Progetto

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Contents

Descriptive analysis on Y

```
data <- read.csv("../data/Laptop2.csv")
str(data)
```

```
## 'data.frame':    1303 obs. of  22 variables:
##  $ X                 : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ Company           : Factor w/ 19 levels "Acer","Apple",..: 2 2 8 2 2 1 2 2 3 1 ...
##  $ Product           : Factor w/ 618 levels "110-15ACL (A6-7310/4GB/500GB/W10)",..: 302 300 51 302 30
##  $ TypeName          : Factor w/ 6 levels "2 in 1 Convertible",..: 5 5 4 5 5 4 5 5 5 5 ...
##  $ Inches            : num  13.3 13.3 15.6 15.4 13.3 15.6 15.4 13.3 14 14 ...
##  $ ScreenResolution  : Factor w/ 40 levels "1366x768","1440x900",..: 24 2 9 26 24 1 26 2 9 16 ...
##  $ Cpu               : Factor w/ 118 levels "AMD A10-Series 9600P 2.4GHz",..: 55 53 64 75 57 15 74 53
##  $ Ram               : int  8 8 8 16 8 4 16 8 16 8 ...
##  $ Memory            : Factor w/ 38 levels "1024GB HDD","1024GB HDD +  1024GB HDD",..: 8 6 17 29 17 1
##  $ Gpu               : Factor w/ 110 levels "AMD FirePro W4190M",..: 59 52 54 10 60 18 61 52 98 62 .
##  $ OpSys             : Factor w/ 9 levels "Android","Chrome OS",..: 5 5 6 5 5 7 4 5 7 7 ...
##  $ Weight            : num  1.37 1.34 1.86 1.83 1.37 2.1 2.04 1.34 1.3 1.6 ...
##  $ Price             : num  1340 899 575 2537 1804 ...
##  $ Frequenza         : num  2.3 1.8 2.5 2.7 3.1 3 2.2 1.8 1.8 1.6 ...
##  $ Risoluzione       : Factor w/ 15 levels "1366x768","1440x900",..: 11 2 4 13 11 1 13 2 4 4 ...
##  $ Pixel             : int  4096000 1296000 2073600 5184000 4096000 1049088 5184000 1296000 2073600 1
##  $ GpuCompany        : Factor w/ 4 levels "AMD","ARM","Intel",..: 3 3 3 1 3 1 3 3 4 3 ...
##  $ MemoriaSSD        : int  128 0 256 512 256 0 0 0 512 256 ...
##  $ SolidStateDisk    : Factor w/ 2 levels "False","True": 2 1 2 2 2 1 1 1 2 2 ...
##  $ TotalMemory       : int  128 128 256 512 256 500 256 256 512 256 ...
##  $ dedicated_GPU     : Factor w/ 2 levels "False","True": 1 1 1 2 1 2 1 1 2 1 ...
##  $ Aggregated_Company: Factor w/ 10 levels "Acer","Apple",..: 2 2 5 2 2 1 2 2 3 1 ...
```

```r
head(data)
```

```
##   X Company     Product  TypeName Inches
## 1 1   Apple MacBook Pro Ultrabook   13.3
## 2 2   Apple Macbook Air Ultrabook   13.3
## 3 3      HP      250 G6  Notebook   15.6
## 4 4   Apple MacBook Pro Ultrabook   15.4
## 5 5   Apple MacBook Pro Ultrabook   13.3
## 6 6    Acer    Aspire 3  Notebook   15.6
##                     ScreenResolution                         Cpu Ram
## 1 IPS Panel Retina Display 2560x1600       Intel Core i5 2.3GHz   8
## 2                          1440x900       Intel Core i5 1.8GHz   8
## 3                Full HD 1920x1080 Intel Core i5 7200U 2.5GHz   8
## 4 IPS Panel Retina Display 2880x1800       Intel Core i7 2.7GHz  16
## 5 IPS Panel Retina Display 2560x1600       Intel Core i5 3.1GHz   8
## 6                          1366x768    AMD A9-Series 9420 3GHz   4
##                Memory                          Gpu      OpSys Weight
## 1           128GB SSD Intel Iris Plus Graphics 640      macOS   1.37
## 2 128GB Flash Storage       Intel HD Graphics 6000      macOS   1.34
## 3           256GB SSD        Intel HD Graphics 620      No OS   1.86
## 4           512GB SSD           AMD Radeon Pro 455      macOS   1.83
## 5           256GB SSD Intel Iris Plus Graphics 650      macOS   1.37
## 6           500GB HDD                AMD Radeon R5 Windows 10   2.10
##     Price Frequenza Risoluzione   Pixel GpuCompany MemoriaSSD
## 1 1339.69       2.3   2560x1600 4096000      Intel        128
## 2  898.94       1.8    1440x900 1296000      Intel          0
## 3  575.00       2.5   1920x1080 2073600      Intel        256
## 4 2537.45       2.7   2880x1800 5184000        AMD        512
## 5 1803.60       3.1   2560x1600 4096000      Intel        256
## 6  400.00       3.0    1366x768 1049088        AMD          0
##   SolidStateDisk TotalMemory dedicated_GPU Aggregated_Company
## 1           True         128         False              Apple
## 2          False         128         False              Apple
## 3           True         256         False                 HP
## 4           True         512          True              Apple
## 5           True         256         False              Apple
## 6          False         500          True               Acer
```

```r
summary(data)
```

```
##        X             Company                   Product
##  Min.   :   1.0   Dell   :297   XPS 13            :  30
##  1st Qu.: 331.5   Lenovo :297   Inspiron 3567     :  29
##  Median : 659.0   HP     :274   250 G6            :  21
##  Mean   : 660.2   Asus   :158   Legion Y520-15IKBN:  19
##  3rd Qu.: 990.5   Acer   :103   Vostro 3568       :  19
##  Max.   :1320.0   MSI    : 54   Inspiron 5570     :  18
##                   (Other):120   (Other)           :1167
##                TypeName       Inches
##  2 in 1 Convertible:121   Min.   :10.10
##  Gaming            :205   1st Qu.:14.00
##  Netbook           : 25   Median :15.60
##  Notebook          :727   Mean   :15.02
##  Ultrabook         :196   3rd Qu.:15.60
```

```
##  Workstation       : 29   Max.   :18.40
##
##                                    ScreenResolution
##  Full HD 1920x1080                          :507
##  1366x768                                   :281
##  IPS Panel Full HD 1920x1080                :230
##  IPS Panel Full HD / Touchscreen 1920x1080: 53
##  Full HD / Touchscreen 1920x1080            : 47
##  1600x900                                   : 23
##  (Other)                                    :162
##                             Cpu           Ram
##  Intel Core i5 7200U 2.5GHz :190   Min.   : 2.000
##  Intel Core i7 7700HQ 2.8GHz:146   1st Qu.: 4.000
##  Intel Core i7 7500U 2.7GHz :134   Median : 8.000
##  Intel Core i7 8550U 1.8GHz : 73   Mean   : 8.382
##  Intel Core i5 8250U 1.6GHz : 72   3rd Qu.: 8.000
##  Intel Core i5 6200U 2.3GHz : 68   Max.   :64.000
##  (Other)                    :620
##                       Memory                           Gpu
##  256GB SSD                :412   Intel HD Graphics 620  :281
##  1024GB HDD               :224   Intel HD Graphics 520  :185
##  500GB HDD                :132   Intel UHD Graphics 620 : 68
##  512GB SSD                :118   Nvidia GeForce GTX 1050: 66
##  128GB SSD +  1024GB HDD: 94   Nvidia GeForce GTX 1060: 48
##  128GB SSD                : 76   Nvidia GeForce 940MX   : 43
##  (Other)                  :247   (Other)                :612
##         OpSys          Weight          Price        Frequenza
##  Windows 10:1072   Min.   :0.690   Min.   : 174   Min.   :0.900
##  No OS     :  66   1st Qu.:1.500   1st Qu.: 599   1st Qu.:2.000
##  Linux     :  62   Median :2.040   Median : 977   Median :2.500
##  Windows 7 :  45   Mean   :2.039   Mean   :1124   Mean   :2.299
##  Chrome OS :  27   3rd Qu.:2.300   3rd Qu.:1488   3rd Qu.:2.700
##  macOS     :  13   Max.   :4.700   Max.   :6099   Max.   :3.600
##  (Other)   :  18
##     Risoluzione      Pixel          GpuCompany    MemoriaSSD
##  1920x1080:841   Min.   :1049088   AMD   :180   Min.   :  0.0
##  1366x768 :308   1st Qu.:1440000   ARM   :  1   1st Qu.:  0.0
##  3840x2160: 43   Median :2073600   Intel :722   Median :128.0
##  3200x1800: 27   Mean   :2168807   Nvidia:400   Mean   :170.5
##  1600x900 : 23   3rd Qu.:2073600                3rd Qu.:256.0
##  2560x1440: 23   Max.   :8294400                Max.   :512.0
##  (Other)  : 38
##  SolidStateDisk  TotalMemory     dedicated_GPU Aggregated_Company
##  False:476      Min.   :   8.0   False:723     Dell   :297
##  True :827      1st Qu.: 256.0   True :580     Lenovo :297
##                 Median : 500.0                 HP     :274
##                 Mean   : 620.1                 Asus   :158
##                 3rd Qu.:1024.0                 Acer   :103
##                 Max.   :2560.0                 MSI    : 54
##                                                (Other):120
```

```
nums <- sapply(data, is.numeric)
var_numeric <- data[,nums]
head(var_numeric)
```

```
##   X Inches Ram Weight   Price Frequenza   Pixel MemoriaSSD TotalMemory
## 1 1   13.3   8   1.37 1339.69       2.3 4096000        128          128
## 2 2   13.3   8   1.34  898.94       1.8 1296000          0          128
## 3 3   15.6   8   1.86  575.00       2.5 2073600        256          256
## 4 4   15.4  16   1.83 2537.45       2.7 5184000        512          512
## 5 5   13.3   8   1.37 1803.60       3.1 4096000        256          256
## 6 6   15.6   4   2.10  400.00       3.0 1049088          0          500
```

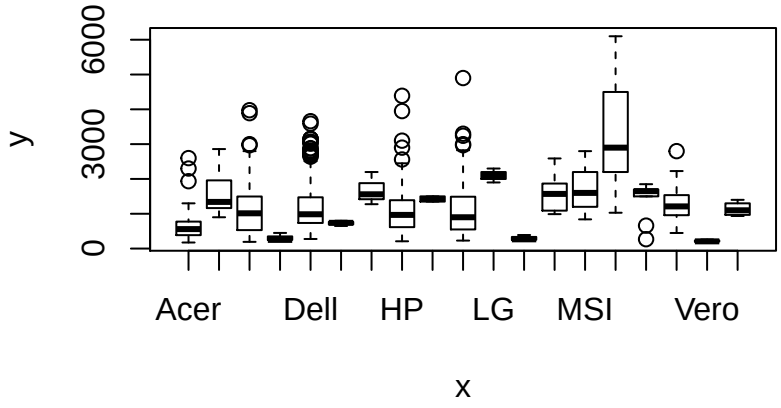
```
data$Weight<-as.numeric(data$Weight)
data$Ram<-as.numeric(data$Ram)
```

```
sapply(data, function(x)(sum(is.na(x))))
```

```
##                   X             Company             Product
##                   0                   0                   0
##            TypeName              Inches  ScreenResolution
##                   0                   0                   0
##                 Cpu                 Ram              Memory
##                   0                   0                   0
##                 Gpu               OpSys              Weight
##                   0                   0                   0
##               Price           Frequenza        Risoluzione
##                   0                   0                   0
##               Pixel          GpuCompany         MemoriaSSD
##                   0                   0                   0
##     SolidStateDisk         TotalMemory      dedicated_GPU
##                   0                   0                   0
## Aggregated_Company
##                   0
```

```
# Non ci sono missing data!
```

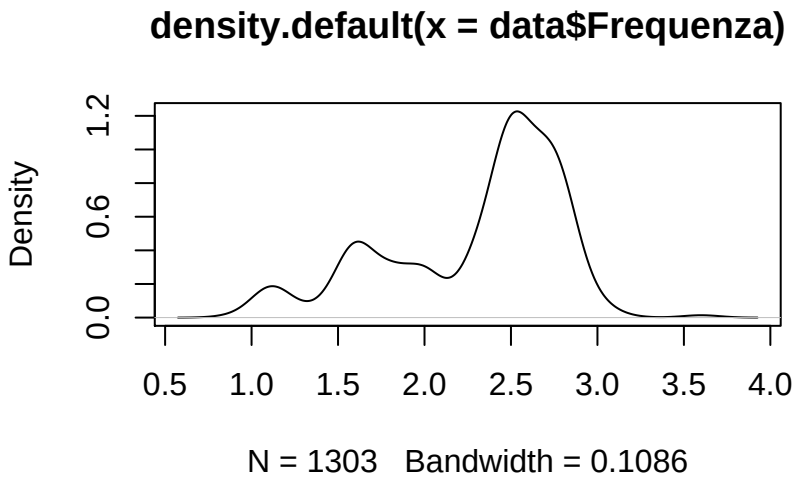
```
plot(data$Company,data$Price)
```




```
class(data$Ram)
```

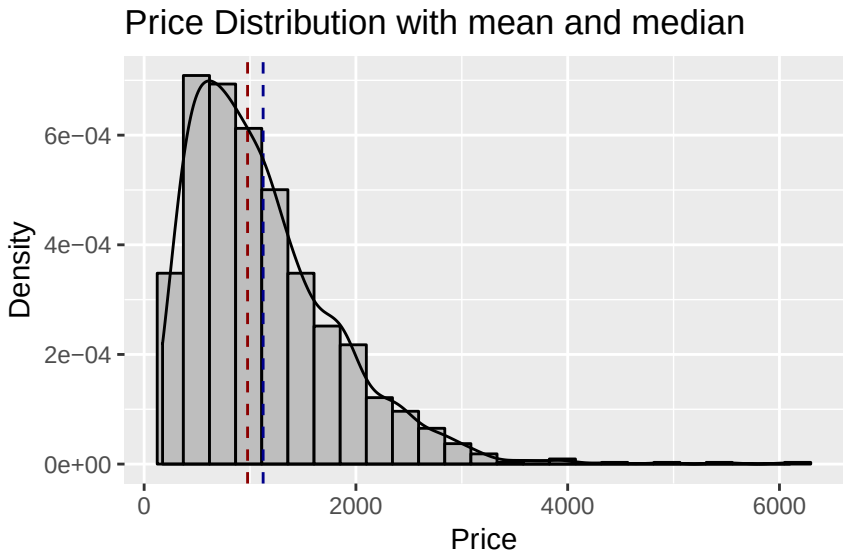
```
## [1] "numeric"
```

```
plot(density(data$Frequenza))
```




```
#hist(data$Price, breaks=25, probability=TRUE)
#lines(density(data$Price))
```

```
library(ggplot2)
ggplot(data,aes(x = Price)) +
        geom_histogram(aes(y =..density..),
                       bins= 25,
                       fill = "grey",
                       color ="black") +
        geom_vline(xintercept = quantile(data$Price, 0.50), color = "dark red", lty = 2) +
        geom_vline(xintercept = mean(data$Price), color = "dark blue", lty = 2) +
        labs(x = "Price", y ="Density") +
        ggtitle("Price Distribution with mean and median") +
          geom_density()
```

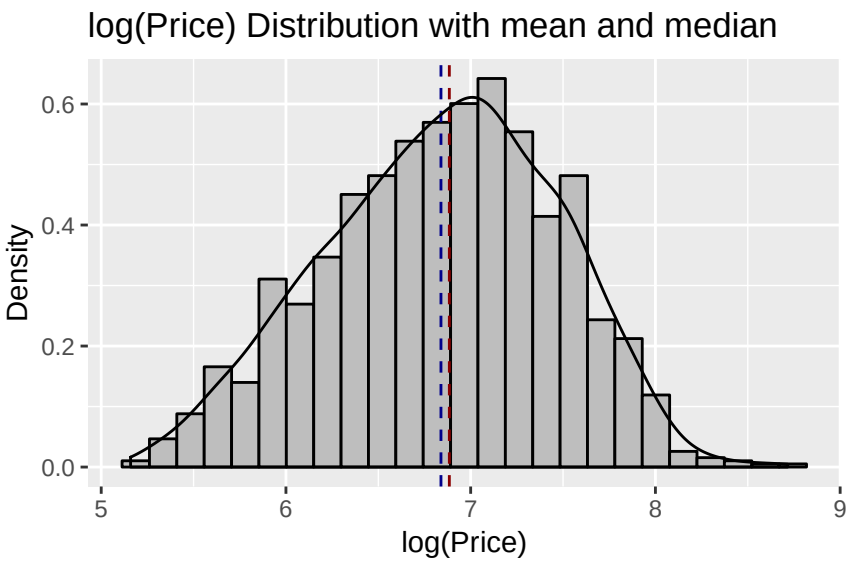


Quite skewed to the right, mean > median

We could try to apply a correction like Log(Y)

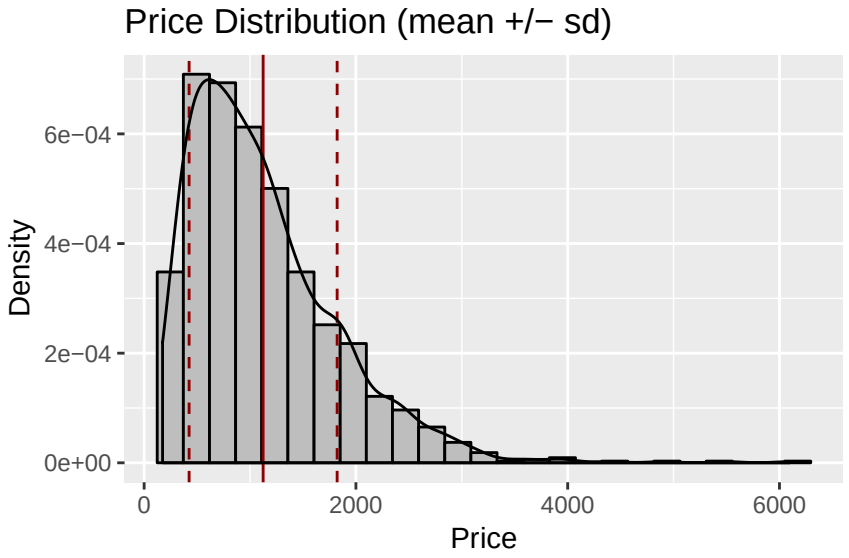
```
data$LogPrice=log(data$Price)
ggplot(data,aes(x = log(Price))) +
        geom_histogram(aes(y =..density..),
```

```
                    bins= 25,
                    fill = "grey",
                    color ="black") +
        geom_vline(xintercept = quantile(data$LogPrice, 0.50), color = "dark red", lty = 2) +
        geom_vline(xintercept = mean(data$LogPrice), color = "dark blue", lty = 2) +
        labs(x = "log(Price)", y ="Density") +
        ggtitle("log(Price) Distribution with mean and median")+  geom_density()
```

