ISLR Lab 3.6

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[1]:
```
library(MASS)
library(ISLR)
```

[2]:
```
fix(Boston)
print(names(Boston))
```

```
 [1] "crim"    "zn"      "indus"   "chas"    "nox"     "rm"      "age"
 [8] "dis"     "rad"     "tax"     "ptratio" "black"   "lstat"   "medv"
```

[3]:
```
lm.fit=lm(medv~lstat)
```

```
Error in eval(predvars, data, env): object 'medv' not found
Traceback:

1. eval(mf, parent.frame())
2. eval(mf, parent.frame())
3. stats::model.frame(formula = medv ~ lstat, drop.unused.levels = TRUE)
4. model.frame.default(formula = medv ~ lstat, drop.unused.levels = TRUE)
5. eval(predvars, data, env)
6. eval(predvars, data, env)
7. .handleSimpleError(function (cnd)
 . {
 .     watcher$capture_plot_and_output()
 .     cnd <- sanitize_call(cnd)
 .     watcher$push(cnd)
 .     switch(on_error, continue = invokeRestart("eval_continue"),
 .         stop = invokeRestart("eval_stop"), error = NULL)
 . }, "object 'medv' not found", base::quote(eval(predvars, data,
 .     env)))
```

[4]:
```
lm.fit=lm(medv~lstat, data=Boston)
attach(Boston)
lm.fit=lm(medv~lstat)
```

[5]:
```
lm.fit
```

```
Call:
lm(formula = medv ~ lstat)

Coefficients:
(Intercept)        lstat
      34.55        -0.95
```

[6]:
```
summary(lm.fit)
```

```
Call:
lm(formula = medv ~ lstat)

Residuals:
    Min      1Q  Median      3Q     Max
-15.168  -3.990  -1.318   2.034  24.500

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 34.55384    0.56263   61.41   <2e-16 ***
lstat       -0.95005    0.03873  -24.53   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 6.216 on 504 degrees of freedom
Multiple R-squared:  0.5441,        Adjusted R-squared:  0.5432
F-statistic: 601.6 on 1 and 504 DF,  p-value: < 2.2e-16
```

[7]:
```
print(names(lm.fit))
```

```
 [1] "coefficients"  "residuals"     "effects"       "rank"
 [5] "fitted.values" "assign"        "qr"            "df.residual"
 [9] "xlevels"       "call"          "terms"         "model"
```

[8]:
```
print(coef(lm.fit))
```

```
(Intercept)       lstat
 34.5538409  -0.9500494
```

[9]:
```
print(confint(lm.fit))
```

```
                2.5 %     97.5 %
(Intercept) 33.448457 35.6592247
lstat       -1.026148 -0.8739505
```

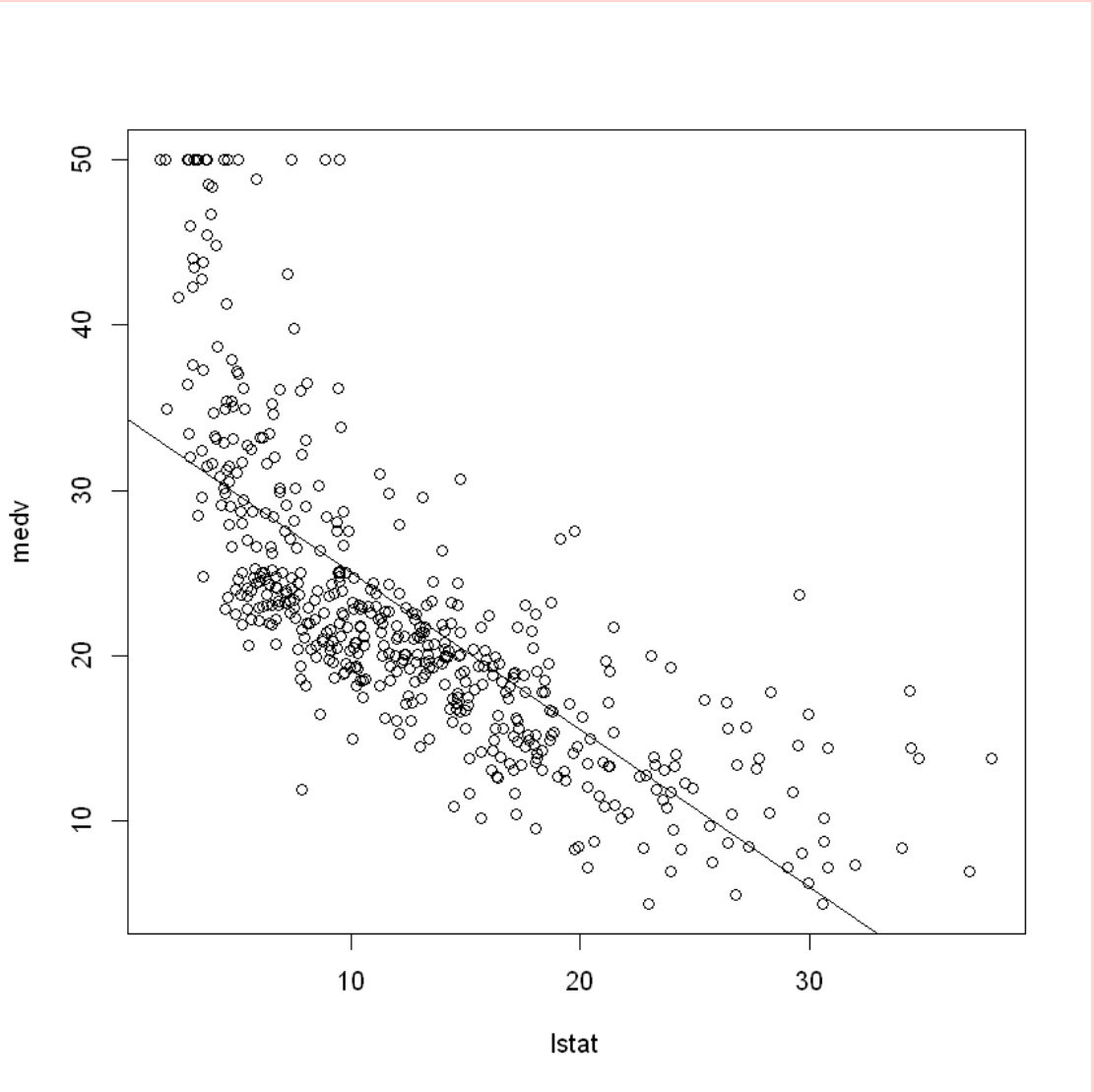
[10]:
```
print(predict(lm.fit, data.frame(lstat=c(5,10 ,15)), interval ="confidence"))
```

```
       fit      lwr      upr
1 29.80359 29.00741 30.59978
2 25.05335 24.47413 25.63256
3 20.30310 19.73159 20.87461
```

