pre-assignment

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Libraries

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

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

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

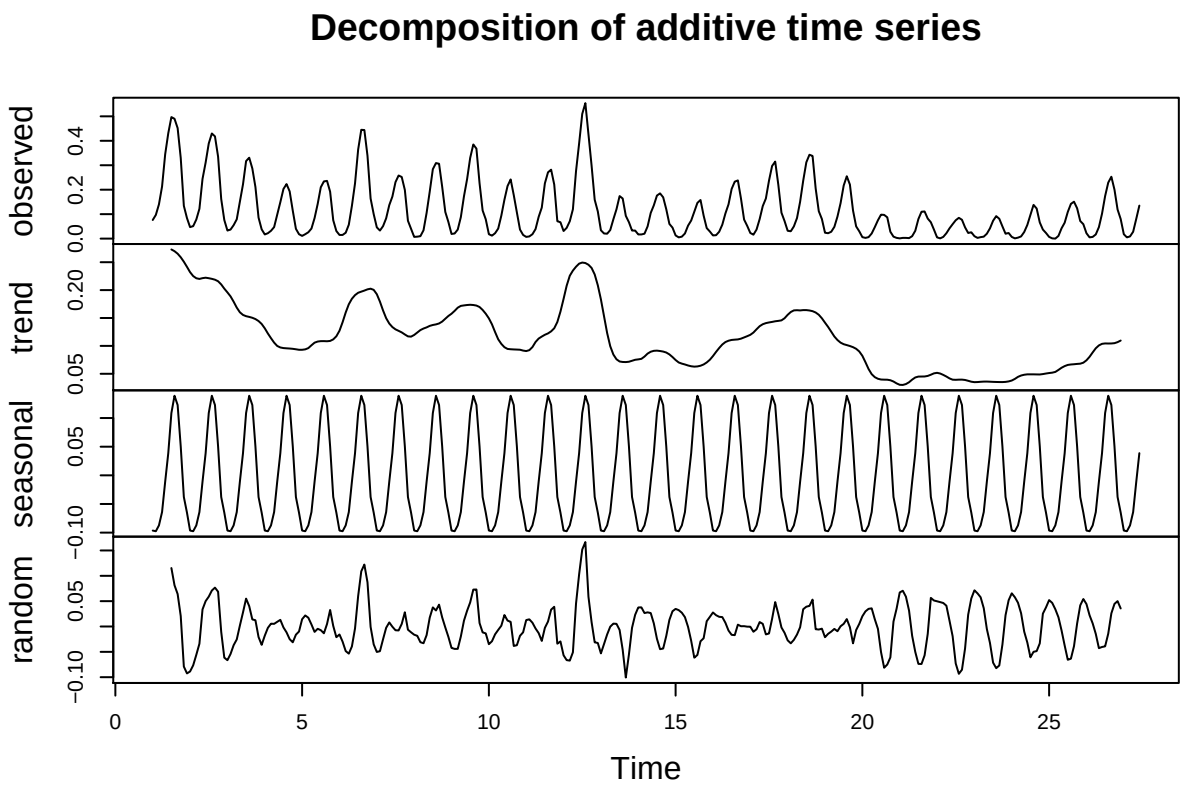
```
##
## Attaching package: 'EnvStats'

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

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

Read data (date = number of days from 1900)

```
data <- read.xlsx("Lions_Den_data.xlsx")
timeseries <- unlist(data[2])
```

Decomposition

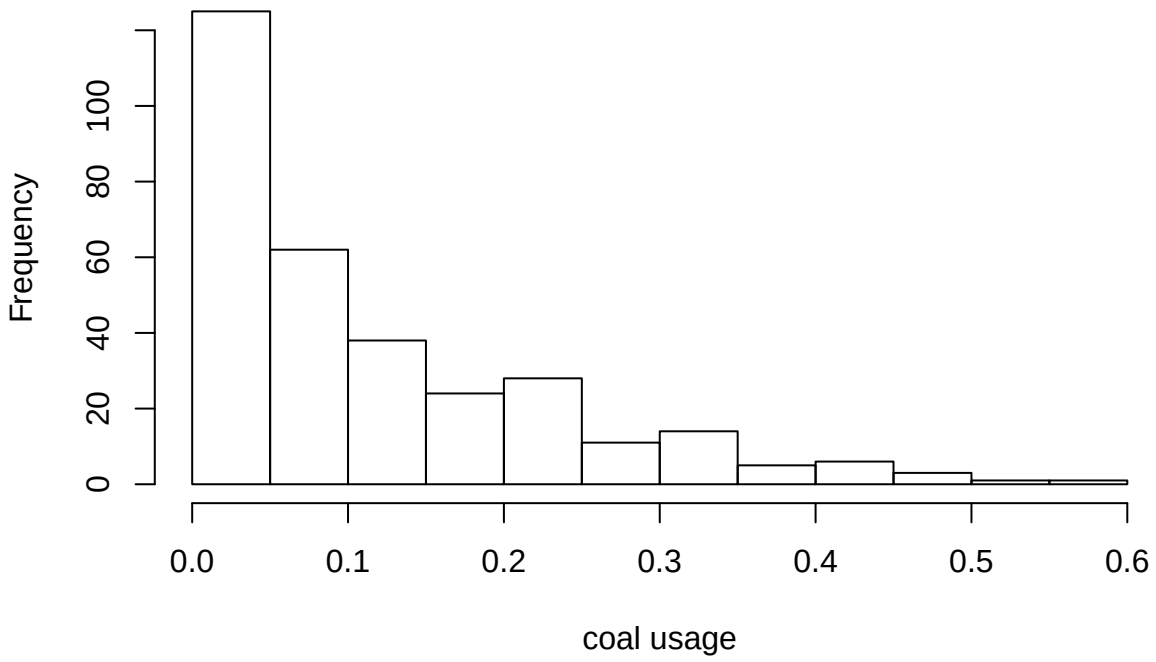
```
ts <- ts(timeseries, frequency = 12)
decompose <- decompose(ts, "additive")
plot(decompose)
```



Outliers

Rosner's test suggest that there is only one outlier.

