Introductory of Data Science

2022-04-12

Contents

Chapter 1

Prerequisites

"4V+C" Value Variatey Volumn Velocity Complex

Chapter 2

R Python

2.0.1 R

1. R S , S “ ”;
2. S 70 , Rick Becker, John Chambers, Allan Wilks ; S S-plus, , , .
3. 1995 , Auckland Robert Gentleman Ross Ihaka, S , S , , R , R .

2.0.2 R

- R R

1.
2.

- r

2.0.3 Rstudio

- Rstudio Rstudio

1. free
2.

- r
- R win

-
- Rstudio Studio R

2.0.4 R

```
# R
x=1:100# 1,2,...,100     x
(x=1:100) # ,
```

```
##   [1]   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18
##  [19]  19  20  21  22  23  24  25  26  27  28  29  30  31  32  33  34  35  36
##  [37]  37  38  39  40  41  42  43  44  45  46  47  48  49  50  51  52  53  54
##  [55]  55  56  57  58  59  60  61  62  63  64  65  66  67  68  69  70  71  72
##  [73]  73  74  75  76  77  78  79  80  81  82  83  84  85  86  87  88  89  90
##  [91]  91  92  93  94  95  96  97  98  99 100
```

```
sample(x,20) # 1,2,...,100     20
```

```
##  [1]  82  85  25  11  12  95  99  43  10  13 100   7  92  68  49  21  73  18  33
## [20]  84
```

```
set.seed(0);sample(1:10,3)#
```

```
## [1] 9 4 7
```

```
# 1,2,...,200000     10000    :
z=sample(1:20,5)
z[1:3]#    z
```

```
## [1]  1  2 11
```

```
y=c(1,3,7,3,4,2)
z[y]# y   z
```

```
## [1]  1 11 NA 11 14  2
```

```
(z=sample(x,100,rep=T))# x     100
```

```
##   [1]  59  51  97  85  21  54  74   7  73  79  85  37  89  37  34  89  44  79
##  [19]  33  84  35  70  74  42  38  20  28  20  44  87  70  40  44  25  70  39
##  [37]  51  42   6  24  32  14   2  45  18  22  78  65  70  87  70  75  81 100
##  [55]  13  40  89  48  89  23  84  29  13  22  93  28  48  33  45  21  31  17
##  [73]  73  87  83  90  48  64  94  96  60  51  93  34  10   1  43  59  26  15
##  [91]  58  29  24  42  48  76  39  24  53  92
```

```
(z1=unique(z))
```

```
##  [1]  59  51  97  85  21  54  74   7  73  79  37  89  34  44  33  84  35  70  42
## [20]  38  20  28  87  40  25  39   6  24  32  14   2  45  18  22  78  65  75  81
## [39] 100  13  48  23  29  93  31  17  83  90  64  94  96  60  10   1  43  26  15
## [58]  58  76  53  92
```

```
length(z1)#z
```

```
## [1] 61
```

```
xz=setdiff(x,z) #x z    --
sort(union(xz,z))# xz z
```

```
##   [1]   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18
##  [19]  19  20  21  22  23  24  25  26  27  28  29  30  31  32  33  34  35  36
##  [37]  37  38  39  40  41  42  43  44  45  46  47  48  49  50  51  52  53  54
##  [55]  55  56  57  58  59  60  61  62  63  64  65  66  67  68  69  70  71  72
##  [73]  73  74  75  76  77  78  79  80  81  82  83  84  85  86  87  88  89  90
##  [91]  91  92  93  94  95  96  97  98  99 100
```

```
setequal(union(xz,z),x) #xz z   x
```

```
## [1] TRUE
```

```
intersect(1:10,7:50) #
```

```
## [1]  7  8  9 10
```

```
sample(1:100,20,prob=1:100)# 1:100     ,
```

```
##  [1] 91 50 95 36 62 67 82 74 70 90 66 97 84 87 81 29 71 43 31 75
```

```
#
pi*10^2 #  ?"*" ?"^"       , pi
```

```
## [1] 314.1593
```

```
"*"(pi,"^"(10,2)) #   ,   ,  !
```

```
## [1] 314.1593
```

```
pi*(1:10)^-2.3#
```

```
##  [1] 3.14159265 0.63794154 0.25105622 0.12954239 0.07753876 0.05098025
##  [7] 0.03576221 0.02630528 0.02006283 0.01574526
```

```
x = pi * 10^2 ; print(x)
```

```
## [1] 314.1593
```

```
(x=pi *10^2) #
```

```
## [1] 314.1593
```

```
pi^(1:5) #
```

```
## [1]   3.141593   9.869604  31.006277  97.409091 306.019685
```

```
print(x, digits= 12)# x 12
```

```
## [1] 314.159265359
```

```
#R
x=pi*10^2
class(x) #x class
```

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

```
typeof(x) #x type
```

```
## [1] "double"
```

```
class(cars)#cars  R
```

```
## [1] "data.frame"
```

```
typeof(cars) #cars type
```

```
## [1] "list"
```

```
names(cars)#cars
```

```
## [1] "speed" "dist"
```

```
summary(cars) #cars
```

```
##      speed           dist       
##  Min.   : 4.0   Min.   :  2.00  
##  1st Qu.:12.0   1st Qu.: 26.00  
##  Median :15.0   Median : 36.00  
##  Mean   :15.4   Mean   : 42.98  
##  3rd Qu.:19.0   3rd Qu.: 56.00  
##  Max.   :25.0   Max.   :120.00
```

```
head(cars)#cars   ,  cars[1:6,]
```

```
##   speed dist
## 1     4    2
## 2     4   10
## 3     7    4
## 4     7   22
## 5     8   16
## 6     9   10
```

```
tail(cars) #cars
```

```
##    speed dist
## 45    23   54
## 46    24   70
## 47    24   92
## 48    24   93
## 49    24  120
## 50    25   85
```

```
str(cars)#
```

```
## 'data.frame':    50 obs. of  2 variables:
##  $ speed: num  4 4 7 7 8 9 10 10 10 11 ...
##  $ dist : num  2 10 4 22 16 10 18 26 34 17 ...
```

```
row.names(cars) #
```

```
##  [1] "1"  "2"  "3"  "4"  "5"  "6"  "7"  "8"  "9"  "10" "11" "12" "13" "14" "15"
## [16] "16" "17" "18" "19" "20" "21" "22" "23" "24" "25" "26" "27" "28" "29" "30"
## [31] "31" "32" "33" "34" "35" "36" "37" "38" "39" "40" "41" "42" "43" "44" "45"
## [46] "46" "47" "48" "49" "50"
```

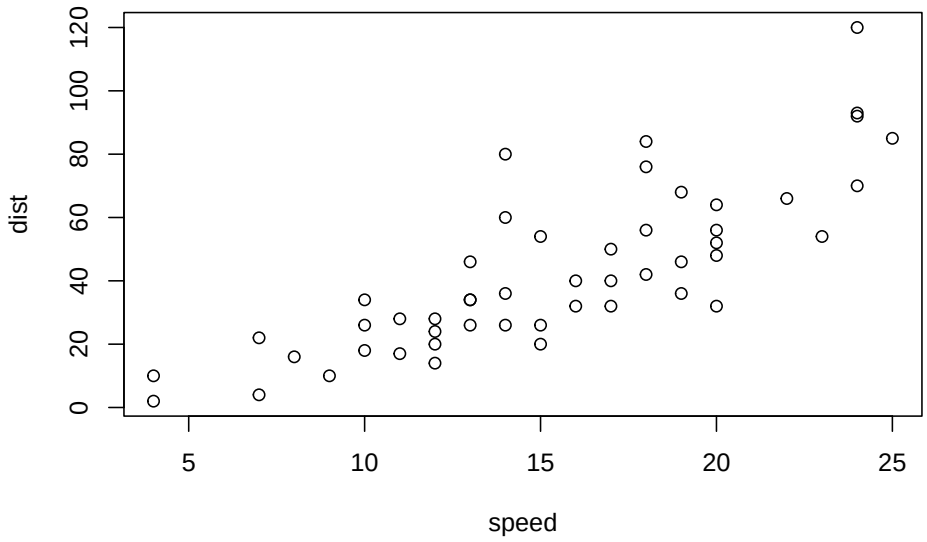
```
attributes(cars)#cars
```

```
## $names
## [1] "speed" "dist"
##
## $class
## [1] "data.frame"
##
## $row.names
##  [1]  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
## [26] 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
```

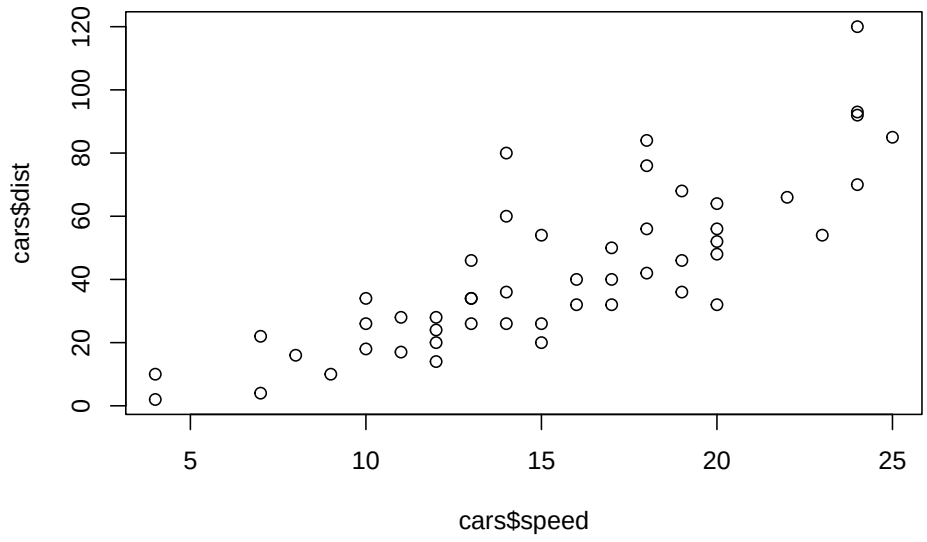
```
class(dist~speed)#  ,"~"   ,
```

```
## [1] "formula"
```

```
plot(dist~speed,cars)#
```




```
plot(cars$speed,cars$dist) #
```




```
#

ncol(cars);nrow(cars) #cars
```

```
## [1] 2
```

```
## [1] 50
```

```
dim(cars) #cars
```

```
## [1] 50  2
```

```
lm(dist ~ speed, data = cars)# dist  ,speed  OLS
```

```
##
## Call:
## lm(formula = dist ~ speed, data = cars)
##
## Coefficients:
## (Intercept)        speed
##     -17.579        3.932
```

```
cars$qspeed =cut(cars$speed, breaks=quantile(cars$speed),
include.lowest = TRUE) #   qspeed,
names(cars) # cars
```

```
## [1] "speed"  "dist"   "qspeed"
```

```
cars[3]#    ,  cars[,3]
```

```
##     qspeed
## 1   [4,12]
## 2   [4,12]
## 3   [4,12]
## 4   [4,12]
## 5   [4,12]
## 6   [4,12]
## 7   [4,12]
## 8   [4,12]
## 9   [4,12]
## 10  [4,12]
## 11  [4,12]
## 12  [4,12]
## 13  [4,12]
## 14  [4,12]
## 15  [4,12]
## 16 (12,15]
## 17 (12,15]
## 18 (12,15]
```

```
## 19 (12,15]
## 20 (12,15]
## 21 (12,15]
## 22 (12,15]
## 23 (12,15]
## 24 (12,15]
## 25 (12,15]
## 26 (12,15]
## 27 (15,19]
## 28 (15,19]
## 29 (15,19]
## 30 (15,19]
## 31 (15,19]
## 32 (15,19]
## 33 (15,19]
## 34 (15,19]
## 35 (15,19]
## 36 (15,19]
## 37 (15,19]
## 38 (15,19]
## 39 (19,25]
## 40 (19,25]
## 41 (19,25]
## 42 (19,25]
## 43 (19,25]
## 44 (19,25]
## 45 (19,25]
## 46 (19,25]
## 47 (19,25]
## 48 (19,25]
## 49 (19,25]
## 50 (19,25]
```

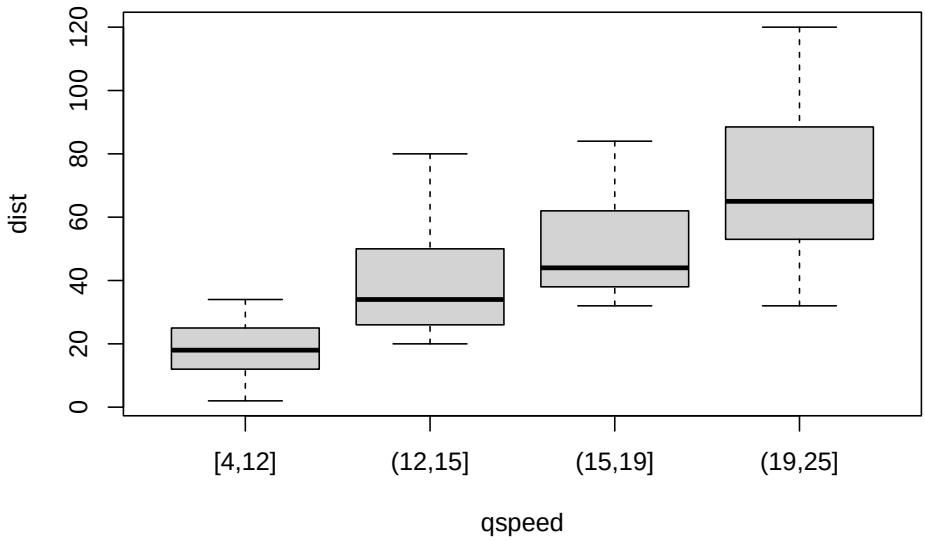
```
table(cars[3])#
```

```
##
##  [4,12] (12,15] (15,19] (19,25]
##      15      11      12      12
```

```
is.factor(cars$qspeed)
```

```
## [1] TRUE
```

```
plot(dist ~ qspeed, data = cars)#
```




```
#   (    ):
(a=lm(dist ~ qspeed, data = cars))
```

```
##
## Call:
## lm(formula = dist ~ qspeed, data = cars)
##
## Coefficients:
##   (Intercept)  qspeed(12,15]  qspeed(15,19]  qspeed(19,25]
##         18.20          21.98          31.97          51.13
```

```
summary(a)#  (    )
```

```
##
## Call:
## lm(formula = dist ~ qspeed, data = cars)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -37.33 -13.96  -3.75   9.30  50.67
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)     18.200      4.551   3.999 0.000228 ***
```

```
## qspeed(12,15]   21.982      6.996   3.142 0.002933 **
## qspeed(15,19]   31.967      6.826   4.683 2.52e-05 ***
## qspeed(19,25]   51.133      6.826   7.491 1.68e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 17.62 on 46 degrees of freedom
## Multiple R-squared:  0.5609, Adjusted R-squared:  0.5322
## F-statistic: 19.59 on 3 and 46 DF,  p-value: 2.517e-08
```

```
x <- round(runif(20,0,20), digits=2)#
summary(x) #
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    1.28    6.74   12.36   11.29   16.89   18.06
```

```
min(x);max(x) # ,  range(x)
```

```
## [1] 1.28
```

```
## [1] 18.06
```

```
median(x)  #   (median)
```

```
## [1] 12.36
```

```
mean(x)    #  (mean)
```

```
## [1] 11.29
```

```
var(x)     # (variance)
```

```
## [1] 30.12734
```

```
sd(x)      #   (standard deviation),
```

```
## [1] 5.488837
```

```
sqrt(var(x)) #
```

```
## [1] 5.488837
```

```
rank(x)    # (rank)
```

```
##  [1]  1  5 13  6 11 15 16  8  7 19 12 14 10 20  4  3 18  9 17  2
```

```
order(x)#   x
```

```
##  [1]  1 20 16 15  2  4  9  8 18 13  5 11  3 12  6  7 19 17 10 14
```

```
order(x,decreasing = T)#   x
```

```
##  [1] 14 10 17 19  7  6 12  3 11  5 13 18  8  9  4  2 15 16 20  1
```

```
x[order(x)] # sort(x)
```

```
##  [1]  1.28  3.78  3.83  5.87  6.71  6.75  7.61  7.83 10.07 12.11 12.61 12.89
## [13] 14.47 14.82 16.81 17.12 17.54 17.73 17.91 18.06
```

```
sort(x)     # :    x
```

```
##  [1]  1.28  3.78  3.83  5.87  6.71  6.75  7.61  7.83 10.07 12.11 12.61 12.89
## [13] 14.47 14.82 16.81 17.12 17.54 17.73 17.91 18.06
```

```
sort(x,decreasing=T)#sort(x,dec=T)    x
```

```
##  [1] 18.06 17.91 17.73 17.54 17.12 16.81 14.82 14.47 12.89 12.61 12.11 10.07
## [13]  7.83  7.61  6.75  6.71  5.87  3.83  3.78  1.28
```

```
sum(x);length(x)#
```

```
## [1] 225.8
```

```
## [1] 20
```

```
round(x) #   , round(x,0), round(x,5)    5
```

```
##  [1]  1  7 14  7 13 17 17  8  8 18 13 15 12 18  6  4 18 10 18  4
```

```
fivenum(x)  #   , quantile
```

```
## [1]  1.280  6.730 12.360 16.965 18.060
```

```
quantile(x) #    quantile (different convention)
```

```
##      0%     25%     50%     75%    100%
##  1.2800  6.7400 12.3600 16.8875 18.0600
```

```
quantile(x, c(0,.33,.66,1))
```

```
##      0%     33%     66%    100%
##  1.2800  7.6694 14.6590 18.0600
```

```
mad(x) # "median average distance":
```

```
## [1] 7.368522
```

```
cummax(x)#
```

```
##  [1]  1.28  6.71 14.47 14.47 14.47 16.81 17.12 17.12 17.12 17.91 17.91 17.91
## [13] 17.91 18.06 18.06 18.06 18.06 18.06 18.06 18.06
```

```
cummin(x)#
```

```
##  [1] 1.28 1.28 1.28 1.28 1.28 1.28 1.28 1.28 1.28 1.28 1.28 1.28 1.28 1.28 1.28
## [16] 1.28 1.28 1.28 1.28 1.28
```

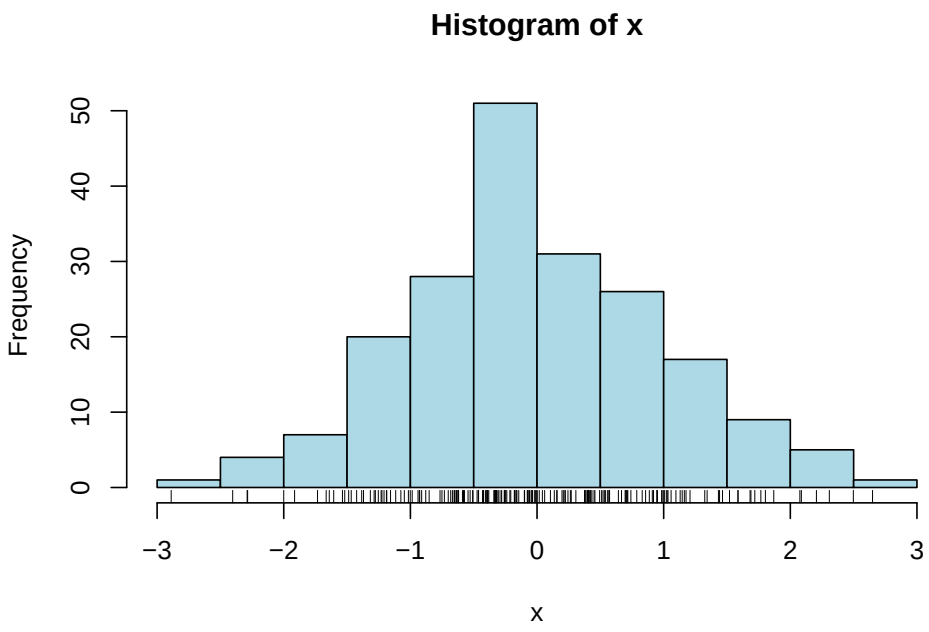
```
cumprod(x)#
```

```
##  [1] 1.280000e+00 8.588800e+00 1.242799e+02 8.388896e+02 1.057840e+04
##  [6] 1.778229e+05 3.044327e+06 2.383708e+07 1.814002e+08 3.248878e+09
## [11] 4.187803e+10 6.206325e+11 7.515859e+12 1.357364e+14 7.967727e+14
## [16] 3.051640e+15 5.410557e+16 5.448431e+17 9.556548e+18 3.612375e+19
```

```
cor(x,sin(x/20)) #    (linear correlation)
```

```
## [1] 0.9981333
```

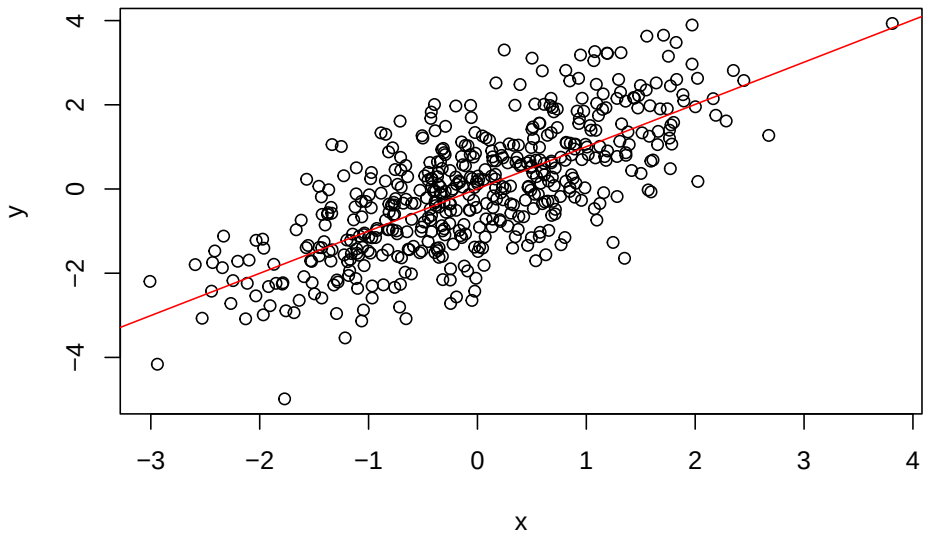
```
#
x=rnorm(200)# 200     x
hist(x, col = "light blue")#  (histogram)
rug(x) #
```




```
stem(x)#
```

```
##
##   The decimal point is at the |
##
##   -2 | 9
##   -2 | 4330
##   -1 | 977665555
##   -1 | 4443333222222110000
##   -0 | 99999988777777666666665555555
##   -0 | 444444443333333333333332222222222111111110000000
##    0 | 000111222222233344444444444
##    0 | 55555556666677777778899999
##    1 | 0000000011112223344
##    1 | 5566777889
##    2 | 1123
##    2 | 56
```

```
x <- rnorm(500)
y <- x + rnorm(500) #
plot(y~ x) #
a=lm(y~x) #
abline(a,col="red")# abline(lm(y~x),col="red")
```




```
print("Hello World!")
```

```
## [1] "Hello World!"
```

