Proj1markdown

Jared Yu

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```
#set working directory to where the file can be found
setwd("C:/Users/jyqq9/Desktop/STA 108/Project 1")

#read the data file and place in a variable
mydata = read.table("UN.txt", header = T) #header=F if no first row.

#Display some of the data
head(mydata)
```

```
##      Locality Fertility PPgdp
## 1 Afghanistan      6.80    98
## 2     Albania      2.28  1317
## 3     Algeria      2.80  1784
## 4      Angola      7.20   739
## 5   Argentina      2.44  7163
## 6   Australia      1.70 18788
```

```
#Display all of the data
mydata
```

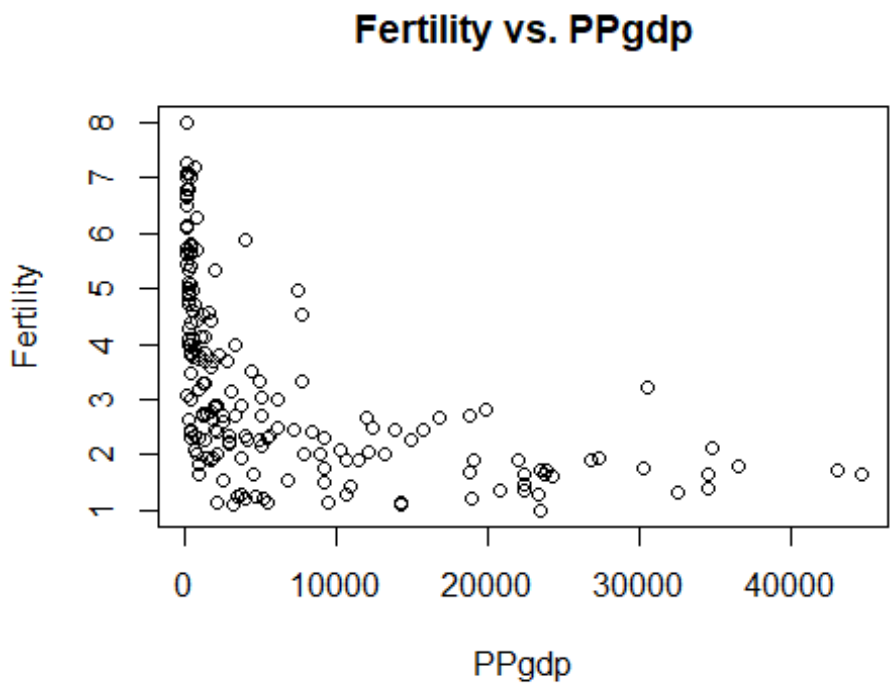
```
##                  Locality Fertility PPgdp
## 1             Afghanistan      6.80    98
## 2                 Albania      2.28  1317
## 3                 Algeria      2.80  1784
## 4                  Angola      7.20   739
## 5               Argentina      2.44  7163
## 6               Australia      1.70 18788
## 7                 Austria      1.28 23260
## 8              Azerbaijan      2.10   695
## 9                 Bahamas      2.29 14856
## 10                Bahrain      2.66 12012
## 11             Bangladesh      3.46   345
## 12               Barbados      1.50  9255
## 13                Belgium      1.66 22351
## 14                 Belize      3.15  3123
## 15                  Benin      5.66   361
## 16                Bermuda      1.67 44579
## 17                 Bhutan      5.02   241
## 18                Bolivia      3.82   935
## 19               Botswana      3.70  2872
## 20                 Brazil      2.21  2888
## 21                 Brunei      2.48 12435
```

