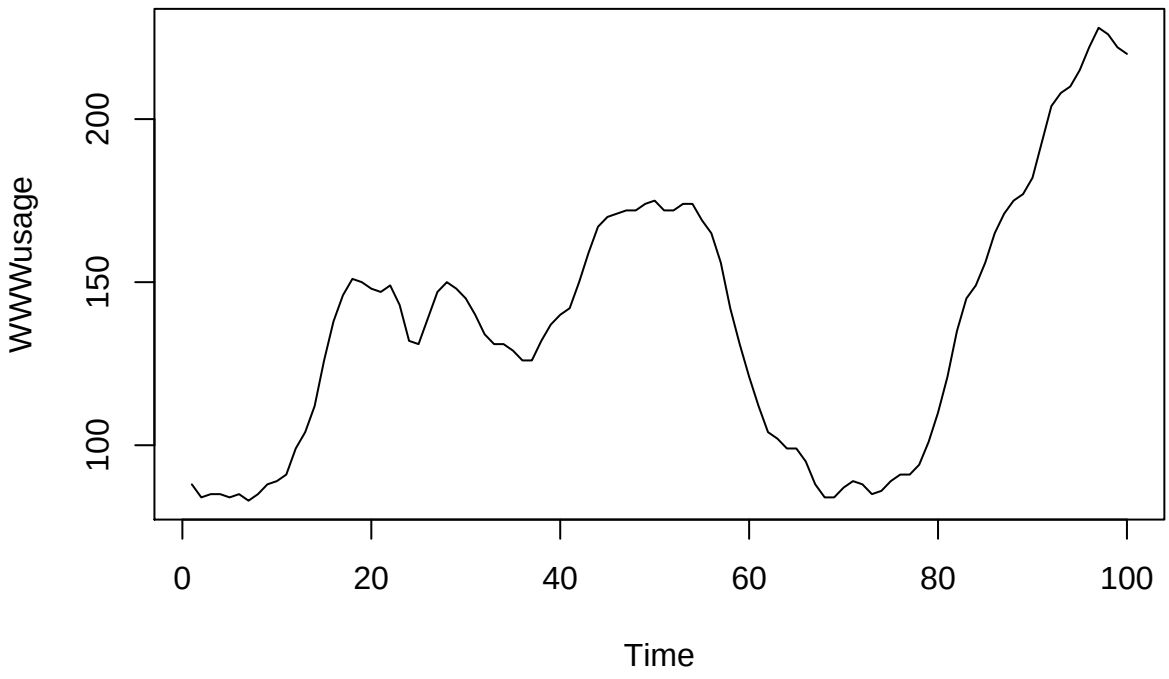
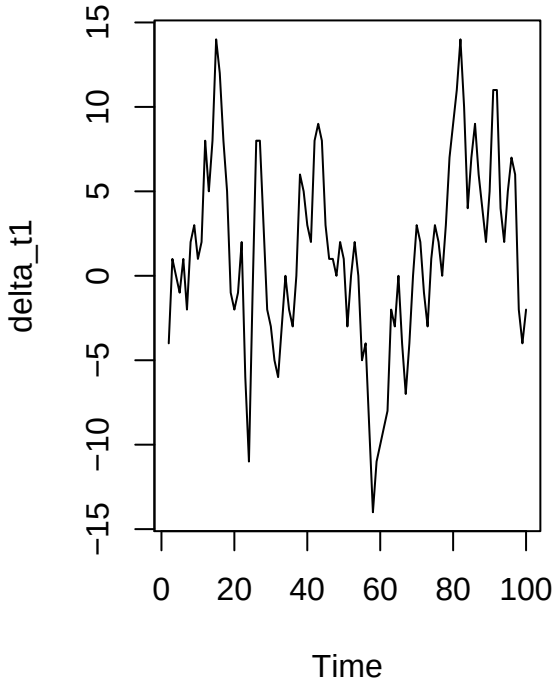
Analyze WWWUsage analysis

