Exp 8-5 Edit

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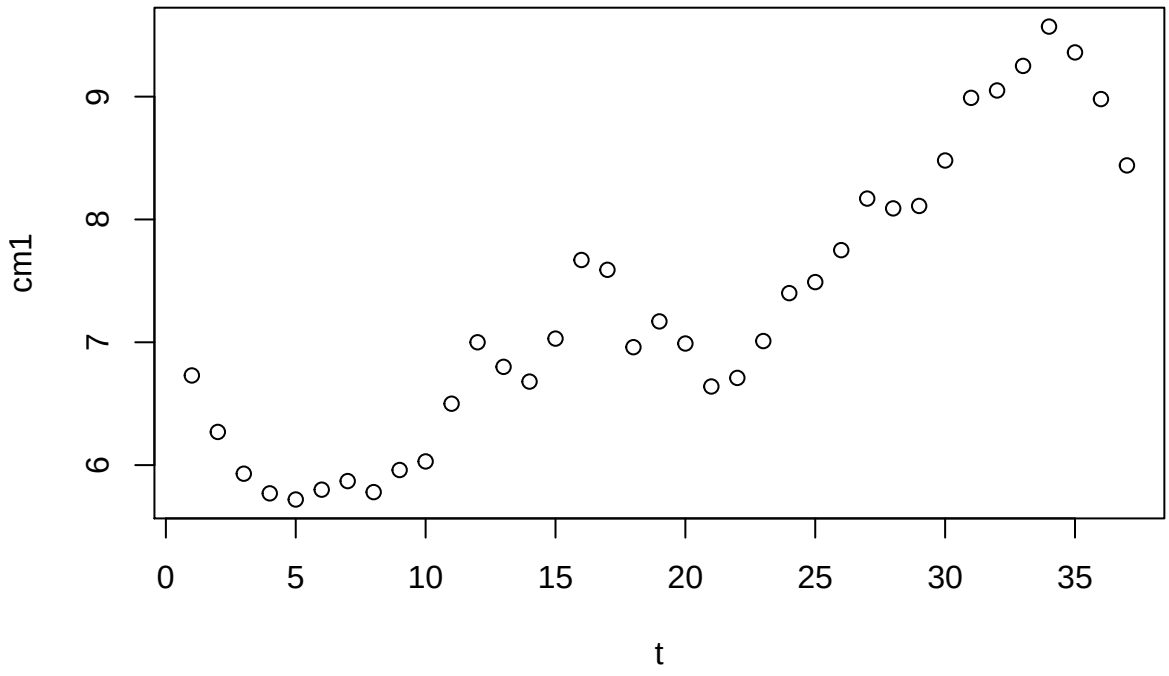
```
# Example 8.6 ARM problem

#1. Read and preview
# read data (change path for your computer)
cm1=scan("cm1.txt")
n=length(cm1)
t=seq(1,n,1)
# plot data
#par(mfcol=c(2,2))
plot(t,cm1)
```

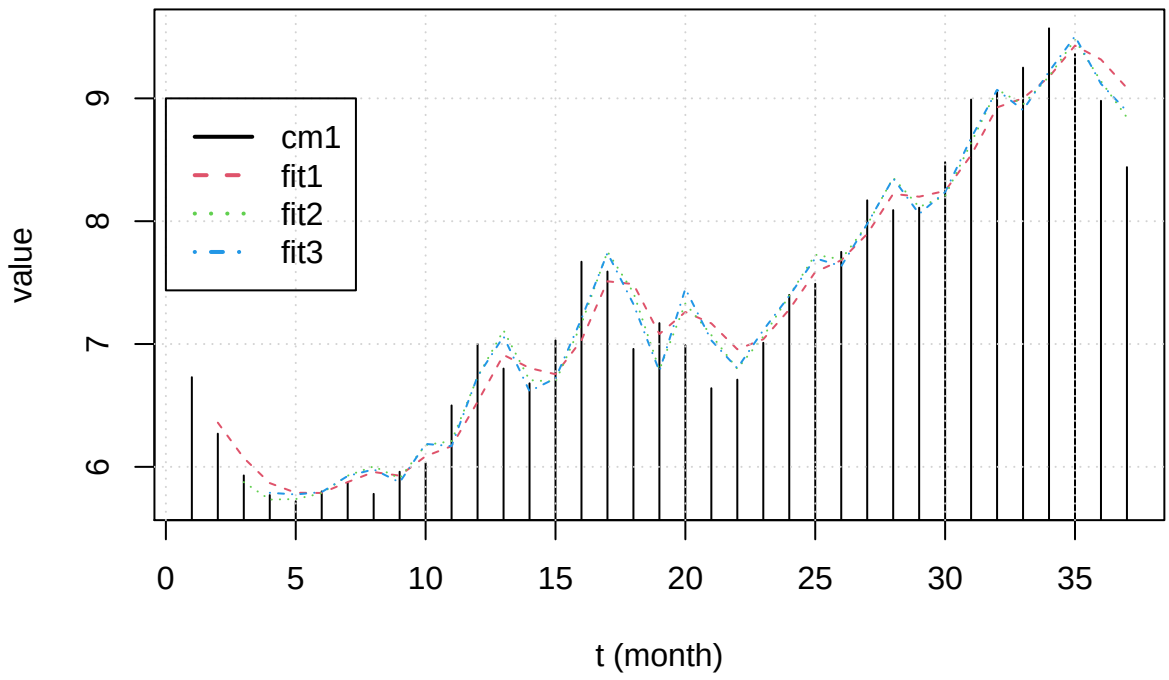



```
#2. Data manipulation
#repeat for Autoregression involving 1:3 previous terms
```

