

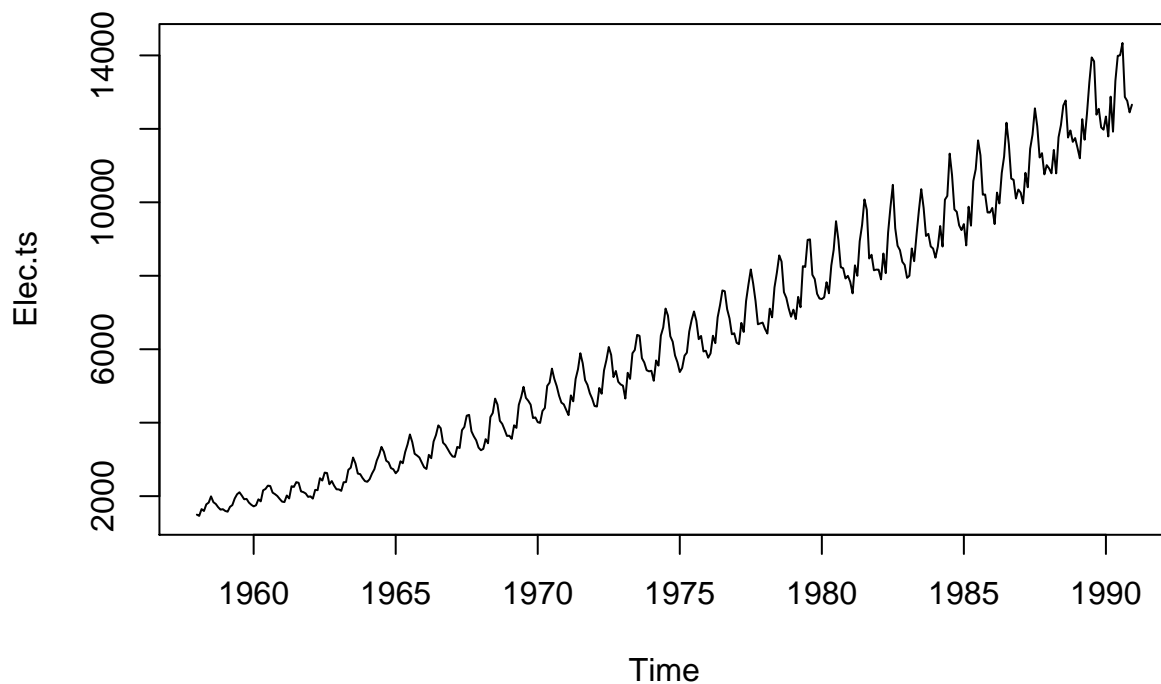
Non-stationary Models

YIK LUN, KEI
allen29@ucla.edu

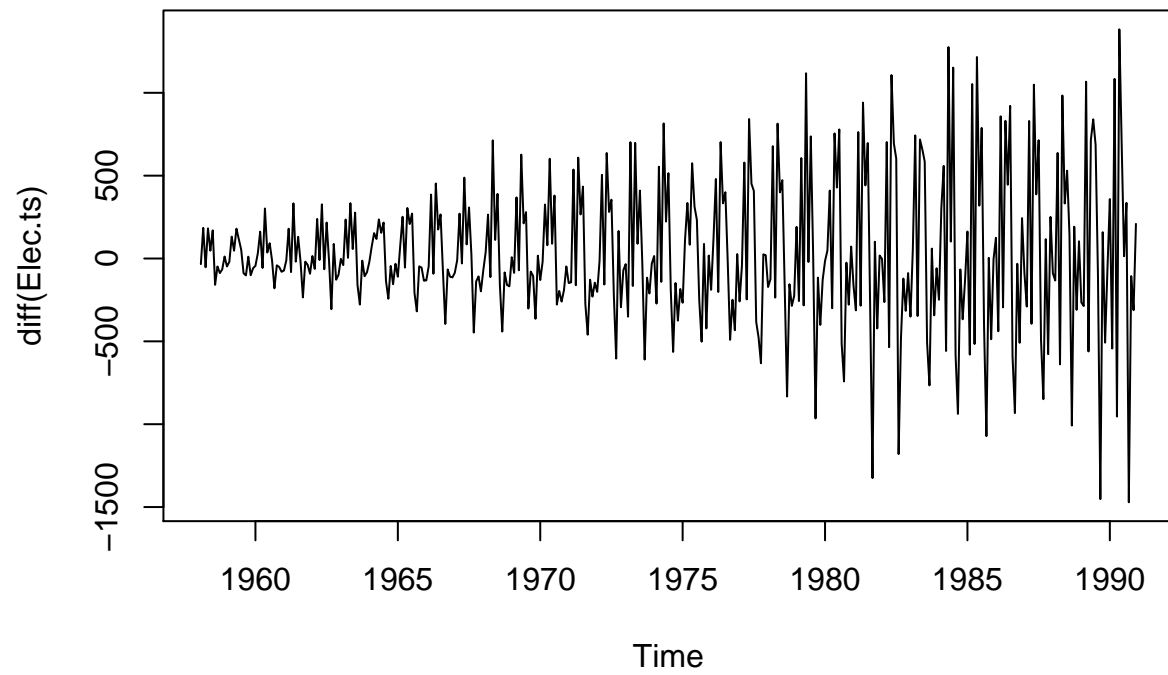
This paper is a practice from the book called *Introductory Time Series with R* by Cowpertwait, Paul SP, and Andrew V. Metcalfe. All R codes and comments below are belonged to the book and authors.