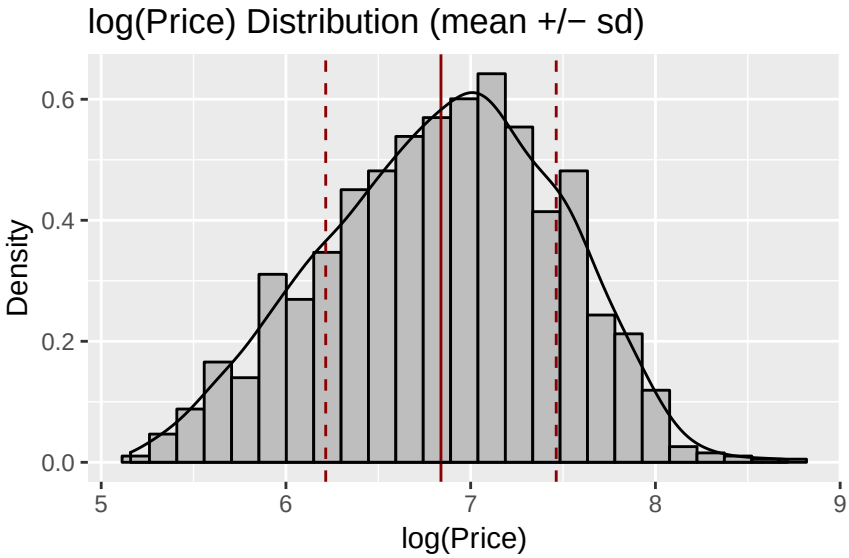


Now the distribution is looking a bit better (as regards normality)

```
ggplot(data,aes(x = Price)) +
        geom_histogram(aes(y =..density..),
                    bins= 25,
                    fill = "grey",
                    color ="black") +
        geom_vline(xintercept = mean(data$Price), color = "dark red") +
        geom_vline(xintercept = mean(data$Price) + sd(data$Price), color = "dark red", lty = 2) +
        geom_vline(xintercept = mean(data$Price) - sd(data$Price), color = "dark red", lty = 2) +
        labs(x = "Price", y ="Density") +
        ggtitle("Price Distribution (mean +/- sd)") +
          geom_density()
```

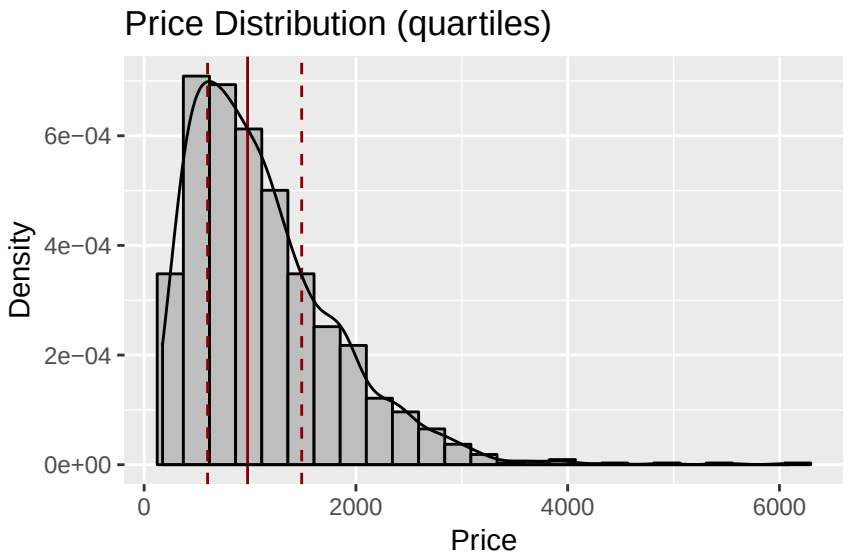



```
ggplot(data,aes(x = log(Price))) +
        geom_histogram(aes(y =..density..),
                       bins= 25,
                       fill = "grey",
                       color ="black") +
        geom_vline(xintercept = mean(data$LogPrice), color = "dark red") +
        geom_vline(xintercept = mean(data$LogPrice) + sd(data$LogPrice), color = "dark red", lty = 2) +
        geom_vline(xintercept = mean(data$LogPrice) - sd(data$LogPrice), color = "dark red", lty = 2) +
        labs(x = "log(Price)", y ="Density") +
        ggtitle("log(Price) Distribution (mean +/- sd)") +
          geom_density()
```

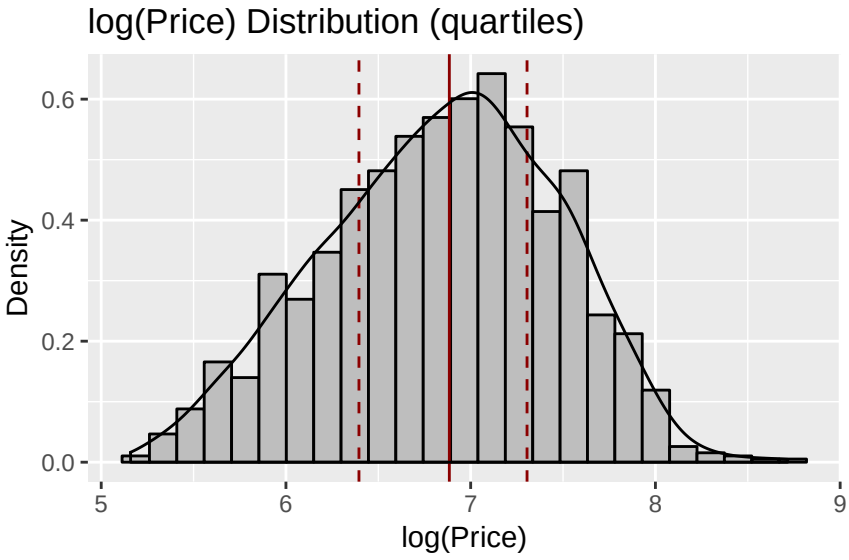



```
ggplot(data,aes(x = Price)) +
        geom_histogram(aes(y =..density..),
                       bins= 25,
                       fill = "grey",
                       color ="black") +
        geom_vline(xintercept = quantile(data$Price, 0.25), color = "dark red",lty = 2) +
```

```
        geom_vline(xintercept = quantile(data$Price, 0.5), color = "dark red", ) +
        geom_vline(xintercept = quantile(data$Price, 0.75), color = "dark red", lty = 2) +
        labs(x = "Price", y ="Density") +
        ggtitle("Price Distribution (quartiles)") +
          geom_density()
```

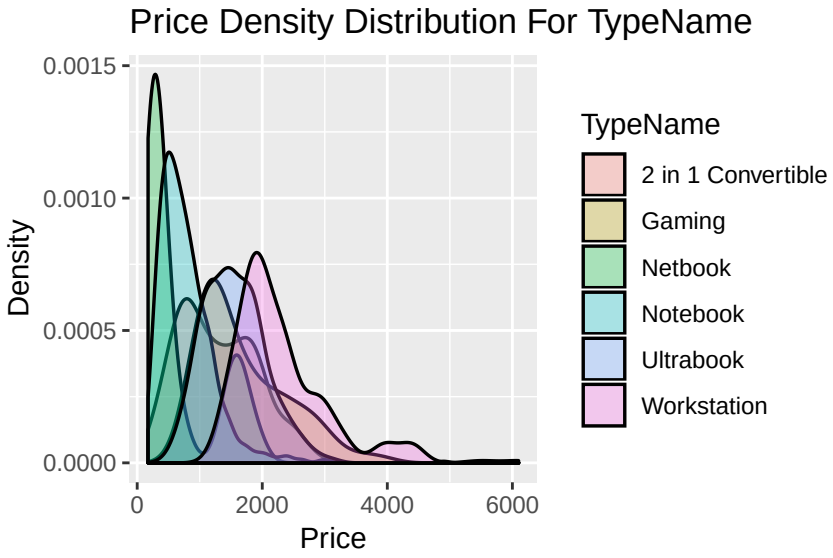



```
ggplot(data,aes(x = log(Price))) +
        geom_histogram(aes(y =..density..),
                       bins= 25,
                       fill = "grey",
                       color ="black") +
        geom_vline(xintercept = quantile(data$LogPrice, 0.25), color = "dark red",lty = 2) +
        geom_vline(xintercept = quantile(data$LogPrice, 0.5), color = "dark red", ) +
        geom_vline(xintercept = quantile(data$LogPrice, 0.75), color = "dark red", lty = 2) +
           labs(x = "log(Price)", y ="Density") +
        ggtitle("log(Price) Distribution (quartiles)") +
          geom_density()
```

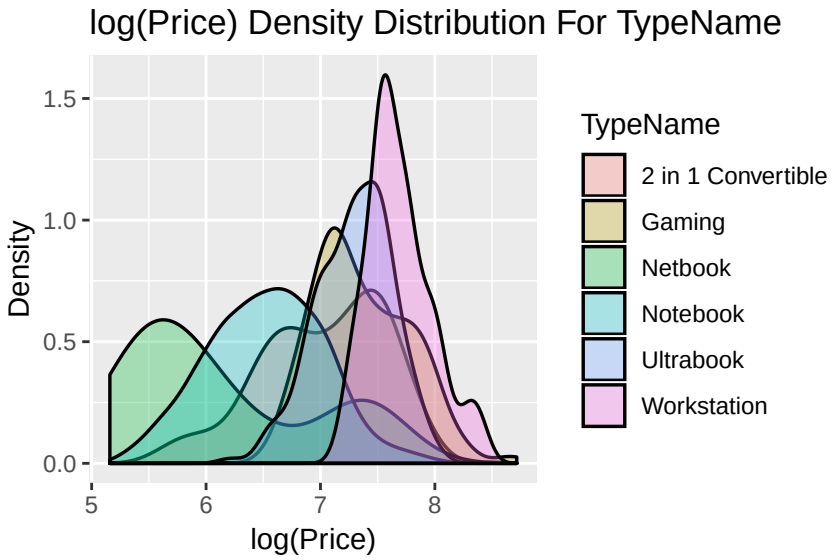


Descrittive variabile dipendente price

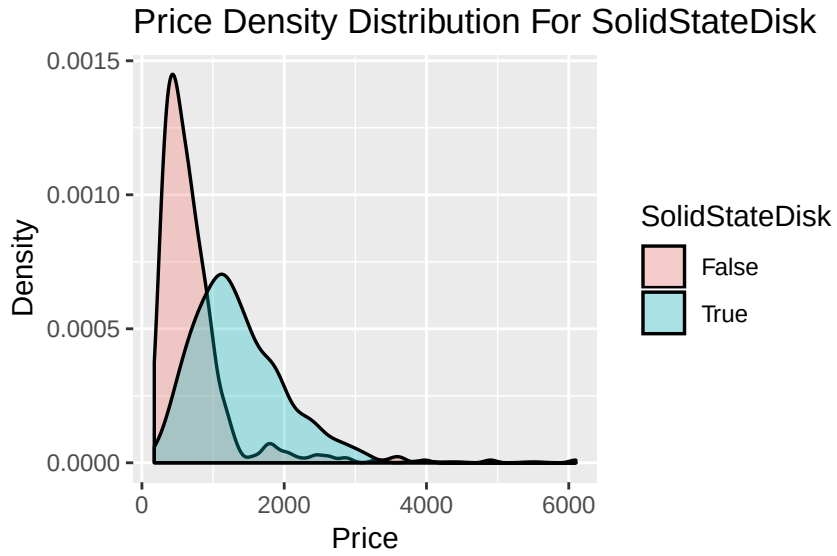
```
ggplot(data, aes(x = Price, fill = TypeName)) +
        geom_density(size = 0.6, alpha = .3) +
        labs(x = "Price", y ="Density", fill = "TypeName") +
        ggtitle("Price Density Distribution For TypeName")
```



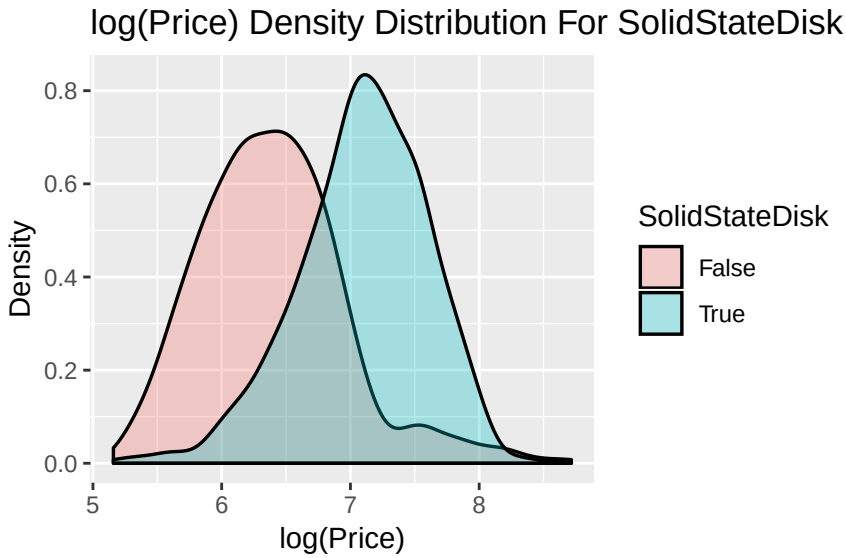

```
ggplot(data, aes(x = log(Price), fill = TypeName)) +
        geom_density(size = 0.6, alpha = .3) +
        labs(x = "log(Price)", y ="Density", fill = "TypeName") +
        ggtitle("log(Price) Density Distribution For TypeName")
```




```
ggplot(data, aes(x = Price, fill = SolidStateDisk)) +
        geom_density(size = 0.6, alpha = .3) +
        labs(x = "Price", y ="Density", fill = "SolidStateDisk") +
        ggtitle("Price Density Distribution For SolidStateDisk")
```




```
ggplot(data, aes(x = log(Price), fill = SolidStateDisk)) +
        geom_density(size = 0.6, alpha = .3) +
        labs(x = "log(Price)", y ="Density", fill = "SolidStateDisk") +
        ggtitle("log(Price) Density Distribution For SolidStateDisk")
```

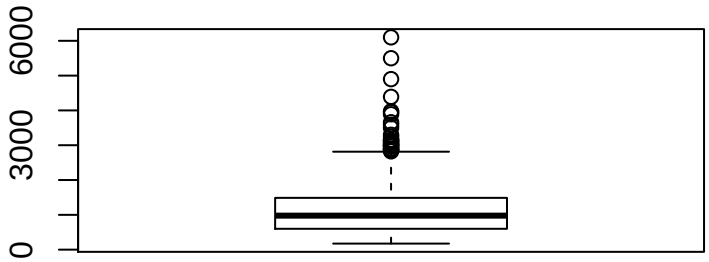



```
library(psych)
describe(data$Price)
```

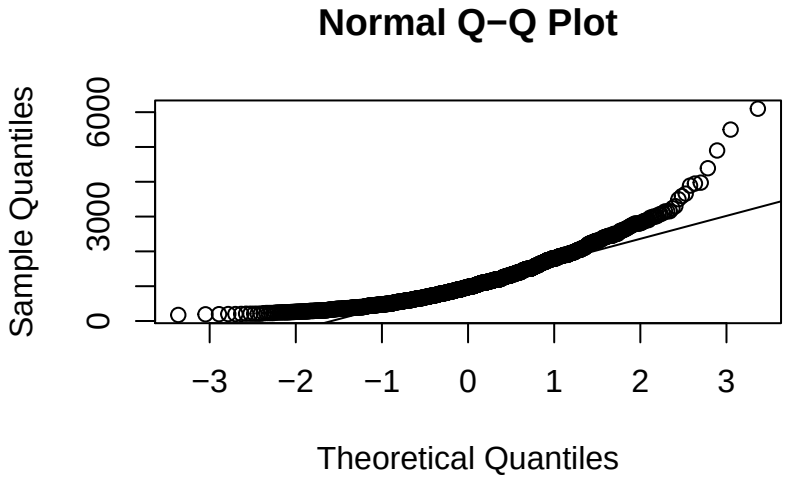
```
##    vars    n    mean     sd median trimmed    mad min  max range skew
## X1    1 1303 1123.69 699.01    977 1038.47 619.73 174 6099  5925 1.52
##    kurtosis    se
## X1     4.34 19.36
```

```
library(nortest)
# NORMALITA'

boxplot(data$Price)
```




```
qqnorm(data$Price);qqline(data$Price)
```




```
shapiro.test(data$Price)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  data$Price
## W = 0.89382, p-value < 2.2e-16
```

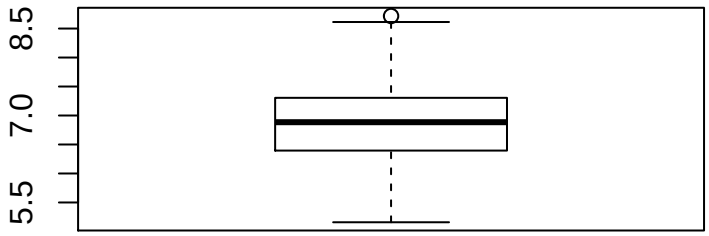
```
ad.test(data$Price)
```

```
##
##  Anderson-Darling normality test
##
## data:  data$Price
## A = 28.319, p-value < 2.2e-16
```

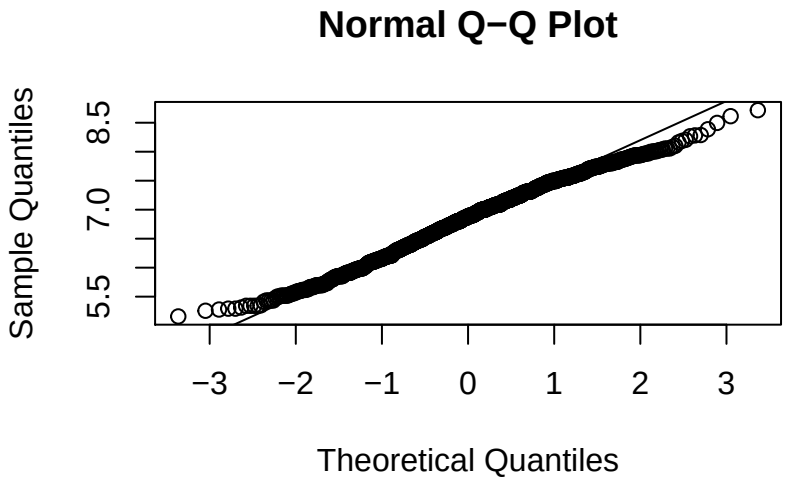
```
#wilcox.test(data$Price, conf.int = TRUE, mu = ) #worth it?
#if(!require(Envstats)) install.packages("EnvStats")
```

Trying with the log correction:

```
# Correzione NORMALITA'
library(nortest)
boxplot(data$LogPrice)
```




```
qqnorm(data$LogPrice);qqline(data$LogPrice)
```




```
shapiro.test(data$LogPrice) #better than before, but still not normal according to shapiro
```

```
##
##  Shapiro-Wilk normality test
##
## data:  data$LogPrice
## W = 0.99252, p-value = 3.628e-06
```

```
ad.test(data$LogPrice)
```

```
##
##  Anderson-Darling normality test
##
## data:  data$LogPrice
## A = 2.5942, p-value = 1.515e-06
```

Test on a mean (justify H0) on Y and confidence limits.