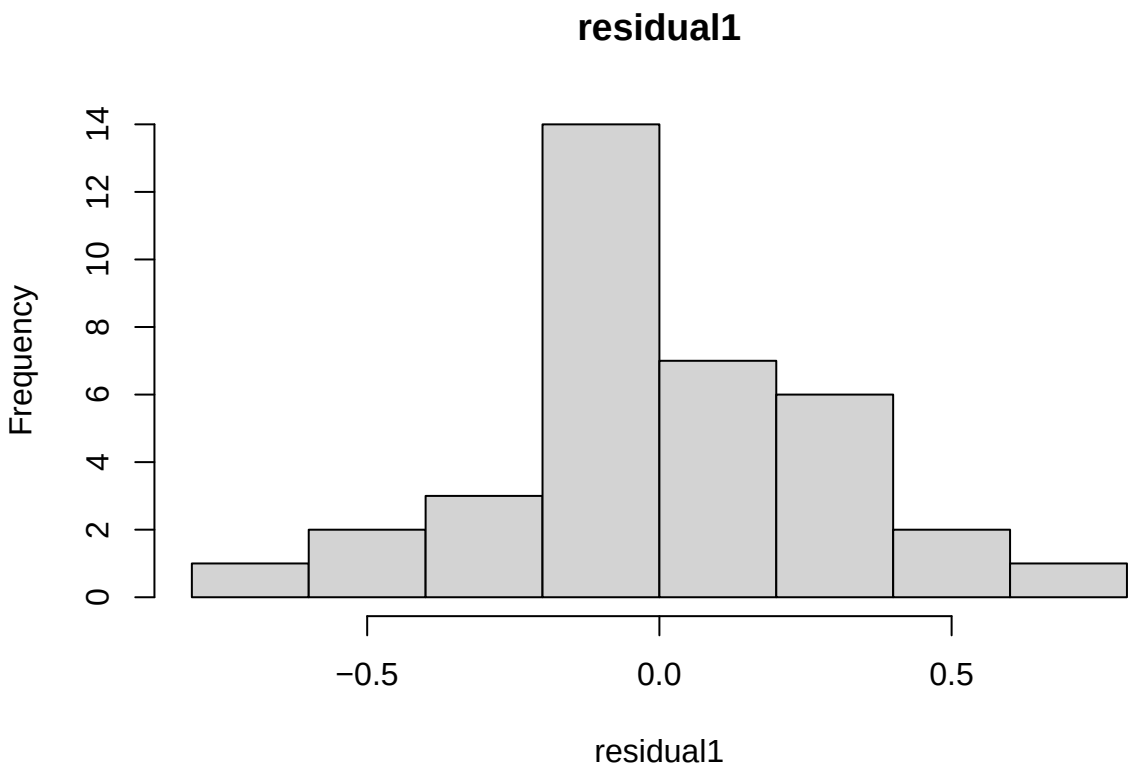
```r
#(to avoid copying and pasting lag1=...,fit1...)

cm1df = data.frame(t=t,cm1=cm1)
cm1df = within(cm1df,{
  for(i in 1:3) assign(paste0('lag',i),c(rep(NA,i),cm1[1:(n-i)]))#assign lag1:lag3
  remove(i)
})
#for(i in 1:3) assign(paste0('lag',i),c(rep(NA,i),cm1[1:(n-i)]))#assign lag1:lag3

fit1 = lm(cm1~t+lag1,data=cm1df)
fit2 = lm(cm1~t+lag1+lag2,data = cm1df)
fit3 = lm(cm1~t+lag1+lag2+lag3,data = cm1df)

cm1df = within(cm1df,{
  for(i in 1:3) assign(paste0('fit',i),c(rep(NA,i),predict.lm(eval(parse(text = paste0('fit',i))))))#as
  remove(i)
})
cm1df =within(cm1df,{
  for(i in 1:3) assign(paste0('res',i),cm1 - get(paste0('fit',i)))#assign lag1:lag3
  remove(i)
})
#cm1df
head(cm1df)
```