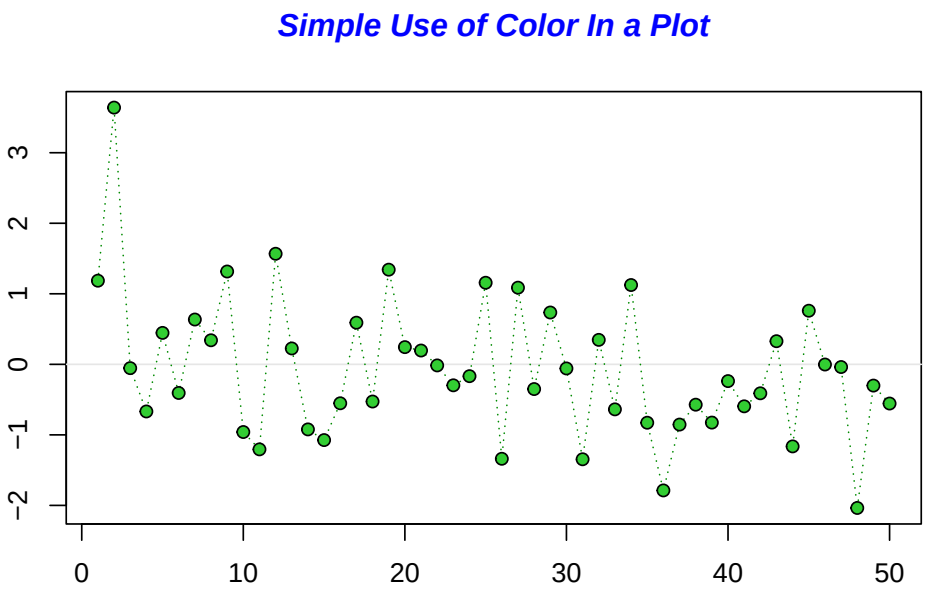
```
paste("x   = ", min(x)) #
```

```
## [1] "x   =  -3.00804859892048"
```

```
demo(graphics)#  ( Enter )
```

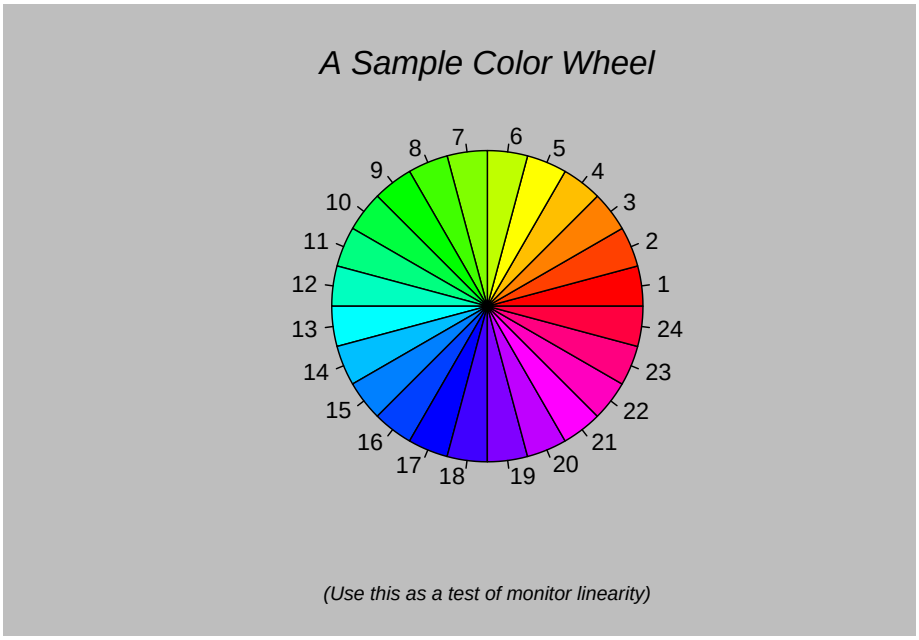
```
##
##
##  demo(graphics)
##  ---- ~~~~~~~~
##
## > #  Copyright (C) 1997-2009 The R Core Team
## >
## > require(datasets)
##
```

```
## > require(grDevices); require(graphics)
##
## > ## Here is some code which illustrates some of the differences between
## > ## R and S graphics capabilities.  Note that colors are generally specified
## > ## by a character string name (taken from the X11 rgb.txt file) and that line
## > ## textures are given similarly.  The parameter "bg" sets the background
## > ## parameter for the plot and there is also an "fg" parameter which sets
## > ## the foreground color.
## >
## >
## > x <- stats::rnorm(50)
##
## > opar <- par(bg = "white")
##
## > plot(x, ann = FALSE, type = "n")
```



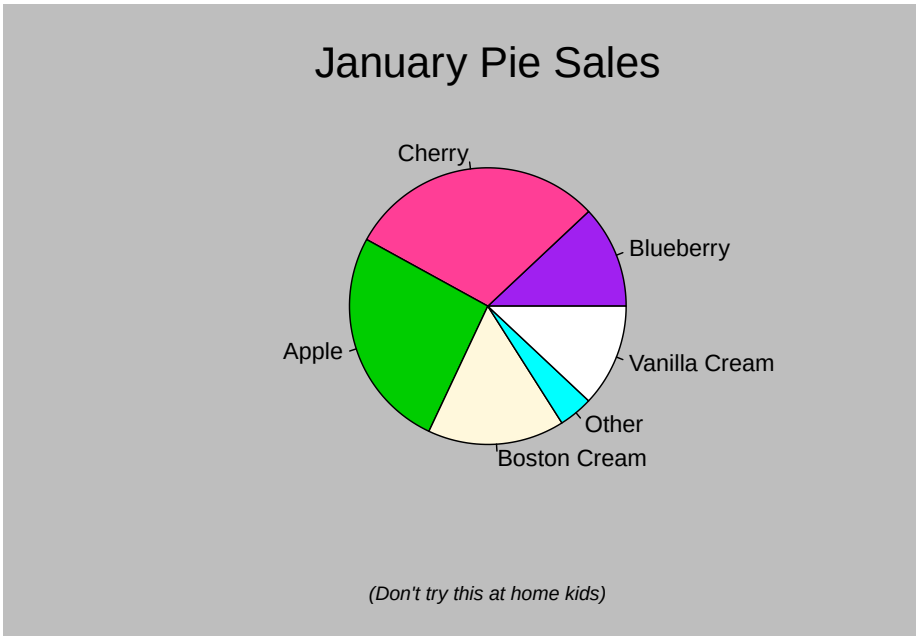

```
##
## > abline(h = 0, col = gray(.90))
##
## > lines(x, col = "green4", lty = "dotted")
##
## > points(x, bg = "limegreen", pch = 21)
##
## > title(main = "Simple Use of Color In a Plot",
```

```
## +       xlab = "Just a Whisper of a Label",
## +       col.main = "blue", col.lab = gray(.8),
## +       cex.main = 1.2, cex.lab = 1.0, font.main = 4, font.lab = 3)
##
## > ## A little color wheel.    This code just plots equally spaced hues in
## > ## a pie chart.    If you have a cheap SVGA monitor (like me) you will
## > ## probably find that numerically equispaced does not mean visually
## > ## equispaced.  On my display at home, these colors tend to cluster at
## > ## the RGB primaries.  On the other hand on the SGI Indy at work the
## > ## effect is near perfect.
## >
## > par(bg = "gray")
##
## > pie(rep(1,24), col = rainbow(24), radius = 0.9)
```



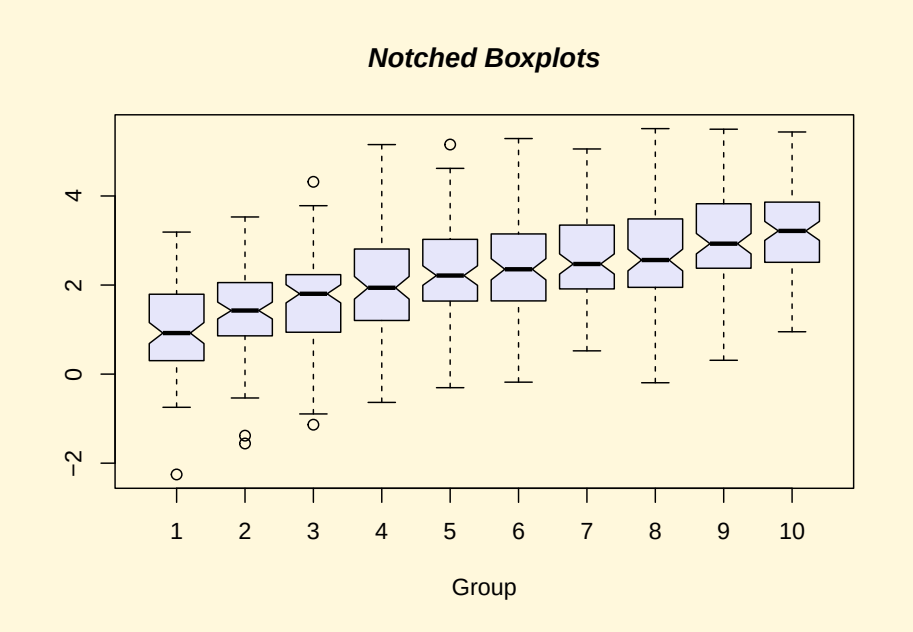

```
##
## > title(main = "A Sample Color Wheel", cex.main = 1.4, font.main = 3)
##
## > title(xlab = "(Use this as a test of monitor linearity)",
## +       cex.lab = 0.8, font.lab = 3)
##
## > ## We have already confessed to having these.  This is just showing off X11
## > ## color names (and the example (from the postscript manual) is pretty "cute".
## >
```

```
## > pie.sales <- c(0.12, 0.3, 0.26, 0.16, 0.04, 0.12)
##
## > names(pie.sales) <- c("Blueberry", "Cherry",
## +              "Apple", "Boston Cream", "Other", "Vanilla Cream")
##
## > pie(pie.sales,
## +     col = c("purple","violetred1","green3","cornsilk","cyan","white"))
```

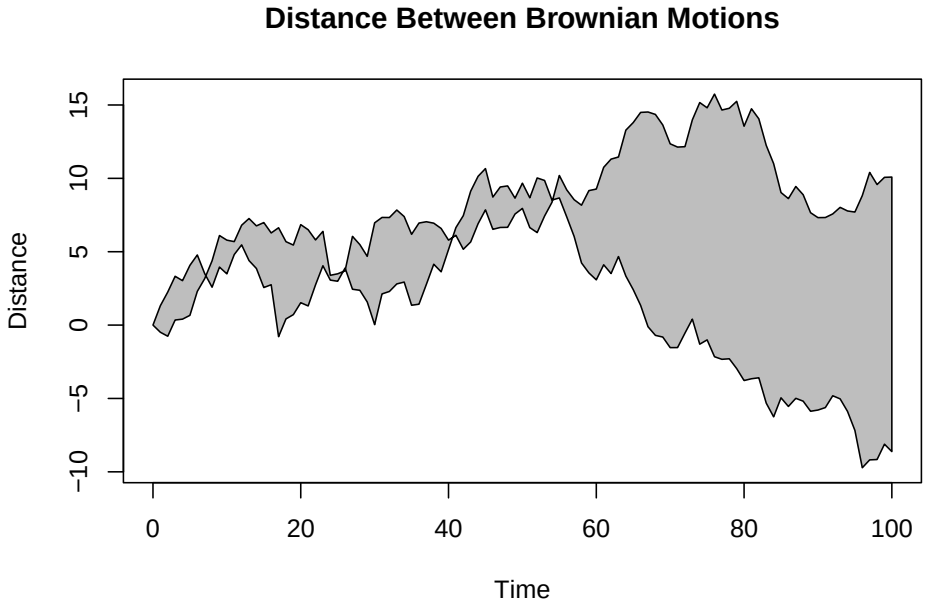



```
##
## > title(main = "January Pie Sales", cex.main = 1.8, font.main = 1)
##
## > title(xlab = "(Don't try this at home kids)", cex.lab = 0.8, font.lab = 3)
##
## > ## Boxplots:  I couldn't resist the capability for filling the "box".
## > ## The use of color seems like a useful addition, it focuses attention
## > ## on the central bulk of the data.
## >
## > par(bg="cornsilk")
##
## > n <- 10
##
## > g <- gl(n, 100, n*100)
##
## > x <- rnorm(n*100) + sqrt(as.numeric(g))
```

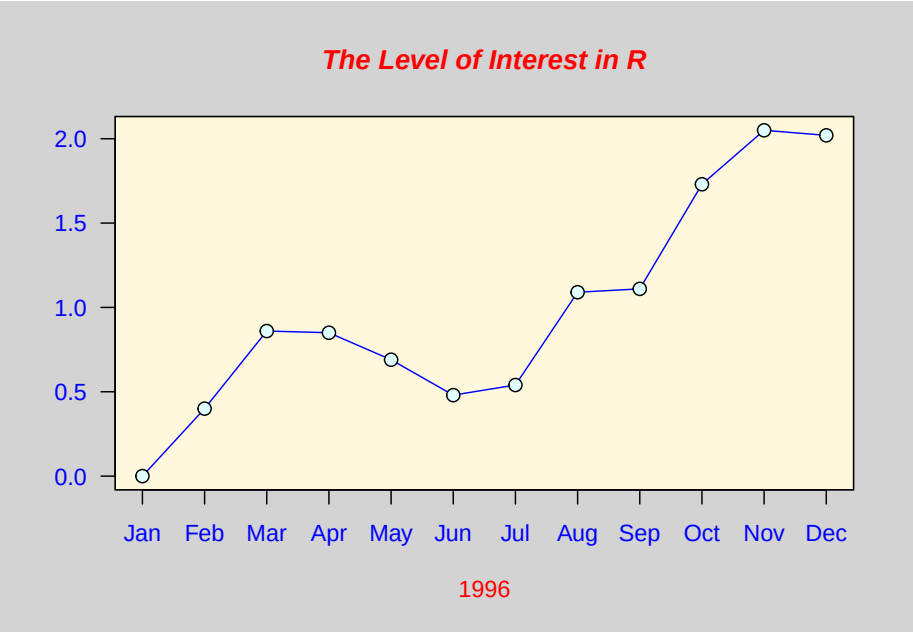
```
##
## > boxplot(split(x,g), col="lavender", notch=TRUE)
```




```
##
## > title(main="Notched Boxplots", xlab="Group", font.main=4, font.lab=1)
##
## > ## An example showing how to fill between curves.
## >
## > par(bg="white")
##
## > n <- 100
##
## > x <- c(0,cumsum(rnorm(n)))
##
## > y <- c(0,cumsum(rnorm(n)))
##
## > xx <- c(0:n, n:0)
##
## > yy <- c(x, rev(y))
##
## > plot(xx, yy, type="n", xlab="Time", ylab="Distance")
```

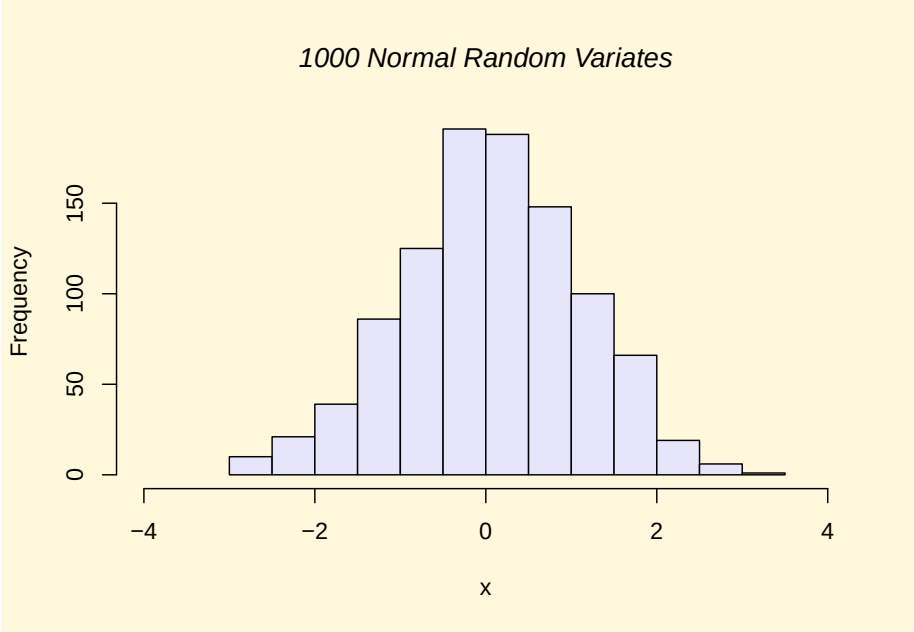



```
##
## > polygon(xx, yy, col="gray")
##
## > title("Distance Between Brownian Motions")
##
## > ## Colored plot margins, axis labels and titles.    You do need to be
## > ## careful with these kinds of effects.    It's easy to go completely
## > ## over the top and you can end up with your lunch all over the keyboard.
## > ## On the other hand, my market research clients love it.
## >
## > x <- c(0.00, 0.40, 0.86, 0.85, 0.69, 0.48, 0.54, 1.09, 1.11, 1.73, 2.05, 2.02)
##
## > par(bg="lightgray")
##
## > plot(x, type="n", axes=FALSE, ann=FALSE)
```

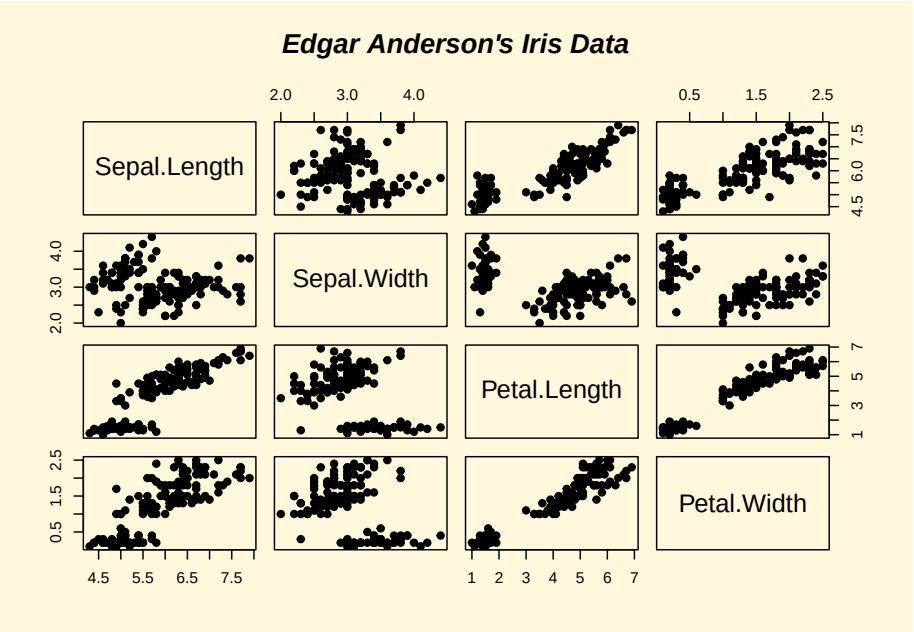



```
##
## > usr <- par("usr")
##
## > rect(usr[1], usr[3], usr[2], usr[4], col="cornsilk", border="black")
##
## > lines(x, col="blue")
##
## > points(x, pch=21, bg="lightcyan", cex=1.25)
##
## > axis(2, col.axis="blue", las=1)
##
## > axis(1, at=1:12, lab=month.abb, col.axis="blue")
##
## > box()
##
## > title(main= "The Level of Interest in R", font.main=4, col.main="red")
##
## > title(xlab= "1996", col.lab="red")
##
## > ## A filled histogram, showing how to change the font used for the
## > ## main title without changing the other annotation.
## >
## > par(bg="cornsilk")
##
## > x <- rnorm(1000)
```

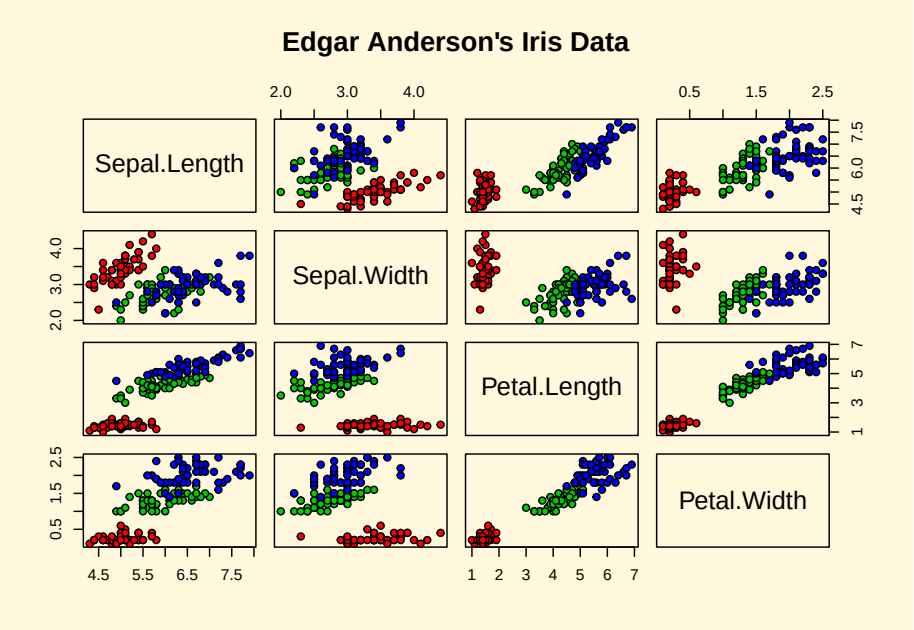
```
##
## > hist(x, xlim=range(-4, 4, x), col="lavender", main="")
```



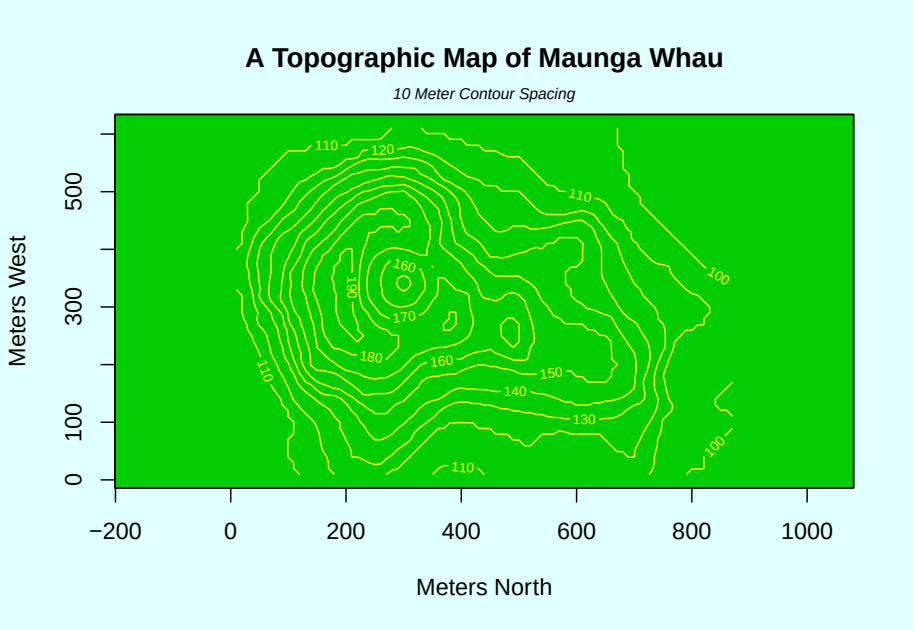

```
##
## > title(main="1000 Normal Random Variates", font.main=3)
##
## > ## A scatterplot matrix
## > ## The good old Iris data (yet again)
## >
## > pairs(iris[1:4], main="Edgar Anderson's Iris Data", font.main=4, pch=19)
```



