732A62 Lab 1

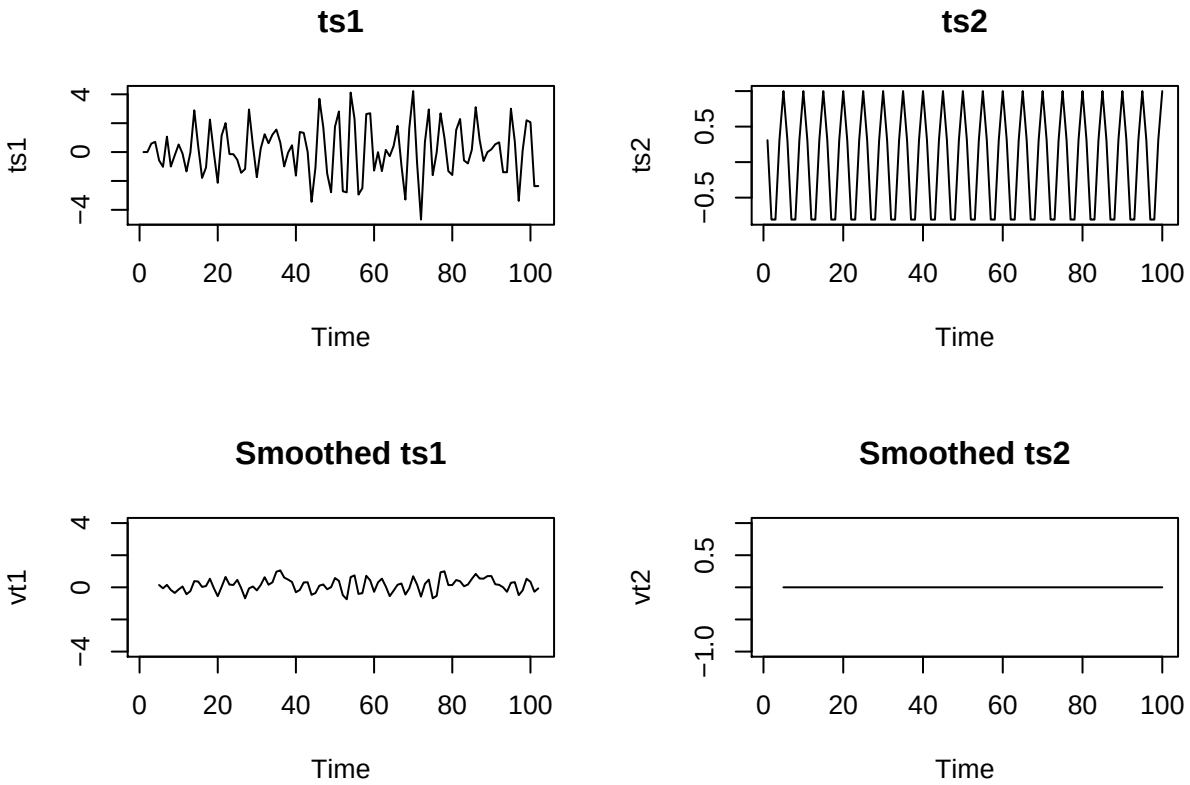
Emil K Svensson & Rasmus Holm

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"
```

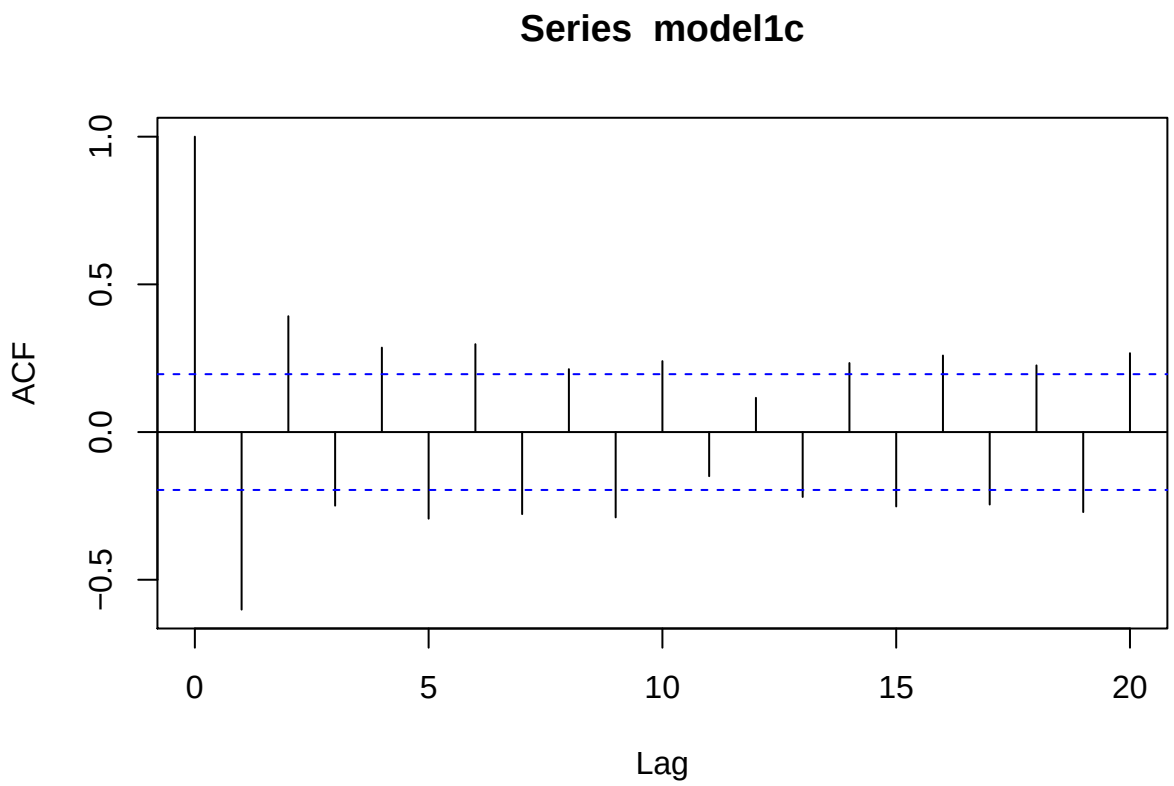
```
sapply(invertible, complex_dist)
```

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

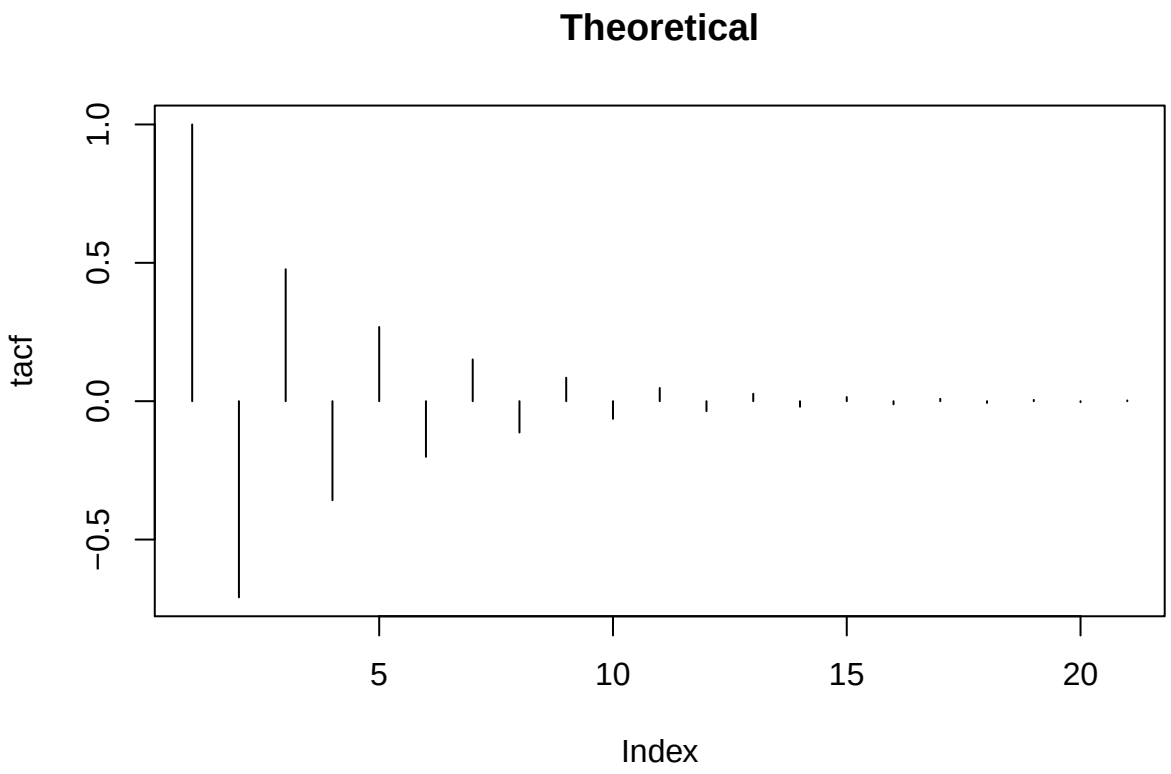
Since both parts contains values below 1 they are inside the unit circle and therefor are not causal nor invertible.