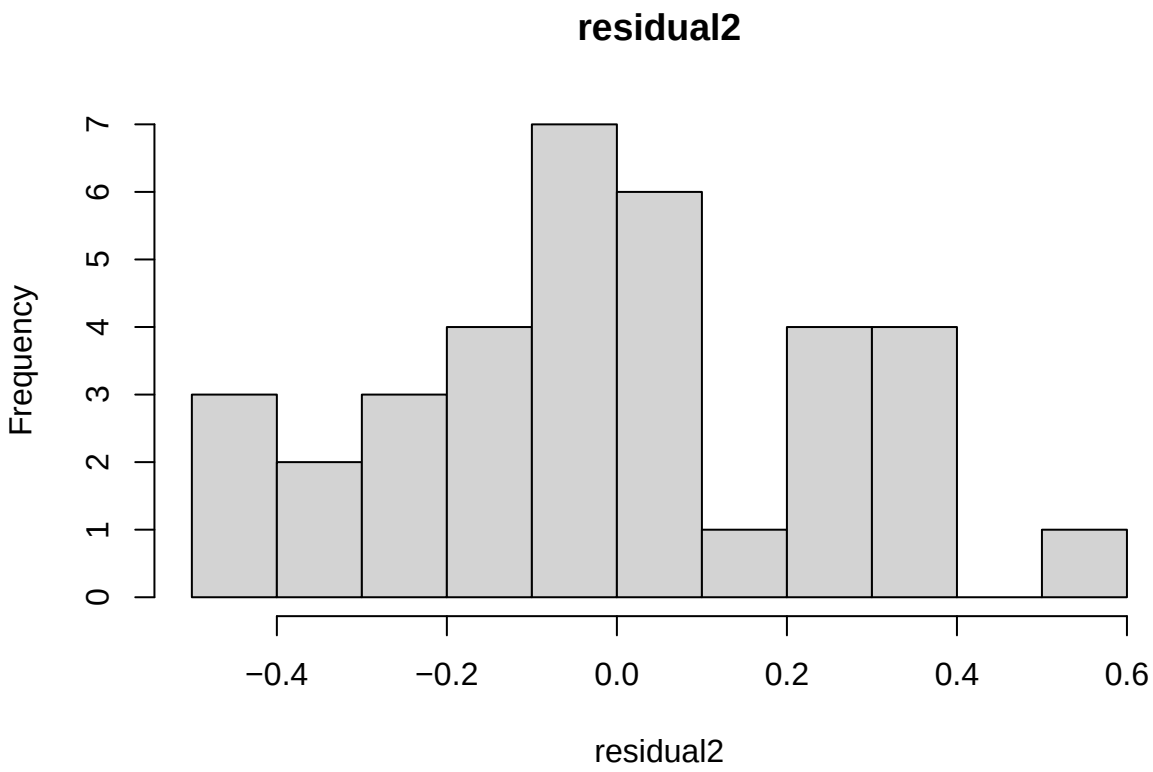
```
##   t  cm1 lag3 lag2 lag1     fit3     fit2     fit1         res3        res2
## 1 1 6.73   NA   NA   NA       NA       NA       NA           NA          NA
## 2 2 6.27   NA   NA 6.73       NA       NA 6.359942           NA          NA
## 3 3 5.93   NA 6.73 6.27       NA 5.875437 6.072003           NA  0.05456274
## 4 4 5.77 6.73 6.27 5.93 5.788715 5.733346 5.867784 -0.018714877  0.03665432
## 5 5 5.72 6.27 5.93 5.77 5.775334 5.737694 5.789145 -0.055333863 -0.01769442
## 6 6 5.80 5.93 5.77 5.72 5.794679 5.785128 5.787249  0.005321005  0.01487194
##          res1
## 1          NA
## 2 -0.08994206
## 3 -0.14200271
## 4 -0.09778354
## 5 -0.06914464
## 6  0.01275077
```

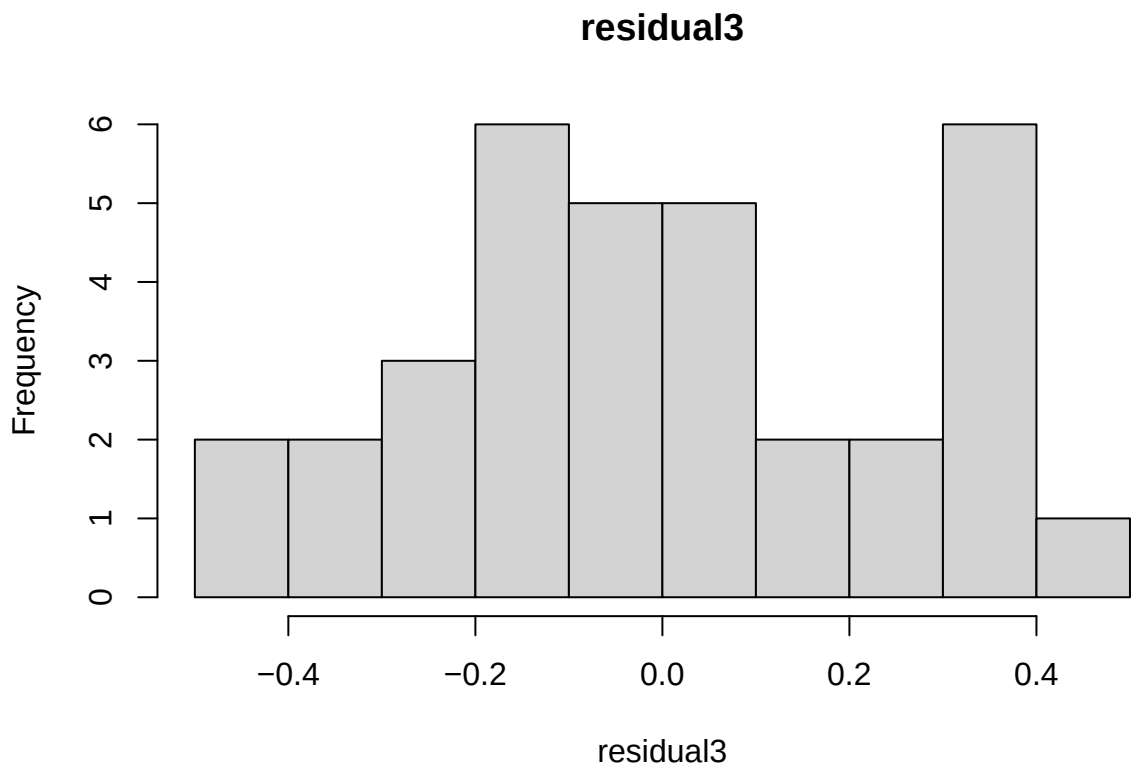
```r
layout(1)
cm1pred = c('cm1','fit1','fit2','fit3')
matplot(x=cm1df[,'t'],y=cm1df[,cm1pred],type = c('h','l','l','l'),lty = 1:4,col =1:4,
        xlab = 't (month)',ylab = 'value')
grid()
legend(0,9,legend = cm1pred,lwd=2,col = 1:4,lty = 1:4)
```



