171023 Statistical Learning

Mattia G.

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R commands notes 3

```r
#### data cars

library(MASS)
data("Cars93")
attach(Cars93)

Rear.seat.room.cm <- Rear.seat.room * 2.54

#### mean

mean(Rear.seat.room.cm)
```

```
## [1] NA
```

```r
mean(Rear.seat.room.cm, na.rm=TRUE)
```

```
## [1] 70.68736
```

```r
#### removing NA's

# using the function is.na()
is.na(Rear.seat.room.cm)
```

```
##  [1] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [13] FALSE FALSE FALSE FALSE FALSE FALSE  TRUE FALSE FALSE FALSE FALSE FALSE
## [25] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [37] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [49] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE  TRUE FALSE FALSE FALSE
## [61] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [73] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
## [85] FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
```

```r
Rear.seat.room.cm[!is.na(Rear.seat.room.cm)]
```

```
##  [1] 67.31 76.20 71.12 78.74 68.58 71.12 77.47 77.47 67.31 88.90 78.74 63.50
## [13] 66.04 63.50 72.39 77.47 85.09 74.93 78.74 77.47 91.44 67.31 67.31 77.47
## [25] 67.31 77.47 50.80 67.31 76.20 66.04 71.12 69.85 60.96 58.42 76.20 69.85
## [37] 76.20 69.85 62.23 59.69 71.12 71.12 66.04 71.12 59.69 78.74 73.66 69.85
## [49] 63.50 76.20 80.01 68.58 67.31 74.93 69.85 66.04 68.58 48.26 71.12 66.04
## [61] 69.85 66.04 72.39 68.58 72.39 71.12 71.12 77.47 80.01 62.23 64.77 63.50
## [73] 63.50 72.39 77.47 67.31 67.31 59.69 69.85 68.58 69.85 60.96 58.42 72.39
## [85] 88.90 66.04 86.36 80.01 66.04 74.93 76.20
```

```
# using the function na.omit()

na.omit(Rear.seat.room.cm)
```

```
##   [1] 67.31 76.20 71.12 78.74 68.58 71.12 77.47 77.47 67.31 88.90 78.74 63.50
## [13] 66.04 63.50 72.39 77.47 85.09 74.93 78.74 77.47 91.44 67.31 67.31 77.47
## [25] 67.31 77.47 50.80 67.31 76.20 66.04 71.12 69.85 60.96 58.42 76.20 69.85
## [37] 76.20 69.85 62.23 59.69 71.12 71.12 66.04 71.12 59.69 78.74 73.66 69.85
## [49] 63.50 76.20 80.01 68.58 67.31 74.93 69.85 66.04 68.58 48.26 71.12 66.04
## [61] 69.85 66.04 72.39 68.58 72.39 71.12 71.12 77.47 80.01 62.23 64.77 63.50
## [73] 63.50 72.39 77.47 67.31 67.31 59.69 69.85 68.58 69.85 60.96 58.42 72.39
## [85] 88.90 66.04 86.36 80.01 66.04 74.93 76.20
## attr(,"na.action")
## [1] 19 57
## attr(,"class")
## [1] "omit"
```

```
Rear.seat.room.cm <- na.omit(Rear.seat.room.cm)
```
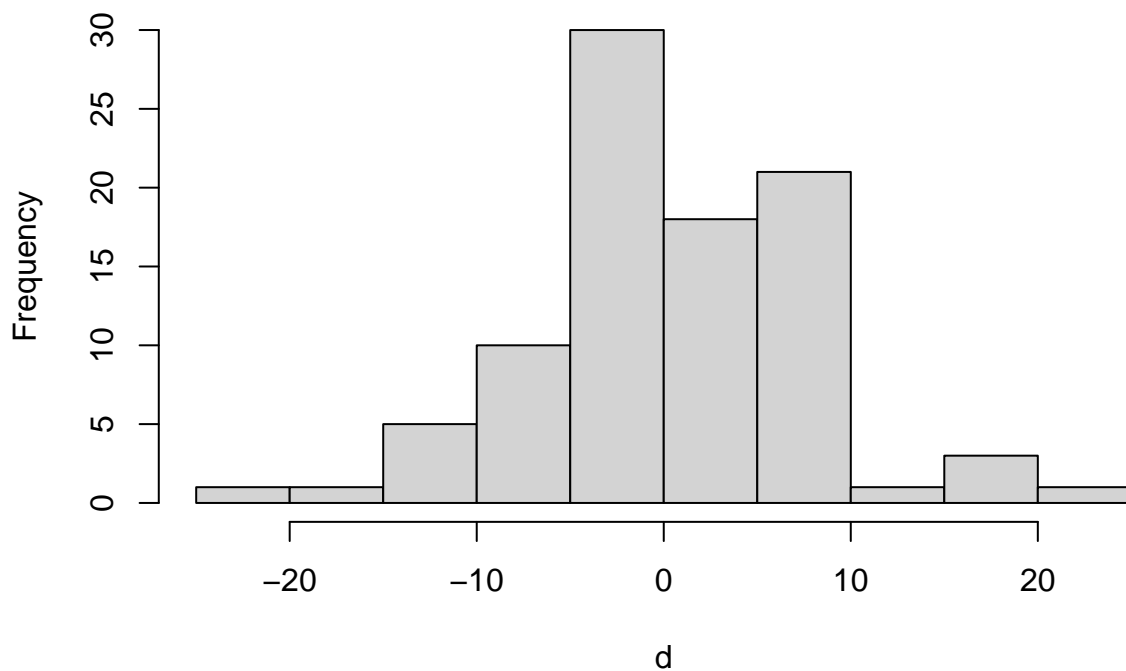
```
#### deviations from the mean

bar.x <- mean(Rear.seat.room.cm)
d <- Rear.seat.room.cm - bar.x

# check that deviations from the mean are centered about zero
hist(d)
```


Histogram of d

```
sum(d)
```

```
## [1] -9.237056e-14
```

```r
# median

median(Rear.seat.room.cm)
```

```
## [1] 69.85
```

```r
sort(Rear.seat.room.cm)[46]
```

```
## [1] 69.85
```

```r
# variance and standard deviation

x <- Rear.seat.room.cm
s2 <- sum((x-mean(x))^2)/(length(x)-1)
var(x)
```

```
## [1] 57.64217
```

```r
sd(x)
```

```
## [1] 7.592244
```

```r
sqrt(s2)
```

```
## [1] 7.592244
```

```r
# quantiles

quantile(Rear.seat.room.cm, 0.3)
```

```
##   30%
## 67.31
```

```r
quantile(Rear.seat.room.cm, c(0.3, 0.6))
```

```
##   30%   60%
## 67.31 71.12
```

```r
quantile(Rear.seat.room.cm)
```

```
##    0%   25%   50%   75%  100%
## 48.26 66.04 69.85 76.20 91.44
```

```r
# five number summary

IQR(Rear.seat.room.cm)
```

```
## [1] 10.16
```

```r
summary(Rear.seat.room.cm)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   48.26   66.04   69.85   70.69   76.20   91.44
```

```r
####################################
#
# Scatterplots and boxplots
#
####################################

### EDA
```

```
boxplot(Rear.seat.room.cm)
```



```
boxplot(Min.Price)
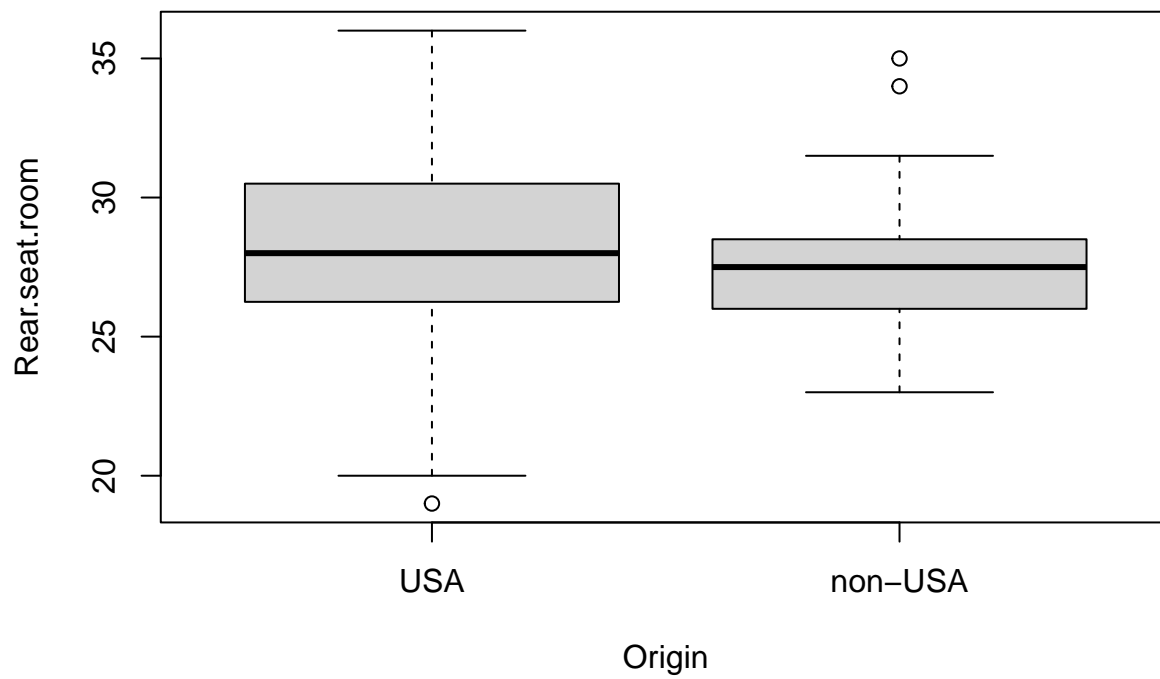```
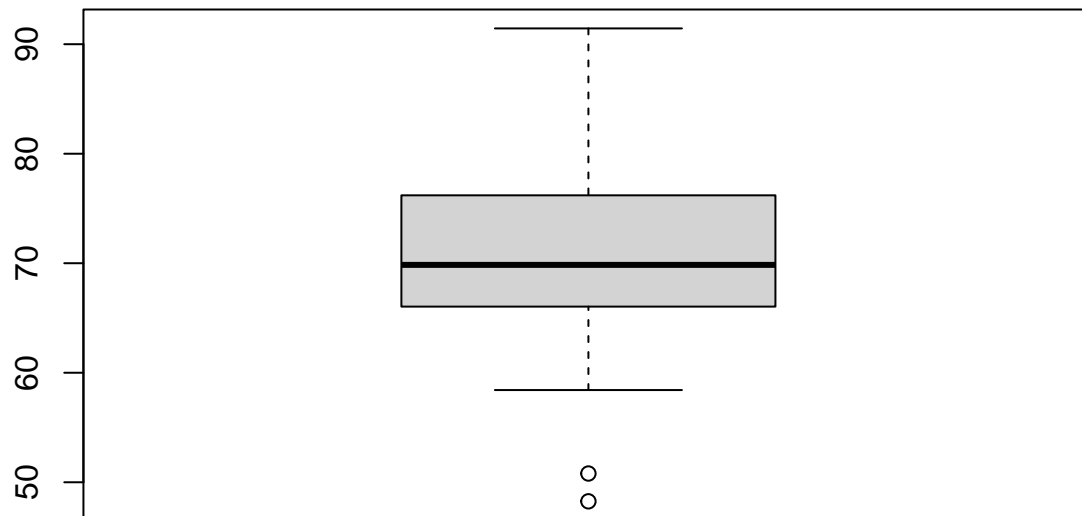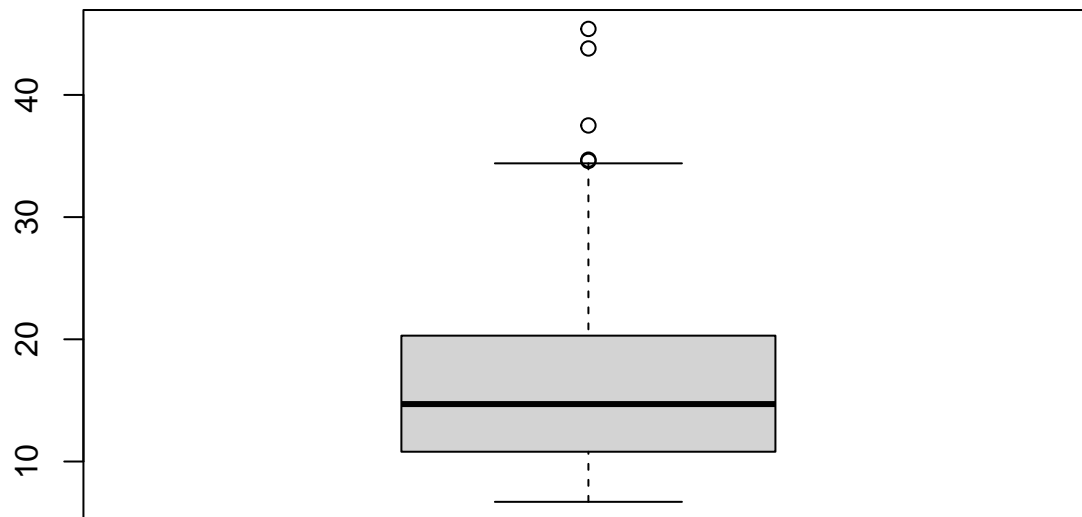
```
Rear.seat.USA <- Rear.seat.room.cm[Origin=="USA"]
Rear.seat.non.USA <- Rear.seat.room.cm[Origin=="non-USA"]

