HW 9 ARIMA

2022-11-14

```
library(fpp)
```

```
## Loading required package: forecast
```

```
## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

```
## Loading required package: fma
```

```
## Loading required package: expsmooth
```

```
## Loading required package: lmtest
```

```
## Loading required package: zoo
```

```
##
## Attaching package: 'zoo'
```

```
## The following objects are masked from 'package:base':
##
##     as.Date, as.Date.numeric
```

```
## Loading required package: tseries
```

```
library(fpp2)
```

```
## -- Attaching packages --------------------------------------------- fpp2 2.4 --
```

```
## v ggplot2 3.3.6
```

```
##
```

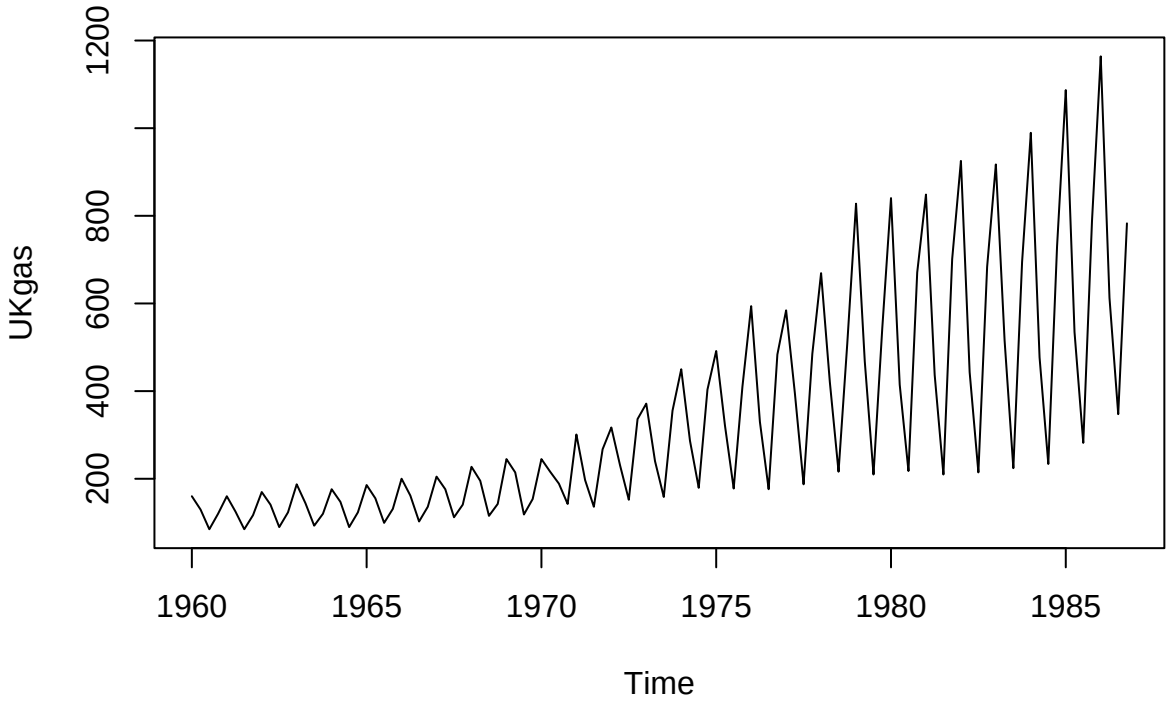
```
##
## Attaching package: 'fpp2'
```

```
## The following objects are masked from 'package:fpp':
##
##     ausair, ausbeer, austa, austourists, debitcards, departures,
##     elecequip, euretail, guinearice, oil, sunspotarea, usmelec
```

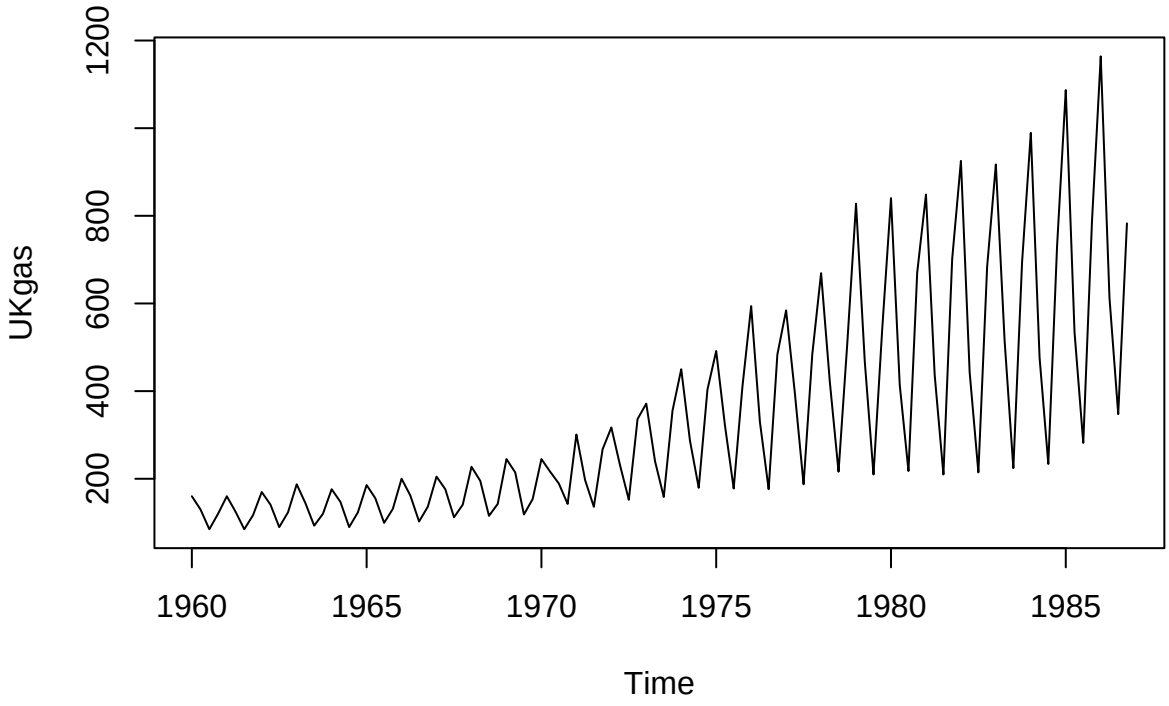
```
library(forecast)

UKgas
```

```
##        Qtr1   Qtr2   Qtr3   Qtr4
## 1960  160.1  129.7   84.8  120.1
## 1961  160.1  124.9   84.8  116.9
## 1962  169.7  140.9   89.7  123.3
## 1963  187.3  144.1   92.9  120.1
## 1964  176.1  147.3   89.7  123.3
## 1965  185.7  155.3   99.3  131.3
## 1966  200.1  161.7  102.5  136.1
## 1967  204.9  176.1  112.1  140.9
## 1968  227.3  195.3  115.3  142.5
## 1969  244.9  214.5  118.5  153.7
## 1970  244.9  216.1  188.9  142.5
## 1971  301.0  196.9  136.1  267.3
## 1972  317.0  230.5  152.1  336.2
## 1973  371.4  240.1  158.5  355.4
## 1974  449.9  286.6  179.3  403.4
## 1975  491.5  321.8  177.7  409.8
## 1976  593.9  329.8  176.1  483.5
## 1977  584.3  395.4  187.3  485.1
## 1978  669.2  421.0  216.1  509.1
## 1979  827.7  467.5  209.7  542.7
## 1980  840.5  414.6  217.7  670.8
## 1981  848.5  437.0  209.7  701.2
## 1982  925.3  443.4  214.5  683.6
## 1983  917.3  515.5  224.1  694.8
## 1984  989.4  477.1  233.7  730.0
## 1985 1087.0  534.7  281.8  787.6
## 1986 1163.9  613.1  347.4  782.8
```