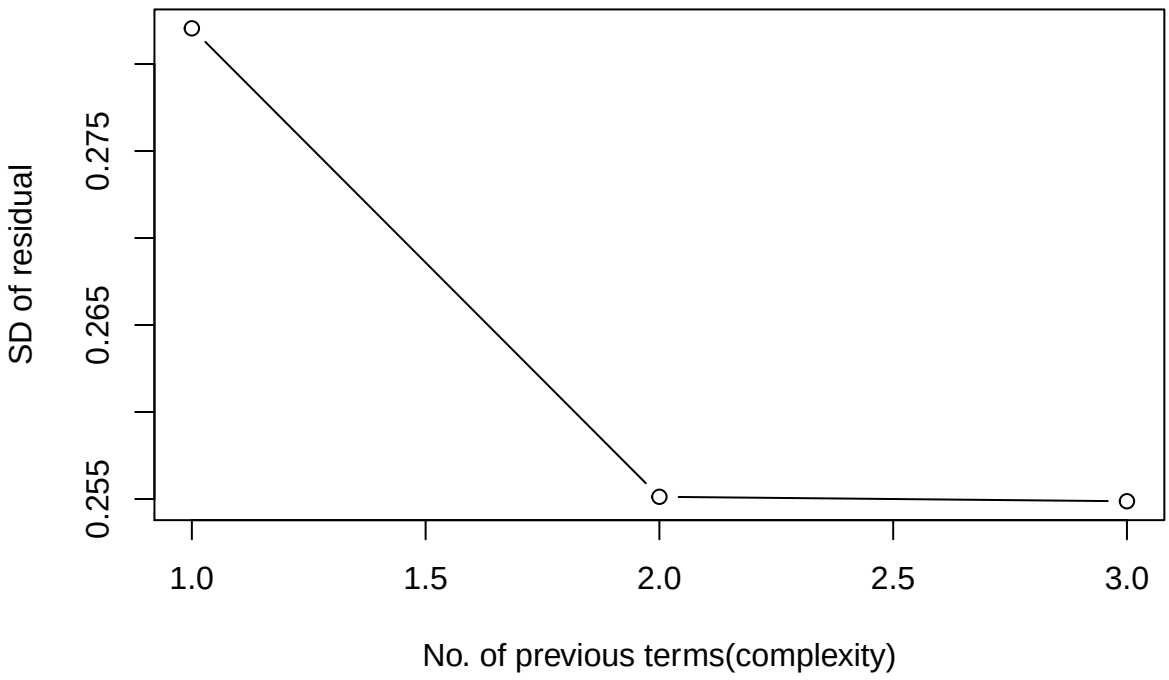

```
#layout(1:3)
for(i in 1:3) hist(cm1df[,as.character(paste0('res',i))],xlab =  paste0('residual',i),main = paste0('res
```