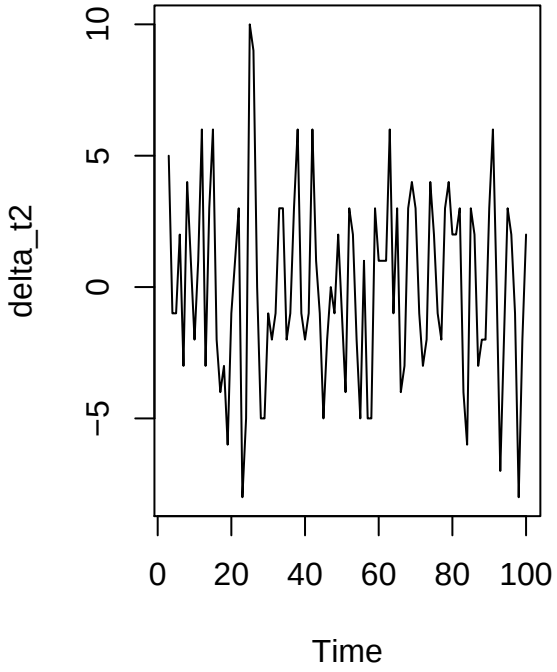
We look at WWWusage (already in R) (we call it x). (1) Let T = 1. Draw Delta T x, Delta 2 T x, Delta 3 T x, Delta 4 T x. (2) What is the degree of the polynomial trend of x ? We call k this degree (3) Make a test of level 0,05 to decide wether Delta k+1 T x is a white noise

```
# plot the original time series
plot(WWWusage)
```

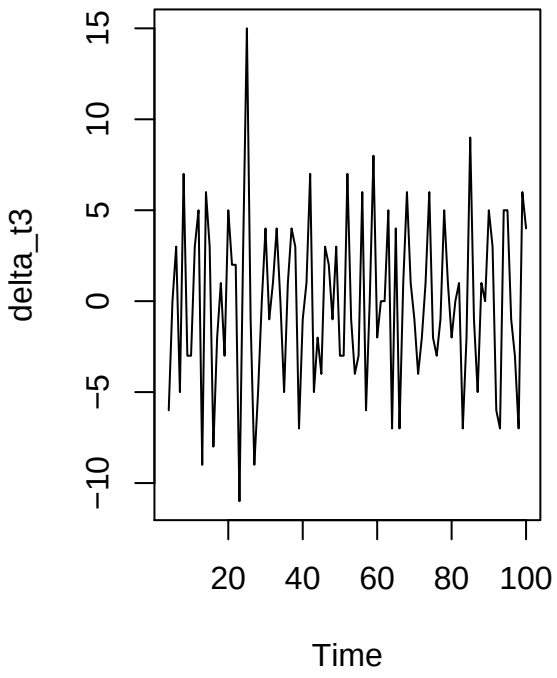


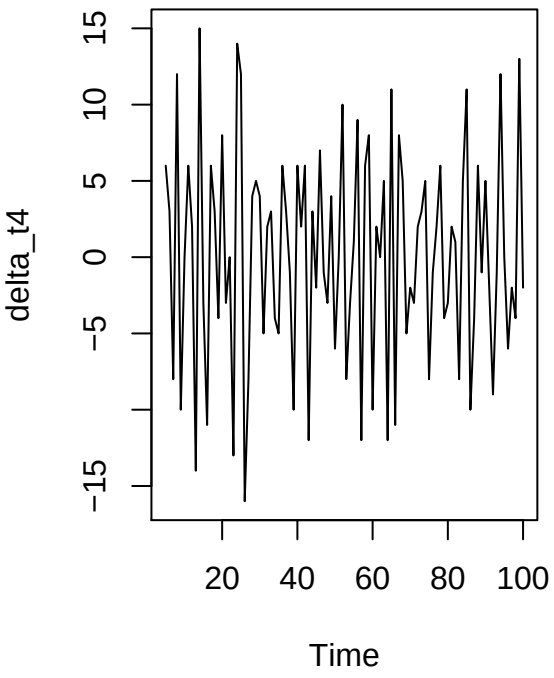

```
#plot delta/derivatives 1,2,3,4 and check the plots
x <- WWWusage
delta_t1 <- diff(x, differences = 1)
delta_t2 <- diff(x, differences = 2)
delta_t3 <- diff(x, differences = 3)
delta_t4 <- diff(x, differences = 4)

par(mfrow=c(1,2))
plot.ts(delta_t1)
plot.ts(delta_t2)
```






```
plot.ts(delta_t3)
plot.ts(delta_t4)
```






```
usageforecats <- HoltWinters(as.ts(x,start=1,end=95,frequency=1), gamma=FALSE)
print(usageforecats)
```

```
## Holt-Winters exponential smoothing with trend and without seasonal component.
##
## Call:
## HoltWinters(x = as.ts(x, start = 1, end = 95, frequency = 1),     gamma = FALSE)
##
## Smoothing parameters:
##  alpha: 1
##  beta : 1
##  gamma: FALSE
##
## Coefficients:
##   [,1]
## a  220
## b   -2
```

```
print(usageforecats$SSE)
```

```
## [1] 1274
```