```
plot(UKgas)
```




```
plot(UKgas)
```



R Markdown

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see http://rmarkdown.rstudio.com.

When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

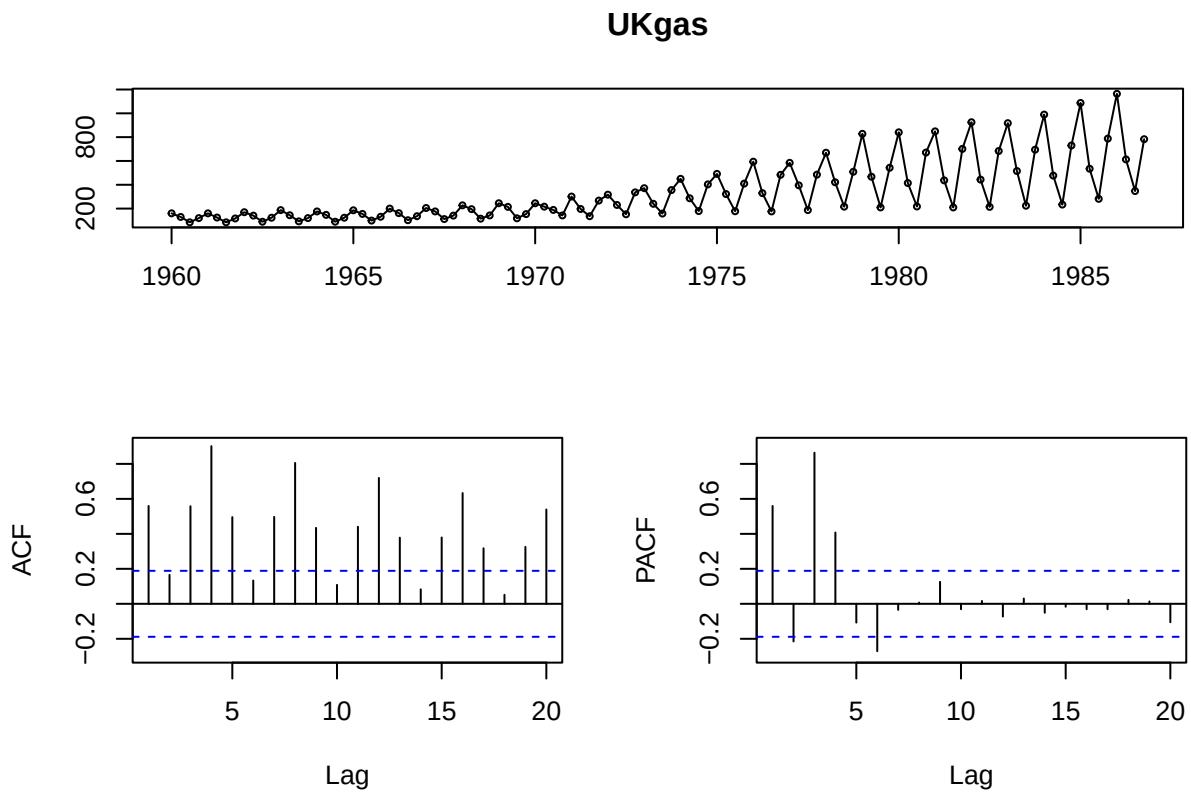
```
ndiffs(UKgas)
```

```
## [1] 1
```

Including Plots

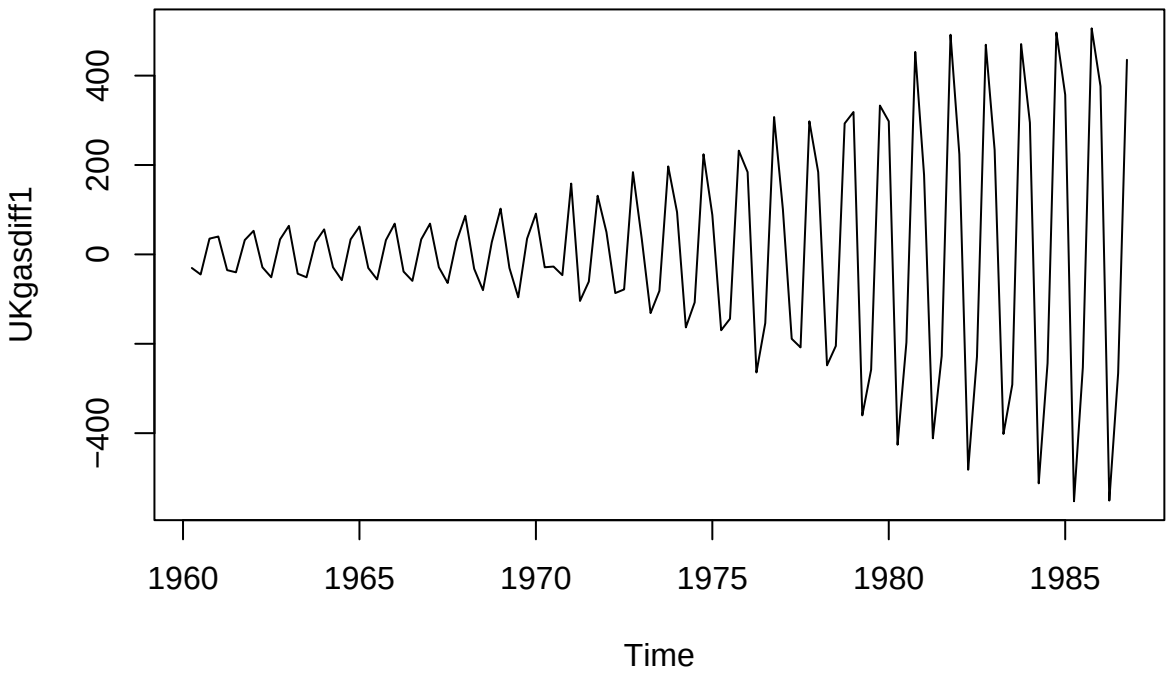
You can also embed plots, for example:

```
tsdisplay(UKgas)
```

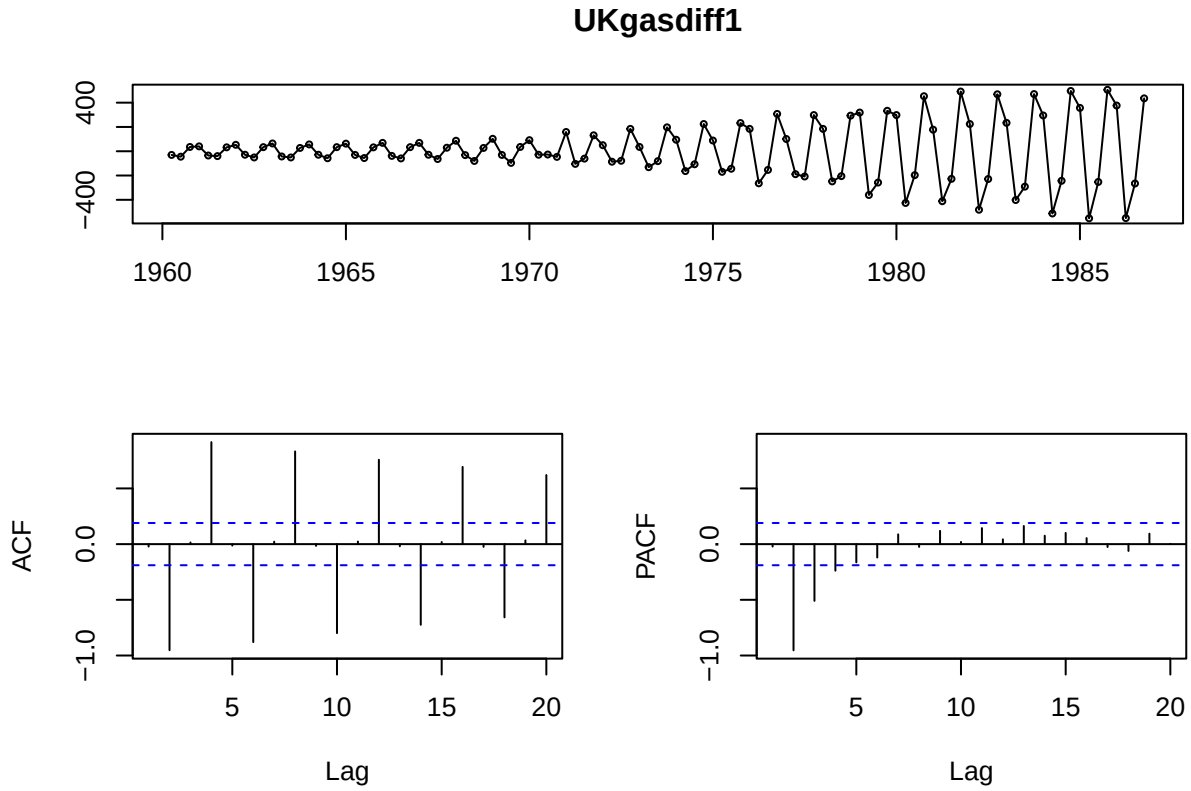


Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.