residual1
Frequency
0
2
4
6
8
10
12
14
−0.5
0.0
0.5
residual1

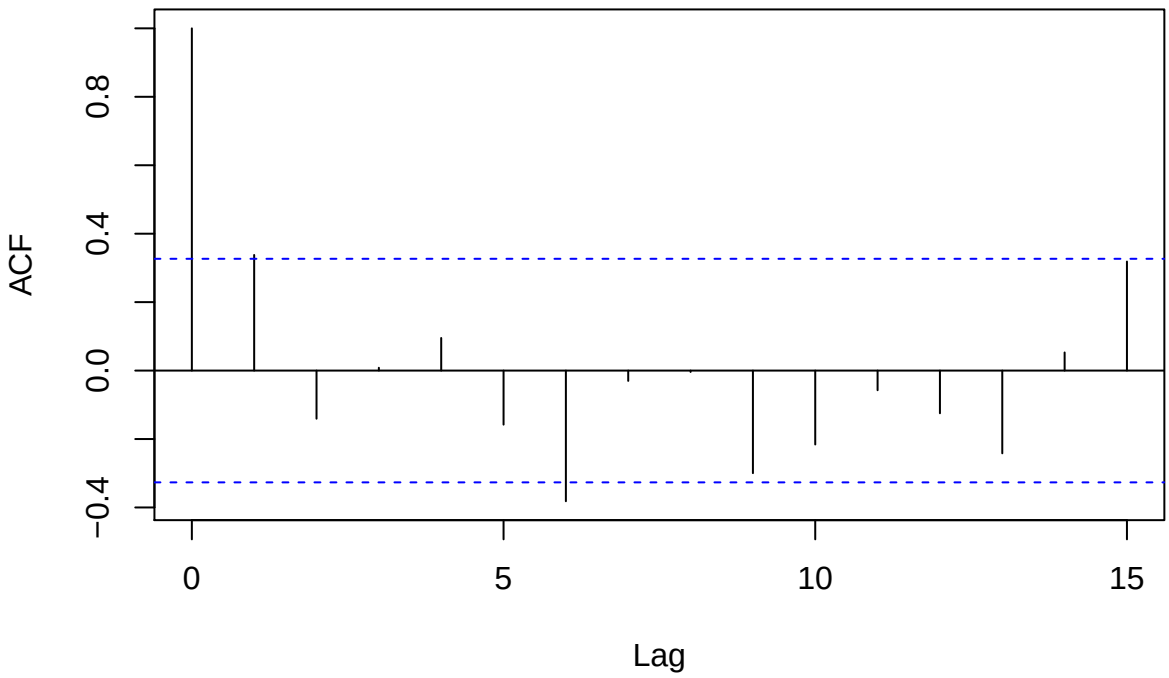

residual2
Frequency
0
1
2
3
4
5
6
7
−0.4
−0.2
0.0
0.2
0.4
0.6
residual2

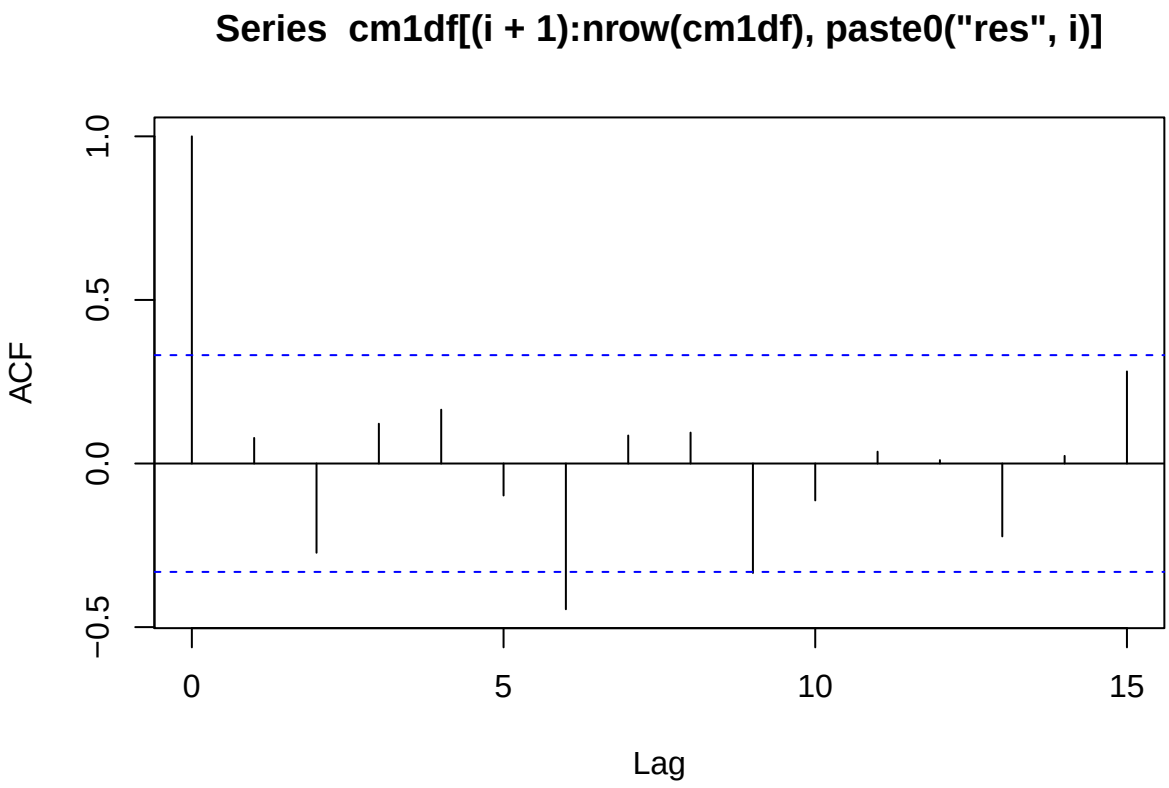


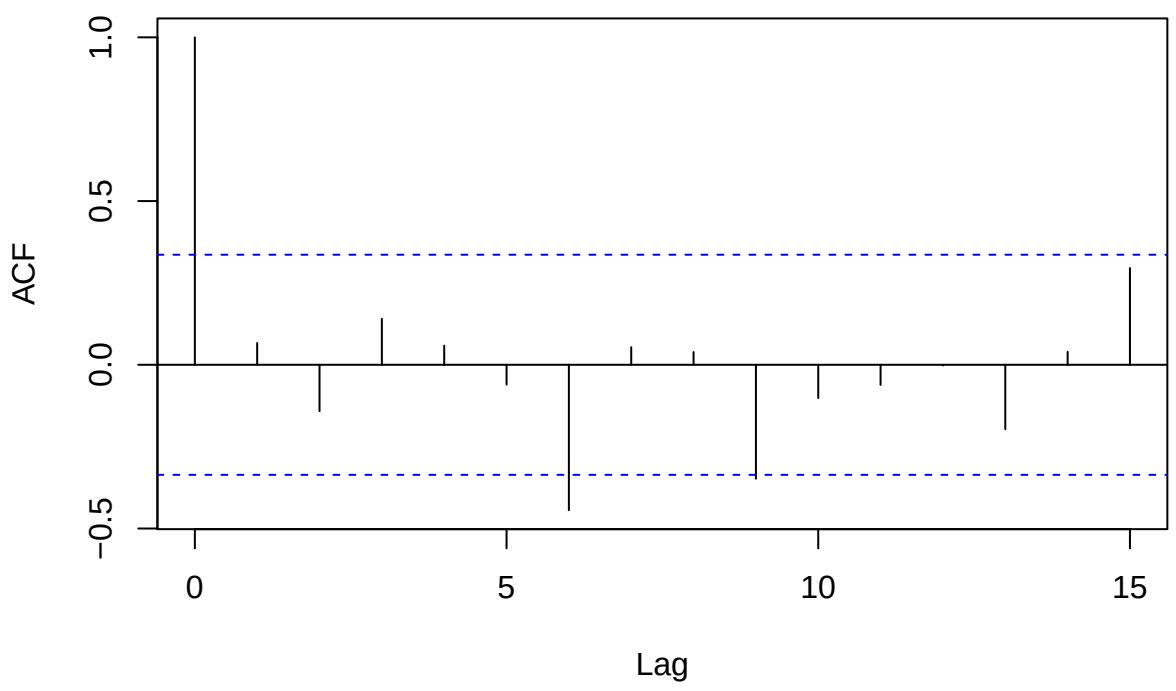

```
layout(1)
sd_error=numeric(3)
for(i in 1:3) sd_error[i] = sd(cm1df[,as.character(paste0('res',i))],na.rm =T)
plot(c(1:3), sd_error,
     xlab = 'No. of previous terms(complexity)',ylab = 'SD of residual',type = 'b')
```




```
#plot shows how residuals get lowered at the expense of greater complexity

#uncomment the code below to avoid copying and pasting
#!!!Note that this is usually not encouraged because it is unintuitive
#(to avoid copying and pasting lag1=...,fit1...)
#for(i in 1:3){
#  indp = paste0('lag',1:i)
#  sapply(indp,paste,sep = "+")
#  assign(paste0('fit',i),lm(as.formula(paste('cm1 ~ t +',indp))))
#}
#  for(i in 1:3) print(summary(eval(parse(text = paste0('fit',i)))))


# plot autocovariance function for these residuals
#require(graphics)
#layout(1:3)
for(i in 1:3) acf(cm1df[(i+1):nrow(cm1df),paste0('res',i)])
```


