pre-assignment

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Libraries

```r
library(openxlsx)
library(tseries)
```

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

```r
library(forecast)
library(EnvStats)
```

```
##
## Attaching package: 'EnvStats'

## The following objects are masked from 'package:stats':
##
##     predict, predict.lm

## The following object is masked from 'package:base':
##
##     print.default
```

```r
library(lmtest)
```

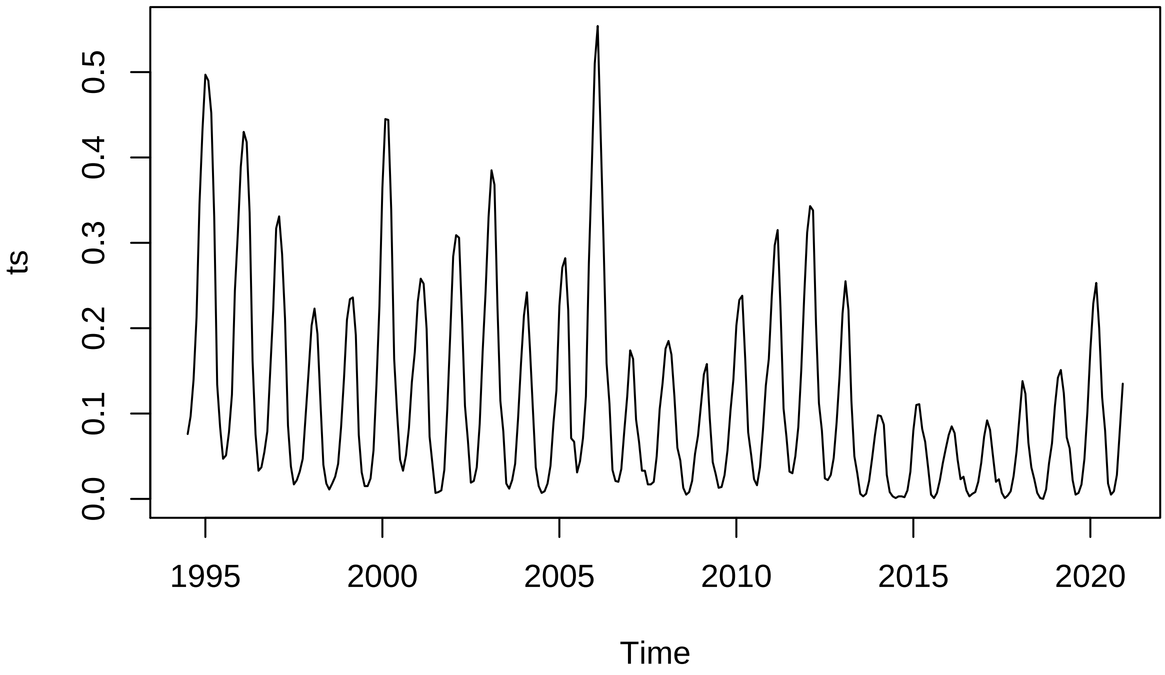
```
## Loading required package: zoo

##
## Attaching package: 'zoo'

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

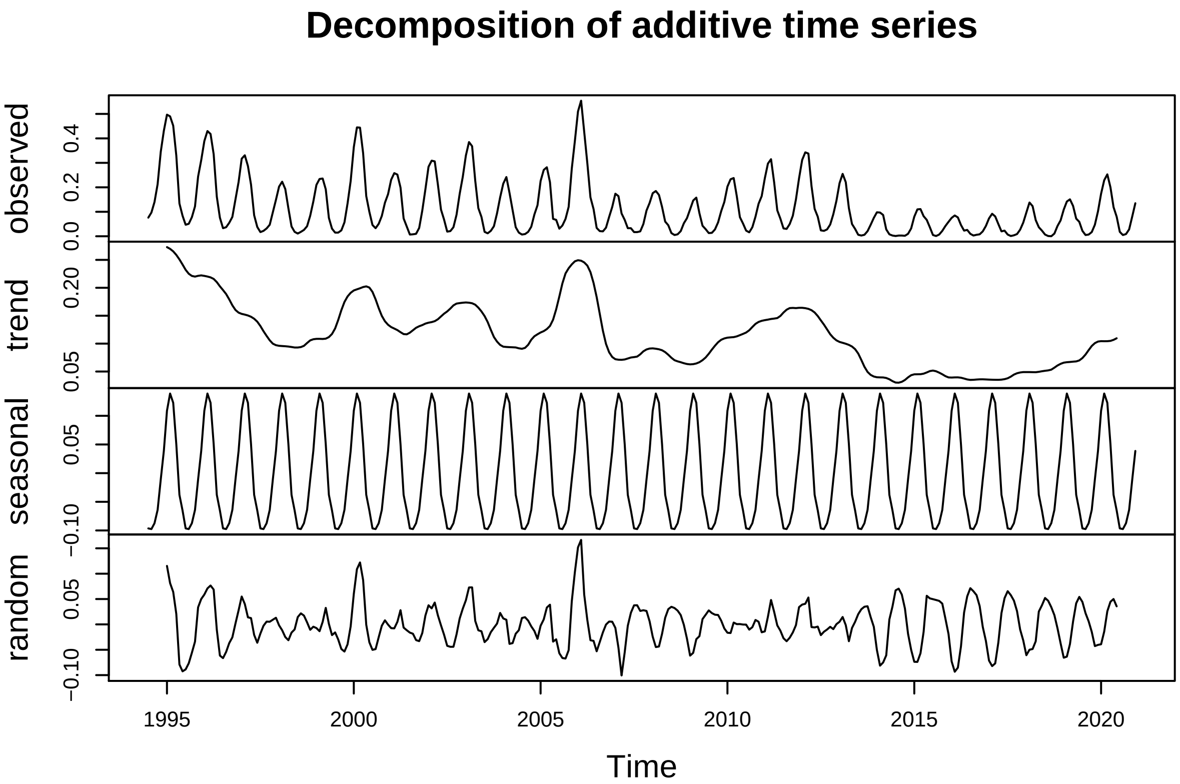
Read data