```
hist(timeseries,
  xlab = "coal usage",
)
```




```
test <- rosnerTest(timeseries,
  k = 3
)
test
```

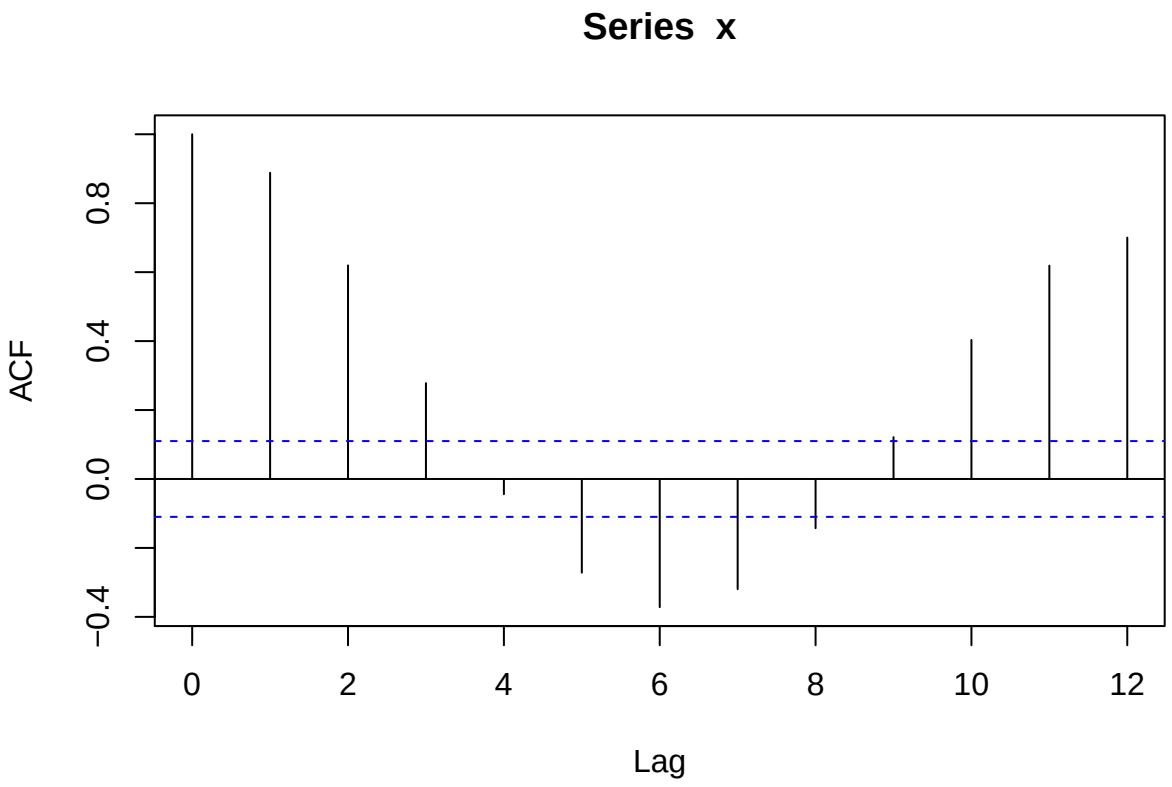
```
##
## Results of Outlier Test
## -------------------------
##
## Test Method:                     Rosner's Test for Outliers
##
## Hypothesized Distribution:       Normal
##
## Data:                            timeseries
##
## Sample Size:                     318
##
## Test Statistics:                 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.

```
x <- timeseries
#autocorrelation
acf(x, lag.max = 12)
```