```
## 22            Burkina.Faso      6.68   203
## 23                 Burundi      6.80   107
## 24                Cambodia      4.77   233
## 25                Cameroon      4.61   557
## 26                  Canada      1.48 22385
## 27              Cape.Verde      3.30  1259
## 28     Central.African.Rep      4.92   242
## 29                    Chad      6.65   127
## 30                   Chile      2.35  3992
## 31                   China      1.83   918
## 32               Hong.Kong      1.00 23499
## 33                   Macao      1.10 14281
## 34                Colombia      2.62  1900
## 35                 Comoros      4.90   278
## 36                   Congo      6.29   779
## 37             Cook.Islands      3.50  4388
## 38               Costa.Rica      2.28  4148
## 39             Cote.dIvoire      4.73   637
## 40                 Croatia      1.65  4558
## 41                    Cuba      1.55  2545
## 42                  Cyprus      1.90 11449
## 43              Czech.Rep      1.16  5501
## 44           Dem.Rep.Congo      6.70   138
## 45                 Denmark      1.77 30265
## 46                Djibouti      5.70   819
## 47           Dominican.Rep      2.71  2500
## 48                 Ecuador      2.76  1425
## 49                   Egypt      3.29  1390
## 50              El.Salvador      2.88  2189
## 51       Equatorial.Guinea      5.89  3940
## 52                 Eritrea      5.43   177
## 53                 Estonia      1.22  4010
## 54                Ethiopia      6.14    90
## 55                    Fiji      2.88  2046
## 56                 Finland      1.73 23456
## 57                  France      1.89 21990
## 58              Fr.Guiana      3.33  7737
## 59            Fr.Polynesia      2.44 13891
## 60                   Gabon      3.99  3379
## 61                  Gambia      4.70   300
## 62                 Germany      1.35 22418
## 63                   Ghana      4.11   265
## 64                  Greece      1.27 10727
## 65              Guadeloupe      2.10 10323
## 66               Guatemala      4.41  1717
## 67                  Guinea      5.82   375
## 68           Guinea-Bissau      7.10   174
## 69                  Guyana      2.31   936
## 70                   Haiti      3.98   431
## 71                Honduras      3.72   960
```

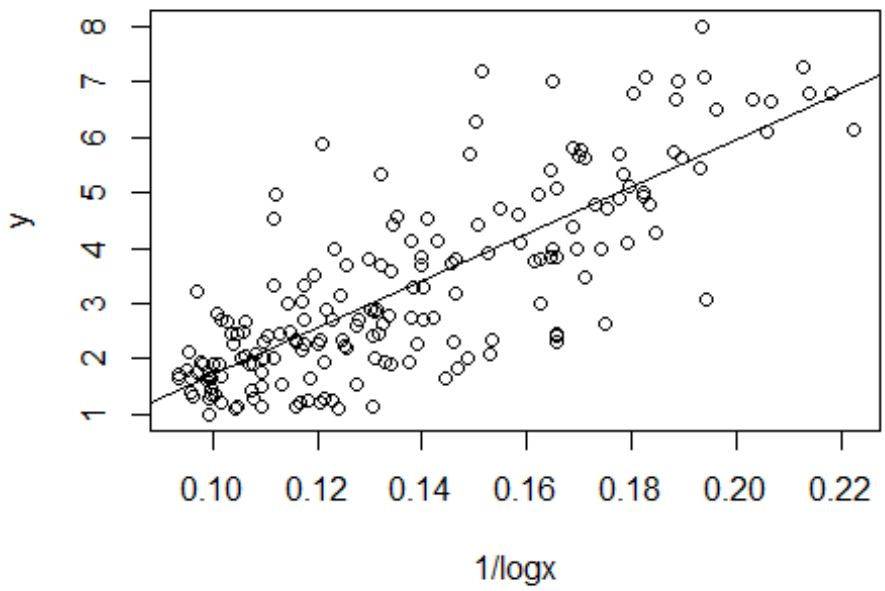
```
## 72                 Hungary      1.20  5209
## 73                 Iceland      1.95 27281
## 74                   India      3.01   467
## 75               Indonesia      2.35   678
## 76                    Iran      2.33  5645
## 77                 Ireland      1.90 26725
## 78                  Israel      2.70 18816
## 79                   Italy      1.23 18928
## 80                 Jamaica      2.36  2990
## 81                   Japan      1.32 32540
## 82                  Jordan      3.57  1726
## 83              Kazakhstan      1.95  1441
## 84                   Kenya      4.00   367
## 85                Kiribati      3.80   468
## 86                 S.Korea      2.02  8955
## 87                  Kuwait      2.66 16782
## 88              Kyrgyzstan      2.64   306
## 89                    Laos      4.78   324
## 90                  Latvia      1.10  3212
## 91                 Lebanon      2.18  5087
## 92                 Lesotho      3.84   419
## 93                 Liberia      6.80   256
## 94                   Libya      3.02  5099
## 95           Liechtenstein      1.64 34504
## 96               Lithuania      1.25  3442
## 97              Luxembourg      1.73 43041
## 98              Madagascar      5.70   278
## 99                  Malawi      6.10   129
## 100               Malaysia      2.90  3748
## 101               Maldives      5.33  1947
## 102                   Mali      7.00   200
## 103                  Malta      1.77  9245
## 104            Marshall.Is      3.68  1938
## 105             Martinique      1.90 10723
## 106             Mauritania      5.79   353
## 107              Mauritius      1.95  3787
## 108                 Mexico      2.50  6150
## 109             Micronesia      3.80  2215
## 110               Mongolia      2.42   417
## 111                Morocco      2.75  1145
## 112             Mozambique      5.63   196
## 113                Namibia      4.56  1639
## 114                  Nepal      4.26   226
## 115            Netherlands      1.72 23785
## 116          Neth.Antilles      2.05 12149
## 117          New.Caledonia      2.45 15750
## 118            New.Zealand      2.01 13185
## 119              Nicaragua      3.75   489
## 120                  Niger      8.00   176
## 121                Nigeria      5.42   435
```