c)

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

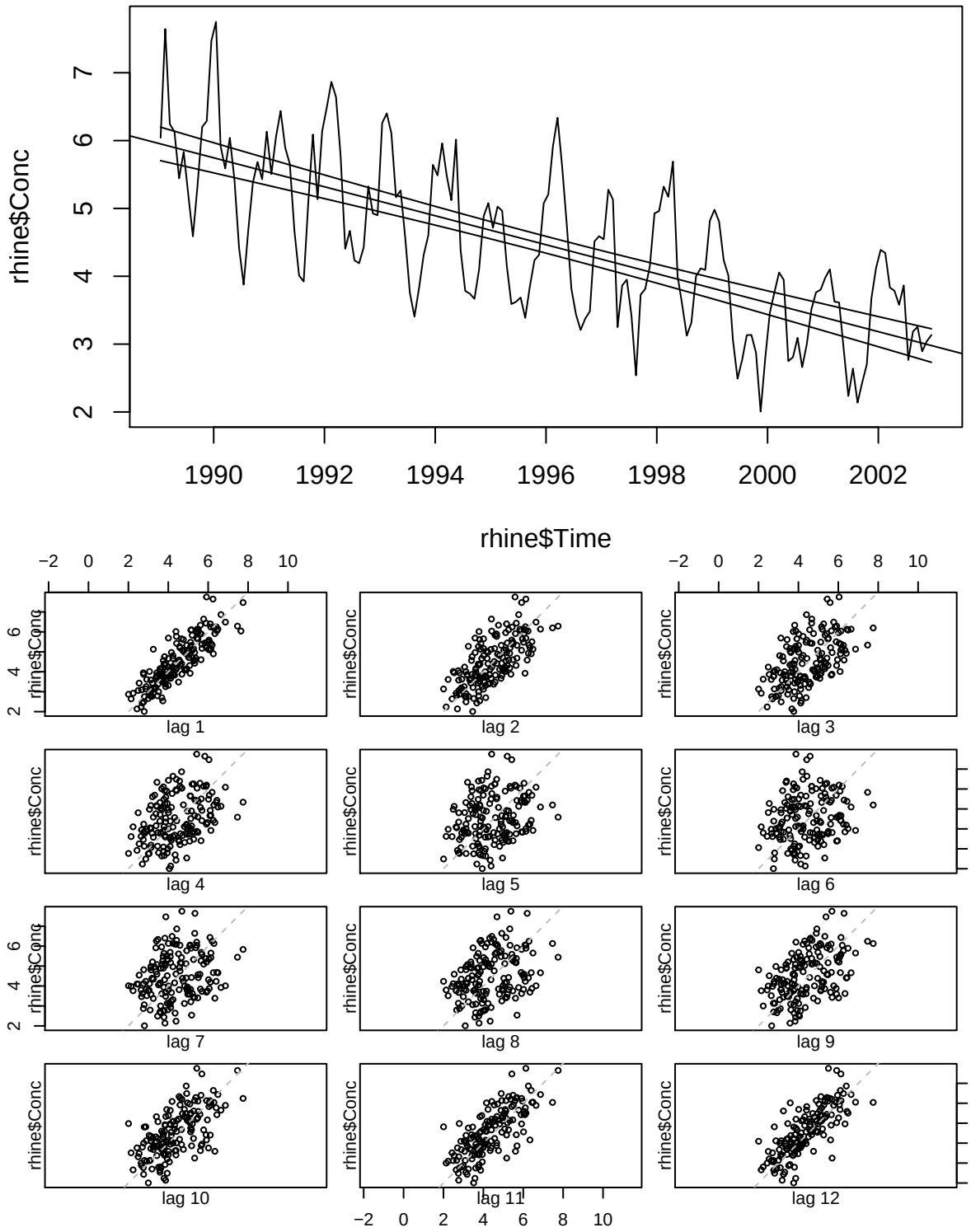



```
tacf <- ARMAacf(ar=c(-3 / 4), ma=c(0, -1/9), lag.max=20)
plot(tacf, type="n", main="Theoretical")
segments(1:length(tacf), rep(0, length(tacf)), 1:length(tacf), tacf)
```



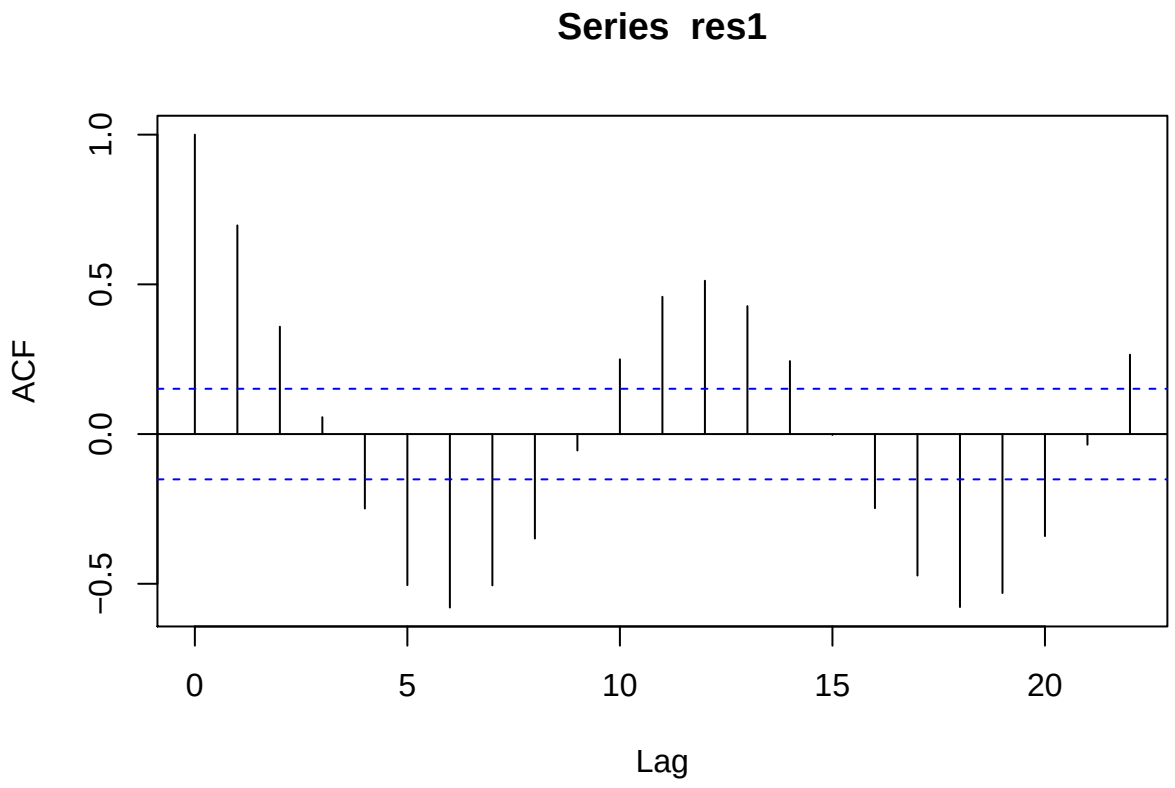
Assignment 2

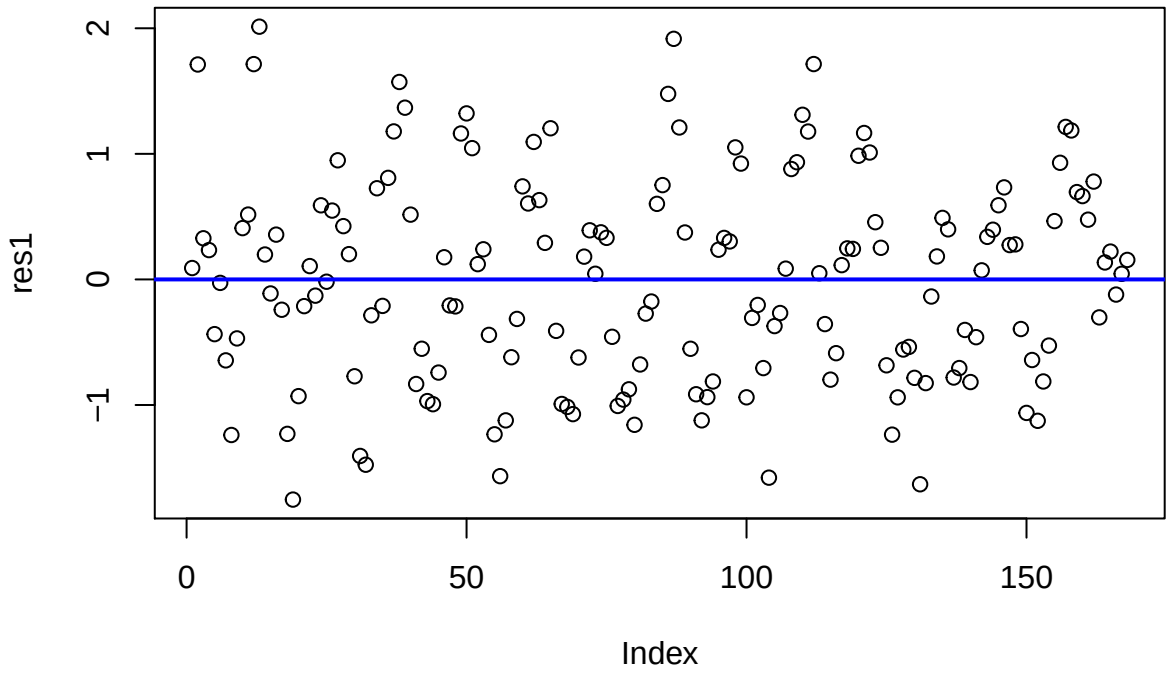
```
rhine <- read.csv2("../data/Rhine.csv")