```
data <- read.xlsx("Lions_Den_data.xlsx")
ts <- ts(unlist(data[2]), start=c(1994, 7), frequency=12)
plot(ts)
```



Decomposition

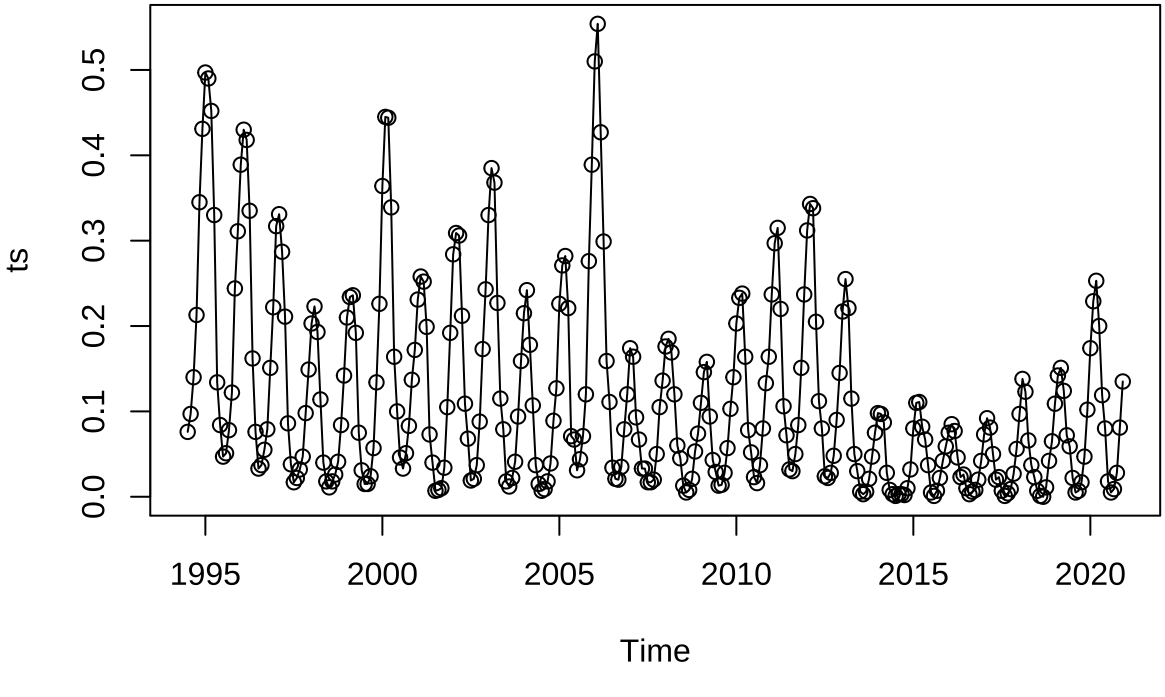
```
decompose <- decompose(ts, "additive")
plot(decompose)
```



Outliers

Test on raw data that the winter 2006 does not match. We have tried to manipulate data(differentiation, decomposition, etc) in order to get more outliers, but there were no reasonable results.