boxplot(Rear.seat.USA, Rear.seat.non.USA)
```
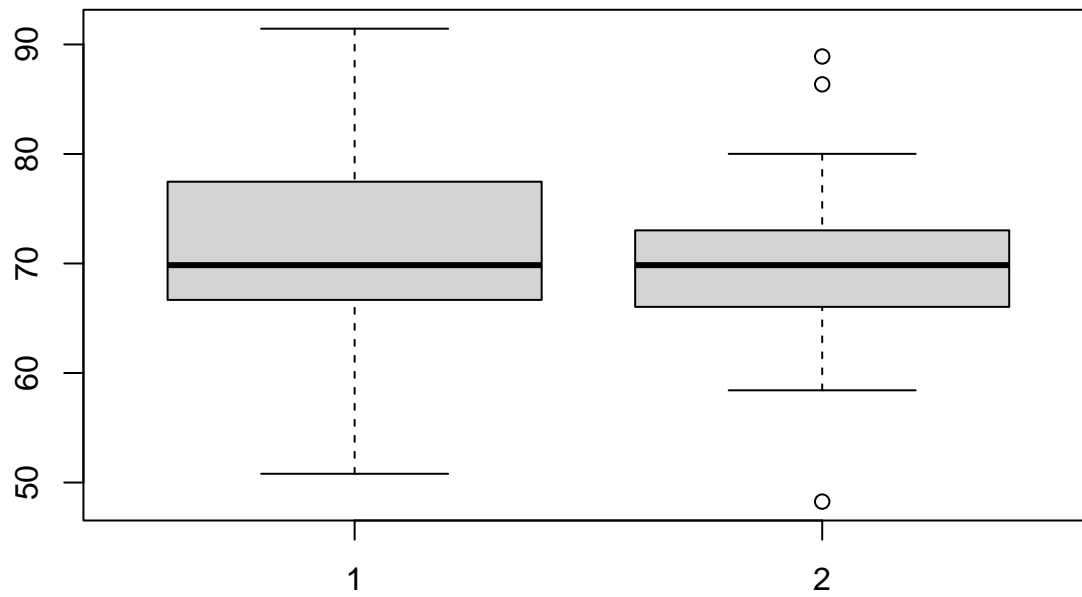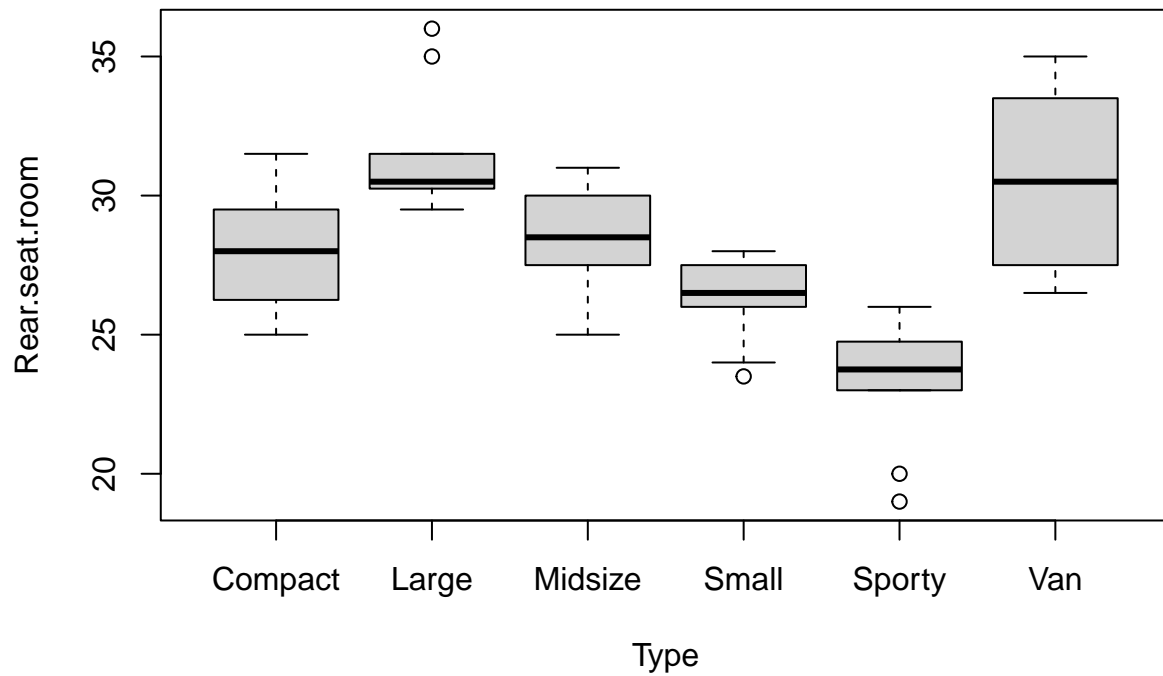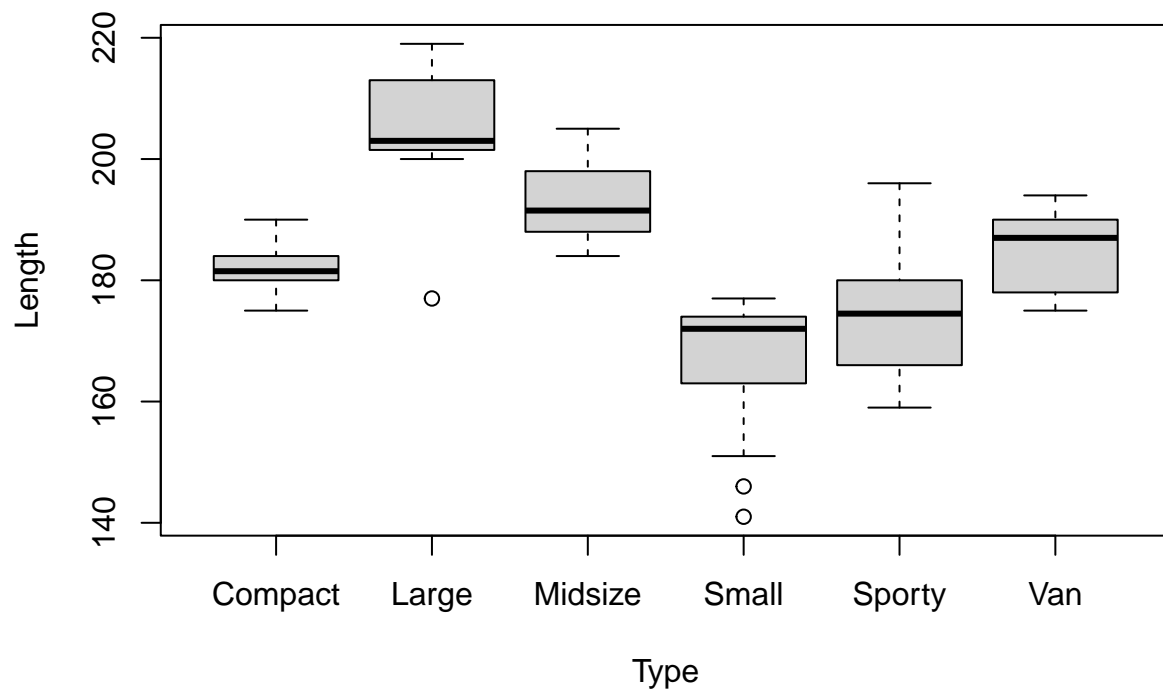
```
model formula syntax
```
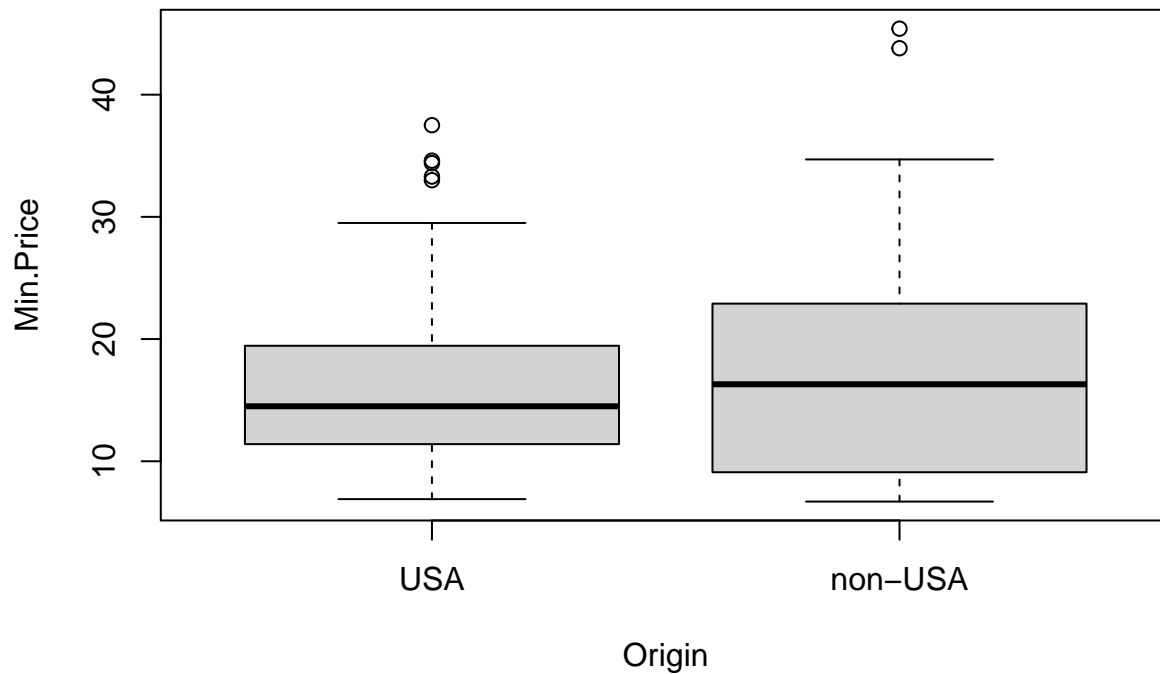
```
boxplot(Rear.seat.room ~ Origin)
```



```
boxplot(Rear.seat.room~Type)
```

```
boxplot(Length~Type)
```



```
boxplot(Min.Price~Origin)
```

```
detach(Cars93)

#####################
# "Old faithful" data
# and scatterplots

data("faithful")
attach(faithful)
help("faithful")

# EDA of waiting time

summary(waiting)
```
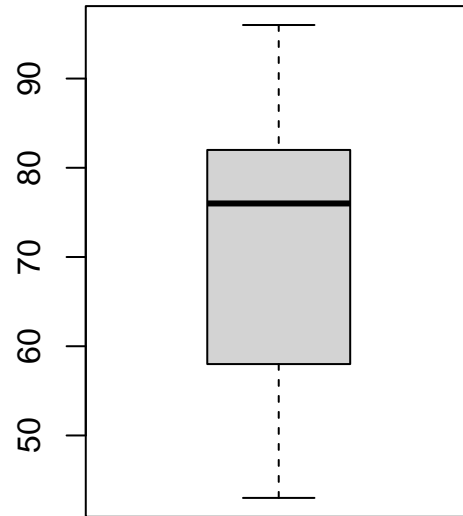
```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    43.0    58.0    76.0    70.9    82.0    96.0
```

```
par(mfrow=c(1, 2))
hist(waiting, col="orange", freq=FALSE, main="")
boxplot(waiting, col="lightgray")
```
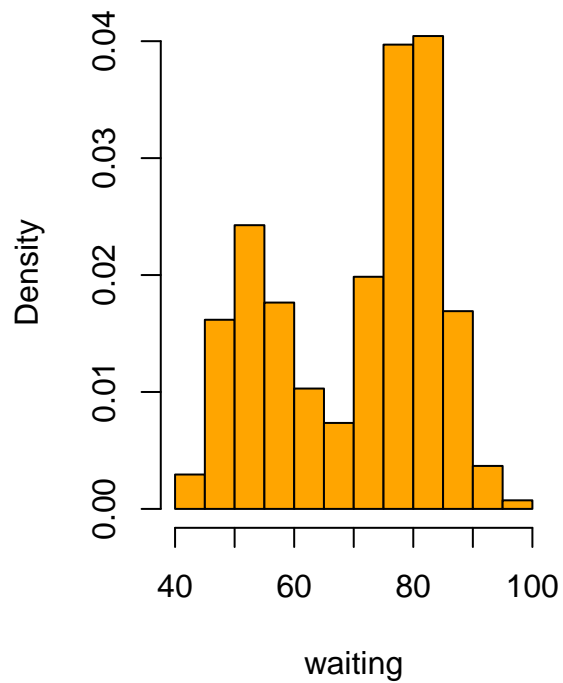
```
par(mfrow=c(1,1))

# EDA of eruption duration

summary(eruptions)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.600   2.163   4.000   3.488   4.454   5.100
```

```
par(mfrow=c(1, 2))
hist(eruptions, col="orange", prob=TRUE, main="")
boxplot(eruptions, col="lightgray")
```
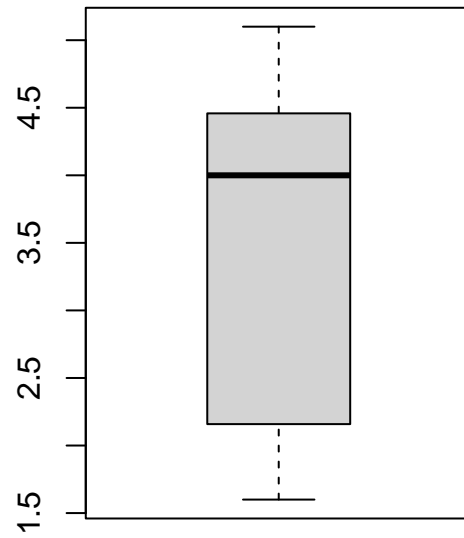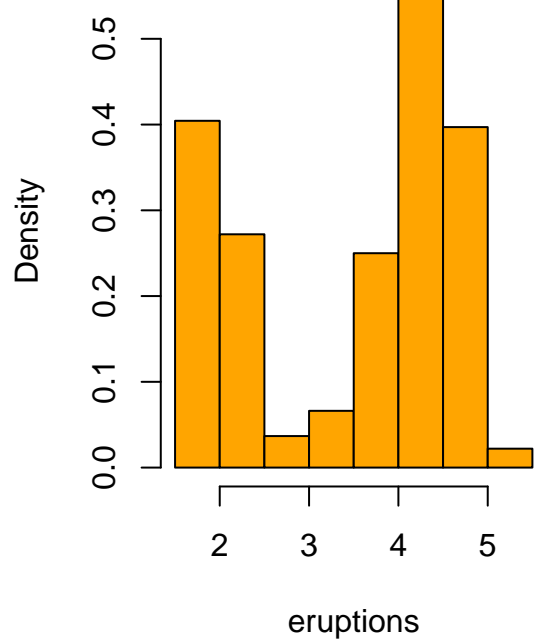
```
par(mfrow=c(1,1))

summary(faithful)
```

```
##    eruptions         waiting
##  Min.   :1.600   Min.   :43.0
##  1st Qu.:2.163   1st Qu.:58.0
##  Median :4.000   Median :76.0
##  Mean   :3.488   Mean   :70.9
##  3rd Qu.:4.454   3rd Qu.:82.0
##  Max.   :5.100   Max.   :96.0
```