Differencing

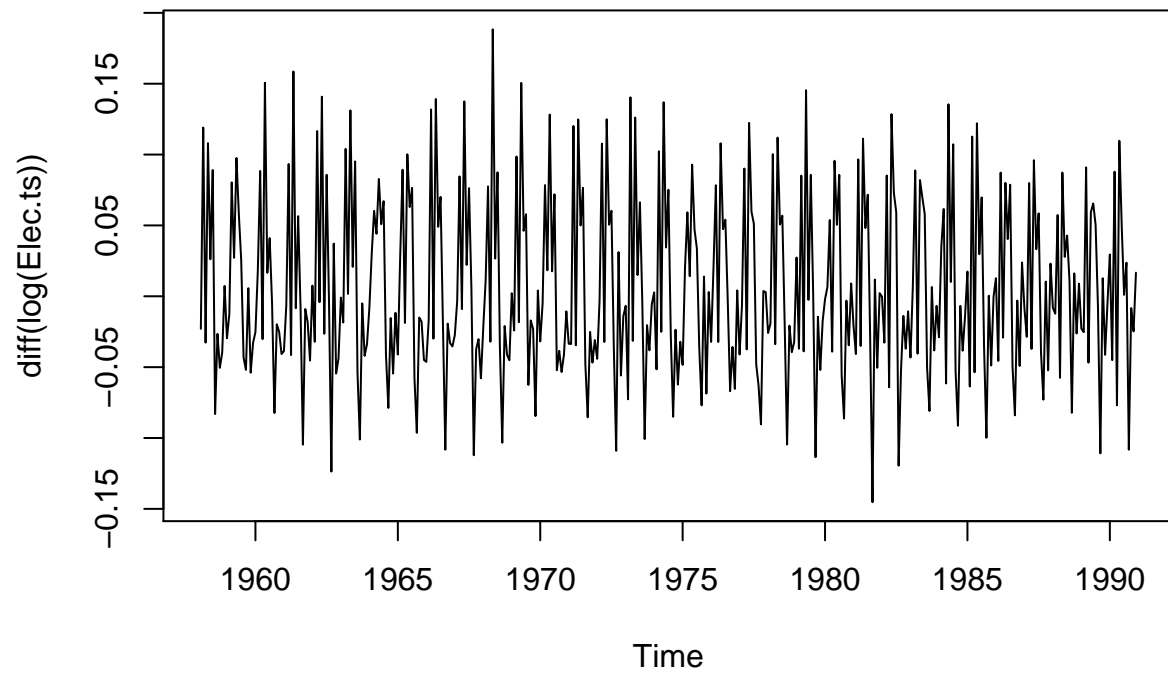
```
CBE <- read.table("http://staff.elena.aut.ac.nz/Paul-Cowpertwait/ts/cbe.dat", header = T)
Elec.ts <- ts(CBE[, 3], start = 1958, freq = 12)
plot(Elec.ts)
```



```
plot(diff(Elec.ts))
```