```
plot(ts, type="o")
```



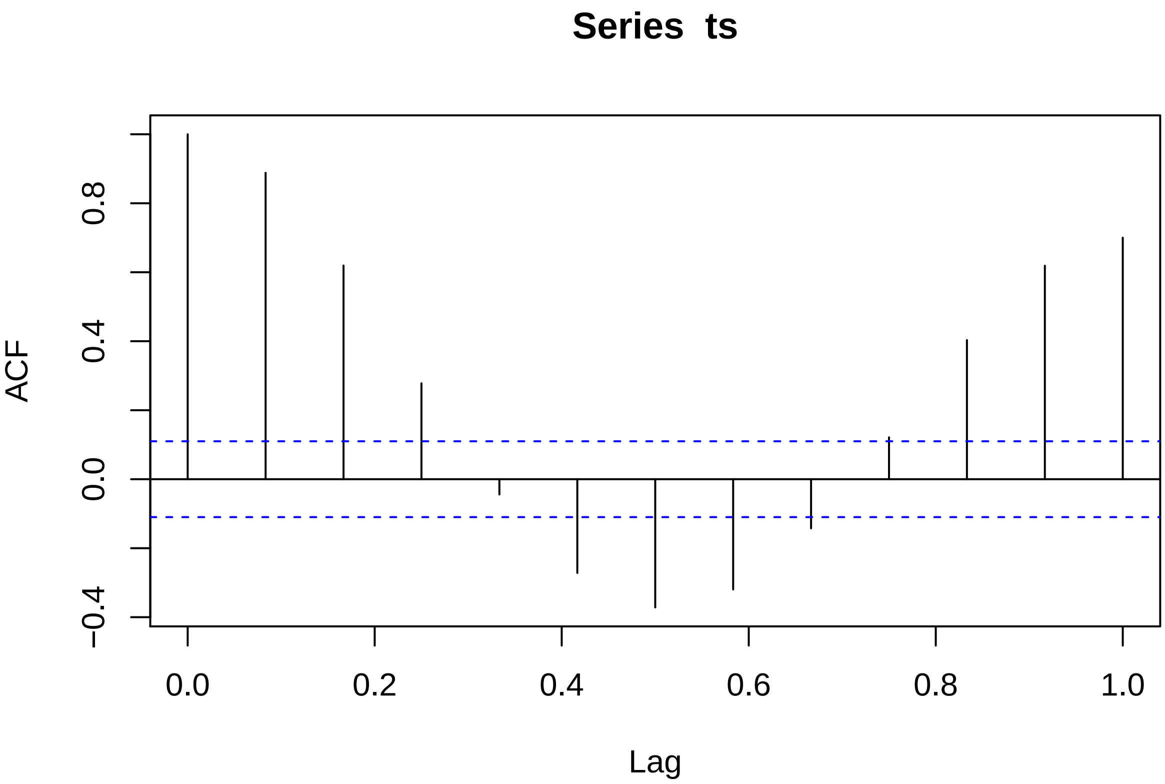
```r
rosnerTest(ts, k = 3)
```

