

ARMA Model

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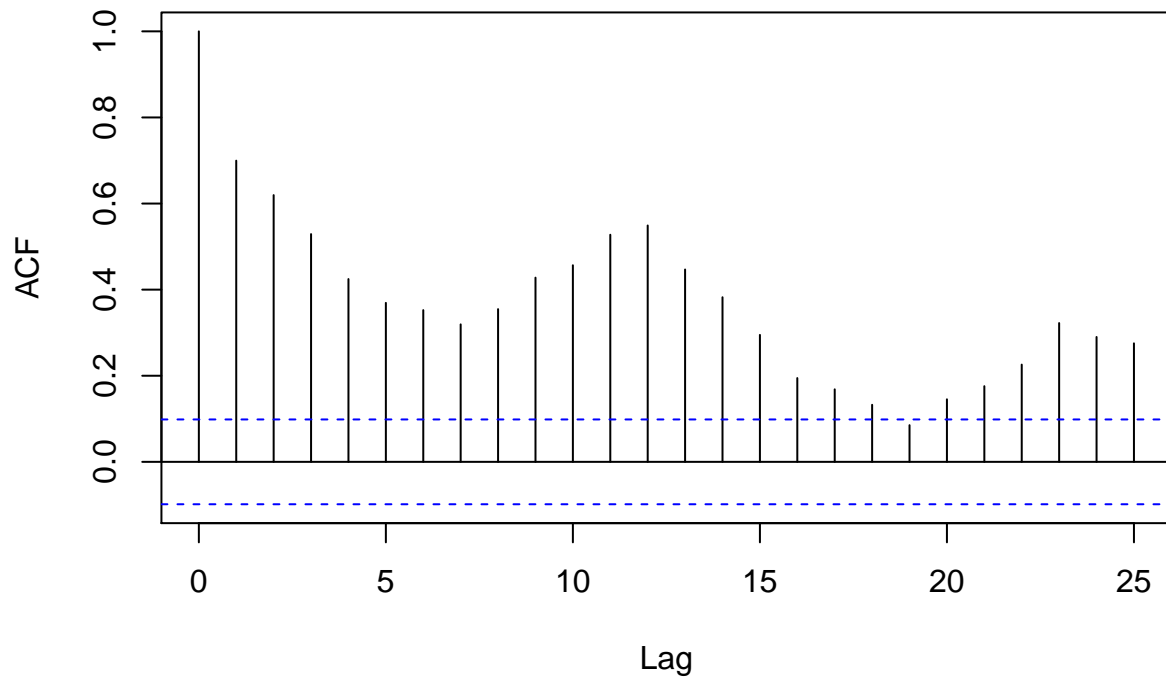
This paper is a practice from the book called Introductory Time Series with R by Cowpertwait, Paul SP, and Andrew V. Metcalfe. All R codes and comments below are belonged to the book and authors.

```
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)
Time <- 1:length(Elec.ts);Imth <- cycle(Elec.ts)
Elec.lm <- lm(log(Elec.ts) ~ Time + I(Time^2) + factor(Imth))
summary(Elec.lm)
```

```
##
## Call:
## lm(formula = log(Elec.ts) ~ Time + I(Time^2) + factor(Imth))
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.087594 -0.022203 -0.000396  0.020059  0.104350
##
## Coefficients:
##              Estimate Std. Error  t value Pr(>|t|)
## (Intercept)   7.271e+00  7.130e-03 1019.786 < 2e-16 ***
## Time          7.960e-03  5.603e-05  142.070 < 2e-16 ***
## I(Time^2)     -6.883e-06  1.367e-07  -50.359 < 2e-16 ***
## factor(Imth)2 -1.991e-02  7.826e-03   -2.544  0.01134 *
## factor(Imth)3  6.598e-02  7.826e-03    8.430  7.14e-16 ***
## factor(Imth)4  3.288e-02  7.826e-03    4.201  3.31e-05 ***
## factor(Imth)5  1.462e-01  7.826e-03   18.687 < 2e-16 ***
## factor(Imth)6  1.777e-01  7.826e-03   22.711 < 2e-16 ***
## factor(Imth)7  2.375e-01  7.826e-03   30.344 < 2e-16 ***
## factor(Imth)8  1.994e-01  7.827e-03   25.477 < 2e-16 ***
## factor(Imth)9  1.074e-01  7.827e-03   13.719 < 2e-16 ***
## factor(Imth)10 9.044e-02  7.827e-03   11.555 < 2e-16 ***
## factor(Imth)11 4.278e-02  7.827e-03    5.465  8.35e-08 ***
## factor(Imth)12 2.350e-02  7.828e-03    3.002  0.00286 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.03179 on 382 degrees of freedom
## Multiple R-squared:  0.9974, Adjusted R-squared:  0.9973
## F-statistic: 1.117e+04 on 13 and 382 DF,  p-value: < 2.2e-16
```

```
acf(resid(Elec.lm))
```