```
## 122                 Norway      1.80 36445
## 123                   Oman      4.96  7421
## 124               Pakistan      5.08   418
## 125                  Palau      3.00  6179
## 126                 Panama      2.70  3391
## 127       Papua.New.Guinea      4.09   545
## 128               Paraguay      3.84  1286
## 129                   Peru      2.86  2053
## 130            Philippines      3.18   924
## 131                 Poland      1.26  4657
## 132               Portugal      1.45 10944
## 133            Puerto.Rico      1.89 19083
## 134                  Qatar      3.22 30493
## 135                Reunion      2.30  9188
## 136                 Russia      1.14  2139
## 137                 Rwanda      5.74   205
## 138  Saint.Kitts.and.Nevis      2.41  8426
## 139            Saint.Lucia      2.27  4994
## 140  St.Vincent/Grenadines      2.23  2940
## 141                  Samoa      4.12  1402
## 142  Sao.Tome.and.Principe      3.99   312
## 143           Saudi.Arabia      4.53  7724
## 144                Senegal      4.97   479
## 145 Serbia.and.Montenegro.      1.65  1008
## 146             Seychelles      2.00  7850
## 147           Sierra.Leone      6.50   164
## 148              Singapore      1.36 20755
## 149               Slovakia      1.28  3767
## 150               Slovenia      1.14  9463
## 151        Solomon.Islands      4.42   760
## 152                Somalia      7.25   110
## 153           South.Africa      2.61  2550
## 154                  Spain      1.15 14234
## 155              Sri.Lanka      2.01   827
## 156                  Sudan      4.39   376
## 157               Suriname      2.45  1965
## 158              Swaziland      4.54  1204
## 159                 Sweden      1.64 23680
## 160            Switzerland      1.41 34449
## 161                  Syria      3.32  4976
## 162             Tajikistan      3.06   172
## 163               Thailand      1.93  1858
## 164             Macedonia      1.90  1723
## 165            Timor-Leste      3.85   438
## 166                   Togo      5.33   273
## 167                  Tonga      3.71  1284
## 168    Trinidad.and.Tobago      1.55  6817
## 169                Tunisia      2.01  2077
## 170                 Turkey      2.43  2136
## 171           Turkmenistan      2.70  1263
```

```
## 172                 Uganda      7.10   239
## 173   United.Arab.Emirates      2.82 19816
## 174         United.Kingdom      1.60 24186
## 175               Tanzania      5.11   263
## 176                    USA      2.11 34788
## 177                Uruguay      2.30  5514
## 178             Uzbekistan      2.44   418
## 179                Vanuatu      4.13  1085
## 180              Venezuela      2.72  5009
## 181               Viet.Nam      2.30   416
## 182                  Yemen      7.01   431
## 183                 Zambia      5.64   345
## 184               Zimbabwe      3.90   703

#Set x and y to mydata's height and weight
x=mydata$PPgdp
y=mydata$Fertility

#Display some of the data for mydata
str(x)

##  int [1:184] 98 1317 1784 739 7163 18788 23260 695 14856 12012 ...

str(y)

##  num [1:184] 6.8 2.28 2.8 7.2 2.44 1.7 1.28 2.1 2.29 2.66 ...

str(mydata)

## 'data.frame':    184 obs. of  3 variables:
##  $ Locality : Factor w/ 184 levels "Afghanistan",..: 1 2 3 4 5 6 7 8 9 10
...
##  $ Fertility: num  6.8 2.28 2.8 7.2 2.44 1.7 1.28 2.1 2.29 2.66 ...
##  $ PPgdp    : int  98 1317 1784 739 7163 18788 23260 695 14856 12012 ...