colnames(rhine)[4] <- "Conc"
```



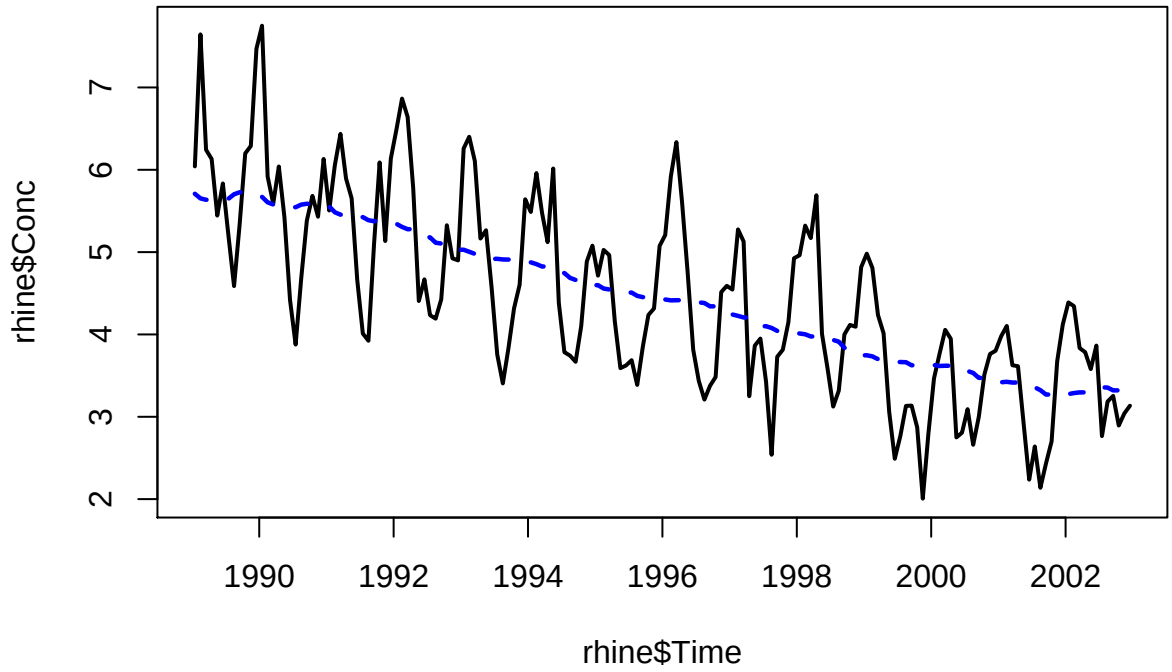
```r
lmobj <- lm(Conc ~ Time, data = rhine)
res1 <- residuals(lmobj)
summary(lmobj)
```

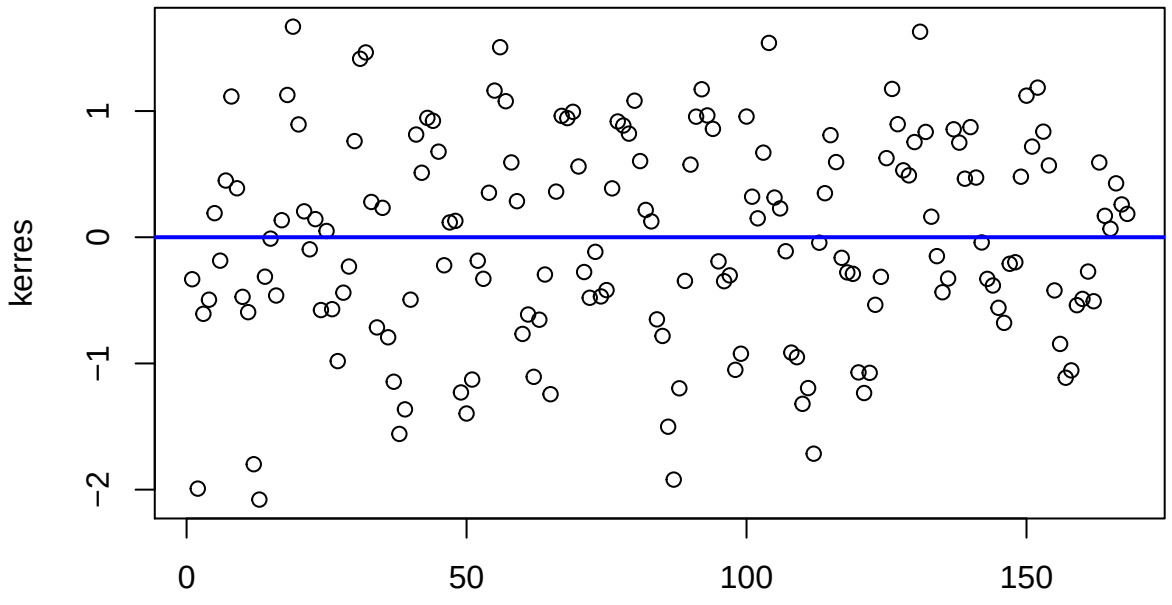
```
##
## Call:
## lm(formula = Conc ~ Time, data = rhine)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.75325 -0.65296  0.06071  0.52453  2.01276
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 430.70725   31.26570   13.78   <2e-16 ***