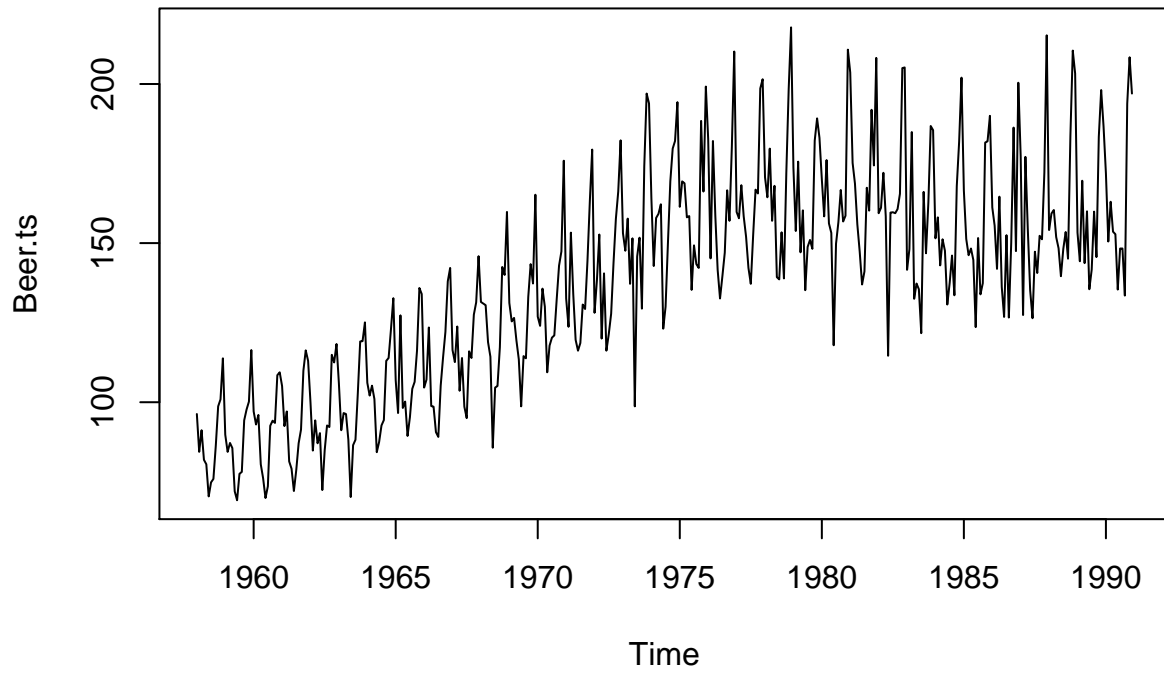


```
plot(diff(log(Elec.ts)))
```

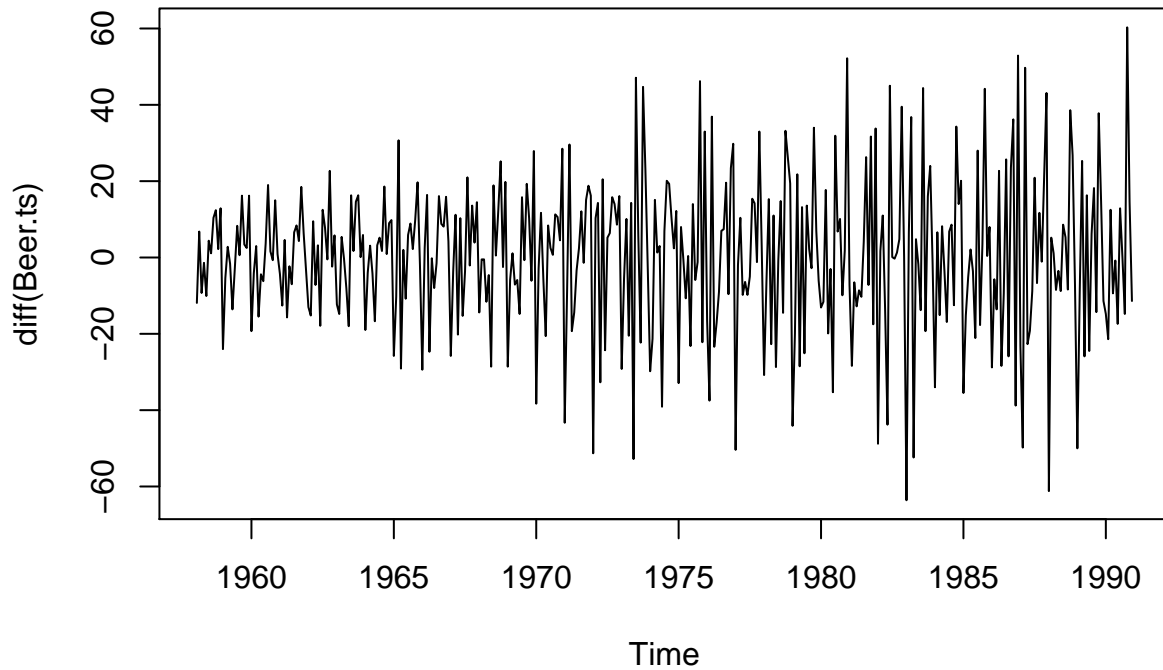


IMA(1, 1)

```
Beer.ts <- ts(CBE[, 2], start = 1958, freq = 12)  
plot(Beer.ts)
```



```
plot(diff(Beer.ts))
```