```
UKgasdiff1 <- diff(UKgas, differences=1)
plot(UKgasdiff1)
```




```
tsdisplay(UKgasdiff1)
```




```
auto_fit <- auto.arima(UKgas, trace=TRUE, stepwise = FALSE)
```

```
##
##  ARIMA(0,1,0)(0,1,0)[4]                     : 1099.253
##  ARIMA(0,1,0)(0,1,1)[4]                     : 1100.167
##  ARIMA(0,1,0)(0,1,2)[4]                     : 1102.189
##  ARIMA(0,1,0)(1,1,0)[4]                     : 1100.125
##  ARIMA(0,1,0)(1,1,1)[4]                     : 1102.248
##  ARIMA(0,1,0)(1,1,2)[4]                     : Inf
##  ARIMA(0,1,0)(2,1,0)[4]                     : 1102.247
##  ARIMA(0,1,0)(2,1,1)[4]                     : Inf
##  ARIMA(0,1,0)(2,1,2)[4]                     : Inf
##  ARIMA(0,1,1)(0,1,0)[4]                     : 1030.795
##  ARIMA(0,1,1)(0,1,1)[4]                     : 1032.911
##  ARIMA(0,1,1)(0,1,2)[4]                     : 1034.826
##  ARIMA(0,1,1)(1,1,0)[4]                     : 1032.91
##  ARIMA(0,1,1)(1,1,1)[4]                     : Inf
##  ARIMA(0,1,1)(1,1,2)[4]                     : 1030.945
##  ARIMA(0,1,1)(2,1,0)[4]                     : 1034.734
##  ARIMA(0,1,1)(2,1,1)[4]                     : Inf
##  ARIMA(0,1,1)(2,1,2)[4]                     : Inf
##  ARIMA(0,1,2)(0,1,0)[4]                     : 1031.488
##  ARIMA(0,1,2)(0,1,1)[4]                     : 1033.598
##  ARIMA(0,1,2)(0,1,2)[4]                     : 1035.571
##  ARIMA(0,1,2)(1,1,0)[4]                     : 1033.592
```

```
##  ARIMA(0,1,2)(1,1,1)[4]                    : Inf
##  ARIMA(0,1,2)(1,1,2)[4]                    : 1032.218
##  ARIMA(0,1,2)(2,1,0)[4]                    : 1035.435
##  ARIMA(0,1,2)(2,1,1)[4]                    : Inf
##  ARIMA(0,1,3)(0,1,0)[4]                    : 1029.485
##  ARIMA(0,1,3)(0,1,1)[4]                    : 1031.179
##  ARIMA(0,1,3)(0,1,2)[4]                    : 1033.432
##  ARIMA(0,1,3)(1,1,0)[4]                    : 1031.185
##  ARIMA(0,1,3)(1,1,1)[4]                    : 1033.434
##  ARIMA(0,1,3)(2,1,0)[4]                    : 1033.42
##  ARIMA(1,1,0)(0,1,0)[4]                    : 1077.142
##  ARIMA(1,1,0)(0,1,1)[4]                    : 1079.095
##  ARIMA(1,1,0)(0,1,2)[4]                    : 1080.973
##  ARIMA(1,1,0)(1,1,0)[4]                    : 1079.071
##  ARIMA(1,1,0)(1,1,1)[4]                    : Inf
##  ARIMA(1,1,0)(1,1,2)[4]                    : 1074.719
##  ARIMA(1,1,0)(2,1,0)[4]                    : 1080.727
##  ARIMA(1,1,0)(2,1,1)[4]                    : Inf
##  ARIMA(1,1,0)(2,1,2)[4]                    : Inf
##  ARIMA(1,1,1)(0,1,0)[4]                    : 1032.078
##  ARIMA(1,1,1)(0,1,1)[4]                    : 1034.186
##  ARIMA(1,1,1)(0,1,2)[4]                    : 1036.14
##  ARIMA(1,1,1)(1,1,0)[4]                    : 1034.178
##  ARIMA(1,1,1)(1,1,1)[4]                    : Inf
##  ARIMA(1,1,1)(1,1,2)[4]                    : 1032.485
##  ARIMA(1,1,1)(2,1,0)[4]                    : 1035.989
##  ARIMA(1,1,1)(2,1,1)[4]                    : Inf
##  ARIMA(1,1,2)(0,1,0)[4]                    : 1032.042
##  ARIMA(1,1,2)(0,1,1)[4]                    : 1034.252
##  ARIMA(1,1,2)(0,1,2)[4]                    : 1036.383
##  ARIMA(1,1,2)(1,1,0)[4]                    : Inf
##  ARIMA(1,1,2)(1,1,1)[4]                    : Inf
##  ARIMA(1,1,2)(2,1,0)[4]                    : 1036.348
##  ARIMA(1,1,3)(0,1,0)[4]                    : Inf
##  ARIMA(1,1,3)(0,1,1)[4]                    : Inf
##  ARIMA(1,1,3)(1,1,0)[4]                    : Inf
##  ARIMA(2,1,0)(0,1,0)[4]                    : 1054.077
##  ARIMA(2,1,0)(0,1,1)[4]                    : 1056.241
##  ARIMA(2,1,0)(0,1,2)[4]                    : 1058.435
##  ARIMA(2,1,0)(1,1,0)[4]                    : 1056.241
##  ARIMA(2,1,0)(1,1,1)[4]                    : Inf
##  ARIMA(2,1,0)(1,1,2)[4]                    : Inf
##  ARIMA(2,1,0)(2,1,0)[4]                    : 1058.424
##  ARIMA(2,1,0)(2,1,1)[4]                    : Inf
##  ARIMA(2,1,1)(0,1,0)[4]                    : 1029.697
##  ARIMA(2,1,1)(0,1,1)[4]                    : 1031.031
##  ARIMA(2,1,1)(0,1,2)[4]                    : 1033.252
##  ARIMA(2,1,1)(1,1,0)[4]                    : 1031.028
##  ARIMA(2,1,1)(1,1,1)[4]                    : 1033.273
##  ARIMA(2,1,1)(2,1,0)[4]                    : 1033.251
##  ARIMA(2,1,2)(0,1,0)[4]                    : Inf
##  ARIMA(2,1,2)(0,1,1)[4]                    : 1032.349
##  ARIMA(2,1,2)(1,1,0)[4]                    : Inf
##  ARIMA(2,1,3)(0,1,0)[4]                    : Inf
```

```
##  ARIMA(3,1,0)(0,1,0)[4]                    : 1048.368
##  ARIMA(3,1,0)(0,1,1)[4]                    : 1027.279
##  ARIMA(3,1,0)(0,1,2)[4]                    : 1028.564
##  ARIMA(3,1,0)(1,1,0)[4]                    : 1039.702
##  ARIMA(3,1,0)(1,1,1)[4]                    : 1028.809
##  ARIMA(3,1,0)(2,1,0)[4]                    : 1034.455
##  ARIMA(3,1,1)(0,1,0)[4]                    : 1031.906
##  ARIMA(3,1,1)(0,1,1)[4]                    : 1025.717
##  ARIMA(3,1,1)(1,1,0)[4]                    : 1031.733
##  ARIMA(3,1,2)(0,1,0)[4]                    : Inf
##
##
##
##  Best model: ARIMA(3,1,1)(0,1,1)[4]
```