```
# scatterplots

plot(eruptions, waiting)
```
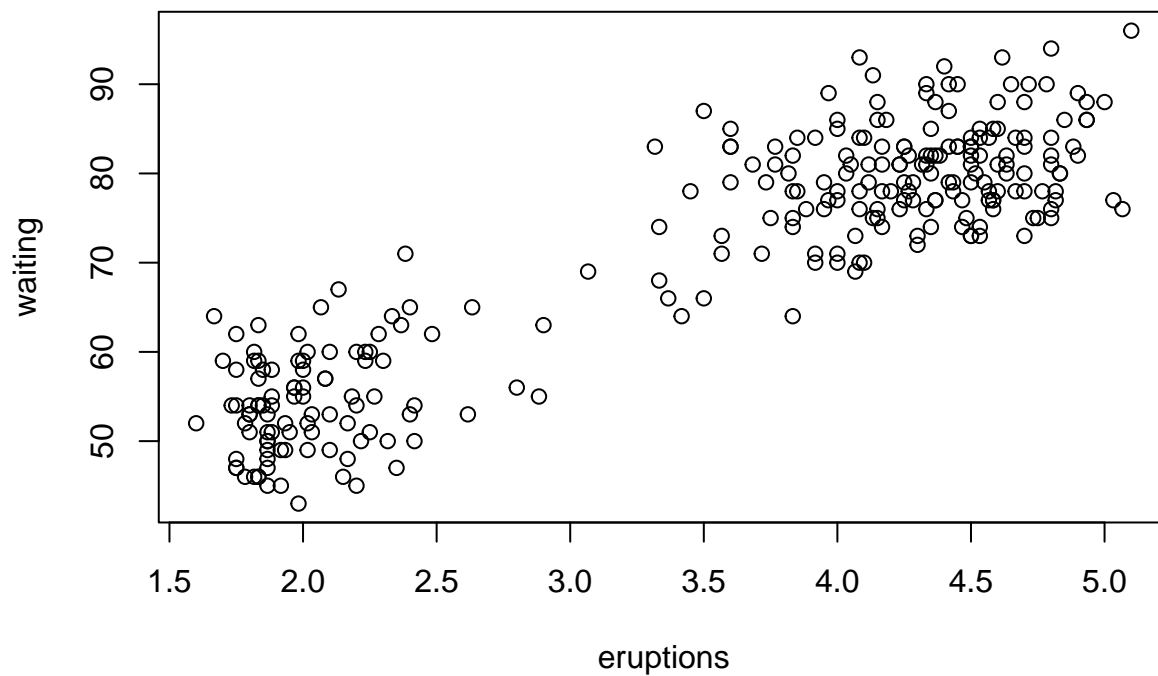
```
plot(waiting ~ eruptions)
```
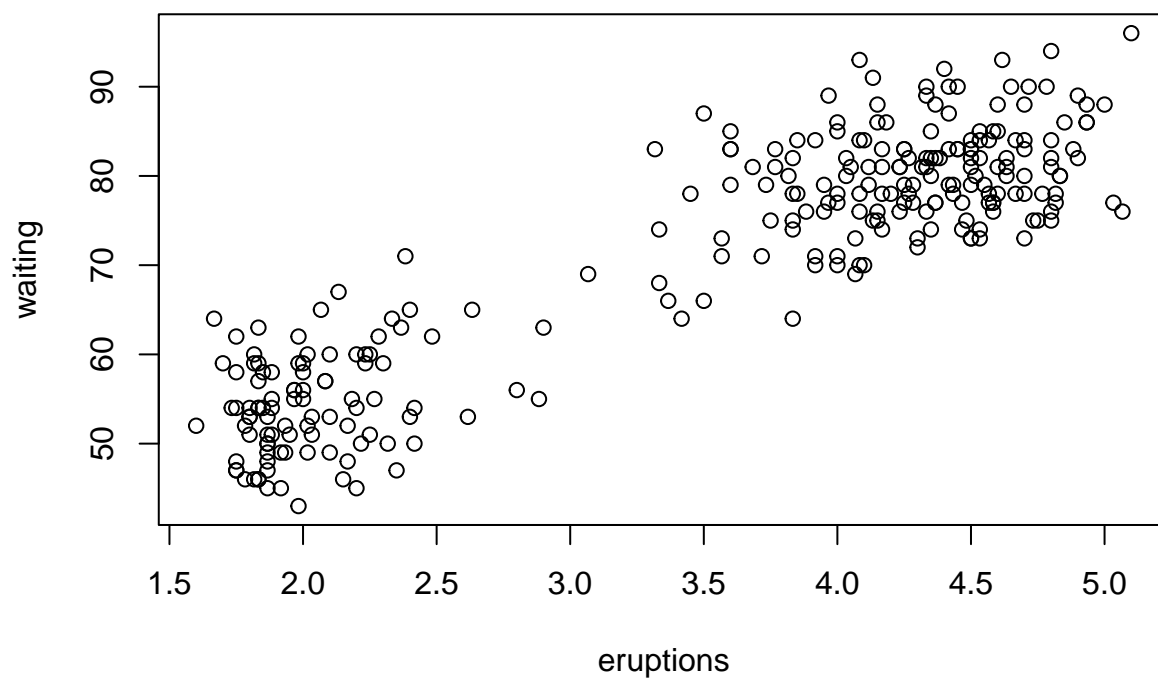


```
# choice of symbol

plot(1:20)
```
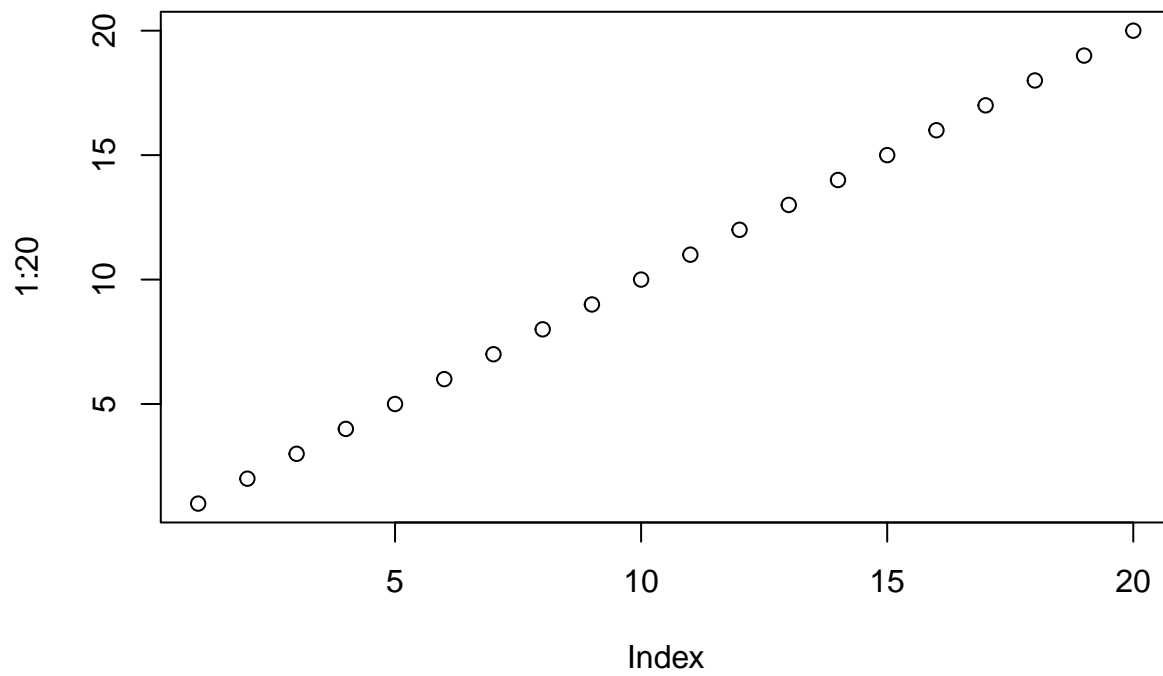
```
plot(1:20, pch="A")
```
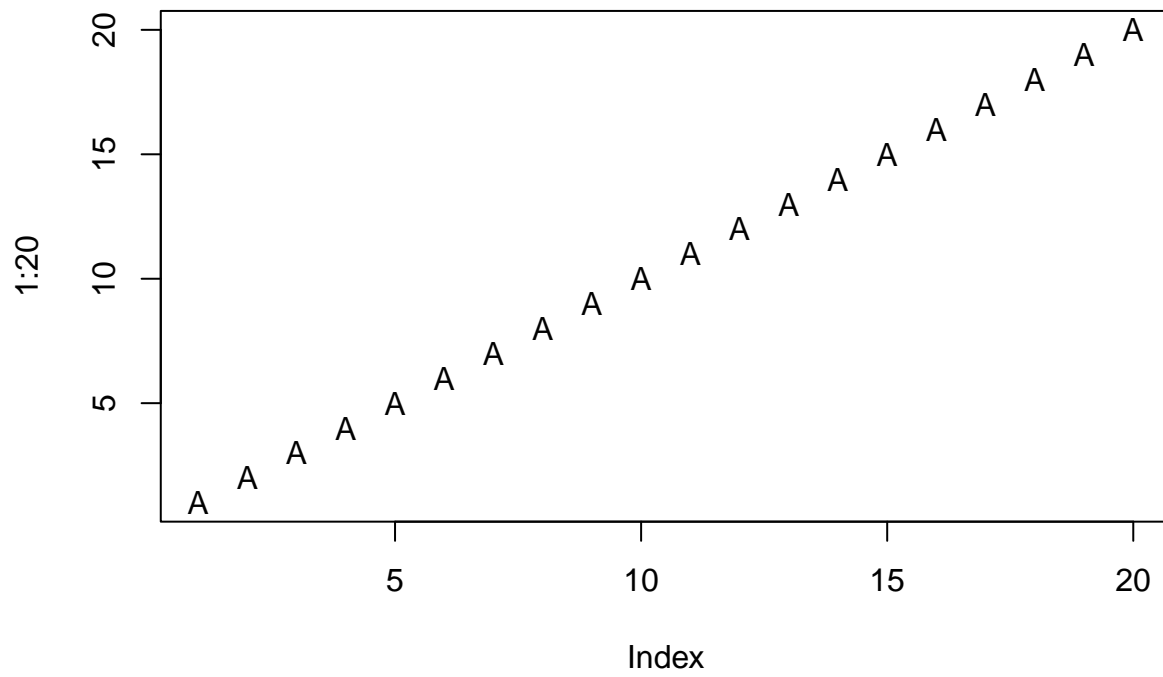


```
plot(1:20, pch=16)
```
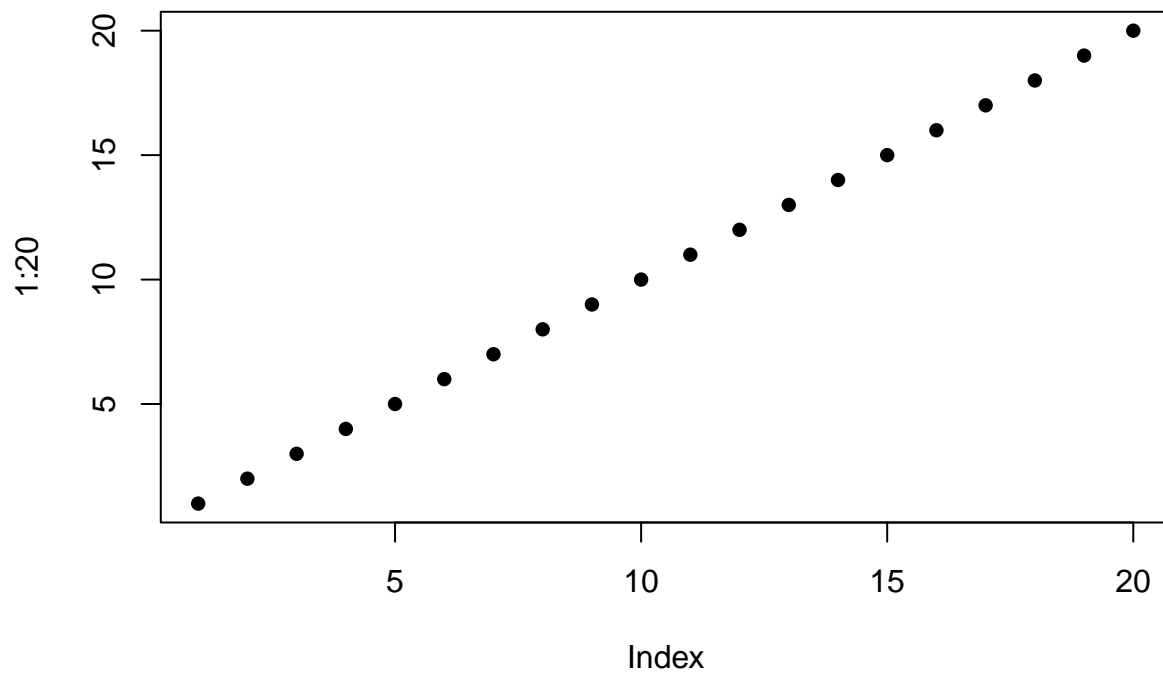
```
plot(1:20, pch=1:20)
```
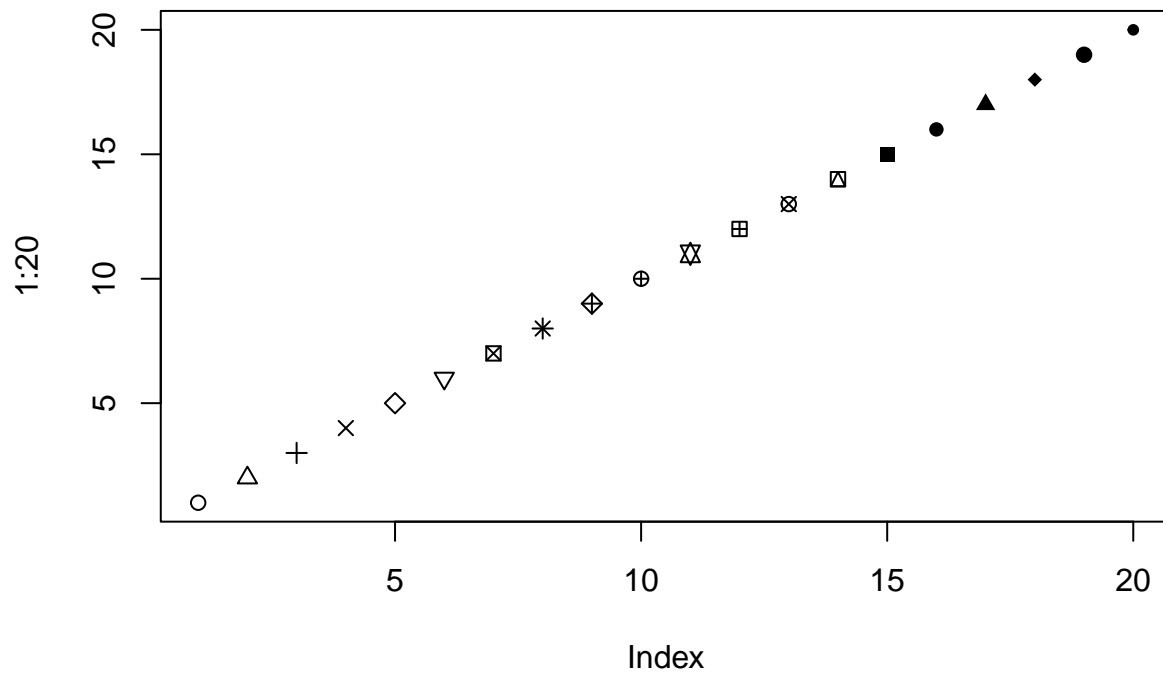