T-test

```
# One sample
ref <- mean(data$Price)
Apple<-data$Price[data$Company=="Apple"]
t.test(Apple,mu=ref,alternative = "greater")
```

```
##
##  One Sample t-test
##
## data:  Apple
```

```
## t = 3.5944, df = 20, p-value = 0.000906
## alternative hypothesis: true mean is greater than 1123.687
## 95 percent confidence interval:
##  1352.823      Inf
## sample estimates:
## mean of x
##  1564.199
```

```
# Wilcoxon Signed Rank Test
wilcox.test(Apple, mu=ref, conf.int = TRUE)
```

```
##
##  Wilcoxon signed rank test
##
## data:  Apple
## V = 206, p-value = 0.0008516
## alternative hypothesis: true location is not equal to 1123.687
## 95 percent confidence interval:
##  1234.50 1829.26
## sample estimates:
## (pseudo)median
##       1514.275
```

```
#FIXME: var test?
library(EnvStats)
varTest(sample(data$Price), sigma.squared = (sd(data$Price)*sd(data$Price)))
```

```
##
##  Chi-Squared Test on Variance
##
## data:  sample(data$Price)
## Chi-Squared = 1302, df = 1302, p-value = 0.9896
## alternative hypothesis: true variance is not equal to 488613.6
## 95 percent confidence interval:
##  453149.5 528432.0
## sample estimates:
## variance
## 488613.6
```

Test two means, two variances (Y vs X) .

```
#Two sample
Other <-data$Price[data$Company!="Apple"]
wilcox.test(Apple, Other, alternative = "g")
```

```
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  Apple and Other
## W = 19689, p-value = 0.0001358
## alternative hypothesis: true location shift is greater than 0
```

```
# F test sulla varianza
var.test(Apple, Other, alternative = "two.sided")
```

```
##
##  F test to compare two variances
##
## data:  Apple and Other
## F = 0.64574, num df = 20, denom df = 1281, p-value = 0.2401
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
##  0.3755878 1.3509884
## sample estimates:
## ratio of variances
##          0.6457382
```

Association/chi square among some couples of categorical Xj

Variabili qualitative: tabella di contingenza e chi quadro

```
b<-data
b.table<-table(b$SolidStateDisk,b$TypeName)
b.table
```

```
##
##         2 in 1 Convertible Gaming Netbook Notebook Ultrabook Workstation
##   False                 29     32      13      376        19           7
##   True                  92    173      12      351       177          22
```

```
prop.table(b.table,2)
```

```
##
##         2 in 1 Convertible     Gaming    Netbook   Notebook  Ultrabook
##   False         0.23966942 0.15609756 0.52000000 0.51719395 0.09693878
##   True          0.76033058 0.84390244 0.48000000 0.48280605 0.90306122
##
##         Workstation
##   False  0.24137931
##   True   0.75862069
```

```
# chi square test

chisq.test(b.table)
```

```
##
##  Pearson's Chi-squared test
##
## data:  b.table
## X-squared = 184.66, df = 5, p-value < 2.2e-16
```

```
chi=chisq.test(b.table)
chi_norm=chi$statistic/(nrow(b)*min(nrow(b.table)-1,ncol(b.table)-1))
chi_norm
```

```
## X-squared
## 0.1417156
```

```
summary(b.table)
```

```
## Number of cases in table: 1303
```

```
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 184.66, df = 5, p-value = 5.42e-38
```

Correlazione per variabili quantitative

```
# seleziona solo variabili quantitative
nums <- sapply(data, is.numeric)
var_numeric <- data[,nums]
head(var_numeric)
```

```
##   X Inches Ram Weight   Price Frequenza   Pixel MemoriaSSD TotalMemory
## 1 1   13.3   8   1.37 1339.69       2.3 4096000        128         128
## 2 2   13.3   8   1.34  898.94       1.8 1296000          0         128
## 3 3   15.6   8   1.86  575.00       2.5 2073600        256         256
## 4 4   15.4  16   1.83 2537.45       2.7 5184000        512         512
## 5 5   13.3   8   1.37 1803.60       3.1 4096000        256         256
## 6 6   15.6   4   2.10  400.00       3.0 1049088          0         500
##   LogPrice
## 1 7.200194
## 2 6.801216
## 3 6.354370
## 4 7.838915
## 5 7.497540
## 6 5.991465
```

```
var_numeric$X=NULL
```

```
# Matrice di correlazione
R<-cor(var_numeric)
R
```

```
##                  Inches       Ram      Weight      Price Frequenza
## Inches       1.00000000 0.2379928  0.82763110 0.06819667 0.3078698
## Ram          0.23799280 1.0000000  0.38387409 0.74300714 0.3680005
## Weight       0.82763110 0.3838741  1.00000000 0.21036980 0.3204336
## Price        0.06819667 0.7430071  0.21036980 1.00000000 0.4302931
## Frequenza    0.30786980 0.3680005  0.32043359 0.43029310 1.0000000
## Pixel       -0.08639917 0.3963585 -0.04403379 0.51548639 0.1352935
## MemoriaSSD  -0.12617118 0.4642349 -0.09500459 0.55288979 0.2482924
## TotalMemory  0.53805897 0.3489632  0.54952713 0.15783025 0.2421317
## LogPrice     0.04432871 0.6848033  0.15167383 0.92758068 0.5041461
##                   Pixel  MemoriaSSD TotalMemory   LogPrice
## Inches      -0.08639917 -0.12617118  0.53805897 0.04432871
## Ram          0.39635848  0.46423485  0.34896315 0.68480333
## Weight      -0.04403379 -0.09500459  0.54952713 0.15167383
## Price        0.51548639  0.55288979  0.15783025 0.92758068
## Frequenza    0.13529350  0.24829236  0.24213174 0.50414608
## Pixel        1.00000000  0.36076909  0.06334134 0.48490475
## MemoriaSSD   0.36076909  1.00000000 -0.16285476 0.61685264
## TotalMemory  0.06334134 -0.16285476  1.00000000 0.15678005
## LogPrice     0.48490475  0.61685264  0.15678005 1.00000000
```

```
# Test di correlazione. (Spearsman's o Kendall tau)
cor.test(var_numeric$Inches, var_numeric$Weight)
```

```
##
```

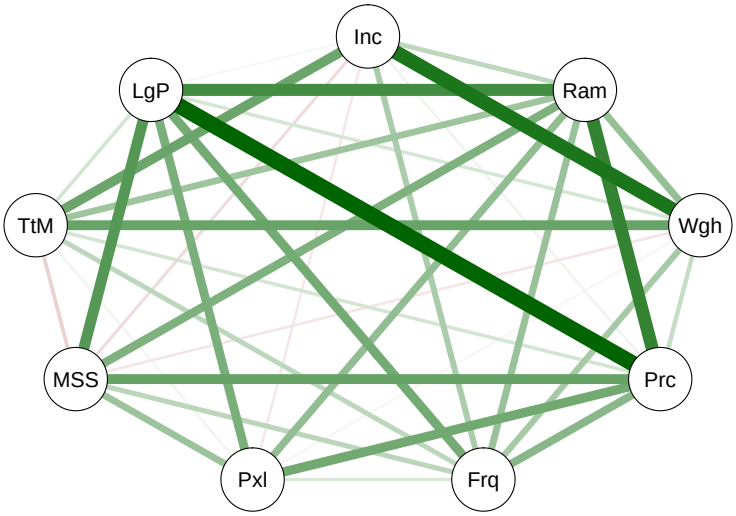
```
##  Pearson's product-moment correlation
##
## data:  var_numeric$Inches and var_numeric$Weight
## t = 53.187, df = 1301, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.8097181 0.8440031
## sample estimates:
##       cor
## 0.8276311
```

```
#corrgram(var_numeric)

# Correlazione come grafo
library(qgraph)
detcor=cor(as.matrix(var_numeric), method="pearson")
round(detcor, 2)
```

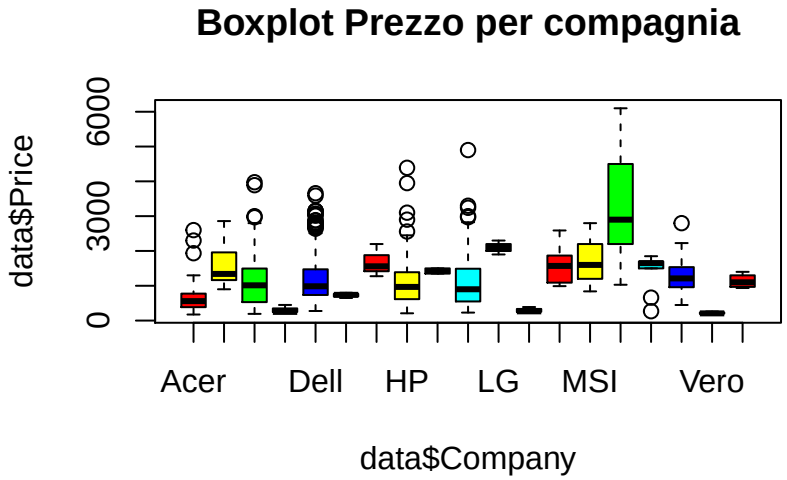
```
##             Inches  Ram Weight Price Frequenza Pixel MemoriaSSD
## Inches        1.00 0.24   0.83  0.07      0.31 -0.09      -0.13
## Ram           0.24 1.00   0.38  0.74      0.37  0.40       0.46
## Weight        0.83 0.38   1.00  0.21      0.32 -0.04      -0.10
## Price         0.07 0.74   0.21  1.00      0.43  0.52       0.55
## Frequenza     0.31 0.37   0.32  0.43      1.00  0.14       0.25
## Pixel        -0.09 0.40  -0.04  0.52      0.14  1.00       0.36
## MemoriaSSD   -0.13 0.46  -0.10  0.55      0.25  0.36       1.00
## TotalMemory   0.54 0.35   0.55  0.16      0.24  0.06      -0.16
## LogPrice      0.04 0.68   0.15  0.93      0.50  0.48       0.62
##             TotalMemory LogPrice
## Inches             0.54     0.04
## Ram                0.35     0.68
## Weight             0.55     0.15
## Price              0.16     0.93
## Frequenza          0.24     0.50
## Pixel              0.06     0.48
## MemoriaSSD        -0.16     0.62
## TotalMemory        1.00     0.16
## LogPrice           0.16     1.00
```

```
# plot corr matrix: green positive red negative
qgraph(detcor, shape="circle", posCol="darkgreen", negCol="darkred")
```

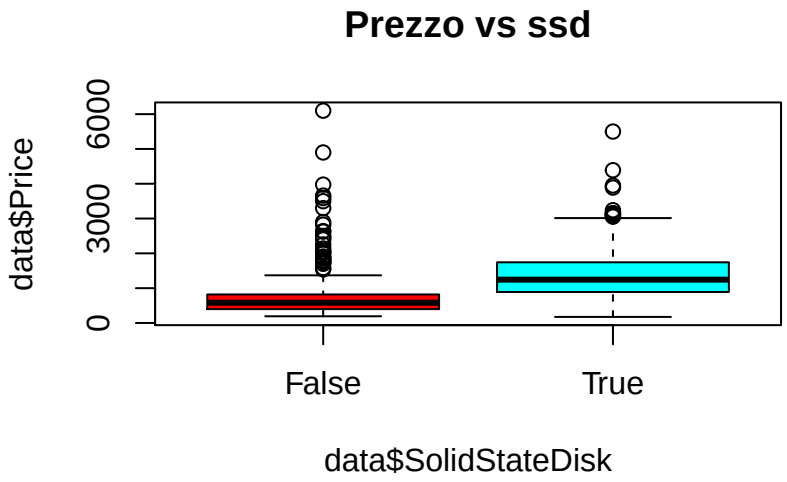


Boxplot di confronto (pre-anova)

```
boxplot(data$Price~data$Company,
        main="Boxplot Prezzo per compagnia",
        col= rainbow(6),
        horizontal = F)
```




```
boxplot(data$Price~data$SolidStateDisk,
        main="Prezzo vs ssd",
        col= rainbow(2),
        horizontal = F)
```



Anova one way Y = Xj, for a categorical X

A una via

```
lmA = lm(Price ~ SolidStateDisk, data=data)
summary(lmA)
```

```
##
## Call:
## lm(formula = Price ~ SolidStateDisk, data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1180.9  -375.9  -132.5   237.0  5377.0
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)           722.00      28.84   25.03   <2e-16 ***
## SolidStateDiskTrue    632.89      36.20   17.48   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 629.3 on 1301 degrees of freedom
## Multiple R-squared:  0.1902, Adjusted R-squared:  0.1896
## F-statistic: 305.6 on 1 and 1301 DF,  p-value: < 2.2e-16
```

```
drop1(lmA, test = 'F')
```

```
## Single term deletions
##
## Model:
## Price ~ SolidStateDisk
##                Df Sum of Sq       RSS   AIC F value    Pr(>F)
## <none>                      515163583 16796
## SolidStateDisk  1 121011379 636174961 17069   305.6 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
anova(lmA)
```

```
## Analysis of Variance Table
##
## Response: Price
##                  Df    Sum Sq   Mean Sq F value    Pr(>F)
## SolidStateDisk    1 121011379 121011379   305.6 < 2.2e-16 ***
## Residuals      1301 515163583    395975
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

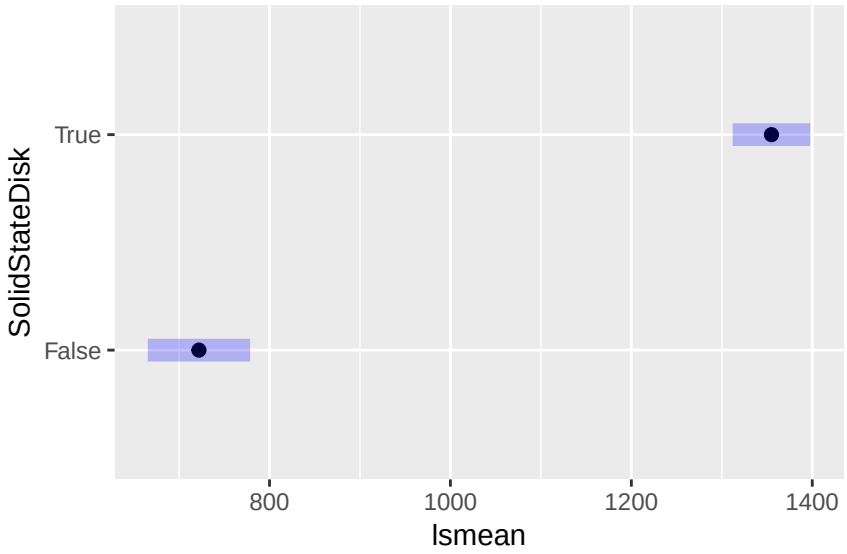
```r
library(lsmeans)
ls_SolidStateDisk = lsmeans(lmA,pairwise ~ SolidStateDisk,adjust = 'tukey')
ls_SolidStateDisk$contrasts
```

```
##  contrast     estimate   SE   df t.ratio p.value
##  False - True     -633 36.2 1301 -17.482 <.0001
```

```r
ls_SolidStateDisk$lsmeans
```

```
##  SolidStateDisk lsmean   SE   df lower.CL upper.CL
##  False             722 28.8 1301      665      779
##  True             1355 21.9 1301     1312     1398
##
## Confidence level used: 0.95
```

```r
plot(ls_SolidStateDisk$lsmeans, alpha = .05)
```




```r
str(data)
```

```
## 'data.frame':    1303 obs. of  23 variables:
##  $ X                : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ Company          : Factor w/ 19 levels "Acer","Apple",..: 2 2 8 2 2 1 2 2 3 1 ...
##  $ Product          : Factor w/ 618 levels "110-15ACL (A6-7310/4GB/500GB/W10)",..: 302 300 51 302 30
##  $ TypeName         : Factor w/ 6 levels "2 in 1 Convertible",..: 5 5 4 5 5 4 5 5 5 5 ...
##  $ Inches           : num  13.3 13.3 15.6 15.4 13.3 15.6 15.4 13.3 14 14 ...
##  $ ScreenResolution : Factor w/ 40 levels "1366x768","1440x900",..: 24 2 9 26 24 1 26 2 9 16 ...
##  $ Cpu              : Factor w/ 118 levels "AMD A10-Series 9600P 2.4GHz",..: 55 53 64 75 57 15 74 53
##  $ Ram              : num  8 8 8 16 8 4 16 8 16 8 ...
```

```
##  $ Memory            : Factor w/ 38 levels "1024GB HDD","1024GB HDD +  1024GB HDD",..: 8 6 17 29 17 1
##  $ Gpu               : Factor w/ 110 levels "AMD FirePro W4190M",..: 59 52 54 10 60 18 61 52 98 62 .
##  $ OpSys             : Factor w/ 9 levels "Android","Chrome OS",..: 5 5 6 5 5 7 4 5 7 7 ...
##  $ Weight            : num  1.37 1.34 1.86 1.83 1.37 2.1 2.04 1.34 1.3 1.6 ...
##  $ Price             : num  1340 899 575 2537 1804 ...
##  $ Frequenza         : num  2.3 1.8 2.5 2.7 3.1 3 2.2 1.8 1.8 1.6 ...
##  $ Risoluzione       : Factor w/ 15 levels "1366x768","1440x900",..: 11 2 4 13 11 1 13 2 4 4 ...
##  $ Pixel             : int  4096000 1296000 2073600 5184000 4096000 1049088 5184000 1296000 2073600 1
##  $ GpuCompany        : Factor w/ 4 levels "AMD","ARM","Intel",..: 3 3 3 1 3 1 3 3 4 3 ...
##  $ MemoriaSSD        : int  128 0 256 512 256 0 0 0 512 256 ...
##  $ SolidStateDisk    : Factor w/ 2 levels "False","True": 2 1 2 2 2 1 1 1 2 2 ...
##  $ TotalMemory       : int  128 128 256 512 256 500 256 256 512 256 ...
##  $ dedicated_GPU     : Factor w/ 2 levels "False","True": 1 1 1 2 1 2 1 1 2 1 ...
##  $ Aggregated_Company: Factor w/ 10 levels "Acer","Apple",..: 2 2 5 2 2 1 2 2 3 1 ...
##  $ LogPrice          : num  7.2 6.8 6.35 7.84 7.5 ...
```