```
auto_fit
```

```
## Series: UKgas
## ARIMA(3,1,1)(0,1,1)[4]
##
## Coefficients:
##           ar1      ar2      ar3      ma1     sma1
##       -0.6938  -0.9083  -0.6588  -0.2470  -0.7296
## s.e.   0.1070   0.0691   0.1151   0.1289   0.1080
##
## sigma^2 = 1115:  log likelihood = -506.42
## AIC=1024.84   AICc=1025.72   BIC=1040.65
```

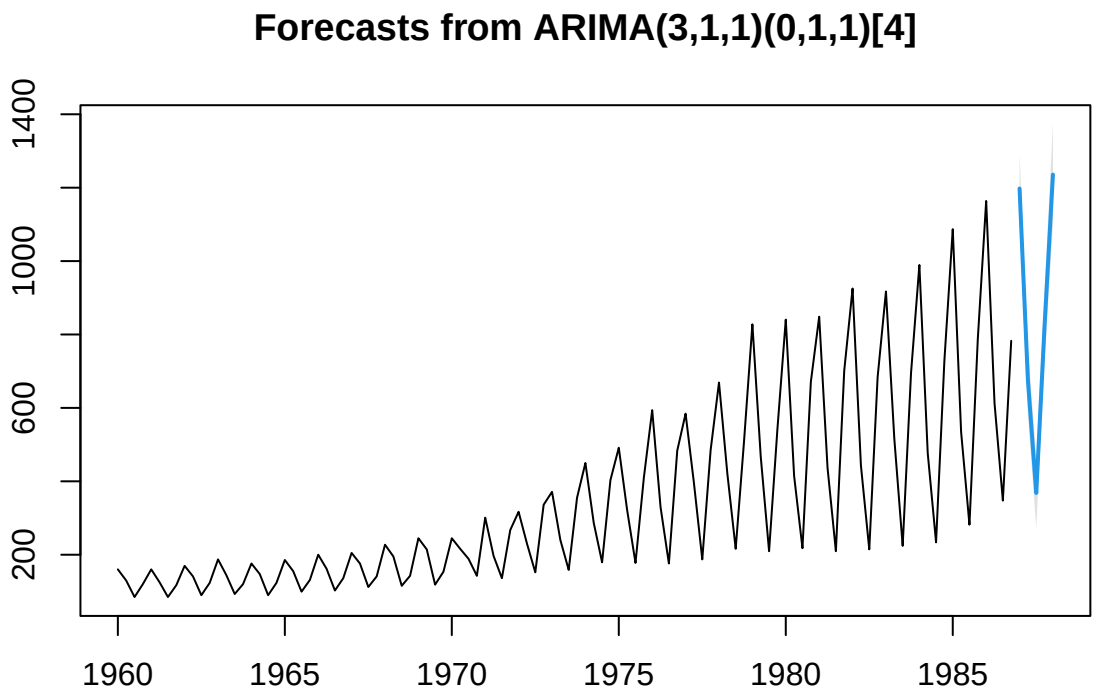
```
auto_fit
```

```
## Series: UKgas
## ARIMA(3,1,1)(0,1,1)[4]
##
## Coefficients:
##           ar1      ar2      ar3      ma1     sma1
##       -0.6938  -0.9083  -0.6588  -0.2470  -0.7296
## s.e.   0.1070   0.0691   0.1151   0.1289   0.1080
##
## sigma^2 = 1115:  log likelihood = -506.42
## AIC=1024.84   AICc=1025.72   BIC=1040.65
```

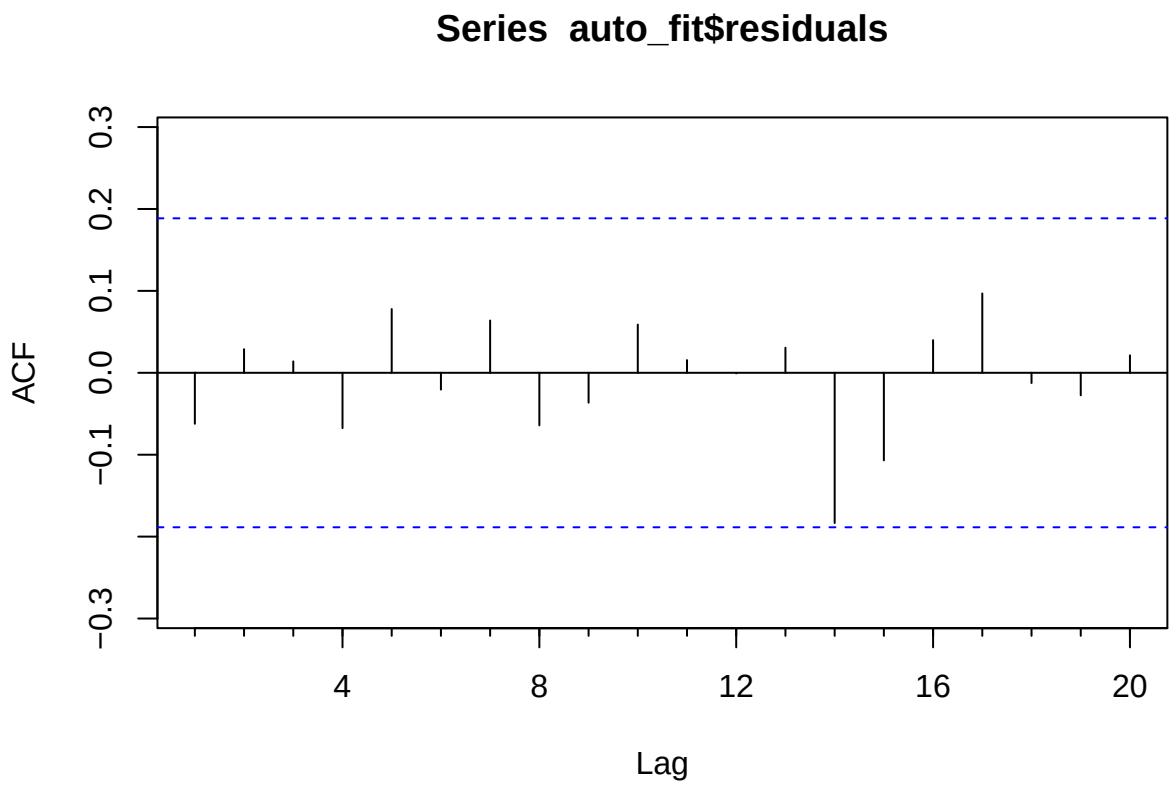
```
attributes(auto_fit)
```

```
## $names
##  [1] "coef"      "sigma2"    "var.coef"  "mask"      "loglik"    "aic"
##  [7] "arma"      "residuals" "call"      "series"    "code"      "n.cond"
## [13] "nobs"      "model"     "bic"       "aicc"      "x"         "fitted"
##
## $class
## [1] "forecast_ARIMA" "ARIMA"          "Arima"
```

```
plot(forecast(auto_fit,h=5,level=c(99.5)))
```



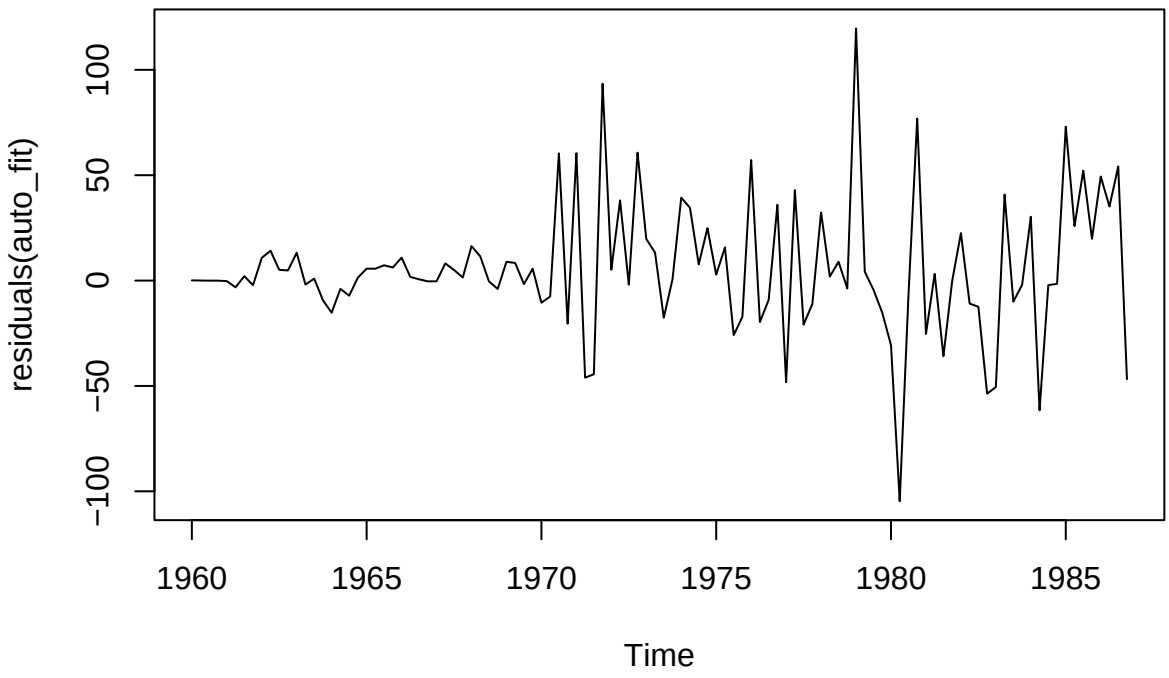

