Assignment 1

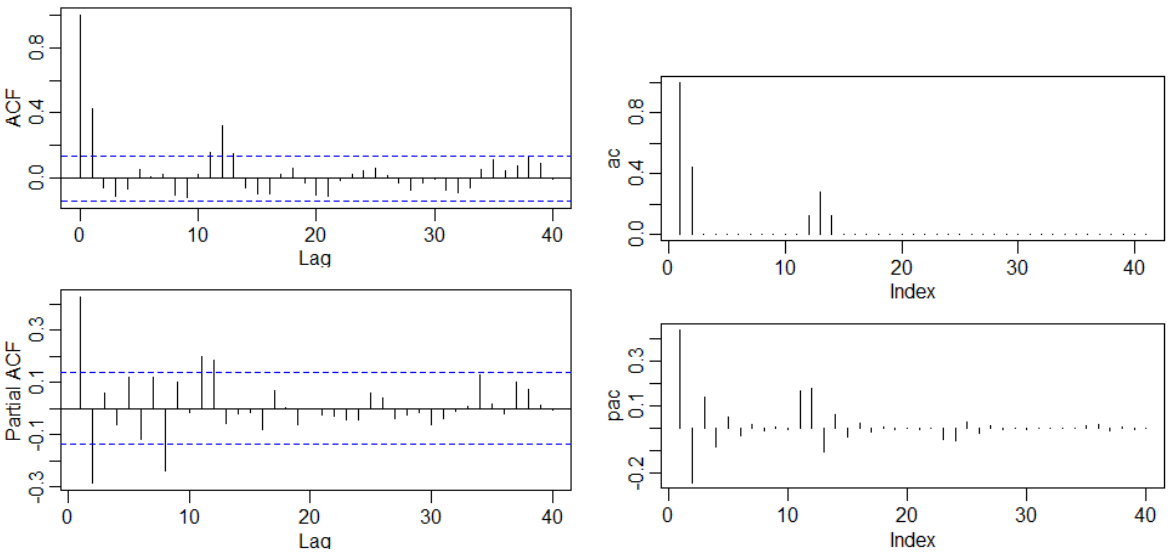
a) Computed by our code: 0.115, computed by pacf: 0.117 true one: 0.1 (third coefficient). For such large n, the result appears to be quite close.

b)
```
> res1

Call:
arima(x = data, order = c(2, 0, 0), method = "CSS")

Coefficients:
         ar1     ar2  intercept
      0.8067  0.1205     0.6028
s.e.  0.0984  0.0994     1.5134

sigma^2 estimated as 1.129:  part log likelihood = -147.94
> res2=arima(data, order=c(2,0,0), method="ML")
> res2

Call:
arima(x = data, order = c(2, 0, 0), method = "ML")

Coefficients:
         ar1     ar2  intercept
      0.7967  0.1189     0.8290
s.e.  0.0992  0.1000     1.1385

sigma^2 estimated as 1.126:  log likelihood = -148.71,  aic = 305.41
> res3=ar.yw(data, aic=F, order.max=2)
> res3

Call:
ar.yw.default(x = data, aic = F, order.max = 2)

Coefficients:
     1       2
0.8029  0.1037

Order selected 2  sigma^2 estimated as  1.267
```

All method give similar results, in this case YW appear to be the closest one. True is within CI.

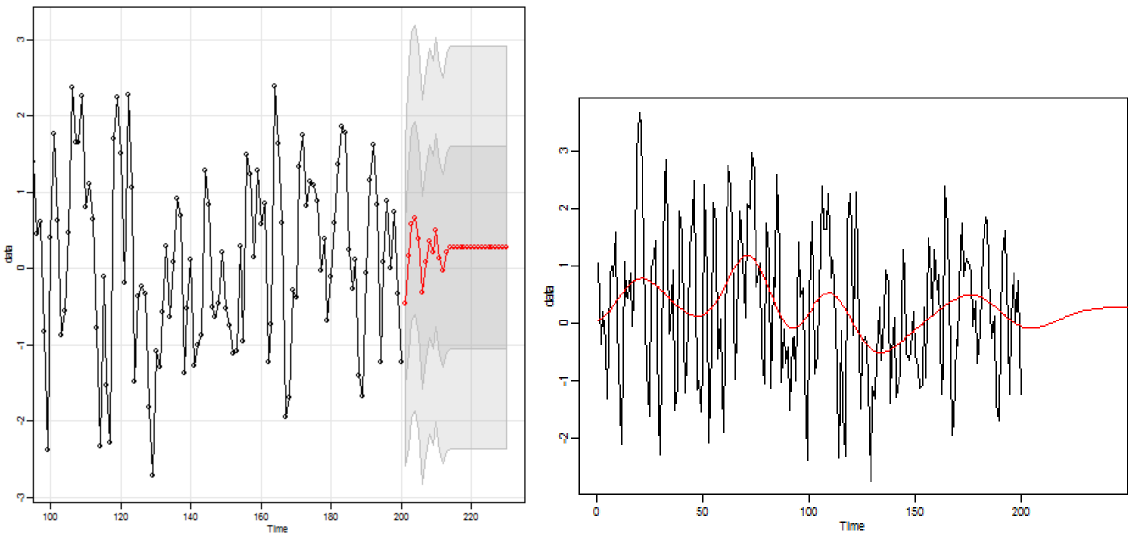
c)

Model equation $x_t = w_t + 0.3w_{t-12} + 0.6w_{t-1} + 0.18w_{t-13}$



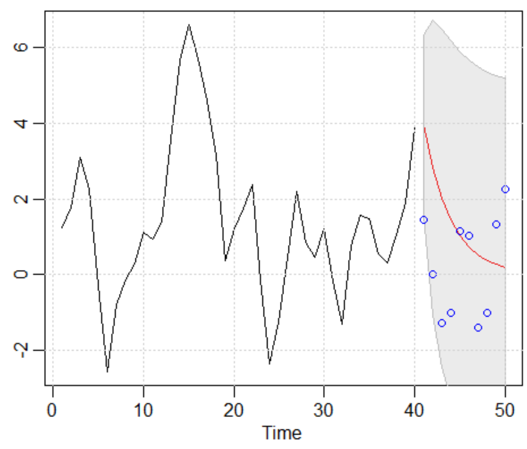
In true one, ACF has only two peaks and some nonzero ACF around, PACF decreases at lag 12 and there is some nonzero pattern around. Similar pattern for sample ACF but nonzero ACFs are everywhere, PACF gets high values in between.