Series resid(Elec.lm)

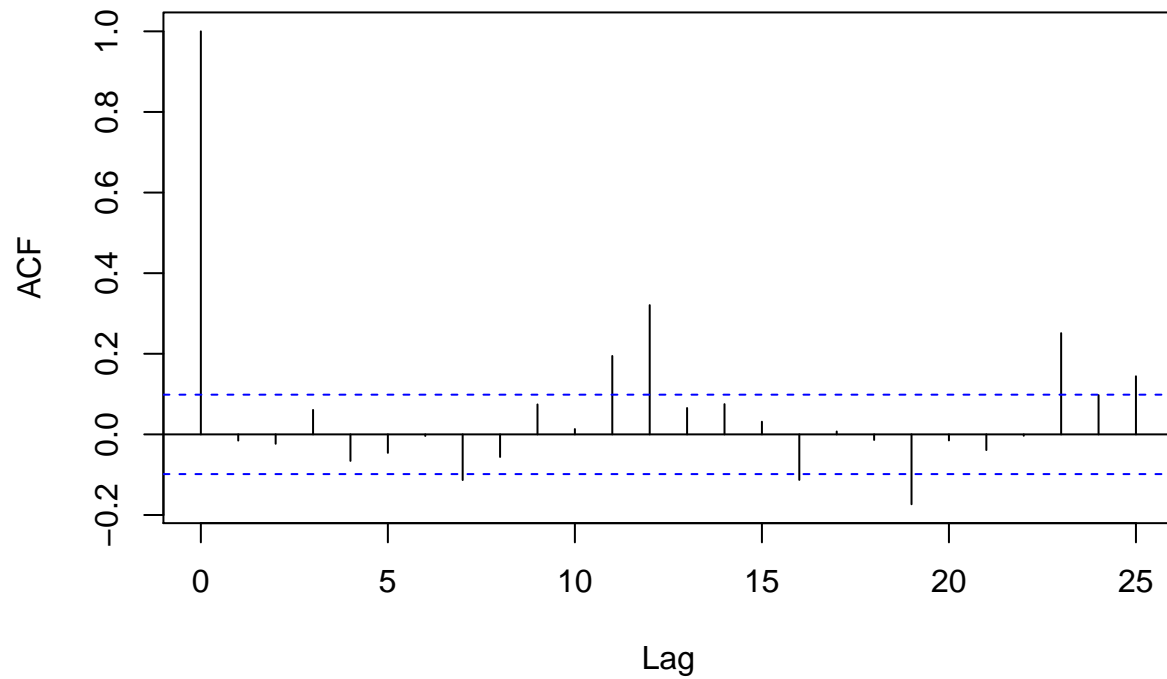


```
best.order <- c(0, 0, 0);best.aic <- Inf
for (i in 0:2) for (j in 0:2) {
  fit.aic <- AIC(arima(resid(Elec.lm), order = c(i,0,j)))
  if (fit.aic < best.aic) {
    best.order <- c(i, 0, j)
    best.arma <- arima(resid(Elec.lm), order = best.order)
    best.aic <- fit.aic
  }
}
best.order
```