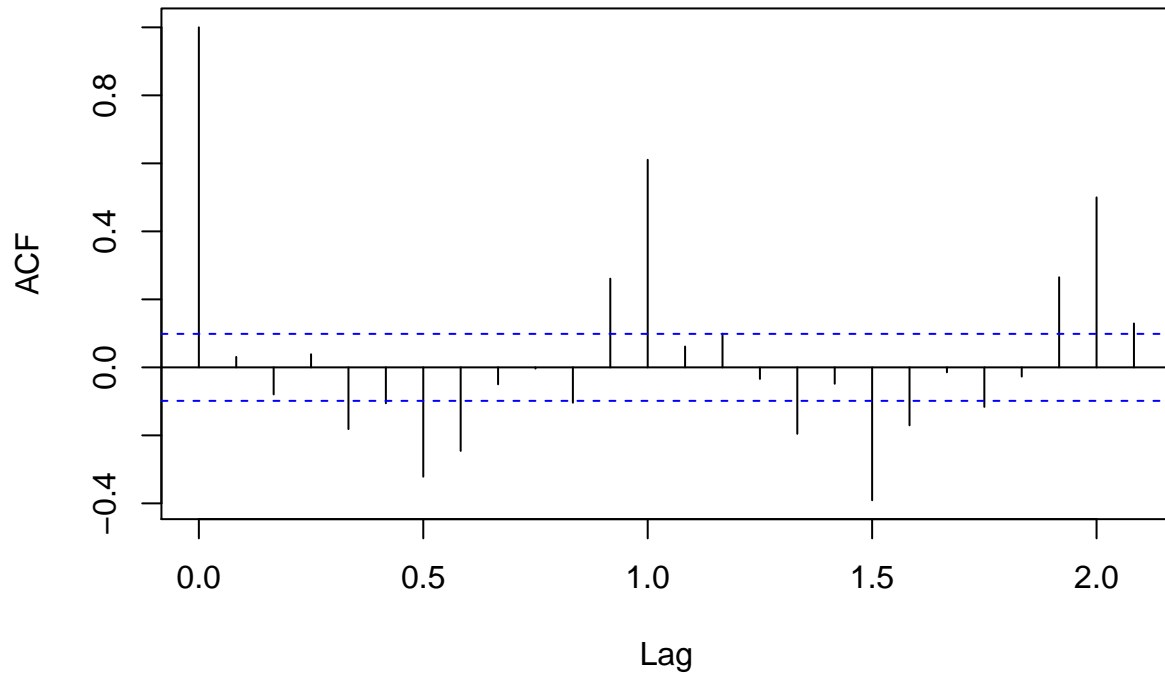


```
Beer.ima <- arima(Beer.ts, order = c(0, 1, 1))  
Beer.ima
```

```
##  
## Call:  
## arima(x = Beer.ts, order = c(0, 1, 1))  
##  
## Coefficients:  
##          ma1  
##       -0.3334  
## s.e.    0.0558  
##  
## sigma^2 estimated as 360.4:  log likelihood = -1723.27,  aic = 3450.53
```

```
acf(resid(Beer.ima))
```

Series resid(Beer.ima)



```
Beer.1991 <- predict(Beer.ima, n.ahead = 12)
sum(Beer.1991$pred)
```

```
## [1] 2365.412
```

Seasonal ARIMA(p, d, q)(P, D, Q)_s

```
get.best.arima <- function(x.ts, maxord = c(1,1,1,1,1,1))
{
  best.aic <- 1e8
  n <- length(x.ts)
  for (p in 0:maxord[1]) for(d in 0:maxord[2]) for(q in 0:maxord[3])
    for (P in 0:maxord[4]) for(D in 0:maxord[5]) for(Q in 0:maxord[6]){
      fit <- arima(x.ts, order = c(p,d,q),seas = list(order = c(P,D,Q),frequency(x.ts)), method = "CSS")
      fit.aic <- -2 * fit$loglik + (log(n) + 1) * length(fit$coef)
      if (fit.aic < best.aic){
        best.aic <- fit.aic
      }
      best.fit <- fit
      best.model <- c(p,d,q,P,D,Q)
    }
  }
  list(best.aic, best.fit, best.model)
```

```

}
best.arima.elec <- get.best.arima( log(Elec.ts),maxord = c(2,2,2,2,2,2))

## Warning in arima(x.ts, order = c(p, d, q), seas = list(order = c(P, D,
## Q), : possible convergence problem: optim gave code = 1

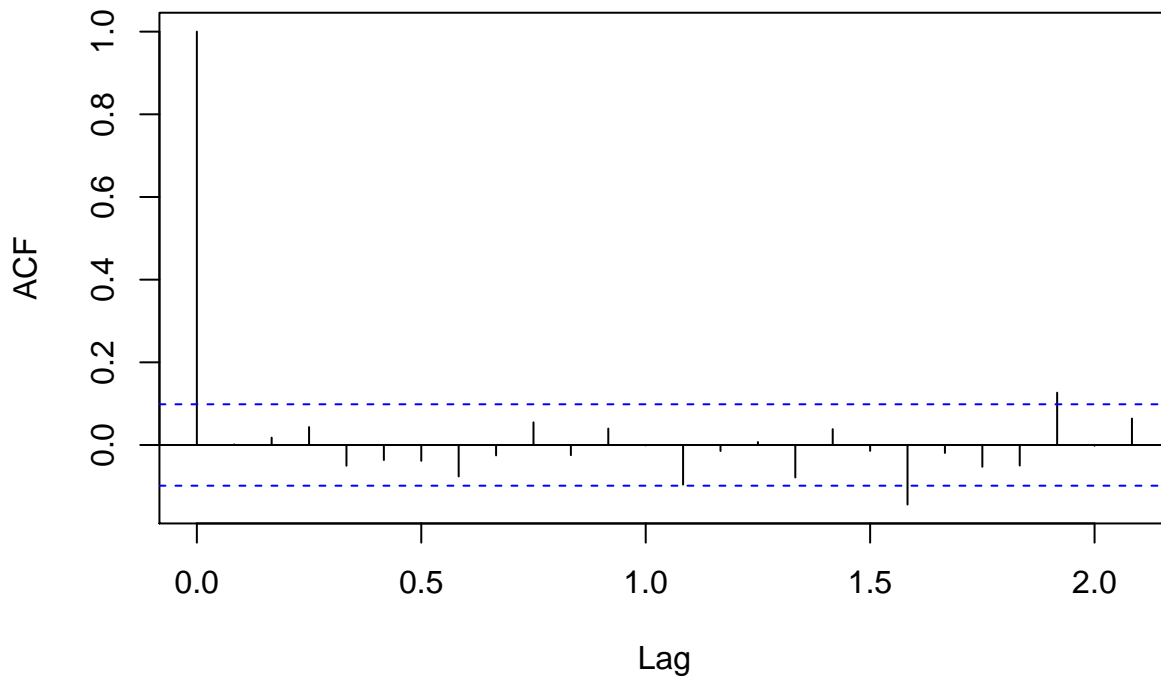
## Warning in arima(x.ts, order = c(p, d, q), seas = list(order = c(P, D,
## Q), : possible convergence problem: optim gave code = 1

## Warning in arima(x.ts, order = c(p, d, q), seas = list(order = c(P, D,
## Q), : possible convergence problem: optim gave code = 1

best.fit.elec <- best.arima.elec[[2]]
acf( resid(best.fit.elec) )