```
lm_gpu_test=lm(Price~GpuCompany, data = data) #just a try
summary(lm_gpu_test)
```

```
##
## Call:
## lm(formula = Price ~ GpuCompany, data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1030.9  -489.6  -140.9   367.8  4609.1
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)        775.65      48.54  15.980  < 2e-16 ***
## GpuCompanyARM     -116.65     653.03  -0.179    0.858
## GpuCompanyIntel    232.58      54.25   4.287 1.95e-05 ***
## GpuCompanyNvidia   714.23      58.45  12.220  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 651.2 on 1299 degrees of freedom
## Multiple R-squared:  0.1341, Adjusted R-squared:  0.1321
## F-statistic: 67.03 on 3 and 1299 DF,  p-value: < 2.2e-16
```

```
drop1(lm_gpu_test, test = 'F')
```

```
## Single term deletions
##
## Model:
## Price ~ GpuCompany
##            Df Sum of Sq       RSS   AIC F value    Pr(>F)
## <none>                  550892912 16888
## GpuCompany  3  85282050 636174961 17069  67.031 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
anova(lm_gpu_test)
```

```
## Analysis of Variance Table
##
```

```
## Response: Price
##              Df    Sum Sq  Mean Sq F value    Pr(>F)
## GpuCompany    3  85282050 28427350  67.031 < 2.2e-16 ***
## Residuals  1299 550892912   424090
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary(data$dedicated_GPU)
```

```
## False  True
##   723   580
```

```
lm_gpu_test=lm(Price~dedicated_GPU, data = data) #FIXME: seems not really worth it
summary(lm_gpu_test)
```

```
##
## Call:
## lm(formula = Price ~ dedicated_GPU, data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1069.2  -523.2  -169.2   391.3  4830.8
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)        1007.74      25.56   39.43  < 2e-16 ***
## dedicated_GPUTrue   260.48      38.30    6.80 1.59e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 687.2 on 1301 degrees of freedom
## Multiple R-squared:  0.03432,    Adjusted R-squared:  0.03358
## F-statistic: 46.24 on 1 and 1301 DF,  p-value: 1.59e-11
```

```
drop1(lm_gpu_test, test = 'F')
```

```
## Single term deletions
##
## Model:
## Price ~ dedicated_GPU
##               Df Sum of Sq       RSS   AIC F value   Pr(>F)
## <none>                     614339895 17026
## dedicated_GPU  1  21835067 636174961 17069  46.241 1.59e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
anova(lm_gpu_test)
```

```
## Analysis of Variance Table
##
## Response: Price
##                 Df    Sum Sq  Mean Sq F value   Pr(>F)
## dedicated_GPU    1  21835067 21835067  46.241 1.59e-11 ***
## Residuals     1301 614339895   472206
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
lmB = lm(Price ~ Company, data=data)
summary(lmB)
```

```
##
## Call:
## lm(formula = Price ~ Company, data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2317.1  -452.8  -127.4   288.5  3812.6
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)        626.78      63.43   9.881  < 2e-16 ***
## CompanyApple       937.42     154.14   6.082 1.57e-09 ***
## CompanyAsus        477.39      81.53   5.856 6.03e-09 ***
## CompanyChuwi      -312.48     377.06  -0.829 0.407416
## CompanyDell        559.29      73.62   7.597 5.80e-14 ***
## CompanyFujitsu     102.22     377.06   0.271 0.786352
## CompanyGoogle     1050.89     377.06   2.787 0.005397 **
## CompanyHP          441.00      74.41   5.927 3.96e-09 ***
## CompanyHuawei      797.22     459.62   1.735 0.083065 .
## CompanyLenovo      459.61      73.62   6.243 5.81e-10 ***
## CompanyLG         1472.22     377.06   3.904 9.93e-05 ***
## CompanyMediacom   -331.78     251.46  -1.319 0.187270
## CompanyMicrosoft   985.53     270.37   3.645 0.000278 ***
## CompanyMSI        1102.13     108.16  10.190  < 2e-16 ***
## CompanyRazer      2719.37     251.46  10.814  < 2e-16 ***
## CompanySamsung     786.67     223.77   3.515 0.000454 ***
## CompanyToshiba     641.04     112.51   5.698 1.50e-08 ***
## CompanyVero       -409.35     328.08  -1.248 0.212365
## CompanyXiaomi      506.69     328.08   1.544 0.122740
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 643.8 on 1284 degrees of freedom
## Multiple R-squared:  0.1635, Adjusted R-squared:  0.1518
## F-statistic: 13.94 on 18 and 1284 DF,  p-value: < 2.2e-16
```

```r
drop1(lmB, test = 'F')
```

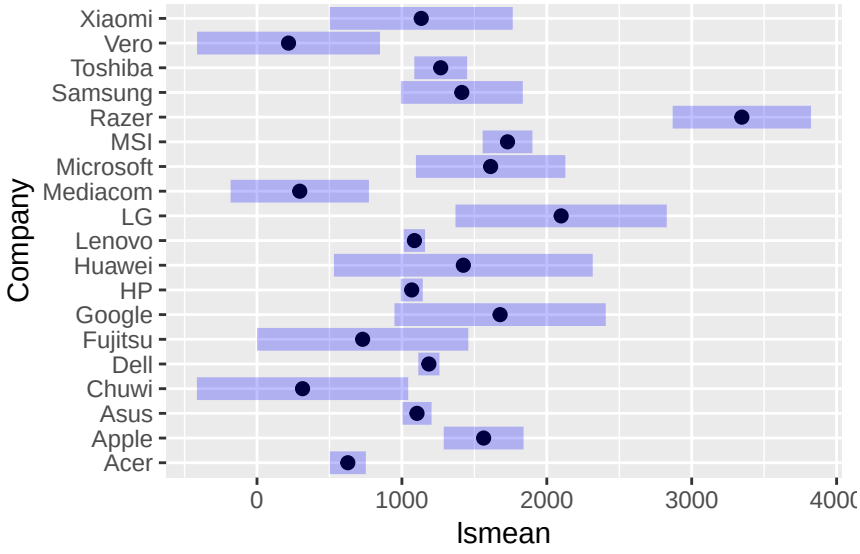
```
## Single term deletions
##
## Model:
## Price ~ Company
##         Df Sum of Sq       RSS   AIC F value    Pr(>F)
## <none>               532160971 16873
## Company 18 104013991 636174961 17069  13.943 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
anova(lmB)
```

```
## Analysis of Variance Table
##
```

```
## Response: Price
##              Df    Sum Sq Mean Sq F value    Pr(>F)
## Company      18 104013991 5778555  13.943 < 2.2e-16 ***
## Residuals 1284 532160971  414456
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
library(lsmeans)
ls_Company = lsmeans(lmB,pairwise ~ Company,adjust = 'tukey')
#ls_Company$contrasts #FIXME: too long to be printed
#ls_Company$lsmeans #mFIXME: aybe only the plot is enough?
plot(ls_Company$lsmeans, alpha = .05)
```




```
lmB_agg = lm(Price ~ Aggregated_Company, data=data) #seems to be fine
summary(lmB_agg)
```

```
##
## Call:
## lm(formula = Price ~ Aggregated_Company, data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2317.1  -465.0  -137.4   312.9  3812.6
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)                  626.78      64.19   9.765  < 2e-16 ***
## Aggregated_CompanyApple      937.42     155.98   6.010 2.41e-09 ***
## Aggregated_CompanyAsus       477.39      82.50   5.787 9.00e-09 ***
## Aggregated_CompanyDell       559.29      74.49   7.508 1.11e-13 ***
## Aggregated_CompanyHP         441.00      75.29   5.857 5.96e-09 ***
## Aggregated_CompanyLenovo     459.61      74.49   6.170 9.12e-10 ***
## Aggregated_CompanyMSI       1102.13     109.45  10.070  < 2e-16 ***
## Aggregated_CompanyOthers     445.30     117.32   3.795 0.000154 ***
## Aggregated_CompanyRazer     2719.37     254.45  10.687  < 2e-16 ***
## Aggregated_CompanyToshiba    641.04     113.85   5.631 2.20e-08 ***
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 651.4 on 1293 degrees of freedom
## Multiple R-squared:  0.1375, Adjusted R-squared:  0.1315
## F-statistic:  22.9 on 9 and 1293 DF,  p-value: < 2.2e-16
```

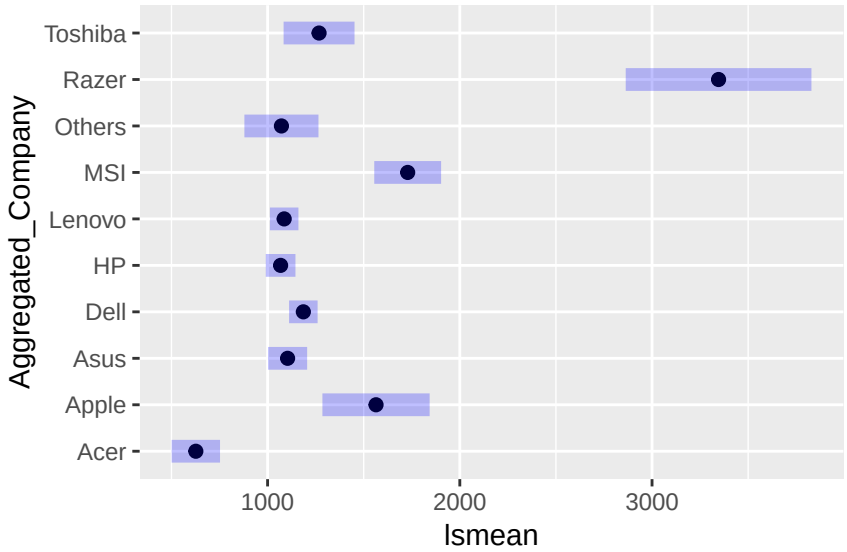
```
drop1(lmB_agg, test = 'F')
```

```
## Single term deletions
##
## Model:
## Price ~ Aggregated_Company
##                     Df Sum of Sq       RSS   AIC F value    Pr(>F)
## <none>                           548712016 16895
## Aggregated_Company  9  87462945 636174961 17069    22.9 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
anova(lmB_agg)
```

```
## Analysis of Variance Table
##
## Response: Price
##                       Df    Sum Sq Mean Sq F value    Pr(>F)
## Aggregated_Company     9  87462945 9718105    22.9 < 2.2e-16 ***
## Residuals           1293 548712016  424371
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
ls_Company_agg = lsmeans(lmB_agg,pairwise ~ Aggregated_Company,adjust = 'tukey')
#ls_Company_agg$contrasts #FIXME: too long to be printed
#ls_Company_agg$lsmeans #mFIXME: aybe only the plot is enough?
plot(ls_Company_agg$lsmeans, alpha = .05) #i guess from here seems fine to leave "Razer" alone?
```




```
lmC = lm(Price ~ TypeName, data=data)
summary(lmC)
```

```
##
## Call:
```

```
## lm(formula = Price ~ TypeName, data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1049.2  -381.7   -98.1   267.6  4367.6
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)          1282.40      50.01  25.642  < 2e-16 ***
## TypeNameGaming        448.98      63.07   7.119 1.79e-12 ***
## TypeNameNetbook      -646.17     120.86  -5.347 1.06e-07 ***
## TypeNameNotebook     -500.32      54.01  -9.263  < 2e-16 ***
## TypeNameUltrabook     265.83      63.60   4.180 3.12e-05 ***
## TypeNameWorkstation   997.96     113.74   8.774  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 550.1 on 1297 degrees of freedom
## Multiple R-squared:  0.383,  Adjusted R-squared:  0.3806
## F-statistic:   161 on 5 and 1297 DF,  p-value: < 2.2e-16
```

```
drop1(lmC, test = 'F')
```

```
## Single term deletions
##
## Model:
## Price ~ TypeName
##          Df Sum of Sq       RSS   AIC F value    Pr(>F)
## <none>                392518380 16450
## TypeName  5 243656581 636174961 17069  161.02 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
anova(lmC)
```

```
## Analysis of Variance Table
##
## Response: Price
##             Df    Sum Sq  Mean Sq F value    Pr(>F)
## TypeName     5 243656581 48731316  161.02 < 2.2e-16 ***
## Residuals 1297 392518380   302636
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
ls_TypeName = lsmeans(lmC,pairwise ~ TypeName,adjust = 'tukey')
ls_TypeName$contrasts
```

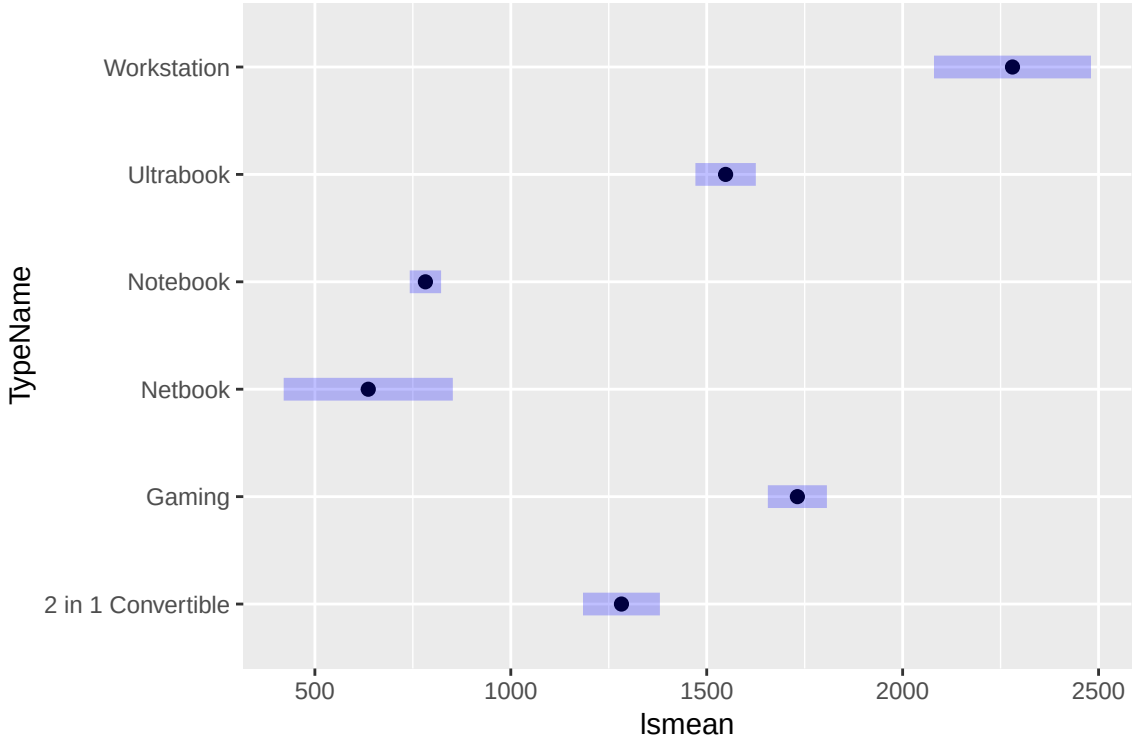
```
##  contrast                          estimate    SE   df t.ratio p.value
##  2 in 1 Convertible - Gaming           -449  63.1 1297  -7.119 <.0001
##  2 in 1 Convertible - Netbook           646 120.9 1297   5.347 <.0001
##  2 in 1 Convertible - Notebook          500  54.0 1297   9.263 <.0001
##  2 in 1 Convertible - Ultrabook        -266  63.6 1297  -4.180 0.0004
##  2 in 1 Convertible - Workstation      -998 113.7 1297  -8.774 <.0001
##  Gaming - Netbook                     1095 116.5 1297   9.397 <.0001
##  Gaming - Notebook                     949  43.5 1297  21.821 <.0001
##  Gaming - Ultrabook                    183  55.0 1297   3.333 0.0114
```

```
##  Gaming - Workstation                -549 109.1 1297  -5.030 <.0001
##  Netbook - Notebook                  -146 111.9 1297  -1.303 0.7833
##  Netbook - Ultrabook                 -912 116.8 1297  -7.806 <.0001
##  Netbook - Workstation              -1644 150.1 1297 -10.951 <.0001
##  Notebook - Ultrabook                -766  44.3 1297 -17.304 <.0001
##  Notebook - Workstation             -1498 104.2 1297 -14.383 <.0001
##  Ultrabook - Workstation             -732 109.5 1297  -6.689 <.0001
##
## P value adjustment: tukey method for comparing a family of 6 estimates
```

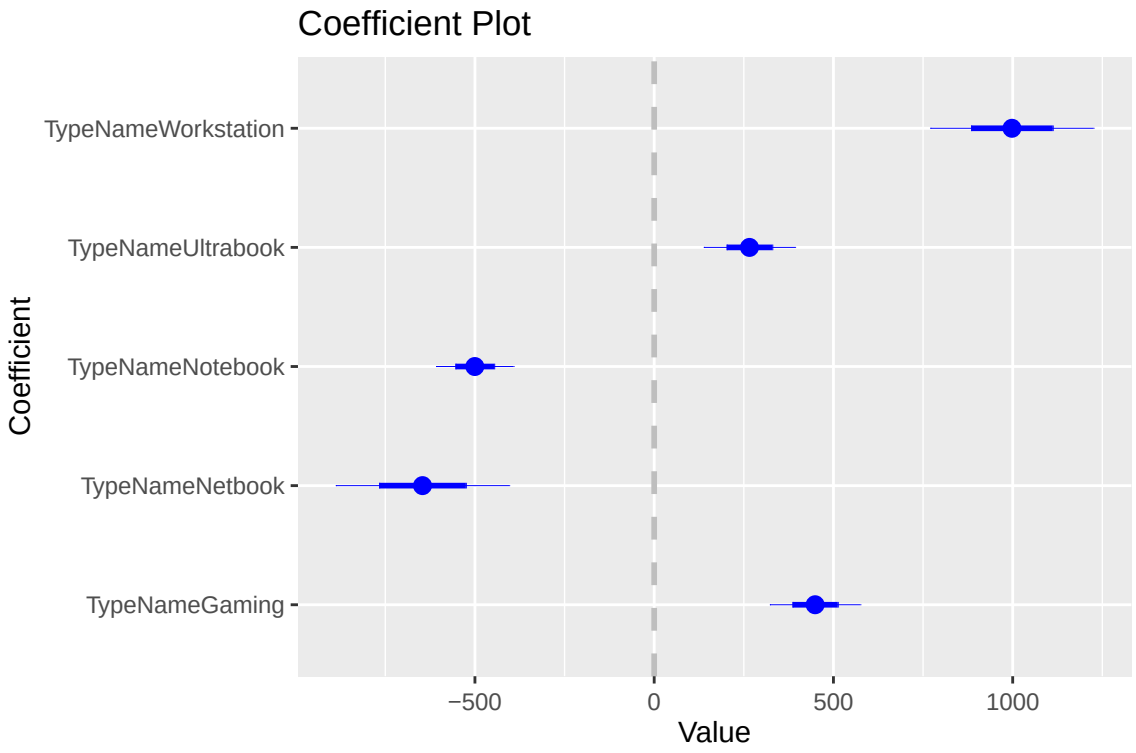
```
ls_TypeName$lsmeans
```