```
plot(1:20, pch=3)
```
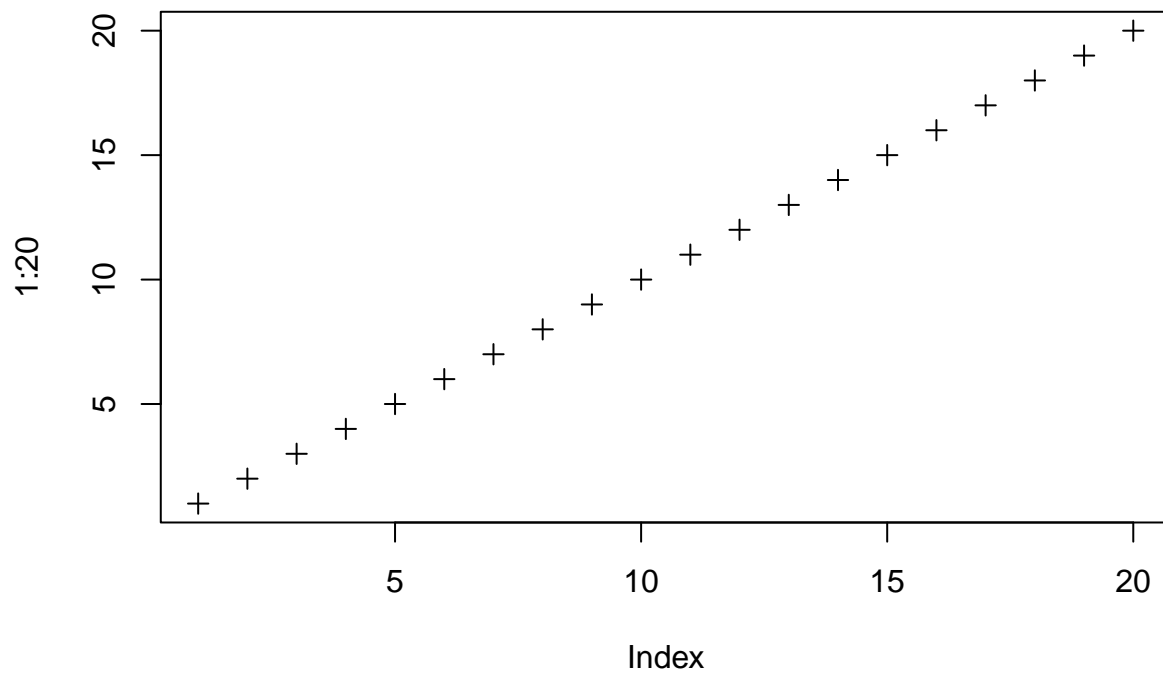
```
# choice of colors

plot(1:20, col=1:8, pch=16)
```
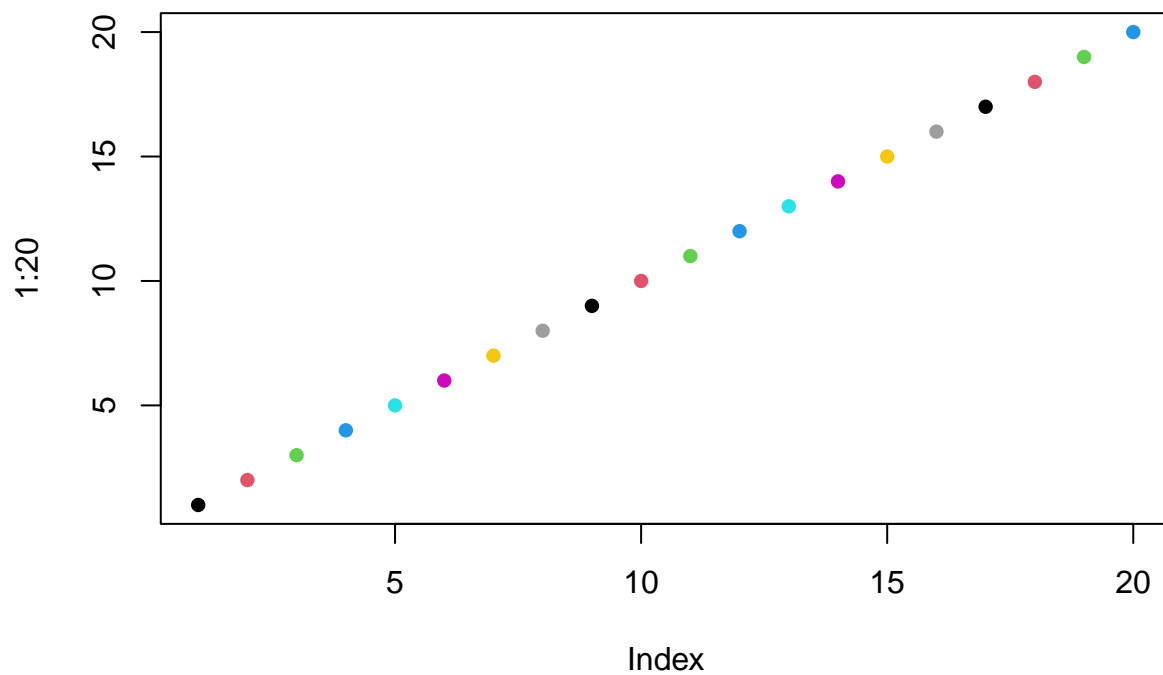


```
colors()
```

```
##   [1] "white"           "aliceblue"        "antiquewhite"
##   [4] "antiquewhite1"   "antiquewhite2"    "antiquewhite3"
##   [7] "antiquewhite4"   "aquamarine"       "aquamarine1"
##  [10] "aquamarine2"     "aquamarine3"      "aquamarine4"
##  [13] "azure"           "azure1"           "azure2"
##  [16] "azure3"          "azure4"           "beige"
```

```
##  [19] "bisque"           "bisque1"          "bisque2"
##  [22] "bisque3"          "bisque4"          "black"
##  [25] "blanchedalmond"   "blue"             "blue1"
##  [28] "blue2"            "blue3"            "blue4"
##  [31] "blueviolet"       "brown"            "brown1"
##  [34] "brown2"           "brown3"           "brown4"
##  [37] "burlywood"        "burlywood1"       "burlywood2"
##  [40] "burlywood3"       "burlywood4"       "cadetblue"
##  [43] "cadetblue1"       "cadetblue2"       "cadetblue3"
##  [46] "cadetblue4"       "chartreuse"       "chartreuse1"
##  [49] "chartreuse2"      "chartreuse3"      "chartreuse4"
##  [52] "chocolate"        "chocolate1"       "chocolate2"
##  [55] "chocolate3"       "chocolate4"       "coral"
##  [58] "coral1"           "coral2"           "coral3"
##  [61] "coral4"           "cornflowerblue"   "cornsilk"
##  [64] "cornsilk1"        "cornsilk2"        "cornsilk3"
##  [67] "cornsilk4"        "cyan"             "cyan1"
##  [70] "cyan2"            "cyan3"            "cyan4"
##  [73] "darkblue"         "darkcyan"         "darkgoldenrod"
##  [76] "darkgoldenrod1"   "darkgoldenrod2"   "darkgoldenrod3"
##  [79] "darkgoldenrod4"   "darkgray"         "darkgreen"
##  [82] "darkgrey"         "darkkhaki"        "darkmagenta"
##  [85] "darkolivegreen"   "darkolivegreen1"  "darkolivegreen2"
##  [88] "darkolivegreen3"  "darkolivegreen4"  "darkorange"
##  [91] "darkorange1"      "darkorange2"      "darkorange3"
##  [94] "darkorange4"      "darkorchid"       "darkorchid1"
##  [97] "darkorchid2"      "darkorchid3"      "darkorchid4"
## [100] "darkred"          "darksalmon"       "darkseagreen"
## [103] "darkseagreen1"    "darkseagreen2"    "darkseagreen3"
## [106] "darkseagreen4"    "darkslateblue"    "darkslategray"
## [109] "darkslategray1"   "darkslategray2"   "darkslategray3"
## [112] "darkslategray4"   "darkslategrey"    "darkturquoise"
## [115] "darkviolet"       "deeppink"         "deeppink1"
## [118] "deeppink2"        "deeppink3"        "deeppink4"
## [121] "deepskyblue"      "deepskyblue1"     "deepskyblue2"
## [124] "deepskyblue3"     "deepskyblue4"     "dimgray"
## [127] "dimgrey"          "dodgerblue"       "dodgerblue1"
## [130] "dodgerblue2"      "dodgerblue3"      "dodgerblue4"
## [133] "firebrick"        "firebrick1"       "firebrick2"
## [136] "firebrick3"       "firebrick4"       "floralwhite"
## [139] "forestgreen"      "gainsboro"        "ghostwhite"
## [142] "gold"             "gold1"            "gold2"
## [145] "gold3"            "gold4"            "goldenrod"
## [148] "goldenrod1"       "goldenrod2"       "goldenrod3"
## [151] "goldenrod4"       "gray"             "gray0"
## [154] "gray1"            "gray2"            "gray3"
## [157] "gray4"            "gray5"            "gray6"
## [160] "gray7"            "gray8"            "gray9"
## [163] "gray10"           "gray11"           "gray12"
## [166] "gray13"           "gray14"           "gray15"
## [169] "gray16"           "gray17"           "gray18"
## [172] "gray19"           "gray20"           "gray21"
## [175] "gray22"           "gray23"           "gray24"
## [178] "gray25"           "gray26"           "gray27"
```

```
## [181] "gray28"       "gray29"       "gray30"
## [184] "gray31"       "gray32"       "gray33"
## [187] "gray34"       "gray35"       "gray36"
## [190] "gray37"       "gray38"       "gray39"
## [193] "gray40"       "gray41"       "gray42"
## [196] "gray43"       "gray44"       "gray45"
## [199] "gray46"       "gray47"       "gray48"
## [202] "gray49"       "gray50"       "gray51"
## [205] "gray52"       "gray53"       "gray54"
## [208] "gray55"       "gray56"       "gray57"
## [211] "gray58"       "gray59"       "gray60"
## [214] "gray61"       "gray62"       "gray63"
## [217] "gray64"       "gray65"       "gray66"
## [220] "gray67"       "gray68"       "gray69"
## [223] "gray70"       "gray71"       "gray72"
## [226] "gray73"       "gray74"       "gray75"
## [229] "gray76"       "gray77"       "gray78"
## [232] "gray79"       "gray80"       "gray81"
## [235] "gray82"       "gray83"       "gray84"
## [238] "gray85"       "gray86"       "gray87"
## [241] "gray88"       "gray89"       "gray90"
## [244] "gray91"       "gray92"       "gray93"
## [247] "gray94"       "gray95"       "gray96"
## [250] "gray97"       "gray98"       "gray99"
## [253] "gray100"      "green"        "green1"
## [256] "green2"       "green3"       "green4"
## [259] "greenyellow"  "grey"         "grey0"
## [262] "grey1"        "grey2"        "grey3"
## [265] "grey4"        "grey5"        "grey6"
## [268] "grey7"        "grey8"        "grey9"
## [271] "grey10"       "grey11"       "grey12"
## [274] "grey13"       "grey14"       "grey15"
## [277] "grey16"       "grey17"       "grey18"
## [280] "grey19"       "grey20"       "grey21"
## [283] "grey22"       "grey23"       "grey24"
## [286] "grey25"       "grey26"       "grey27"
## [289] "grey28"       "grey29"       "grey30"
## [292] "grey31"       "grey32"       "grey33"
## [295] "grey34"       "grey35"       "grey36"
## [298] "grey37"       "grey38"       "grey39"
## [301] "grey40"       "grey41"       "grey42"
## [304] "grey43"       "grey44"       "grey45"
## [307] "grey46"       "grey47"       "grey48"
## [310] "grey49"       "grey50"       "grey51"
## [313] "grey52"       "grey53"       "grey54"
## [316] "grey55"       "grey56"       "grey57"
## [319] "grey58"       "grey59"       "grey60"
## [322] "grey61"       "grey62"       "grey63"
## [325] "grey64"       "grey65"       "grey66"
## [328] "grey67"       "grey68"       "grey69"
## [331] "grey70"       "grey71"       "grey72"
## [334] "grey73"       "grey74"       "grey75"
## [337] "grey76"       "grey77"       "grey78"
## [340] "grey79"       "grey80"       "grey81"
```

```
## [343] "grey82"                "grey83"            "grey84"
## [346] "grey85"                "grey86"            "grey87"
## [349] "grey88"                "grey89"            "grey90"
## [352] "grey91"                "grey92"            "grey93"
## [355] "grey94"                "grey95"            "grey96"
## [358] "grey97"                "grey98"            "grey99"
## [361] "grey100"               "honeydew"          "honeydew1"
## [364] "honeydew2"             "honeydew3"         "honeydew4"
## [367] "hotpink"               "hotpink1"          "hotpink2"
## [370] "hotpink3"              "hotpink4"          "indianred"
## [373] "indianred1"            "indianred2"        "indianred3"
## [376] "indianred4"            "ivory"             "ivory1"
## [379] "ivory2"                "ivory3"            "ivory4"
## [382] "khaki"                 "khaki1"            "khaki2"
## [385] "khaki3"                "khaki4"            "lavender"
## [388] "lavenderblush"         "lavenderblush1"    "lavenderblush2"
## [391] "lavenderblush3"        "lavenderblush4"    "lawngreen"
## [394] "lemonchiffon"          "lemonchiffon1"     "lemonchiffon2"
## [397] "lemonchiffon3"         "lemonchiffon4"     "lightblue"
## [400] "lightblue1"            "lightblue2"        "lightblue3"
## [403] "lightblue4"            "lightcoral"        "lightcyan"
## [406] "lightcyan1"            "lightcyan2"        "lightcyan3"
## [409] "lightcyan4"            "lightgoldenrod"    "lightgoldenrod1"
## [412] "lightgoldenrod2"       "lightgoldenrod3"   "lightgoldenrod4"
## [415] "lightgoldenrodyellow"  "lightgray"         "lightgreen"
## [418] "lightgrey"             "lightpink"         "lightpink1"
## [421] "lightpink2"            "lightpink3"        "lightpink4"
## [424] "lightsalmon"           "lightsalmon1"      "lightsalmon2"
## [427] "lightsalmon3"          "lightsalmon4"      "lightseagreen"
## [430] "lightskyblue"          "lightskyblue1"     "lightskyblue2"
## [433] "lightskyblue3"         "lightskyblue4"     "lightslateblue"
## [436] "lightslategray"        "lightslategrey"    "lightsteelblue"
## [439] "lightsteelblue1"       "lightsteelblue2"   "lightsteelblue3"
## [442] "lightsteelblue4"       "lightyellow"       "lightyellow1"
## [445] "lightyellow2"          "lightyellow3"      "lightyellow4"
## [448] "limegreen"             "linen"             "magenta"
## [451] "magenta1"              "magenta2"          "magenta3"
## [454] "magenta4"              "maroon"            "maroon1"
## [457] "maroon2"               "maroon3"           "maroon4"
## [460] "mediumaquamarine"      "mediumblue"        "mediumorchid"
## [463] "mediumorchid1"         "mediumorchid2"     "mediumorchid3"
## [466] "mediumorchid4"         "mediumpurple"      "mediumpurple1"
## [469] "mediumpurple2"         "mediumpurple3"     "mediumpurple4"
## [472] "mediumseagreen"        "mediumslateblue"   "mediumspringgreen"
## [475] "mediumturquoise"       "mediumvioletred"   "midnightblue"
## [478] "mintcream"             "mistyrose"         "mistyrose1"
## [481] "mistyrose2"            "mistyrose3"        "mistyrose4"
## [484] "moccasin"              "navajowhite"       "navajowhite1"
## [487] "navajowhite2"          "navajowhite3"      "navajowhite4"
## [490] "navy"                  "navyblue"          "oldlace"
## [493] "olivedrab"             "olivedrab1"        "olivedrab2"
## [496] "olivedrab3"            "olivedrab4"        "orange"
## [499] "orange1"               "orange2"           "orange3"
## [502] "orange4"               "orangered"         "orangered1"
```