```

Series resid(best.fit.elec)



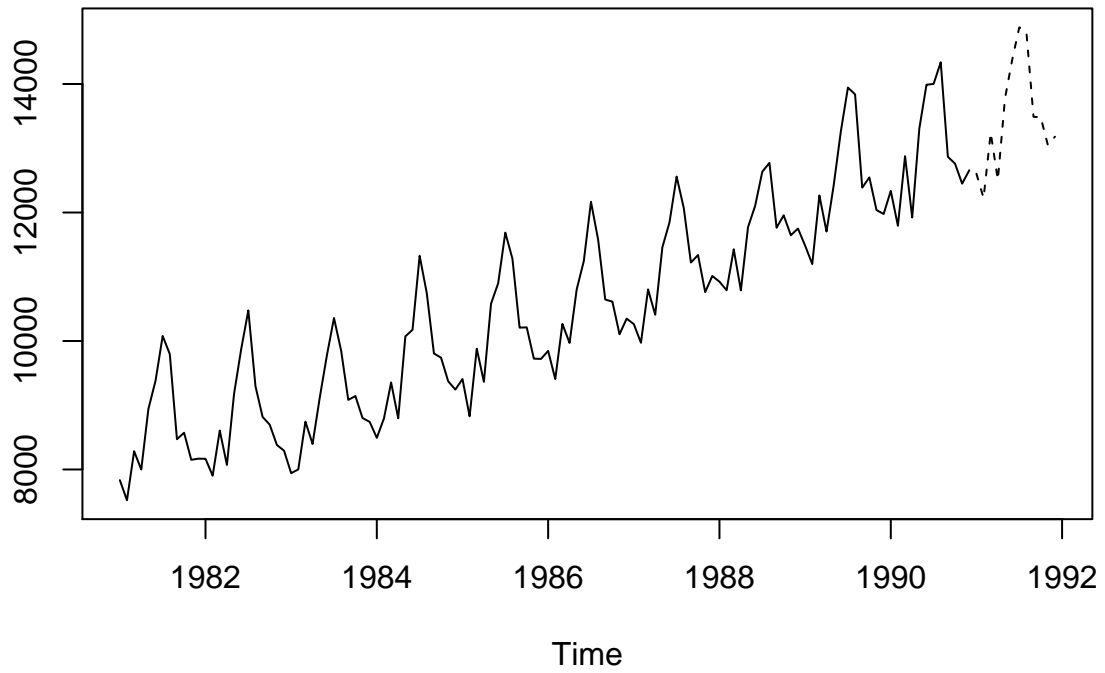
```

best.arima.elec [[3]]

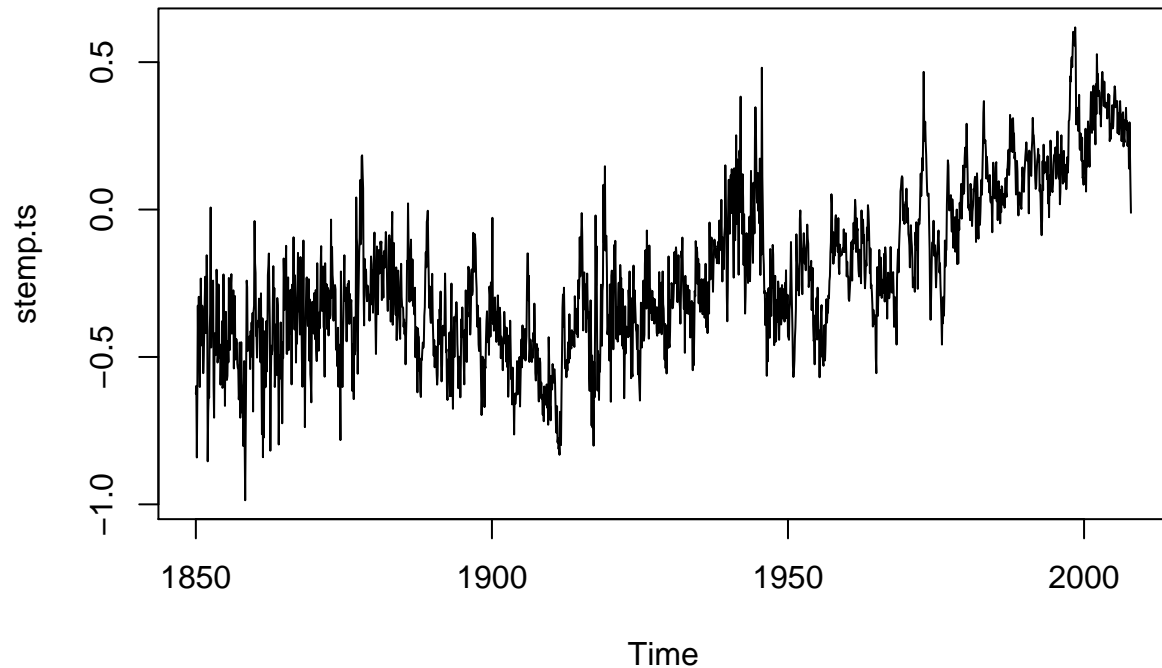
## [1] 0 1 1 2 0 2

ts.plot( cbind( window(Elec.ts,start = 1981),
exp(predict(best.fit.elec,12)$pred) ), lty = 1:2)