d)



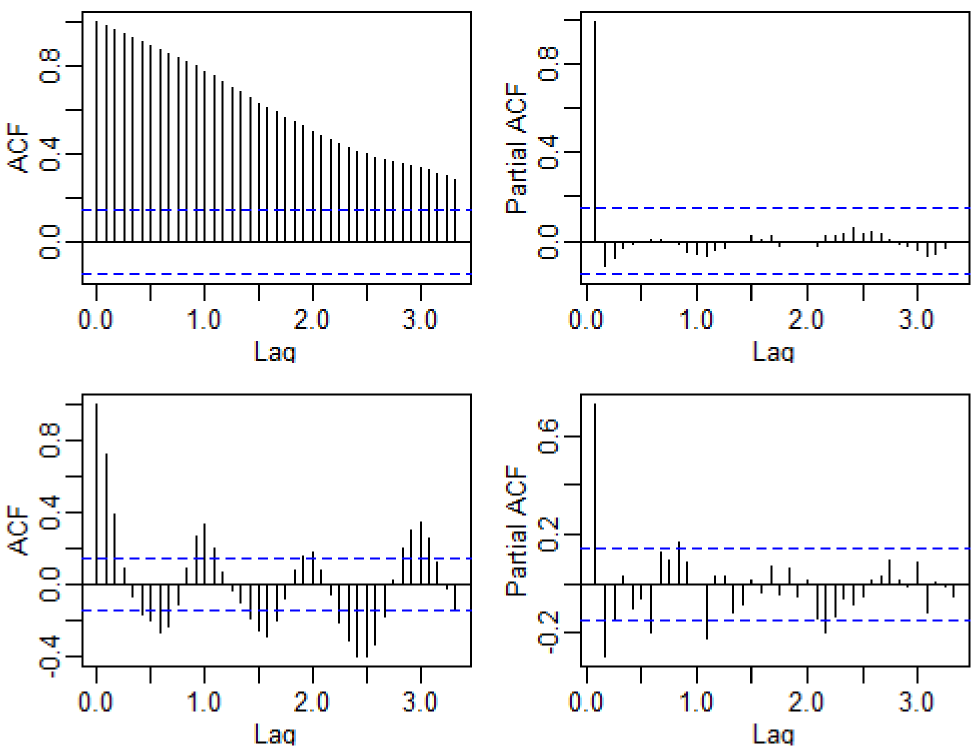
ML models can not see patterns→ predict flat!

e)

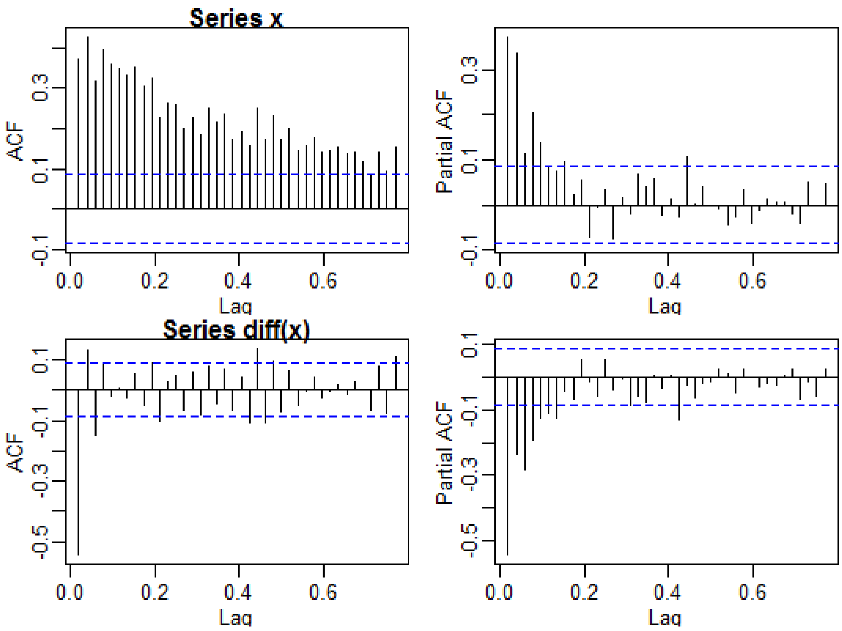


All points except of one are inside the confidence region, one is on the boundary. 9 out of 10 is 90% confidence.