```
#Residual Analysis
Acf(auto_fit$residuals)
```



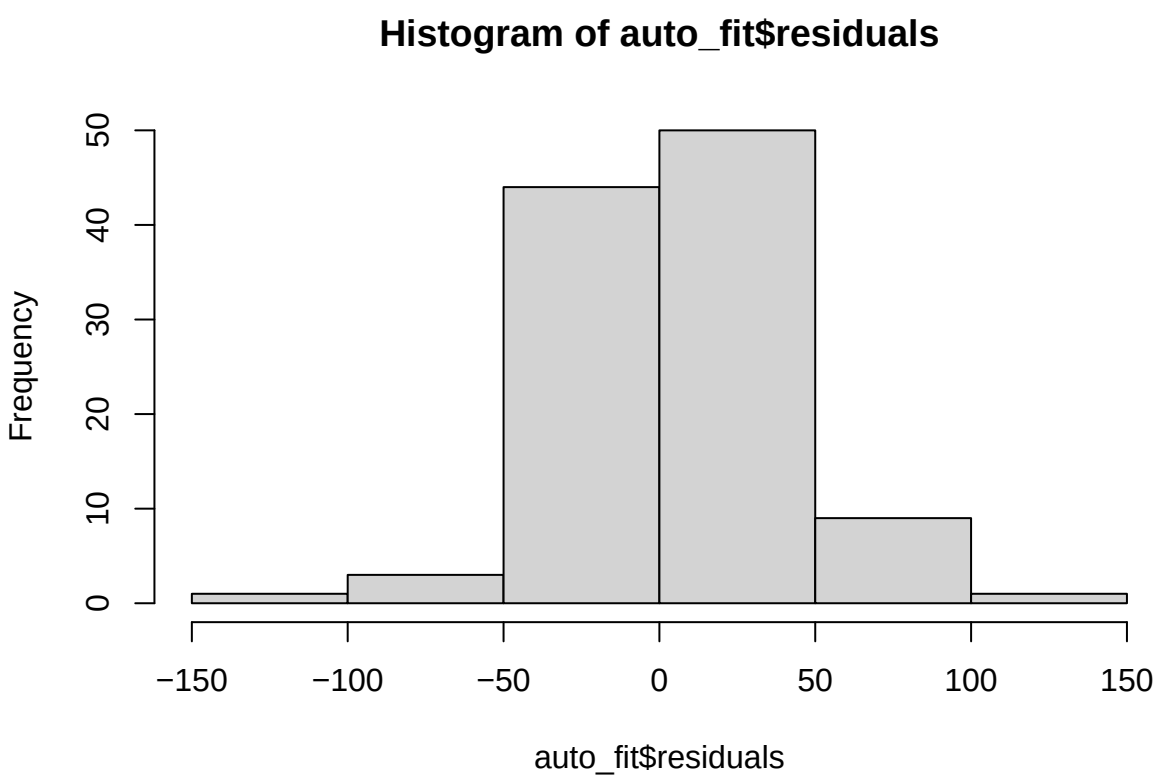

```
Box.test(residuals(auto_fit), lag=20, type="Ljung")
```

```
##
##  Box-Ljung test
##
## data:  residuals(auto_fit)
## X-squared = 10.837, df = 20, p-value = 0.9503
```

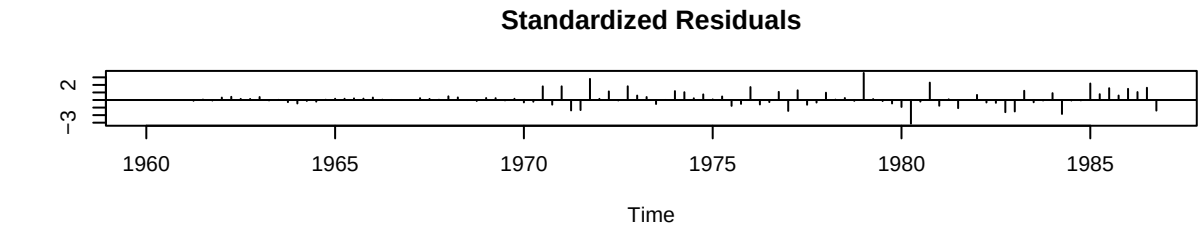
```
plot.ts(residuals(auto_fit))
```

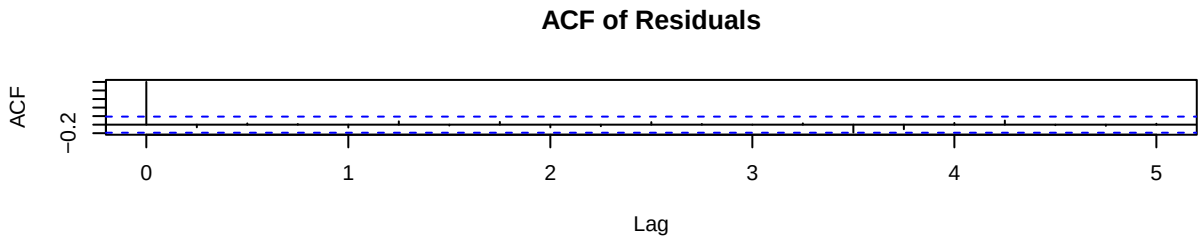


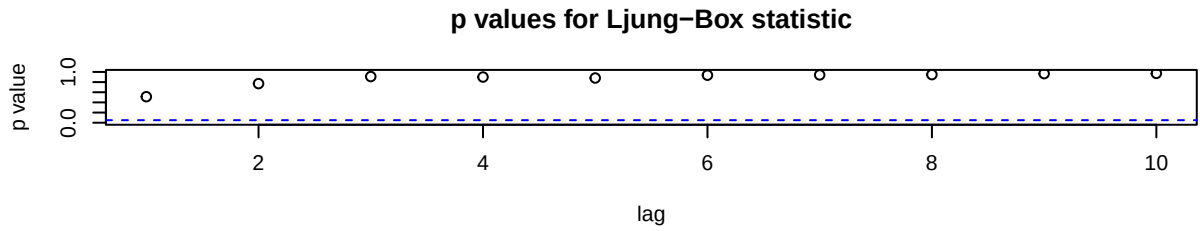