```



```
library(tseries)
stemp <- scan("http://staff.elena.aut.ac.nz/Paul-Cowpertwait/ts/stemp.dat")
stemp.ts <- ts(stemp, start = 1850, freq = 12)
plot(stemp.ts)
```

```
stemp.best <- get.best.arima(stemp.ts, maxord = rep(2,6))
stemp.best[[3]]
```

```
## [1] 1 1 2 2 0 1
```

```
stemp.arima <- arima(stemp.ts, order = c(1,1,2),seas = list(order = c(2,0,1), 12))
t( confint(stemp.arima) )
```

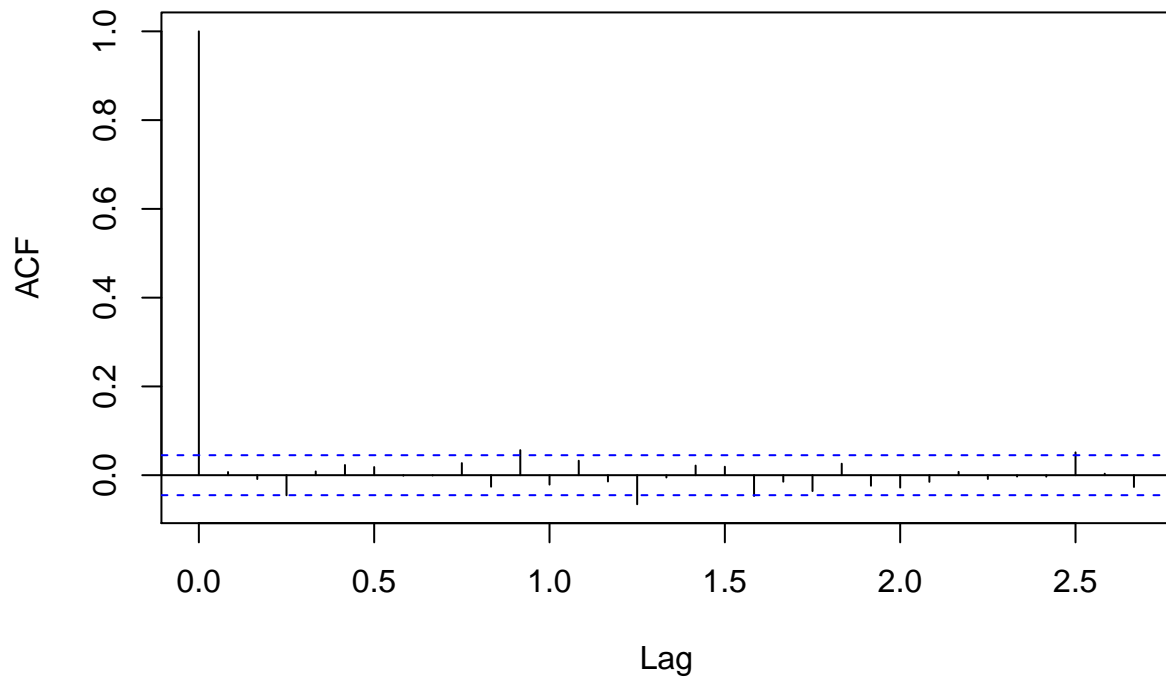
```
##          ar1          ma1          ma2          sar1          sar2          sma1
## 2.5 %  0.8317390 -1.447400  0.3256700  0.8576802 -0.02501883 -0.9690534
## 97.5 %  0.9127946 -1.312553  0.4530475  1.0041396  0.07413424 -0.8507034
```

```
stemp.arima <- arima(stemp.ts, order = c(1,1,2),seas = list(order = c(1,0,1), 12))
t( confint(stemp.arima) )
```

```
##          ar1          ma1          ma2          sar1          sma1
## 2.5 %  0.8303972 -1.445048  0.3242583  0.9243522 -0.969491
## 97.5 %  0.9108145 -1.311231  0.4508911  0.9956641 -0.867927
```