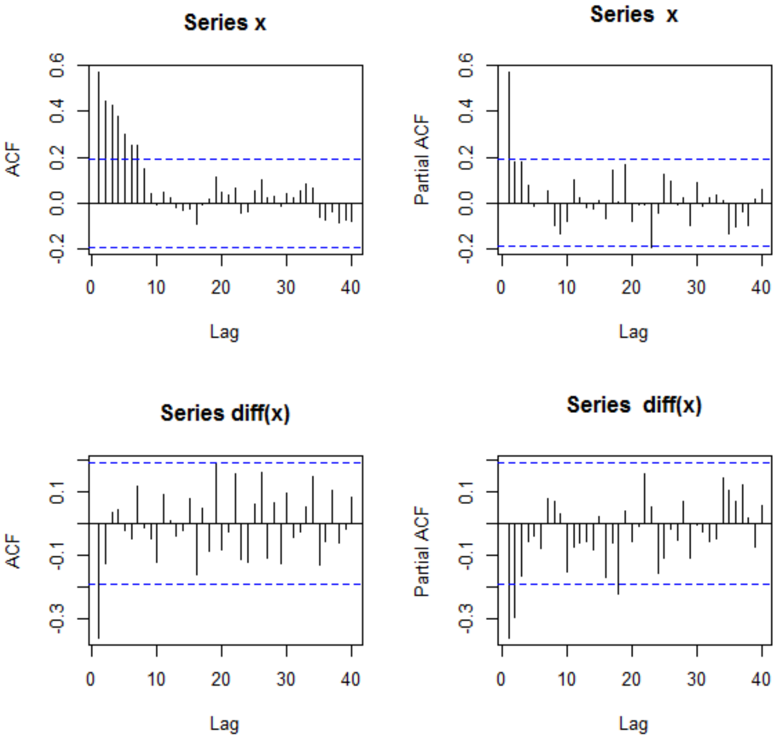
Assignment 2



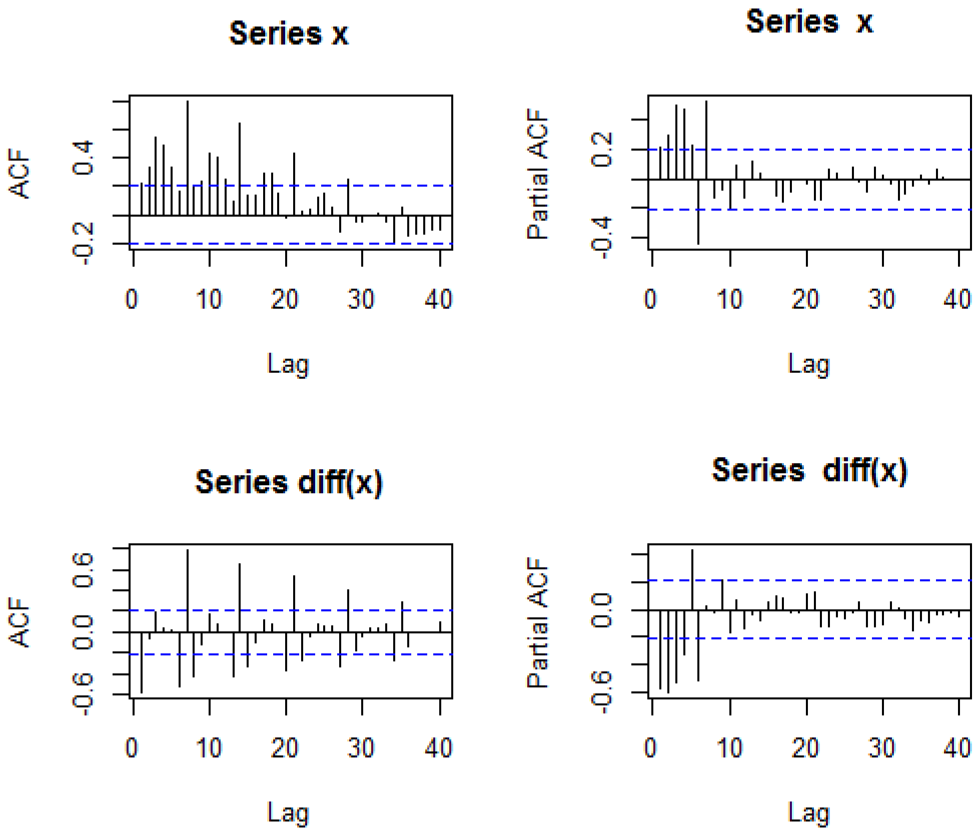
Obviously nonstationary. Process is ARIMA(2,1,0) or ARIMA(3,1,0) or ARIMA(0,1,2) or (since ACF not decaying too much ARIMA(0,1,2)x(0,1,0)_12



Probably ARIMA(0,1,1) or ARIMA(0,1,2)



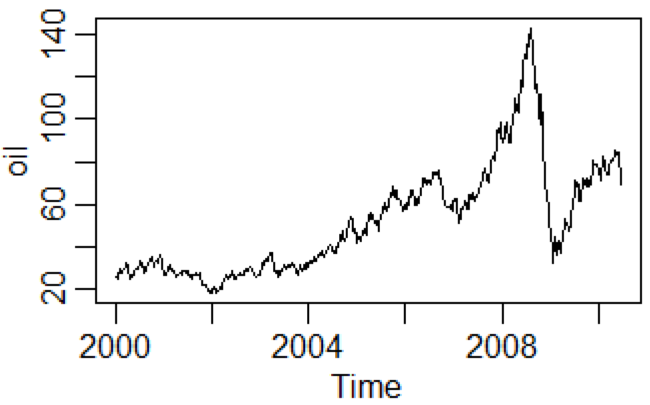
Maybe differencing not needed… ARIMA(1,0,0) or ARIMA(0,1,1)



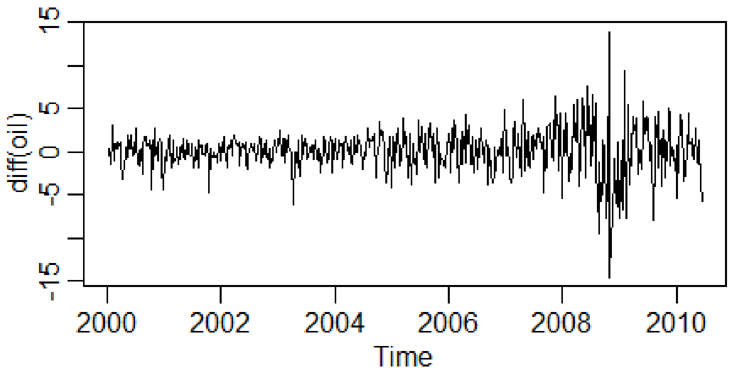
This is definitely a seasonal model with decauomg at 7. Differencing might not be needed. So a tentative model is ARIMA(4,0,0)x(1,0,0) because PACF graph has 1 peak or ARIMA(4,1,0)x*(1,0,0).