```
hist(auto_fit$residuals)
```



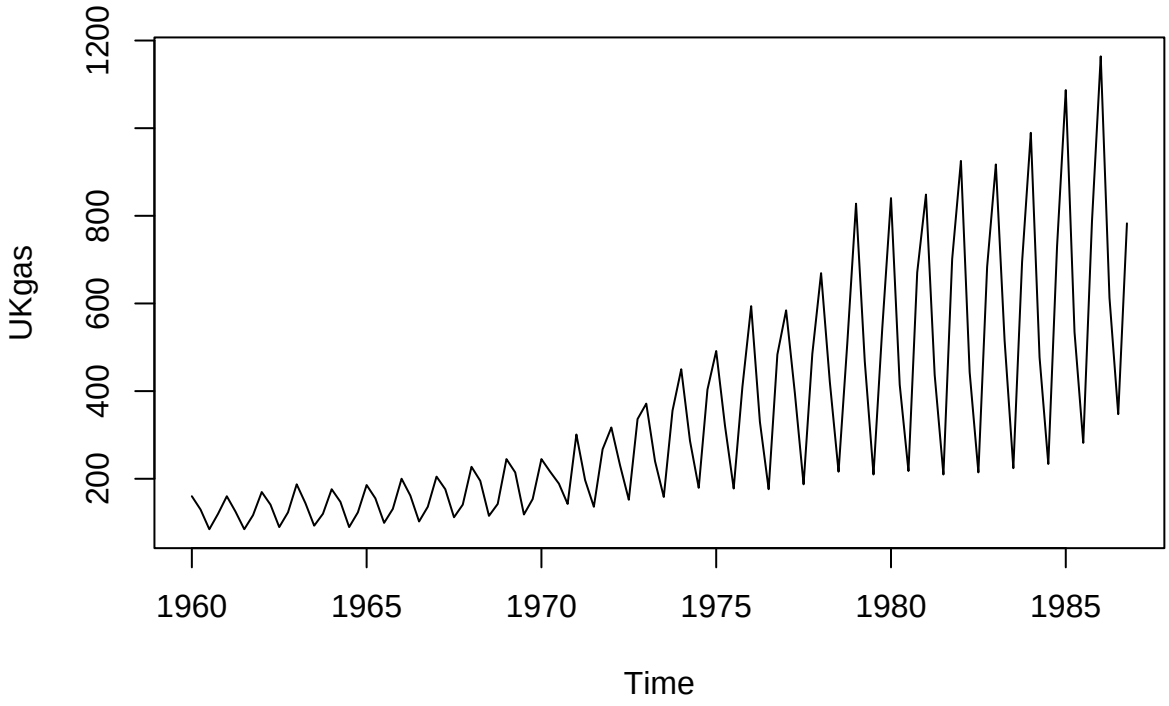

```
tsdiag(auto_fit)
```








```
#Seasonal Data
plot(UKgas)
```




```
#Seasonal Data
nsdiffs(UKgas)
```

```
## [1] 1
```

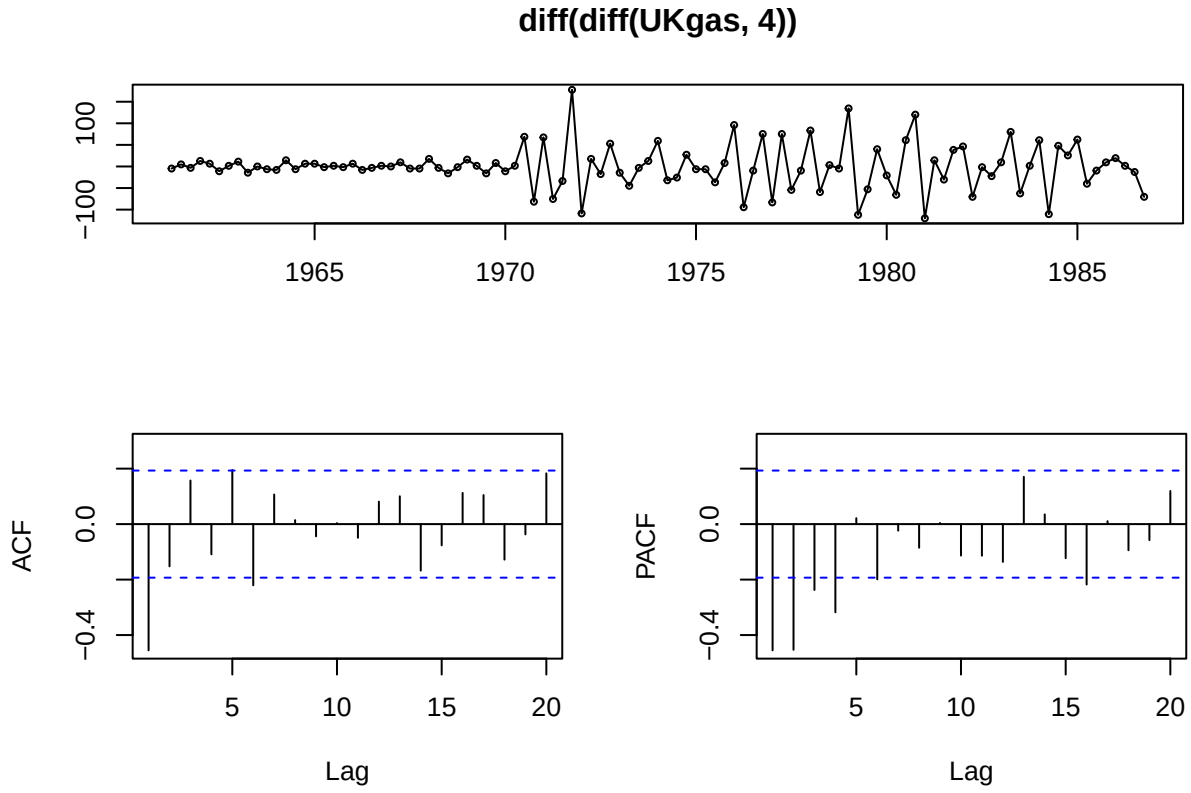
```
#Seasonal Data

ndiffs(euretail)
```

```
## [1] 2
```

```
#Seasonal Data

ndiffs((diff(UKgas,4)))
```

```
## [1] 1
```

```
#Seasonal Data



tsdisplay(diff(diff(UKgas,4)))
```




```
#Seasonal Data

fit3 <- auto.arima(UKgas,trace=TRUE, stepwise = FALSE )
```

```
##
##  ARIMA(0,1,0)(0,1,0)[4]                    : 1099.253
##  ARIMA(0,1,0)(0,1,1)[4]                    : 1100.167
##  ARIMA(0,1,0)(0,1,2)[4]                    : 1102.189
##  ARIMA(0,1,0)(1,1,0)[4]                    : 1100.125
##  ARIMA(0,1,0)(1,1,1)[4]                    : 1102.248
##  ARIMA(0,1,0)(1,1,2)[4]                    : Inf
##  ARIMA(0,1,0)(2,1,0)[4]                    : 1102.247
##  ARIMA(0,1,0)(2,1,1)[4]                    : Inf
##  ARIMA(0,1,0)(2,1,2)[4]                    : Inf
##  ARIMA(0,1,1)(0,1,0)[4]                    : 1030.795
##  ARIMA(0,1,1)(0,1,1)[4]                    : 1032.911
##  ARIMA(0,1,1)(0,1,2)[4]                    : 1034.826
##  ARIMA(0,1,1)(1,1,0)[4]                    : 1032.91
##  ARIMA(0,1,1)(1,1,1)[4]                    : Inf
##  ARIMA(0,1,1)(1,1,2)[4]                    : 1030.945
##  ARIMA(0,1,1)(2,1,0)[4]                    : 1034.734
##  ARIMA(0,1,1)(2,1,1)[4]                    : Inf
##  ARIMA(0,1,1)(2,1,2)[4]                    : Inf
##  ARIMA(0,1,2)(0,1,0)[4]                    : 1031.488
##  ARIMA(0,1,2)(0,1,1)[4]                    : 1033.598
##  ARIMA(0,1,2)(0,1,2)[4]                    : 1035.571
```

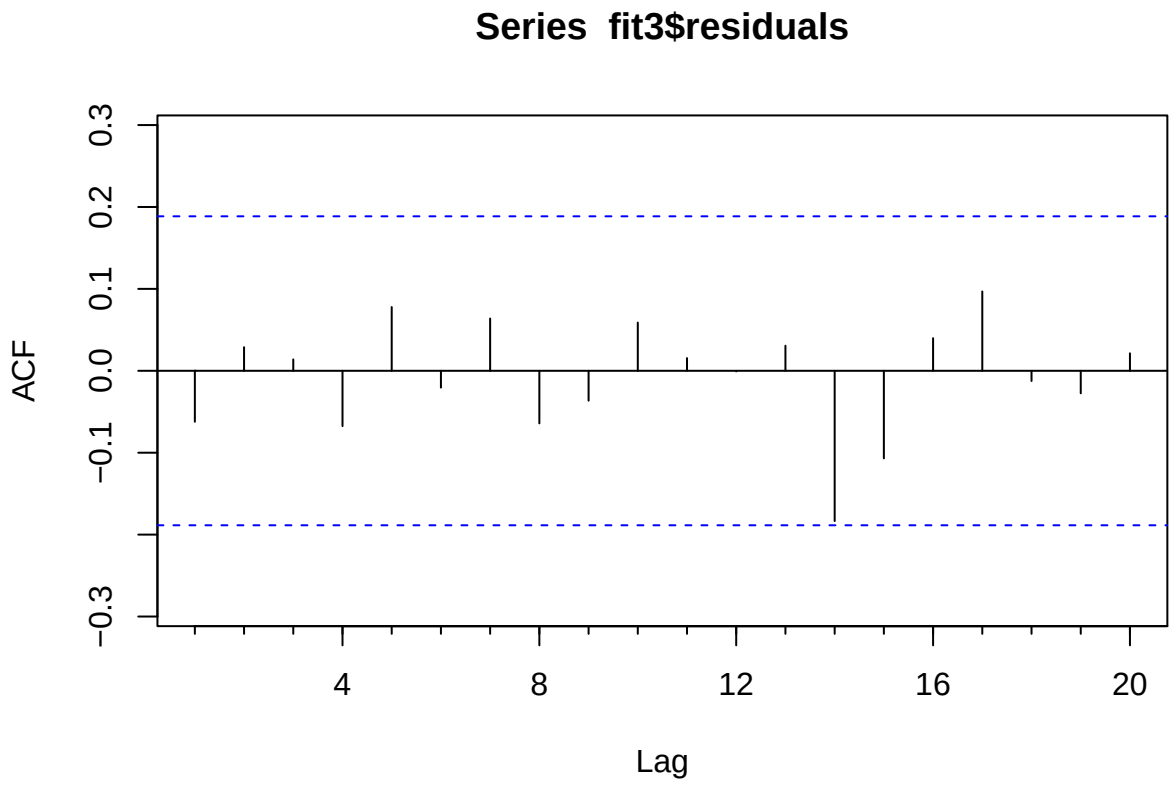
```
##  ARIMA(0,1,2)(1,1,0)[4]                    : 1033.592
##  ARIMA(0,1,2)(1,1,1)[4]                    : Inf
##  ARIMA(0,1,2)(1,1,2)[4]                    : 1032.218
##  ARIMA(0,1,2)(2,1,0)[4]                    : 1035.435
##  ARIMA(0,1,2)(2,1,1)[4]                    : Inf
##  ARIMA(0,1,3)(0,1,0)[4]                    : 1029.485
##  ARIMA(0,1,3)(0,1,1)[4]                    : 1031.179
##  ARIMA(0,1,3)(0,1,2)[4]                    : 1033.432
##  ARIMA(0,1,3)(1,1,0)[4]                    : 1031.185
##  ARIMA(0,1,3)(1,1,1)[4]                    : 1033.434
##  ARIMA(0,1,3)(2,1,0)[4]                    : 1033.42
##  ARIMA(1,1,0)(0,1,0)[4]                    : 1077.142
##  ARIMA(1,1,0)(0,1,1)[4]                    : 1079.095
##  ARIMA(1,1,0)(0,1,2)[4]                    : 1080.973
##  ARIMA(1,1,0)(1,1,0)[4]                    : 1079.071
##  ARIMA(1,1,0)(1,1,1)[4]                    : Inf
##  ARIMA(1,1,0)(1,1,2)[4]                    : 1074.719
##  