```
## [505] "orangered2"        "orangered3"        "orangered4"
## [508] "orchid"            "orchid1"           "orchid2"
## [511] "orchid3"           "orchid4"           "palegoldenrod"
## [514] "palegreen"         "palegreen1"        "palegreen2"
## [517] "palegreen3"        "palegreen4"        "paleturquoise"
## [520] "paleturquoise1"    "paleturquoise2"    "paleturquoise3"
## [523] "paleturquoise4"    "palevioletred"     "palevioletred1"
## [526] "palevioletred2"    "palevioletred3"    "palevioletred4"
## [529] "papayawhip"        "peachpuff"         "peachpuff1"
## [532] "peachpuff2"        "peachpuff3"        "peachpuff4"
## [535] "peru"              "pink"              "pink1"
## [538] "pink2"             "pink3"             "pink4"
## [541] "plum"              "plum1"             "plum2"
## [544] "plum3"             "plum4"             "powderblue"
## [547] "purple"            "purple1"           "purple2"
## [550] "purple3"           "purple4"           "red"
## [553] "red1"              "red2"              "red3"
## [556] "red4"              "rosybrown"         "rosybrown1"
## [559] "rosybrown2"        "rosybrown3"        "rosybrown4"
## [562] "royalblue"         "royalblue1"        "royalblue2"
## [565] "royalblue3"        "royalblue4"        "saddlebrown"
## [568] "salmon"            "salmon1"           "salmon2"
## [571] "salmon3"           "salmon4"           "sandybrown"
## [574] "seagreen"          "seagreen1"         "seagreen2"
## [577] "seagreen3"         "seagreen4"         "seashell"
## [580] "seashell1"         "seashell2"         "seashell3"
## [583] "seashell4"         "sienna"            "sienna1"
## [586] "sienna2"           "sienna3"           "sienna4"
## [589] "skyblue"           "skyblue1"          "skyblue2"
## [592] "skyblue3"          "skyblue4"          "slateblue"
## [595] "slateblue1"        "slateblue2"        "slateblue3"
## [598] "slateblue4"        "slategray"         "slategray1"
## [601] "slategray2"        "slategray3"        "slategray4"
## [604] "slategrey"         "snow"              "snow1"
## [607] "snow2"             "snow3"             "snow4"
## [610] "springgreen"       "springgreen1"      "springgreen2"
## [613] "springgreen3"      "springgreen4"      "steelblue"
## [616] "steelblue1"        "steelblue2"        "steelblue3"
## [619] "steelblue4"        "tan"               "tan1"
## [622] "tan2"              "tan3"              "tan4"
## [625] "thistle"           "thistle1"          "thistle2"
## [628] "thistle3"          "thistle4"          "tomato"
## [631] "tomato1"           "tomato2"           "tomato3"
## [634] "tomato4"           "turquoise"         "turquoise1"
## [637] "turquoise2"        "turquoise3"        "turquoise4"
## [640] "violet"            "violetred"         "violetred1"
## [643] "violetred2"        "violetred3"        "violetred4"
## [646] "wheat"             "wheat1"            "wheat2"
## [649] "wheat3"            "wheat4"            "whitesmoke"
## [652] "yellow"            "yellow1"           "yellow2"
## [655] "yellow3"           "yellow4"           "yellowgreen"
```
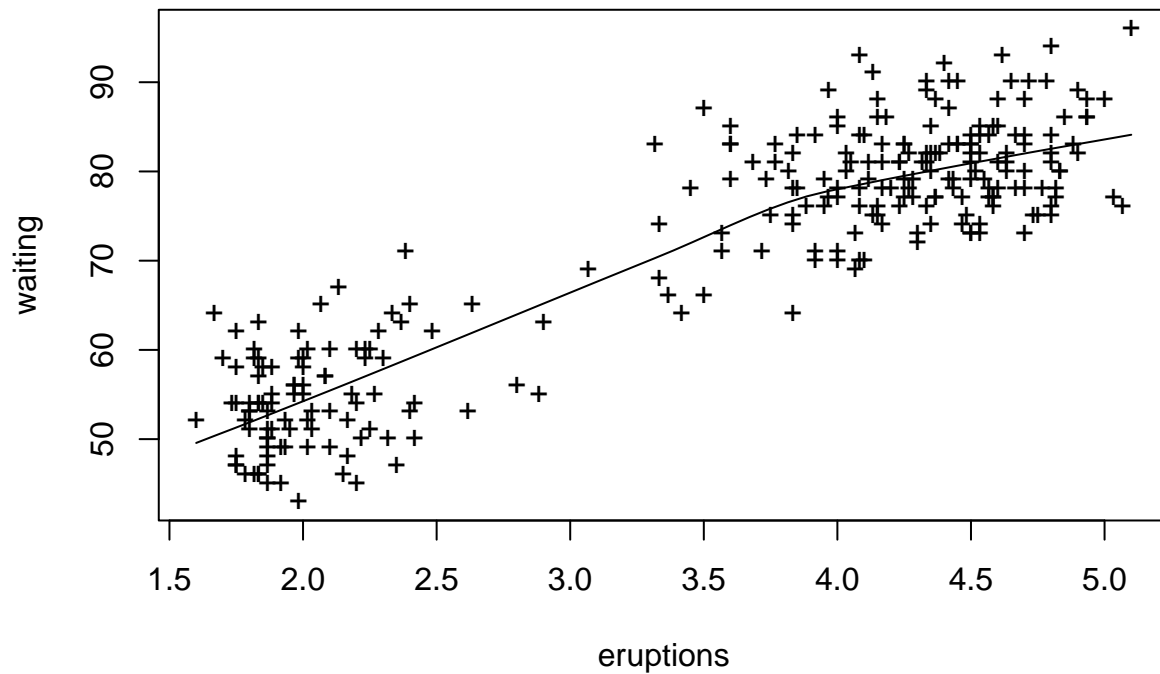
```
# final scatterplot
```

```
lx <- "Eruption time (min)"
ly <- "Waiting time to next eruption (min)"
lmain <- "faithful data: Eruptions of Old Faithful"

plot(eruptions, waiting, xlab=lx, ylab=ly, main=lmain, pch="+")
```

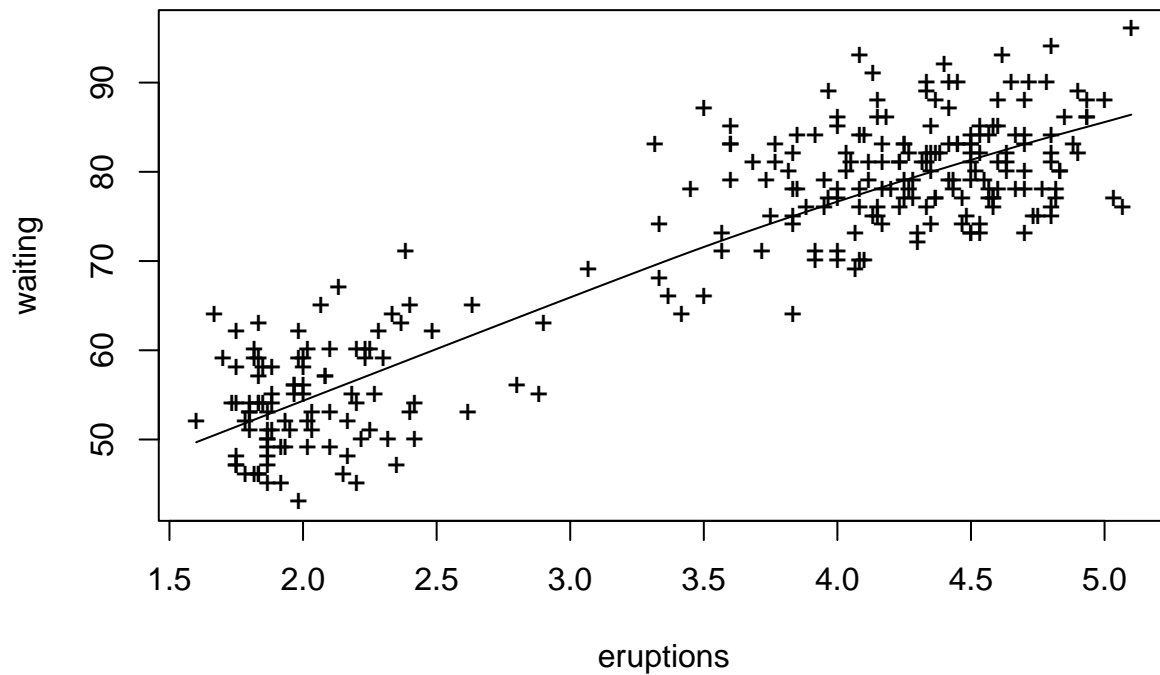**faithful data: Eruptions of Old Faithful**
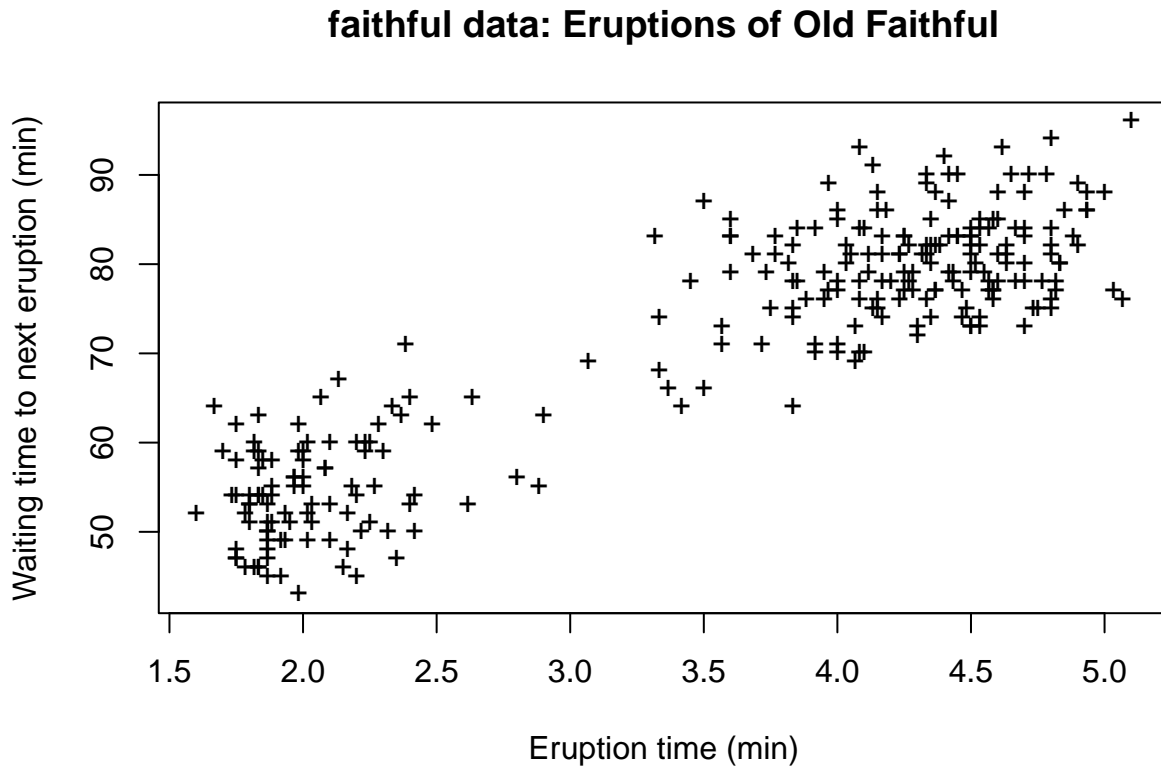

