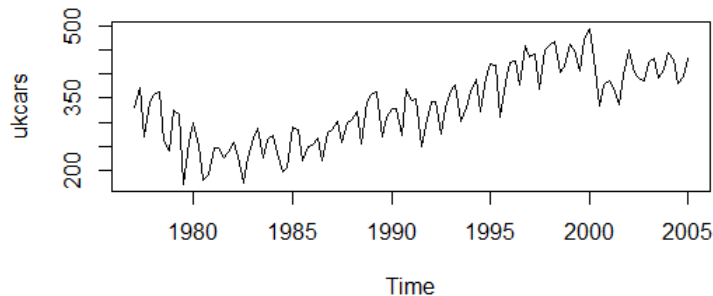
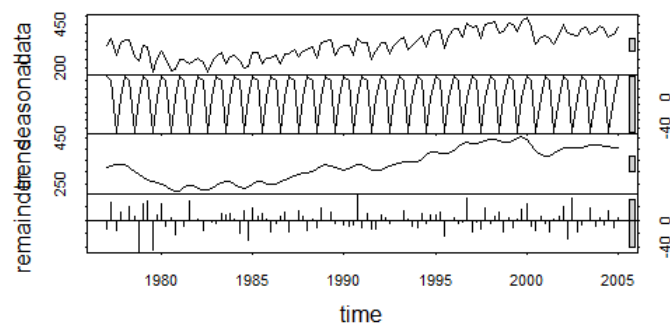


- The following is a time plot of quarterly UK passenger vehicle production data from 1997:12005:1. Describe the mean features of the time series.

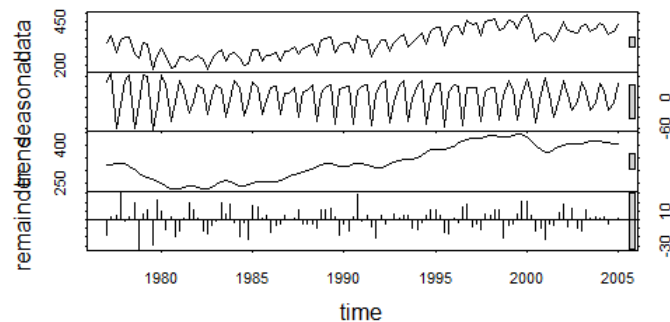


There appears to be strong seasonality and trend on the time series.

- We perform time series decomposition on the data. The following two plots are the results of "stl" function with different arguments. Describe the mean differences on these two plots. What are the differences on the arguments used on the stl function.



The first decomposition set `s.window=periodic`, where the second decomposition set `s.window` to be a small number such as 5.



- Now perform exponential smoothing on the data and we have the following results. Explain what the estimated values of α , β and γ suggest.

```
> HoltWinters(ukcars)
Holt-Winters exponential smoothing with trend and additive seasonal component
Call:
HoltWinters(x = ukcars)
Smoothing parameters:
  alpha:  0.5956685
  beta :  0.03108968
  gamma:  0.4162382

Coefficients:
      [,1]
a 393.0343263
b   0.5020972
s1 25.1326774
s2 -25.7501265
s3  4.4614694
s4 40.4259069
```

Alpha=0.5956 shows that the level component of the results is calculated using a combination of the most recent and distant observations in the time series. Beta=0.031 shows that the trend component is pretty consistent throughout the time series, and it is calculated as a long term trend. Gamma=0.416

shows that the seasonal component of the results is calculated using a combination of the most recent and distant observations in the time series.

- Explain what the following command lines do line by line.

```
a=HoltWinters(ukcars)
b=forecast(a,h=8)
Box.test(b$residuals, lag=20, type="Ljung-Box")
```

1. fit a exponential smoothing model with level, trend and seasonal components. 2. forecast 8 steps ahead. 3. Check if the residuals of the fitted model is autocorrelated or not

- Suppose we have the following test result, explain what it means. What can we say about the model fit.

```
> Box.test(b$residuals, lag=20, type="Ljung-Box")
```

Box-Ljung test

```
data:  b$residuals
X-squared = 44.9384, df = 20, p-value = 0.001125
```

The residuals are autocorrelated. The model is not adequate.

- If we run "a=HoltWinters(ukcars,gamma=FALSE)", what will be the difference between this and "a=HoltWinters(ukcars)".

The former is an exponential smoothing with level and trend. The second one also contains seasonal component.