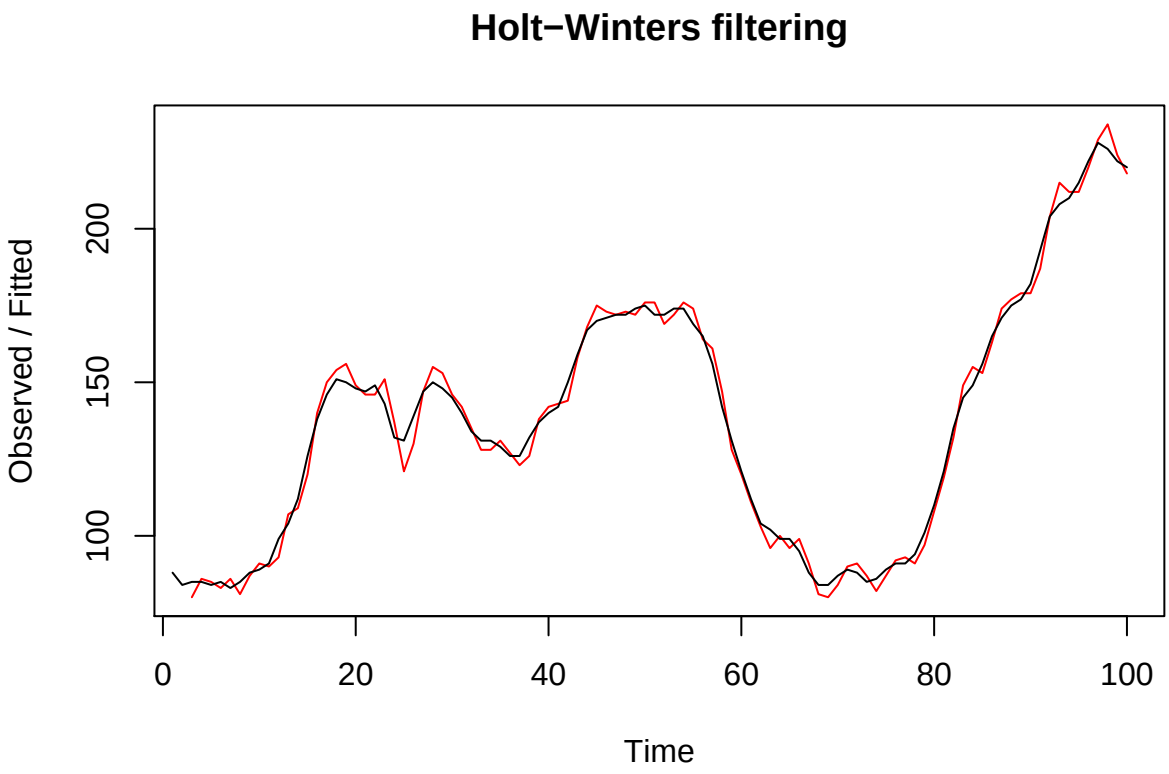
```
# plot fitted series overlaid on Observed
print(usageforecats$fitted)
```

```
## Time Series:
## Start = 3
## End = 100
```

```
## Frequency = 1
##     xhat level trend
##   3   80    84    -4
##   4   86    85     1
##   5   85    85     0
##   6   83    84    -1
##   7   86    85     1
##   8   81    83    -2
##   9   87    85     2
##  10   91    88     3
##  11   90    89     1
##  12   93    91     2
##  13  107    99     8
##  14  109   104     5
##  15  120   112     8
##  16  140   126    14
##  17  150   138    12
##  18  154   146     8
##  19  156   151     5
##  20  149   150    -1
##  21  146   148    -2
##  22  146   147    -1
##  23  151   149     2
##  24  137   143    -6
##  25  121   132   -11
##  26  130   131    -1
##  27  147   139     8
##  28  155   147     8
##  29  153   150     3
##  30  146   148    -2
##  31  142   145    -3
##  32  135   140    -5
##  33  128   134    -6
##  34  128   131    -3
##  35  131   131     0
##  36  127   129    -2
##  37  123   126    -3
##  38  126   126     0
##  39  138   132     6
##  40  142   137     5
##  41  143   140     3
##  42  144   142     2
##  43  158   150     8
##  44  168   159     9
##  45  175   167     8
##  46  173   170     3
##  47  172   171     1
##  48  173   172     1
##  49  172   172     0
##  50  176   174     2
##  51  176   175     1
##  52  169   172    -3
##  53  172   172     0
##  54  176   174     2
```

```
##  55  174   174     0
##  56  164   169    -5
##  57  161   165    -4
##  58  147   156    -9
##  59  128   142   -14
##  60  120   131   -11
##  61  111   121   -10
##  62  103   112    -9
##  63   96   104    -8
##  64  100   102    -2
##  65   96    99    -3
##  66   99    99     0
##  67   91    95    -4
##  68   81    88    -7
##  69   80    84    -4
##  70   84    84     0
##  71   90    87     3
##  72   91    89     2
##  73   87    88    -1
##  74   82    85    -3
##  75   87    86     1
##  76   92    89     3
##  77   93    91     2
##  78   91    91     0
##  79   97    94     3
##  80  108   101     7
##  81  119   110     9
##  82  132   121    11
##  83  149   135    14
##  84  155   145    10
##  85  153   149     4
##  86  163   156     7
##  87  174   165     9
##  88  177   171     6
##  89  179   175     4
##  90  179   177     2
##  91  187   182     5
##  92  204   193    11
##  93  215   204    11
##  94  212   208     4
##  95  212   210     2
##  96  220   215     5
##  97  229   222     7
##  98  234   228     6
##  99  224   226    -2
## 100  218   222    -4
```

```
plot(usageforecats)
```




```
# to find the level of significance 0.05
library("forecast")
```