## 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
```



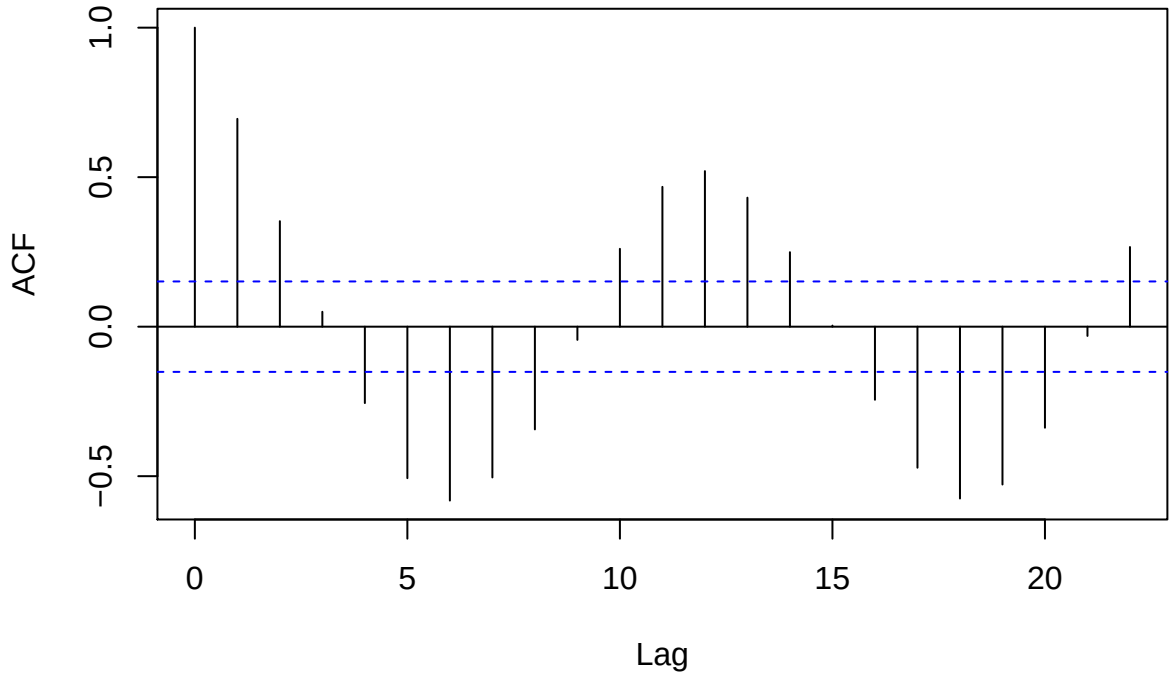



```
kersmo <- ksmooth(y = rhine$Conc, x = rhine$Time, bandwidth = 5)
kerres <- kersmo$y - rhine$Conc
```

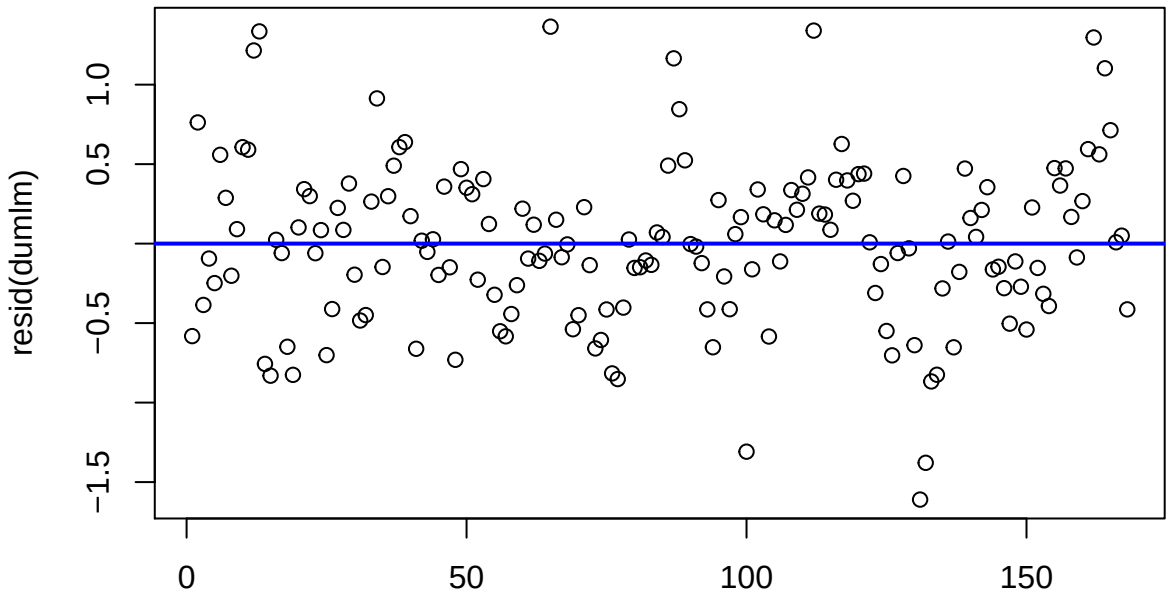


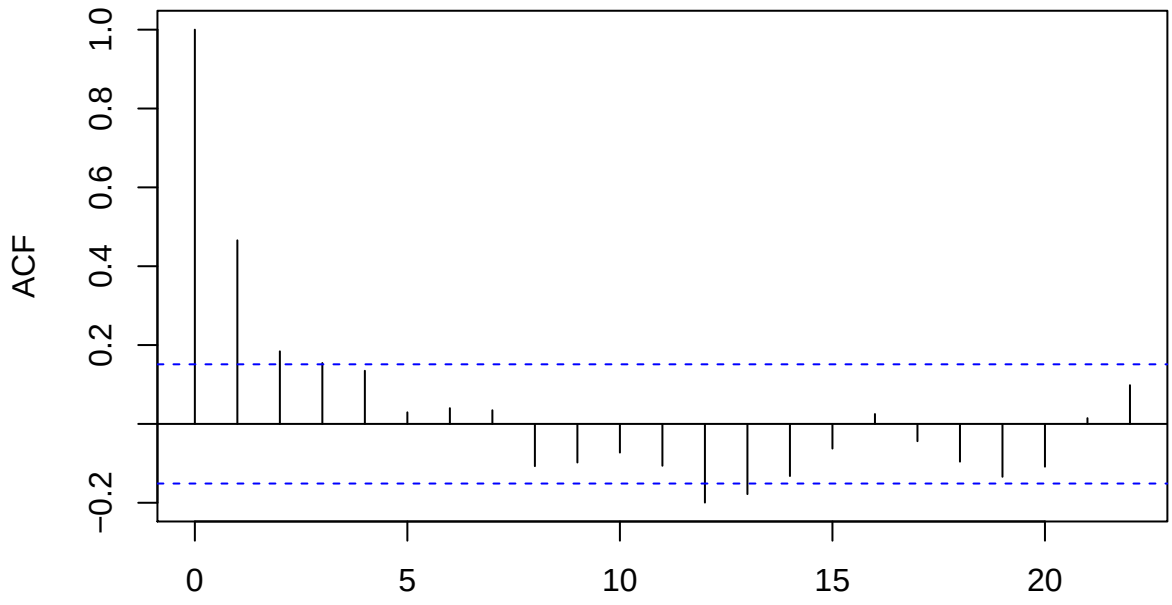


Series kerres




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






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