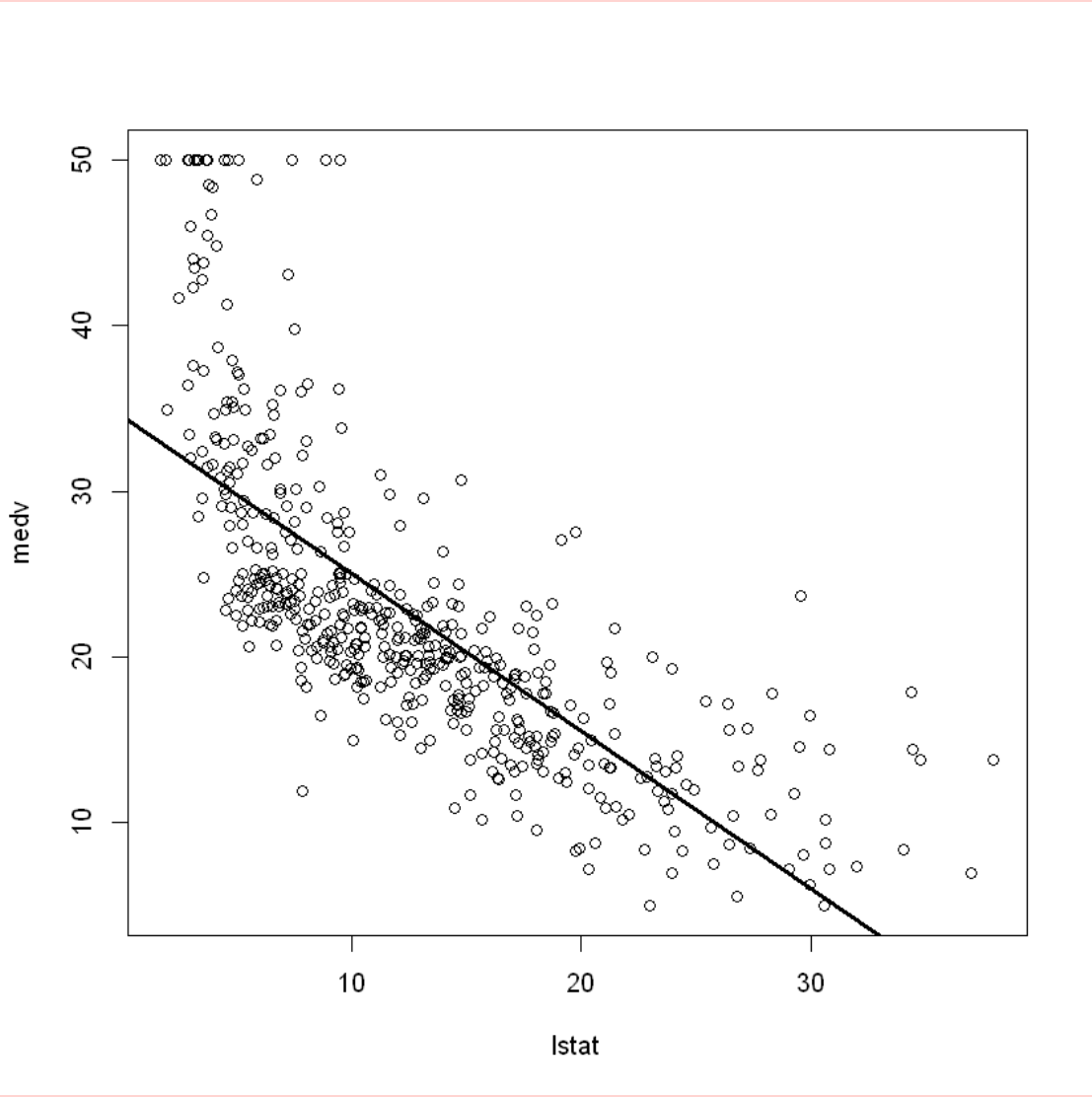
[11]:
```
print(predict(lm.fit, data.frame(lstat=c(5,10 ,15)), interval ="prediction"))
```

```
       fit       lwr      upr
1 29.80359 17.565675 42.04151
2 25.05335 12.827626 37.27907
3 20.30310  8.077742 32.52846
```

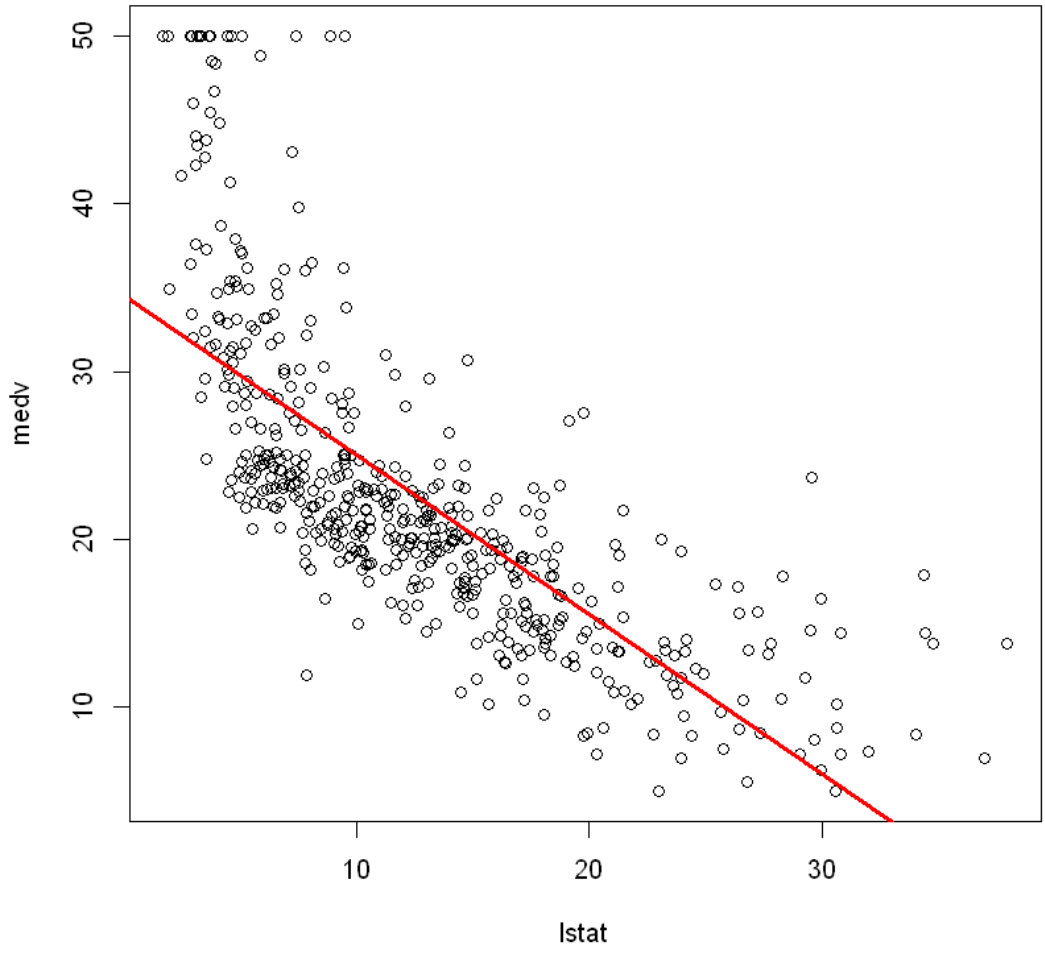
[12]:
```
plot(lstat, medv)
abline(lm.fit)
```