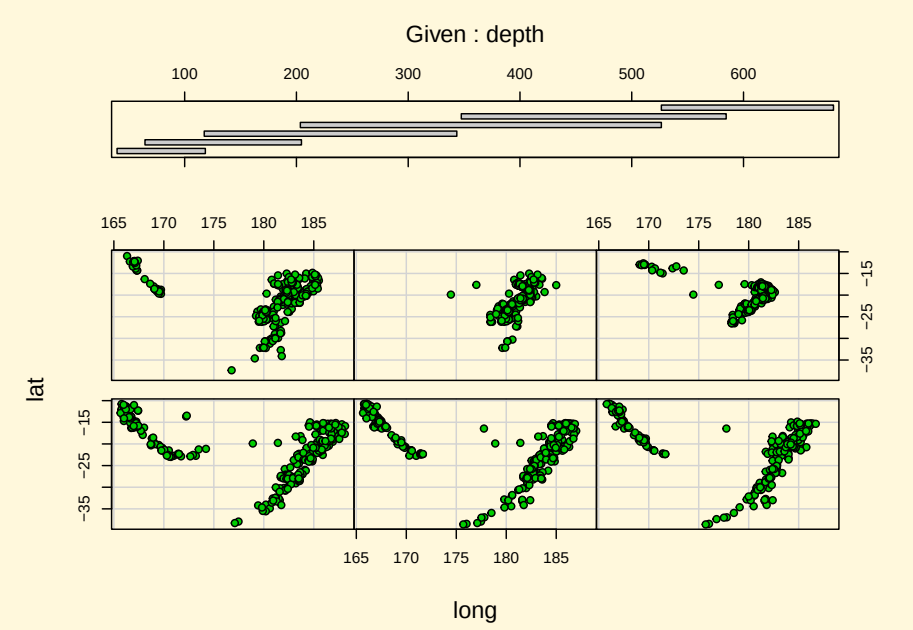

```
##
## > pairs(iris[1:4], main="Edgar Anderson's Iris Data", pch=21,
## +       bg = c("red", "green3", "blue")[unclass(iris$Species)])
```



```
##
## > ## Contour plotting
## > ## This produces a topographic map of one of Auckland's many volcanic "peaks".
## >
## > x <- 10*1:nrow(volcano)
##
## > y <- 10*1:ncol(volcano)
##
## > lev <- pretty(range(volcano), 10)
##
## > par(bg = "lightcyan")
##
## > pin <- par("pin")
##
## > xdelta <- diff(range(x))
##
## > ydelta <- diff(range(y))
##
## > xscale <- pin[1]/xdelta
##
## > yscale <- pin[2]/ydelta
##
## > scale <- min(xscale, yscale)
##
## > xadd <- 0.5*(pin[1]/scale - xdelta)
##
## > yadd <- 0.5*(pin[2]/scale - ydelta)
##
## > plot(numeric(0), numeric(0),
## +      xlim = range(x)+c(-1,1)*xadd, ylim = range(y)+c(-1,1)*yadd,
## +      type = "n", ann = FALSE)
```




```
##
## > usr <- par("usr")
##
## > rect(usr[1], usr[3], usr[2], usr[4], col="green3")
##
## > contour(x, y, volcano, levels = lev, col="yellow", lty="solid", add=TRUE)
##
## > box()
##
## > title("A Topographic Map of Maunga Whau", font= 4)
##
## > title(xlab = "Meters North", ylab = "Meters West", font= 3)
##
## > mtext("10 Meter Contour Spacing", side=3, line=0.35, outer=FALSE,
## +       at = mean(par("usr")[1:2]), cex=0.7, font=3)
##
## > ## Conditioning plots
## >
## > par(bg="cornsilk")
##
## > coplot(lat ~ long | depth, data = quakes, pch = 21, bg = "green3")
```




```
##
## > par(opar)
```

```
#
(2+4i)^-3.5+(2i+4.5)*(-1.7-2.3i)/((2.6-7i)*(-4+5.1i))#
```

```
## [1] -0.2790593-0.091246i
```

```
#   10  ,     10    :
(z <-complex(real=rnorm(10), imaginary =rnorm(10)))
```

```
##  [1] -0.4742553+0.5064816i -0.0698126+0.5236044i -0.7625232+0.6249499i
##  [4] -0.5726097-2.9808548i -1.1276920+1.8869267i  0.1227265+0.4598803i
##  [7]  1.2287895+0.3914276i -0.5875730-1.1872535i -1.8391681+0.4443236i
## [10]  0.4978261-0.7539440i
```

```
complex(re=rnorm(3),im=rnorm(3))#3
```

```
## [1]  0.2110114+0.6801056i -0.1367521-0.0557254i  0.0132440-0.4990980i
```

```
Re(z) #
```

```
##  [1] -0.47425527 -0.06981258 -0.76252319 -0.57260970 -1.12769199  0.12272654
##  [7]  1.22878953 -0.58757302 -1.83916811  0.49782614
```

```
Im(z) #
```

```
##  [1]  0.5064816  0.5236044  0.6249499 -2.9808548  1.8869267  0.4598803
##  [7]  0.3914276 -1.1872535  0.4443236 -0.7539440
```

```
Mod(z) #
```

```
##  [1] 0.6938600 0.5282380 0.9859026 3.0353545 2.1982224 0.4759744 1.2896276
##  [8] 1.3246935 1.8920790 0.9034724
```

```
Arg(z) #
```

```
##  [1]  2.3233470  1.7033453  2.4550253 -1.7605803  2.1094745  1.3100076
##  [7]  0.3083847 -2.0303565  2.9045454 -0.9872172
```

```
choose(3,2) #
```

```
## [1] 3
```

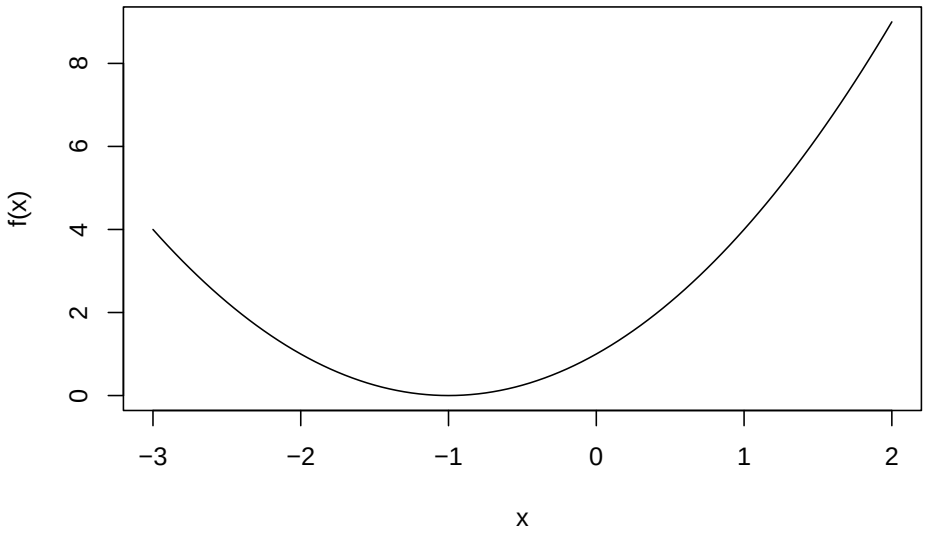
```
factorial(6)# 6!
```

```
## [1] 720
```

```
#
f=function(x) x^2+2*x+1 #
optimize(f,c(-2,2))#  (-2,2)
```

```
## $minimum
## [1] -1
##
## $objective
## [1] 0
```

```
curve(f, from = -3,to=2)#  (-3,2)     f
```




```
#    5     1, 2, 2, 4, -9, 8    :
polyroot(c(1,2,2,4,-9,8))
```

```
## [1] -0.1128081+0.4980033i -0.3912226+0.0000000i -0.1128081-0.4980033i
## [4]  0.8709194-0.6833257i  0.8709194+0.6833257i
```

```
#
a=factor(letters[1:10]);a #letters:    ,LETTERS:
```

```
##  [1] a b c d e f g h i j
## Levels: a b c d e f g h i j
```

```
a[3]="w" # !
```

```
## Warning in `[<-.factor`(`*tmp*`, 3, value = "w"): invalid factor level, NA
## generated
```

```
a=as.character(a) #
a[3]="w" #
a;factor(a) #
```

```
##  [1] "a" "b" "w" "d" "e" "f" "g" "h" "i" "j"
```

```
##  [1] a b w d e f g h i j
## Levels: a b d e f g h i j w
```

```
#    :
levels(factor(a))
```

```
##  [1] "a" "b" "d" "e" "f" "g" "h" "i" "j" "w"
```

```
sex=sample(0:1,10,r=T)
sex=factor(sex);levels(sex)
```

```
## [1] "0" "1"
```

```
#    :
levels(sex)=c("Male","Female");levels(sex)
```

```
## [1] "Male"   "Female"
```

```
#    :
sex=ordered(sex,c("Female","Male"));sex
```

```
##  [1] Female Female Female Female Male   Male   Male   Female Female Female
## Levels: Female < Male
```

```
levels(sex)
```

```
## [1] "Female" "Male"
```

```
#

(z=seq(-1,10,length=100))# -1 10  100
```

```
##   [1] -1.0000000 -0.8888889 -0.7777778 -0.6666667 -0.5555556 -0.4444444
##   [7] -0.3333333 -0.2222222 -0.1111111  0.0000000  0.1111111  0.2222222
##  [13]  0.3333333  0.4444444  0.5555556  0.6666667  0.7777778  0.8888889
##  [19]  1.0000000  1.1111111  1.2222222  1.3333333  1.4444444  1.5555556
##  [25]  1.6666667  1.7777778  1.8888889  2.0000000  2.1111111  2.2222222
##  [31]  2.3333333  2.4444444  2.5555556  2.6666667  2.7777778  2.8888889
##  [37]  3.0000000  3.1111111  3.2222222  3.3333333  3.4444444  3.5555556
##  [43]  3.6666667  3.7777778  3.8888889  4.0000000  4.1111111  4.2222222
##  [49]  4.3333333  4.4444444  4.5555556  4.6666667  4.7777778  4.8888889
##  [55]  5.0000000  5.1111111  5.2222222  5.3333333  5.4444444  5.5555556
```

```
##  [61]  5.6666667  5.7777778  5.8888889  6.0000000  6.1111111  6.2222222
##  [67]  6.3333333  6.4444444  6.5555556  6.6666667  6.7777778  6.8888889
##  [73]  7.0000000  7.1111111  7.2222222  7.3333333  7.4444444  7.5555556
##  [79]  7.6666667  7.7777778  7.8888889  8.0000000  8.1111111  8.2222222
##  [85]  8.3333333  8.4444444  8.5555556  8.6666667  8.7777778  8.8888889
##  [91]  9.0000000  9.1111111  9.2222222  9.3333333  9.4444444  9.5555556
##  [97]  9.6666667  9.7777778  9.8888889 10.0000000
```

```
z=seq(-1,10,len=100)#
(z=seq(10,-1,-0.1)) #10 -1  -0.1
```

```
##   [1] 10.0  9.9  9.8  9.7  9.6  9.5  9.4  9.3  9.2  9.1  9.0  8.9  8.8  8.7  8.6
##  [16]  8.5  8.4  8.3  8.2  8.1  8.0  7.9  7.8  7.7  7.6  7.5  7.4  7.3  7.2  7.1
##  [31]  7.0  6.9  6.8  6.7  6.6  6.5  6.4  6.3  6.2  6.1  6.0  5.9  5.8  5.7  5.6
##  [46]  5.5  5.4  5.3  5.2  5.1  5.0  4.9  4.8  4.7  4.6  4.5  4.4  4.3  4.2  4.1
##  [61]  4.0  3.9  3.8  3.7  3.6  3.5  3.4  3.3  3.2  3.1  3.0  2.9  2.8  2.7  2.6
##  [76]  2.5  2.4  2.3  2.2  2.1  2.0  1.9  1.8  1.7  1.6  1.5  1.4  1.3  1.2  1.1
##  [91]  1.0  0.9  0.8  0.7  0.6  0.5  0.4  0.3  0.2  0.1  0.0 -0.1 -0.2 -0.3 -0.4
## [106] -0.5 -0.6 -0.7 -0.8 -0.9 -1.0
```

```
(x=rep(1:3,3))  #  1:3
```

```
## [1] 1 2 3 1 2 3 1 2 3
```

```
(x=rep(3:5,1:3)) #  ,    ?
```

```
## [1] 3 4 4 5 5 5
```

```
x=rep(c(1,10),c(4,5))
w=c(1,3,x,z);w[3]#  (  ) (combine)
```

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

```
x=rep(0,10);z=1:3;x+z #  (   , R    )
```

```
## Warning in x + z: longer object length is not a multiple of shorter object
## length
```

```
##  [1] 1 2 3 1 2 3 1 2 3 1
```

```
x*z   #
```

```
## Warning in x * z: longer object length is not a multiple of shorter object
## length
```

```
##  [1] 0 0 0 0 0 0 0 0 0 0
```

```
rev(x)#
```

```
##  [1] 0 0 0 0 0 0 0 0 0 0
```

```
z=c("no cat","has ","nine","tails") #
z[1]=="no cat" #
```

```
## [1] TRUE
```

```
z=1:5
z[7]=8;z #  ? :NA  (not available)
```

```
## [1]  1  2  3  4  5 NA  8
```

```
z=NULL
z[c(1,3,5)]=1:3;
z
```

```
## [1]  1 NA  2 NA  3
```

```
rnorm(10)[c(2,5)]
```

```
## [1]  0.4232452 -1.2447383
```

```
z[-c(1,3)]# 1 3
```

```
## [1] NA NA  3
```

```
z=sample(1:100,10);z
```

```
##  [1] 57 59 72 81 35 80 78 46  9 50
```

```
which(z==max(z))#
```

```
## [1] 4
```

```
#
x=sample(1:100,12);x #
```

```
##  [1] 74 77 82 90 35 53 73 32  9 97 25 87
```

```
all(x>0);all(x!=0);any(x>0);(1:10)[x>0]#
```

```
## [1] TRUE
```

```
## [1] TRUE
```

```
## [1] TRUE
```

```
##  [1]  1  2  3  4  5  6  7  8  9 10 NA NA
```

```
diff(x) #
```

```
##  [1]   3   5   8 -55  18  20 -41 -23  88 -72  62
```

```
diff(x,lag=2) #
```

```
##  [1]   8  13 -47 -37  38 -21 -64  65  16 -10
```

```
x=matrix(1:20,4,5);x #
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    1    5    9   13   17
## [2,]    2    6   10   14   18
## [3,]    3    7   11   15   19
## [4,]    4    8   12   16   20
```

```
x=matrix(1:20,4,5,byrow=T);x#   ,
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    1    2    3    4    5
## [2,]    6    7    8    9   10
## [3,]   11   12   13   14   15
## [4,]   16   17   18   19   20
```

```
t(x) #
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    1    6   11   16
## [2,]    2    7   12   17
## [3,]    3    8   13   18
## [4,]    4    9   14   19
## [5,]    5   10   15   20
```

```
x=matrix(sample(1:100,20),4,5)
2*x
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,]   10  156  180   42  192
## [2,]  142   68   50   16   36
## [3,]   92  188   34  160  116
## [4,]  168   76  178   72    2
```

```
x+5
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,]   10   83   95   26  101
## [2,]   76   39   30   13   23
## [3,]   51   99   22   85   63
## [4,]   89   43   94   41    6
```

```
y=matrix(sample(1:100,20),5,4)
x+t(y) #
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,]   90  121  141  107  153
## [2,]   75   88   38   41   73
## [3,]   91  168   40  180   85
## [4,]  178  134  123   48   54
```

```
(z=x%*%y) #
```

```
##       [,1]  [,2]  [,3]  [,4]
## [1,] 15647 11375 12759 16358
## [2,] 10486  3699  7572 11838
## [3,] 19005 11311 18983 17960
## [4,] 16466  4788 12266 15055
```

```
z1=solve(z) # solve(a,b)   ax=b
z1%*%z #    ,        0
```

```
##               [,1]          [,2]         [,3]          [,4]
## [1,]  1.000000e+00  4.440892e-16 8.881784e-16  0.000000e+00
## [2,]  6.661338e-16  1.000000e+00 1.665335e-16  7.216450e-16
## [3,] -1.332268e-15 -2.220446e-16 1.000000e+00 -8.881784e-16
## [4,] -8.881784e-16 -4.440892e-16 8.881784e-16  1.000000e+00
```

```
round(z1%*%z,14)  #
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    1    0    0    0
## [2,]    0    1    0    0
## [3,]    0    0    1    0
## [4,]    0    0    0    1
```

```
b=solve(z,1:4); b #
```

```
## [1]  0.0003395198 -0.0004037309  0.0001621552 -0.0001093633
```

```
nrow(x);ncol(x);dim(x)#
```

```
## [1] 4
```

```
## [1] 5
```

```
## [1] 4 5
```

```
x=matrix(rnorm(24),4,6)
x[c(2,1),]# 2 1
```

```
##            [,1]      [,2]        [,3]       [,4]       [,5]       [,6]
## [1,] -0.9365147 0.1059030 -0.08914275  1.4195890 -0.4112898 -0.2461206
## [2,] -0.3927860 0.7224822 -0.65481462 -0.5366891  0.4255549 -0.3605743
```

```
x[,c(1,3)] # 1 3
```

```
##            [,1]        [,2]
## [1,] -0.3927860 -0.65481462
## [2,] -0.9365147 -0.08914275
## [3,] -1.7652404 -0.68941147
## [4,] -1.7593115  0.14239838
```

```r
x[2,1] # [2,1]
```

```
## [1] -0.9365147
```

```r
x[x[,1]>0,1] # 1  0
```

```
## numeric(0)
```

```r
sum(x[,1]>0) # 1  0
```

```
## [1] 0
```

```r
sum(x[,1]<=0) # 1  0
```

```
## [1] 4
```

```r
x[,-c(1,3)]#  1 3 x.
```

```
##            [,1]       [,2]       [,3]        [,4]
## [1,]  0.7224822 -0.5366891  0.4255549 -0.36057432
## [2,]  0.1059030  1.4195890 -0.4112898 -0.24612056
## [3,]  0.3901370  0.5257376  1.0709248  2.63284399
## [4,] -1.6439634 -0.3600024  1.0468222  0.08287321
```

```r
diag(x)  #x
```

```
## [1] -0.3927860  0.1059030 -0.6894115 -0.3600024
```

```r
diag(1:5) # 1:5   ,   0
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    1    0    0    0    0
## [2,]    0    2    0    0    0
## [3,]    0    0    3    0    0
## [4,]    0    0    0    4    0
## [5,]    0    0    0    0    5
```

```r
diag(5) #5
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    1    0    0    0    0
## [2,]    0    1    0    0    0
## [3,]    0    0    1    0    0
## [4,]    0    0    0    1    0
## [5,]    0    0    0    0    1
```

```
x[-2,-c(1,3)]# 2 , 1 3 x
```

```
##            [,1]       [,2]      [,3]        [,4]
## [1,]  0.7224822 -0.5366891 0.4255549 -0.36057432
## [2,]  0.3901370  0.5257376 1.0709248  2.63284399
## [3,] -1.6439634 -0.3600024 1.0468222  0.08287321
```

```
x[x[,1]>0&x[,3]<=1,1]# 1 >0  3 <=1  1
```

```
## numeric(0)
```

```
x[x[,2]>0|x[,1]<.51,1]# 1 <.51  2 >0  1
```

```
## [1] -0.3927860 -0.9365147 -1.7652404 -1.7593115
```

```
x[!x[,2]<.51,1]# 1   2 >=.51
```

```
## [1] -0.392786
```

```
apply(x,1,mean)# ( )
```

```
## [1] -0.13280450 -0.02626265  0.36083192 -0.41519726
```

```
apply(x,2,sum)# ( )
```

```
## [1] -4.8538526 -0.4254413 -1.2909705  1.0486350  2.1320120  2.1090223
```

```
x=matrix(rnorm(24),4,6)
x[lower.tri(x)]=0;x #
```

```
##            [,1]     [,2]        [,3]       [,4]       [,5]       [,6]
## [1,] -0.9937466 0.328458  0.12652026 -0.5102973 -0.4326447  0.8705996
## [2,]  0.0000000 1.116416  1.08006177  0.9086136 -0.6296527  1.4198028
## [3,]  0.0000000 0.000000 -0.03321312 -0.3875161 -0.7808975  0.6927386
## [4,]  0.0000000 0.000000  0.00000000  2.0610544  0.1123042 -2.2616133
```

```
#    ,  x[upper.tri(x)]=0)

#
x=array(runif(24),c(4,3,2));x
```

```
## , , 1
##
##           [,1]         [,2]       [,3]
## [1,] 0.7621944 0.6249739686 0.66882891
## [2,] 0.5977404 0.3937319745 0.03062896
## [3,] 0.9377406 0.0006681741 0.26985517
## [4,] 0.1647563 0.9758263885 0.58781404
##
## , , 2
##
##           [,1]      [,2]       [,3]
## [1,] 0.9329398 0.3036185 0.08949422
## [2,] 0.7366948 0.1091237 0.85924212
## [3,] 0.1824314 0.7497612 0.56492248
## [4,] 0.6861288 0.6995164 0.45189637
```

```
# 24       4 3 2
is.matrix(x)
```

```
## [1] FALSE
```

```
dim(x)#  (4,3,2)
```

```
## [1] 4 3 2
```

```
is.matrix(x[1,,])#
```

```
## [1] TRUE
```

```
x=array(1:24,c(4,3,2))
x[c(1,3),,]
```

```
## , , 1
##
##      [,1] [,2] [,3]
## [1,]    1    5    9
## [2,]    3    7   11
```

```
##
## , , 2
##
##      [,1] [,2] [,3]
## [1,]   13   17   21
## [2,]   15   19   23
```

```
x=array(1:24,c(4,3,2))
apply(x,1,mean)   #
```

```
## [1] 11 12 13 14
```

```
apply(x,1:2,sum)  #
```

```
##      [,1] [,2] [,3]
## [1,]   14   22   30
## [2,]   16   24   32
## [3,]   18   26   34
## [4,]   20   28   36
```

```
apply(x,c(1,3),prod) #
```

```
##      [,1] [,2]
## [1,]   45 4641
## [2,]  120 5544
## [3,]  231 6555
## [4,]  384 7680
```

```
#

x=matrix(1:20,5,4) #5 4
sweep(x,1,1:5,"*")#  1:5
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    1    6   11   16
## [2,]    4   14   24   34
## [3,]    9   24   39   54
## [4,]   16   36   56   76
## [5,]   25   50   75  100
```

```
sweep(x,2,1:4,"+")#  1:4
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    2    8   14   20
## [2,]    3    9   15   21
## [3,]    4   10   16   22
## [4,]    5   11   17   23
## [5,]    6   12   18   24
```

```
x*1:5
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    1    6   11   16
## [2,]    4   14   24   34
## [3,]    9   24   39   54
## [4,]   16   36   56   76
## [5,]   25   50   75  100
```

```
# x  ,      ,
(x=matrix(sample(1:100,24),6,4));(x1=scale(x))
```

```
##      [,1] [,2] [,3] [,4]
## [1,]   42   10    3    2
## [2,]   21   50   92   30
## [3,]   68   47   33   72
## [4,]   36   98   86   39
## [5,]   87   20   80   54
## [6,]   45   56    8    4
```

```
##            [,1]         [,2]       [,3]       [,4]
## [1,] -0.3299111 -1.190175934 -1.1672959 -1.1414992
## [2,] -1.2143536  0.102322818  1.0275492 -0.1268332
## [3,]  0.7651129  0.005385411 -0.4274605  1.3951657
## [4,] -0.5826089  1.653321320  0.8795821  0.1993094
## [5,]  1.5653228 -0.867051246  0.7316150  0.7428804
## [6,] -0.2035622  0.296197631 -1.0439900 -1.0690230
## attr(,"scaled:center")
## [1] 49.83333 46.83333 50.33333 33.50000
## attr(,"scaled:scale")
## [1] 23.74377 30.94781 40.54956 27.59529
```

```
(x2=scale(x,scale=F))#
```

```
##            [,1]        [,2]      [,3]  [,4]
## [1,]  -7.833333 -36.8333333 -47.33333 -31.5
```

```
## [2,] -28.833333   3.1666667  41.66667  -3.5
## [3,]  18.166667   0.1666667 -17.33333  38.5
## [4,] -13.833333  51.1666667  35.66667   5.5
## [5,]  37.166667 -26.8333333  29.66667  20.5
## [6,]  -4.833333   9.1666667 -42.33333 -29.5
## attr(,"scaled:center")
## [1] 49.83333 46.83333 50.33333 33.50000
```

```
(x3=scale(x,center=F)) #
```

```
##           [,1]      [,2]      [,3]       [,4]
## [1,] 0.7055287 0.1669033 0.0438323 0.04355862
## [2,] 0.3527644 0.8345164 1.3441906 0.65337927
## [3,] 1.1422846 0.7844454 0.4821553 1.56811024
## [4,] 0.6047389 1.6356522 1.2565260 0.84939305
## [5,] 1.4614523 0.3338066 1.1688614 1.17608268
## [6,] 0.7559236 0.9346584 0.1168861 0.08711724
## attr(,"scaled:scale")
## [1] 59.52982 59.91494 68.44268 45.91514
```

```
round(apply(x1,2,mean),14) #
```

```
## [1] 0 0 0 0
```

```
apply(x1,2,sd)#
```