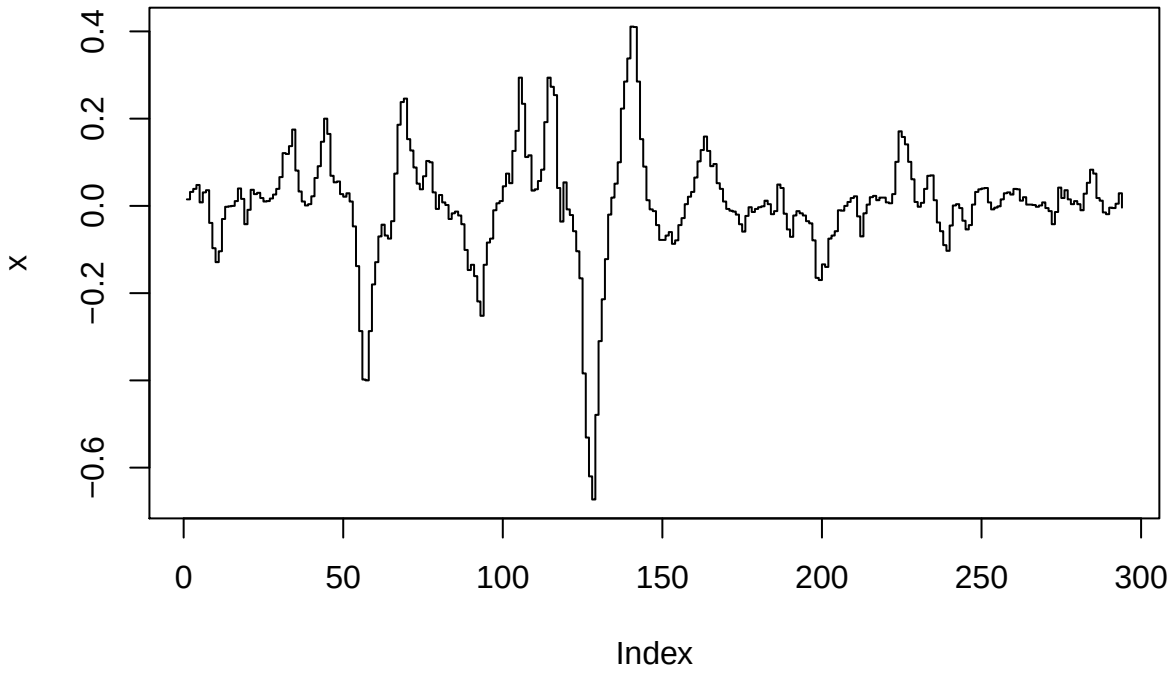

```
#stationary test
adf.test(x)
```

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

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

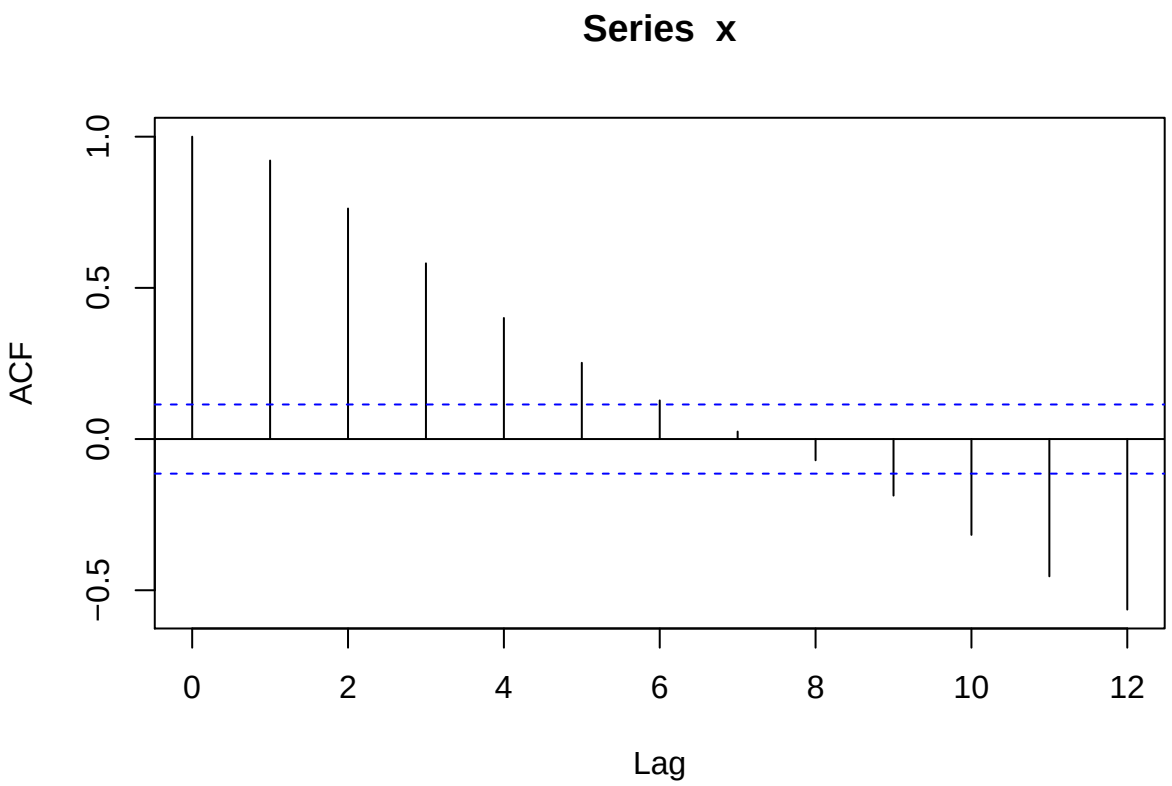
Transform time series

Remove seasonal trend and linear trend by using differentiation with lag=12 and decompose result.

```
x <- diff(timeseries, lag=12, difference=2)
plot(x, type="s")
```



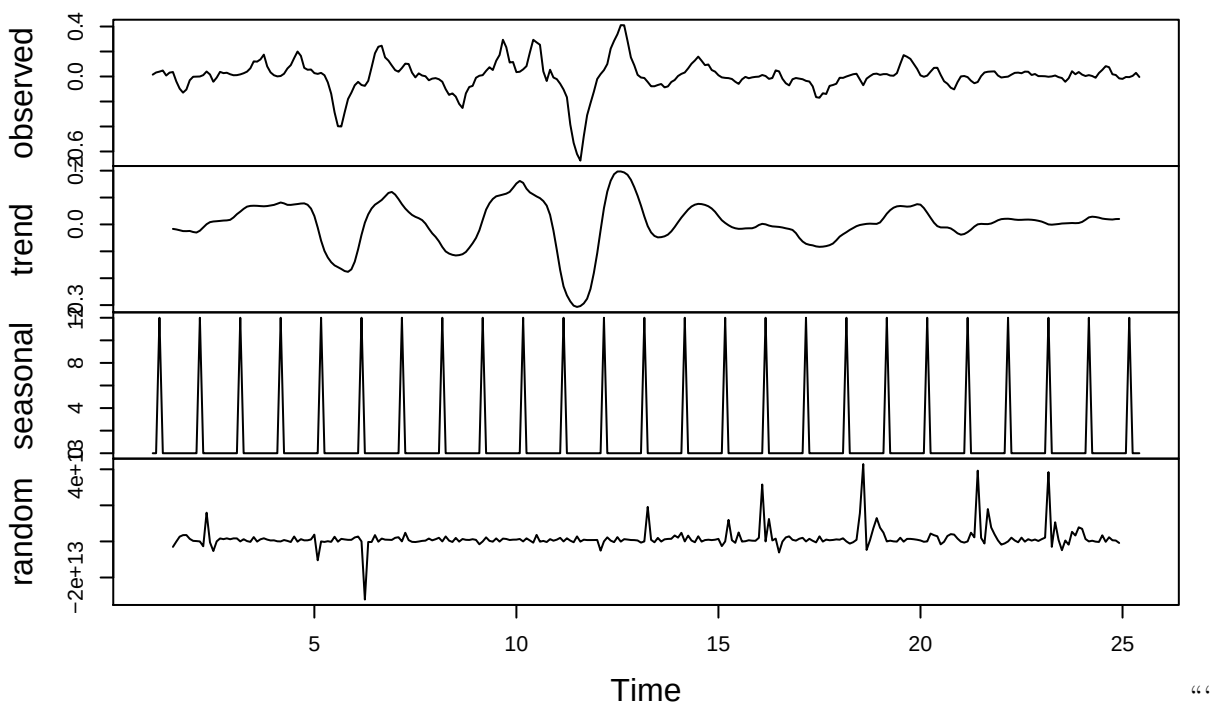

```
#autocorrelation
acf(x, lag.max = 12)
```




```
#stationary test
print(adf.test(x))
```

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

##
## Results of Hypothesis Test
## --------------------------
##
## Alternative Hypothesis:          stationary
##
## Test Name:                       Augmented Dickey-Fuller Test
##
## Data:                            x
##
## Test Statistic:                  Dickey-Fuller = -5.216909
##
## Test Statistic Parameter:        Lag order = 6
##
## P-value:                         0.01
```

```
ts <- ts(x, frequency = 12)
decompose = decompose(ts, "multiplicative")
plot(decompose)
```


Decomposition of multiplicative time series
observed
trend
seasonal
random
Time
5
10
15
20
25

“‘