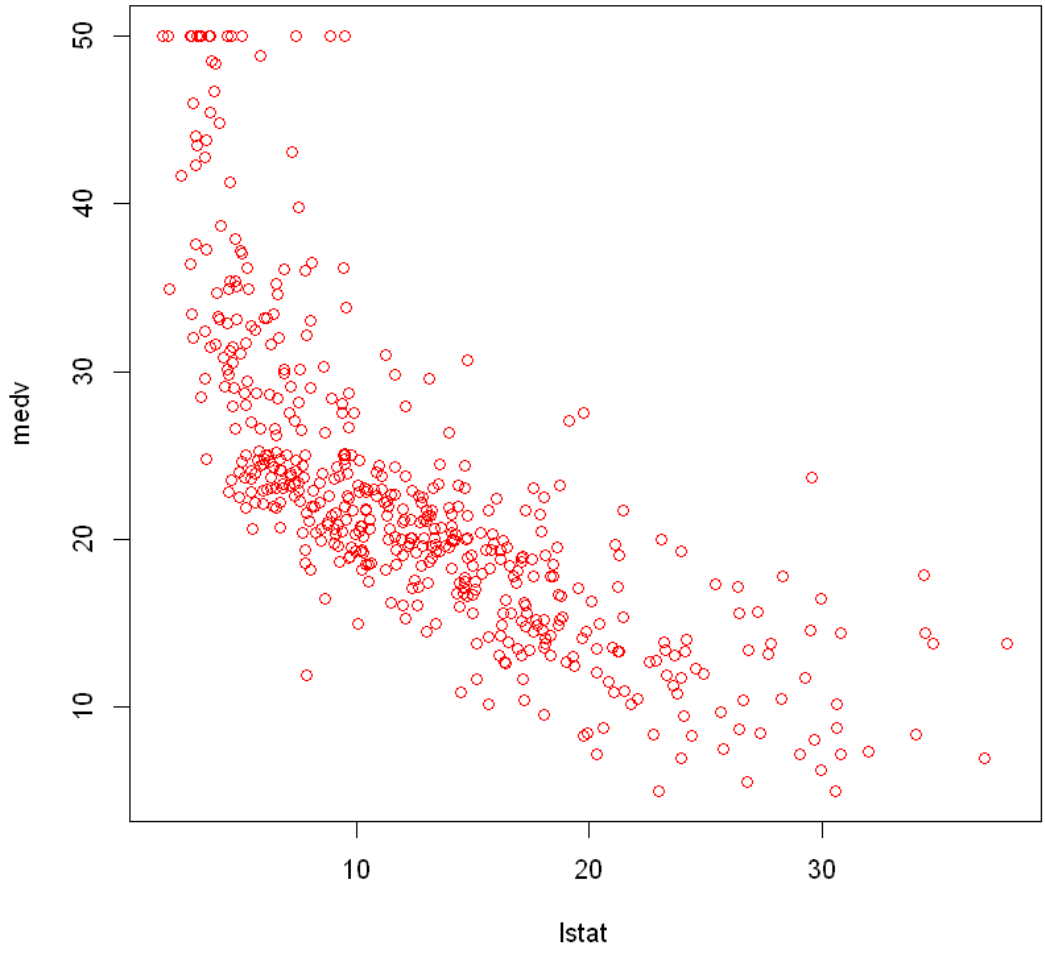
[13]:
```
plot(lstat, medv)
abline(lm.fit, lwd=3)
```



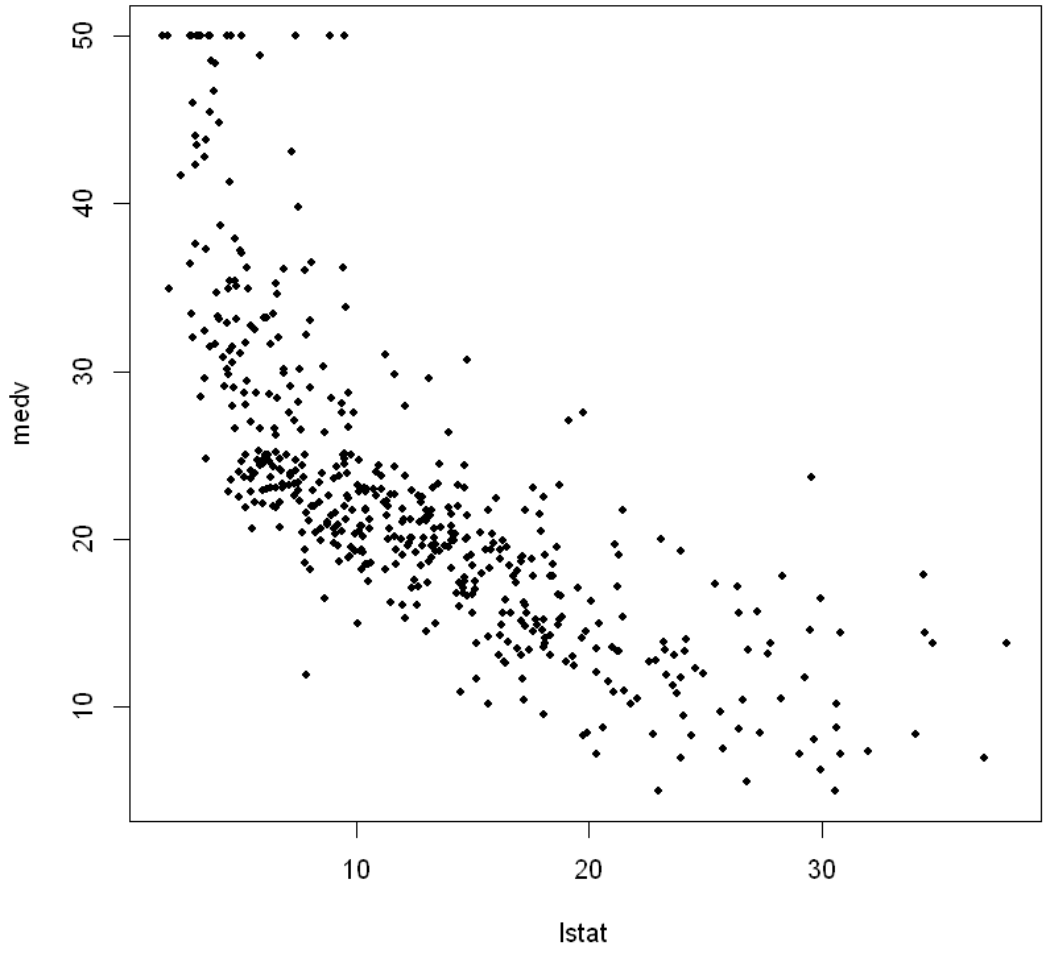
[14]:
```
plot(lstat, medv)
abline(lm.fit, lwd=3, col="red")
```