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

```
round(apply(x2,2,mean),14);apply(x2,2,sd)#
```

```
## [1] 0 0 0 0
```

```
## [1] 23.74377 30.94781 40.54956 27.59529
```

```
round(apply(x3,2,mean),14);apply(x3,2,sd)#
```

```
## [1] 0.8371154 0.7816637 0.7354086 0.7296068
```

```
## [1] 0.3988551 0.5165290 0.5924601 0.6010063
```

```
# ,
airquality #  (NA) R
```

```
##     Ozone Solar.R Wind Temp Month Day
## 1      41     190  7.4   67     5   1
## 2      36     118  8.0   72     5   2
## 3      12     149 12.6   74     5   3
## 4      18     313 11.5   62     5   4
## 5      NA      NA 14.3   56     5   5
## 6      28      NA 14.9   66     5   6
## 7      23     299  8.6   65     5   7
## 8      19      99 13.8   59     5   8
## 9       8      19 20.1   61     5   9
## 10     NA     194  8.6   69     5  10
## 11      7      NA  6.9   74     5  11
## 12     16     256  9.7   69     5  12
## 13     11     290  9.2   66     5  13
## 14     14     274 10.9   68     5  14
## 15     18      65 13.2   58     5  15
## 16     14     334 11.5   64     5  16
## 17     34     307 12.0   66     5  17
## 18      6      78 18.4   57     5  18
## 19     30     322 11.5   68     5  19
## 20     11      44  9.7   62     5  20
## 21      1       8  9.7   59     5  21
## 22     11     320 16.6   73     5  22
## 23      4      25  9.7   61     5  23
## 24     32      92 12.0   61     5  24
## 25     NA      66 16.6   57     5  25
## 26     NA     266 14.9   58     5  26
## 27     NA      NA  8.0   57     5  27
## 28     23      13 12.0   67     5  28
## 29     45     252 14.9   81     5  29
## 30    115     223  5.7   79     5  30
## 31     37     279  7.4   76     5  31
## 32     NA     286  8.6   78     6   1
## 33     NA     287  9.7   74     6   2
## 34     NA     242 16.1   67     6   3
## 35     NA     186  9.2   84     6   4
## 36     NA     220  8.6   85     6   5
## 37     NA     264 14.3   79     6   6
## 38     29     127  9.7   82     6   7
## 39     NA     273  6.9   87     6   8
## 40     71     291 13.8   90     6   9
## 41     39     323 11.5   87     6  10
```

```
## 42     NA     259 10.9   93     6  11
## 43     NA     250  9.2   92     6  12
## 44     23     148  8.0   82     6  13
## 45     NA     332 13.8   80     6  14
## 46     NA     322 11.5   79     6  15
## 47     21     191 14.9   77     6  16
## 48     37     284 20.7   72     6  17
## 49     20      37  9.2   65     6  18
## 50     12     120 11.5   73     6  19
## 51     13     137 10.3   76     6  20
## 52     NA     150  6.3   77     6  21
## 53     NA      59  1.7   76     6  22
## 54     NA      91  4.6   76     6  23
## 55     NA     250  6.3   76     6  24
## 56     NA     135  8.0   75     6  25
## 57     NA     127  8.0   78     6  26
## 58     NA      47 10.3   73     6  27
## 59     NA      98 11.5   80     6  28
## 60     NA      31 14.9   77     6  29
## 61     NA     138  8.0   83     6  30
## 62    135     269  4.1   84     7   1
## 63     49     248  9.2   85     7   2
## 64     32     236  9.2   81     7   3
## 65     NA     101 10.9   84     7   4
## 66     64     175  4.6   83     7   5
## 67     40     314 10.9   83     7   6
## 68     77     276  5.1   88     7   7
## 69     97     267  6.3   92     7   8
## 70     97     272  5.7   92     7   9
## 71     85     175  7.4   89     7  10
## 72     NA     139  8.6   82     7  11
## 73     10     264 14.3   73     7  12
## 74     27     175 14.9   81     7  13
## 75     NA     291 14.9   91     7  14
## 76      7      48 14.3   80     7  15
## 77     48     260  6.9   81     7  16
## 78     35     274 10.3   82     7  17
## 79     61     285  6.3   84     7  18
## 80     79     187  5.1   87     7  19
## 81     63     220 11.5   85     7  20
## 82     16       7  6.9   74     7  21
## 83     NA     258  9.7   81     7  22
## 84     NA     295 11.5   82     7  23
## 85     80     294  8.6   86     7  24
## 86    108     223  8.0   85     7  25
## 87     20      81  8.6   82     7  26
```

```
## 88     52      82 12.0   86     7  27
## 89     82     213  7.4   88     7  28
## 90     50     275  7.4   86     7  29
## 91     64     253  7.4   83     7  30
## 92     59     254  9.2   81     7  31
## 93     39      83  6.9   81     8   1
## 94      9      24 13.8   81     8   2
## 95     16      77  7.4   82     8   3
## 96     78      NA  6.9   86     8   4
## 97     35      NA  7.4   85     8   5
## 98     66      NA  4.6   87     8   6
## 99    122     255  4.0   89     8   7
## 100    89     229 10.3   90     8   8
## 101   110     207  8.0   90     8   9
## 102    NA     222  8.6   92     8  10
## 103    NA     137 11.5   86     8  11
## 104    44     192 11.5   86     8  12
## 105    28     273 11.5   82     8  13
## 106    65     157  9.7   80     8  14
## 107    NA      64 11.5   79     8  15
## 108    22      71 10.3   77     8  16
## 109    59      51  6.3   79     8  17
## 110    23     115  7.4   76     8  18
## 111    31     244 10.9   78     8  19
## 112    44     190 10.3   78     8  20
## 113    21     259 15.5   77     8  21
## 114     9      36 14.3   72     8  22
## 115    NA     255 12.6   75     8  23
## 116    45     212  9.7   79     8  24
## 117   168     238  3.4   81     8  25
## 118    73     215  8.0   86     8  26
## 119    NA     153  5.7   88     8  27
## 120    76     203  9.7   97     8  28
## 121   118     225  2.3   94     8  29
## 122    84     237  6.3   96     8  30
## 123    85     188  6.3   94     8  31
## 124    96     167  6.9   91     9   1
## 125    78     197  5.1   92     9   2
## 126    73     183  2.8   93     9   3
## 127    91     189  4.6   93     9   4
## 128    47      95  7.4   87     9   5
## 129    32      92 15.5   84     9   6
## 130    20     252 10.9   80     9   7
## 131    23     220 10.3   78     9   8
## 132    21     230 10.9   75     9   9
## 133    24     259  9.7   73     9  10
```

```
## 134    44     236 14.9   81     9  11
## 135    21     259 15.5   76     9  12
## 136    28     238  6.3   77     9  13
## 137     9      24 10.9   71     9  14
## 138    13     112 11.5   71     9  15
## 139    46     237  6.9   78     9  16
## 140    18     224 13.8   67     9  17
## 141    13      27 10.3   76     9  18
## 142    24     238 10.3   68     9  19
## 143    16     201  8.0   82     9  20
## 144    13     238 12.6   64     9  21
## 145    23      14  9.2   71     9  22
## 146    36     139 10.3   81     9  23
## 147     7      49 10.3   69     9  24
## 148    14      20 16.6   63     9  25
## 149    30     193  6.9   70     9  26
## 150    NA     145 13.2   77     9  27
## 151    14     191 14.3   75     9  28
## 152    18     131  8.0   76     9  29
## 153    20     223 11.5   68     9  30
```

```
complete.cases(airquality)#
```

```
##   [1]  TRUE  TRUE  TRUE  TRUE FALSE FALSE  TRUE  TRUE  TRUE FALSE FALSE  TRUE
##  [13]  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE
##  [25] FALSE FALSE FALSE  TRUE  TRUE  TRUE  TRUE FALSE FALSE FALSE FALSE FALSE
##  [37] FALSE  TRUE FALSE  TRUE  TRUE FALSE FALSE  TRUE FALSE FALSE  TRUE  TRUE
##  [49]  TRUE  TRUE  TRUE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
##  [61] FALSE  TRUE  TRUE  TRUE FALSE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE FALSE
##  [73]  TRUE  TRUE FALSE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE FALSE FALSE
##  [85]  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE FALSE
##  [97] FALSE FALSE  TRUE  TRUE  TRUE FALSE FALSE  TRUE  TRUE  TRUE FALSE  TRUE
## [109]  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE FALSE  TRUE  TRUE  TRUE FALSE  TRUE
## [121]  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE
## [133]  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE  TRUE
## [145]  TRUE  TRUE  TRUE  TRUE  TRUE FALSE  TRUE  TRUE  TRUE
```

```
which(complete.cases(airquality)==F) #
```

```
##  [1]   5   6  10  11  25  26  27  32  33  34  35  36  37  39  42  43  45  46  52
## [20]  53  54  55  56  57  58  59  60  61  65  72  75  83  84  96  97  98 102 103
## [39] 107 115 119 150
```

```
sum(complete.cases(airquality)) #
```

```
## [1] 111
```

```
na.omit(airquality) #
```

```
##     Ozone Solar.R Wind Temp Month Day
## 1      41     190  7.4   67     5   1
## 2      36     118  8.0   72     5   2
## 3      12     149 12.6   74     5   3
## 4      18     313 11.5   62     5   4
## 7      23     299  8.6   65     5   7
## 8      19      99 13.8   59     5   8
## 9       8      19 20.1   61     5   9
## 12     16     256  9.7   69     5  12
## 13     11     290  9.2   66     5  13
## 14     14     274 10.9   68     5  14
## 15     18      65 13.2   58     5  15
## 16     14     334 11.5   64     5  16
## 17     34     307 12.0   66     5  17
## 18      6      78 18.4   57     5  18
## 19     30     322 11.5   68     5  19
## 20     11      44  9.7   62     5  20
## 21      1       8  9.7   59     5  21
## 22     11     320 16.6   73     5  22
## 23      4      25  9.7   61     5  23
## 24     32      92 12.0   61     5  24
## 28     23      13 12.0   67     5  28
## 29     45     252 14.9   81     5  29
## 30    115     223  5.7   79     5  30
## 31     37     279  7.4   76     5  31
## 38     29     127  9.7   82     6   7
## 40     71     291 13.8   90     6   9
## 41     39     323 11.5   87     6  10
## 44     23     148  8.0   82     6  13
## 47     21     191 14.9   77     6  16
## 48     37     284 20.7   72     6  17
## 49     20      37  9.2   65     6  18
## 50     12     120 11.5   73     6  19
## 51     13     137 10.3   76     6  20
## 62    135     269  4.1   84     7   1
## 63     49     248  9.2   85     7   2
## 64     32     236  9.2   81     7   3
## 66     64     175  4.6   83     7   5
```

```
## 67     40     314 10.9   83     7   6
## 68     77     276  5.1   88     7   7
## 69     97     267  6.3   92     7   8
## 70     97     272  5.7   92     7   9
## 71     85     175  7.4   89     7  10
## 73     10     264 14.3   73     7  12
## 74     27     175 14.9   81     7  13
## 76      7      48 14.3   80     7  15
## 77     48     260  6.9   81     7  16
## 78     35     274 10.3   82     7  17
## 79     61     285  6.3   84     7  18
## 80     79     187  5.1   87     7  19
## 81     63     220 11.5   85     7  20
## 82     16       7  6.9   74     7  21
## 85     80     294  8.6   86     7  24
## 86    108     223  8.0   85     7  25
## 87     20      81  8.6   82     7  26
## 88     52      82 12.0   86     7  27
## 89     82     213  7.4   88     7  28
## 90     50     275  7.4   86     7  29
## 91     64     253  7.4   83     7  30
## 92     59     254  9.2   81     7  31
## 93     39      83  6.9   81     8   1
## 94      9      24 13.8   81     8   2
## 95     16      77  7.4   82     8   3
## 99    122     255  4.0   89     8   7
## 100    89     229 10.3   90     8   8
## 101   110     207  8.0   90     8   9
## 104    44     192 11.5   86     8  12
## 105    28     273 11.5   82     8  13
## 106    65     157  9.7   80     8  14
## 108    22      71 10.3   77     8  16
## 109    59      51  6.3   79     8  17
## 110    23     115  7.4   76     8  18
## 111    31     244 10.9   78     8  19
## 112    44     190 10.3   78     8  20
## 113    21     259 15.5   77     8  21
## 114     9      36 14.3   72     8  22
## 116    45     212  9.7   79     8  24
## 117   168     238  3.4   81     8  25
## 118    73     215  8.0   86     8  26
## 120    76     203  9.7   97     8  28
## 121   118     225  2.3   94     8  29
## 122    84     237  6.3   96     8  30
## 123    85     188  6.3   94     8  31
## 124    96     167  6.9   91     9   1
```

```
## 125    78     197  5.1   92     9   2
## 126    73     183  2.8   93     9   3
## 127    91     189  4.6   93     9   4
## 128    47      95  7.4   87     9   5
## 129    32      92 15.5   84     9   6
## 130    20     252 10.9   80     9   7
## 131    23     220 10.3   78     9   8
## 132    21     230 10.9   75     9   9
## 133    24     259  9.7   73     9  10
## 134    44     236 14.9   81     9  11
## 135    21     259 15.5   76     9  12
## 136    28     238  6.3   77     9  13
## 137     9      24 10.9   71     9  14
## 138    13     112 11.5   71     9  15
## 139    46     237  6.9   78     9  16
## 140    18     224 13.8   67     9  17
## 141    13      27 10.3   76     9  18
## 142    24     238 10.3   68     9  19
## 143    16     201  8.0   82     9  20
## 144    13     238 12.6   64     9  21
## 145    23      14  9.2   71     9  22
## 146    36     139 10.3   81     9  23
## 147     7      49 10.3   69     9  24
## 148    14      20 16.6   63     9  25
## 149    30     193  6.9   70     9  26
## 151    14     191 14.3   75     9  28
## 152    18     131  8.0   76     9  29
## 153    20     223 11.5   68     9  30
```

```
# ,     : append,cbind,rbind
x=1:10;x[12]=3
(x1=append(x,77,after=5))
```

```
##  [1]  1  2  3  4  5 77  6  7  8  9 10 NA  3
```

```
cbind(1:5,rnorm(5))
```

```
##      [,1]        [,2]
## [1,]    1 -0.90721116
## [2,]    2 -0.09268695
## [3,]    3 -2.50332775
## [4,]    4 -0.58279251
## [5,]    5  1.12082699
```

```
rbind(1:5,rnorm(5))
```

```
##           [,1]      [,2]      [,3]      [,4]       [,5]
## [1,] 1.000000  2.000000 3.0000000  4.000000  5.0000000
## [2,] 1.165117 -1.013695 0.2718095 -0.910262 -0.7411211
```

```
cbind(1:3,4:6);rbind(1:3,4:6) #
```

```
##      [,1] [,2]
## [1,]    1    4
## [2,]    2    5
## [3,]    3    6
```

```
##      [,1] [,2] [,3]
## [1,]    1    2    3
## [2,]    4    5    6
```

```
(x=rbind(1:5,runif(5),runif(5),1:5,7:11))
```

```
##           [,1]      [,2]         [,3]       [,4]       [,5]
## [1,] 1.0000000 2.0000000 3.0000000000  4.0000000  5.0000000
## [2,] 0.3347674 0.2420137 0.7735781306  0.3814162  0.7419370
## [3,] 0.7229625 0.3269700 0.0009185066  0.8552947  0.2524031
## [4,] 1.0000000 2.0000000 3.0000000000  4.0000000  5.0000000
## [5,] 7.0000000 8.0000000 9.0000000000 10.0000000 11.0000000
```

```
x[!duplicated(x),]
```

```
##           [,1]      [,2]         [,3]       [,4]       [,5]
## [1,] 1.0000000 2.0000000 3.0000000000  4.0000000  5.0000000
## [2,] 0.3347674 0.2420137 0.7735781306  0.3814162  0.7419370
## [3,] 0.7229625 0.3269700 0.0009185066  0.8552947  0.2524031
## [4,] 7.0000000 8.0000000 9.0000000000 10.0000000 11.0000000
```

```
unique(x)
```

```
##           [,1]      [,2]         [,3]       [,4]       [,5]
## [1,] 1.0000000 2.0000000 3.0000000000  4.0000000  5.0000000
## [2,] 0.3347674 0.2420137 0.7735781306  0.3814162  0.7419370
## [3,] 0.7229625 0.3269700 0.0009185066  0.8552947  0.2524031
## [4,] 7.0000000 8.0000000 9.0000000000 10.0000000 11.0000000
```

```
#  list
#list    ( list )
z=list(1:3,Tom=c(1:2,a=list("R",letters[1:5]),w="hi!"))
z[[1]];z[[2]]
```

```
## [1] 1 2 3
```

```
## [[1]]
## [1] 1
##
## [[2]]
## [1] 2
##
## $a1
## [1] "R"
##
## $a2
## [1] "a" "b" "c" "d" "e"
##
## $w
## [1] "hi!"
```

```
z$T
```

```
## [[1]]
## [1] 1
##
## [[2]]
## [1] 2
##
## $a1
## [1] "R"
##
## $a2
## [1] "a" "b" "c" "d" "e"
##
## $w
## [1] "hi!"
```

```
z$T$a2
```

```
## [1] "a" "b" "c" "d" "e"
```

```
z$T[[3]]
```

```
## [1] "R"
```

```
z$T$w
```

```
## [1] "hi!"
```

```
for (i in z){
  print(i)
  for (j in i)
    print(j)
}
```

```
## [1] 1 2 3
## [1] 1
## [1] 2
## [1] 3
## [[1]]
## [1] 1
##
## [[2]]
## [1] 2
##
## $a1
## [1] "R"
##
## $a2
## [1] "a" "b" "c" "d" "e"
##
## $w
## [1] "hi!"
##
## [1] 1
## [1] 2
## [1] "R"
## [1] "a" "b" "c" "d" "e"
## [1] "hi!"
```

```
y=list(1:5,rnorm(10))
lapply(y, function(x) sum(x^2))# list      ,  list
```

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

```
## [1] 55
##
## [[2]]
## [1] 14.28871
```

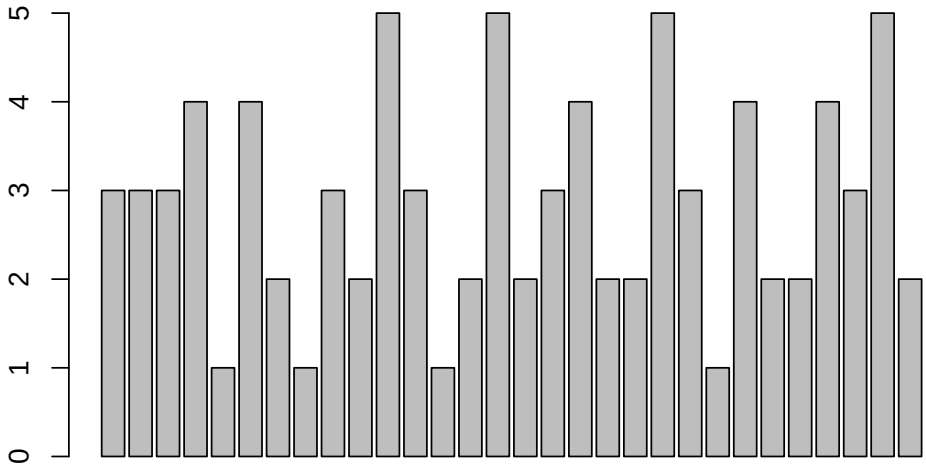
```
sapply(y, function(x) sum(x^2))# ,
```

```
## [1] 55.00000 14.28871
```

```
#

x=scan()#30
x <- c(3, 3, 3, 4, 1, 4, 2, 1, 3, 2, 5, 3, 1, 2, 5, 2, 3, 4, 2, 2, 5, 3, 1, 4, 2, 2, 4, 3, 5, 2)

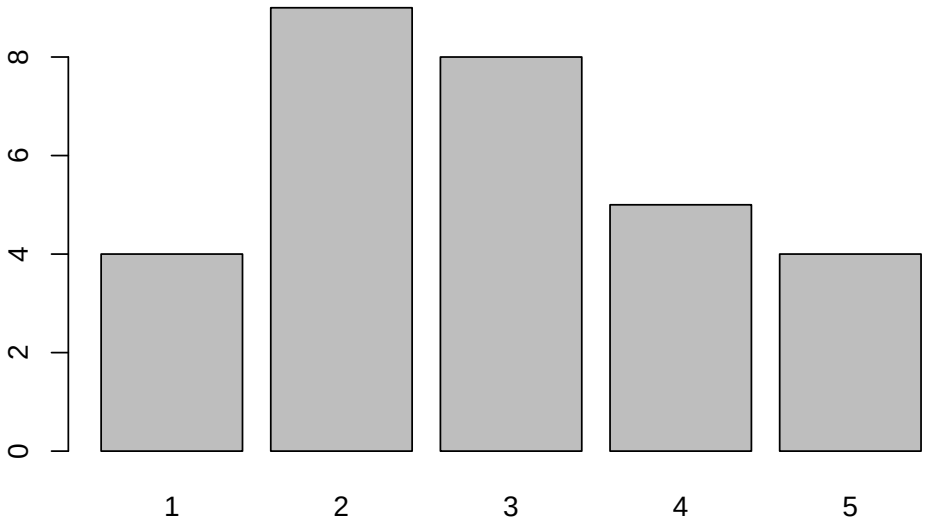
barplot(x) #
```