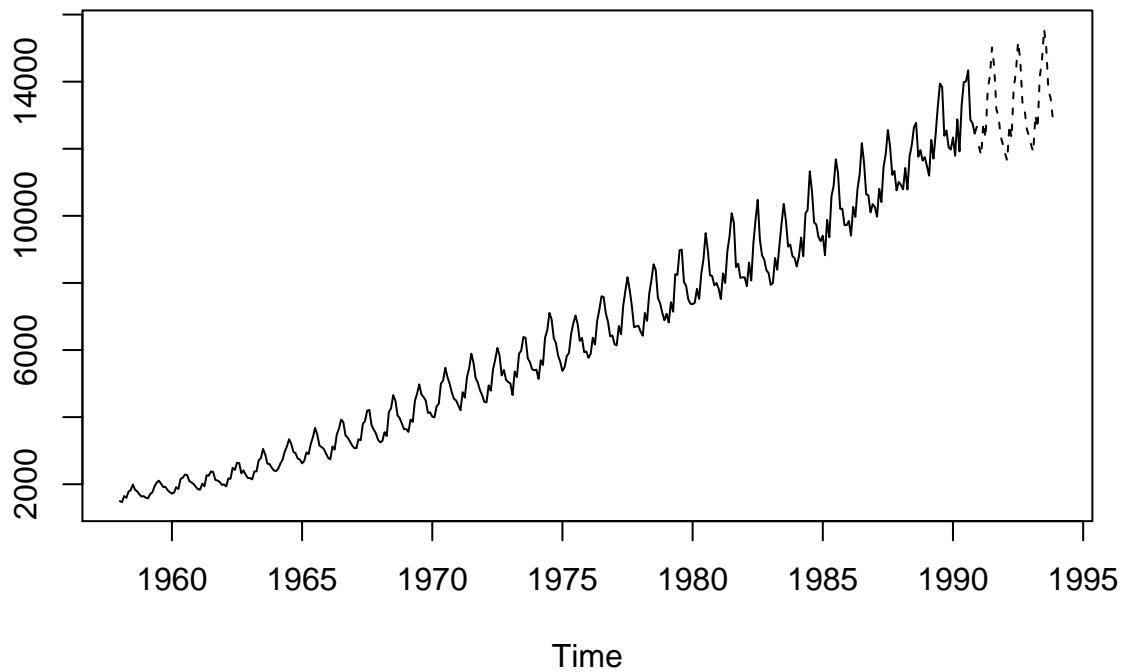
```
## [1] 2 0 0
```

```
acf(resid(best.arma))
```

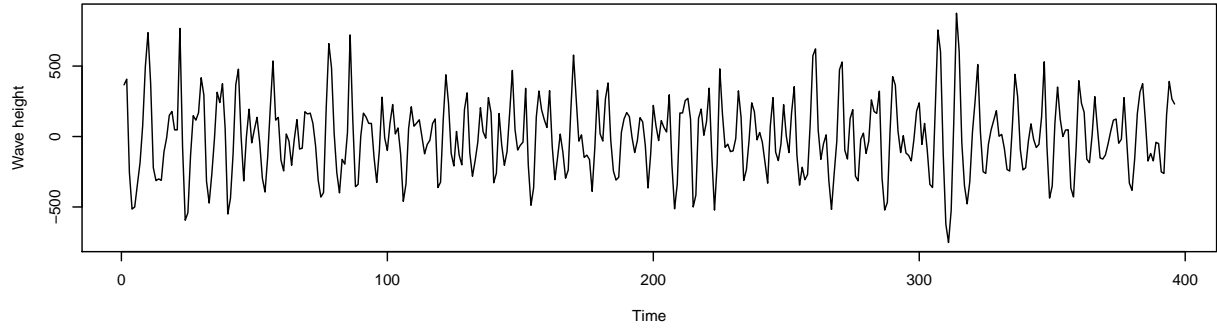
Series resid(best.arma)