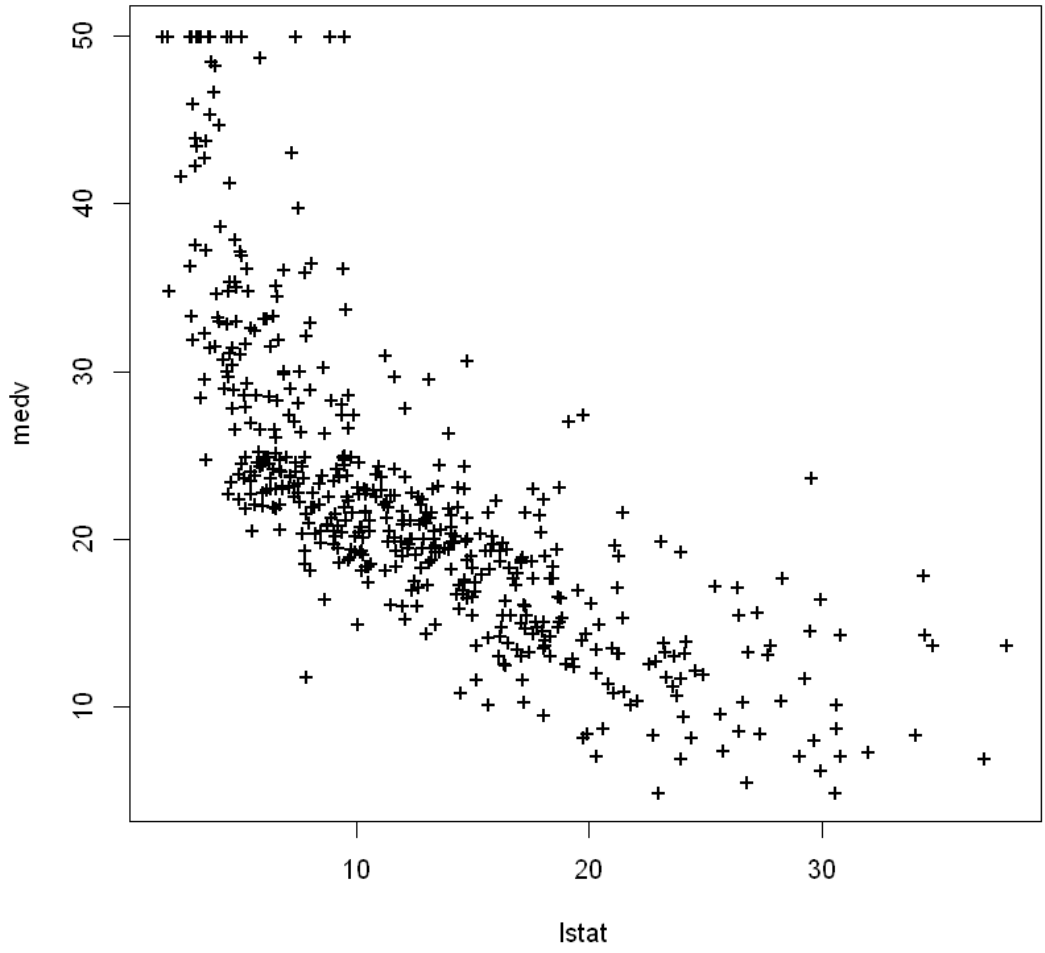
[15]:
```
plot(lstat ,medv ,col="red")
```



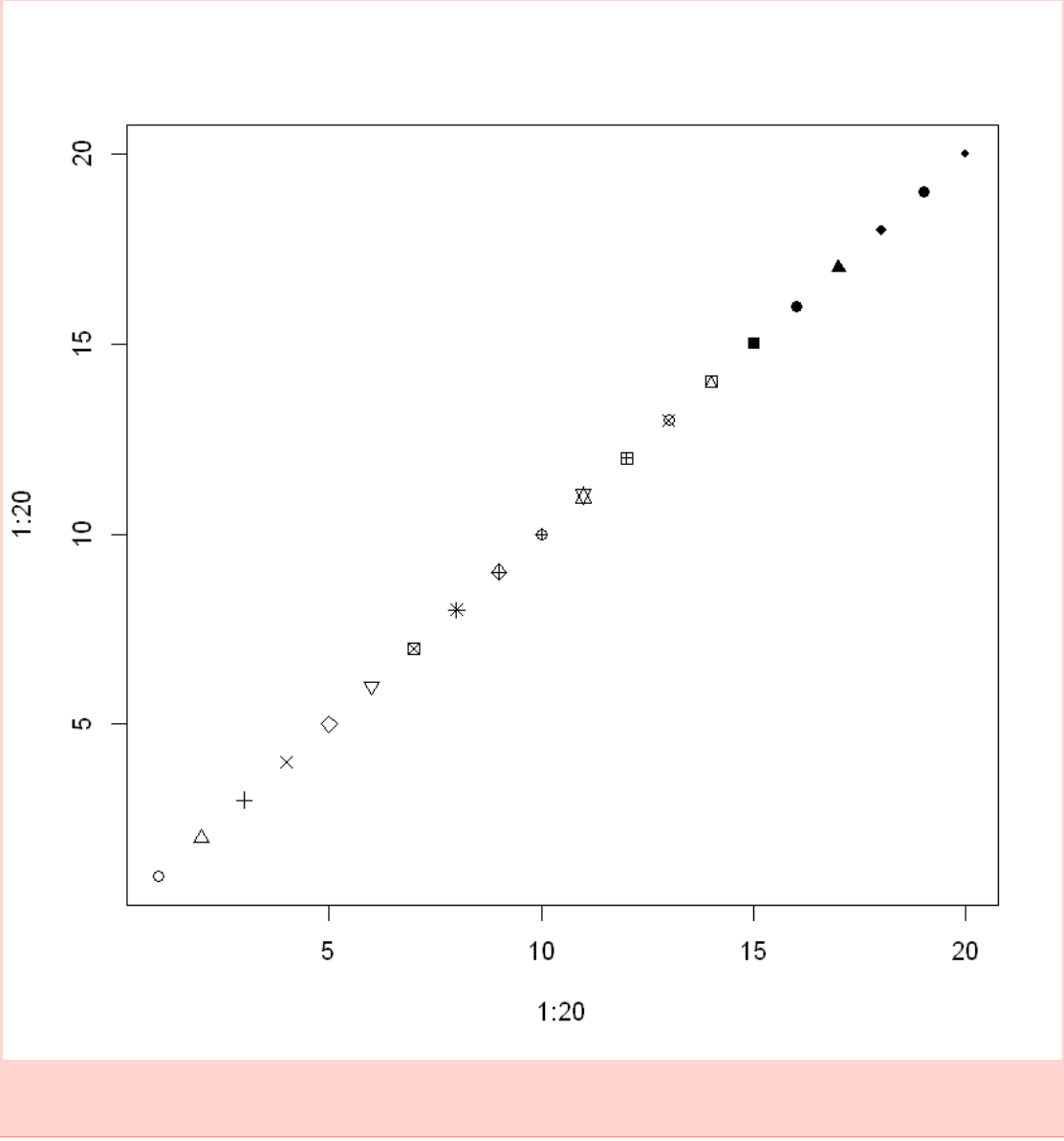
[16]:
```
plot(lstat ,medv ,pch =20)
```