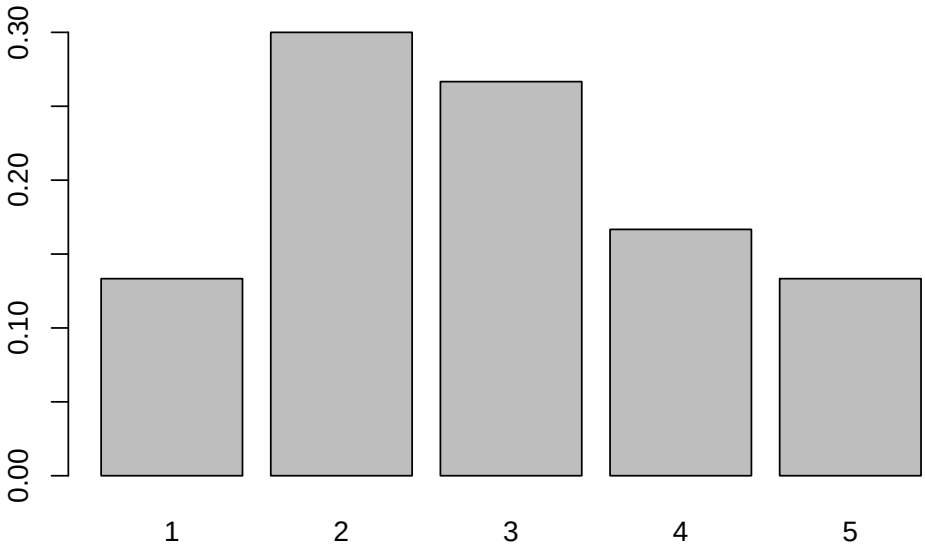

```
table(x) #
```

```
## x
## 1 2 3 4 5
## 4 9 8 5 4
```

```
barplot(table(x)) #
```




```
barplot(table(x)/length(x)) # (    )
```




```
table(x)/length(x)
```

```
## x
##         1         2         3         4         5
## 0.1333333 0.3000000 0.2666667 0.1666667 0.1333333
```

```
#
library(MASS)#   MASS
quine #MASS
```

```
##     Eth Sex Age Lrn Days
## 1     A   M  F0  SL    2
## 2     A   M  F0  SL   11
## 3     A   M  F0  SL   14
## 4     A   M  F0  AL    5
## 5     A   M  F0  AL    5
## 6     A   M  F0  AL   13
## 7     A   M  F0  AL   20
## 8     A   M  F0  AL   22
## 9     A   M  F1  SL    6
## 10    A   M  F1  SL    6
## 11    A   M  F1  SL   15
## 12    A   M  F1  AL    7
## 13    A   M  F1  AL   14
## 14    A   M  F2  SL    6
## 15    A   M  F2  SL   32
## 16    A   M  F2  SL   53
## 17    A   M  F2  SL   57
## 18    A   M  F2  AL   14
## 19    A   M  F2  AL   16
## 20    A   M  F2  AL   16
## 21    A   M  F2  AL   17
## 22    A   M  F2  AL   40
## 23    A   M  F2  AL   43
## 24    A   M  F2  AL   46
## 25    A   M  F3  AL    8
## 26    A   M  F3  AL   23
## 27    A   M  F3  AL   23
## 28    A   M  F3  AL   28
## 29    A   M  F3  AL   34
## 30    A   M  F3  AL   36
## 31    A   M  F3  AL   38
## 32    A   F  F0  SL    3
## 33    A   F  F0  AL    5
## 34    A   F  F0  AL   11
## 35    A   F  F0  AL   24
## 36    A   F  F0  AL   45
## 37    A   F  F1  SL    5
## 38    A   F  F1  SL    6
## 39    A   F  F1  SL    6
## 40    A   F  F1  SL    9
```

```
## 41    A   F  F1  SL   13
## 42    A   F  F1  SL   23
## 43    A   F  F1  SL   25
## 44    A   F  F1  SL   32
## 45    A   F  F1  SL   53
## 46    A   F  F1  SL   54
## 47    A   F  F1  AL    5
## 48    A   F  F1  AL    5
## 49    A   F  F1  AL   11
## 50    A   F  F1  AL   17
## 51    A   F  F1  AL   19
## 52    A   F  F2  SL    8
## 53    A   F  F2  SL   13
## 54    A   F  F2  SL   14
## 55    A   F  F2  SL   20
## 56    A   F  F2  SL   47
## 57    A   F  F2  SL   48
## 58    A   F  F2  SL   60
## 59    A   F  F2  SL   81
## 60    A   F  F2  AL    2
## 61    A   F  F3  AL    0
## 62    A   F  F3  AL    2
## 63    A   F  F3  AL    3
## 64    A   F  F3  AL    5
## 65    A   F  F3  AL   10
## 66    A   F  F3  AL   14
## 67    A   F  F3  AL   21
## 68    A   F  F3  AL   36
## 69    A   F  F3  AL   40
## 70    N   M  F0  SL    6
## 71    N   M  F0  SL   17
## 72    N   M  F0  SL   67
## 73    N   M  F0  AL    0
## 74    N   M  F0  AL    0
## 75    N   M  F0  AL    2
## 76    N   M  F0  AL    7
## 77    N   M  F0  AL   11
## 78    N   M  F0  AL   12
## 79    N   M  F1  SL    0
## 80    N   M  F1  SL    0
## 81    N   M  F1  SL    5
## 82    N   M  F1  SL    5
## 83    N   M  F1  SL    5
## 84    N   M  F1  SL   11
## 85    N   M  F1  SL   17
## 86    N   M  F1  AL    3
```

```
## 87    N   M  F1  AL    4
## 88    N   M  F2  SL   22
## 89    N   M  F2  SL   30
## 90    N   M  F2  SL   36
## 91    N   M  F2  AL    8
## 92    N   M  F2  AL    0
## 93    N   M  F2  AL    1
## 94    N   M  F2  AL    5
## 95    N   M  F2  AL    7
## 96    N   M  F2  AL   16
## 97    N   M  F2  AL   27
## 98    N   M  F3  AL    0
## 99    N   M  F3  AL   30
## 100   N   M  F3  AL   10
## 101   N   M  F3  AL   14
## 102   N   M  F3  AL   27
## 103   N   M  F3  AL   41
## 104   N   M  F3  AL   69
## 105   N   F  F0  SL   25
## 106   N   F  F0  AL   10
## 107   N   F  F0  AL   11
## 108   N   F  F0  AL   20
## 109   N   F  F0  AL   33
## 110   N   F  F1  SL    5
## 111   N   F  F1  SL    7
## 112   N   F  F1  SL    0
## 113   N   F  F1  SL    1
## 114   N   F  F1  SL    5
## 115   N   F  F1  SL    5
## 116   N   F  F1  SL    5
## 117   N   F  F1  SL    5
## 118   N   F  F1  SL    7
## 119   N   F  F1  SL   11
## 120   N   F  F1  SL   15
## 121   N   F  F1  AL    5
## 122   N   F  F1  AL   14
## 123   N   F  F1  AL    6
## 124   N   F  F1  AL    6
## 125   N   F  F1  AL    7
## 126   N   F  F1  AL   28
## 127   N   F  F2  SL    0
## 128   N   F  F2  SL    5
## 129   N   F  F2  SL   14
## 130   N   F  F2  SL    2
## 131   N   F  F2  SL    2
## 132   N   F  F2  SL    3
```

```
## 133   N   F  F2  SL    8
## 134   N   F  F2  SL   10
## 135   N   F  F2  SL   12
## 136   N   F  F2  AL    1
## 137   N   F  F3  AL    1
## 138   N   F  F3  AL    9
## 139   N   F  F3  AL   22
## 140   N   F  F3  AL    3
## 141   N   F  F3  AL    3
## 142   N   F  F3  AL    5
## 143   N   F  F3  AL   15
## 144   N   F  F3  AL   18
## 145   N   F  F3  AL   22
## 146   N   F  F3  AL   37
```

```
attach(quine)#
#
table(Age)
```

```
## Age
## F0 F1 F2 F3
## 27 46 40 33
```

```
table(Sex, Age); tab=xtabs(~ Sex + Age, quine); unclass(tab)
```

```
##    Age
## Sex F0 F1 F2 F3
##   F 10 32 19 19
##   M 17 14 21 14
```

```
##    Age
## Sex F0 F1 F2 F3
##   F 10 32 19 19
##   M 17 14 21 14
## attr(,"call")
## xtabs(formula = ~Sex + Age, data = quine)
```

```
tapply(Days, Age, mean)
```

```
##       F0       F1       F2       F3
## 14.85185 11.15217 21.05000 19.60606
```

```
tapply(Days, list(Sex, Age), mean)
```

```
##         F0       F1       F2       F3
## F 18.70000 12.96875 18.42105 14.00000
## M 12.58824  7.00000 23.42857 27.21429
```

```
#
#      (  ,    ) n
ss=function(n=100){
  z=2
  for (i in 2:n)
    if(any(i%%2:(i-1)==0)==F)z=c(z,i)
  return(z)
}
#fix(ss) #
ss() # 100
```

```
##  [1]  2  3  5  7 11 13 17 19 23 29 31 37 41 43 47 53 59 61 67 71 73 79 83 89 97
```

```
#t1=Sys.time() #
#ss(10000) # 10000
#Sys.time()-t1 #
#system.time(ss(10000))#  ss(10000)
#   return,    return
#      list
detach(quine) #attach

#

x=seq(-3,3,len=20);y=dnorm(x)#
w= data.frame(x,y)# x,  w
par(mfcol=c(2,2))#
plot(y ~ x, w,main="   ")
```

```
## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e6>
```

```
## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <ad>
```

```
## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <a3>
```

```
## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e6>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <80>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <81>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e5>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <af>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <86>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e5>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <ba>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <a6>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e5>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <87>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <bd>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e6>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <95>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <b0>
```

```
plot(y ~ x,w,type="l", main="    ")
```

```
## Warning in title(...): conversion failure on '    ' in 'mbcsToSbcs': dot
## substituted for <e6>

## Warning in title(...): conversion failure on '    ' in 'mbcsToSbcs': dot
## substituted for <ad>

## Warning in title(...): conversion failure on '    ' in 'mbcsToSbcs': dot
## substituted for <a3>

## Warning in title(...): conversion failure on '    ' in 'mbcsToSbcs': dot
## substituted for <e6>

## Warning in title(...): conversion failure on '    ' in 'mbcsToSbcs': dot
## substituted for <80>

## Warning in title(...): conversion failure on '    ' in 'mbcsToSbcs': dot
## substituted for <81>

## Warning in title(...): conversion failure on '    ' in 'mbcsToSbcs': dot
## substituted for <e5>

## Warning in title(...): conversion failure on '    ' in 'mbcsToSbcs': dot
## substituted for <af>

## Warning in title(...): conversion failure on '    ' in 'mbcsToSbcs': dot
## substituted for <86>

## Warning in title(...): conversion failure on '    ' in 'mbcsToSbcs': dot
## substituted for <e5>

## Warning in title(...): conversion failure on '    ' in 'mbcsToSbcs': dot
## substituted for <ba>

## Warning in title(...): conversion failure on '    ' in 'mbcsToSbcs': dot
## substituted for <a6>

## Warning in title(...): conversion failure on '    ' in 'mbcsToSbcs': dot
## substituted for <e5>
```

```
## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <87>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <bd>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e6>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <95>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <b0>
```

```
plot(y ~ x,w,type="o", main="   ")
```

```
## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e6>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <ad>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <a3>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e6>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <80>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <81>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e5>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <af>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <86>
```

```
## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e5>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <ba>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <a6>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e5>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <87>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <bd>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e6>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <95>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <b0>
```

```
plot(y ~ x,w,type="b",main="   ")
```

```
## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e6>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <ad>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <a3>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e6>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <80>
```

```
## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <81>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e5>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <af>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <86>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e5>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <ba>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <a6>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e5>

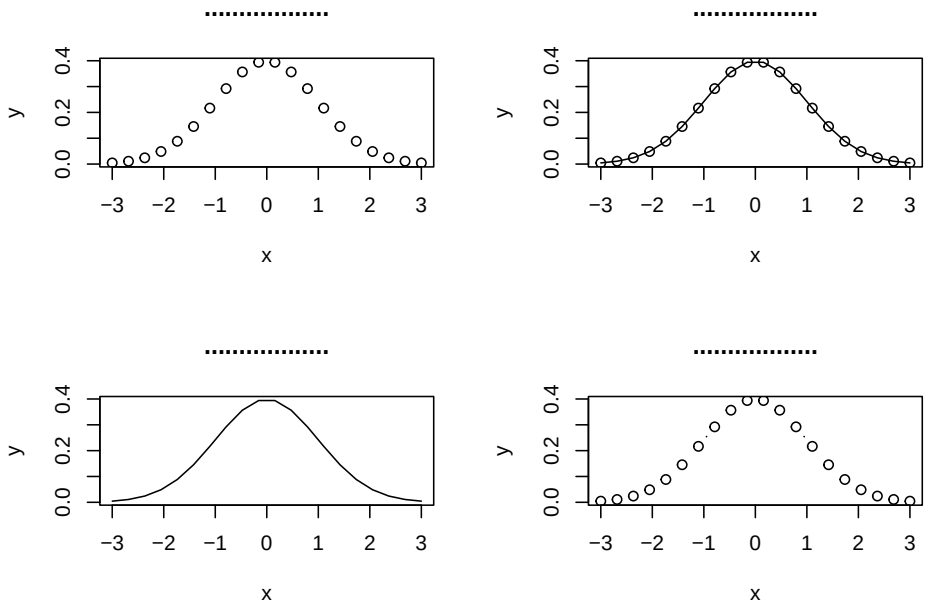
## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <87>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <bd>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <e6>

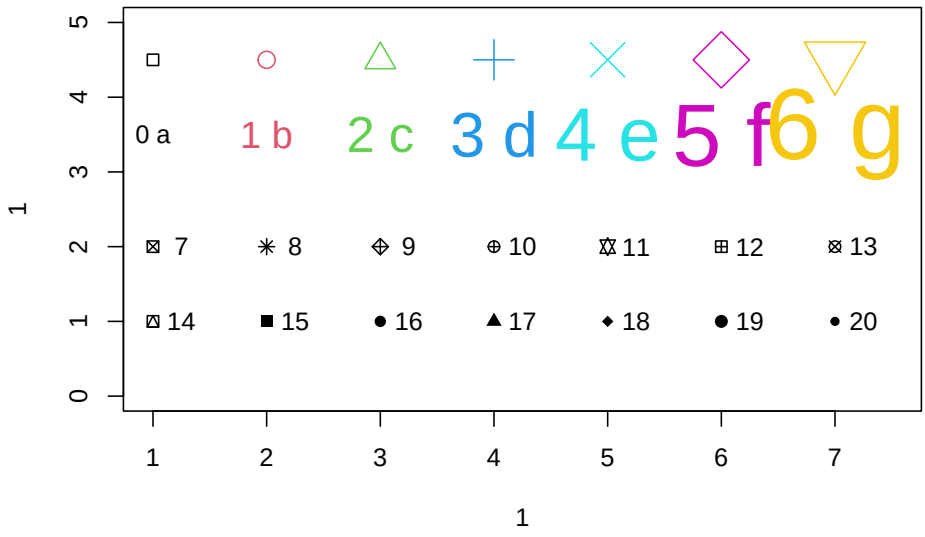
## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <95>

## Warning in title(...): conversion failure on '   ' in 'mbcsToSbcs': dot
## substituted for <b0>
```




```
par(mfcol=c(1,1))# par(mfcol=c(2,2))

#
plot(1,1,xlim=c(1,7.5),ylim=c(0,5),type="n") #
# plot    (    lines ):
points(1:7,rep(4.5,7),cex=seq(1,4,l=7),col=1:7, pch=0:6)
text(1:7,rep(3.5,7),labels=paste(0:6,letters[1:7]),
cex=seq(1,4,l=7),col=1:7)#
points(1:7,rep(2,7), pch=(0:6)+7)#  7 13
text((1:7)+0.25, rep(2,7), paste((0:6)+7))#
points(1:7,rep(1,7), pch=(0:6)+14) #  14 20
text((1:7)+0.25, rep(1,7), paste((0:6)+14)) #
```




```
#                "?par"
```

2.0.5 python

- Anaconda
- python

```
x = [1,2,3,4]
print(x[2])
```

```
## 3
```

Chapter 3

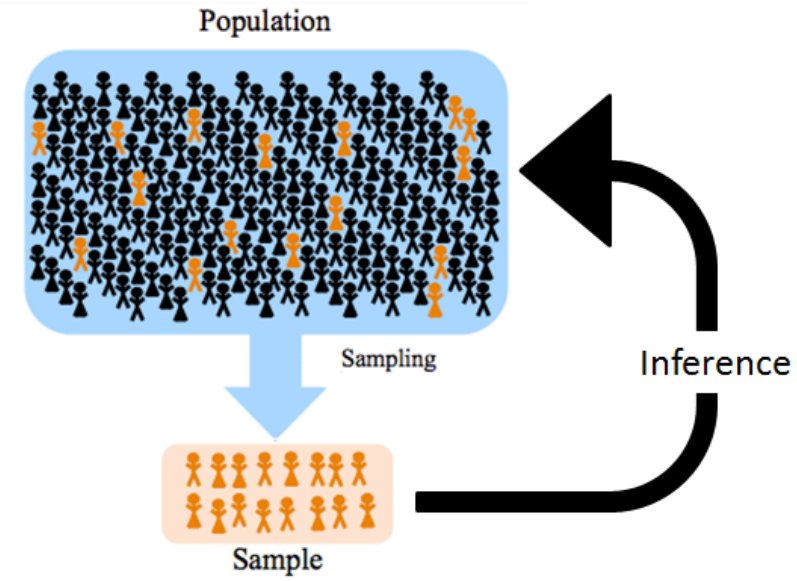
3.0.1

1.

- (Categorical) (Nominal) (Ordinal)
- (Numerical) (interval data) (ratio);

2. (UCI,kaggle)

- datalist(datalist) ;
- UCI (uci dataset): 1987
- Fastai(Fastai): NLP (image localization)
- Kaggle(kaggle)
- Sklearn(Skearn)



3. (
4. (,rows), (,columns)

```
library(ISLR)
#View(Auto)
head(Auto) #    5
```

```
##   mpg cylinders displacement horsepower weight acceleration year origin
## 1  18         8          307        130   3504         12.0   70      1
## 2  15         8          350        165   3693         11.5   70      1
## 3  18         8          318        150   3436         11.0   70      1
## 4  16         8          304        150   3433         12.0   70      1
## 5  17         8          302        140   3449         10.5   70      1
## 6  15         8          429        198   4341         10.0   70      1
##                       name
## 1 chevrolet chevelle malibu
## 2         buick skylark 320
## 3        plymouth satellite
## 4             amc rebel sst
## 5               ford torino
## 6          ford galaxie 500
```

```
names(Auto) #
```

```
## [1] "mpg"          "cylinders"    "displacement" "horsepower"   "weight"
```

```
## [6] "acceleration" "year"         "origin"       "name"
```

3.0.2

```
library(ISLR)
summary(Auto)
```

```
##       mpg          cylinders      displacement     horsepower        weight
##  Min.   : 9.00   Min.   :3.000   Min.   : 68.0   Min.   : 46.0   Min.   :1613
##  1st Qu.:17.00   1st Qu.:4.000   1st Qu.:105.0   1st Qu.: 75.0   1st Qu.:2225
##  Median :22.75   Median :4.000   Median :151.0   Median : 93.5   Median :2804
##  Mean   :23.45   Mean   :5.472   Mean   :194.4   Mean   :104.5   Mean   :2978
##  3rd Qu.:29.00   3rd Qu.:8.000   3rd Qu.:275.8   3rd Qu.:126.0   3rd Qu.:3615
##  Max.   :46.60   Max.   :8.000   Max.   :455.0   Max.   :230.0   Max.   :5140
##
##   acceleration        year           origin                      name
##  Min.   : 8.00   Min.   :70.00   Min.   :1.000   amc matador       :  5
##  1st Qu.:13.78   1st Qu.:73.00   1st Qu.:1.000   ford pinto        :  5
##  Median :15.50   Median :76.00   Median :1.000   toyota corolla    :  5
##  Mean   :15.54   Mean   :75.98   Mean   :1.577   amc gremlin       :  4
##  3rd Qu.:17.02   3rd Qu.:79.00   3rd Qu.:2.000   amc hornet        :  4
##  Max.   :24.80   Max.   :82.00   Max.   :3.000   chevrolet chevette:  4
##                                                  (Other)           :365
```

```
mean(Auto$mpg)
```

```
## [1] 23.44592
```

- $$\bar{Y} = \frac{1}{n}\sum_{i=1}^{n} y_i$$
- $$s^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2$$
- $$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}}$$
- 7 8 11 7 13 9 5 9

- $\bar{x} = \frac{8+11+7+13+9+5+9}{7} = 8.85$
- $s^2 = \frac{(8-8.85)^2+\cdots+(9-8.85)^2}{7-1} = 6.81$
- $s = \sqrt{s^2} = \sqrt{6.81} = 2.6$
- Median = 9; Mode = 9; Range = Max - min = 13-5=8

```
d <- c(8,11,7,13,9,5,9)
mean(d)
```

```
## [1] 8.857143
```

```
median(d)
```

```
## [1] 9
```

```
mode(d)
```

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

```
quantile(d)
```

```
##   0%  25%  50%  75% 100%
##  5.0  7.5  9.0 10.0 13.0
```

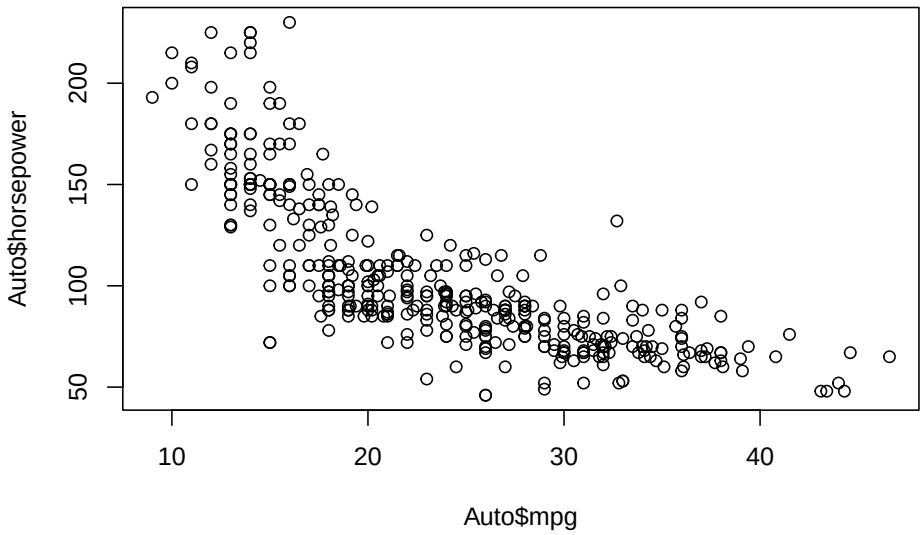
```
sd(d)
```

```
## [1] 2.609506
```

3.0.3

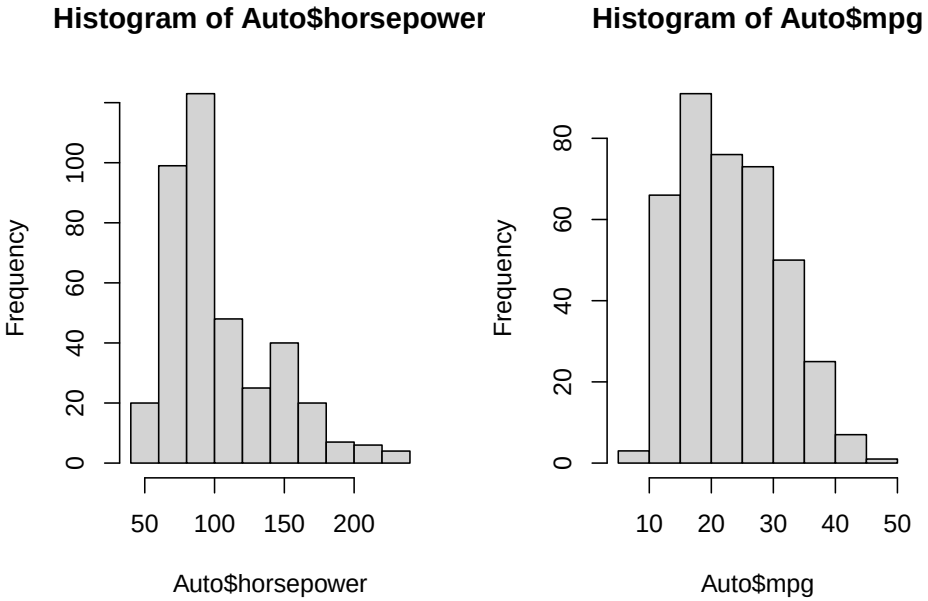
1. (scatter)

```
library(ISLR)
plot(Auto$mpg,Auto$horsepower)
```



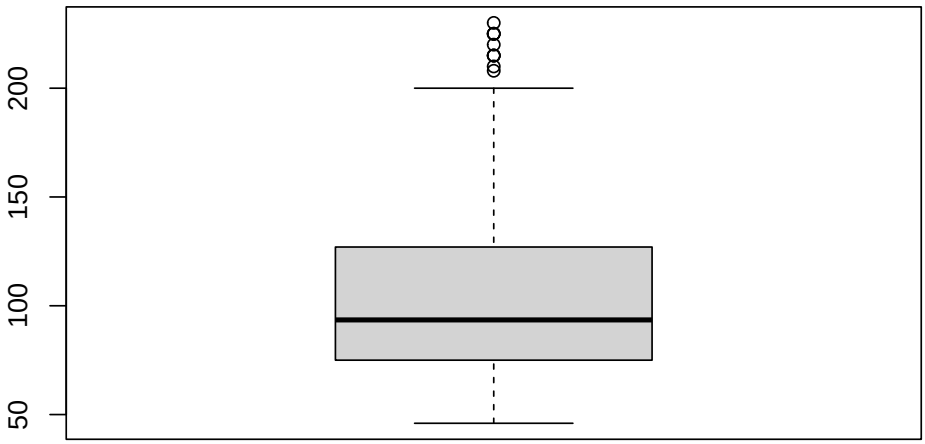
2. (histogram)