Assignment 3

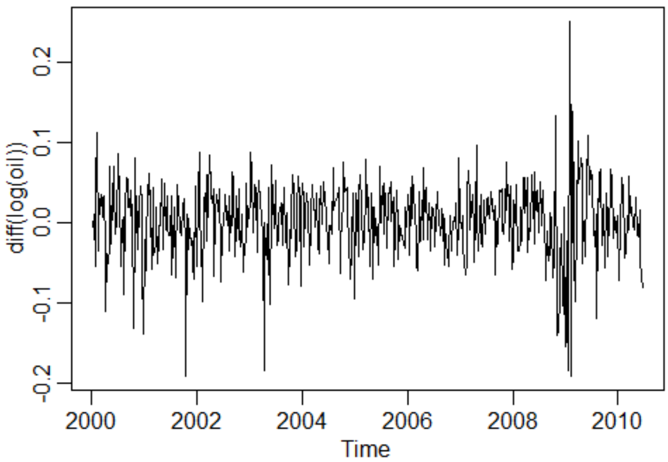
A)



#nonstationary, trying first differencing

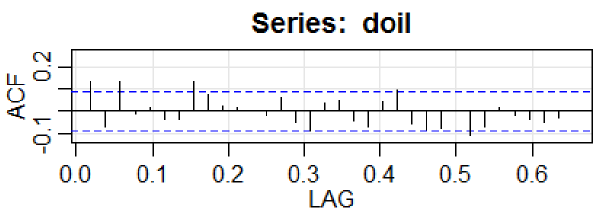


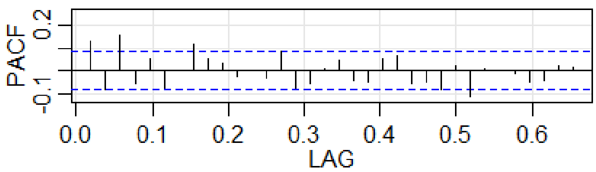
#variance non-constant




```
> tseries::adf.test(doil)

        Augmented Dickey-Fuller Test

data:  doil
Dickey-Fuller = -6.3708, Lag order = 8, p-value = 0.01
```