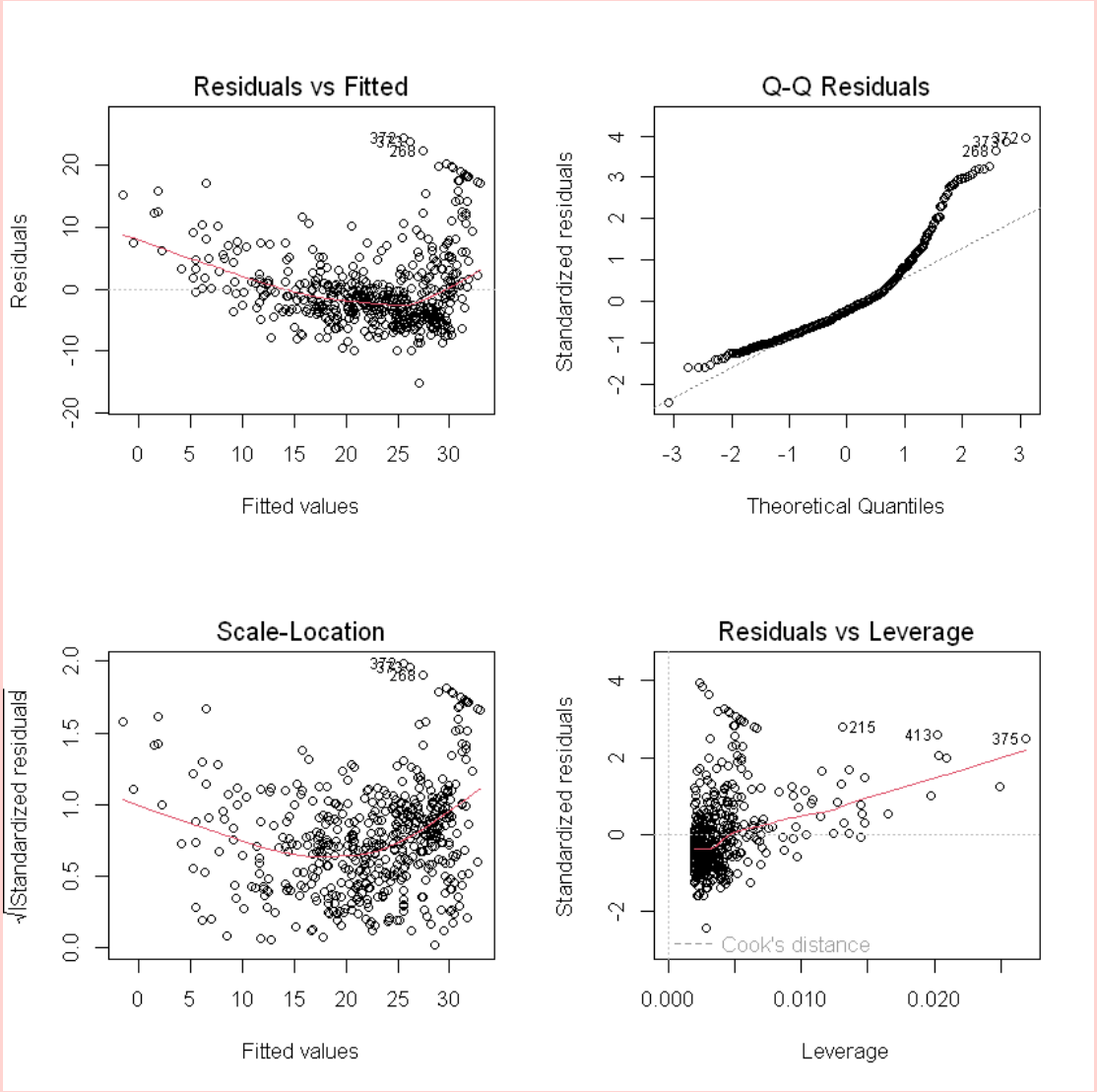
[17]:
```
plot(lstat ,medv ,pch ="+")
```