```
##
## Results of Outlier Test
## -------------------------
##
## Test Method:                     Rosner's Test for Outliers
##
## Hypothesized Distribution:       Normal
##
## Data:                            ts
##
## Sample Size:                     318
##
## Test Statistics:                 R.1 = 3.782021
##                                  R.2 = 3.487550
##                                  R.3 = 3.445420
##
## Test Statistic Parameter:        k = 3
##
## Alternative Hypothesis:          Up to 3 observations are not
##                                  from the same Distribution.
##
## Type I Error:                    5%
##
## Number of Outliers Detected:     1
##
##   i    Mean.i      SD.i Value Obs.Num    R.i+1 lambda.i+1 Outlier
## 1 0 0.1170692 0.1155284 0.554     140 3.782021   3.739949    TRUE
## 2 1 0.1156909 0.1130619 0.510     139 3.487550   3.739067   FALSE
## 3 2 0.1144430 0.1110335 0.497       7 3.445420   3.738181   FALSE
```

Autocorrelation and stationarity analysis

We can see that time-series is already stationary and is slightly correlated with itself 12 month earlier.

```r
#autocorrelation
acf(ts, lag.max = 12)
```



```
#stationary test
adf.test(ts)
```

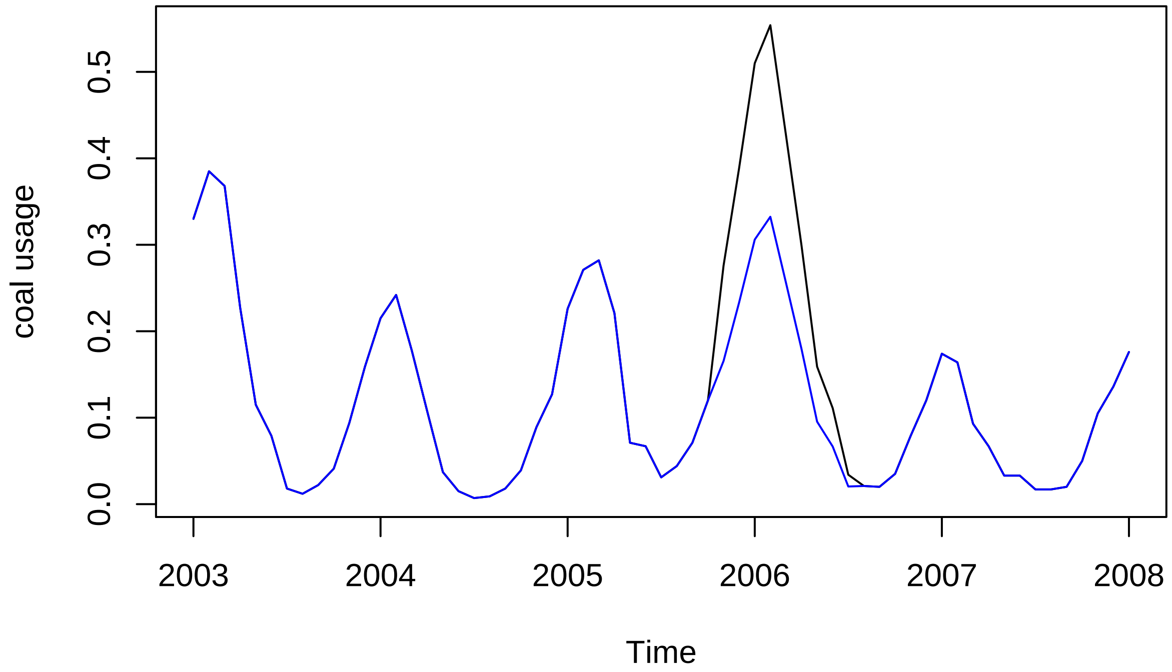
```
## Warning in adf.test(ts): p-value smaller than printed p-value
```