```
##  TypeName           lsmean    SE   df lower.CL upper.CL
##  2 in 1 Convertible   1282  50.0 1297     1184     1381
##  Gaming               1731  38.4 1297     1656     1807
##  Netbook               636 110.0 1297      420      852
##  Notebook              782  20.4 1297      742      822
##  Ultrabook            1548  39.3 1297     1471     1625
##  Workstation          2280 102.2 1297     2080     2481
##
## Confidence level used: 0.95
```

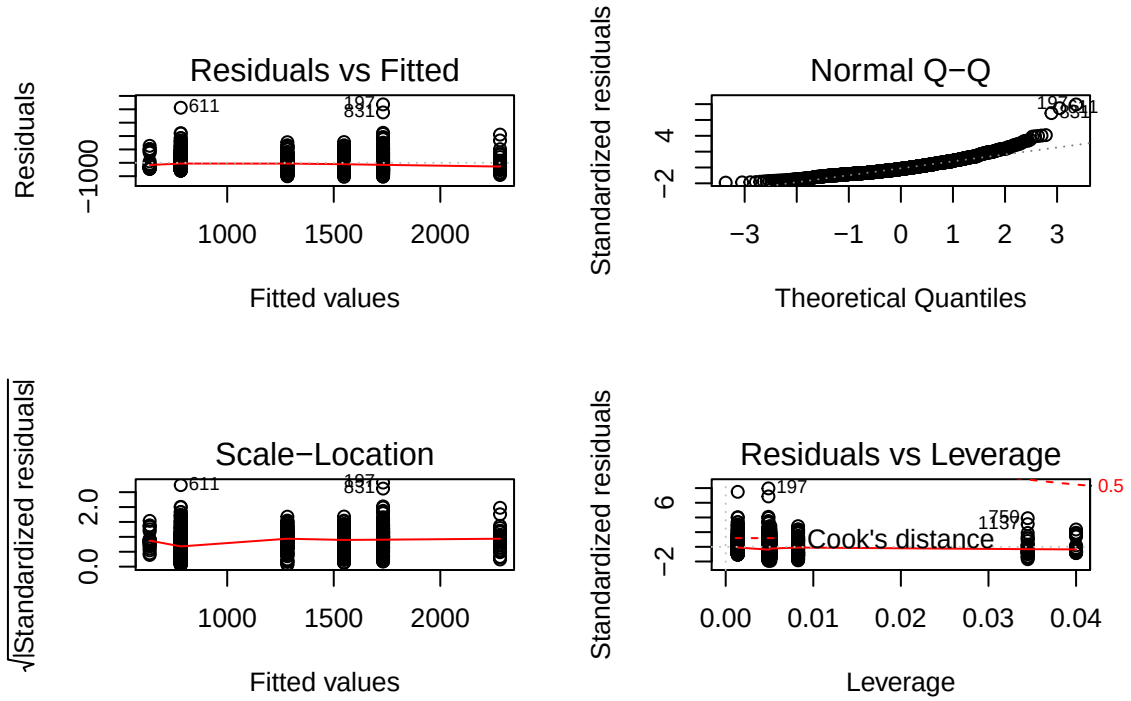
```
plot(ls_TypeName$lsmeans, alpha = .05)
```



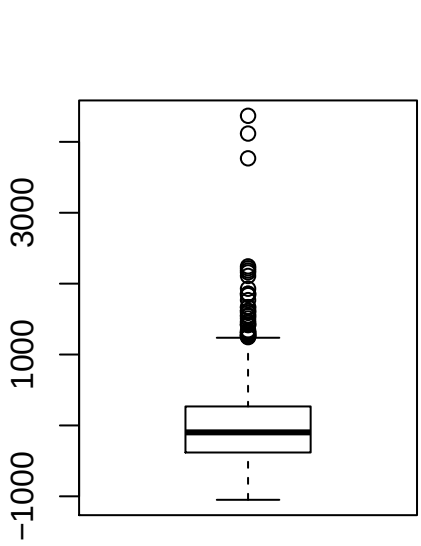

```
library(coefplot)
#library(forestmodel)
coefplot(lmC, intercept = FALSE)
```

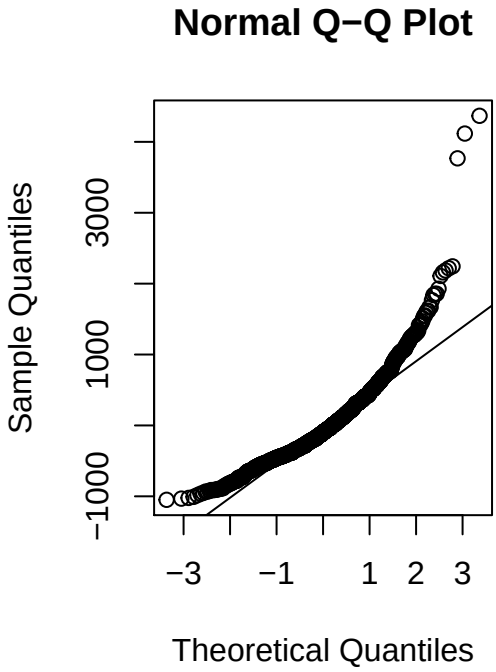



```
par(mfrow = c(2,2))
plot(lmC)
```




```
#(not) normal distribution of residuals
par(mfrow=c(1,2))
boxplot(lmC$residuals)
qqnorm(lmC$residuals);qqline(lmC$residuals)
```






```
ad.test(lmC$residuals)
```

```
##
##  Anderson-Darling normality test
##
## data:  lmC$residuals
## A = 22.667, p-value < 2.2e-16
```

```
shapiro.test(lmC$residuals)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  lmC$residuals
## W = 0.89641, p-value < 2.2e-16
```

```
#let's try again with the log correction
lmC_log = lm(log(Price) ~ TypeName, data=data)
summary(lmC_log)#R^2 increases
```

```
##
## Call:
## lm(formula = log(Price) ~ TypeName, data = data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.40971 -0.33589  0.00698  0.33215  1.96853
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)          7.02648    0.04379 160.456  < 2e-16 ***
## TypeNameGaming       0.33865    0.05522   6.133 1.15e-09 ***
## TypeNameNetbook     -0.91149    0.10583  -8.613  < 2e-16 ***
## TypeNameNotebook    -0.49823    0.04729 -10.534  < 2e-16 ***
```

```
## TypeNameUltrabook    0.26648    0.05569   4.785 1.91e-06 ***
## TypeNameWorkstation  0.66479    0.09959   6.675 3.65e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4817 on 1297 degrees of freedom
## Multiple R-squared:  0.4061, Adjusted R-squared:  0.4038
## F-statistic: 177.4 on 5 and 1297 DF,  p-value: < 2.2e-16
```

```
drop1(lmC_log, test = 'F')
```

```
## Single term deletions
##
## Model:
## log(Price) ~ TypeName
##          Df Sum of Sq    RSS     AIC F value    Pr(>F)
## <none>                300.95 -1897.5
## TypeName  5    205.76 506.71 -1228.7  177.36 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
anova(lmC_log)
```

```
## Analysis of Variance Table
##
## Response: log(Price)
##             Df Sum Sq Mean Sq F value    Pr(>F)
## TypeName     5 205.76  41.152  177.36 < 2.2e-16 ***
## Residuals 1297 300.95   0.232
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

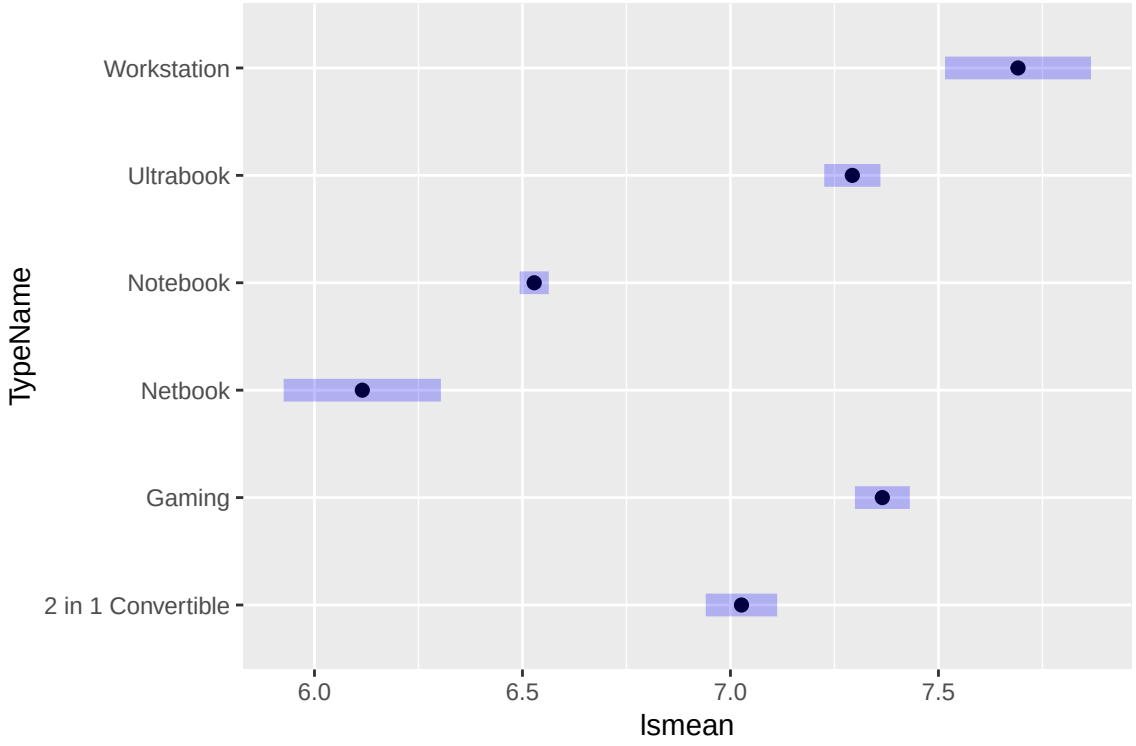
```
ls_TypeName_log = lsmeans(lmC_log,pairwise ~ TypeName,adjust = 'tukey')
ls_TypeName_log$contrasts
```

```
##  contrast                          estimate     SE   df t.ratio p.value
##  2 in 1 Convertible - Gaming        -0.3387 0.0552 1297  -6.133 <.0001
##  2 in 1 Convertible - Netbook        0.9115 0.1058 1297   8.613 <.0001
##  2 in 1 Convertible - Notebook       0.4982 0.0473 1297  10.534 <.0001
##  2 in 1 Convertible - Ultrabook     -0.2665 0.0557 1297  -4.785 <.0001
##  2 in 1 Convertible - Workstation   -0.6648 0.0996 1297  -6.675 <.0001
##  Gaming - Netbook                    1.2501 0.1020 1297  12.251 <.0001
##  Gaming - Notebook                   0.8369 0.0381 1297  21.970 <.0001
##  Gaming - Ultrabook                  0.0722 0.0481 1297   1.500 0.6644
##  Gaming - Workstation               -0.3261 0.0956 1297  -3.413 0.0087
##  Netbook - Notebook                 -0.4133 0.0980 1297  -4.218 0.0004
##  Netbook - Ultrabook                -1.1780 0.1023 1297 -11.515 <.0001
##  Netbook - Workstation              -1.5763 0.1315 1297 -11.990 <.0001
##  Notebook - Ultrabook               -0.7647 0.0388 1297 -19.725 <.0001
##  Notebook - Workstation             -1.1630 0.0912 1297 -12.750 <.0001
##  Ultrabook - Workstation            -0.3983 0.0958 1297  -4.156 0.0005
##
## Results are given on the log (not the response) scale.
## P value adjustment: tukey method for comparing a family of 6 estimates
```

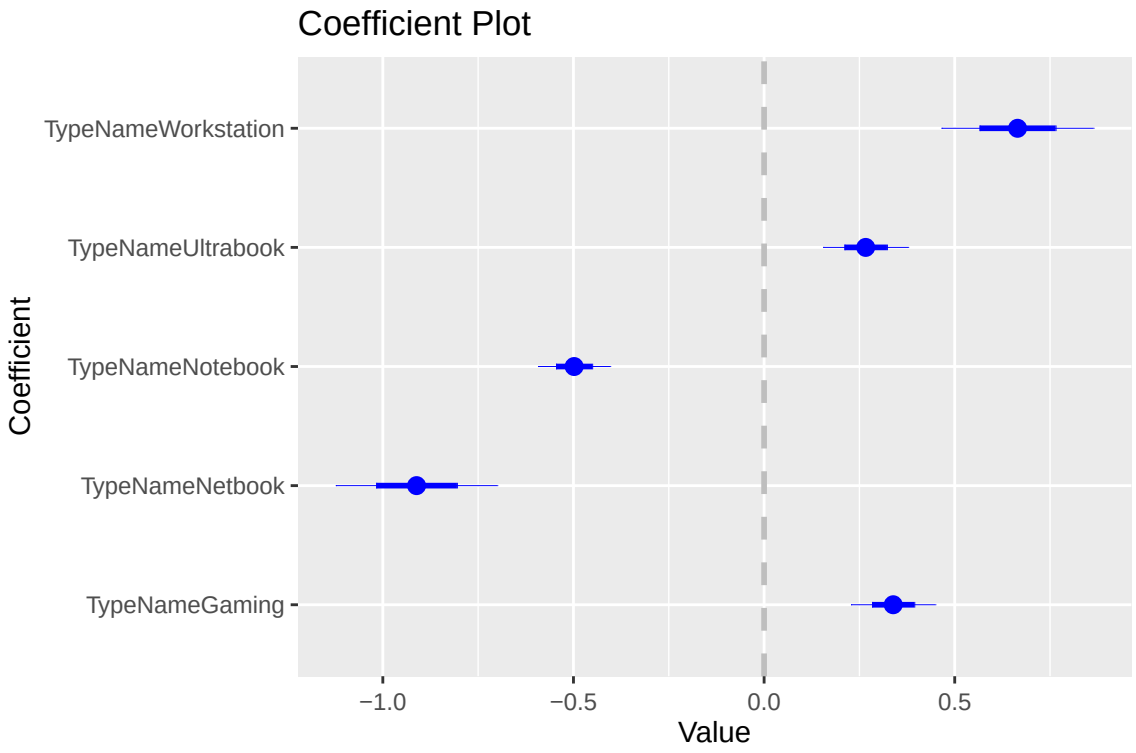
```
ls_TypeName_log$lsmeans
```

```
##  TypeName           lsmean     SE   df lower.CL upper.CL
##  2 in 1 Convertible   7.03 0.0438 1297     6.94     7.11
##  Gaming               7.37 0.0336 1297     7.30     7.43
##  Netbook              6.11 0.0963 1297     5.93     6.30
##  Notebook             6.53 0.0179 1297     6.49     6.56
##  Ultrabook            7.29 0.0344 1297     7.23     7.36
##  Workstation          7.69 0.0894 1297     7.52     7.87
##
## Results are given on the log (not the response) scale.
## Confidence level used: 0.95
```

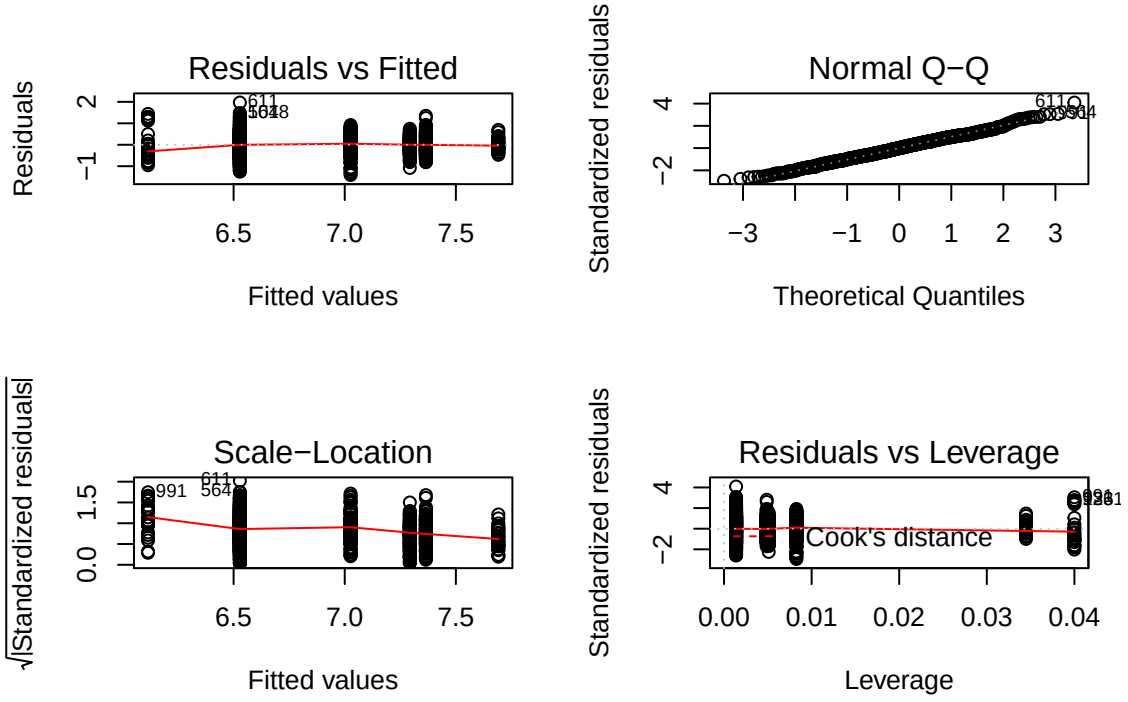
```
plot(ls_TypeName_log$lsmeans, alpha = .05)
```



