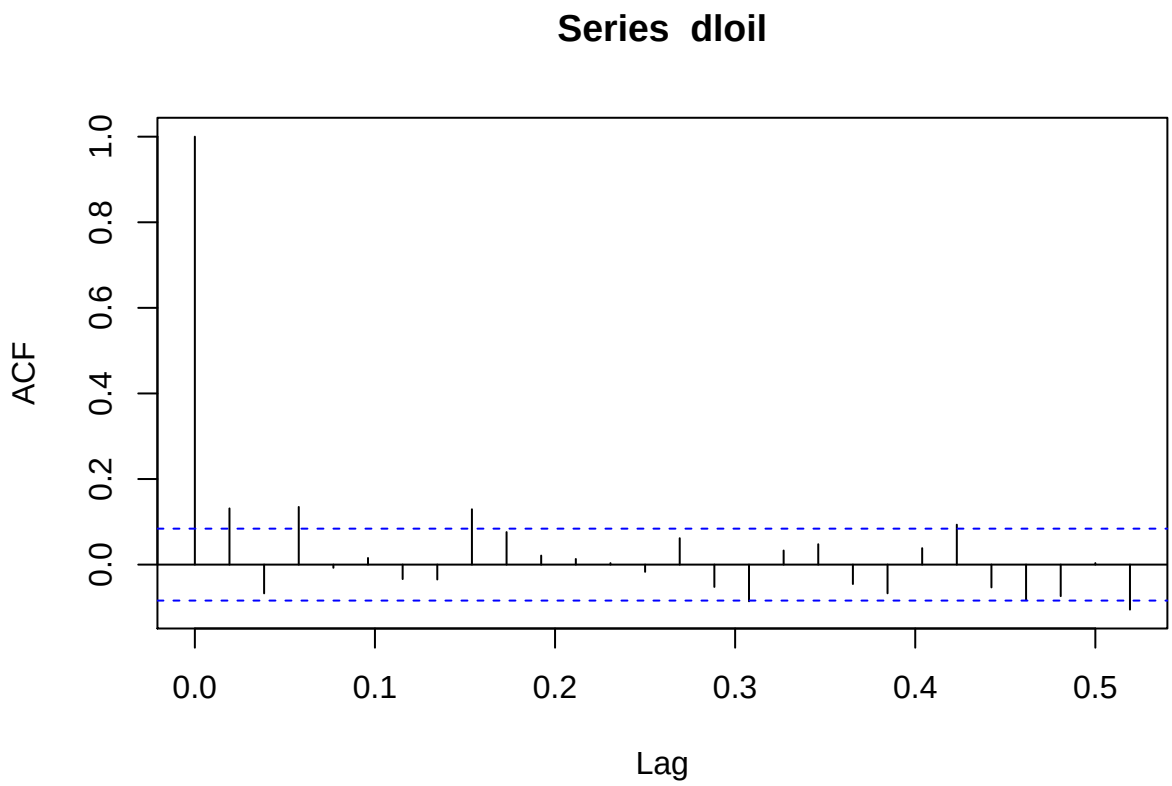

```
loil <- log(oil)
lgas <- log(gas)

plot(loil, col = "blue", ylim = c(2, 6))
lines(lgas, col = "red")
```



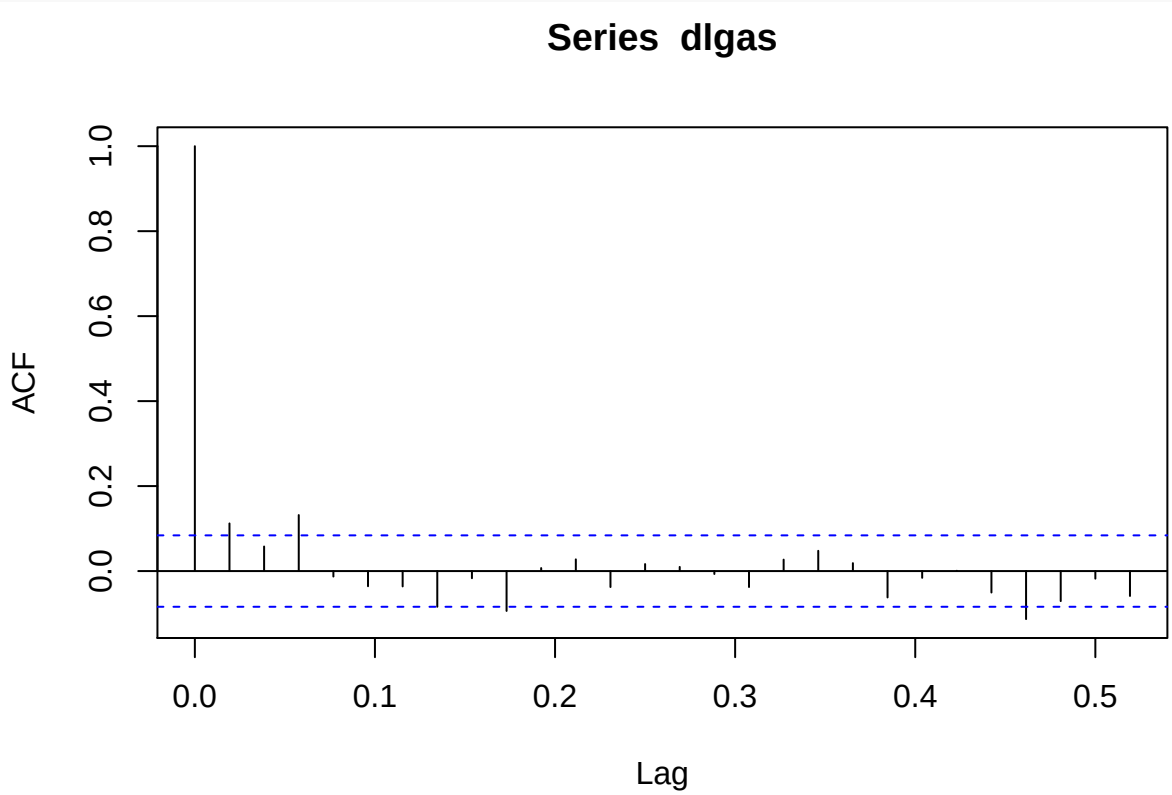

```
dloil <- diff(loil)
dlgas <- diff(lgas)

plot(dloil,col = "blue", ylim = c(-0.3, 0.4), lwd = 2)