#1
#plot x and y, label the axes
plot(x,y,xlab="PPgdp",ylab="Fertility",main="Fertility vs. PPgdp")
```



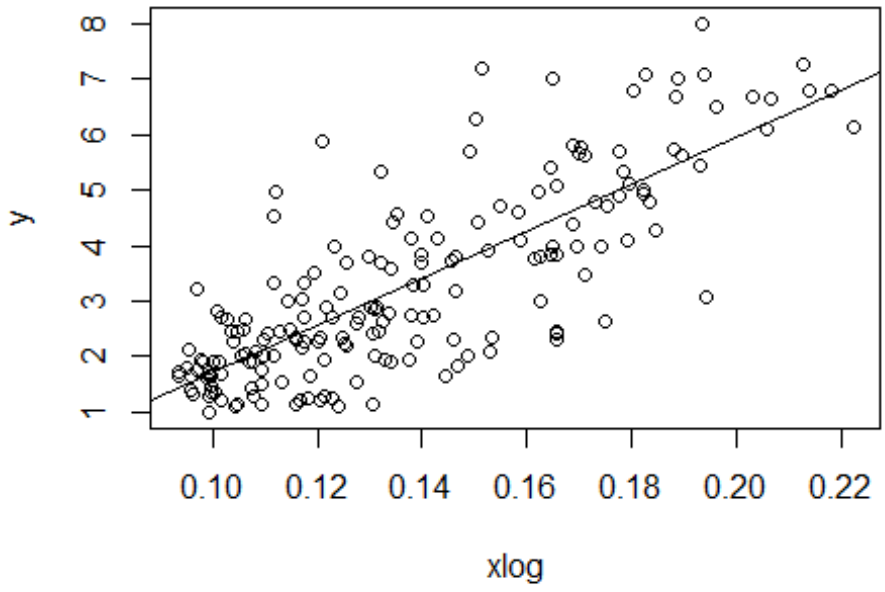

```
#2
#create variables for the log transformations
xlog = 1/log(x)

plot(xlog, y, xlab="1/logx",ylab="y")

#3a
#xbar and ybar
ybar=mean(y)
xbar=mean(xlog)

#n, the number of variables
n=length(x)

#betahat1 and betahat0
betahat1=sum((xlog-xbar)*(y-ybar))/sum((xlog-xbar)^2)
betahat0=ybar-betahat1*xbar
betahat0

## [1] -2.560345

betahat1

## [1] 42.57107

#plot a straight line for the data using slope and intercept
abline(a = betahat0, b = betahat1)
```




```
#yhat
yhat = betahat0+betahat1*xlog

#SSR
SSR = sum((yhat-ybar)^2)

#SSE
SSE = sum((y-yhat)^2)

#SSTO
SSTO = sum((y-ybar)^2)

#R^2 and rsquared
R2 = SSR/SSTO
R2

## [1] 0.6360678

rsquared = (1 - SSE/SSTO)
rsquared

## [1] 0.6360678

#3b
#lm function
model = lm(y~xlog)
summary(model)
```

```
##
## Call:
## lm(formula = y ~ xlog)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.6499 -0.5764 -0.0475  0.5886  3.3154
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -2.5603     0.3363  -7.612 1.41e-12 ***
## xlog         42.5711     2.3869  17.835  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.031 on 182 degrees of freedom
## Multiple R-squared:  0.6361, Adjusted R-squared:  0.6341
## F-statistic: 318.1 on 1 and 182 DF,  p-value: < 2.2e-16
```