Root test says that data is stationary

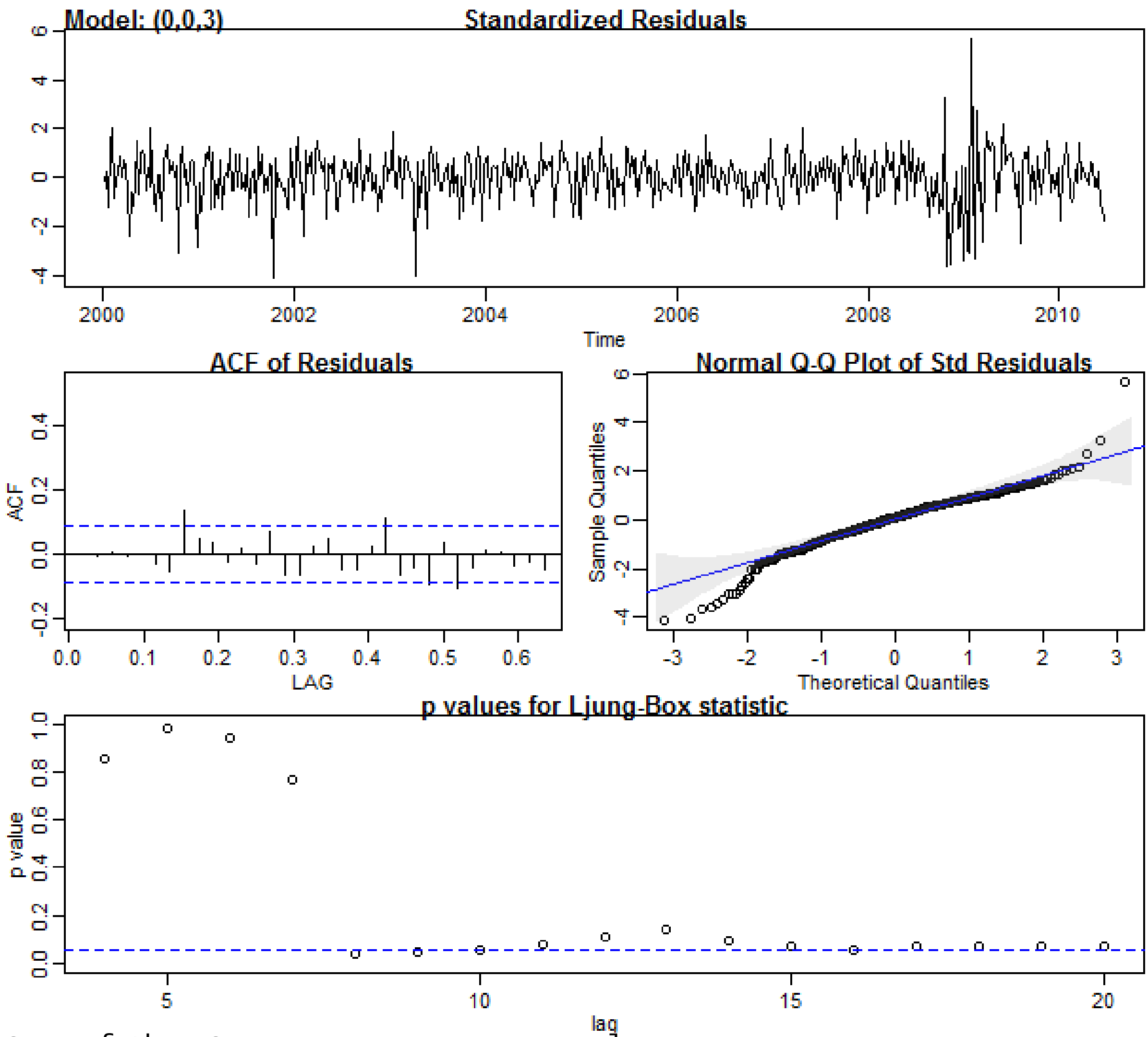




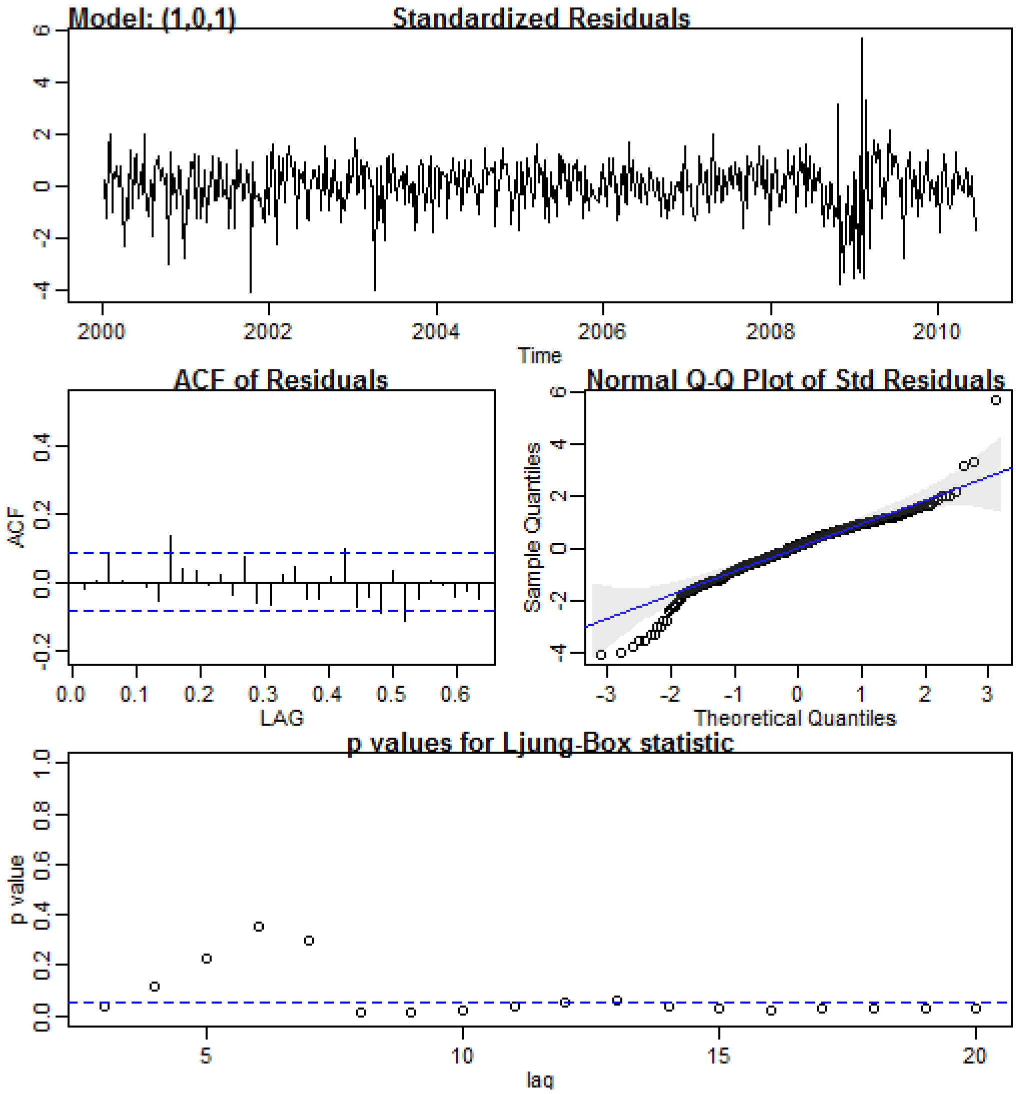
#neither of them cuts, trying eacf

```
> TSA::eacf(doil)
AR/MA
  0 1 2 3 4 5 6 7 8 9 10 11 12 13
0 x o x o o o o x o o o  o  o  o
```

```
1 x o x o o o o x o o o  o  o  o
2 x x x o o o o x o o o  o  o  o
3 x x x o o o o x o o o  o  o  o
4 x o x o o o o x o o o  o  o  o
5 x x x o x o o x o o o  o  o  o
6 o x x o x x o x o o o  o  o  x #Trying AR(0,3) or ARMA(1,1)
7 o x x x x x x x o x o  o  o  o
```



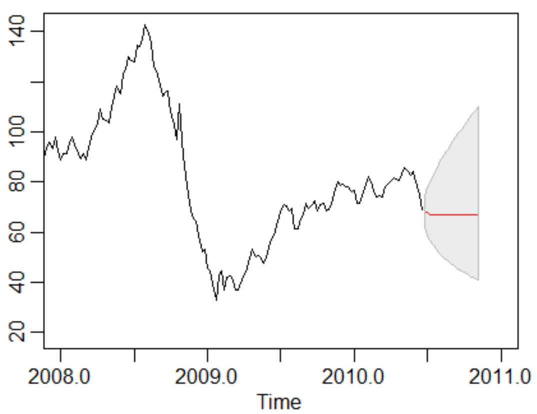
Some of the ACFs go up, error non-normal
ljung-box finds some dependences.