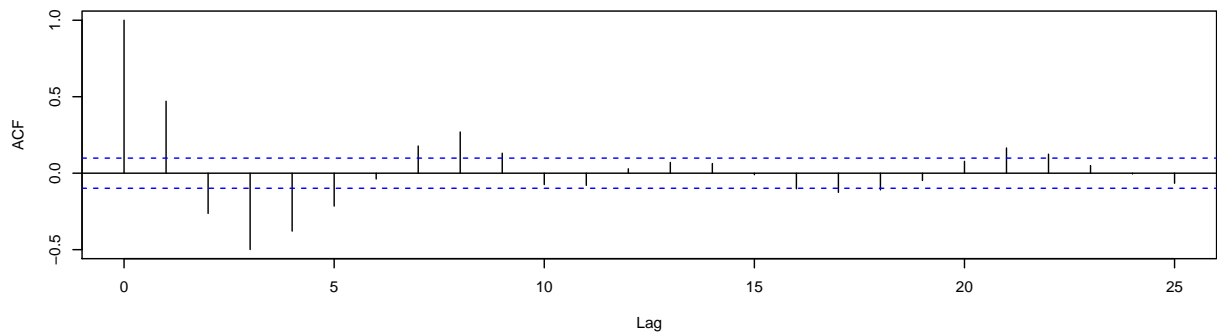
```
new.data <- data.frame(Time=seq(length(Elec.ts), length=36), Imth = rep(1:12,3))
predict.lm <- predict(Elec.lm, new.data)
predict.arma <- predict(best.arma, n.ahead = 36)
elec.pred <- ts(exp(predict.lm + predict.arma$pred), start = 1991,
freq = 12)
ts.plot(cbind(Elec.ts, elec.pred), lty = 1:2)
```



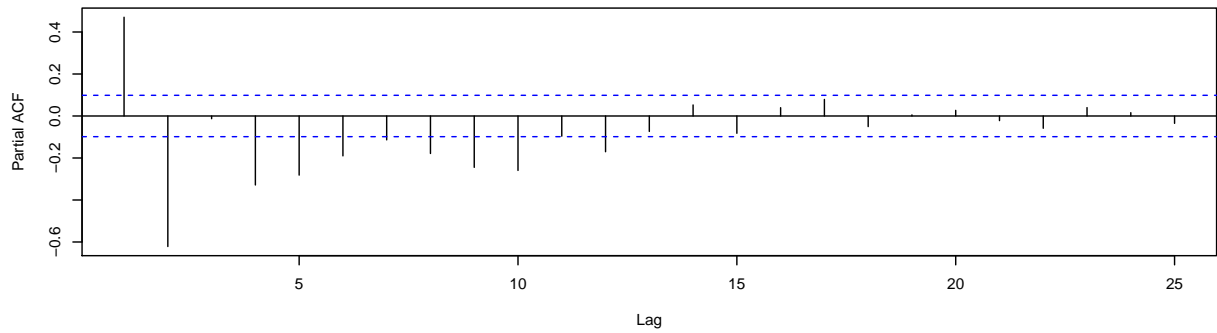
```
wave.dat <- read.table("http://staff.elena.aut.ac.nz/Paul-Cowpertwait/ts/wave.dat", header = T)
attach (wave.dat)
layout(1:3)
plot (as.ts(waveht), ylab = 'Wave height')
acf (waveht)
pacf (waveht)
```