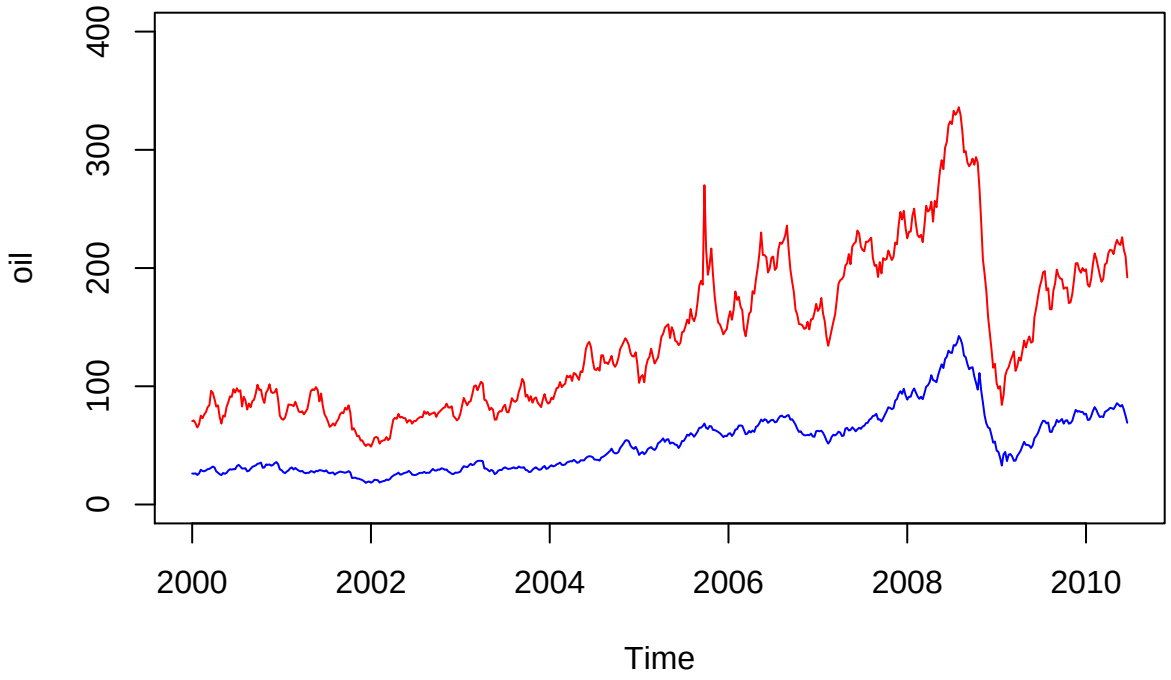
```
## Start:  AIC=-202.02
## Conc ~ Time + Month.f
##
##            Df Sum of Sq     RSS      AIC
## <none>                  43.237 -202.023
```

```
## - Month.f 11    68.524 111.761  -64.477
## - Time     1   118.387 161.624   17.499
```

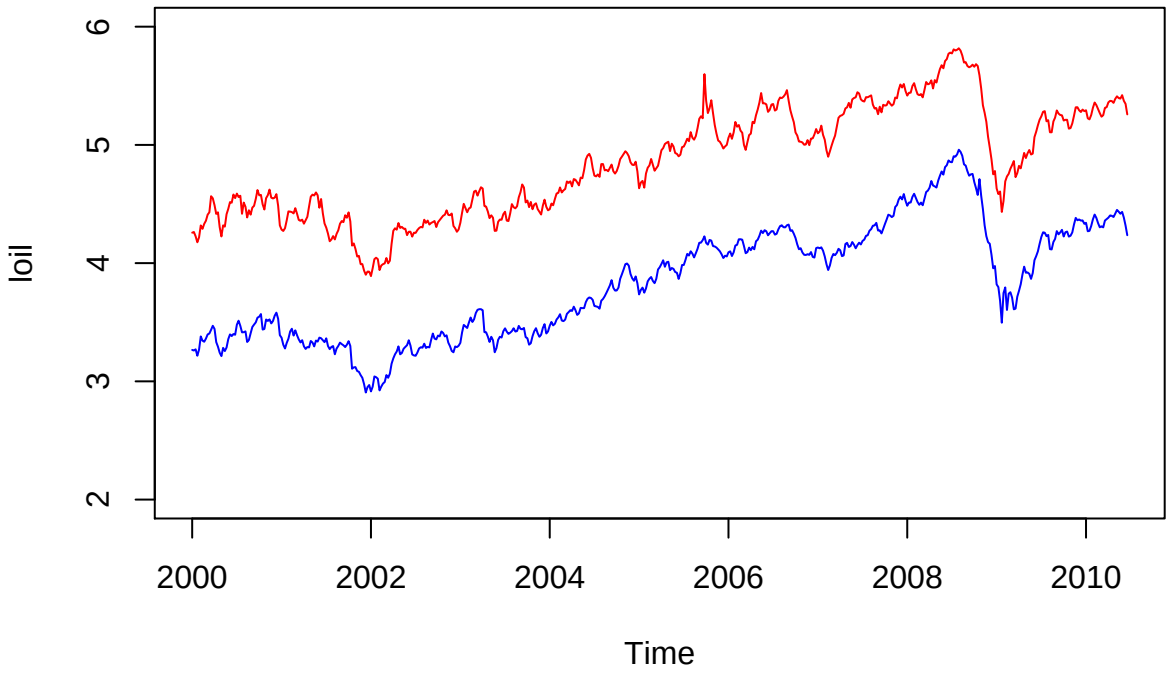
```
##
## Call:
## lm(formula = Conc ~ Time + Month.f, data = rhine)
##
## Coefficients:
## (Intercept)         