Still errors non-normal, some stick out

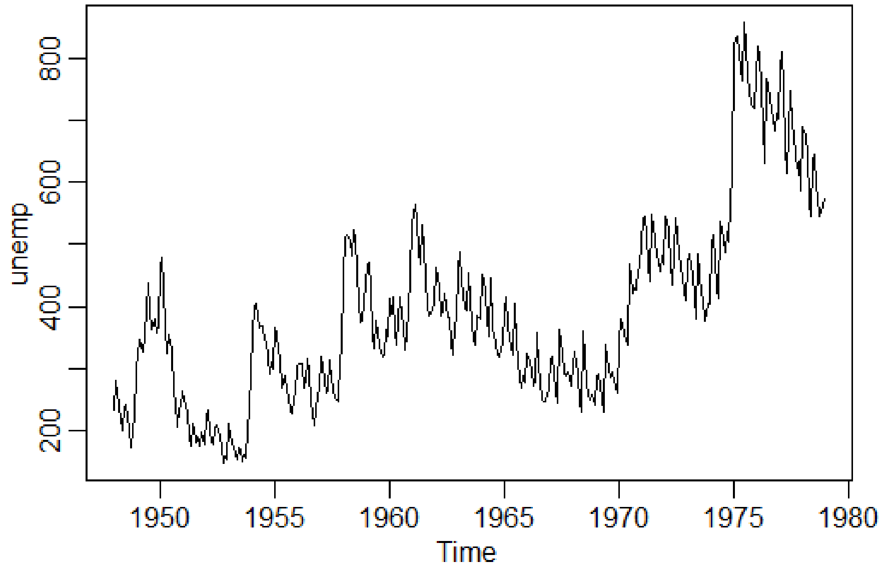
#models are similar, Ljung-box looks better for ARMA(0,3). Coefficients in both models significant

#so we choose ARIMA(0,1,3)

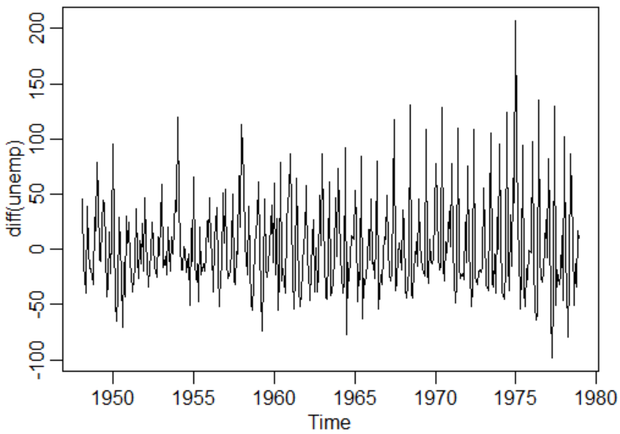


$$x_t - x_{t-1} = 0.17w_{t-1} + 0.09w_{t-2} + 0.15w_{t-3}$$

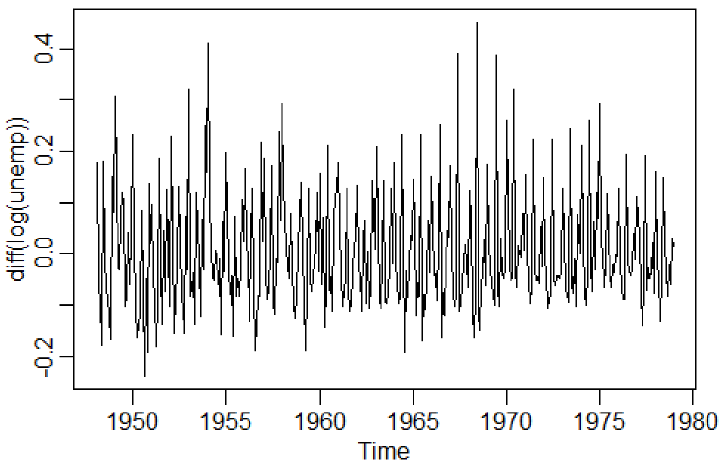
C)