```
##
##  Augmented Dickey-Fuller Test
##
## data:  ts
## Dickey-Fuller = -4.9571, Lag order = 6, p-value = 0.01
## alternative hypothesis: stationary
```

PREDICTION

Delete outlier

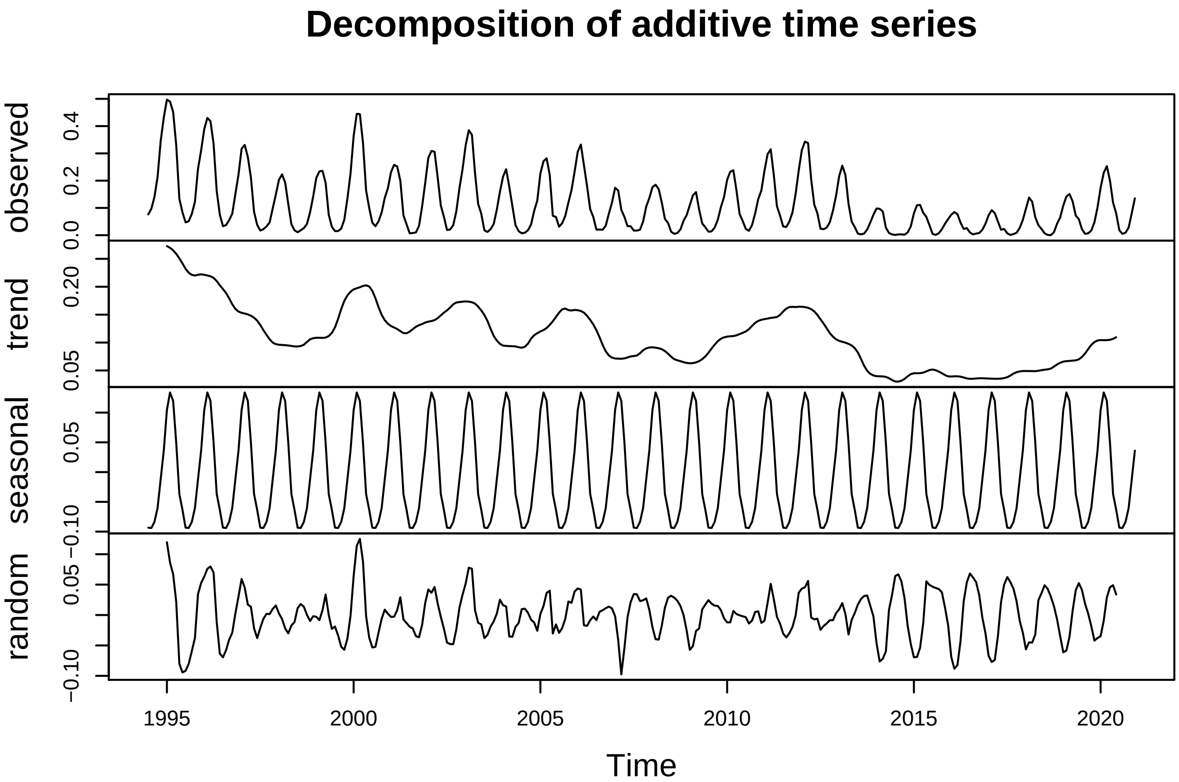
```
ts_ <- ts
plot(window(ts_, 2003, 2008), type="l", ylab="coal usage")
ts_[137:145] = ts_[137:145] * 0.6
lines(window(ts_, 2003, 2008), type="l", col="blue")
```



#

Perform new decomposition.