Time     Month.f2     Month.f3     Month.f4
##   420.82746     -0.20824      0.27659      0.04006     -0.34643
##    Month.f5     Month.f6     Month.f7     Month.f8     Month.f9
##    -0.86165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

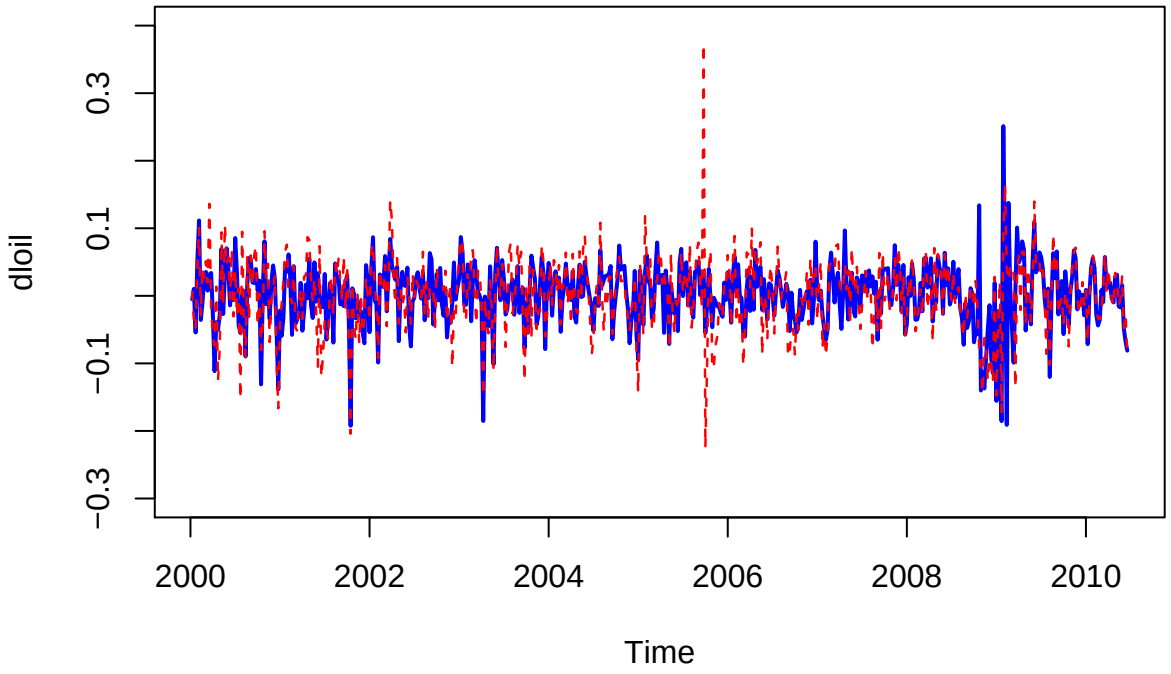
Assignment 3

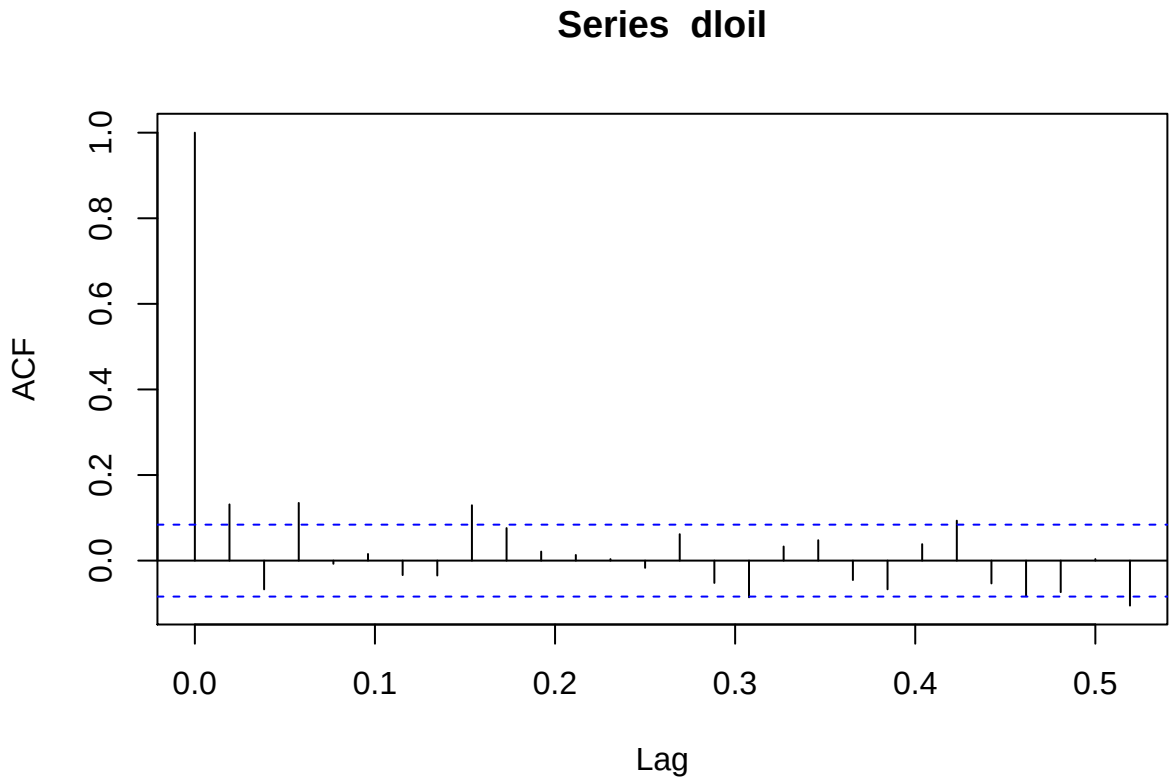
```
library(astsa)

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