```
# scatter.smooth with different smoothing parameters

scatter.smooth(eruptions, waiting, pch="+")
```
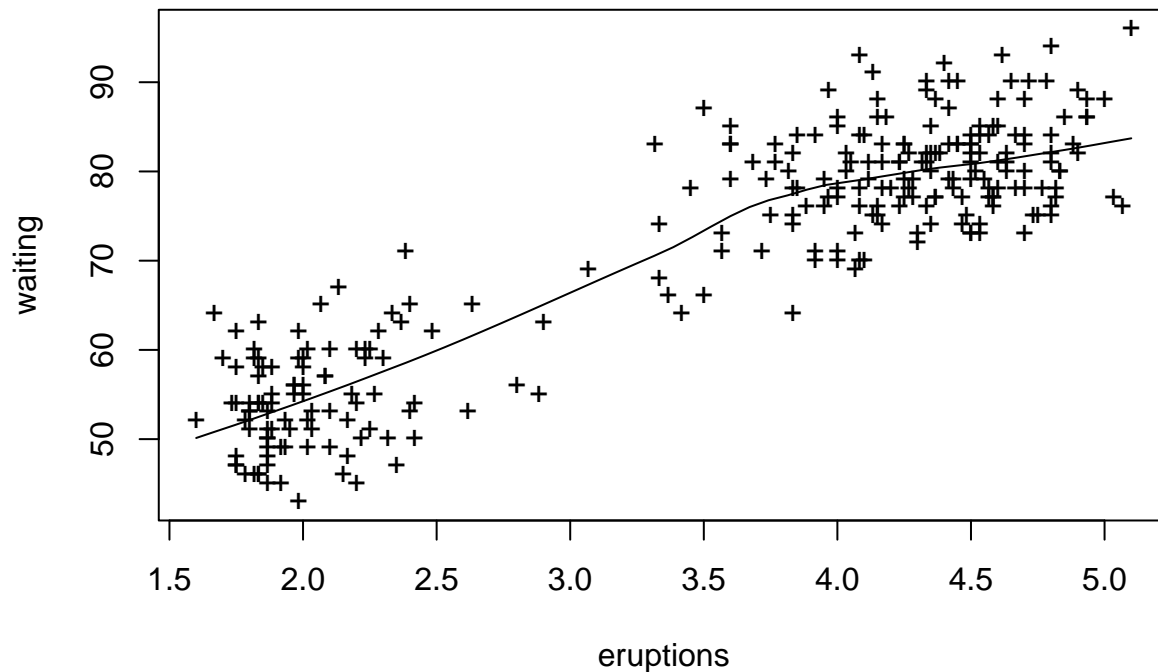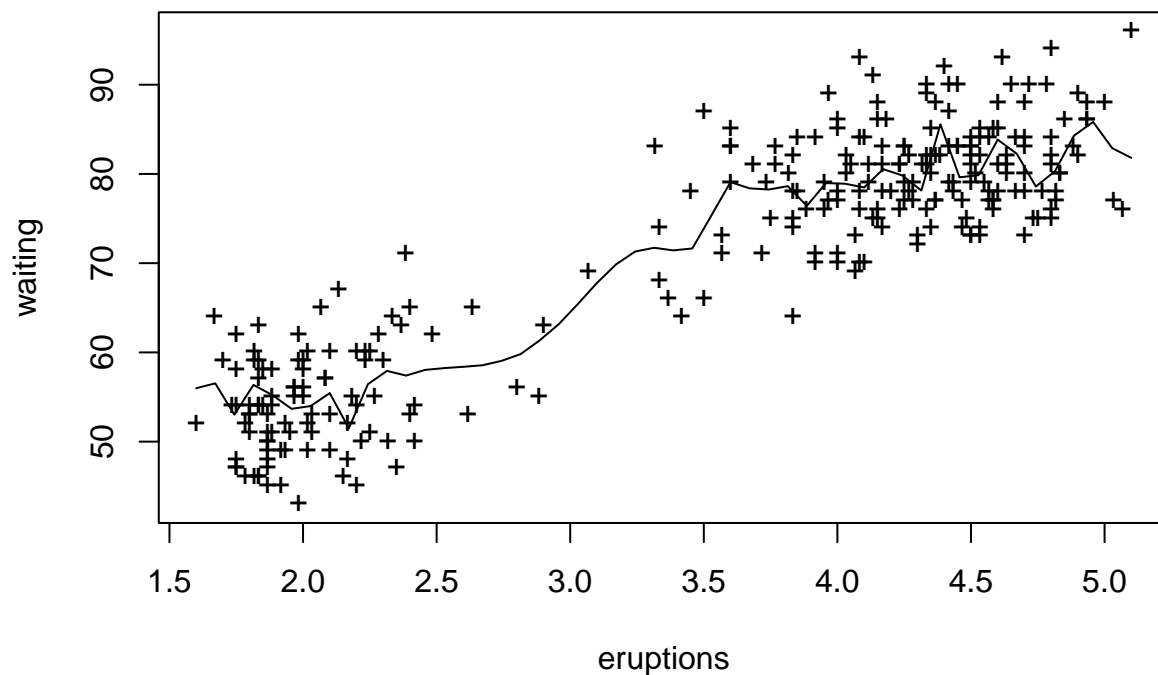
```
scatter.smooth(eruptions, waiting, span=2/3, pch="+") # this is the default value
scatter.smooth(eruptions, waiting, span=1, pch="+")
```



```
scatter.smooth(eruptions, waiting, span=1/2, pch="+")
```

```
scatter.smooth(eruptions, waiting, span=1/20, pch="+")
```



```
# LOESS= LOcally Estimated Scatterplot Smoothing
# different smoothing parameters for loess

int.line1 <- loess.smooth(eruptions, waiting, span=1)
int.line.66 <- loess.smooth(eruptions, waiting, span=2/3)
int.line.5 <- loess.smooth(eruptions, waiting, span=1/2)
int.line.05 <- loess.smooth(eruptions, waiting, span=1/20)

plot(eruptions, waiting, xlab=lx, ylab=ly, main=lmain, pch="+")
```

faithful data: Eruptions of Old Faithful


```
# add legend

plot(eruptions, waiting, xlab=lx, ylab=ly, main=lmain, pch="+")
# add lines

lines(int.line1,  col=2, lty=2, lwd=2)
lines(int.line.66, col=3, lty=1, lwd=4)
lines(int.line.5, col=4, lty=3, lwd=2)
lines(int.line.05, col=5, lty=4, lwd=4)


legend(x=1.5,y=95, legend=c("smoothing=1","smoothing=2/3","smoothing=0.5",  "smoothing=0.1"), col=2:5,

# alternative way for legend position
#
# "bottomright", "bottom", "bottomleft", "left",
# "topleft", "top", "topright", "right",  "center"

legend("topleft", y=NULL,
        legend=c("smoothing=1","smoothing=2/3","smoothing=0.5",  "smoothing=0.1"), col=2:5, lty=c(2,1,3,4

# size of the legend
```

```
legend("topleft", y=NULL, cex=0.8,
       legend=c("smoothing=1","smoothing=2/3","smoothing=0.5",  "smoothing=0.1"), col=2:5, lty=c(2,1,3,4
```

faithful data: Eruptions of Old Faithful
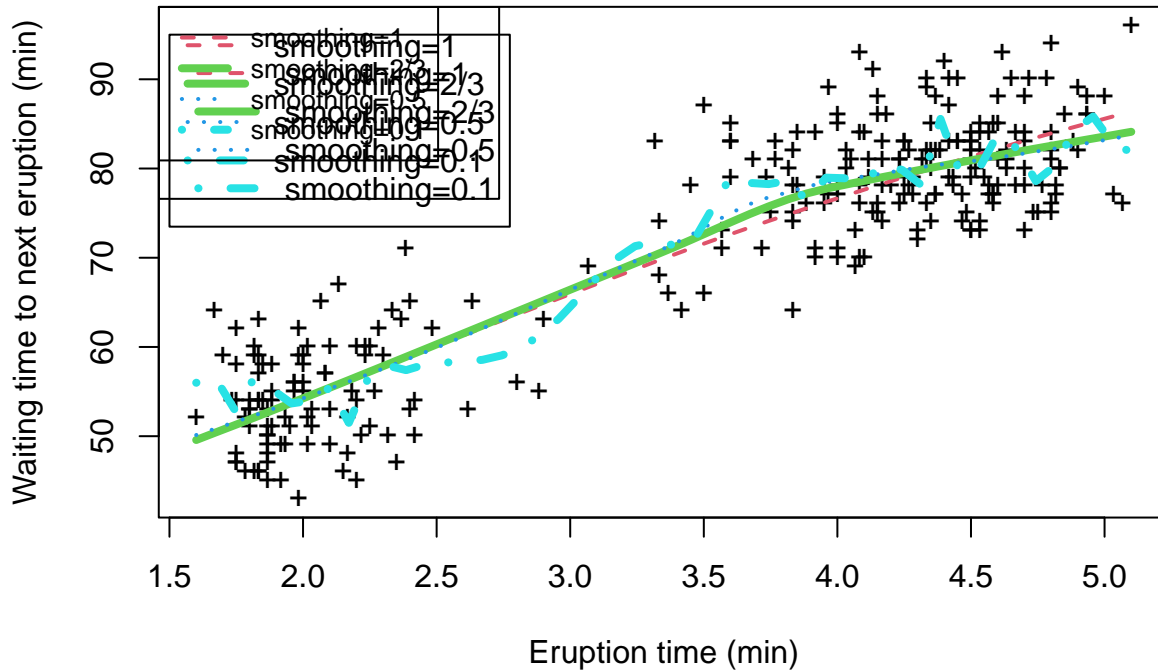
Another example
```
library(MASS)
data("mcycle")
help(mcycle)
attach(mcycle)

plot(times, accel, pch="+")
```
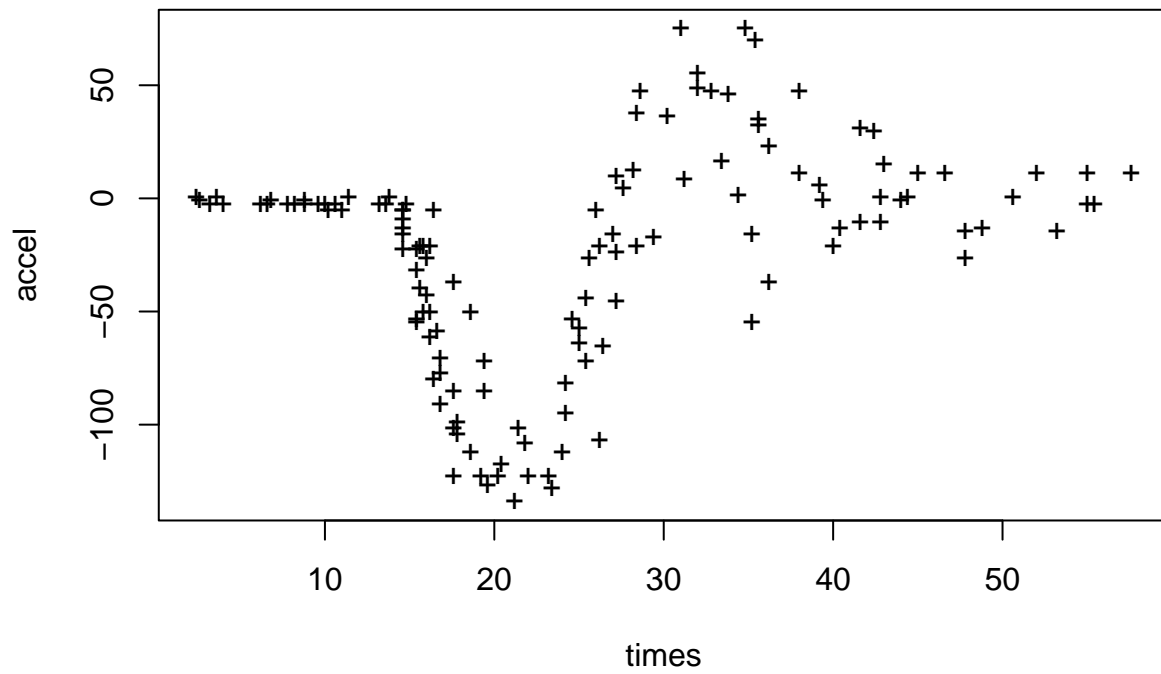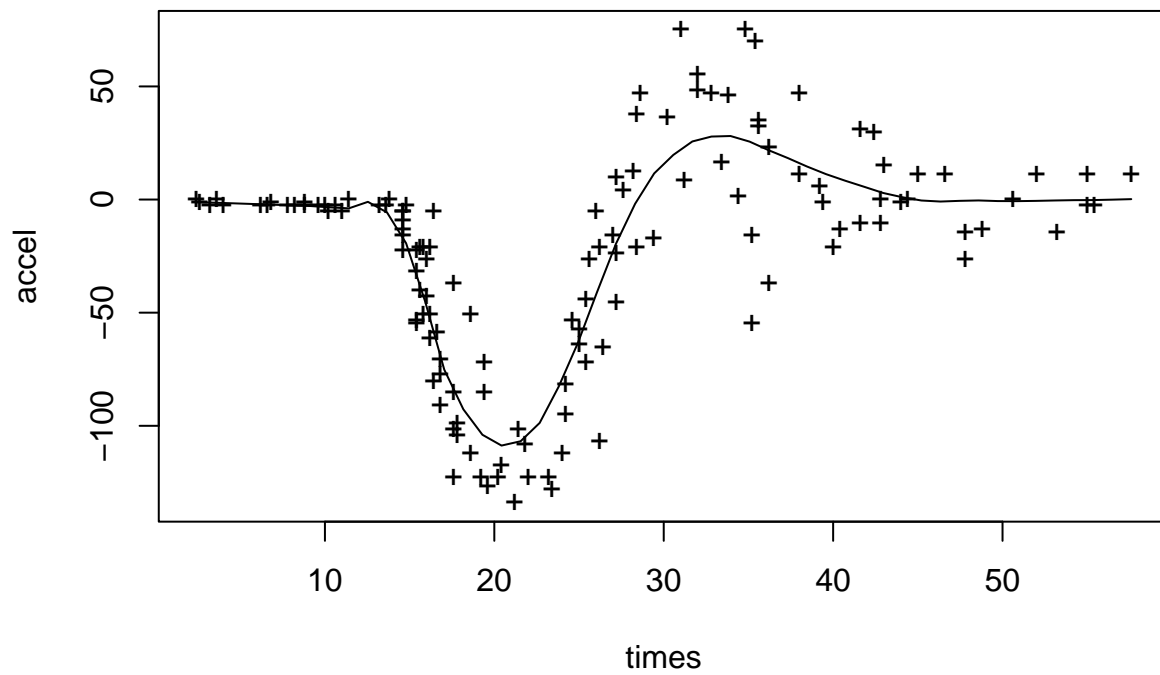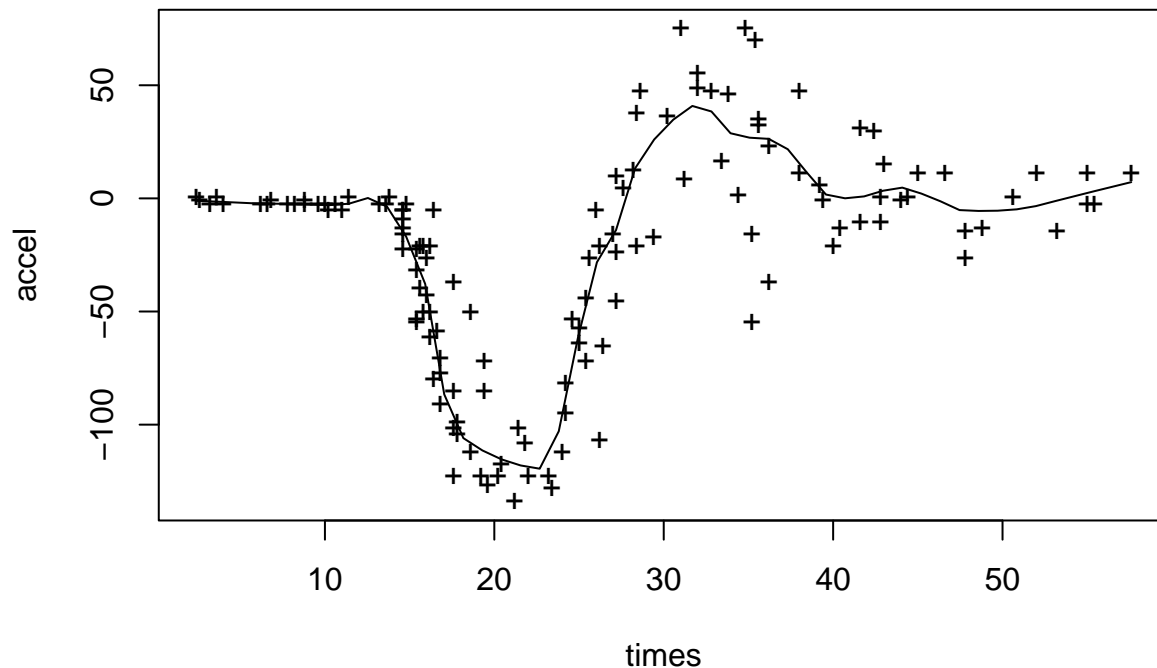
```
scatter.smooth(times, accel, span=1, pch="+")
```
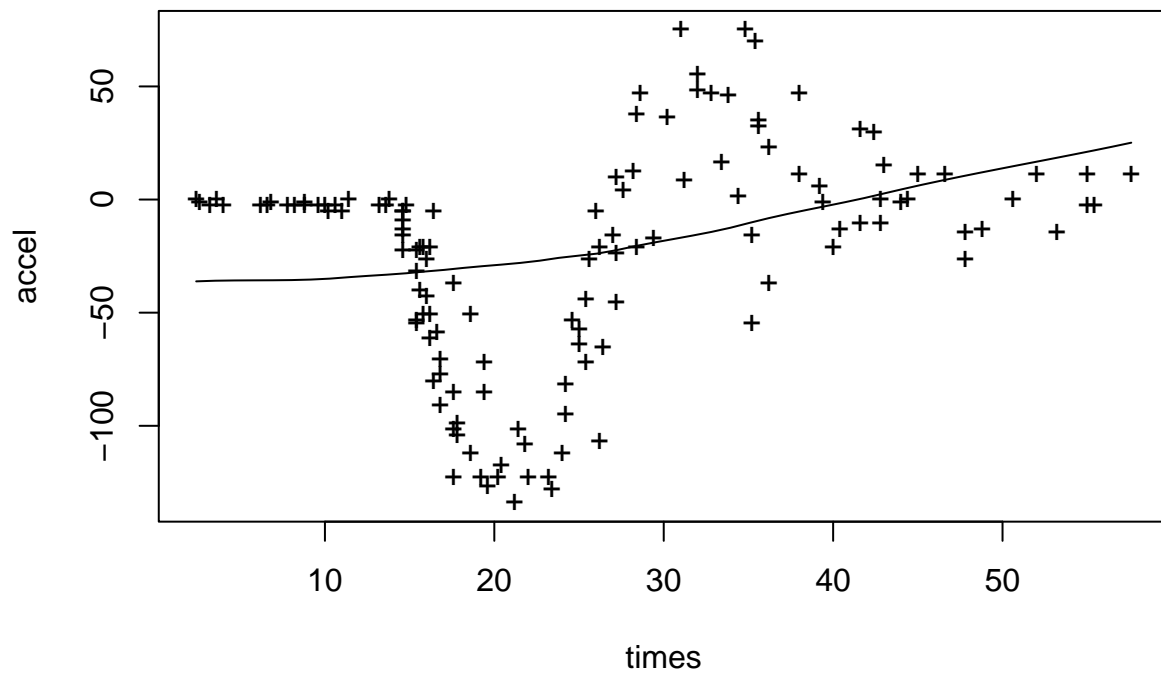