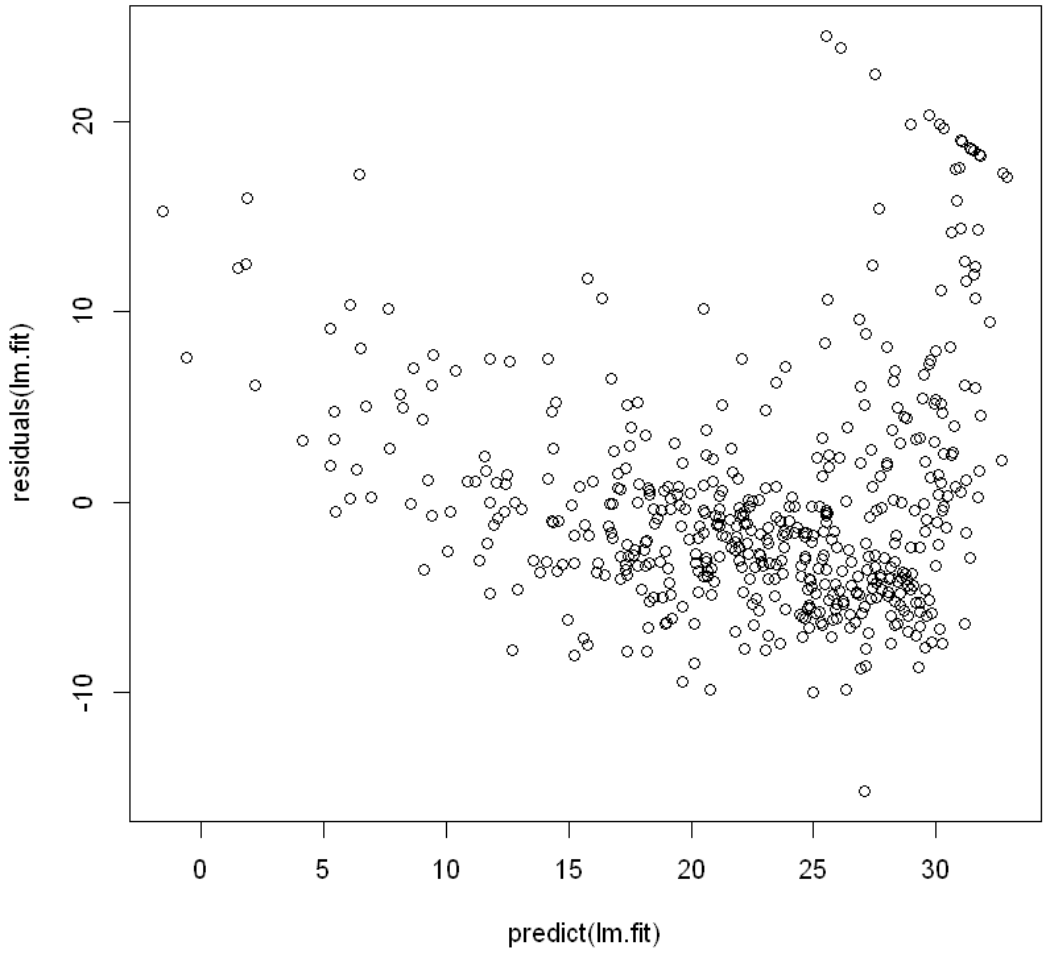
[18]:
```
plot(1:20,1:20,pch =1:20)
```



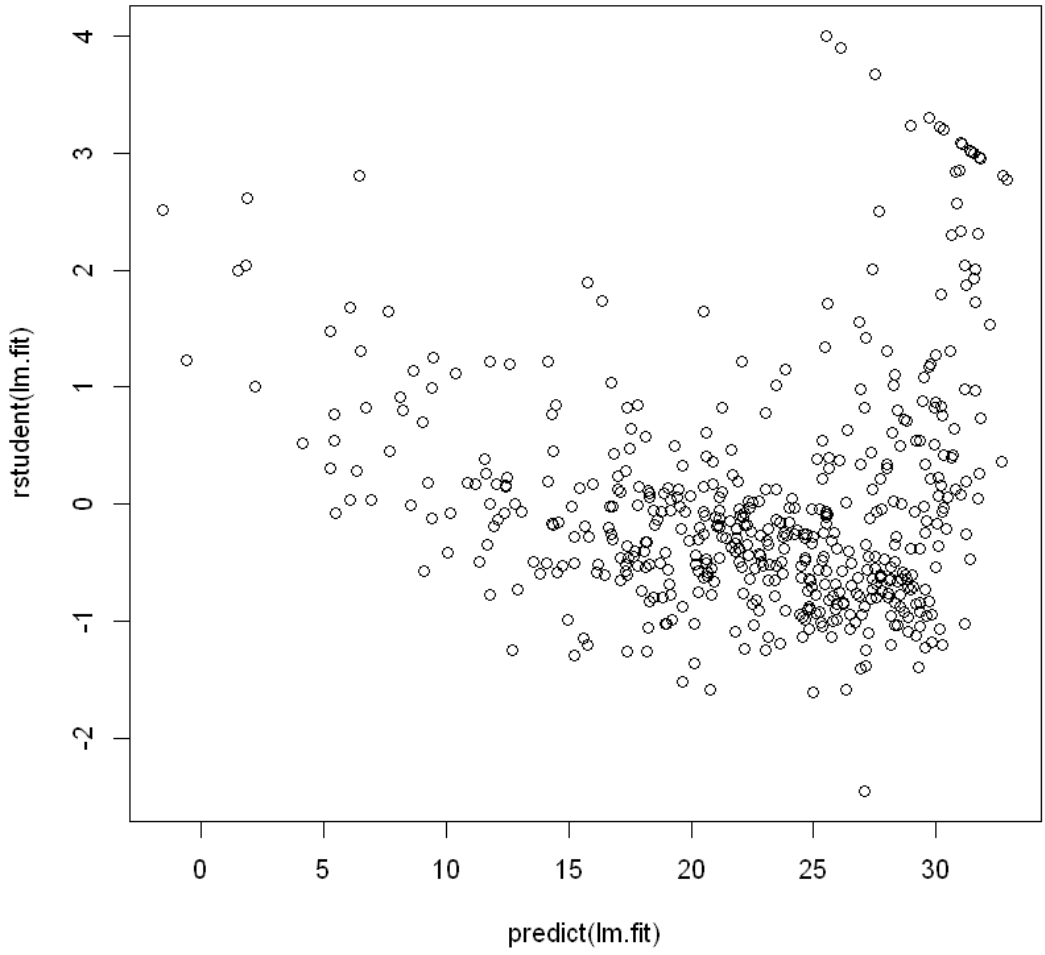
[19]:
```
par(mfrow=c(2,2))
plot(lm.fit)
```



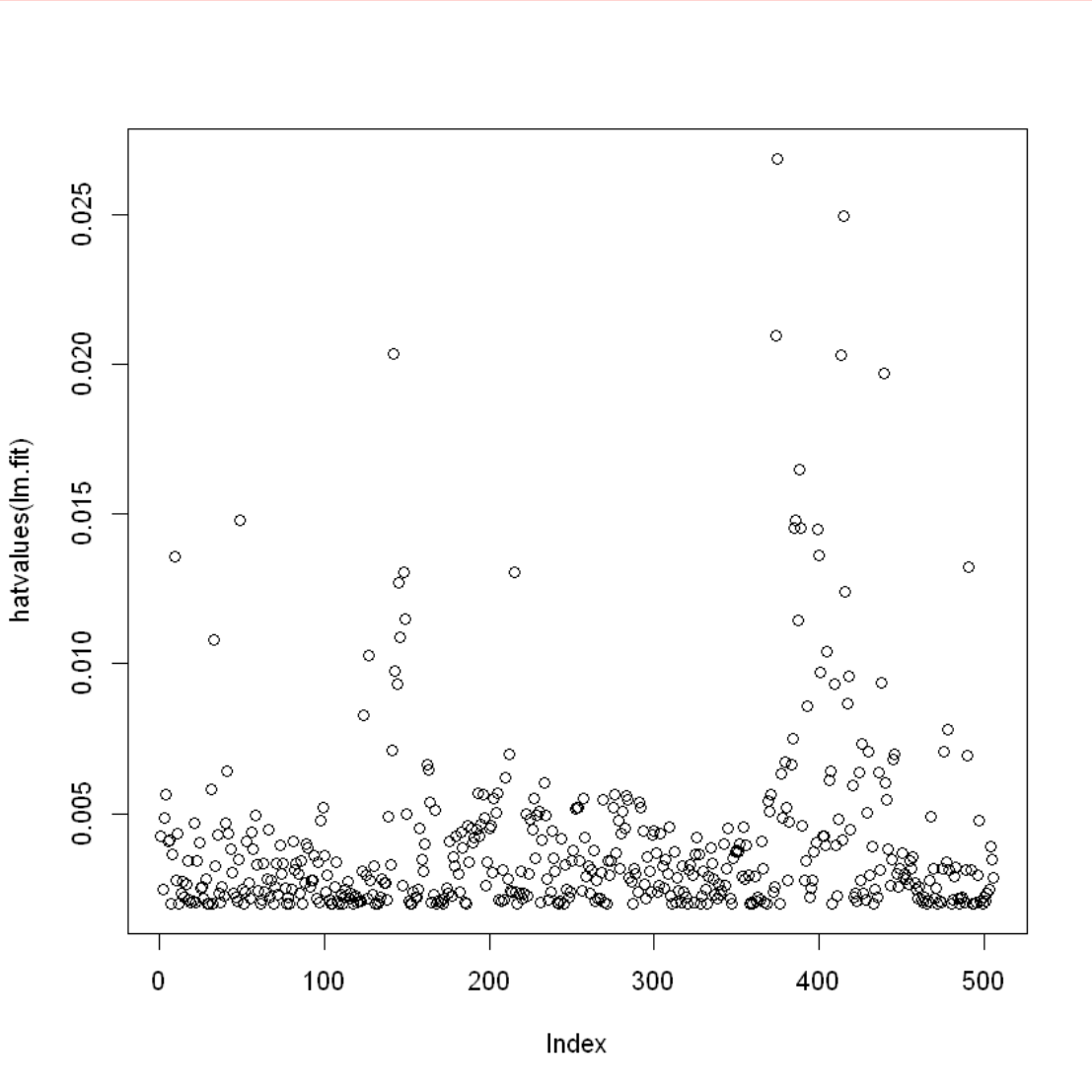
[20]:
```
plot(predict(lm.fit), residuals(lm.fit))
```