```
plot(xlog,y)
#plot fitted line
abline(model$coefficients)
```




```
#3c
#matrix manipulation
head(mydata)
```

```
##      Locality Fertility PPgdp
## 1 Afghanistan      6.80    98
## 2     Albania      2.28  1317
## 3     Algeria      2.80  1784
## 4      Angola      7.20   739
## 5   Argentina      2.44  7163
## 6   Australia      1.70 18788
```

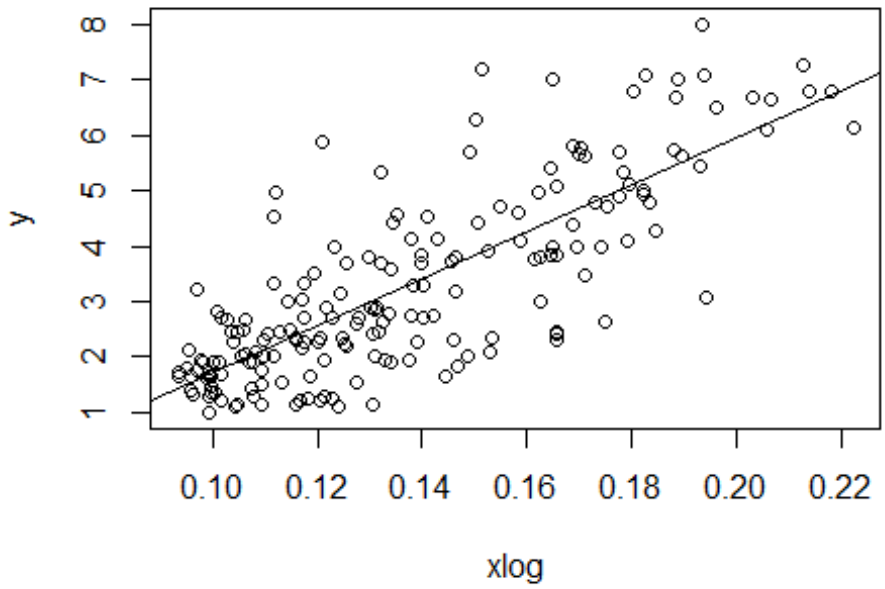
```
X=as.matrix(cbind(rep(1,n),1/log(mydata[,3])))
View(X)
str(X)
```

```
##  num [1:184, 1:2] 1 1 1 1 1 1 1 1 1 1 ...
```

```
XTX = t(X)%*%X
XTXinv = solve(XTX)
Y = as.matrix(mydata[,2])
View(Y)
XTY = t(X)%*%Y
betahatMatrix = XTXinv%*%XTY
betahatMatrix
```

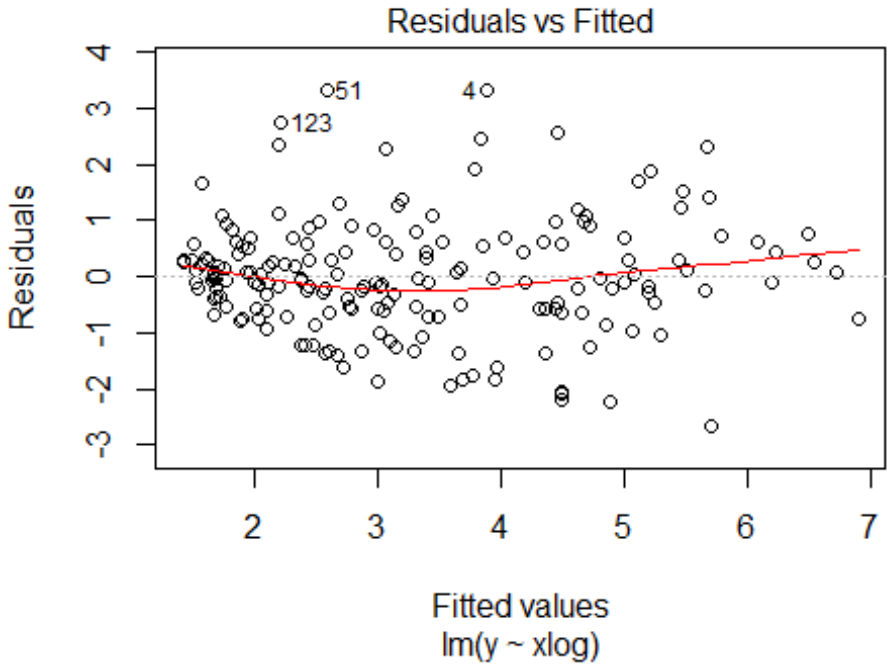
```
##           [,1]
## [1,] -2.560345
## [2,] 42.571070
```