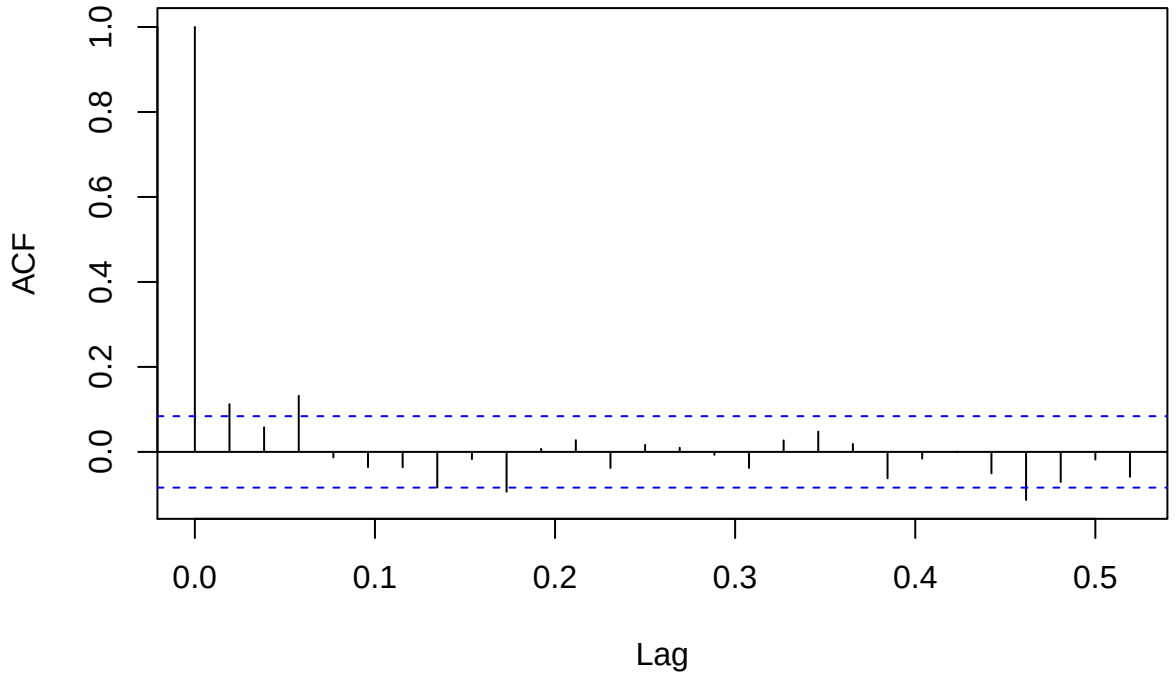


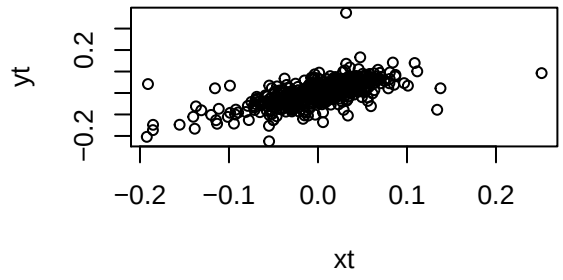

```
loil <- log(oil)
lgas <- log(gas)

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

xt <- dloil
yt <- dlgas
```

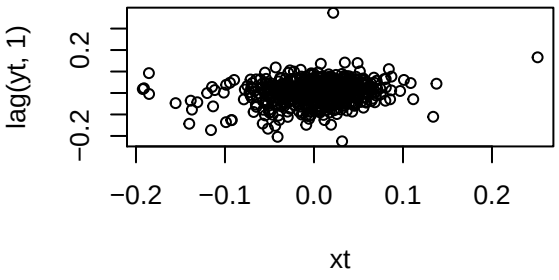

loil
2
3
4
5
6
2000
2002
2004
2006
2008
2010
Time

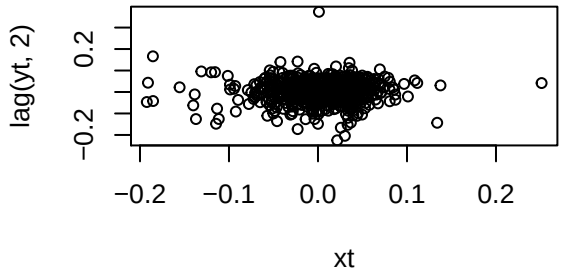

dloil
−0.3
−0.1
0.1
0.3
2000
2002
2004
2006
2008
2010
Time

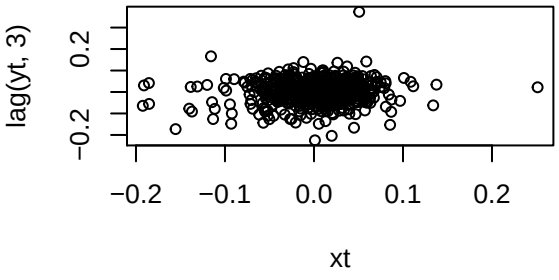