[21]:
```
plot(predict(lm.fit), rstudent(lm.fit))
```



[22]:
```
plot(hatvalues(lm.fit))
```



[23]:
```
which.max(hatvalues(lm.fit))
```

375: 375

[24]:
```
lm.fit=lm(medv~lstat+age ,data=Boston )
summary(lm.fit)
```

```

Call:
lm(formula = medv ~ lstat + age, data = Boston)

Residuals:
    Min      1Q  Median      3Q     Max
-15.981  -3.978  -1.283   1.968  23.158
```

```
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 33.22276    0.73085  45.458  < 2e-16 ***
lstat       -1.03207    0.04819 -21.416  < 2e-16 ***
age          0.03454    0.01223   2.826  0.00491 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 6.173 on 503 degrees of freedom
Multiple R-squared:  0.5513,        Adjusted R-squared:  0.5495
F-statistic:   309 on 2 and 503 DF,  p-value: < 2.2e-16
```

[25]:
```
lm.fit=lm(medv~. ,data=Boston )
summary(lm.fit)
```

```
Call:
lm(formula = medv ~ ., data = Boston)

Residuals:
    Min      1Q  Median      3Q     Max
-15.595  -2.730  -0.518   1.777  26.199

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  3.646e+01  5.103e+00   7.144 3.28e-12 ***
crim        -1.080e-01  3.286e-02  -3.287 0.001087 **
zn           4.642e-02  1.373e-02   3.382 0.000778 ***
indus        2.056e-02  6.150e-02   0.334 0.738288
chas         2.687e+00  8.616e-01   3.118 0.001925 **
nox         -1.777e+01  3.820e+00  -4.651 4.25e-06 ***
rm           3.810e+00  4.179e-01   9.116  < 2e-16 ***
age          6.922e-04  1.321e-02   0.052 0.958229
dis         -1.476e+00  1.995e-01  -7.398 6.01e-13 ***
rad          3.060e-01  6.635e-02   4.613 5.07e-06 ***
tax         -1.233e-02  3.760e-03  -3.280 0.001112 **
ptratio     -9.527e-01  1.308e-01  -7.283 1.31e-12 ***
black        9.312e-03  2.686e-03   3.467 0.000573 ***
lstat       -5.248e-01  5.072e-02 -10.347  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 4.745 on 492 degrees of freedom
Multiple R-squared:  0.7406,        Adjusted R-squared:  0.7338
F-statistic: 108.1 on 13 and 492 DF,  p-value: < 2.2e-16
```

[26]:
```
library(car)
print(vif(lm.fit))
```

```
Loading required package: carData

    crim       zn    indus     chas      nox       rm      age      dis
1.792192 2.298758 3.991596 1.073995 4.393720 1.933744 3.100826 3.955945
     rad      tax  ptratio    black    lstat
7.484496 9.008554 1.799084 1.348521 2.941491
```

[27]:
```
lm.fit1=lm(medv~.-age ,data=Boston )
summary (lm.fit1)
```

```

Call:
lm(formula = medv ~ . - age, data = Boston)

Residuals:
     Min       1Q   Median       3Q      Max
-15.6054  -2.7313  -0.5188   1.7601  26.2243

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  36.436927   5.080119   7.172 2.72e-12 ***
crim         -0.108006   0.032832  -3.290 0.001075 **
zn            0.046334   0.013613   3.404 0.000719 ***
indus         0.020562   0.061433   0.335 0.737989
chas          2.689026   0.859598   3.128 0.001863 **
nox         -17.713540   3.679308  -4.814 1.97e-06 ***
rm            3.814394   0.408480   9.338  < 2e-16 ***
dis          -1.478612   0.190611  -7.757 5.03e-14 ***
rad           0.305786   0.066089   4.627 4.75e-06 ***
tax          -0.012329   0.003755  -3.283 0.001099 **
ptratio      -0.952211   0.130294  -7.308 1.10e-12 ***
black         0.009321   0.002678   3.481 0.000544 ***
lstat        -0.523852   0.047625 -10.999  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 4.74 on 493 degrees of freedom
Multiple R-squared:  0.7406,        Adjusted R-squared:  0.7343
F-statistic: 117.3 on 12 and 493 DF,  p-value: < 2.2e-16
```

[28]:
```
lm.fit1=update(lm.fit , ~.-age)
```

[29]:
```
summary (lm(medv~lstat*age ,data=Boston))
```

```
Call:
lm(formula = medv ~ lstat * age, data = Boston)

Residuals:
    Min      1Q  Median      3Q     Max
-15.806  -4.045  -1.333   2.085  27.552

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) 36.0885359  1.4698355  24.553  < 2e-16 ***
lstat       -1.3921168  0.1674555  -8.313 8.78e-16 ***
age         -0.0007209  0.0198792  -0.036   0.9711
lstat:age    0.0041560  0.0018518   2.244   0.0252 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 6.149 on 502 degrees of freedom
Multiple R-squared:  0.5557,        Adjusted R-squared:  0.5531
F-statistic: 209.3 on 3 and 502 DF,  p-value: < 2.2e-16
```