```
plot(xlog,y)
#draw fitted matrix line
abline(betahatMatrix)
```

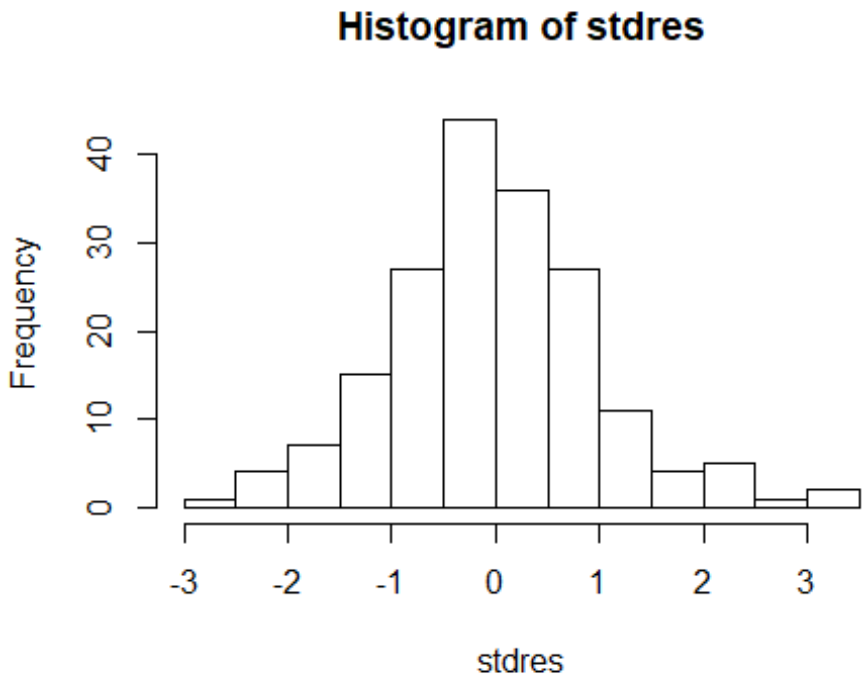



```
Yhat = X%*%betahatMatrix
head(Yhat)

##          [,1]
## [1,] 6.724578
## [2,] 3.366205
## [3,] 3.125947
## [4,] 3.884643
## [5,] 2.235485
## [6,] 1.765555

res = as.vector(Y - Yhat)
head(res)

## [1]  0.07542232 -1.08620457 -0.32594674  3.31535670  0.20451514 -
0.06555487

SSE = res%*%res

SSTO = sum((Y-mean(Y))^2)

Rsquaredmatrix = 1 - SSE/SSTO
Rsquaredmatrix

##           [,1]
## [1,] 0.6360678
```

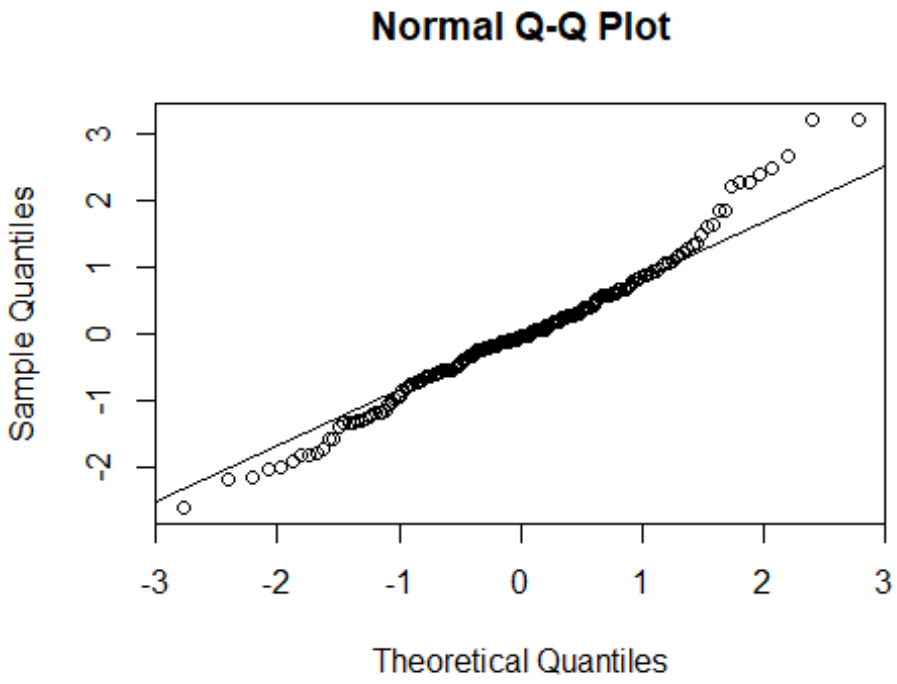
```r
#4
model = lm(y~xlog)
plot(model, which=1)
```