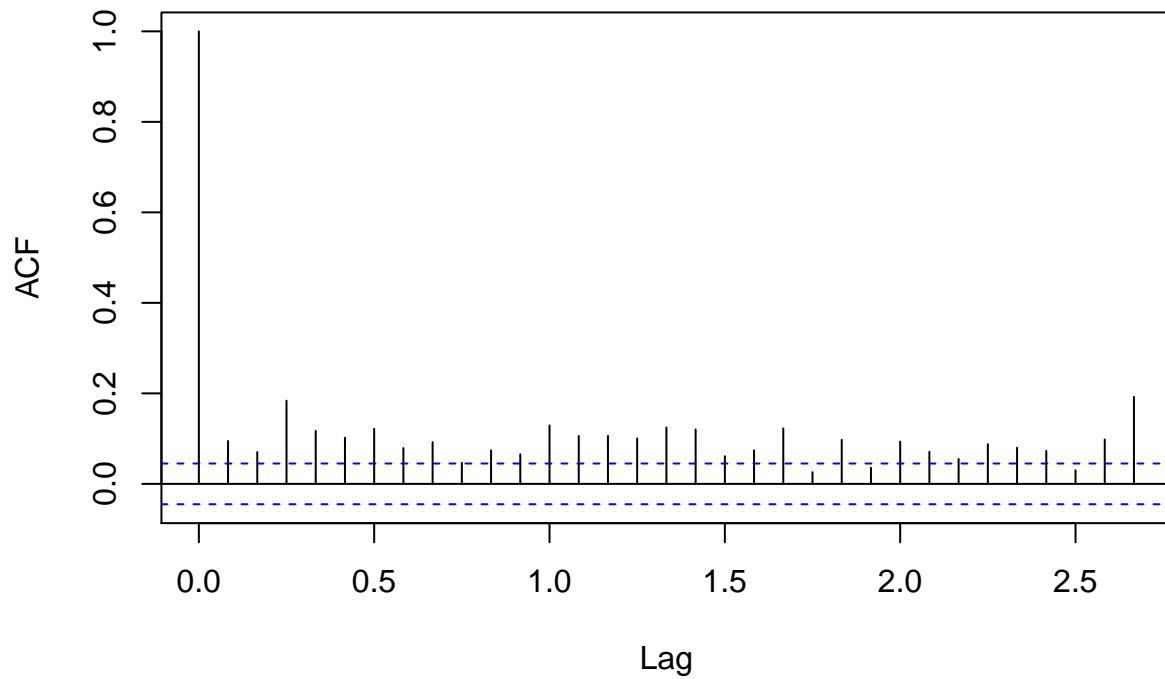
```
stemp.res <- resid(stemp.arima)
acf(stemp.res)
```