Series cm1df[(i + 1):nrow(cm1df), paste0("res", i)]
ACF
0.8
0.4
0.0
−0.4
0
5
10
15
Lag


Series cm1df[(i + 1):nrow(cm1df), paste0("res", i)]
ACF
1.0
0.5
0.0
−0.5
0
5
10
15
Lag

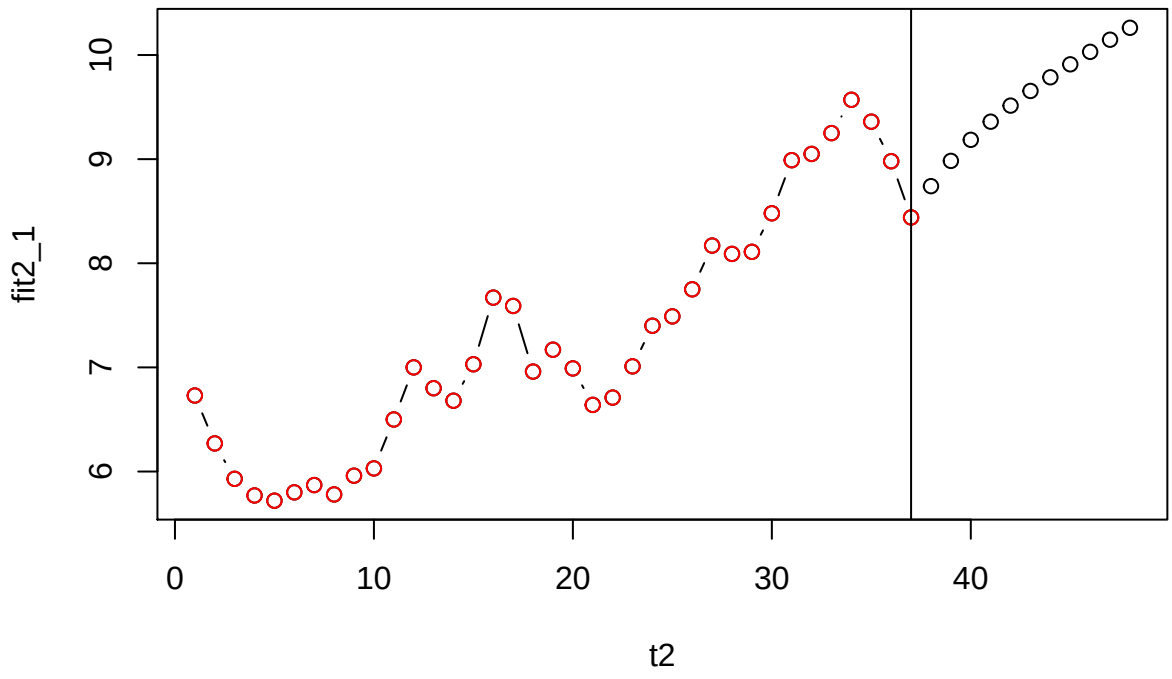


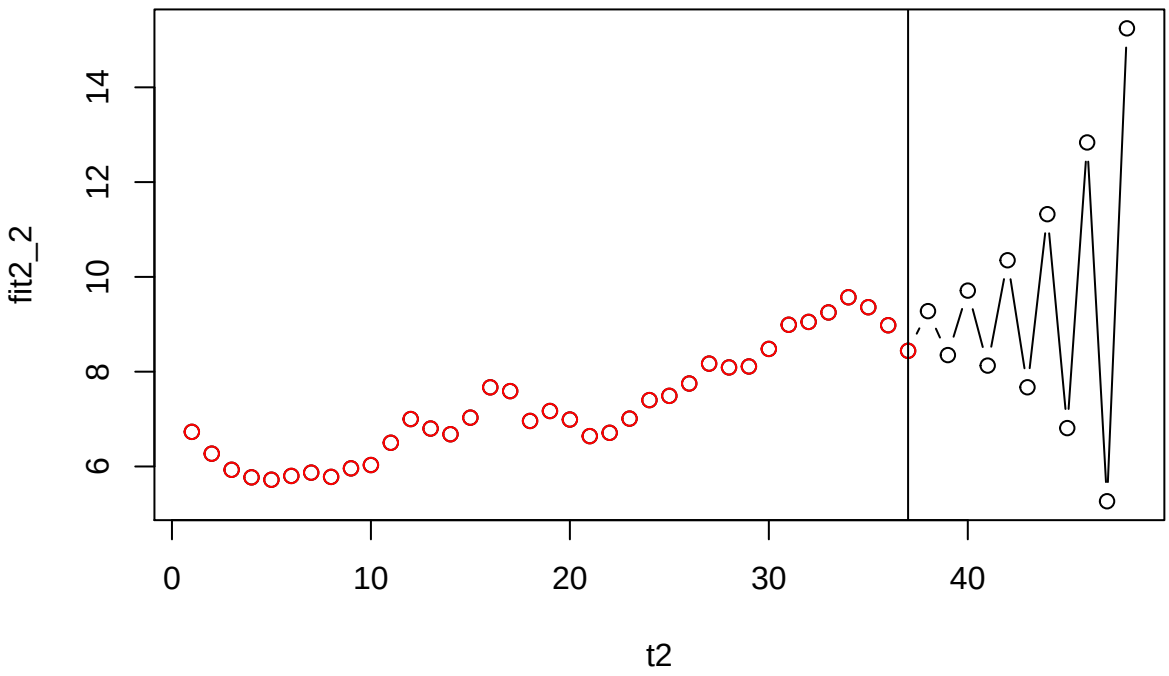

```
#acf(e1)


# forecast cm1 for May 1990
for(i in 1:3) {
  assign(paste0('coef',i),coef(get(paste0('fit',i))))
 print(get(paste0('coef',i)))
 }
```