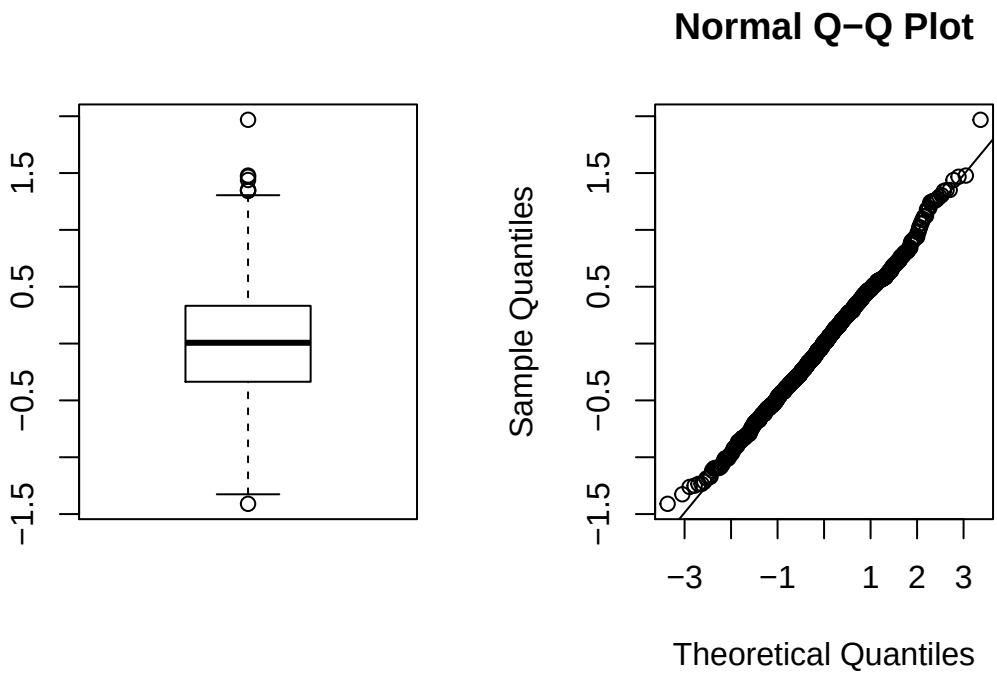

```
coefplot(lmC_log, intercept = FALSE)
```




```
par(mfrow = c(2,2))
plot(lmC_log)
```




```
#(not) normal distribution of residuals
par(mfrow=c(1,2))
boxplot(lmC_log$residuals)
qqnorm(lmC_log$residuals);qqline(lmC_log$residuals)
```




```
ad.test(lmC_log$residuals) #normal now!
```

```
##
##  Anderson-Darling normality test
##
## data:  lmC_log$residuals
## A = 0.51757, p-value = 0.1886
```

```
shapiro.test(lmC_log$residuals) #borderline now!
```

```
##
##  Shapiro-Wilk normality test
##
## data:  lmC_log$residuals
## W = 0.99764, p-value = 0.05462
```

Anova two way Y = Xj Xk for some categorical X

A due vie

```
# Con interazione
lmC = lm(Price ~ Company*TypeName  , data=data)
drop1(lmC, test="F")
```

```
## Single term deletions
##
## Model:
## Price ~ Company * TypeName
##                   Df Sum of Sq       RSS   AIC F value    Pr(>F)
## <none>                          320739568 16273
## Company:TypeName 25  29159364 349898932 16336  4.5602 1.181e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
#summary(lmC) #FIXME: too long to be printed

lmC = lm(Price ~ Company+TypeName  , data=data)
# type I effects A, B/A   C/A,B
anova(lmC)
```

```
## Analysis of Variance Table
##
## Response: Price
##             Df    Sum Sq  Mean Sq F value    Pr(>F)
## Company     18 104013991  5778555  21.123 < 2.2e-16 ***
## TypeName     5 182262038 36452408 133.246 < 2.2e-16 ***
## Residuals 1279 349898932   273572
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
# type III effects A/B,C , B/A,C   C/A,B
drop1(lmC, test="F")
```

```
## Single term deletions
##
## Model:
## Price ~ Company + TypeName
##          Df Sum of Sq       RSS   AIC  F value    Pr(>F)
## <none>                349898932 16336
## Company  18  42619448 392518380 16450   8.6549 < 2.2e-16 ***
## TypeName  5 182262038 532160971 16873 133.2460 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
summary(lmC)
```

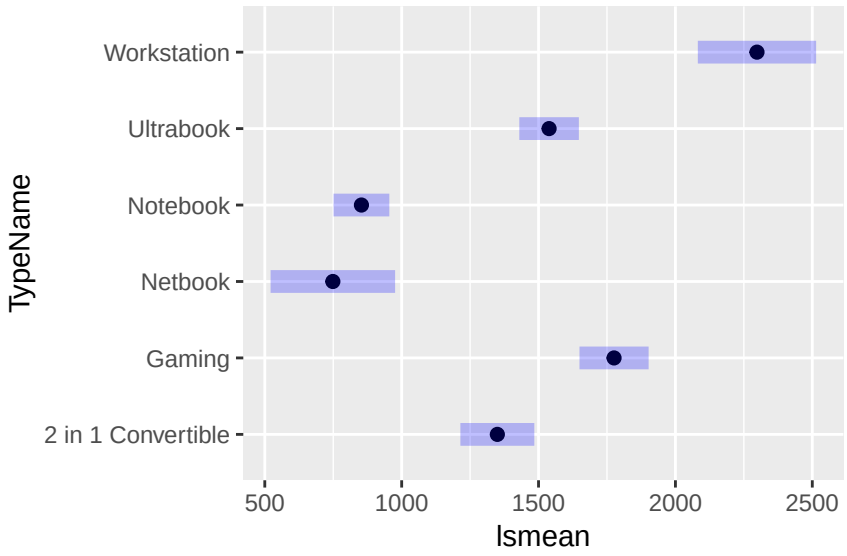
```
##
## Call:
## lm(formula = Price ~ Company + TypeName, data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2147.6  -343.2   -81.9   243.1  4081.9
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)           991.52      69.88  14.189  < 2e-16 ***
## CompanyApple          383.70     132.62   2.893  0.00388 **
## CompanyAsus           168.81      67.79   2.490  0.01290 *
## CompanyChuwi         -180.68     306.47  -0.590  0.55559
## CompanyDell           350.73      60.52   5.796 8.56e-09 ***
## CompanyFujitsu        234.02     306.47   0.764  0.44525
## CompanyGoogle         497.17     309.44   1.607  0.10837
## CompanyHP             337.48      60.85   5.546 3.55e-08 ***
## CompanyHuawei         243.50     375.96   0.648  0.51731
## CompanyLenovo         322.12      60.24   5.348 1.05e-07 ***
## CompanyLG             918.50     309.44   2.968  0.00305 **
## CompanyMediacom      -270.91     204.43  -1.325  0.18534
## CompanyMicrosoft      431.81     223.95   1.928  0.05406 .
```

```
## CompanyMSI             311.10      98.62   3.155  0.00165 **
## CompanyRazer          1996.14     207.24   9.632  < 2e-16 ***
## CompanySamsung         438.88     183.82   2.388  0.01710 *
## CompanyToshiba         601.45      92.12   6.529 9.52e-11 ***
## CompanyVero           -277.55     266.70  -1.041  0.29821
## CompanyXiaomi          295.72     267.40   1.106  0.26896
## TypeNameGaming         426.29      65.51   6.507 1.10e-10 ***
## TypeNameNetbook       -600.94     115.75  -5.192 2.42e-07 ***
## TypeNameNotebook      -496.54      51.98  -9.552  < 2e-16 ***
## TypeNameUltrabook      188.98      63.81   2.962  0.00312 **
## TypeNameWorkstation    948.46     109.22   8.684  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 523 on 1279 degrees of freedom
## Multiple R-squared:   0.45,  Adjusted R-squared:  0.4401
## F-statistic:  45.5 on 23 and 1279 DF,  p-value: < 2.2e-16
```

```
# contrasti
library(lsmeans)
ls=lsmeans(lmC, #FIXME: @Andrea, c'era lmB ma credo tu volessi scrivere lmC, in case check it
           pairwise ~ TypeName ,
           adjust="tukey")
ls$lsmeans
```

```
##  TypeName           lsmean    SE   df lower.CL upper.CL
##  2 in 1 Convertible   1350  68.9 1279     1214     1485
##  Gaming               1776  64.4 1279     1649     1902
##  Netbook               749 115.9 1279      521      976
##  Notebook              853  52.0 1279      751      955
##  Ultrabook            1538  55.5 1279     1430     1647
##  Workstation          2298 110.1 1279     2082     2514
##
## Results are averaged over the levels of: Company
## Confidence level used: 0.95
```

```
# plot lsmeans and 95% confid int
plot(ls$lsmeans, alpha = .05)
```




```
# contrasts between predicted lsmeans
ls$contrasts
```

```
##  contrast                          estimate    SE   df t.ratio p.value
##  2 in 1 Convertible - Gaming           -426  65.5 1279  -6.507 <.0001
##  2 in 1 Convertible - Netbook          601 115.7 1279   5.192 <.0001
##  2 in 1 Convertible - Notebook         497  52.0 1279   9.552 <.0001
##  2 in 1 Convertible - Ultrabook       -189  63.8 1279  -2.962 0.0367
##  2 in 1 Convertible - Workstation     -948 109.2 1279  -8.684 <.0001
##  Gaming - Netbook                    1027 114.5 1279   8.972 <.0001
##  Gaming - Notebook                    923  49.4 1279  18.671 <.0001
##  Gaming - Ultrabook                   237  61.1 1279   3.882 0.0015
##  Gaming - Workstation                -522 108.3 1279  -4.820 <.0001
##  Netbook - Notebook                  -104 107.0 1279  -0.975 0.9258
##  Netbook - Ultrabook                 -790 113.3 1279  -6.969 <.0001
##  Netbook - Workstation              -1549 143.8 1279 -10.774 <.0001
##  Notebook - Ultrabook                -686  46.5 1279 -14.754 <.0001
##  Notebook - Workstation             -1445  99.8 1279 -14.475 <.0001
##  Ultrabook - Workstation             -759 106.4 1279  -7.138 <.0001
##
## Results are averaged over the levels of: Company
## P value adjustment: tukey method for comparing a family of 6 estimates
```

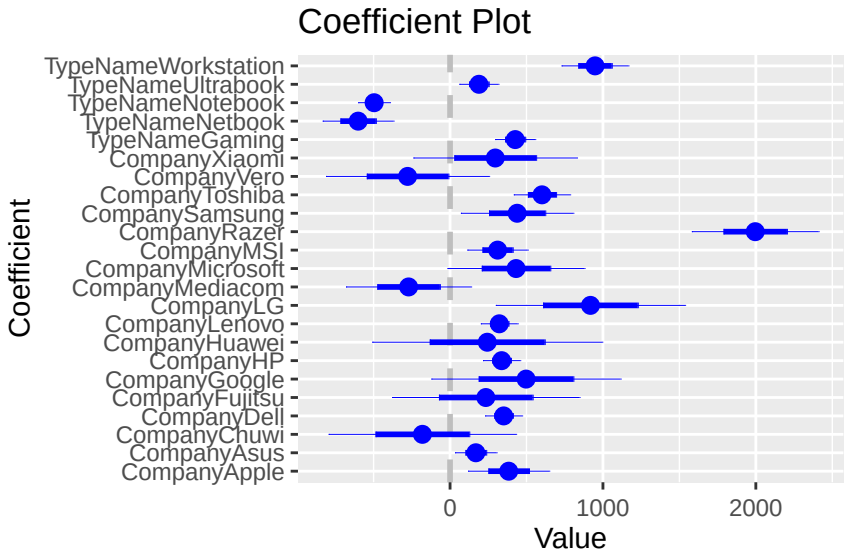
```
# if at least one contrast is significant, the variable
# is significant in the anova table # drop1 effects

# contrast among predicted lsmeans and overall lsmean
c= contrast(ls, method = "eff")
c
```

```
## $lsmeans
##  contrast                  estimate   SE   df t.ratio p.value
##  2 in 1 Convertible effect    -77.7 47.9 1279  -1.623 0.1048
##  Gaming effect                348.6 46.0 1279   7.583 <.0001
##  Netbook effect              -678.6 90.2 1279  -7.521 <.0001
##  Notebook effect             -574.2 31.8 1279 -18.032 <.0001
##  Ultrabook effect             111.3 43.8 1279   2.542 0.0134
##  Workstation effect           870.7 84.6 1279  10.287 <.0001
```

```
##
## Results are averaged over the levels of: Company
## P value adjustment: fdr method for 6 tests
##
## $contrasts
##  contrast                                estimate    SE   df t.ratio
##  2 in 1 Convertible - Gaming effect        -150.6  71.6 1279  -2.103
##  2 in 1 Convertible - Netbook effect        876.6 121.9 1279   7.192
##  2 in 1 Convertible - Notebook effect       772.2  51.2 1279  15.077
##  2 in 1 Convertible - Ultrabook effect       86.7  57.9 1279   1.498
##  2 in 1 Convertible - Workstation effect   -672.8  74.0 1279  -9.093
##  Gaming - Netbook effect                  1302.9 123.6 1279  10.544
##  Gaming - Notebook effect                 1198.5  55.4 1279  21.649
##  Gaming - Ultrabook effect                 513.0  60.9 1279   8.416
##  Gaming - Workstation effect              -246.5  77.4 1279  -3.186
##  Netbook - Notebook effect                 171.2 107.0 1279   1.600
##  Netbook - Ultrabook effect               -514.3 110.5 1279  -4.655
##  Netbook - Workstation effect            -1273.7 119.6 1279 -10.649
##  Notebook - Ultrabook effect              -409.9  55.3 1279  -7.416
##  Notebook - Workstation effect           -1169.3  71.6 1279 -16.325
##  Ultrabook - Workstation effect           -483.8  84.4 1279  -5.730
##  p.value
##  0.0411
##  <.0001
##  <.0001
##  0.1345
##  <.0001
##  <.0001
##  <.0001
##  <.0001
##  0.0018
##  0.1177
##  <.0001
##  <.0001
##  <.0001
##  <.0001
##  <.0001
##
## Results are averaged over the levels of: Company
## P value adjustment: fdr method for 15 tests
```

```
library(coefplot)
coefplot(lmC, intercept=FALSE) #FIXME: @Andrea, same goes here
```



ANOVA k way

```
lmK = lm(Price ~ Company+TypeName+SolidStateDisk  , data=data)
summary(lmK)
```

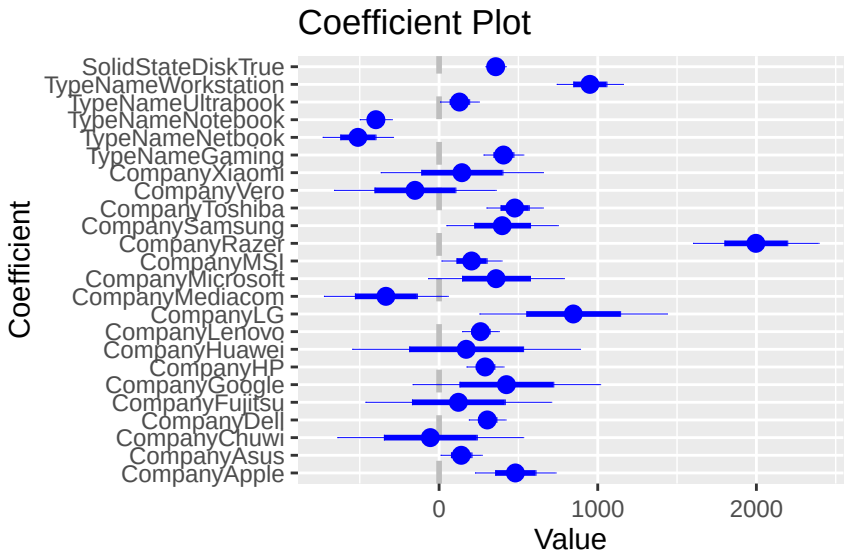
```
##
## Call:
## lm(formula = Price ~ Company + TypeName + SolidStateDisk, data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2220.9  -304.8   -66.1   212.1  4268.4
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)           767.82      69.59  11.034  < 2e-16 ***
## CompanyApple          480.95     126.85   3.792 0.000157 ***
## CompanyAsus           139.64      64.74   2.157 0.031210 *
## CompanyChuwi          -55.11     292.67  -0.188 0.850666
## CompanyDell           303.66      57.90   5.244 1.83e-07 ***
## CompanyFujitsu        121.68     292.63   0.416 0.677611
## CompanyGoogle         424.48     295.36   1.437 0.150913
## CompanyHP             290.08      58.22   4.982 7.14e-07 ***
## CompanyHuawei         170.81     358.83   0.476 0.634132
## CompanyLenovo         261.18      57.74   4.524 6.64e-06 ***
## CompanyLG             845.81     295.36   2.864 0.004256 **
## CompanyMediacom      -335.25     195.17  -1.718 0.086087 .
## CompanyMicrosoft      359.12     213.81   1.680 0.093275 .
## CompanyMSI            204.88      94.58   2.166 0.030485 *
## CompanyRazer         1996.74     197.77  10.096  < 2e-16 ***
## CompanySamsung        397.79     175.45   2.267 0.023539 *
## CompanyToshiba        476.72      88.60   5.380 8.83e-08 ***
## CompanyVero          -151.98     254.75  -0.597 0.550877
## CompanyXiaomi         143.73     255.53   0.562 0.573878
## TypeNameGaming        405.95      62.54   6.491 1.22e-10 ***
## TypeNameNetbook      -511.64     110.74  -4.620 4.22e-06 ***
## TypeNameNotebook     -398.41      50.36  -7.910 5.52e-15 ***
```

```
## TypeNameUltrabook     128.51      61.13   2.102 0.035727 *
## TypeNameWorkstation   950.57     104.22   9.120  < 2e-16 ***
## SolidStateDiskTrue    356.87      31.73  11.248  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 499.1 on 1278 degrees of freedom
## Multiple R-squared:  0.4995, Adjusted R-squared:  0.4901
## F-statistic: 53.15 on 24 and 1278 DF,  p-value: < 2.2e-16
```

```
drop1(lmK, test="F") # type III SS
```

```
## Single term deletions
##
## Model:
## Price ~ Company + TypeName + SolidStateDisk
##                Df Sum of Sq       RSS   AIC  F value    Pr(>F)
## <none>                      318382025 16216
## Company        18  38122976 356505001 16327   8.5015 < 2.2e-16 ***
## TypeName        5 124171618 442553644 16634  99.6861 < 2.2e-16 ***
## SolidStateDisk  1  31516907 349898932 16336 126.5103 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
coefplot(lmK, intercept=FALSE)
```