lines(dlgas,col = "red", lty = 2, lwd = 1.25)
```




```
acf(dloil)
```

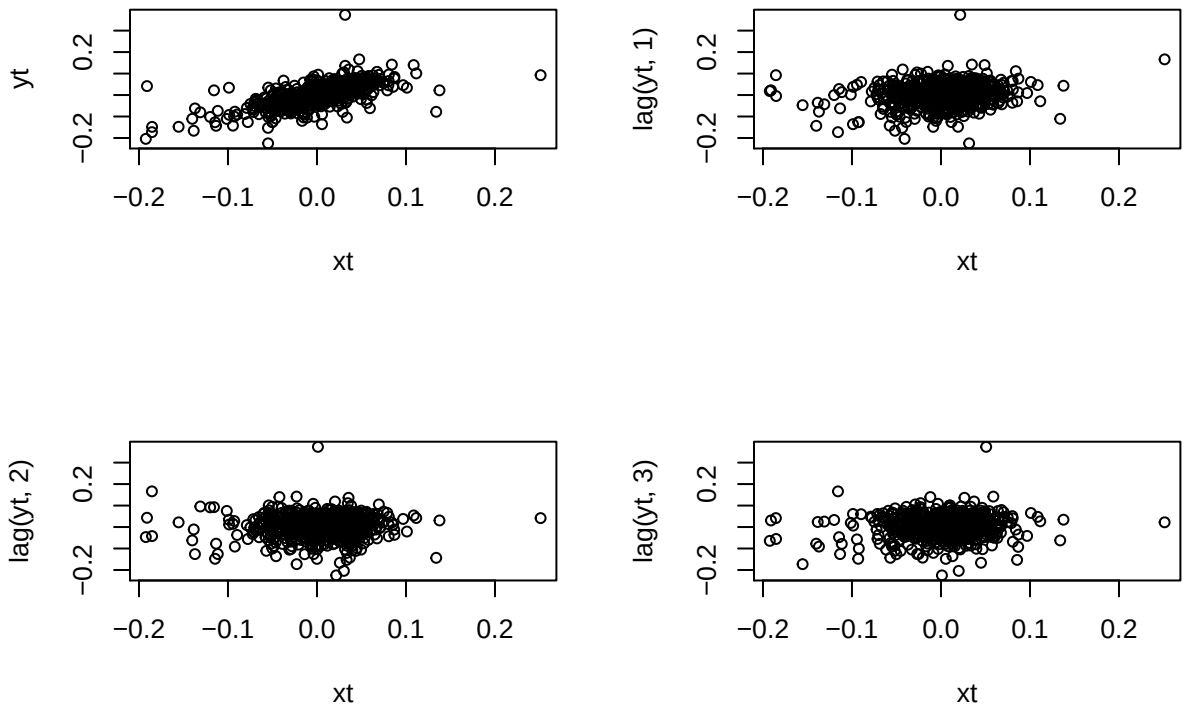



```
acf(dlgas)
```



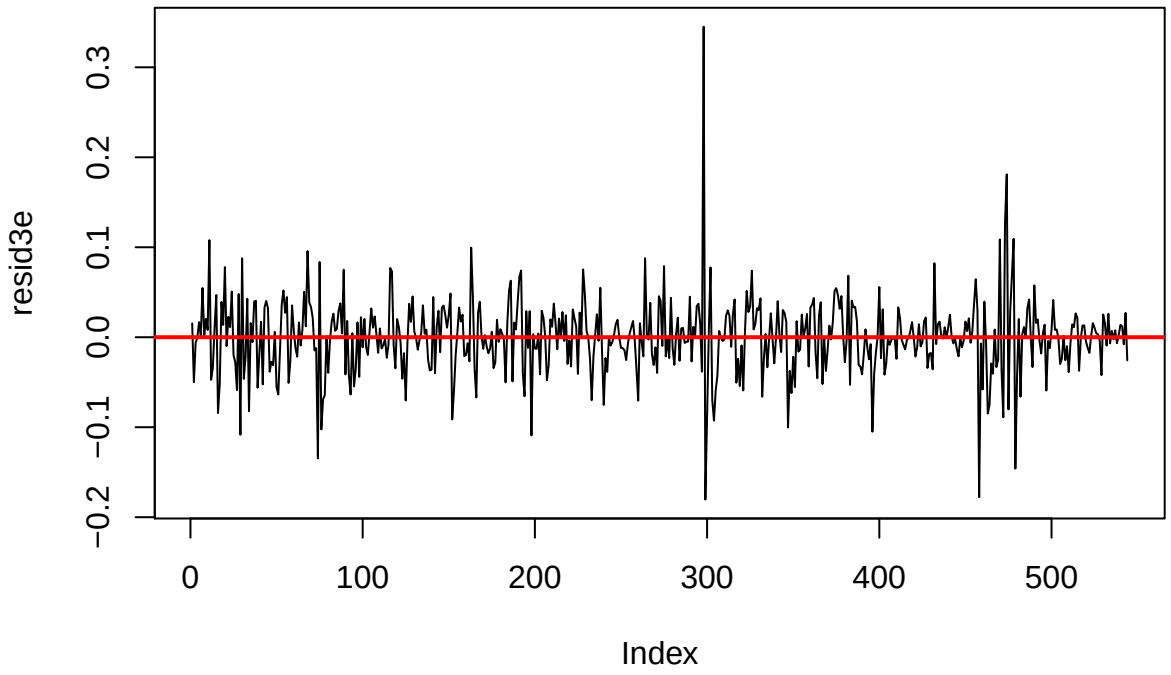

```
xt <- dloil
yt <- dlgas
```

```
old <- par(mfrow = c(2,2))
plot(x = xt, y = yt )