```
scatter.smooth(times, accel, pch="+") # span=2/3
```
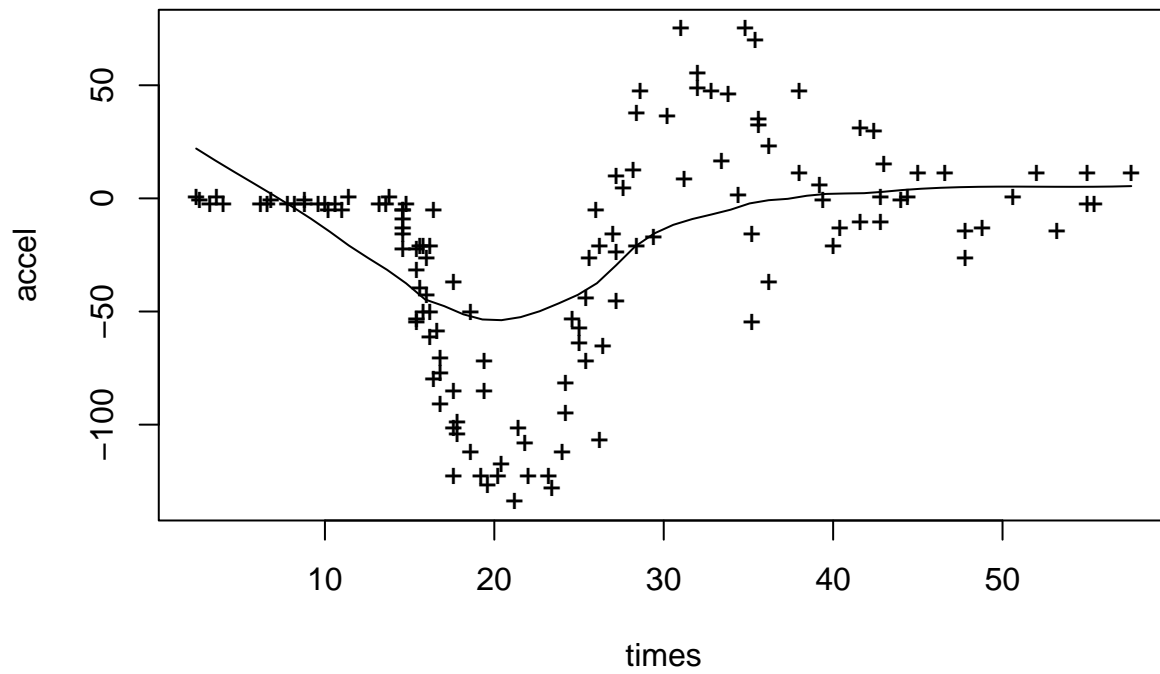
```
scatter.smooth(times, accel, span=1/4, pch="+")
```



```
scatter.smooth(times, accel, span=1/10, pch="+")
```

```
scatter.smooth(times, accel, span=1/20, pch="+")
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## pseudoinverse used at 15.6
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## neighborhood radius 0.2
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## reciprocal condition number 0
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## There are other near singularities as well. 0.04
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## zero-width neighborhood. make span bigger
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## pseudoinverse used at 15.6
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## neighborhood radius 0.2
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## reciprocal condition number 0
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## There are other near singularities as well. 0.04
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## zero-width neighborhood. make span bigger
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## pseudoinverse used at 15.6
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## neighborhood radius 0.2
```

```
## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## reciprocal condition number 0

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## There are other near singularities as well. 0.04

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## zero-width neighborhood. make span bigger

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## pseudoinverse used at 15.6

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## neighborhood radius 0.2

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## reciprocal condition number 0

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## There are other near singularities as well. 0.04

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## zero-width neighborhood. make span bigger

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## pseudoinverse used at 15.6

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## neighborhood radius 0.2

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## reciprocal condition number 0

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## There are other near singularities as well. 0.04

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric = FALSE, :
## zero-width neighborhood. make span bigger
```
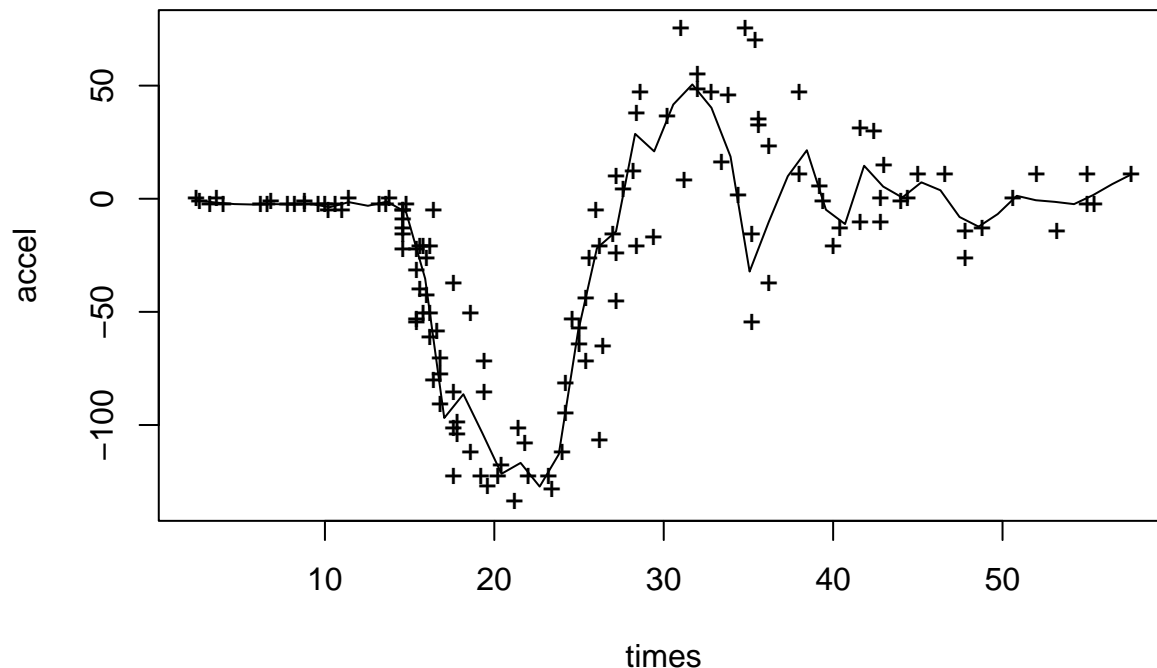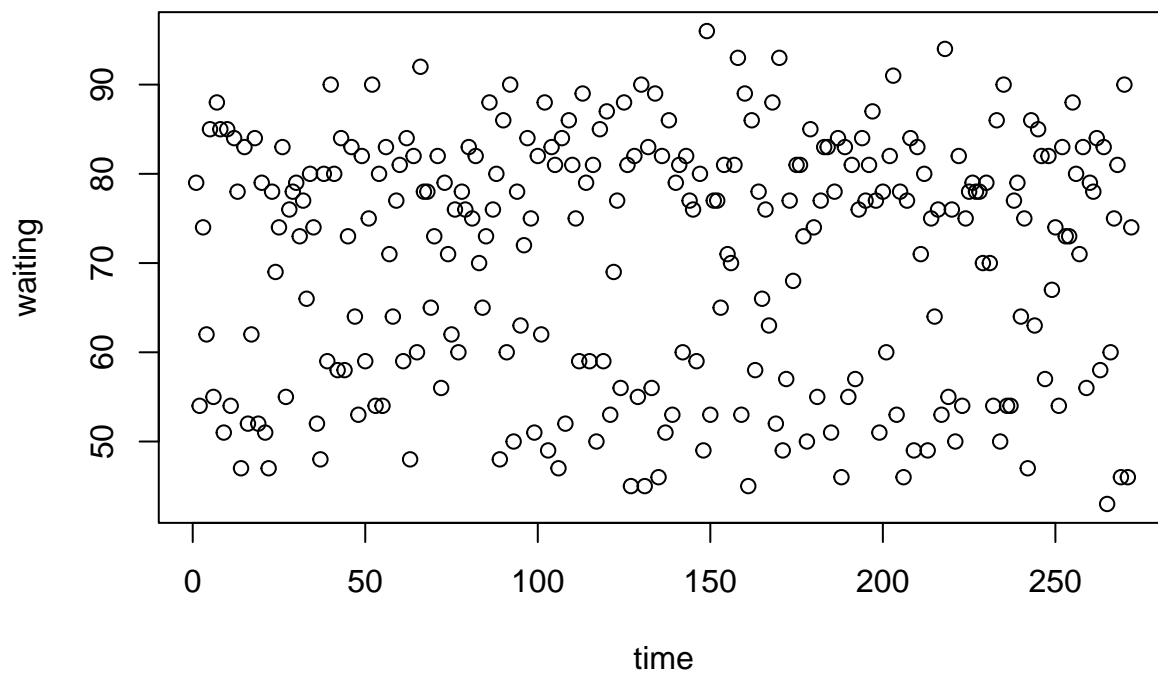
```
# old faithful data are time series

n <- length(waiting)
time <- 1:n

plot(time, waiting)
```
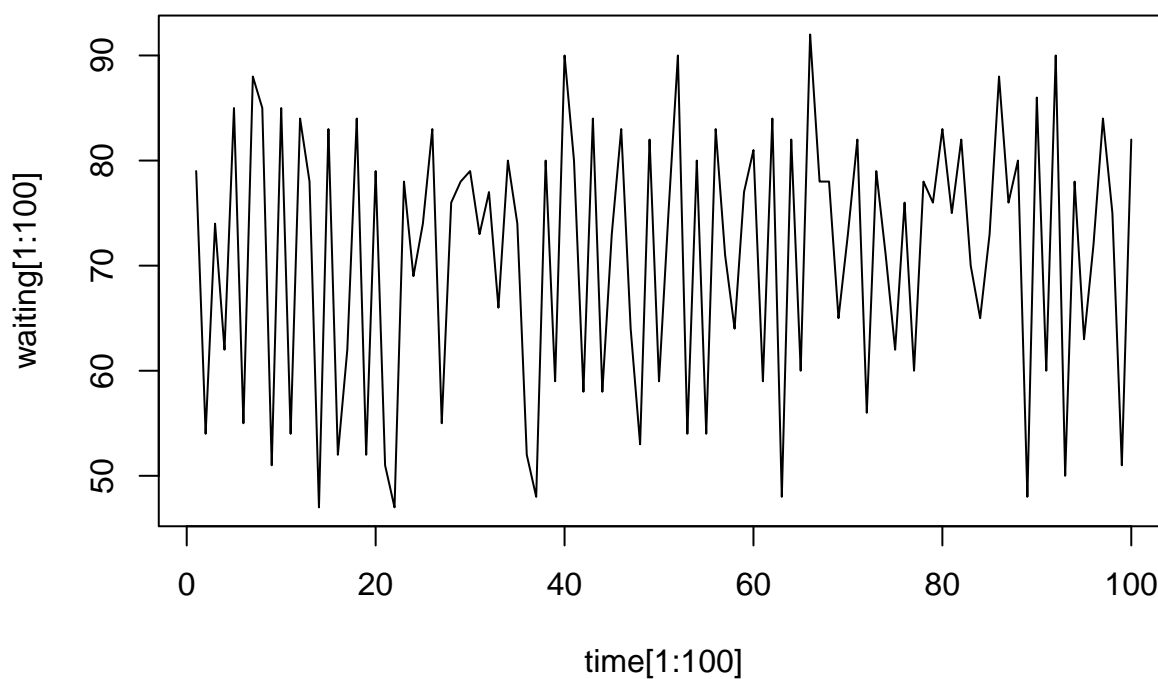


```
# first 100 time points and plot with "line"