Series waveht



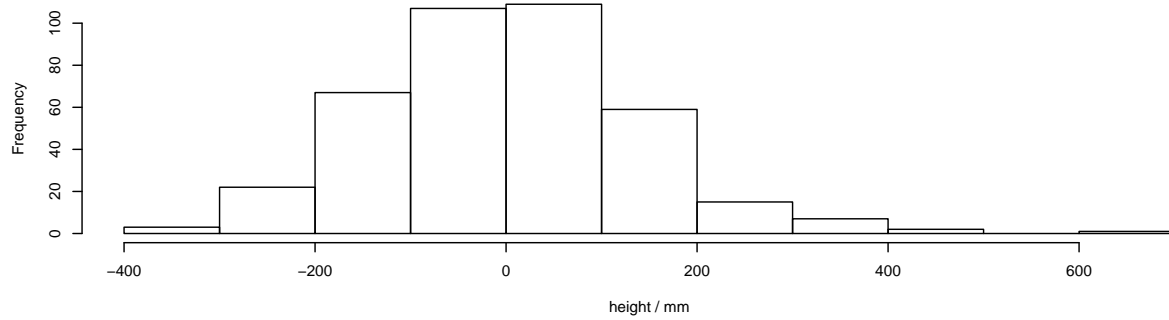
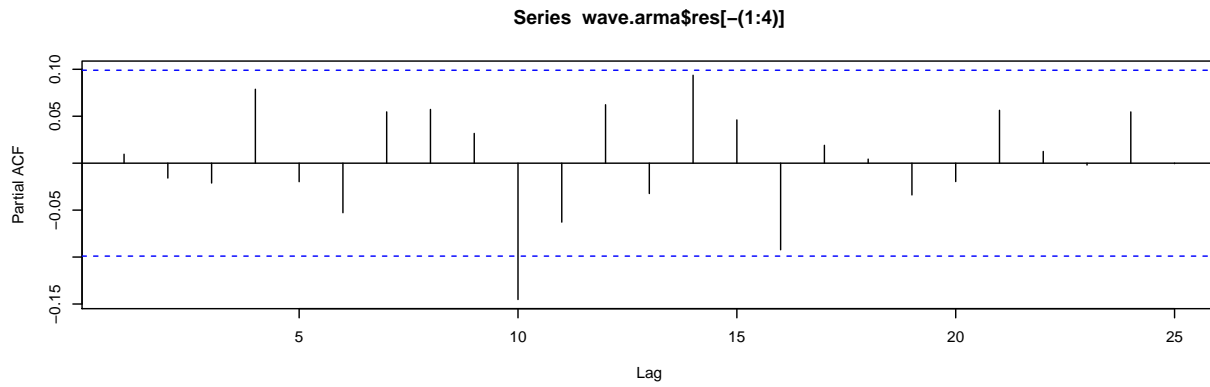
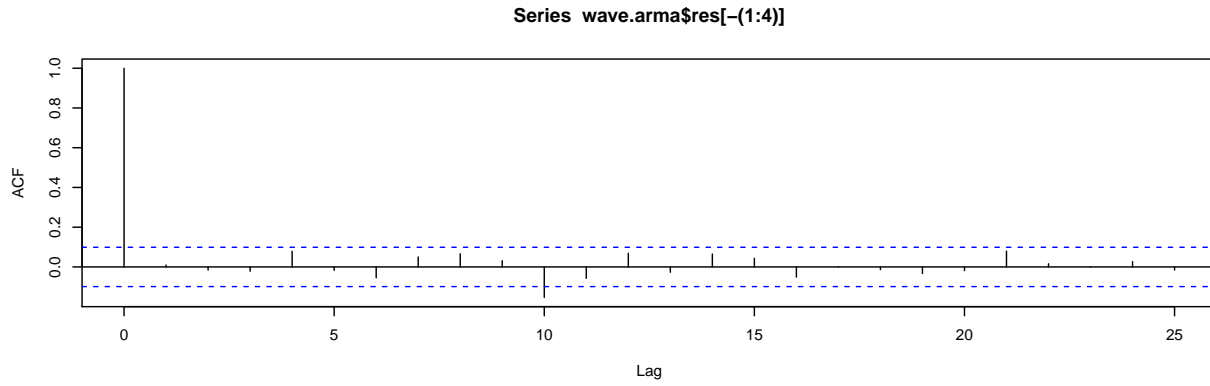
Series waveht



```

wave.arma <- arima(waveht, order = c(4,0,4))
acf (wave.arma$res[-(1:4)])
pacf (wave.arma$res[-(1:4)])
hist(wave.arma$res[-(1:4)], xlab='height / mm', main='')

```



Reference:

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