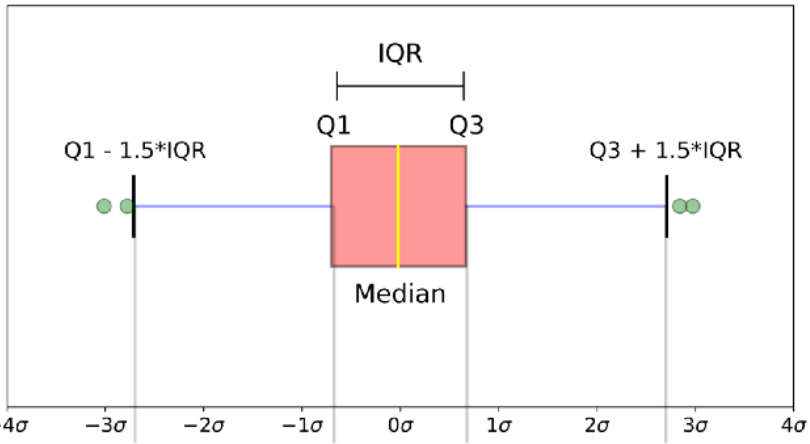
```
par(mfrow=c(1,2))
hist(Auto$horsepower)
hist(Auto$mpg)
```

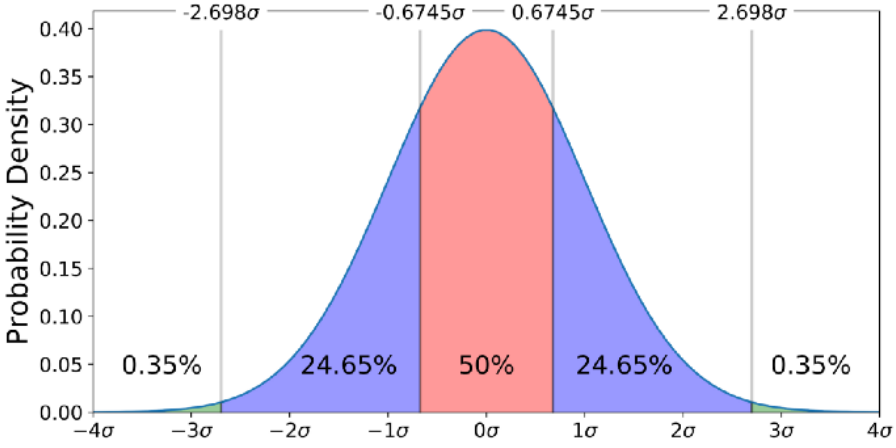


3. (boxplot)

```
boxplot(Auto$horsepower)
```

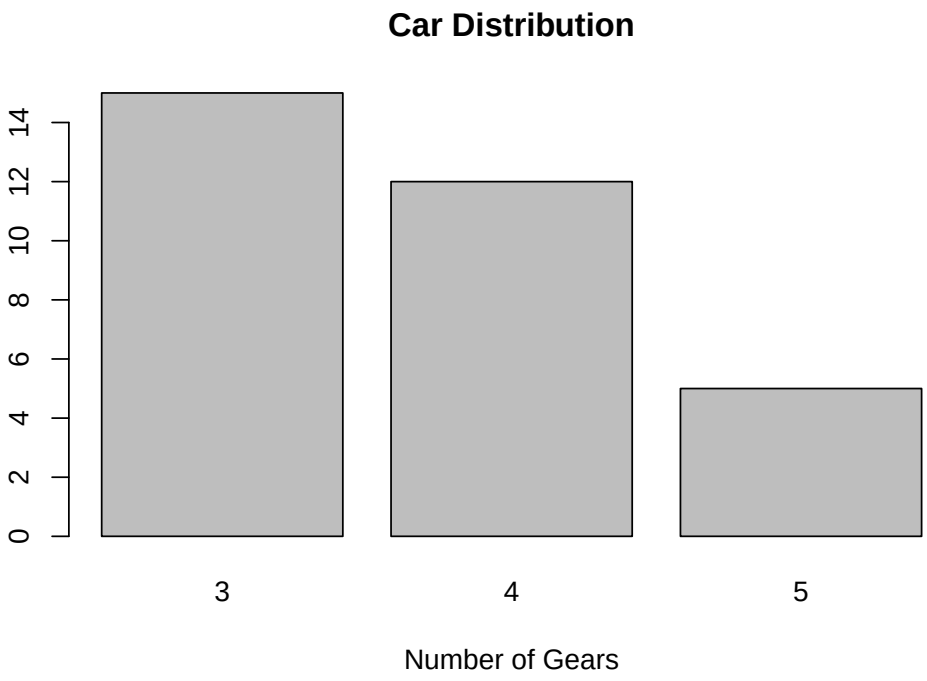






4. , , , ( ): (barplot)

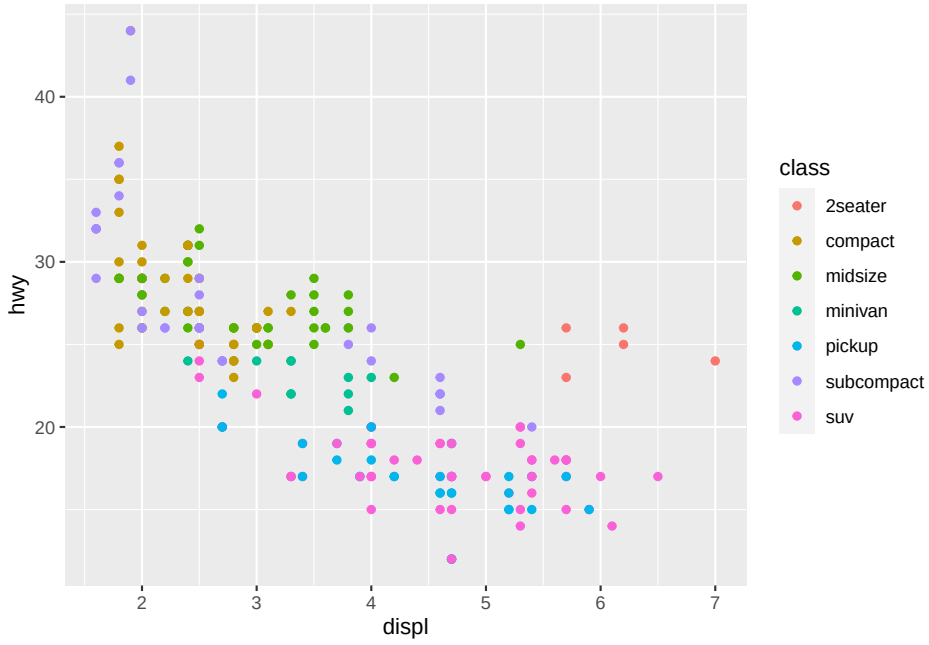
```
# Simple Bar Plot
counts <- table(mtcars$gear)
barplot(counts, main="Car Distribution",
   xlab="Number of Gears")
```



5. ggplot2(ggplot2):ggplot2 ggplot2

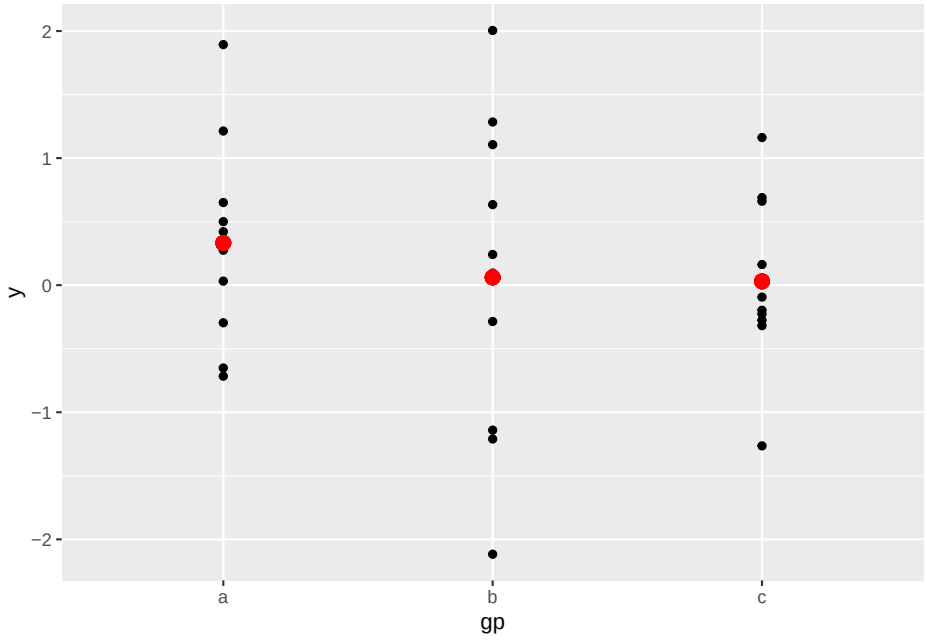
- ggplot2

```
library(ggplot2)
ggplot(mpg, aes(displ, hwy, colour = class)) +
  geom_point()
```




```
# Generate some sample data, then compute mean and standard deviation
# in each group
df <- data.frame(
  gp = factor(rep(letters[1:3], each = 10)),
  y = rnorm(30)
)
ds <- do.call(rbind, lapply(split(df, df$gp), function(d) {
  data.frame(mean = mean(d$y), sd = sd(d$y), gp = d$gp)
}))

# The summary data frame ds is used to plot larger red points on top
# of the raw data. Note that we don't need to supply `data` or `mapping`
# in each layer because the defaults from ggplot() are used.
ggplot(df, aes(gp, y)) +
  geom_point() +
  geom_point(data = ds, aes(y = mean), colour = 'red', size = 3)
```



6.

- Data Component :
- Geometric Component : scatter plot, line graphs, barplots, histograms, qqplots, smooth densities, boxplots, pairplots, heatmaps, etc.
- Mapping Component : .
- Scale Component : . linear scale, log scale, etc.
- Labels Component : This include things like axes labels, titles, legends, font size to use, etc.
- Ethical Component: Here, you want to make sure your visualization tells the true story. You need to be aware of your actions when cleaning, summarizing, manipulating and producing a data visualization and ensure you aren't using your visualization to mislead or manipulate your audience.

Chapter 4

- (missing data) (outlier)
- 80%

4.1

-

```
# download data from http://data.un.org/Data.aspx?q=GDP&d=SNAAMA&f=grID%3a101%3bcurrID%3aNCU%3bp
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.1 --

## v ggplot2 3.3.5     v purrr   0.3.4
## v tibble  3.1.6     v dplyr   1.0.8
## v tidyr   1.2.0     v stringr 1.4.0
## v readr   2.1.2     v forcats 0.5.1

## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(ggplot2)

gdp1 <- read.csv("./data/UNdata_Export_20220406_093714228.csv")

head(gdp1)
```

```
##   Country.or.Area Year
## 1     Afghanistan 2020
## 2     Afghanistan 2020
## 3     Afghanistan 2020
## 4     Afghanistan 2020
## 5     Afghanistan 2020
## 6     Afghanistan 2020
##
## 1                                                                 Final consumption exper
## 2 Household consumption expenditure (including Non-profit institutions serving house
## 3                                          General government final consumption exper
## 4                                                                 Gross capital for
## 5       Gross fixed capital formation (including Acquisitions less disposals of valu
## 6                                                                 Exports of goods and se
##          Value
## 1 1.628089e+12
## 2 1.354293e+12
## 3 2.737961e+11
## 4 1.816860e+11
## 5 1.816860e+11
## 6 2.043364e+11
```

```
names(gdp1)
```

```
## [1] "Country.or.Area" "Year"            "Item"            "Value"
```

```
#levels(as.factor(gdp1[,3]))=paste0("V",1:9)
tb <- as.tibble(gdp1)
```

```
## Warning: `as.tibble()` was deprecated in tibble 2.0.0.
## Please use `as_tibble()` instead.
## The signature and semantics have changed, see `?as_tibble`.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was generated
```

```
head(tb)
```

```
## # A tibble: 6 x 4
##   Country.or.Area  Year Item                                                  Value
##   <chr>           <int> <chr>                                                 <dbl>
## 1 Afghanistan      2020 Final consumption expenditure                       1.63e12
## 2 Afghanistan      2020 Household consumption expenditure (including No~ 1.35e12
## 3 Afghanistan      2020 General government final consumption expenditure 2.74e11
```

```
## 4 Afghanistan      2020 Gross capital formation                          1.82e11
## 5 Afghanistan      2020 Gross fixed capital formation (including Acquis~ 1.82e11
## 6 Afghanistan      2020 Exports of goods and services                    2.04e11
```

```
names(tb)
```

```
## [1] "Country.or.Area" "Year"            "Item"            "Value"
```

```
# filter year 2016 data
tb2016 <- tb[tb$Year==2016,-2]%>%spread(key="Item",value="Value")
head(tb2016,3)
```

```
## # A tibble: 3 x 10
##   Country.or.Area `Changes in inventories` `Exports of goods ~` `Final consump~`
##   <chr>                              <dbl>                <dbl>            <dbl>
## 1 Afghanistan                           NA         203769211430          1.26e12
## 2 Albania                        12602872911         426693482069          1.36e12
## 3 Algeria                      1349202900000        3655739600000          1.11e13
## # ... with 6 more variables:
## #   `General government final consumption expenditure` <dbl>,
## #   `Gross capital formation` <dbl>, `Gross Domestic Product (GDP)` <dbl>,
## #   `Gross fixed capital formation (including Acquisitions less disposals of valuables)` <dbl>
## #   `Household consumption expenditure (including Non-profit institutions serving households)`
## #   `Imports of goods and services` <dbl>
```

```
names(tb2016)[2:10] <- paste0("V",1:9)
head(tb2016)
```

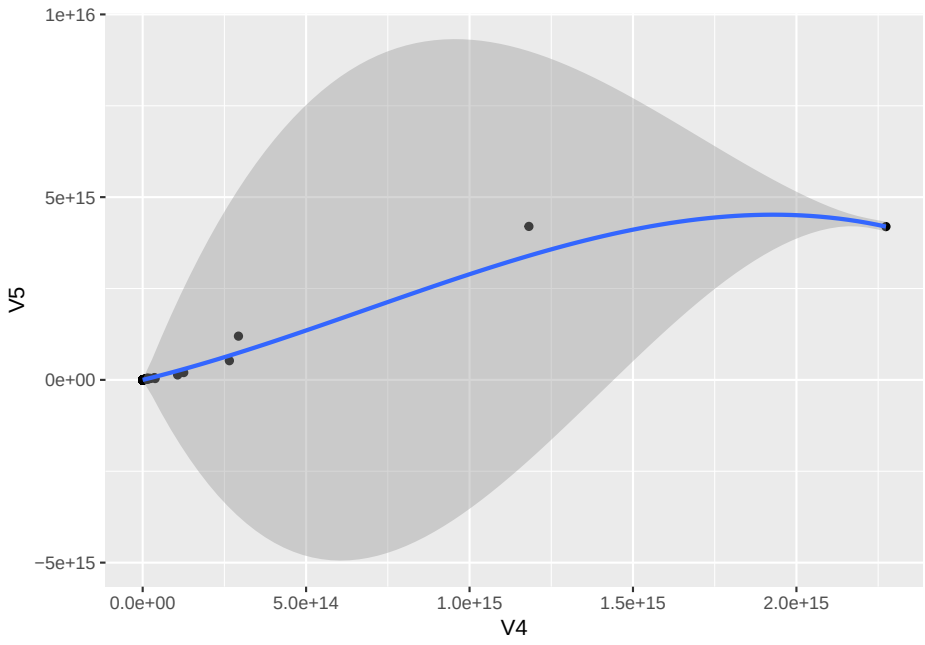
```
## # A tibble: 6 x 10
##   Country.or.Area            V1       V2      V3      V4      V5      V6      V7
##   <chr>                   <dbl>    <dbl>   <dbl>   <dbl>   <dbl>   <dbl>   <dbl>
## 1 Afghanistan                NA  2.04e11 1.26e12 2.81e11 1.54e11 1.22e12 1.54e11
## 2 Albania           12602872911  4.27e11 1.36e12 1.66e11 3.71e11 1.47e12 3.59e11
## 3 Algeria         1349202900000  3.66e12 1.11e13 3.66e12 8.89e12 1.75e13 7.54e12
## 4 Andorra             20754648  8.87e 8 2.02e 9 4.99e 8 4.91e 8 2.62e 9 4.70e 8
## 5 Angola          165743151505  4.65e12 1.16e13 2.30e12 4.50e12 1.65e13 4.34e12
## 6 Anguilla                   NA  5.62e 8 8.62e 8 1.41e 8 1.80e 8 8.61e 8 1.80e 8
## # ... with 2 more variables: V8 <dbl>, V9 <dbl>
```

```
ggplot(tb2016,aes(x=V4,y=V5))+
  geom_point()+
  geom_smooth()
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

```
## Warning: Removed 1 rows containing non-finite values (stat_smooth).
```

```
## Warning: Removed 1 rows containing missing values (geom_point).
```




```
# Draw time series chart
tb %>% subset(Country.or.Area=="Japan") %>%
  ggplot(aes(x=Year,y=Value))+
    geom_line(aes(color=Item),size=1)+
    theme_minimal()
```

4.2

-

```
NN <-  c("./data/D1.csv","./data/D2.csv","./data/D3.csv")
df <- lapply(NN,read.csv)
head(df)
```

```
## [[1]]
##                                Country.or.Area Year.s. Value Value.Footnotes
## 1                                  Afghanistan    2012  -2.4              NA
## 2                                      Albania    2012  -0.3              NA
## 3                                      Algeria    2012  -1.9              NA
## 4                                      Andorra    2012   0.0              NA
## 5                                       Angola    2012  -3.1              NA
## 6                          Antigua and Barbuda    2012  -1.1              NA
## 7                                    Argentina    2012  -0.9              NA
## 8                                      Armenia    2012  -0.2              NA
## 9                                    Australia    2012  -1.3              NA
## 10                                     Austria    2012  -0.4              NA
## 11                                  Azerbaijan    2012  -1.2              NA
## 12                                     Bahamas    2012  -1.6              NA
## 13                                     Bahrain    2012  -1.9              NA
```

```
## 14                                Bangladesh    2012  -1.3             NA
## 15                                  Barbados    2012  -0.4             NA
## 16                                   Belarus    2012   0.5             NA
## 17                                   Belgium    2012  -0.5             NA
## 18                                    Belize    2012  -2.5             NA
## 19                                     Benin    2012  -2.7             NA
## 20                                    Bhutan    2012  -1.8             NA
## 21          Bolivia (Plurinational State of)    2012  -1.7             NA
## 22                    Bosnia and Herzegovina    2012   0.1             NA
## 23                                  Botswana    2012  -0.9             NA
## 24                                    Brazil    2012  -1.0             NA
## 25                      Brunei Darussalam    2012  -1.2             NA
## 26                                  Bulgaria    2012   0.8             NA
## 27                              Burkina Faso    2012  -2.9             NA
## 28                                   Burundi    2012  -3.2             NA
## 29                                Cabo Verde    2012  -0.6             NA
## 30                                  Cambodia    2012  -1.8             NA
## 31                                  Cameroon    2012  -2.5             NA
## 32                                    Canada    2012  -1.0             NA
## 33                  Central African Republic    2012  -2.0             NA
## 34                                      Chad    2012  -3.0             NA
## 35                                     Chile    2012  -0.9             NA
## 36                                     China    2012  -0.7             NA
## 37                                  Colombia    2012  -1.3             NA
## 38                                   Comoros    2012  -2.5             NA
## 39                                     Congo    2012  -2.6             NA
## 40                              Cook Islands    2012  -4.9             NA
## 41                                Costa Rica    2012  -1.4             NA
## 42                             Côte d'Ivoire    2012  -2.3             NA
## 43                                   Croatia    2012   0.4             NA
## 44                                      Cuba    2012   0.0             NA
## 45                                    Cyprus    2012  -1.1             NA
## 46                            Czech Republic    2012  -0.5             NA
## 47     Democratic People's Republic of Korea    2012  -0.5             NA
## 48          Democratic Republic of the Congo    2012  -2.7             NA
## 49                                   Denmark    2012  -0.4             NA
## 50                                  Djibouti    2012  -1.5             NA
## 51                                  Dominica    2012  -1.4             NA
## 52                        Dominican Republic    2012  -1.3             NA
## 53                                   Ecuador    2012  -1.6             NA
## 54                                     Egypt    2012  -1.7             NA
## 55                               El Salvador    2012  -0.7             NA
## 56                         Equatorial Guinea    2012  -2.8             NA
## 57                                   Eritrea    2012  -3.3             NA
## 58                                   Estonia    2012   0.2             NA
## 59                                  Ethiopia    2012  -2.6             NA
```

```
## 60                                   Fiji    2012  -0.8             NA
## 61                                Finland    2012  -0.4             NA
## 62                                 France    2012  -0.6             NA
## 63                                  Gabon    2012  -2.4             NA
## 64                                 Gambia    2012  -3.2             NA
## 65                                Georgia    2012   0.4             NA
## 66                                Germany    2012   0.1             NA
## 67                                  Ghana    2012  -2.2             NA
## 68                                 Greece    2012  -0.1             NA
## 69                                Grenada    2012   0.0             NA
## 70                              Guatemala    2012  -2.5             NA
## 71                                 Guinea    2012  -2.6             NA
## 72                          Guinea-Bissau    2012  -2.4             NA
## 73                                 Guyana    2012  -0.5             NA
## 74                                  Haiti    2012  -1.4             NA
## 75                               Honduras    2012  -2.0             NA
## 76                                Hungary    2012   0.2             NA
## 77                                Iceland    2012  -1.2             NA
## 78                                  India    2012  -1.6             NA
## 79                              Indonesia    2012  -1.2             NA
## 80              Iran (Islamic Republic of)    2012  -1.3             NA
## 81                                   Iraq    2012  -2.9             NA
## 82                                Ireland    2012  -1.2             NA
## 83                                 Israel    2012  -1.3             NA
## 84                                  Italy    2012  -0.3             NA
## 85                                Jamaica    2012  -0.5             NA
## 86                                  Japan    2012   0.0             NA
## 87                                 Jordan    2012  -4.0             NA
## 88                             Kazakhstan    2012  -1.1             NA
## 89                                  Kenya    2012  -2.7             NA
## 90                               Kiribati    2012  -2.0             NA
## 91                                 Kuwait    2012  -3.9             NA
## 92                              Kyrgyzstan    2012  -1.3             NA
## 93          Lao People's Democratic Republic    2012  -1.9             NA
## 94                                 Latvia    2012   0.6             NA
## 95                                Lebanon    2012  -3.7             NA
## 96                                Lesotho    2012  -1.1             NA
## 97                                Liberia    2012  -2.7             NA
## 98                                  Libya    2012  -0.8             NA
## 99                              Lithuania    2012   0.5             NA
## 100                            Luxembourg    2012  -1.5             NA
## 101                            Madagascar    2012  -2.8             NA
## 102                                Malawi    2012  -2.9             NA
## 103                              Malaysia    2012  -1.7             NA
## 104                              Maldives    2012  -1.8             NA
## 105                                  Mali    2012  -3.0             NA
```

```
## 106                                Malta    2012  -0.5             NA
## 107                     Marshall Islands    2012  -1.9             NA
## 108                           Mauritania    2012  -2.5             NA
## 109                            Mauritius    2012  -0.4             NA
## 110                               Mexico    2012  -1.7             NA
## 111 Micronesia (Federated States of)    2012   0.0             NA
## 112                               Monaco    2012  -2.7             NA
## 113                             Mongolia    2012  -1.5             NA
## 114                           Montenegro    2012   0.0             NA
## 115                              Morocco    2012  -1.4             NA
## 116                           Mozambique    2012  -2.5             NA
## 117                              Myanmar    2012  -0.8             NA
## 118                              Namibia    2012  -1.8             NA
## 119                                Nauru    2012   0.0             NA
## 120                                Nepal    2012  -1.2             NA
## 121                          Netherlands    2012  -0.3             NA
## 122                          New Zealand    2012  -1.0             NA
## 123                            Nicaragua    2012  -1.5             NA
## 124                                Niger    2012  -3.8             NA
## 125                              Nigeria    2012  -3.0             NA
## 126                                 Niue    2012   0.0             NA
## 127                               Norway    2012  -1.0             NA
## 128                                 Oman    2012  -9.1             NA
## 129                             Pakistan    2012  -1.7             NA
## 130                                Palau    2012   0.0             NA
## 131                               Panama    2012  -1.6             NA
## 132                     Papua New Guinea    2012  -2.2             NA
## 133                             Paraguay    2012  -1.7             NA
## 134                                 Peru    2012  -1.3             NA
## 135                          Philippines    2012  -1.7             NA
## 136                               Poland    2012   0.0             NA
## 137                             Portugal    2012  -0.1             NA
## 138                                Qatar    2012  -7.1             NA
## 139                  Republic of Korea    2012  -0.6             NA
## 140                Republic of Moldova    2012   0.8             NA
## 141                            Romania    2012   0.2             NA
## 142                 Russian Federation    2012   0.0             NA
## 143                             Rwanda    2012  -2.8             NA
## 144               Saint Kitts and Nevis    2012  -1.9             NA
## 145                        Saint Lucia    2012  -1.1             NA
## 146 Saint Vincent and the Grenadines    2012   0.0             NA
## 147                              Samoa    2012  -1.1             NA
## 148                          San Marino    2012   0.0             NA
## 149               Sao Tome and Principe    2012  -2.7             NA
## 150                       Saudi Arabia    2012  -1.9             NA
## 151                            Senegal    2012  -2.9             NA
```