plot(x = xt, y = lag(yt,1) )
plot(x = xt, y = lag(yt,2) )
plot(x = xt, y = lag(yt,3) )
```

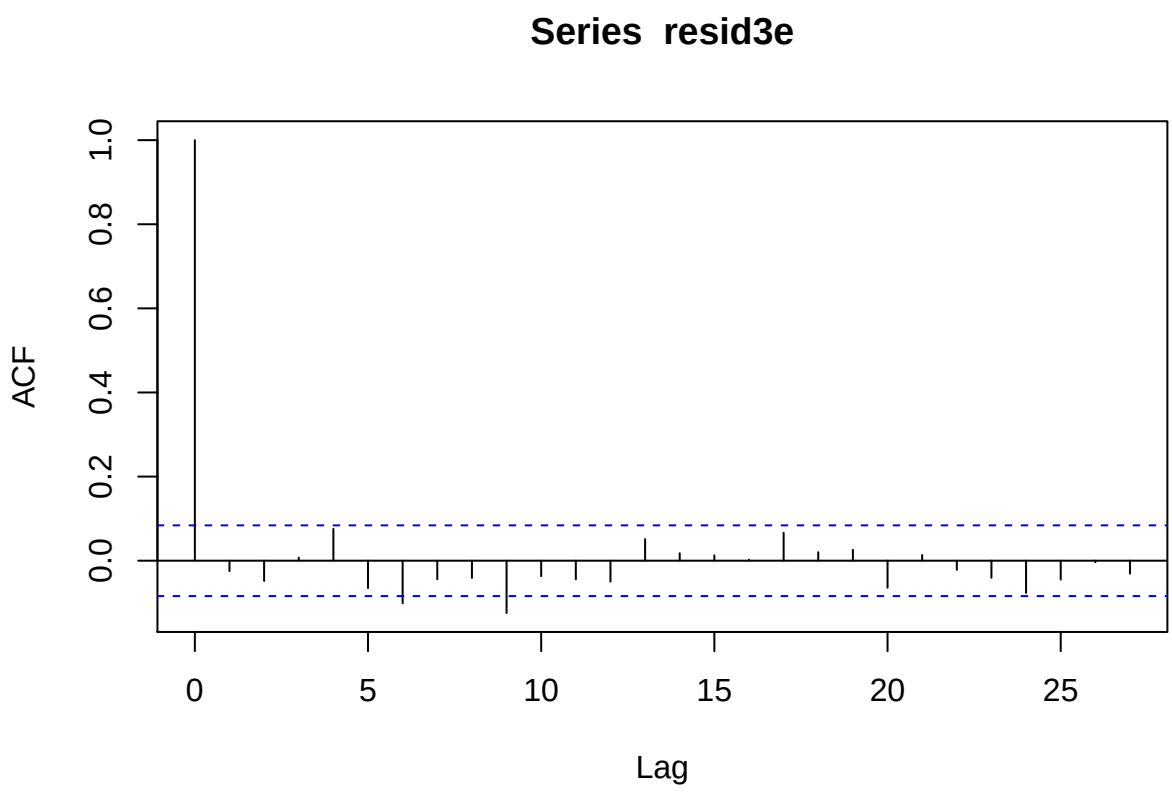



```
par(old)
```

```
oilframe <- data.frame(yt,xt, dummy = ts(as.numeric(xt > 0)),lagxt = lag(xt, -1))
oilframe <- ts.intersect(oilframe)
model3e <- lm(yt~dummy + xt + lagxt, data = oilframe)

resid3e <- resid(model3e)

plot(resid3e, type = "l")
abline(h=0, col = "red", lwd = 2, lty =1)
```


resid3e
0.3
0.2
0.1
0.0
−0.1
−0.2
0
100
200
300
400
500
Index

```
acf(resid3e)
```


Series resid3e
ACF
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
Lag