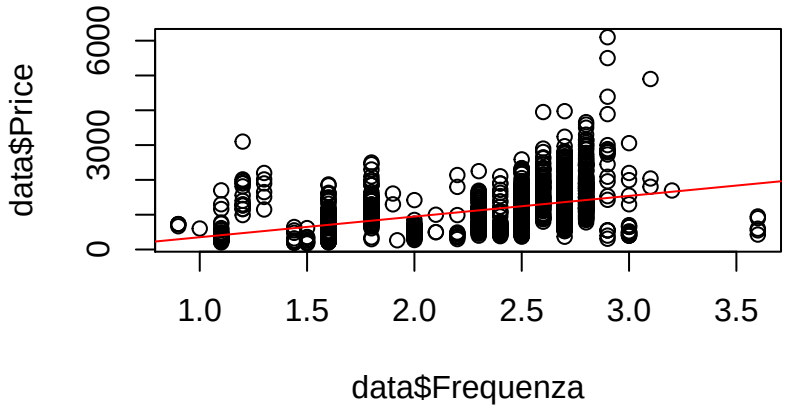
Regressione lineare

```
lmA<-lm(Price ~ Frequenza  , data=data)
summary(lmA)
```

```
##
## Call:
## lm(formula = Price ~ Frequenza, data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1467.6  -453.8  -119.6   327.6  4618.2
```

```
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -241.84      81.32  -2.974    0.003 **
## Frequenza     594.02      34.55  17.194   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 631.2 on 1301 degrees of freedom
## Multiple R-squared:  0.1852, Adjusted R-squared:  0.1845
## F-statistic: 295.6 on 1 and 1301 DF,  p-value: < 2.2e-16
```

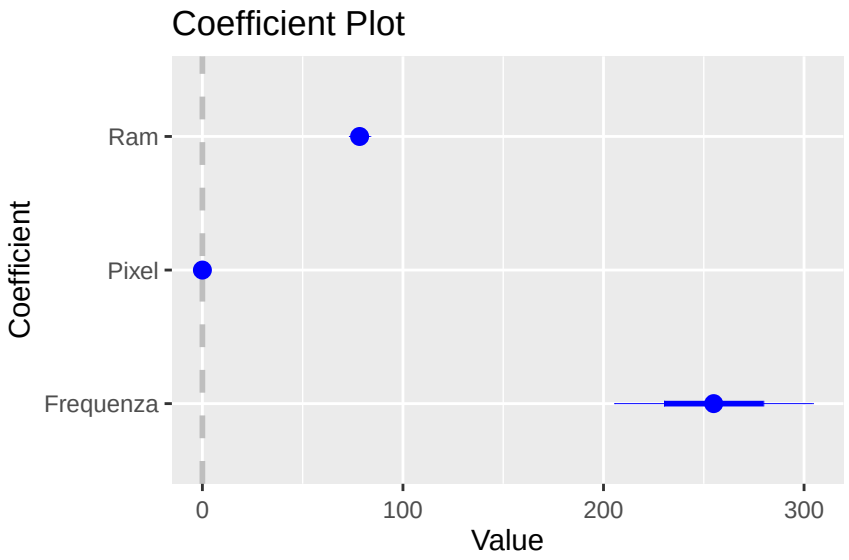
```
plot(data$Frequenza,data$Price)
abline(lmA,col="red")
```




```
lmA<-lm(Price ~ Frequenza+Pixel+Ram  , data=data)
summary(lmA)
```

```
##
## Call:
## lm(formula = Price ~ Frequenza + Pixel + Ram, data = data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1785.72  -257.23   -66.06   191.11  2791.53
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept) -4.076e+02  5.547e+01  -7.349 3.52e-13 ***
## Frequenza    2.549e+02  2.474e+01  10.306  < 2e-16 ***
## Pixel        1.329e-04  9.117e-06  14.575  < 2e-16 ***
## Ram          7.839e+01  2.658e+00  29.488  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 420.2 on 1299 degrees of freedom
## Multiple R-squared:  0.6395, Adjusted R-squared:  0.6386
## F-statistic:   768 on 3 and 1299 DF,  p-value: < 2.2e-16
```

```r
coefplot(lmA, intercept=FALSE)
```



Ancova Y = all covariates (qualitative +quantitative)

```r
lmK = lm(Price ~ Company+TypeName+SolidStateDisk+ Frequenza+Pixel+Ram  , data=data)
summary(lmK)
```

```
##
## Call:
## lm(formula = Price ~ Company + TypeName + SolidStateDisk + Frequenza +
##     Pixel + Ram, data = data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1881.48  -214.66   -31.28   165.08  1905.88
##
## Coefficients:
##                       Estimate Std. Error t value Pr(>|t|)
## (Intercept)         -1.544e+02  6.752e+01  -2.286  0.02240 *
## CompanyApple         2.629e+02  9.105e+01   2.888  0.00394 **
## CompanyAsus          5.442e+01  4.625e+01   1.177  0.23950
## CompanyChuwi        -9.371e+01  2.098e+02  -0.447  0.65521
## CompanyDell          1.134e+02  4.166e+01   2.721  0.00660 **
## CompanyFujitsu       6.262e+01  2.087e+02   0.300  0.76421
## CompanyGoogle        3.043e+02  2.122e+02   1.434  0.15186
## CompanyHP            2.073e+02  4.167e+01   4.975 7.41e-07 ***
## CompanyHuawei        5.645e+01  2.559e+02   0.221  0.82547
## CompanyLenovo        1.301e+02  4.141e+01   3.141  0.00172 **
## CompanyLG            6.774e+02  2.107e+02   3.216  0.00133 **
## CompanyMediacom     -9.928e+01  1.403e+02  -0.708  0.47932
## CompanyMicrosoft     2.374e+02  1.527e+02   1.554  0.12034
## CompanyMSI           2.116e+02  6.742e+01   3.139  0.00173 **
## CompanyRazer         1.105e+03  1.441e+02   7.673 3.32e-14 ***
## CompanySamsung       8.825e+01  1.256e+02   0.703  0.48241
```

```
## CompanyToshiba       2.941e+02  6.359e+01   4.625 4.12e-06 ***
## CompanyVero          5.760e+00  1.825e+02   0.032  0.97483
## CompanyXiaomi       -8.005e+00  1.823e+02  -0.044  0.96498
## TypeNameGaming      -3.957e+01  4.846e+01  -0.816  0.41443
## TypeNameNetbook     -1.126e+02  8.012e+01  -1.406  0.16010
## TypeNameNotebook    -2.507e+02  3.672e+01  -6.828 1.33e-11 ***
## TypeNameUltrabook    9.767e+01  4.373e+01   2.233  0.02570 *
## TypeNameWorkstation  7.122e+02  7.560e+01   9.420  < 2e-16 ***
## SolidStateDiskTrue   1.589e+02  2.341e+01   6.790 1.71e-11 ***
## Frequenza            1.742e+02  2.339e+01   7.448 1.74e-13 ***
## Pixel                8.775e-05  8.303e-06  10.568  < 2e-16 ***
## Ram                  6.744e+01  2.568e+00  26.266  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 355.7 on 1275 degrees of freedom
## Multiple R-squared:  0.7464, Adjusted R-squared:  0.741
## F-statistic:   139 on 27 and 1275 DF,  p-value: < 2.2e-16
```

```
drop1(lmK, .~., test="F")
```

```
## Single term deletions
##
## Model:
## Price ~ Company + TypeName + SolidStateDisk + Frequenza + Pixel +
##     Ram
##                Df Sum of Sq       RSS   AIC  F value    Pr(>F)
## <none>                      161324026 15336
## Company        18  13792368 175116394 15406   6.0559 2.398e-14 ***
## TypeName        5  35840561 197164587 15587  56.6521 < 2.2e-16 ***
## SolidStateDisk  1   5833506 167157532 15380  46.1042 1.714e-11 ***
## Frequenza       1   7019435 168343461 15389  55.4770 1.736e-13 ***
## Pixel           1  14131083 175455109 15443 111.6829 < 2.2e-16 ***
## Ram             1  87292336 248616362 15897 689.9018 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
ls=lsmeans(lmK,
           pairwise ~ Company ,
           adjust="tukey")
c= contrast(ls, method = "eff")
#c #FIXME: too long to be printed
```

```
data$LogPrice=NULL
data$Product=NULL
data$X=NULL
str(data)
```

```
## 'data.frame':    1303 obs. of  20 variables:
##  $ Company           : Factor w/ 19 levels "Acer","Apple",..: 2 2 8 2 2 1 2 2 3 1 ...
##  $ TypeName          : Factor w/ 6 levels "2 in 1 Convertible",..: 5 5 4 5 5 4 5 5 5 5 ...
##  $ Inches            : num  13.3 13.3 15.6 15.4 13.3 15.6 15.4 13.3 14 14 ...
##  $ ScreenResolution  : Factor w/ 40 levels "1366x768","1440x900",..: 24 2 9 26 24 1 26 2 9 16 ...
##  $ Cpu               : Factor w/ 118 levels "AMD A10-Series 9600P 2.4GHz",..: 55 53 64 75 57 15 74 53
##  $ Ram               : num  8 8 8 16 8 4 16 8 16 8 ...
##  $ Memory            : Factor w/ 38 levels "1024GB HDD","1024GB HDD +  1024GB HDD",..: 8 6 17 29 17 1
```

```
##  $ Gpu               : Factor w/ 110 levels "AMD FirePro W4190M",..: 59 52 54 10 60 18 61 52 98 62 .
##  $ OpSys             : Factor w/ 9 levels "Android","Chrome OS",..: 5 5 6 5 5 7 4 5 7 7 ...
##  $ Weight            : num  1.37 1.34 1.86 1.83 1.37 2.1 2.04 1.34 1.3 1.6 ...
##  $ Price             : num  1340 899 575 2537 1804 ...
##  $ Frequenza         : num  2.3 1.8 2.5 2.7 3.1 3 2.2 1.8 1.8 1.6 ...
##  $ Risoluzione       : Factor w/ 15 levels "1366x768","1440x900",..: 11 2 4 13 11 1 13 2 4 4 ...
##  $ Pixel             : int  4096000 1296000 2073600 5184000 4096000 1049088 5184000 1296000 2073600 1
##  $ GpuCompany        : Factor w/ 4 levels "AMD","ARM","Intel",..: 3 3 3 1 3 1 3 3 4 3 ...
##  $ MemoriaSSD        : int  128 0 256 512 256 0 0 0 512 256 ...
##  $ SolidStateDisk    : Factor w/ 2 levels "False","True": 2 1 2 2 2 1 1 1 2 2 ...
##  $ TotalMemory       : int  128 128 256 512 256 500 256 256 512 256 ...
##  $ dedicated_GPU     : Factor w/ 2 levels "False","True": 1 1 1 2 1 2 1 1 2 1 ...
##  $ Aggregated_Company: Factor w/ 10 levels "Acer","Apple",..: 2 2 5 2 2 1 2 2 3 1 ...
```

```
lm_full = lm(Price ~ ., data = data)
#summary(lm_full) #FIXME: wayyy too long to be printed, R^2 =0.9586
anova(lm_full, test="F")
```

```
## Analysis of Variance Table
##
## Response: Price
##                    Df    Sum Sq  Mean Sq  F value    Pr(>F)
## Company            18 104013991  5778555 114.6831 < 2.2e-16 ***
## TypeName            5 182262038 36452408 723.4463 < 2.2e-16 ***
## Inches              1   6163570  6163570 122.3242 < 2.2e-16 ***
## ScreenResolution   36 108074619  3002073  59.5801 < 2.2e-16 ***
## Cpu               110  95329933   866636  17.1995 < 2.2e-16 ***
## Ram                 1  34947028 34947028 693.5700 < 2.2e-16 ***
## Memory             34  17103911   503056   9.9838 < 2.2e-16 ***
## Gpu                88  34266807   389396   7.7281 < 2.2e-16 ***
## OpSys               6   3524179   587363  11.6570 1.186e-12 ***
## Weight              1       944      944   0.0187    0.8911
## Residuals        1002  50487942    50387
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

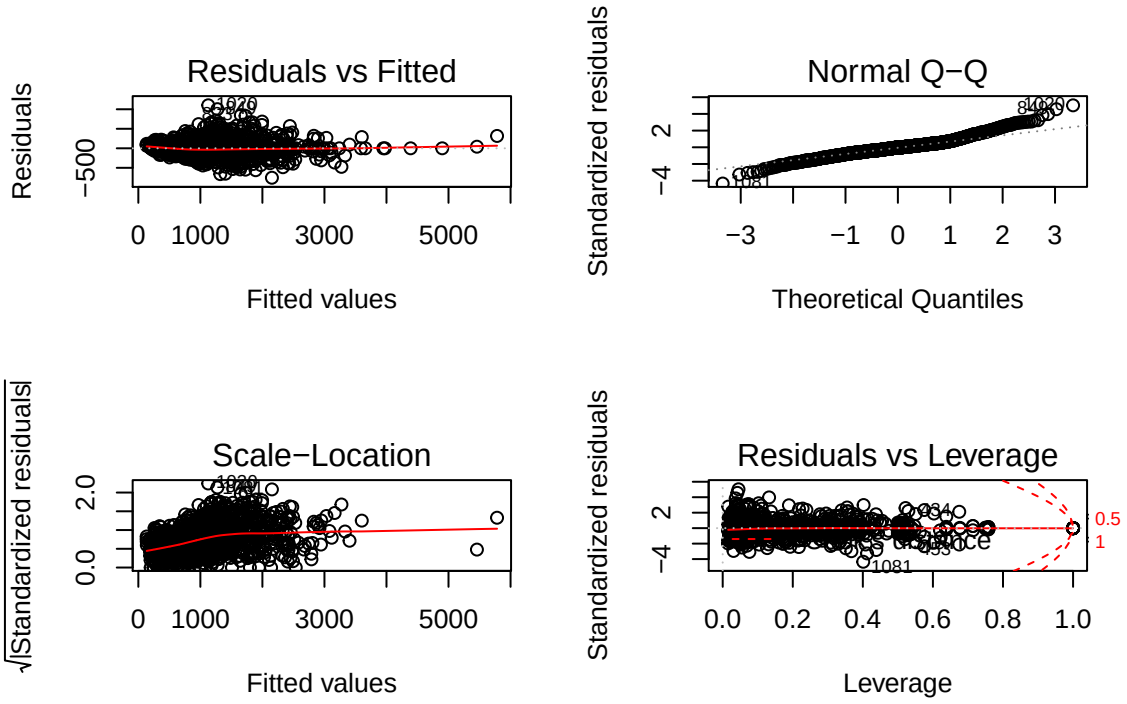
```
drop1(lm_full, test="F")
```

```
## Single term deletions
##
## Model:
## Price ~ Company + TypeName + Inches + ScreenResolution + Cpu +
##     Ram + Memory + Gpu + OpSys + Weight + Frequenza + Risoluzione +
##     Pixel + GpuCompany + MemoriaSSD + SolidStateDisk + TotalMemory +
##     dedicated_GPU + Aggregated_Company
##                    Df Sum of Sq      RSS   AIC F value    Pr(>F)
## <none>                           50487942 14368
## Company             6    648147 51136089 14373  2.1439   0.04621 *
## TypeName            5   3680356 54168297 14450 14.6083 7.662e-14 ***
## Inches              1    210771 50698713 14371  4.1830   0.04109 *
## ScreenResolution   23   5329402 55817344 14453  4.5987 7.463e-12 ***
## Cpu                88  16403980 66891922 14559  3.6995 < 2.2e-16 ***
## Ram                 1   4479889 54967831 14477 88.9093 < 2.2e-16 ***
## Memory             31  10454540 60942481 14551  6.6930 < 2.2e-16 ***
## Gpu                86  29370368 79858310 14793  6.7778 < 2.2e-16 ***
```

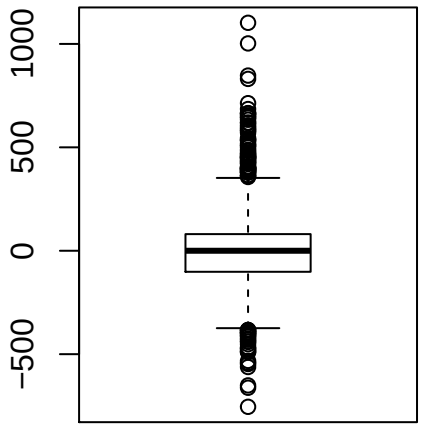
```
## OpSys                6   3516651 54004593 14444 11.6321 1.267e-12 ***
## Weight               1       944 50488886 14366  0.0187   0.89114
## Frequenza            0         0 50487942 14368
## Risoluzione          0         0 50487942 14368
## Pixel                0         0 50487942 14368
## GpuCompany           0         0 50487942 14368
## MemoriaSSD           0         0 50487942 14368
## SolidStateDisk       0         0 50487942 14368
## TotalMemory          0         0 50487942 14368
## dedicated_GPU        0         0 50487942 14368
## Aggregated_Company   0         0 50487942 14368
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

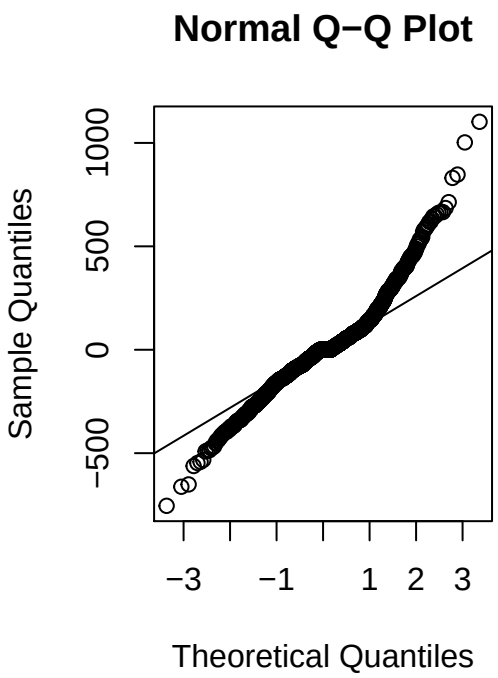
```
#coefplot(lm_full, intercept=FALSE) #meglio di no ahah

par(mfrow=c(2,2))
plot(lm_full)
```




```
par(mfrow=c(1,1))
par(mfrow=c(1,2))
boxplot(lm_full$residuals)
qqnorm(lm_full$residuals);qqline(lm_full$residuals) # probably the correction would work pretty fine he
```