ARIMA(1,1,0)(2,1,0)[4]                    : 1080.727
##  ARIMA(1,1,0)(2,1,1)[4]                    : Inf
##  ARIMA(1,1,0)(2,1,2)[4]                    : Inf
##  ARIMA(1,1,1)(0,1,0)[4]                    : 1032.078
##  ARIMA(1,1,1)(0,1,1)[4]                    : 1034.186
##  ARIMA(1,1,1)(0,1,2)[4]                    : 1036.14
##  ARIMA(1,1,1)(1,1,0)[4]                    : 1034.178
##  ARIMA(1,1,1)(1,1,1)[4]                    : Inf
##  ARIMA(1,1,1)(1,1,2)[4]                    : 1032.485
##  ARIMA(1,1,1)(2,1,0)[4]                    : 1035.989
##  ARIMA(1,1,1)(2,1,1)[4]                    : Inf
##  ARIMA(1,1,2)(0,1,0)[4]                    : 1032.042
##  ARIMA(1,1,2)(0,1,1)[4]                    : 1034.252
##  ARIMA(1,1,2)(0,1,2)[4]                    : 1036.383
##  ARIMA(1,1,2)(1,1,0)[4]                    : Inf
##  ARIMA(1,1,2)(1,1,1)[4]                    : Inf
##  ARIMA(1,1,2)(2,1,0)[4]                    : 1036.348
##  ARIMA(1,1,3)(0,1,0)[4]                    : Inf
##  ARIMA(1,1,3)(0,1,1)[4]                    : Inf
##  ARIMA(1,1,3)(1,1,0)[4]                    : Inf
##  ARIMA(2,1,0)(0,1,0)[4]                    : 1054.077
##  ARIMA(2,1,0)(0,1,1)[4]                    : 1056.241
##  ARIMA(2,1,0)(0,1,2)[4]                    : 1058.435
##  ARIMA(2,1,0)(1,1,0)[4]                    : 1056.241
##  ARIMA(2,1,0)(1,1,1)[4]                    : Inf
##  ARIMA(2,1,0)(1,1,2)[4]                    : Inf
##  ARIMA(2,1,0)(2,1,0)[4]                    : 1058.424
##  ARIMA(2,1,0)(2,1,1)[4]                    : Inf
##  ARIMA(2,1,1)(0,1,0)[4]                    : 1029.697
##  ARIMA(2,1,1)(0,1,1)[4]                    : 1031.031
##  ARIMA(2,1,1)(0,1,2)[4]                    : 1033.252
##  ARIMA(2,1,1)(1,1,0)[4]                    : 1031.028
##  ARIMA(2,1,1)(1,1,1)[4]                    : 1033.273
##  ARIMA(2,1,1)(2,1,0)[4]                    : 1033.251
##  ARIMA(2,1,2)(0,1,0)[4]                    : Inf
##  ARIMA(2,1,2)(0,1,1)[4]                    : 1032.349
##  ARIMA(2,1,2)(1,1,0)[4]                    : Inf
```

```
##  ARIMA(2,1,3)(0,1,0)[4]                    : Inf
##  ARIMA(3,1,0)(0,1,0)[4]                    : 1048.368
##  ARIMA(3,1,0)(0,1,1)[4]                    : 1027.279
##  ARIMA(3,1,0)(0,1,2)[4]                    : 1028.564
##  ARIMA(3,1,0)(1,1,0)[4]                    : 1039.702
##  ARIMA(3,1,0)(1,1,1)[4]                    : 1028.809
##  ARIMA(3,1,0)(2,1,0)[4]                    : 1034.455
##  ARIMA(3,1,1)(0,1,0)[4]                    : 1031.906
##  ARIMA(3,1,1)(0,1,1)[4]                    : 1025.717
##  ARIMA(3,1,1)(1,1,0)[4]                    : 1031.733
##  ARIMA(3,1,2)(0,1,0)[4]                    : Inf
##
##
##
##  Best model: ARIMA(3,1,1)(0,1,1)[4]
```