```
## 152                                    Serbia    2012   0.5              NA
## 153                                  Seychelles    2012   0.0              NA
## 154                                Sierra Leone    2012  -1.9              NA
## 155                                   Singapore    2012  -2.1              NA
## 156                                    Slovakia    2012  -0.1              NA
## 157                                    Slovenia    2012  -0.3              NA
## 158                             Solomon Islands    2012  -2.2              NA
## 159                                     Somalia    2012  -2.9              NA
## 160                                South Africa    2012  -0.8              NA
## 161                                 South Sudan    2012  -4.3              NA
## 162                                       Spain    2012  -0.5              NA
## 163                                   Sri Lanka    2012  -0.8              NA
## 164                                       Sudan    2012  -2.1              NA
## 165                                    Suriname    2012  -0.9              NA
## 166                                   Swaziland    2012  -1.6              NA
## 167                                      Sweden    2012  -0.7              NA
## 168                                 Switzerland    2012  -1.0              NA
## 169                        Syrian Arab Republic    2012  -0.4              NA
## 170                                  Tajikistan    2012  -2.5              NA
## 171                                    Thailand    2012  -0.3              NA
## 172 The former Yugoslav Republic of Macedonia    2012  -0.1              NA
## 173                                  Timor-Leste    2012  -1.6              NA
## 174                                         Togo    2012  -2.6              NA
## 175                                       Tonga    2012   0.0              NA
## 176                         Trinidad and Tobago    2012  -0.3              NA
## 177                                      Tunisia    2012  -1.1              NA
## 178                                       Turkey    2012  -1.3              NA
## 179                                 Turkmenistan    2012  -1.3              NA
## 180                                       Tuvalu    2012   0.0              NA
## 181                                       Uganda    2012  -3.4              NA
## 182                                      Ukraine    2012   0.6              NA
## 183                         United Arab Emirates    2012  -3.1              NA
## 184                               United Kingdom    2012  -0.6              NA
## 185                  United Republic of Tanzania    2012  -3.0              NA
## 186                     United States of America    2012  -0.9              NA
## 187                                      Uruguay    2012  -0.4              NA
## 188                                   Uzbekistan    2012  -1.4              NA
## 189                                      Vanuatu    2012  -2.0              NA
## 190          Venezuela (Bolivarian Republic of)    2012  -1.5              NA
## 191                                    Viet Nam    2012  -1.0              NA
## 192                                       Yemen    2012  -2.3              NA
## 193                                      Zambia    2012  -3.2              NA
## 194                                    Zimbabwe    2012  -2.7              NA
##
## [[2]]
##                               Country.or.Area Year.s. Value Value.Footnotes
```

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##                    Afghanistan 2012  60 NA
##                    Afghanistan 2011  54 NA
##                    Afghanistan 2010  41 NA
##                        Albania 2012 111 NA
##                        Albania 2011  96 NA
##                        Albania 2010 142 NA
##                        Algeria 2012  98 NA
##                        Algeria 2011  99 NA
##                        Algeria 2010  92 NA
##                        Andorra 2012  81 NA
##                        Andorra 2011  75 NA
##                        Andorra 2010  77 NA
##                         Angola 2012  47 NA
##                         Angola 2011  48 NA
##                         Angola 2010  47 NA
##          Antigua and Barbuda 2012 143 NA
##          Antigua and Barbuda 2011 196 NA
##          Antigua and Barbuda 2010 189 NA
##                      Argentina 2012 152 NA
##                      Argentina 2011 135 NA
##                      Argentina 2010 142 NA
##                        Armenia 2012 112 NA
##                        Armenia 2011 104 NA
##                        Armenia 2010 125 NA
##                      Australia 2012 106 NA
##                      Australia 2011 108 NA
##                      Australia 2010 101 NA
##                        Austria 2012 161 NA
##                        Austria 2011 155 NA
##                        Austria 2010 146 NA
##                     Azerbaijan 2012 109 NA
##                     Azerbaijan 2011 109 NA
##                     Azerbaijan 2010  99 NA
##                        Bahamas 2012  81 NA
##                        Bahamas 2011  86 NA
##                        Bahamas 2010 125 NA
##                        Bahrain 2012 161 NA
##                        Bahrain 2011 128 NA
##                        Bahrain 2010 124 NA
##                     Bangladesh 2012  63 NA
##                     Bangladesh 2011  56 NA
##                     Bangladesh 2010  46 NA
##                       Barbados 2012 123 NA
##                       Barbados 2011 127 NA
##                       Barbados 2010 128 NA
##                        Belarus 2012 114 NA
```

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## 47                                 Belarus    2011   112             NA
## 48                                 Belarus    2010   108             NA
## 49                                 Belgium    2012   111             NA
## 50                                 Belgium    2011   117             NA
## 51                                 Belgium    2010   113             NA
## 52                                  Belize    2012    53             NA
## 53                                  Belize    2011    70             NA
## 54                                  Belize    2010    62             NA
## 55                                   Benin    2012    84             NA
## 56                                   Benin    2011    85             NA
## 57                                   Benin    2010    80             NA
## 58                                  Bhutan    2012    76             NA
## 59                                  Bhutan    2011    66             NA
## 60                                  Bhutan    2010    54             NA
## 61          Bolivia (Plurinational State of)   2012    90             NA
## 62          Bolivia (Plurinational State of)   2011    83             NA
## 63          Bolivia (Plurinational State of)   2010    72             NA
## 64                    Bosnia and Herzegovina   2012    88             NA
## 65                    Bosnia and Herzegovina   2011    85             NA
## 66                    Bosnia and Herzegovina   2010    83             NA
## 67                                  Botswana   2012   154             NA
## 68                                  Botswana   2011   143             NA
## 69                                  Botswana   2010   118             NA
## 70                                    Brazil   2012   125             NA
## 71                                    Brazil   2011   124             NA
## 72                                    Brazil   2010   104             NA
## 73                        Brunei Darussalam    2012   114             NA
## 74                        Brunei Darussalam    2011   109             NA
## 75                        Brunei Darussalam    2010   109             NA
## 76                                  Bulgaria   2012   148             NA
## 77                                  Bulgaria   2011   141             NA
## 78                                  Bulgaria   2010   136             NA
## 79                              Burkina Faso   2012    61             NA
## 80                              Burkina Faso   2011    45             NA
## 81                              Burkina Faso   2010    35             NA
## 82                                   Burundi   2012    23             NA
## 83                                   Burundi   2011    22             NA
## 84                                   Burundi   2010    14             NA
## 85                                Cabo Verde   2012    86             NA
## 86                                Cabo Verde   2011    79             NA
## 87                                Cabo Verde   2010    75             NA
## 88                                  Cambodia   2012   129             NA
## 89                                  Cambodia   2011    96             NA
## 90                                  Cambodia   2010    58             NA
## 91                                  Cameroon   2012    60             NA
## 92                                  Cameroon   2011    52             NA
```

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## 93                                  Cameroon    2010    44              NA
## 94                                    Canada    2012    80              NA
## 95                                    Canada    2011    80              NA
## 96                                    Canada    2010    71              NA
## 97                  Central African Republic    2012    25              NA
## 98                  Central African Republic    2011    41              NA
## 99                  Central African Republic    2010    22              NA
## 100                                     Chad    2012    35              NA
## 101                                     Chad    2011    32              NA
## 102                                     Chad    2010    24              NA
## 103                                    Chile    2012   138              NA
## 104                                    Chile    2011   130              NA
## 105                                    Chile    2010   116              NA
## 106                                    China    2012    80              NA
## 107                                    China    2011    73              NA
## 108                                    China    2010    64              NA
## 109                                 Colombia    2012   103              NA
## 110                                 Colombia    2011    98              NA
## 111                                 Colombia    2010    96              NA
## 112                                  Comoros    2012    40              NA
## 113                                  Comoros    2011    29              NA
## 114                                  Comoros    2010    22              NA
## 115                                    Congo    2012    99              NA
## 116                                    Congo    2011    94              NA
## 117                                    Congo    2010    94              NA
## 118                             Cook Islands    2010    38              NA
## 119                               Costa Rica    2012   112              NA
## 120                               Costa Rica    2011    92              NA
## 121                               Costa Rica    2010    65              NA
## 122                            Côte d'Ivoire    2012    91              NA
## 123                            Côte d'Ivoire    2011    86              NA
## 124                            Côte d'Ivoire    2010    76              NA
## 125                                  Croatia    2012   115              NA
## 126                                  Croatia    2011   116              NA
## 127                                  Croatia    2010   144              NA
## 128                                     Cuba    2012    15              NA
## 129                                     Cuba    2011    12              NA
## 130                                     Cuba    2010     9              NA
## 131                                   Cyprus    2012    98              NA
## 132                                   Cyprus    2011    98              NA
## 133                                   Cyprus    2010    94              NA
## 134                           Czech Republic    2012   127              NA
## 135                           Czech Republic    2011   123              NA
## 136                           Czech Republic    2010   137              NA
## 137    Democratic People's Republic of Korea    2012     7              NA
## 138    Democratic People's Republic of Korea    2011     4              NA
```

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## 139     Democratic People's Republic of Korea    2010     2              NA
## 140          Democratic Republic of the Congo    2012    31              NA
## 141          Democratic Republic of the Congo    2011    23              NA
## 142          Democratic Republic of the Congo    2010    18              NA
## 143                                   Denmark    2012   118              NA
## 144                                   Denmark    2011   128              NA
## 145                                   Denmark    2010   125              NA
## 146                                  Djibouti    2012    25              NA
## 147                                  Djibouti    2011    21              NA
## 148                                  Djibouti    2010    19              NA
## 149                                  Dominica    2012   152              NA
## 150                                  Dominica    2011   164              NA
## 151                                  Dominica    2010   156              NA
## 152                        Dominican Republic    2012    87              NA
## 153                        Dominican Republic    2011    87              NA
## 154                        Dominican Republic    2010    90              NA
## 155                                   Ecuador    2012   106              NA
## 156                                   Ecuador    2011   105              NA
## 157                                   Ecuador    2010   102              NA
## 158                                     Egypt    2012   120              NA
## 159                                     Egypt    2011   101              NA
## 160                                     Egypt    2010    87              NA
## 161                               El Salvador    2012   137              NA
## 162                               El Salvador    2011   134              NA
## 163                               El Salvador    2010   124              NA
## 164                         Equatorial Guinea    2012    68              NA
## 165                         Equatorial Guinea    2011    59              NA
## 166                         Equatorial Guinea    2010    57              NA
## 167                                   Eritrea    2012     5              NA
## 168                                   Eritrea    2011     4              NA
## 169                                   Eritrea    2010     4              NA
## 170                                   Estonia    2012   160              NA
## 171                                   Estonia    2011   139              NA
## 172                                   Estonia    2010   123              NA
## 173                                  Ethiopia    2012    22              NA
## 174                                  Ethiopia    2011    17              NA
## 175                                  Ethiopia    2010     8              NA
## 176                                      Fiji    2012    98              NA
## 177                                      Fiji    2011    84              NA
## 178                                      Fiji    2010    81              NA
## 179                                   Finland    2012   172              NA
## 180                                   Finland    2011   166              NA
## 181                                   Finland    2010   156              NA
## 182                                    France    2012    97              NA
## 183                                    France    2011    95              NA
## 184                                    France    2010   101              NA
```

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## 185          Gabon 2012 179   NA
## 186          Gabon 2011 117   NA
## 187          Gabon 2010 107   NA
## 188         Gambia 2012  85   NA
## 189         Gambia 2011  79   NA
## 190         Gambia 2010  86   NA
## 191        Georgia 2012 108   NA
## 192        Georgia 2011 102   NA
## 193        Georgia 2010  91   NA
## 194        Germany 2012 112   NA
## 195        Germany 2011 132   NA
## 196        Germany 2010 127   NA
## 197          Ghana 2012 101   NA
## 198          Ghana 2011  85   NA
## 199          Ghana 2010  71   NA
## 200         Greece 2012 120   NA
## 201         Greece 2011 106   NA
## 202         Greece 2010 108   NA
## 203        Grenada 2012 121   NA
## 204        Grenada 2010 117   NA
## 205      Guatemala 2012 138   NA
## 206      Guatemala 2011 140   NA
## 207      Guatemala 2010 126   NA
## 208         Guinea 2012  42   NA
## 209         Guinea 2011  44   NA
## 210         Guinea 2010  40   NA
## 211  Guinea-Bissau 2012  63   NA
## 212  Guinea-Bissau 2011  56   NA
## 213  Guinea-Bissau 2010  39   NA
## 214         Guyana 2012  69   NA
## 215         Guyana 2011  70   NA
## 216         Guyana 2010  74   NA
## 217          Haiti 2012  60   NA
## 218          Haiti 2011  41   NA
## 219          Haiti 2010  40   NA
## 220       Honduras 2012  93   NA
## 221       Honduras 2011 104   NA
## 222       Honduras 2010 125   NA
## 223        Hungary 2012 116   NA
## 224        Hungary 2011 117   NA
## 225        Hungary 2010 120   NA
## 226        Iceland 2012 108   NA
## 227        Iceland 2011 106   NA
## 228        Iceland 2010 107   NA
## 229          India 2012  70   NA
## 230          India 2011  72   NA
```

```
## 231                                 India    2010    61              NA
## 232                             Indonesia    2012   114              NA
## 233                             Indonesia    2011   103              NA
## 234                             Indonesia    2010    92              NA
## 235               Iran (Islamic Republic of)    2012    76              NA
## 236               Iran (Islamic Republic of)    2011    75              NA
## 237               Iran (Islamic Republic of)    2010    91              NA
## 238                                  Iraq    2012    82              NA
## 239                                  Iraq    2011    78              NA
## 240                                  Iraq    2010    76              NA
## 241                               Ireland    2012   107              NA
## 242                               Ireland    2011   108              NA
## 243                               Ireland    2010   105              NA
## 244                                Israel    2012   121              NA
## 245                                Israel    2011   122              NA
## 246                                Israel    2010   133              NA
## 247                                 Italy    2012   160              NA
## 248                                 Italy    2011   158              NA
## 249                                 Italy    2010   150              NA
## 250                               Jamaica    2012    96              NA
## 251                               Jamaica    2011   108              NA
## 252                               Jamaica    2010   116              NA
## 253                                 Japan    2012   111              NA
## 254                                 Japan    2011   105              NA
## 255                                 Japan    2010    95              NA
## 256                                Jordan    2012   128              NA
## 257                                Jordan    2011   118              NA
## 258                                Jordan    2010   107              NA
## 259                            Kazakhstan    2012   186              NA
## 260                            Kazakhstan    2011   156              NA
## 261                            Kazakhstan    2010   121              NA
## 262                                 Kenya    2012    71              NA
## 263                                 Kenya    2011    67              NA
## 264                                 Kenya    2010    62              NA
## 265                              Kiribati    2012    16              NA
## 266                              Kiribati    2011    14              NA
## 267                              Kiribati    2010    10              NA
## 268                                Kuwait    2012   157              NA
## 269                                Kuwait    2011   175              NA
## 270                                Kuwait    2010   161              NA
## 271                             Kyrgyzstan    2012   124              NA
## 272                             Kyrgyzstan    2011   116              NA
## 273                             Kyrgyzstan    2010    99              NA
## 274         Lao People's Democratic Republic    2012    65              NA
## 275         Lao People's Democratic Republic    2011    87              NA
## 276         Lao People's Democratic Republic    2010    65              NA
```

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## 277                    Latvia 2012 112  NA
## 278                    Latvia 2011 103  NA
## 279                    Latvia 2010 102  NA
## 280                   Lebanon 2012  81  NA
## 281                   Lebanon 2011  79  NA
## 282                   Lebanon 2010  68  NA
## 283                   Lesotho 2012  75  NA
## 284                   Lesotho 2011  56  NA
## 285                   Lesotho 2010  45  NA
## 286                   Liberia 2012  57  NA
## 287                   Liberia 2011  49  NA
## 288                   Liberia 2010  39  NA
## 289                     Libya 2012 156  NA
## 290                     Libya 2011 156  NA
## 291                     Libya 2010 172  NA
## 292                 Lithuania 2012 165  NA
## 293                 Lithuania 2011 151  NA
## 294                 Lithuania 2010 147  NA
## 295                Luxembourg 2012 145  NA
## 296                Luxembourg 2011 148  NA
## 297                Luxembourg 2010 143  NA
## 298                Madagascar 2012  39  NA
## 299                Madagascar 2011  41  NA
## 300                Madagascar 2010  37  NA
## 301                    Malawi 2012  29  NA
## 302                    Malawi 2011  26  NA
## 303                    Malawi 2010  20  NA
## 304                  Malaysia 2012 141  NA
## 305                  Malaysia 2011 127  NA
## 306                  Malaysia 2010 119  NA
## 307                  Maldives 2012 166  NA
## 308                  Maldives 2011 166  NA
## 309                  Maldives 2010 157  NA
## 310                      Mali 2012  98  NA
## 311                      Mali 2011  68  NA
## 312                      Mali 2010  48  NA
## 313                     Malta 2012 127  NA
## 314                     Malta 2011 125  NA
## 315                     Malta 2010 109  NA
## 316           Marshall Islands 2010   7  NA
## 317                 Mauritania 2012 106  NA
## 318                 Mauritania 2011  94  NA
## 319                 Mauritania 2010  79  NA
## 320                  Mauritius 2012 120  NA
## 321                  Mauritius 2011  99  NA
## 322                  Mauritius 2010  92  NA
```

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## 323                                 Mexico    2012    83              NA
## 324                                 Mexico    2011    82              NA
## 325                                 Mexico    2010    81              NA
## 326          Micronesia (Federated States of)    2012    30              NA
## 327          Micronesia (Federated States of)    2010    25              NA
## 328                                 Monaco    2012    88              NA
## 329                                 Monaco    2011    90              NA
## 330                                 Monaco    2010    74              NA
## 331                               Mongolia    2012   121              NA
## 332                               Mongolia    2011   105              NA
## 333                               Mongolia    2010    91              NA
## 334                             Montenegro    2012   181              NA
## 335                             Montenegro    2010   185              NA
## 336                                Morocco    2012   120              NA
## 337                                Morocco    2011   113              NA
## 338                                Morocco    2010   100              NA
## 339                             Mozambique    2012    36              NA
## 340                             Mozambique    2011    33              NA
## 341                             Mozambique    2010    31              NA
## 342                                Myanmar    2012    10              NA
## 343                                Myanmar    2011     3              NA
## 344                                Myanmar    2010     1              NA
## 345                                Namibia    2012    95              NA
## 346                                Namibia    2011    96              NA
## 347                                Namibia    2010    67              NA
## 348                                  Nauru    2012    68              NA
## 349                                  Nauru    2011    65              NA
## 350                                  Nauru    2010    60              NA
## 351                                  Nepal    2012    60              NA
## 352                                  Nepal    2011    44              NA
## 353                                  Nepal    2010    31              NA
## 354                            Netherlands    2012   118              NA
## 355                            Netherlands    2010   115              NA
## 356                            New Zealand    2012   110              NA
## 357                            New Zealand    2011   109              NA
## 358                            New Zealand    2010   115              NA
## 359                              Nicaragua    2012    86              NA
## 360                              Nicaragua    2011    82              NA
## 361                              Nicaragua    2010    65              NA
## 362                                  Niger    2012    31              NA
## 363                                  Niger    2011    30              NA
## 364                                  Niger    2010    25              NA
## 365                                Nigeria    2012    67              NA
## 366                                Nigeria    2011    59              NA
## 367                                Nigeria    2010    55              NA
## 368                                   Niue    2010     0              NA
```