```r
#The dispersion of the residuals seem to be smaller at first, but they spread out as
#fitted values increase. At the end they shrink again, but the change is not severe.
stdres=rstandard(model)
hist(stdres)
```




```r
#The histogram appears unimodal, with the standard deviation of residuals
#going to -3 and 3.
qqnorm(stdres)
qqline(stdres)
```

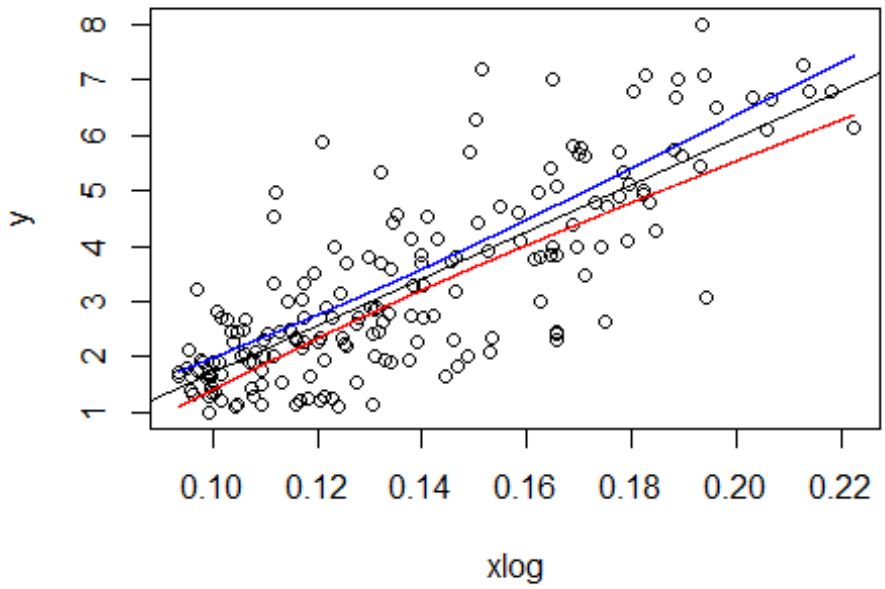



```
#The QQ plot lies mostly along the line, so there is a mostly normal
distribution.

#5
#test whether beta1 = 0 at 0.05 significance level
#H0: b1 = 0 v.s. H1: b1 =/= 0
#T.S. t* = (b1hat - 0)/SE(b1hat)
summary(model)

##
## Call:
## lm(formula = y ~ xlog)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.6499 -0.5764 -0.0475  0.5886  3.3154
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -2.5603     0.3363  -7.612 1.41e-12 ***
## xlog         42.5711     2.3869  17.835  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.031 on 182 degrees of freedom
## Multiple R-squared:  0.6361, Adjusted R-squared:  0.6341
## F-statistic: 318.1 on 1 and 182 DF,  p-value: < 2.2e-16
```

```r
#for the lm model, the slope has a p-value of < 2*10^-16, therefore the
conclusion
#is to reject the null hypothesis

#6
MSE = summary(model)$sigma^2
Xh = 1/log(20000)
Yh=betahat0+betahat1*Xh
Yh+c(-1,1)*qt((1-0.01/2),n-2)*sqrt(MSE*(1/n + ((Xh-mean(xlog))^2)/sum((xlog-
mean(xlog))^2)))
```

```
## [1] 1.438266 2.038231
```

```r
#1.438266 2.038231

#7
xseq = seq(min(mydata[,3]), max(mydata[,3]), 0.1)
xlogseq = 1/log(xseq)
W = sqrt(2*qf(1-0.05, 2, n-2))
yseq=betahat0+betahat1*xlogseq
se.y.seq = sqrt(MSE*(1/n + ((xlogseq-mean(xlog))^2)/sum((xlog-
mean(xlog))^2)))
low = yseq - W*se.y.seq
high = yseq + W*se.y.seq

plot(xlog, y)
abline(betahat0,betahat1)
lines(xlogseq,low, col="red")
lines(xlogseq,high, col="blue")
```




```
#8
MSE = summary(model)$sigma^2
Xh = 1/log(25000)
Yh=betahat0+betahat1*Xh
Yh+c(-1,1)*qt((1-0.01/2),n-2)*sqrt(MSE*(1/n + 1 + ((Xh-
mean(xlog))^2)/sum((xlog-mean(xlog))^2)))

## [1] -1.057710  4.344765

#-1.057710  4.344765
```