plot(time[1:100], waiting[1:100], type="l")
```
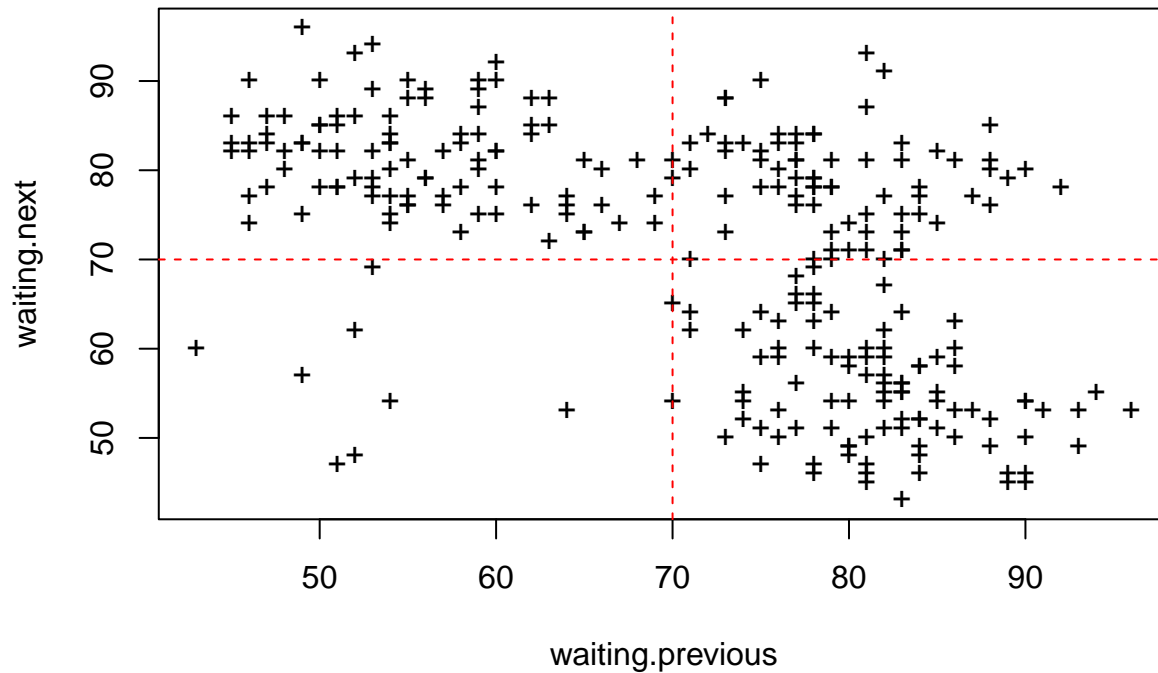
```
waiting.next <- waiting[-1]
waiting.previous <- waiting[-n]

plot(waiting.previous, waiting.next, pch="+")

abline(h=70, lty=2, col="red")
abline(v=70, lty=2, col="red")
```



```
detach(faithful)

####################
# "Animals" data
#  and transformations

library(MASS)
data("Animals")
attach(Animals)
help("Animals")


summary(body)
```
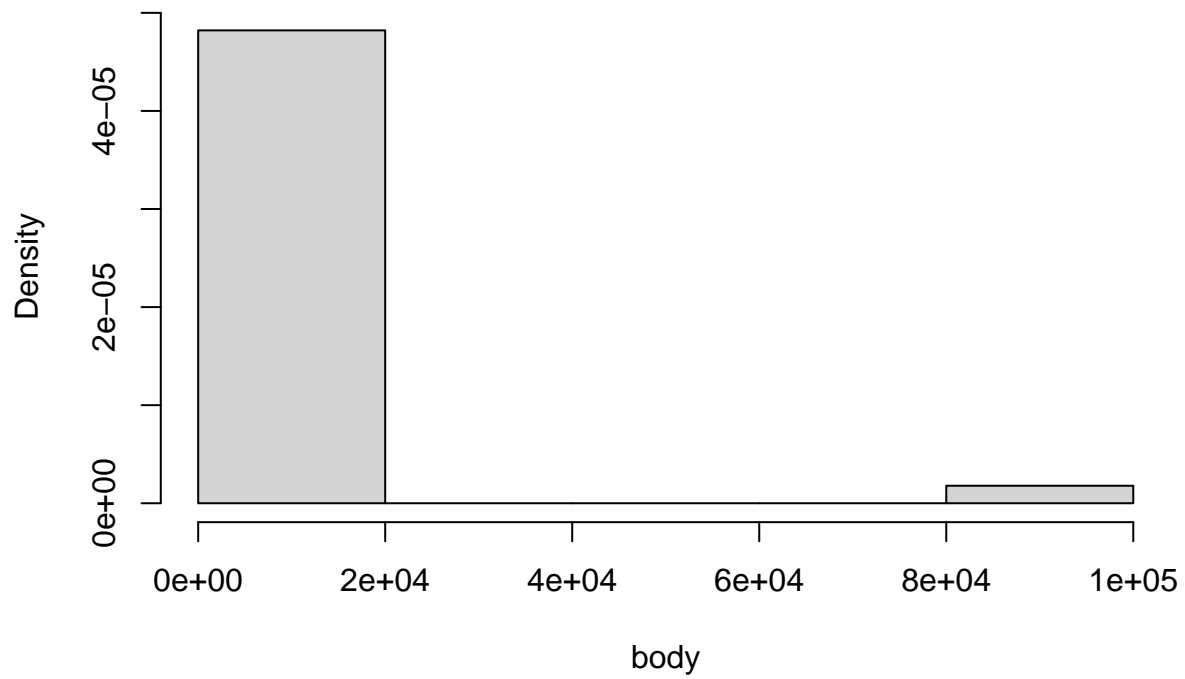
```
##     Min. 1st Qu.  Median    Mean 3rd Qu.     Max.
##     0.02    3.10   53.83 4278.44  479.00 87000.00
```
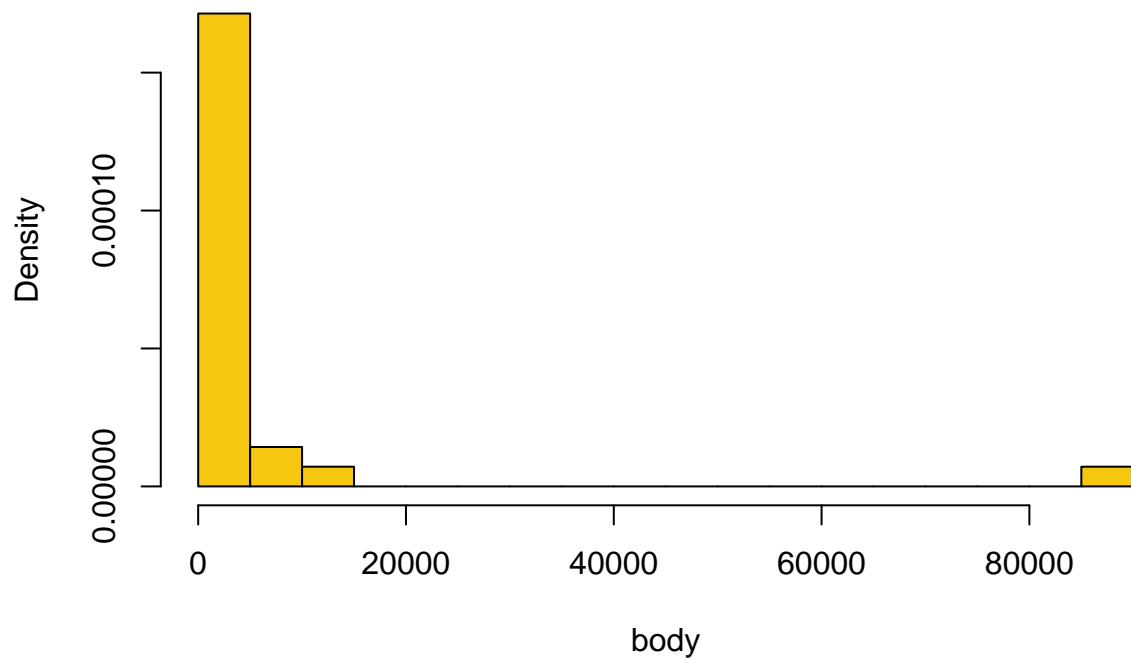
```
hist(body, prob=TRUE)
```

Histogram of body


```
hist(body, breaks=20, prob=TRUE, col=7)
```

Histogram of body

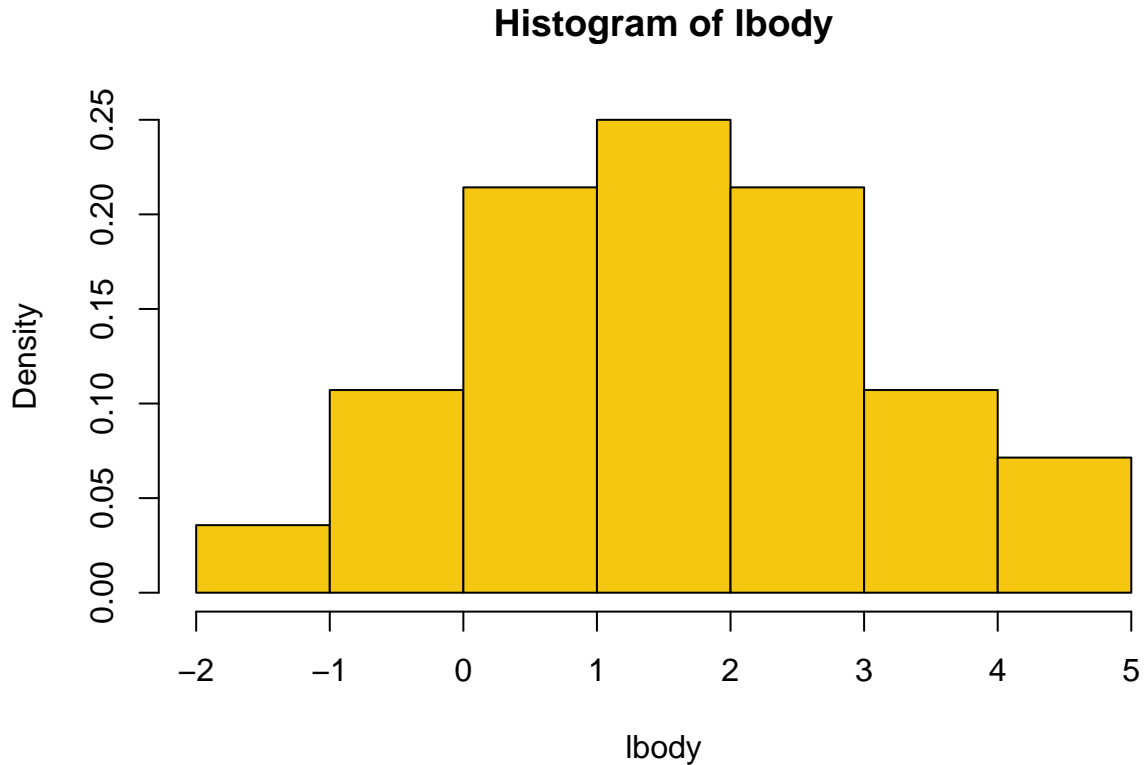

```
# Logarithmic transformation

lbody <- log10(body)
```

```
summary(lbody)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -1.6383  0.4884  1.7308  1.6379  2.6798  4.9395
```

```
hist(lbody, prob=TRUE, col=7)
```

Histogram of lbody


```
# inverse transformation

10^mean(lbody)
```

```
## [1] 43.43674
```

```
summary(body)
```

```
##     Min. 1st Qu.   Median     Mean 3rd Qu.      Max.
##     0.02    3.10    53.83  4278.44  479.00 87000.00
```
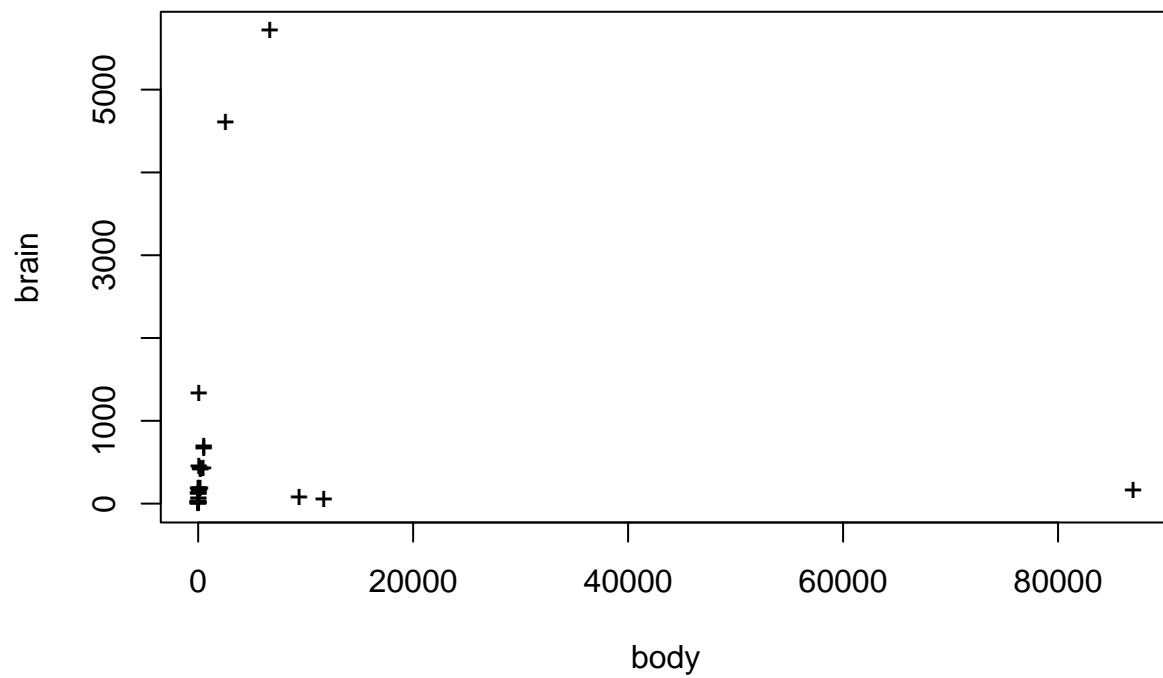
```
# geometric mean
n <- length(body)
prod(body)^(1/n)
```

```
## [1] 43.43674
```

```
# scatterplot
plot(body, brain, pch="+")
```

```
lbrain <- log10(brain)
plot(lbody, lbrain, pch=16)
```


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