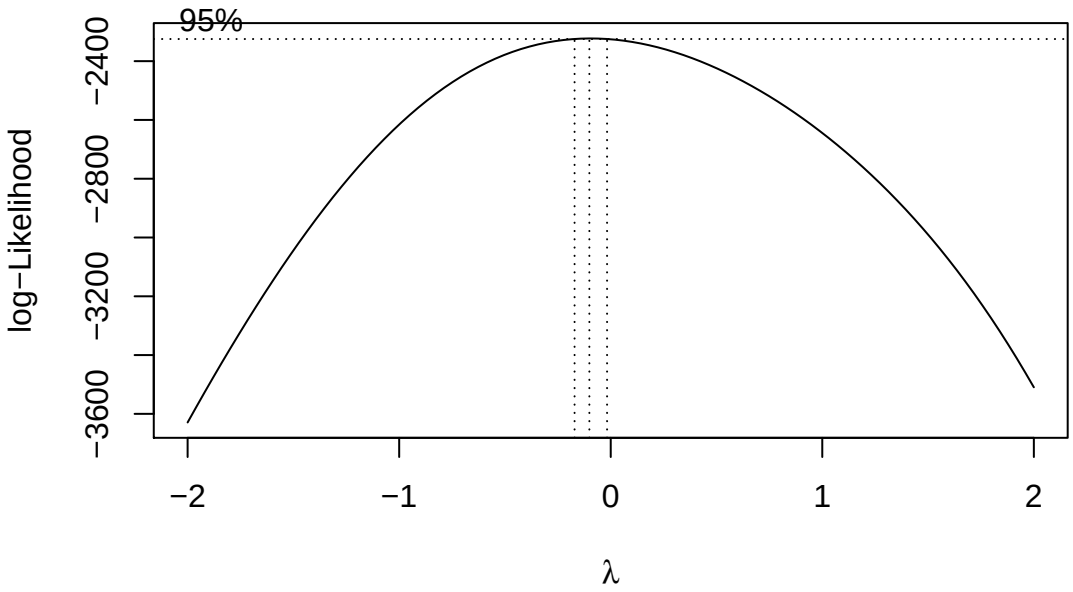

```
#tests
ad.test(lm_full$residuals)
```

```
##
##  Anderson-Darling normality test
##
## data:  lm_full$residuals
## A = 19.734, p-value < 2.2e-16
```

```
shapiro.test(lm_full$residuals)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  lm_full$residuals
## W = 0.94932, p-value < 2.2e-16
```

```
library(MASS)
#to justify log correction
boxcoxreg1<-boxcox(lm_full, plotit=T)
```




```
which.max(boxcoxreg1$y)
```

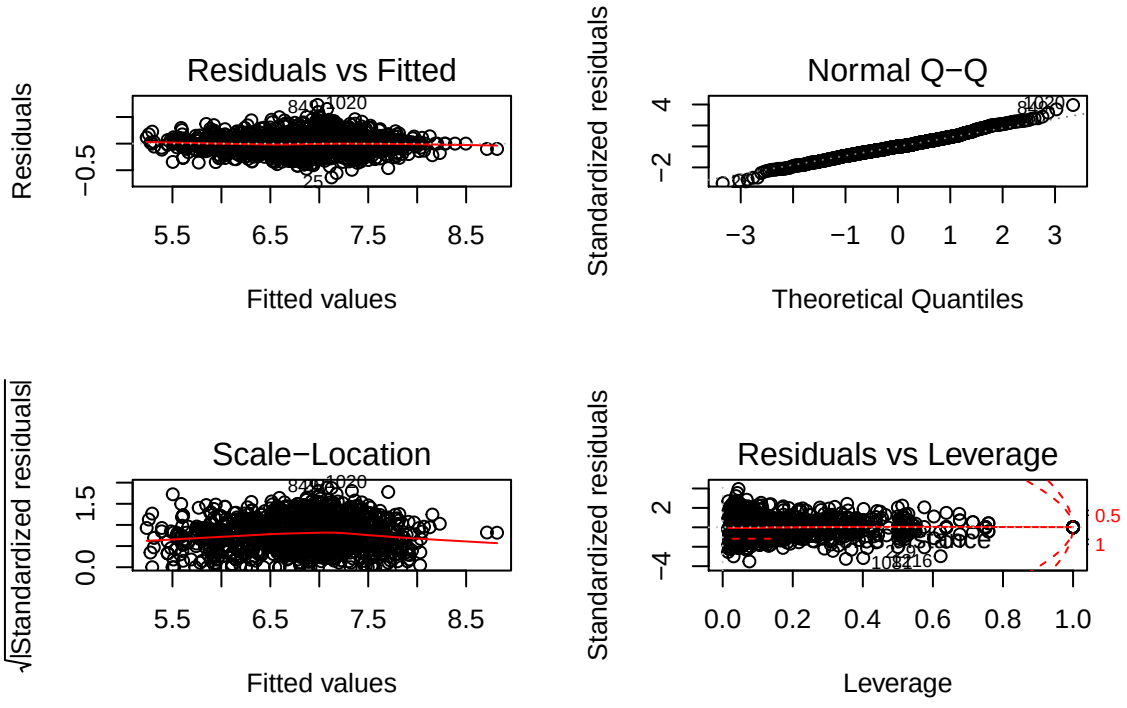
```
## [1] 48
```

```
lambda=boxcoxreg1$x[which.max(boxcoxreg1$y)]
lambda #FIXME: not really 0, one should actually apply (((y  )^lambda) - 1) / lambda but meh
```

```
## [1] -0.1010101
```

```
lm_full_t = lm(log(Price) ~ ., data = data)

par(mfrow=c(2,2))
plot(lm_full_t) #quite better
```



```
ad.test(lm_full_t$residuals) #not really
```

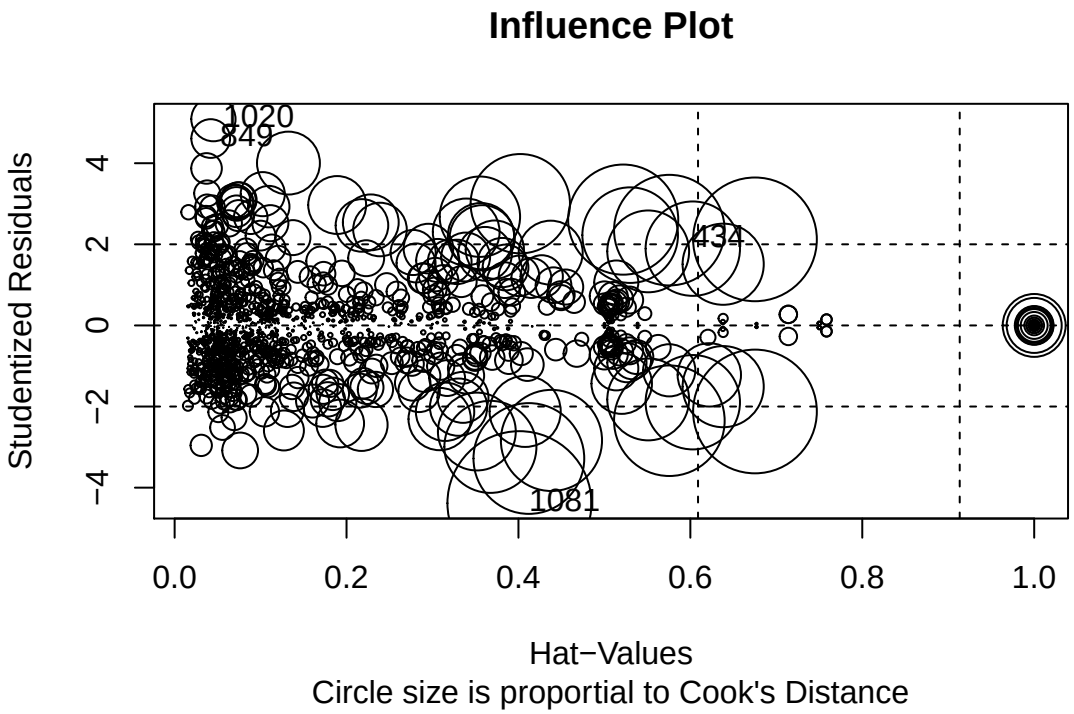
```
##
##  Anderson-Darling normality test
##
## data:  lm_full_t$residuals
## A = 7.3367, p-value < 2.2e-16
```

```
shapiro.test(lm_full_t$residuals)  #not really
```

```
##
##  Shapiro-Wilk normality test
##
## data:  lm_full_t$residuals
## W = 0.98508, p-value = 2.573e-10
```

A look over outliers

```
library(car)
influencePlot(lm_full,main="Influence Plot", sub="Circle size is proportial to Cook's Distance" )
```

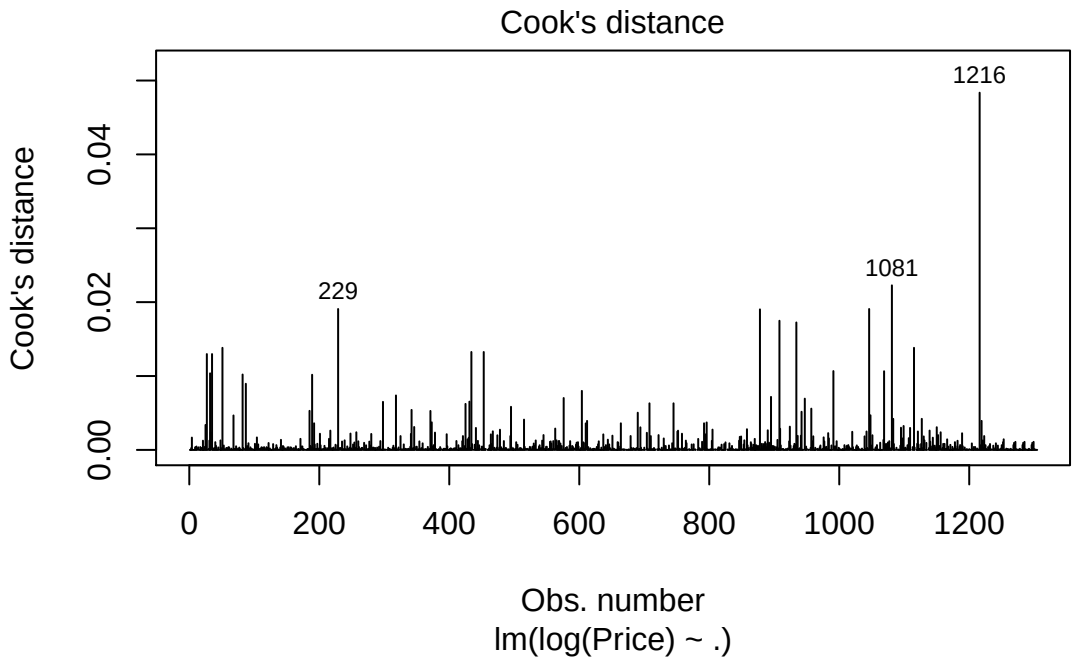



```
##        StudRes        Hat       CookD
## 13         NaN 1.00000000         NaN
## 15         NaN 1.00000000         NaN
## 434   2.121962 0.67517279 0.030985293
## 849   4.608379 0.04197115 0.003029829
## 1020  5.086222 0.04512122 0.003962863
## 1081 -4.382893 0.40114339 0.041986565
```

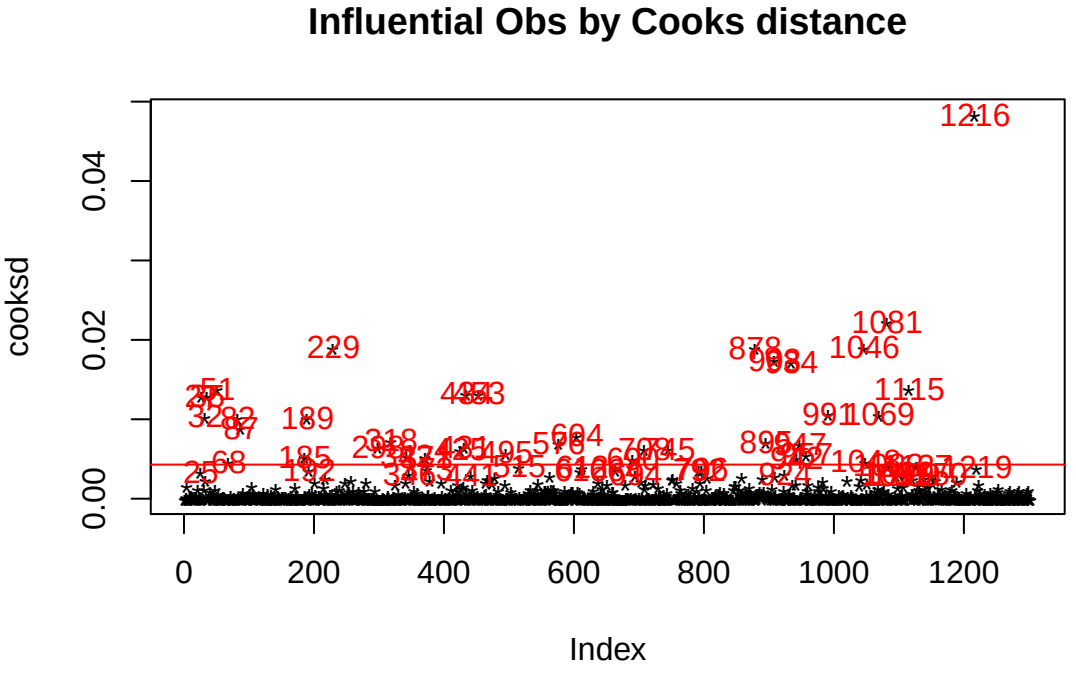
```
#Cook's Distance
cooksd <- cooks.distance(lm_full_t)
cooksda=data.frame(cooksd)
summary(cooksd)
```

```
##     Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
## 0.00000 0.00003 0.00013 0.00073 0.00053 0.04835      91
```

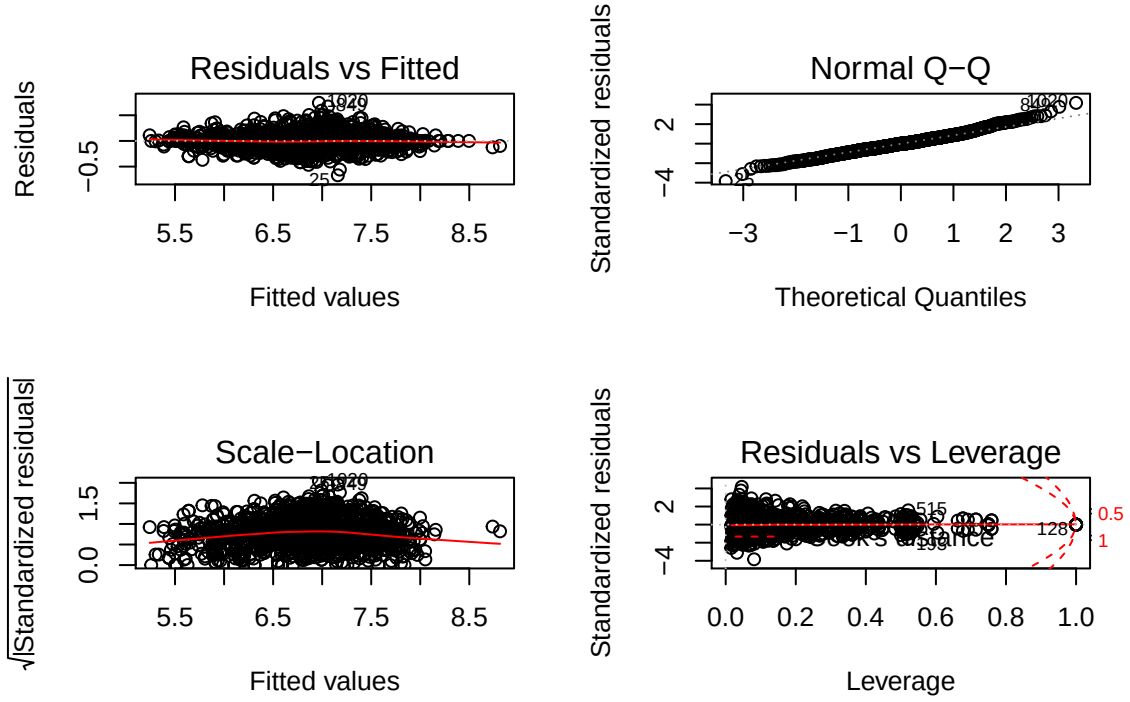
```
# identify D values > 4/(n-k-1)
# Cook's D plot
cutoff <- 4/((nrow(data)-length(lm_full_t$coefficients)-2))
plot(lm_full_t, which=4, cook.levels=cutoff)
```




```
plot(cooksd, pch="*", cex=1, main="Influential Obs by Cooks distance") # plot cook's distance
abline(h = cutoff, col="red") # add cutoff line
text(x=1:length(cooksd)+1, y=cooksd, labels=ifelse(cooksd>4*mean(cooksd, na.rm=T),names(cooksd),""),
col="red")#add labels
```



```
#extract influencial obs
influential <- as.numeric(names(cooksd)[(cooksd > cutoff)]) # influential row numbers
influ=data.frame(data[cooksd > cutoff, ])
filtered_data <- data[ !(row.names(data) %in% c(influential)), ]
#Outlier rimossi
lm_full_t_no_OUTliers = lm(log(Price) ~ ., data = filtered_data)
par(mfrow=c(2,2))
plot(lm_full_t_no_OUTliers)
```




```
#summary(lm_full_t_no_OUTliers) #FIXME: too long to be printed, R^2=0.9727
ncvTest(lm_full_t_no_OUTliers)
```

```
## Non-constant Variance Score Test
## Variance formula: ~ fitted.values
## Chisquare = 1.672606, Df = 1, p = 0.19591
```

```
null = lm(log(Price) ~ 1, data = filtered_data)
full = lm(log(Price) ~ ., data = filtered_data)
lm_fit = stepAIC(null, scope = list(upper = full), direction = "both", trace = FALSE)
drop1(lm_fit, test = 'F')
```

```
## Single term deletions
##
## Model:
## log(Price) ~ Cpu + Memory + OpSys + Gpu + TypeName + ScreenResolution +
##     Company + Ram + Inches
##                  Df Sum of Sq    RSS     AIC F value    Pr(>F)
## <none>                        32.192 -4060.0
## Cpu              84   15.4886 47.680 -3731.1  5.5731 < 2.2e-16 ***
## Memory           33    9.9446 42.136 -3785.4  9.1083 < 2.2e-16 ***
## OpSys             5    5.9088 38.101 -3856.8 35.7188 < 2.2e-16 ***
## Gpu              86   10.7637 42.956 -3867.1  3.7830 < 2.2e-16 ***
```

```
## TypeName          4    2.1581 34.350 -3985.9 16.3072 6.159e-13 ***
## ScreenResolution 29    4.7135 36.905 -3945.1  4.9126 1.419e-15 ***
## Company          14    3.1033 35.295 -3971.5  6.6999 3.640e-13 ***
## Ram               1    1.5490 33.741 -4002.5 46.8194 1.375e-11 ***
## Inches            1    1.0441 33.236 -4021.6 31.5567 2.528e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```