#nonstationary

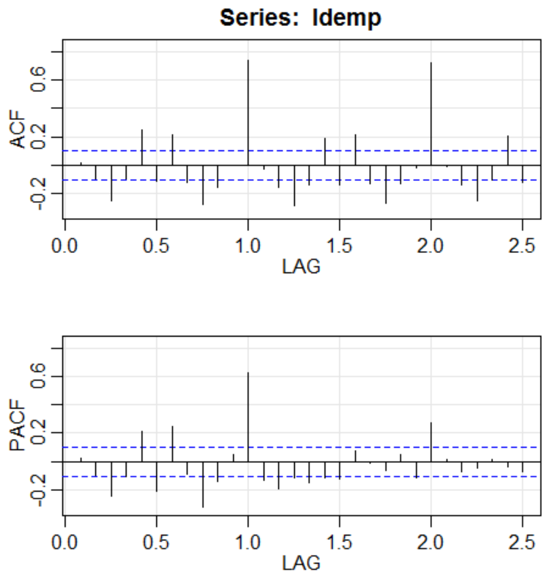


#feels like non-constant variance

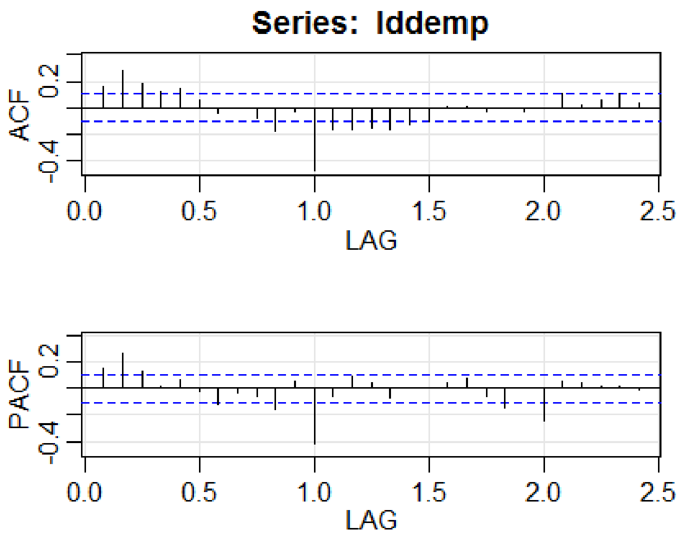


#better now

Stationary acc to unit root test

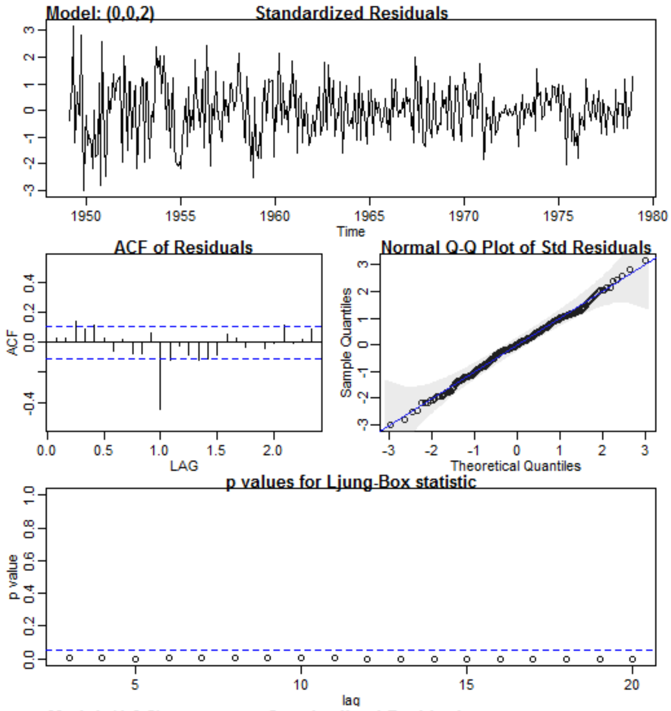


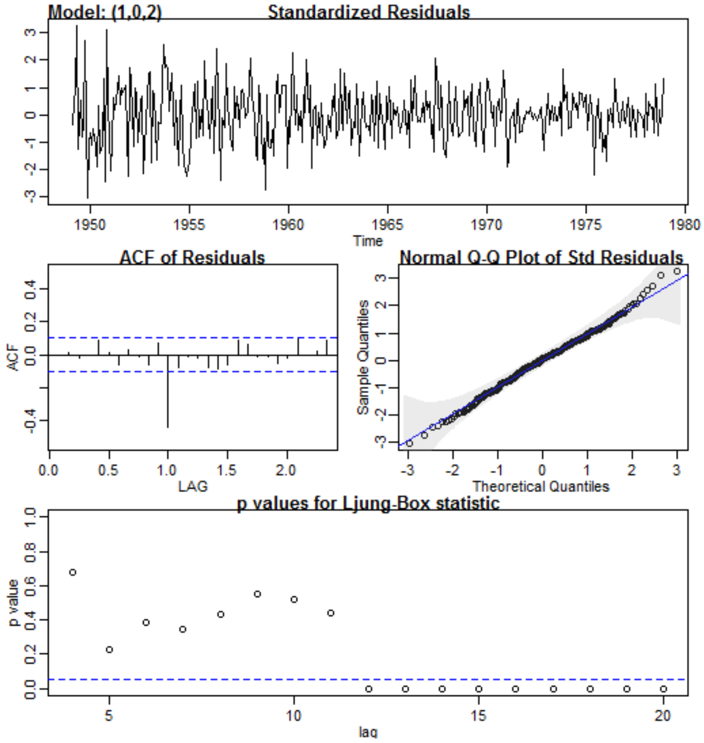
ACF non-decaying at lag 12h→ further differencing



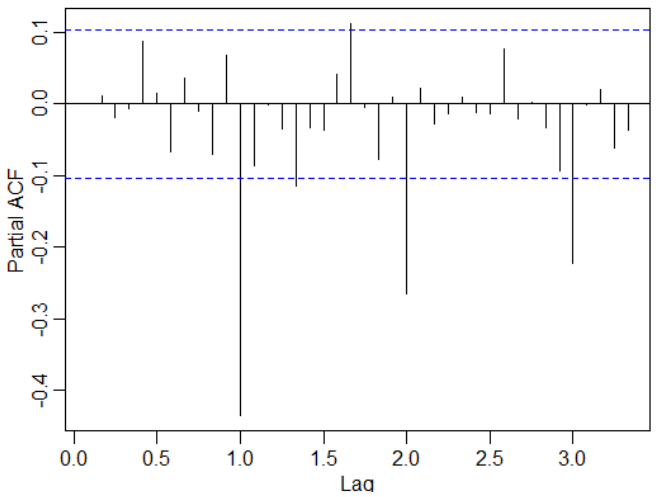
#non-seasonal: PACF cuts off at lag 2, or maybe both decay

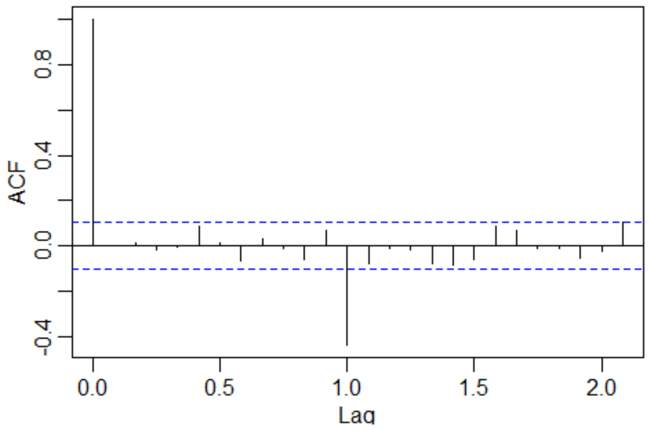
```
> TSA::eacf(lddemp)
AR/MA
  0 1 2 3 4 5 6 7 8 9 10 11 12 13
0 x x x x x o o o o x o  x  x  x
1 x x o o o o o o o x o  x  x  o
2 x x o o o o o o o o o  x  x  x
3 x x o o o o o o o o o  x  x  x
4 x x o x o o o o o o o  x  o  o
5 x x o x x o o o o o o  x  x  o
6 x x o x o o o o o o o  x  o  o →Maybe(1,0,2)?
7 x x x x o o o o o o o  x  x  x
```