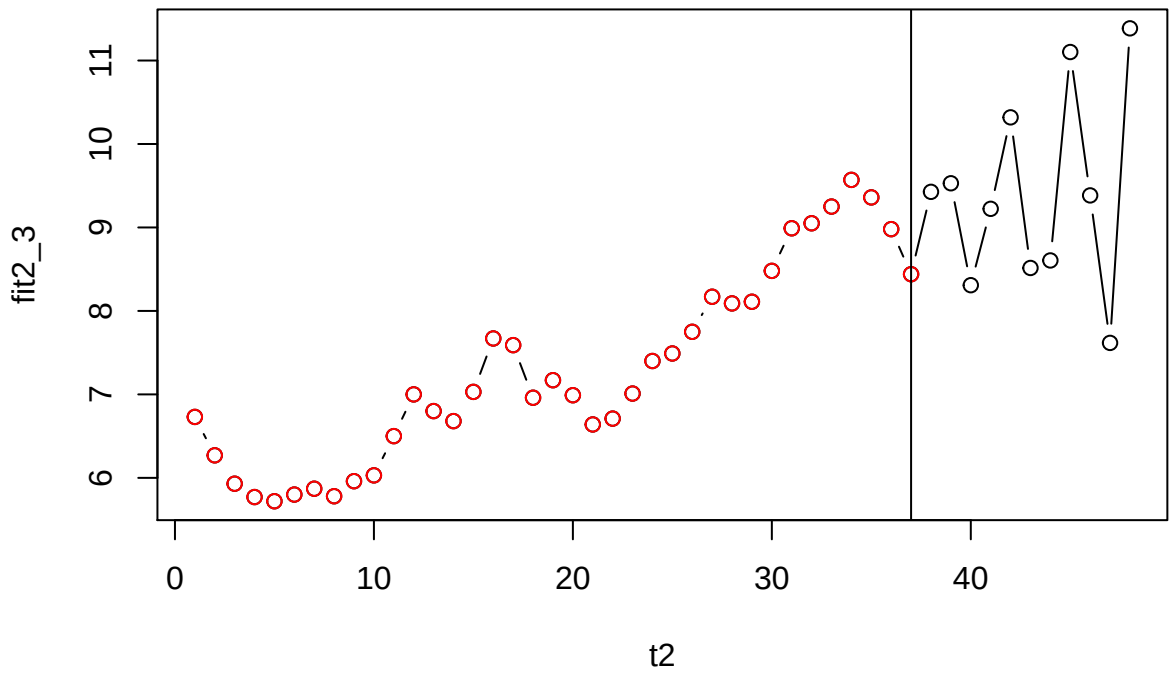
```
## (Intercept)           t        lag1
##   1.5986595   0.0329880   0.6976681
## (Intercept)           t        lag1        lag2
##  1.78482453  0.03300389  1.10359733 -0.43506006
## (Intercept)           t        lag1        lag2        lag3
##  1.63315690  0.03188948  1.17110722 -0.64645712  0.16888861
```

```
nf=11#n of forcast
t2=seq(1,n+nf,1)
for(i in 1:3){
  #for every model
  cm1f = c(cm1,numeric(nf))
  #for(k in 1:i){
   #   #for every lag
    #  coeflag = c(coeflag,get(paste0('coef',k))[paste0('lag',k)])
    #}
```