Series dloil
ACF
0.0
0.2
0.4
0.6
0.8
1.0
0.0
0.1
0.2
0.3
0.4
0.5
Lag


Series dlgas
ACF
0.0
0.2
0.4
0.6
0.8
1.0
0.0
0.1
0.2
0.3
0.4
0.5
Lag

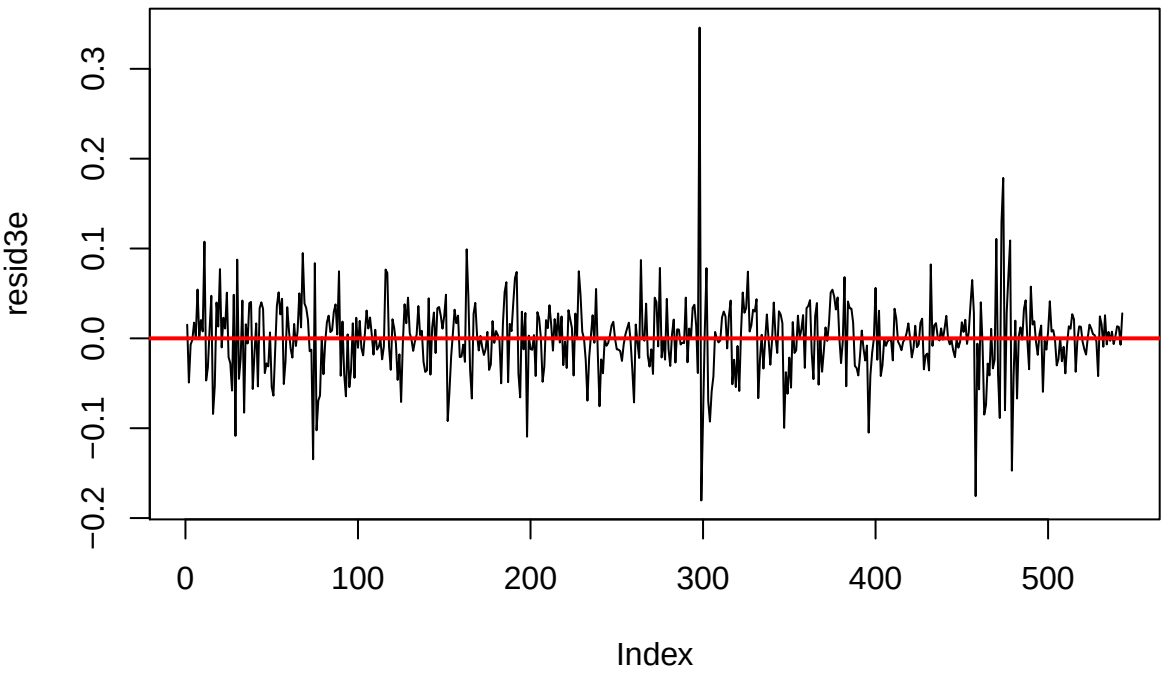


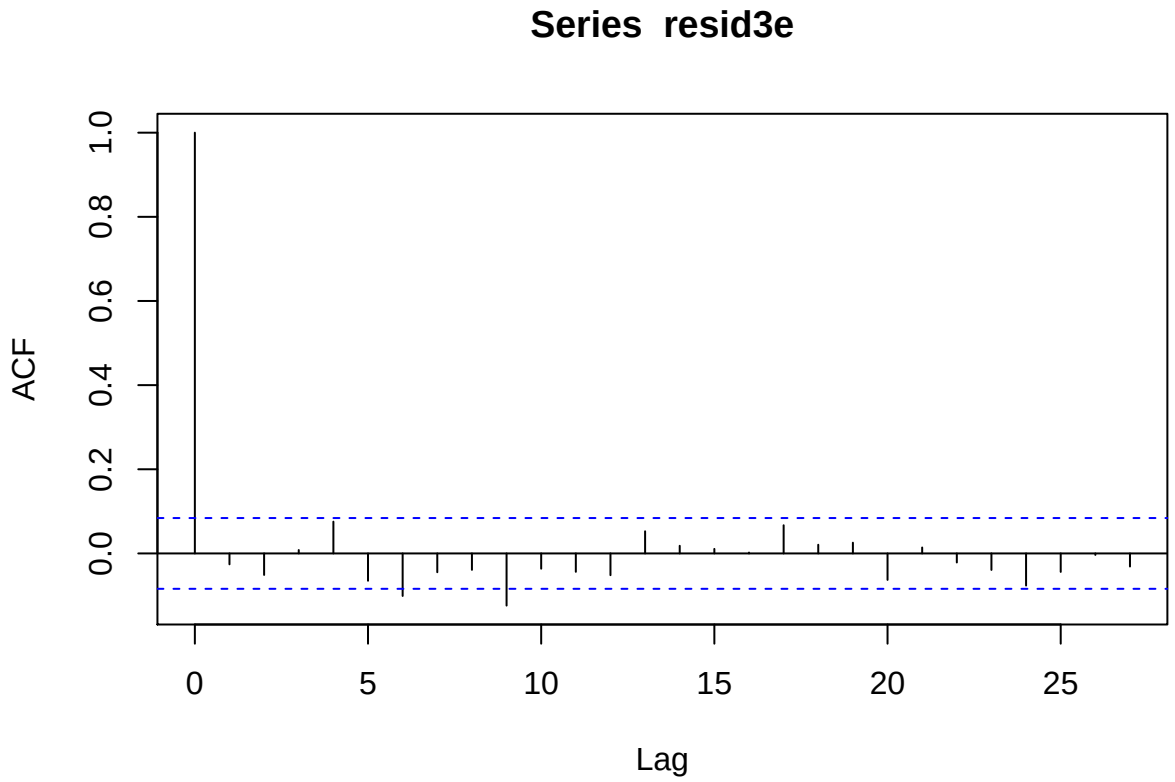







```
tss <- ts.intersect(yt=yt, xt=xt, lag1xt=lag(xt, 1), dummy=xt > 0)
model3e <- lm(yt ~ xt + lag1xt + dummy, data = tss)
resid3e <- resid(model3e)
```




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