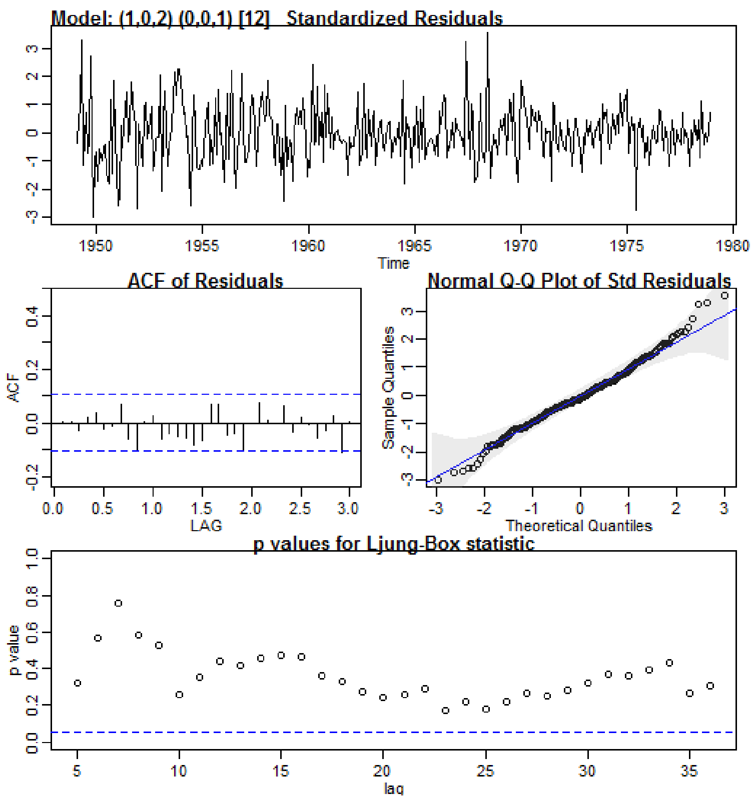


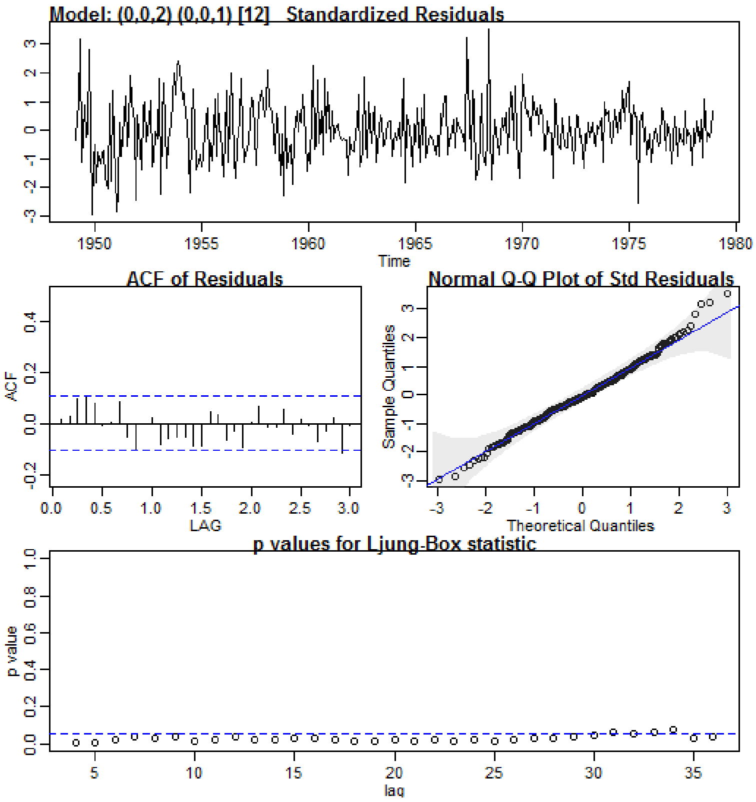
In the first model, coeffs are not significant->using (1,0,2)





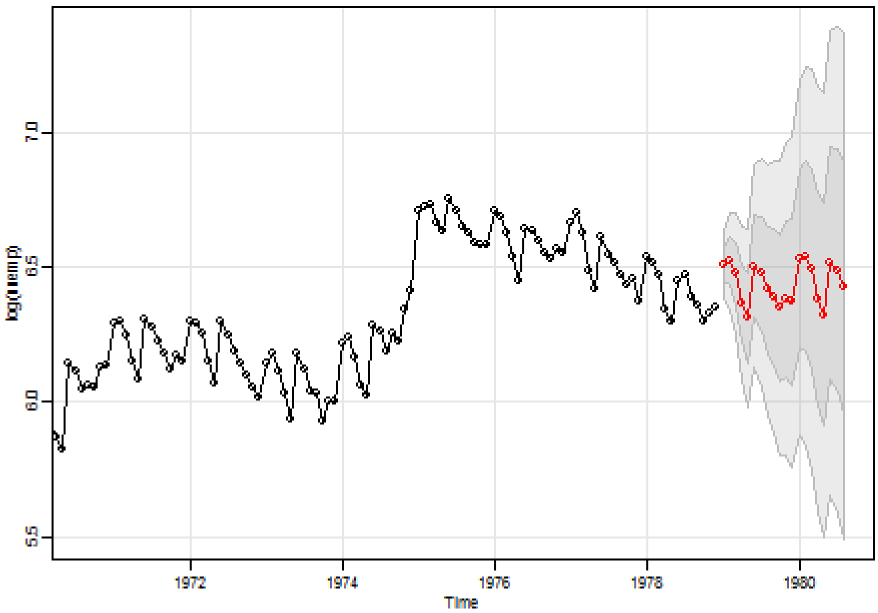
ACF cuts at lag 1, PACF decays→Q=1





Ljung box rejects the second model.

AIC,BIC values for the first model are better. Our final choice: #so we choose (1,1,2)x(0,1,1)_12



Model equation:

```
Coefficients:
         ar1      ma1     ma2     sma1    xmean
      0.7307  -0.6794  0.1365  -0.7094  -0.0003
s.e.  0.1011   0.1112  0.0544   0.0442   0.0017
```

$(1-0.73B)(1-B)(1-B^{12})x_t=(1-0.68B+0.14B^2)(1+0.7B^{12})w_t$