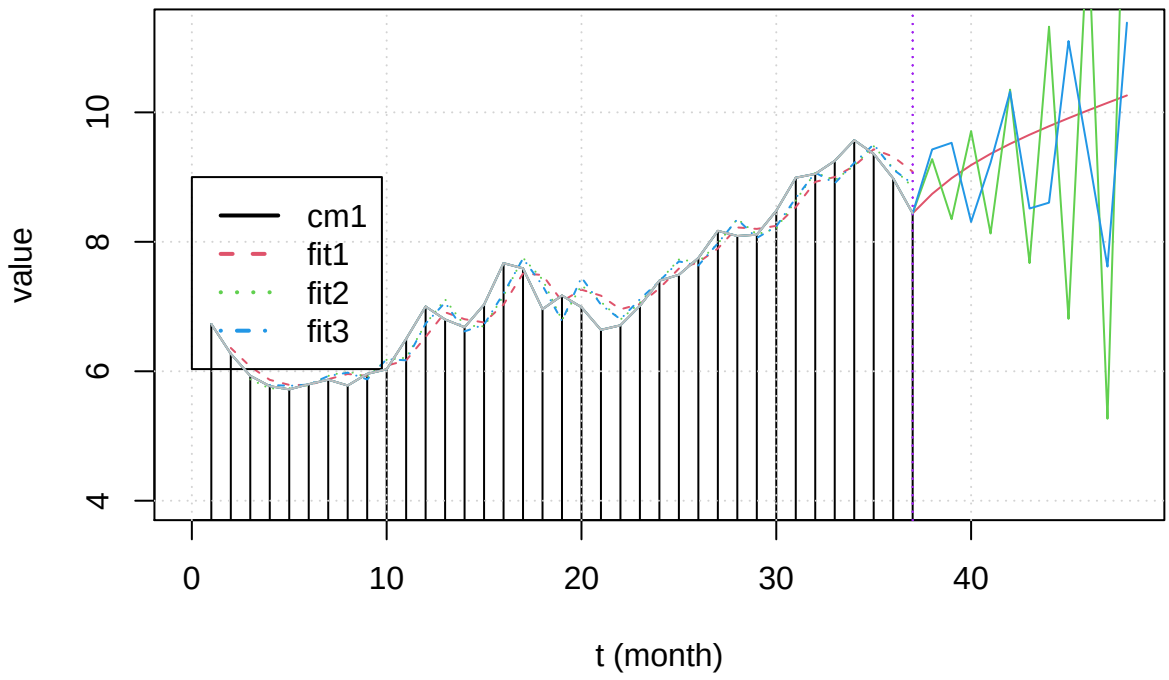
```r
  for(j in n+1:nf){
    #for every ts term


    #cm1flag = NULL
    #for(k in 1:i){
      #for every lag
    cm1flag= cm1f[(j-i):(j-1)]
    cm1f[j] = sum(get(paste0('coef',i))*c(1,t2[j],cm1flag))
  }
  assign(paste0('cm1f',i),cm1f)
  #fit2 = numeric(length(cm1f))
  #for(j in n+i:nf){
  #  fit2[j] = sum(get(paste0('coef',i))*c(1,t2[j],cm1f[(j-i+1):(j)]))
  #}
  assign(paste0('fit2_',i),fit2)
}
#layout(1:3)
for(i in 1:3){
  plot(t2,get(paste0('cm1f',i)),ylab=paste0('fit2_',i), type ='b')
  points(t,cm1,col = 'red')
  abline(v = n)
}
```




fit2_2
6
8
10
12
14
0
10
20
30
40
t2




```
layout(1)
cm1pred = c('cm1','fit1','fit2','fit3')
matplot(x=cm1df[,'t'],y=cm1df[,cm1pred],type = c('h','l','l','l'),lty = 1:4,col =1:4,
        xlab = 't (month)',ylab = 'value',
        xlim = c(0,n+nf),
        ylim = c(min(cm1) - 1.5*sd(cm1),
                 (max(cm1)+1.5*sd(cm1))))
grid()
legend(0,9,legend = cm1pred,lwd=2,col = 1:4,lty = 1:4)
for(i in 1:3){
  lines(t2,get(paste0('cm1f',i)),ylab=paste0('fit2_',i), type ='l',col = i+1)
  #points(t,cm1,col = 'red')
  abline(v = n,col = 'purple',lty = 3)
}
lines(t,cm1,col = 'grey')
```




```
for(i in 1:3) {
  print(i)
  print(get(paste0('cm1f',i)))
}
```

```
## [1] 1
##  [1]  6.730000  6.270000  5.930000  5.770000  5.720000  5.800000  5.870000
##  [8]  5.780000  5.960000  6.030000  6.500000  7.000000  6.800000  6.680000
## [15]  7.030000  7.670000  7.590000  6.960000  7.170000  6.990000  6.640000
## [22]  6.710000  7.010000  7.400000  7.490000  7.750000  8.170000  8.090000
## [29]  8.110000  8.480000  8.990000  9.050000  9.250000  9.570000  9.360000
## [36]  8.980000  8.440000  8.740522  8.983175  9.185455  9.359566  9.514027
## [43]  9.654777  9.785961  9.910473 10.030328 10.146936 10.261277
## [1] 2
##  [1]  6.730000  6.270000  5.930000  5.770000  5.720000  5.800000  5.870000
##  [8]  5.780000  5.960000  6.030000  6.500000  7.000000  6.800000  6.680000
## [15]  7.030000  7.670000  7.590000  6.960000  7.170000  6.990000  6.640000
## [22]  6.710000  7.010000  7.400000  7.490000  7.750000  8.170000  8.090000
## [29]  8.110000  8.480000  8.990000  9.050000  9.250000  9.570000  9.360000
## [36]  8.980000  8.440000  9.277369  8.350125  9.710655  8.128442 10.351280
## [43]  7.671090 11.323256  6.809497 12.836778  5.266181 15.244541
## [1] 3
##  [1]  6.730000  6.270000  5.930000  5.770000  5.720000  5.800000  5.870000
##  [8]  5.780000  5.960000  6.030000  6.500000  7.000000  6.800000  6.680000
## [15]  7.030000  7.670000  7.590000  6.960000  7.170000  6.990000  6.640000
## [22]  6.710000  7.010000  7.400000  7.490000  7.750000  8.170000  8.090000
```

```
## [29]  8.110000  8.480000  8.990000  9.050000  9.250000  9.570000  9.360000
## [36]  8.980000  8.440000  9.426756  9.529363  8.308289  9.223218 10.319165
## [43]  8.514676  8.604805 11.101913  9.384021  7.617056 11.385450
```