```
#Seasonal Data

fit3
```

```
## Series: UKgas
## ARIMA(3,1,1)(0,1,1)[4]
##
## Coefficients:
##           ar1      ar2      ar3      ma1     sma1
##       -0.6938  -0.9083  -0.6588  -0.2470  -0.7296
## s.e.   0.1070   0.0691   0.1151   0.1289   0.1080
##
## sigma^2 = 1115:  log likelihood = -506.42
## AIC=1024.84   AICc=1025.72   BIC=1040.65
```

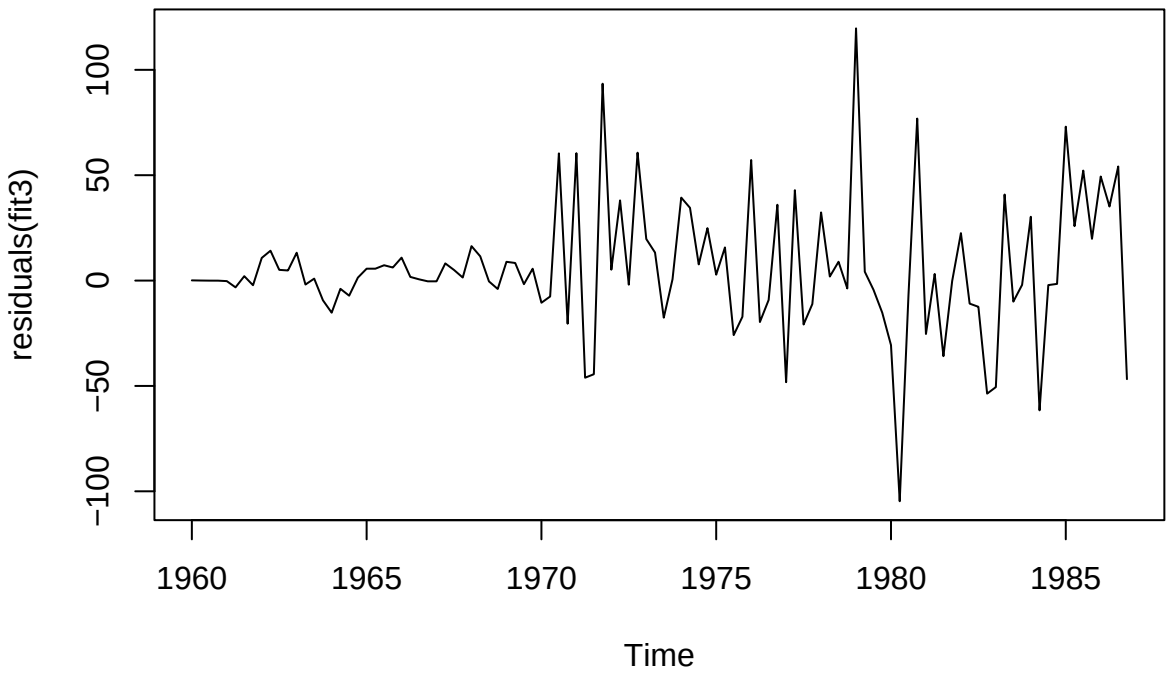
```
#Residual Analysis
Acf(fit3$residuals)
```



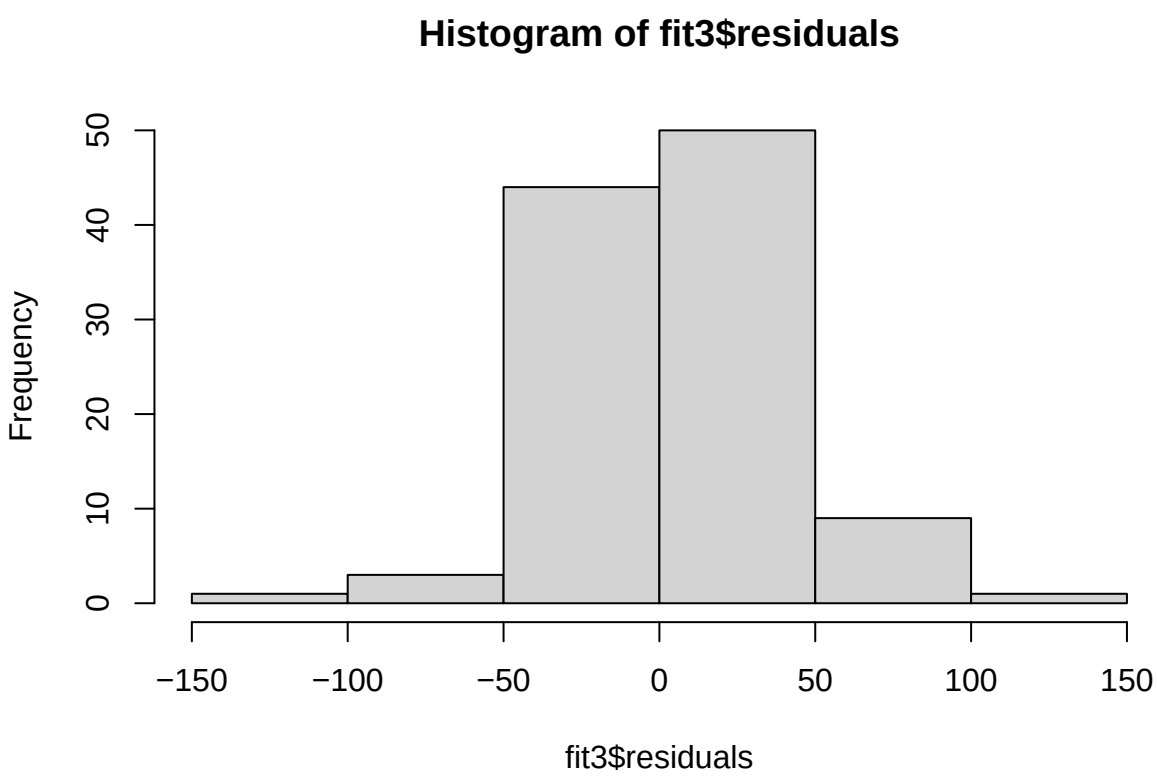

```
Box.test(residuals(fit3), lag=20, type="Ljung")
```

```
##
##  Box-Ljung test
##
## data:  residuals(fit3)
## X-squared = 10.837, df = 20, p-value = 0.9503
```

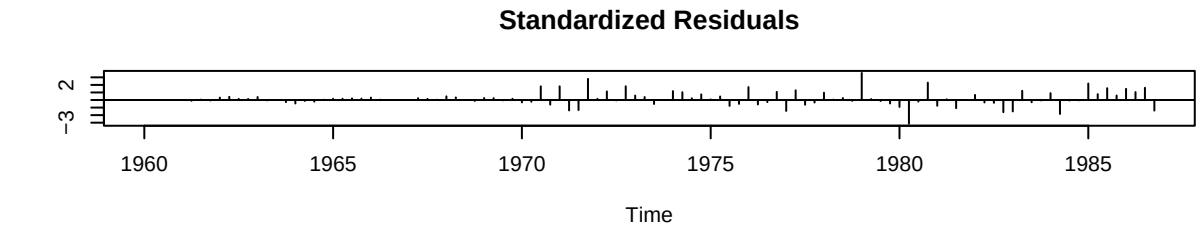
```
#Residual Analysis
plot.ts(residuals(fit3))
```

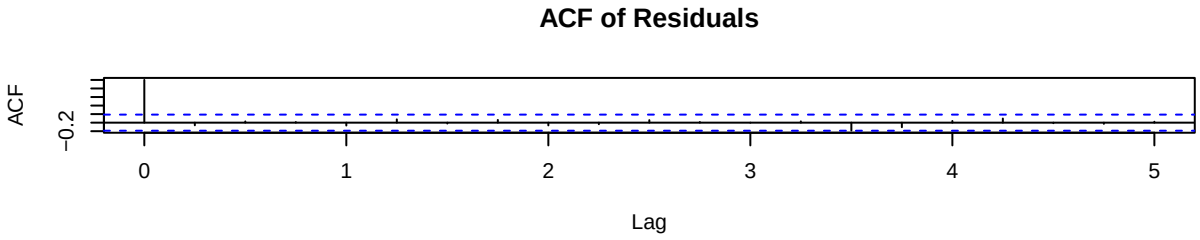


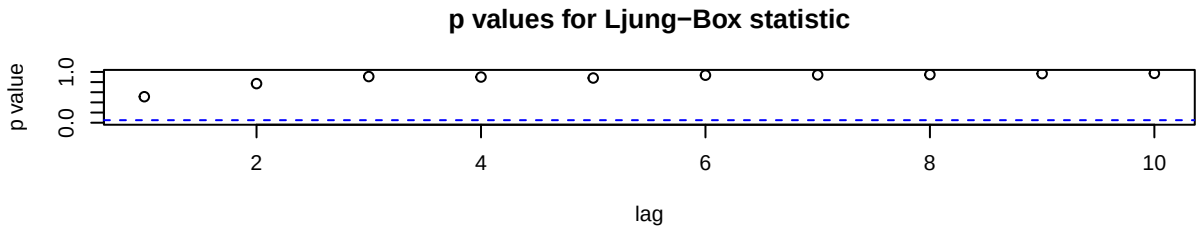

```
hist(fit3$residuals)
```


Histogram of fit3$residuals
Frequency
0
10
20
30
40
50
−150
−100
−50
0
50
100
150
fit3$residuals

```
tsdiag(fit3)
```


Standardized Residuals
−3
2
1960
1965
1970
1975
1980
1985
Time


ACF of Residuals
ACF
−0.2
0
1
2
3
4
5
Lag


p values for Ljung−Box statistic
p value
0.0
1.0
2
4
6
8
10
lag