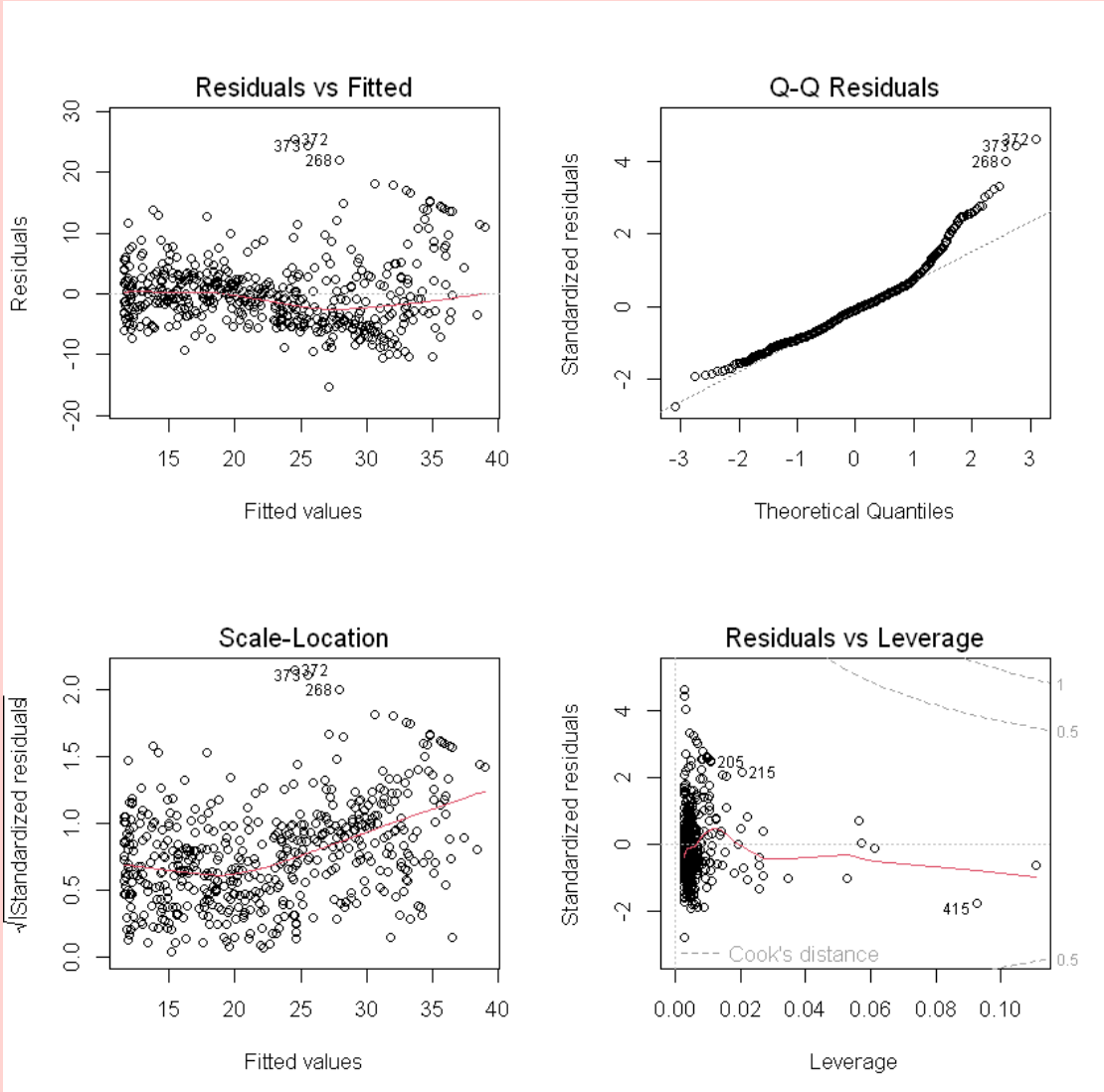
[30]:
```
lm.fit2=lm(medv~lstat+I(lstat^2))
summary (lm.fit2)
```

```
Call:
lm(formula = medv ~ lstat + I(lstat^2))

Residuals:
     Min       1Q   Median       3Q      Max
-15.2834  -3.8313  -0.5295   2.3095  25.4148

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 42.862007   0.872084   49.15   <2e-16 ***
lstat       -2.332821   0.123803  -18.84   <2e-16 ***
I(lstat^2)   0.043547   0.003745   11.63   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 5.524 on 503 degrees of freedom
Multiple R-squared:  0.6407,        Adjusted R-squared:  0.6393
F-statistic: 448.5 on 2 and 503 DF,  p-value: < 2.2e-16
```

[31]:
```
lm.fit=lm(medv~lstat)
print(anova(lm.fit ,lm.fit2))
```

```
Analysis of Variance Table

Model 1: medv ~ lstat
Model 2: medv ~ lstat + I(lstat^2)
  Res.Df   RSS Df Sum of Sq     F    Pr(>F)
1    504 19472
2    503 15347  1    4125.1 135.2 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

[32]:
```
par(mfrow=c(2,2))
plot(lm.fit2)
```



[33]:
```
lm.fit5=lm(medv~poly(lstat ,5))
summary(lm.fit5)
```

```
Call:
lm(formula = medv ~ poly(lstat, 5))

Residuals:
     Min       1Q   Median       3Q      Max
-13.5433  -3.1039  -0.7052   2.0844  27.1153

Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)       22.5328     0.2318  97.197  < 2e-16 ***
poly(lstat, 5)1 -152.4595     5.2148 -29.236  < 2e-16 ***
poly(lstat, 5)2   64.2272     5.2148  12.316  < 2e-16 ***
poly(lstat, 5)3  -27.0511     5.2148  -5.187 3.10e-07 ***
poly(lstat, 5)4   25.4517     5.2148   4.881 1.42e-06 ***
poly(lstat, 5)5  -19.2524     5.2148  -3.692 0.000247 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 5.215 on 500 degrees of freedom
Multiple R-squared:  0.6817,        Adjusted R-squared:  0.6785
F-statistic: 214.2 on 5 and 500 DF,  p-value: < 2.2e-16
```

[34]:
```
summary(lm(medv~log(rm),data=Boston))
```

```
Call:
lm(formula = medv ~ log(rm), data = Boston)

Residuals:
    Min      1Q  Median      3Q     Max
-19.487  -2.875  -0.104   2.837  39.816

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  -76.488      5.028  -15.21   <2e-16 ***
log(rm)       54.055      2.739   19.73   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 6.915 on 504 degrees of freedom
Multiple R-squared:  0.4358,        Adjusted R-squared:  0.4347
F-statistic: 389.3 on 1 and 504 DF,  p-value: < 2.2e-16
```

[35]:
```
fix(Carseats )
print(names(Carseats ))
```

```
 [1] "Sales"       "CompPrice"   "Income"      "Advertising" "Population"
 [6] "Price"       "ShelveLoc"   "Age"         "Education"   "Urban"
[11] "US"
```

[36]:
```
lm.fit=lm(Sales~.+Income :Advertising +Price:Age ,data=Carseats )
summary(lm.fit)
```

```

Call:
lm(formula = Sales ~ . + Income:Advertising + Price:Age, data = Carseats)

Residuals:
    Min      1Q  Median      3Q     Max
-2.9208 -0.7503  0.0177  0.6754  3.3413

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)         6.5755654  1.0087470   6.519 2.22e-10 ***
CompPrice           0.0929371  0.0041183  22.567  < 2e-16 ***
Income              0.0108940  0.0026044   4.183 3.57e-05 ***
Advertising         0.0702462  0.0226091   3.107 0.002030 **
Population          0.0001592  0.0003679   0.433 0.665330
Price              -0.1008064  0.0074399 -13.549  < 2e-16 ***
ShelveLocGood       4.8486762  0.1528378  31.724  < 2e-16 ***
ShelveLocMedium     1.9532620  0.1257682  15.531  < 2e-16 ***
Age                -0.0579466  0.0159506  -3.633 0.000318 ***
Education          -0.0208525  0.0196131  -1.063 0.288361
UrbanYes            0.1401597  0.1124019   1.247 0.213171
USYes              -0.1575571  0.1489234  -1.058 0.290729
Income:Advertising  0.0007510  0.0002784   2.698 0.007290 **
Price:Age           0.0001068  0.0001333   0.801 0.423812
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.011 on 386 degrees of freedom
Multiple R-squared:  0.8761,        Adjusted R-squared:  0.8719
F-statistic:   210 on 13 and 386 DF,  p-value: < 2.2e-16
```

[37]:
```
attach(Carseats )
print(contrasts (ShelveLoc ))
```

```
       Good Medium
Bad       0      0
Good      1      0
```

```
Medium    0      1
```

[2]:
```
LoadLibraries = function() {
    library(ISLR)
    library(MASS)
    print("The libraries have been loaded.")
}
```

[3]:
```
print(LoadLibraries)
```

```
function ()
{
    library(ISLR)
    library(MASS)
    print("The libraries have been loaded.")
}
```

[40]:
```
LoadLibraries()
```

```
[1] "The libraries have been loaded."
```