```
decompose_ <- decompose(ts_, "additive")
plot(decompose_)
```



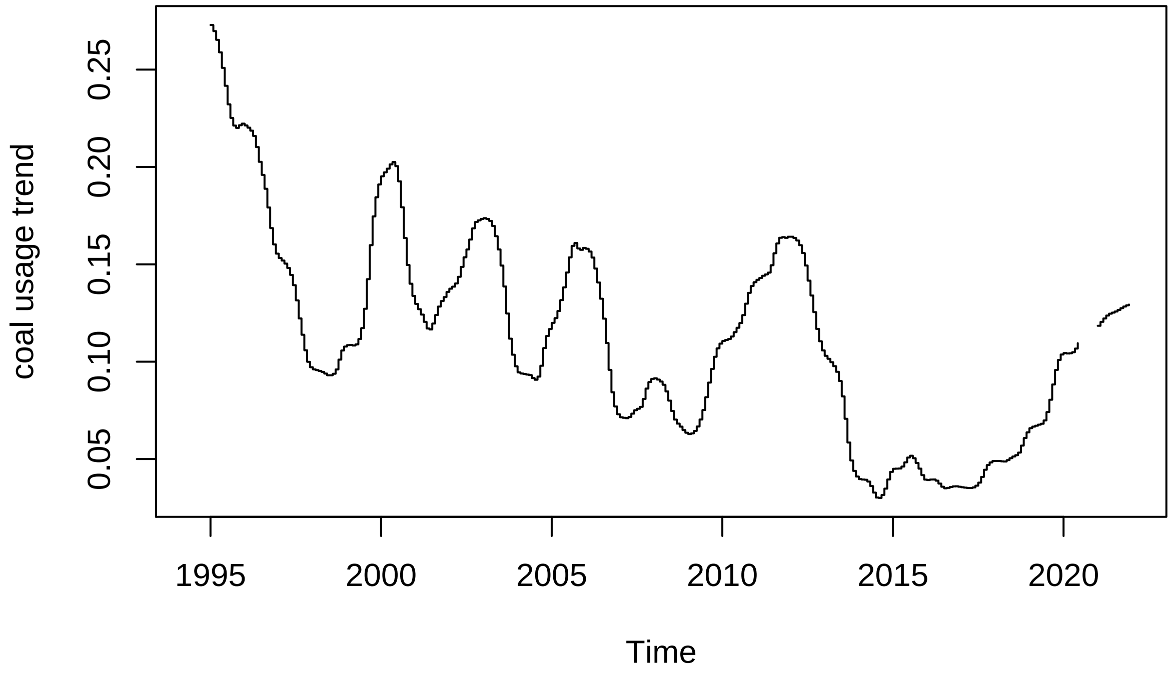
#

Predict trend

```
tsTrend <- ts(decompose_$trend, start=c(1994, 7), frequency=12)
fitARIMA <- arima(tsTrend, order=c(1,1,1),seasonal = list(order = c(1,0,0), period = 12),method="ML")
coeftest(fitARIMA)
```