Series stemp.res



```
acf(stemp.res^2)
```

Series stemp.res^2

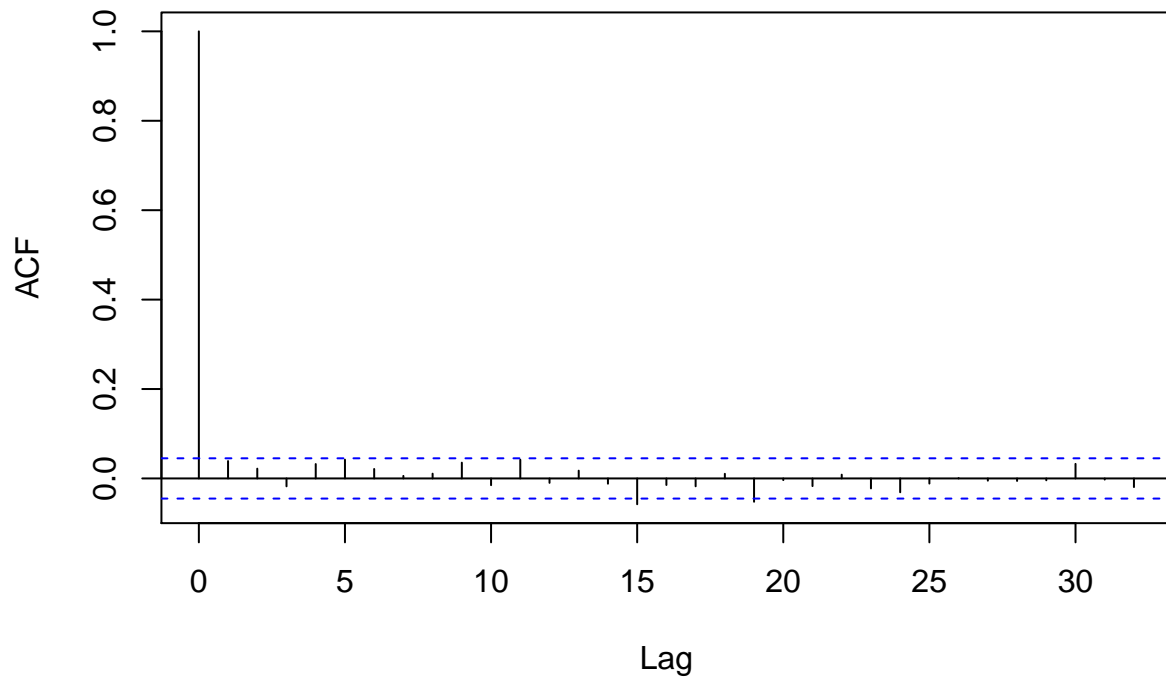


```
stemp.garch <- garch(stemp.res, trace = F)
t(confint(stemp.garch))
```

```
##           a0           a1           b1
## 2.5 % 1.064251e-05 0.03299181 0.9249315
## 97.5 % 1.485814e-04 0.06525680 0.9630787
```

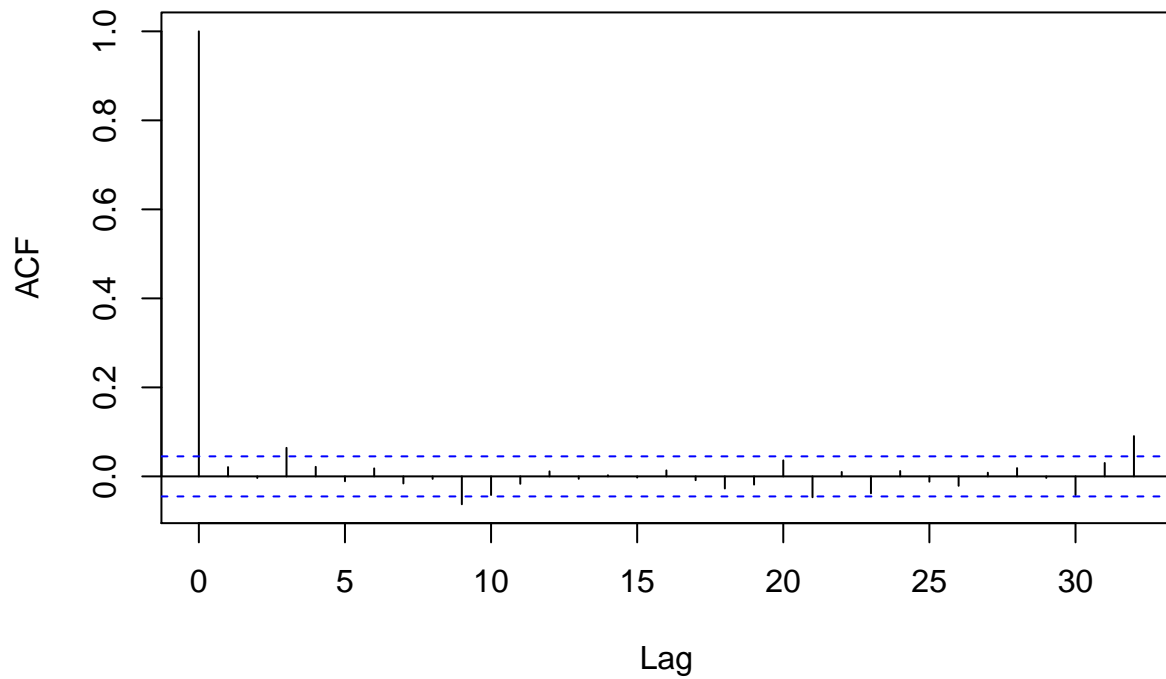
```
stemp.garch.res <- resid(stemp.garch)[-1]
acf(stemp.garch.res)
```

Series stemp.garch.res



```
acf(stemp.garch.res^2)
```

Series stemp.garch.res^2



Reference:

Cowpertwait, Paul SP, and Andrew V. Metcalfe. *Introductory time series with R*. Springer Science & Business Media, 2009.