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

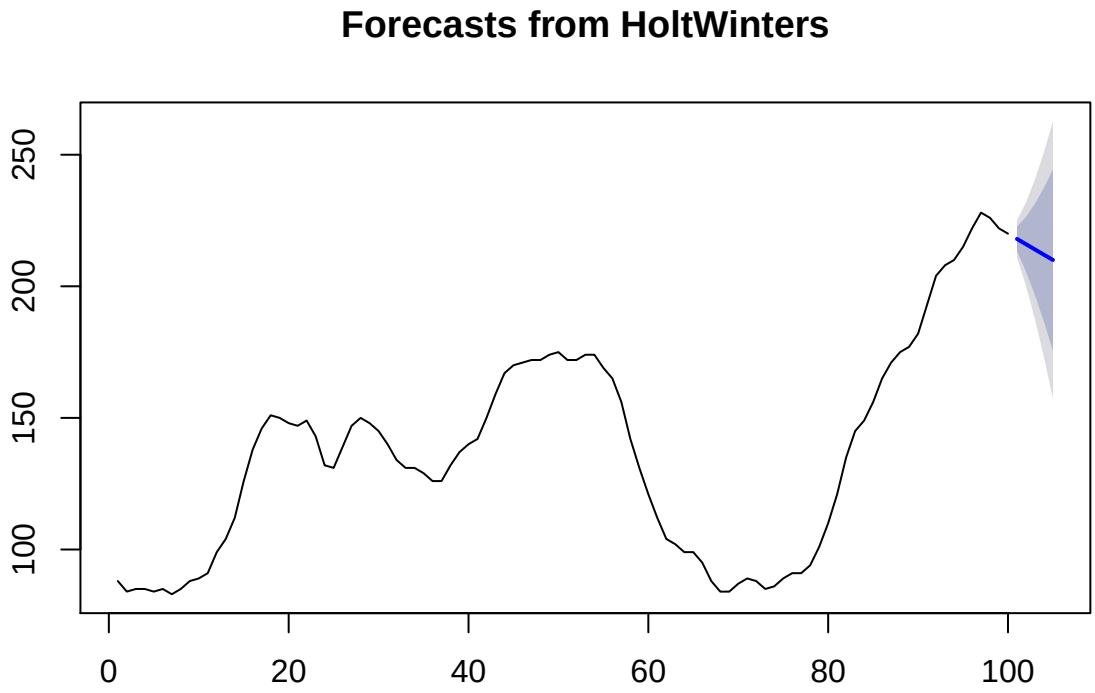
```
##
## Attaching package: 'zoo'
```

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

```
## Loading required package: timeDate
```

```
## This is forecast 7.3
```

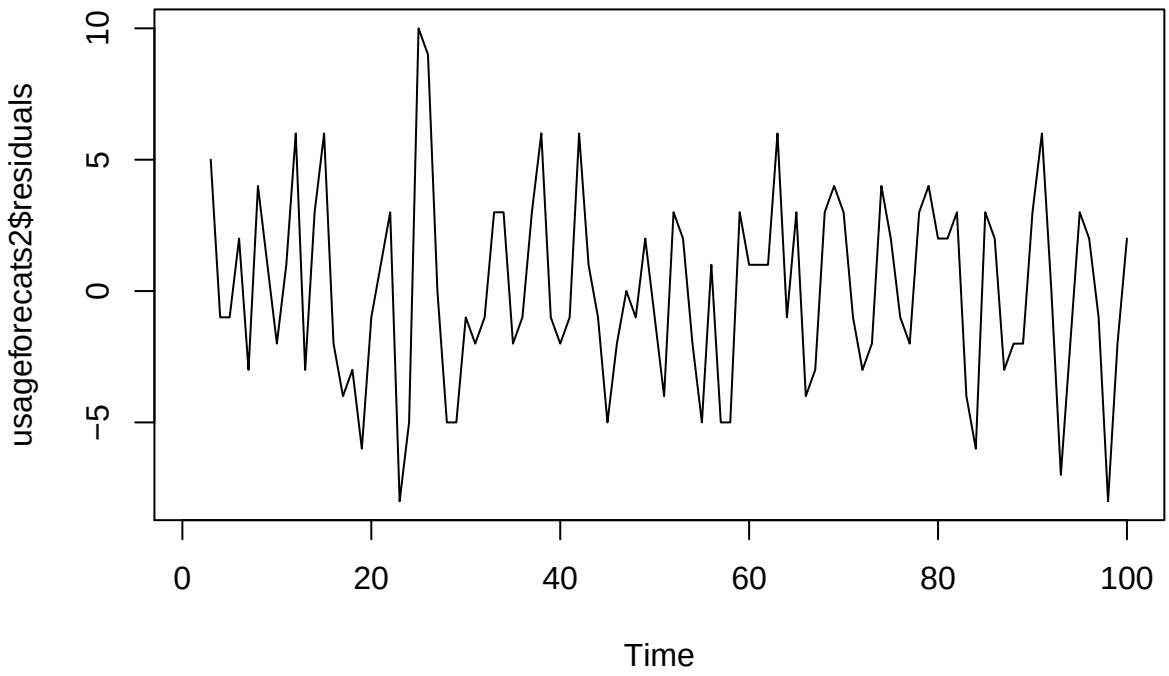
```
usageforecats2<-forecast.HoltWinters(usageforecats, h=5)

plot.forecast(usageforecats2)
```




```
#acf(usageforecats2$residuals, lag.max=2)
Box.test(usageforecats2$residuals, lag=20, type="Ljung-Box")
```

```
##
##  Box-Ljung test
##
## data:  usageforecats2$residuals
## X-squared = 53.603, df = 20, p-value = 6.623e-05
```

```
plot.ts(usageforecats2$residuals)
```


usageforecats2$residuals
10
5
0
−5
0
20
40
60
80
100
Time