```
##
## z test of coefficients:
##
##        Estimate Std. Error  z value  Pr(>|z|)
## ar1   0.9188844  0.0221422  41.4992 < 2.2e-16 ***
## ma1   0.9999989  0.0085314 117.2143 < 2.2e-16 ***
## sar1 -0.3092937  0.0551587  -5.6073 2.055e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
yTrend <- predict(fitARIMA,n.ahead = 12)$pred
cTrend <- ts(
  c(tsTrend, yTrend),
  start=start(tsTrend),
  frequency=12
)
plot(cTrend, type="s", ylab="coal usage trend")
```

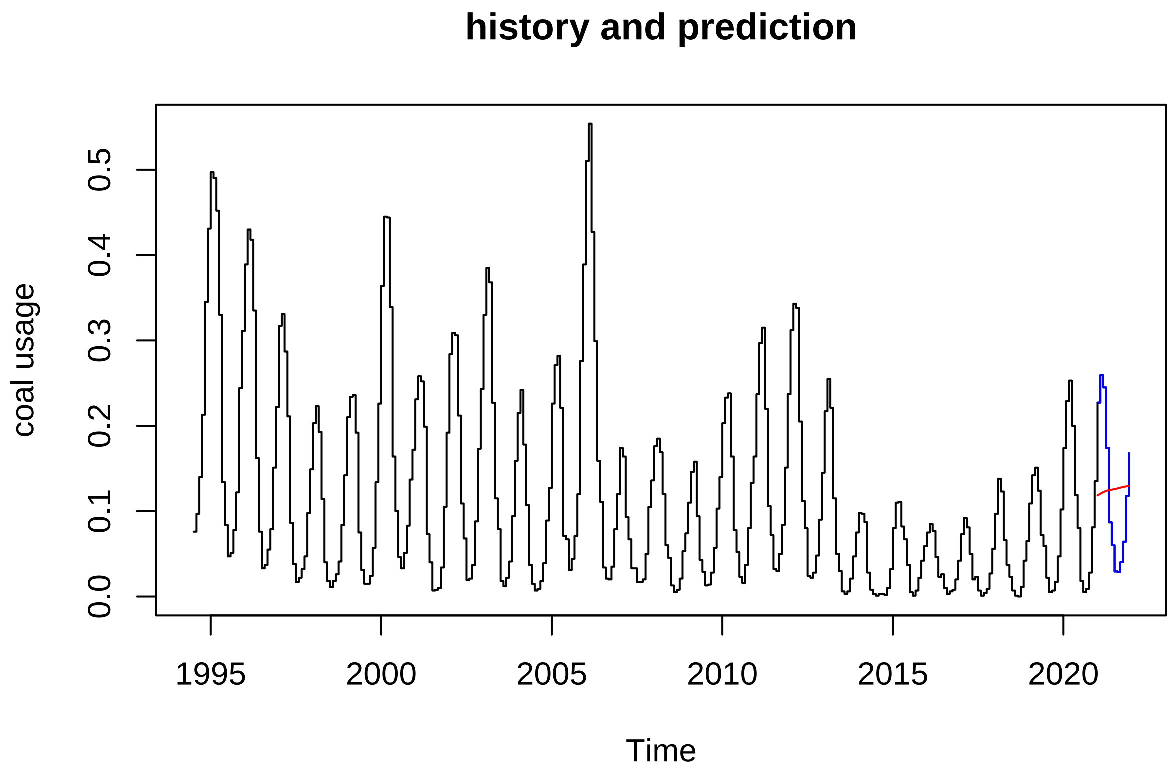


# Extract seasonal

```
ySeasonal <- window(decompose$seasonal, start=2020, end=c(2020,12))
```

Predict coal usage

```
Y <- ts(as.numeric(yTrend) + as.numeric(ySeasonal),
        star=start(yTrend), frequency=12)
TS <- ts(c(ts, Y), start=start(ts), frequency=12)
plot(TS, type="s", ylab="coal usage",
     main="history and prediction")
lines(Y, type="s", col="blue")
lines(yTrend, col="red")
```



```
Y
```

```
##              Jan        Feb        Mar        Apr        May        Jun
## 2021 0.22719068 0.25933252 0.24493153 0.17419903 0.08686344 0.06006777
##              Jul        Aug        Sep        Oct        Nov        Dec
## 2021 0.02937555 0.02900797 0.04012715 0.06425125 0.11783758 0.16806379
```