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## 369                    Norway 2012 117 NA
## 370                    Norway 2011 116 NA
## 371                    Norway 2010 116 NA
## 372                      Oman 2012 159 NA
## 373                      Oman 2011 169 NA
## 374                      Oman 2010 166 NA
## 375                  Pakistan 2012  67 NA
## 376                  Pakistan 2011  62 NA
## 377                  Pakistan 2010  57 NA
## 378                     Palau 2012  83 NA
## 379                     Palau 2011  75 NA
## 380                     Palau 2010  71 NA
## 381                    Panama 2012 178 NA
## 382                    Panama 2011 189 NA
## 383                    Panama 2010 185 NA
## 384          Papua New Guinea 2012  38 NA
## 385          Papua New Guinea 2011  34 NA
## 386          Papua New Guinea 2010  28 NA
## 387                  Paraguay 2012 102 NA
## 388                  Paraguay 2011  99 NA
## 389                  Paraguay 2010  92 NA
## 390                      Peru 2012  98 NA
## 391                      Peru 2011 110 NA
## 392                      Peru 2010 100 NA
## 393               Philippines 2012 107 NA
## 394               Philippines 2011  99 NA
## 395               Philippines 2010  86 NA
## 396                    Poland 2012 140 NA
## 397                    Poland 2011 131 NA
## 398                    Poland 2010 123 NA
## 399                  Portugal 2012 116 NA
## 400                  Portugal 2011 115 NA
## 401                  Portugal 2010 142 NA
## 402                     Qatar 2012 127 NA
## 403                     Qatar 2011 123 NA
## 404                     Qatar 2010 132 NA
## 405           Republic of Korea 2012 109 NA
## 406           Republic of Korea 2011 109 NA
## 407           Republic of Korea 2010 105 NA
## 408        Republic of Moldova 2012 102 NA
## 409        Republic of Moldova 2011 105 NA
## 410        Republic of Moldova 2010  89 NA
## 411                  Romania 2012 105 NA
## 412                  Romania 2011 109 NA
## 413                  Romania 2010 115 NA
## 414         Russian Federation 2012 183 NA
```

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## 415                       Russian Federation    2011   179             NA
## 416                       Russian Federation    2010   166             NA
## 417                                   Rwanda    2012    50             NA
## 418                                   Rwanda    2011    41             NA
## 419                                   Rwanda    2010    33             NA
## 420                    Saint Kitts and Nevis    2012   157             NA
## 421                    Saint Kitts and Nevis    2010   153             NA
## 422                              Saint Lucia    2012   126             NA
## 423                              Saint Lucia    2011   123             NA
## 424                              Saint Lucia    2010   114             NA
## 425  Saint Vincent and the Grenadines    2012   124             NA
## 426  Saint Vincent and the Grenadines    2011   121             NA
## 427  Saint Vincent and the Grenadines    2010   121             NA
## 428                                   Samoa    2010    91             NA
## 429                               San Marino    2012   115             NA
## 430                               San Marino    2011   112             NA
## 431                               San Marino    2010    76             NA
## 432                    Sao Tome and Principe    2012    65             NA
## 433                    Sao Tome and Principe    2011    68             NA
## 434                    Sao Tome and Principe    2010    62             NA
## 435                             Saudi Arabia    2012   187             NA
## 436                             Saudi Arabia    2011   191             NA
## 437                             Saudi Arabia    2010   188             NA
## 438                                  Senegal    2012    84             NA
## 439                                  Senegal    2011    73             NA
## 440                                  Senegal    2010    67             NA
## 441                                   Serbia    2012    96             NA
## 442                                   Serbia    2011   125             NA
## 443                                   Serbia    2010   129             NA
## 444                               Seychelles    2012   148             NA
## 445                               Seychelles    2011   146             NA
## 446                               Seychelles    2010   136             NA
## 447                             Sierra Leone    2012    37             NA
## 448                             Sierra Leone    2011    36             NA
## 449                             Sierra Leone    2010    34             NA
## 450                                Singapore    2012   152             NA
## 451                                Singapore    2011   150             NA
## 452                                Singapore    2010   145             NA
## 453                                 Slovakia    2012   112             NA
## 454                                 Slovakia    2011   109             NA
## 455                                 Slovakia    2010   108             NA
## 456                                 Slovenia    2012   109             NA
## 457                                 Slovenia    2011   107             NA
## 458                                 Slovenia    2010   105             NA
## 459                          Solomon Islands    2012    55             NA
## 460                          Solomon Islands    2011    50             NA
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## 461                              Solomon Islands    2010     6              NA
## 462                                      Somalia    2012    23              NA
## 463                                      Somalia    2011     7              NA
## 464                                      Somalia    2010     7              NA
## 465                                 South Africa    2012   131              NA
## 466                                 South Africa    2011   127              NA
## 467                                 South Africa    2010   100              NA
## 468                                  South Sudan    2012    21              NA
## 469                                        Spain    2012   108              NA
## 470                                        Spain    2011   113              NA
## 471                                        Spain    2010   112              NA
## 472                                    Sri Lanka    2012    92              NA
## 473                                    Sri Lanka    2011    87              NA
## 474                                    Sri Lanka    2010    83              NA
## 475                                        Sudan    2012    74              NA
## 476                                        Sudan    2011    56              NA
## 477                                        Sudan    2010    41              NA
## 478                                     Suriname    2012   106              NA
## 479                                     Suriname    2011   179              NA
## 480                                     Suriname    2010   170              NA
## 481                                    Swaziland    2012    65              NA
## 482                                    Swaziland    2011    64              NA
## 483                                    Swaziland    2010    62              NA
## 484                                       Sweden    2012   125              NA
## 485                                       Sweden    2011   119              NA
## 486                                       Sweden    2010   116              NA
## 487                                  Switzerland    2012   130              NA
## 488                                  Switzerland    2011   131              NA
## 489                                  Switzerland    2010   124              NA
## 490                        Syrian Arab Republic    2012    59              NA
## 491                        Syrian Arab Republic    2011    63              NA
## 492                        Syrian Arab Republic    2010    58              NA
## 493                                   Tajikistan    2012    82              NA
## 494                                   Tajikistan    2011    91              NA
## 495                                   Tajikistan    2010    86              NA
## 496                                     Thailand    2012   127              NA
## 497                                     Thailand    2011   112              NA
## 498                                     Thailand    2010   104              NA
## 499 The former Yugoslav Republic of Macedonia    2012   106              NA
## 500 The former Yugoslav Republic of Macedonia    2011   107              NA
## 501 The former Yugoslav Republic of Macedonia    2010   105              NA
## 502                                  Timor-Leste    2012    56              NA
## 503                                  Timor-Leste    2011    53              NA
## 504                                  Timor-Leste    2010    53              NA
## 505                                         Togo    2012    50              NA
## 506                                         Togo    2011    50              NA
```

```
## 507                          Togo 2010  41   NA
## 508                         Tonga 2012  53   NA
## 509                         Tonga 2011  53   NA
## 510                         Tonga 2010  52   NA
## 511           Trinidad and Tobago 2012 141   NA
## 512           Trinidad and Tobago 2011 136   NA
## 513           Trinidad and Tobago 2010 141   NA
## 514                       Tunisia 2012 118   NA
## 515                       Tunisia 2011 117   NA
## 516                       Tunisia 2010 106   NA
## 517                        Turkey 2012  91   NA
## 518                        Turkey 2011  89   NA
## 519                        Turkey 2010  85   NA
## 520                    Turkmenistan 2012  76   NA
## 521                    Turkmenistan 2011  69   NA
## 522                    Turkmenistan 2010  63   NA
## 523                        Tuvalu 2012  28   NA
## 524                        Tuvalu 2011  22   NA
## 525                        Tuvalu 2010  25   NA
## 526                        Uganda 2012  45   NA
## 527                        Uganda 2011  48   NA
## 528                        Uganda 2010  38   NA
## 529                       Ukraine 2012 130   NA
## 530                       Ukraine 2011 123   NA
## 531                       Ukraine 2010 119   NA
## 532          United Arab Emirates 2012 150   NA
## 533          United Arab Emirates 2011 149   NA
## 534          United Arab Emirates 2010 145   NA
## 535                United Kingdom 2012 135   NA
## 536                United Kingdom 2011 131   NA
## 537                United Kingdom 2010 131   NA
## 538 United Republic of Tanzania 2012  57   NA
## 539 United Republic of Tanzania 2011  56   NA
## 540 United Republic of Tanzania 2010  47   NA
## 541    United States of America 2012  95   NA
## 542    United States of America 2011  93   NA
## 543    United States of America 2010  90   NA
## 544                     Uruguay 2012 147   NA
## 545                     Uruguay 2011 141   NA
## 546                     Uruguay 2010 132   NA
## 547                  Uzbekistan 2012  71   NA
## 548                  Uzbekistan 2011  92   NA
## 549                  Uzbekistan 2010  76   NA
## 550                     Vanuatu 2012  59   NA
## 551                     Vanuatu 2011  56   NA
## 552                     Vanuatu 2010 119   NA
```

```
## 553        Venezuela (Bolivarian Republic of)    2012   102              NA
## 554        Venezuela (Bolivarian Republic of)    2011    98              NA
## 555        Venezuela (Bolivarian Republic of)    2010    96              NA
## 556                                  Viet Nam    2012   148              NA
## 557                                  Viet Nam    2011   143              NA
## 558                                  Viet Nam    2010   175              NA
## 559                                     Yemen    2012    58              NA
## 560                                     Yemen    2011    47              NA
## 561                                     Yemen    2010    46              NA
## 562                                    Zambia    2012    75              NA
## 563                                    Zambia    2011    61              NA
## 564                                    Zambia    2010    42              NA
## 565                                  Zimbabwe    2012    92              NA
## 566                                  Zimbabwe    2011    72              NA
## 567                                  Zimbabwe    2010    61              NA
##
## [[3]]
##                              Country.or.Area   Year.s. Value Value.Footnotes
## 1                                Afghanistan 2010-2011  37.4              NA
## 2                                    Albania 2008-2009  98.6              NA
## 3                                    Algeria      2006  99.3              NA
## 4                                    Andorra      2010   >90              NA
## 5                        Antigua and Barbuda      2010   >90              NA
## 6                                  Argentina      2010   >90              NA
## 7                                    Armenia      2010  99.6              NA
## 8                                  Australia      2010   >90              NA
## 9                                    Austria      2011   >90              NA
## 10                                Azerbaijan      2006  93.6              NA
## 11                                   Bahrain      2009   >90              NA
## 12                                Bangladesh      2006   9.8              NA
## 13                                  Barbados      2007   >90              NA
## 14                                   Belarus      2011   >90              NA
## 15                                   Belgium      2011   >90              NA
## 16                                    Belize      2011  95.2              NA
## 17                                     Benin      2006  60.3              NA
## 18                                    Bhutan      2010  99.9              NA
## 19          Bolivia (Plurinational State of)      2008  75.8              NA
## 20                    Bosnia and Herzegovina      2006  99.5              NA
## 21                                  Botswana 2007-2008  72.2              NA
## 22                                    Brazil      2010  93.4              NA
## 23                      Brunei Darussalam      2008   >90              NA
## 24                                  Bulgaria      2011   >90              NA
## 25                               Burkina Faso      2010  76.9              NA
## 26                                   Burundi      2010  75.2              NA
## 27                                Cabo Verde      2010  91.4              NA
## 28                                  Cambodia      2010  62.1              NA
```

```
## 29                                 Cameroon      2006  70.1             NA
## 30                                   Canada      2009   >90             NA
## 31                   Central African Republic      2010    61             NA
## 32                                     Chad      2010  15.7             NA
## 33                                    Chile      2009  99.5             NA
## 34                                 Colombia      2010  96.5             NA
## 35                                    Congo      2005  81.1             NA
## 36                              Cook Islands      2010   >90             NA
## 37                                Costa Rica      2011   >90             NA
## 38                             Côte d'Ivoire      2006  54.9             NA
## 39                                  Croatia      2011   >90             NA
## 40                                     Cuba      2011   100             NA
## 41                                   Cyprus      2011   >90             NA
## 42                           Czech Republic      2011   >90             NA
## 43      Democratic People's Republic of Korea      2009   100             NA
## 44           Democratic Republic of the Congo      2010  27.8             NA
## 45                                  Denmark      2011   >90             NA
## 46                                 Djibouti      2006  89.2             NA
## 47                                 Dominica      2010   >90             NA
## 48                       Dominican Republic 2009-2010  79.2             NA
## 49                                  Ecuador      2010    90             NA
## 50                                    Egypt      2005    99             NA
## 51                               El Salvador      2008  98.6             NA
## 52                                  Estonia      2011   >90             NA
## 53                                 Ethiopia      2005   6.6             NA
## 54                                     Fiji      2009   >90             NA
## 55                                  Finland      2011   >90             NA
## 56                                   France      2011   >90             NA
## 57                                   Gambia      2010  52.5             NA
## 58                                  Georgia      2011  98.5             NA
## 59                                  Germany      2011   >90             NA
## 60                                    Ghana      2011  62.5             NA
## 61                                   Greece      2011   >90             NA
## 62                                Guatemala      2008  96.7             NA
## 63                                   Guinea      2005  43.2             NA
## 64                            Guinea-Bissau      2010  24.1             NA
## 65                                   Guyana      2009  87.9             NA
## 66                                    Haiti 2005-2006  81.1             NA
## 67                                 Honduras 2005-2006  93.5             NA
## 68                                  Hungary      2011   >90             NA
## 69                                  Iceland      2011   >90             NA
## 70                                    India 2005-2006  41.1             NA
## 71                                Indonesia      2007  53.1             NA
## 72              Iran (Islamic Republic of)      2008   >90             NA
## 73                                     Iraq      2006    95             NA
## 74                                  Ireland      2011   >90             NA
```

```
## 75                                  Israel      2011   >90              NA
## 76                                   Italy      2011   >90              NA
## 77                                 Jamaica      2008  97.8              NA
## 78                                   Japan      2010   >90              NA
## 79                                  Jordan      2010   >90              NA
## 80                              Kazakhstan 2010-2011  99.7              NA
## 81                                   Kenya 2008-2009    60              NA
## 82                                Kiribati      2009  93.5              NA
## 83                                  Kuwait      2010   >90              NA
## 84                               Kyrgyzstan 2005-2006  94.2              NA
## 85          Lao People's Democratic Republic      2006  71.5              NA
## 86                                  Latvia      2011   >90              NA
## 87                                 Lebanon      2009  99.5              NA
## 88                                 Lesotho      2009  45.1              NA
## 89                                 Liberia      2007   3.6              NA
## 90                               Lithuania      2011   >90              NA
## 91                              Luxembourg      2011   >90              NA
## 92                              Madagascar 2008-2009  79.7              NA
## 93                                Malaysia      2010   >90              NA
## 94                                Maldives      2009  92.5              NA
## 95                                    Mali      2010  80.8              NA
## 96                                   Malta      2011   >90              NA
## 97                         Marshall Islands      2007  95.9              NA
## 98                              Mauritania      2007  55.9              NA
## 99                               Mauritius      2011   >90              NA
## 100                               Mongolia      2010    99              NA
## 101                            Montenegro 2005-2006  97.9              NA
## 102                            Mozambique      2008  30.8              NA
## 103                               Myanmar 2009-2010  72.4              NA
## 104                               Namibia 2006-2007  67.1              NA
## 105                                 Nauru      2007  82.6              NA
## 106                                 Nepal      2011  42.3              NA
## 107                           Netherlands      2011   >90              NA
## 108                           New Zealand      2011   >90              NA
## 109                             Nicaragua      2006  81.3              NA
## 110                                 Niger      2006  31.8              NA
## 111                               Nigeria      2008    30              NA
## 112                                  Niue      2009   >90              NA
## 113                                Norway      2011   >90              NA
## 114                              Pakistan 2006-2007  26.5              NA
## 115                                Panama      2011   >90              NA
## 116                                  Peru      2007  92.9              NA
## 117                           Philippines      2009   >90              NA
## 118                                Poland      2011   >90              NA
## 119                              Portugal      2011   >90              NA
## 120                                 Qatar      2011   >90              NA
```

```
## 121                          Republic of Korea      2010   >90             NA
## 122                        Republic of Moldova      2011   >90             NA
## 123                                    Romania      2011   >90             NA
## 124                         Russian Federation      2011   >90             NA
## 125                                     Rwanda      2010  63.2             NA
## 126          Saint Vincent and the Grenadines      2009   >90             NA
## 127                                      Samoa      2009  47.7             NA
## 128                                 San Marino      2011   >90             NA
## 129                      Sao Tome and Principe 2008-2009  75.1             NA
## 130                                   Senegal 2010-2011  74.6             NA
## 131                                    Serbia      2010  98.9             NA
## 132                                Seychelles      2011   >90             NA
## 133                              Sierra Leone      2010    78             NA
## 134                                 Singapore      2011   >90             NA
## 135                                  Slovakia      2011   >90             NA
## 136                                  Slovenia      2011   >90             NA
## 137                                   Somalia      2006     3             NA
## 138                              South Africa      2008  91.8             NA
## 139                               South Sudan      2010  35.4             NA
## 140                                     Spain      2011   >90             NA
## 141                                 Sri Lanka 2006-2007  97.2             NA
## 142                                     Sudan      2010  59.3             NA
## 143                                  Suriname      2006  96.6             NA
## 144                                 Swaziland      2010  49.5             NA
## 145                                    Sweden      2011   >90             NA
## 146                               Switzerland      2011   >90             NA
## 147                       Syrian Arab Republic      2006  95.2             NA
## 148                                Tajikistan      2005  88.3             NA
## 149                                  Thailand 2005-2006  99.4             NA
## 150 The former Yugoslav Republic of Macedonia      2011  99.7             NA
## 151                               Timor-Leste 2009-2010  55.2             NA
## 152                                      Togo      2010  77.9             NA
## 153                        Trinidad and Tobago      2006  95.8             NA
## 154                                   Tunisia      2008   >90             NA
## 155                                    Turkey      2008  93.7             NA
## 156                                Turkmenistan      2006  95.5             NA
## 157                                     Tuvalu      2007  49.9             NA
## 158                                     Uganda      2011  29.9             NA
## 159                                    Ukraine      2005  99.8             NA
## 160                             United Kingdom      2010   >90             NA
## 161                 United Republic of Tanzania      2010  16.3             NA
## 162                    United States of America      2009   >90             NA
## 163                                    Uruguay      2010   >90             NA
## 164                                 Uzbekistan      2006  99.9             NA
## 165                                    Vanuatu      2007  25.6             NA
## 166          Venezuela (Bolivarian Republic of)      2008   >90             NA
```

```
## 167                                  Viet Nam      2011    95              NA
## 168                                     Yemen      2006  22.3              NA
## 169                                    Zambia      2007    14              NA
## 170                                  Zimbabwe 2010-2011  48.8              NA
```

```
# delete rows and columns
U <- NULL
for (i in 1:length(df)){
  U = unique(c(U,unique(as.character(df[[i]][,1]))))
}
Trash = c("1","2","3","4","footnoteSeqID")
U = setdiff(U,Trash)

df = lapply(df,function(x) x[x[,1]%in% U,])
df = lapply(df,function(x) select(x,-Value.Footnotes))
head(df)
```

```
## [[1]]
##                                Country.or.Area Year.s. Value
## 1                                  Afghanistan    2012  -2.4
## 2                                      Albania    2012  -0.3
## 3                                      Algeria    2012  -1.9
## 4                                      Andorra    2012   0.0
## 5                                       Angola    2012  -3.1
## 6                          Antigua and Barbuda    2012  -1.1
## 7                                    Argentina    2012  -0.9
## 8                                      Armenia    2012  -0.2
## 9                                    Australia    2012  -1.3
## 10                                     Austria    2012  -0.4
## 11                                  Azerbaijan    2012  -1.2
## 12                                     Bahamas    2012  -1.6
## 13                                     Bahrain    2012  -1.9
## 14                                  Bangladesh    2012  -1.3
## 15                                    Barbados    2012  -0.4
## 16                                     Belarus    2012   0.5
## 17                                     Belgium    2012  -0.5
## 18                                      Belize    2012  -2.5
## 19                                       Benin    2012  -2.7
## 20                                      Bhutan    2012  -1.8
## 21          Bolivia (Plurinational State of)    2012  -1.7
## 22                    Bosnia and Herzegovina    2012   0.1
## 23                                    Botswana    2012  -0.9
## 24                                      Brazil    2012  -1.0
## 25                        Brunei Darussalam     2012  -1.2
## 26                                    Bulgaria    2012   0.8
```

```
## 27                              Burkina Faso    2012  -2.9
## 28                                   Burundi    2012  -3.2
## 29                                Cabo Verde    2012  -0.6
## 30                                  Cambodia    2012  -1.8
## 31                                  Cameroon    2012  -2.5
## 32                                    Canada    2012  -1.0
## 33                    Central African Republic    2012  -2.0
## 34                                      Chad    2012  -3.0
## 35                                     Chile    2012  -0.9
## 36                                     China    2012  -0.7
## 37                                  Colombia    2012  -1.3
## 38                                   Comoros    2012  -2.5
## 39                                     Congo    2012  -2.6
## 40                                Cook Islands    2012  -4.9
## 41                                Costa Rica    2012  -1.4
## 42                             Côte d'Ivoire    2012  -2.3
## 43                                   Croatia    2012   0.4
## 44                                      Cuba    2012   0.0
## 45                                    Cyprus    2012  -1.1
## 46                            Czech Republic    2012  -0.5
## 47      Democratic People's Republic of Korea    2012  -0.5
## 48           Democratic Republic of the Congo    2012  -2.7
## 49                                   Denmark    2012  -0.4
## 50                                  Djibouti    2012  -1.5
## 51                                  Dominica    2012  -1.4
## 52                        Dominican Republic    2012  -1.3
## 53                                   Ecuador    2012  -1.6
## 54                                     Egypt    2012  -1.7
## 55                               El Salvador    2012  -0.7
## 56                         Equatorial Guinea    2012  -2.8
## 57                                   Eritrea    2012  -3.3
## 58                                   Estonia    2012   0.2
## 59                                  Ethiopia    2012  -2.6
## 60                                      Fiji    2012  -0.8
## 61                                   Finland    2012  -0.4
## 62                                    France    2012  -0.6
## 63                                     Gabon    2012  -2.4
## 64                                    Gambia    2012  -3.2
## 65                                   Georgia    2012   0.4
## 66                                   Germany    2012   0.1
## 67                                     Ghana    2012  -2.2
## 68                                    Greece    2012  -0.1
## 69                                   Grenada    2012   0.0
## 70                                 Guatemala    2012  -2.5
## 71                                    Guinea    2012  -2.6
## 72                             Guinea-Bissau    2012  -2.4
```

```
## 73                                  Guyana    2012  -0.5
## 74                                   Haiti    2012  -1.4
## 75                                Honduras    2012  -2.0
## 76                                 Hungary    2012   0.2
## 77                                 Iceland    2012  -1.2
## 78                                   India    2012  -1.6
## 79                               Indonesia    2012  -1.2
## 80           Iran (Islamic Republic of)    2012  -1.3
## 81                                    Iraq    2012  -2.9
## 82                                 Ireland    2012  -1.2
## 83                                  Israel    2012  -1.3
## 84                                   Italy    2012  -0.3
## 85                                 Jamaica    2012  -0.5
## 86                                   Japan    2012   0.0
## 87                                  Jordan    2012  -4.0
## 88                              Kazakhstan    2012  -1.1
## 89                                   Kenya    2012  -2.7
## 90                                Kiribati    2012  -2.0
## 91                                  Kuwait    2012  -3.9
## 92                              Kyrgyzstan    2012  -1.3
## 93      Lao People's Democratic Republic    2012  -1.9
## 94                                  Latvia    2012   0.6
## 95                                 Lebanon    2012  -3.7
## 96                                 Lesotho    2012  -1.1
## 97                                 Liberia    2012  -2.7
## 98                                   Libya    2012  -0.8
## 99                               Lithuania    2012   0.5
## 100                             Luxembourg    2012  -1.5
## 101                             Madagascar    2012  -2.8
## 102                                 Malawi    2012  -2.9
## 103                               Malaysia    2012  -1.7
## 104                               Maldives    2012  -1.8
## 105                                   Mali    2012  -3.0
## 106                                  Malta    2012  -0.5
## 107                       Marshall Islands    2012  -1.9
## 108                             Mauritania    2012  -2.5
## 109                              Mauritius    2012  -0.4
## 110                                 Mexico    2012  -1.7
## 111     Micronesia (Federated States of)    2012   0.0
## 112                                 Monaco    2012  -2.7
## 113                               Mongolia    2012  -1.5
## 114                             Montenegro    2012   0.0
## 115                                Morocco    2012  -1.4
## 116                             Mozambique    2012  -2.5
## 117                                Myanmar    2012  -0.8
## 118                                Namibia    2012  -1.8
```

```
## 119                                  Nauru    2012   0.0
## 120                                  Nepal    2012  -1.2
## 121                            Netherlands    2012  -0.3
## 122                            New Zealand    2012  -1.0
## 123                              Nicaragua    2012  -1.5
## 124                                  Niger    2012  -3.8
## 125                                Nigeria    2012  -3.0
## 126                                   Niue    2012   0.0
## 127                                 Norway    2012  -1.0
## 128                                   Oman    2012  -9.1
## 129                               Pakistan    2012  -1.7
## 130                                  Palau    2012   0.0
## 131                                 Panama    2012  -1.6
## 132                       Papua New Guinea    2012  -2.2
## 133                               Paraguay    2012  -1.7
## 134                                   Peru    2012  -1.3
## 135                            Philippines    2012  -1.7
## 136                                 Poland    2012   0.0
## 137                               Portugal    2012  -0.1
## 138                                  Qatar    2012  -7.1
## 139                       Republic of Korea    2012  -0.6
## 140                     Republic of Moldova    2012   0.8
## 141                                 Romania    2012   0.2
## 142                      Russian Federation    2012   0.0
## 143                                  Rwanda    2012  -2.8
## 144                  Saint Kitts and Nevis    2012  -1.9
## 145                             Saint Lucia    2012  -1.1
## 146  Saint Vincent and the Grenadines    2012   0.0
## 147                                   Samoa    2012  -1.1
## 148                              San Marino    2012   0.0
## 149                  Sao Tome and Principe    2012  -2.7
## 150                           Saudi Arabia    2012  -1.9
## 151                                Senegal    2012  -2.9
## 152                                 Serbia    2012   0.5
## 153                             Seychelles    2012   0.0
## 154                           Sierra Leone    2012  -1.9
## 155                              Singapore    2012  -2.1
## 156                               Slovakia    2012  -0.1
## 157                               Slovenia    2012  -0.3
## 158                         Solomon Islands    2012  -2.2
## 159                                Somalia    2012  -2.9
## 160                           South Africa    2012  -0.8
## 161                            South Sudan    2012  -4.3
## 162                                  Spain    2012  -0.5
## 163                              Sri Lanka    2012  -0.8
## 164                                  Sudan    2012  -2.1
```

```
## 165                                    Suriname    2012  -0.9
## 166                                   Swaziland    2012  -1.6
## 167                                      Sweden    2012  -0.7
## 168                                 Switzerland    2012  -1.0
## 169                       Syrian Arab Republic    2012  -0.4
## 170                                  Tajikistan    2012  -2.5
## 171                                    Thailand    2012  -0.3
## 172 The former Yugoslav Republic of Macedonia    2012  -0.1
## 173                                  Timor-Leste    2012  -1.6
## 174                                         Togo    2012  -2.6
## 175                                       Tonga    2012   0.0
## 176                           Trinidad and Tobago    2012  -0.3
## 177                                      Tunisia    2012  -1.1
## 178                                       Turkey    2012  -1.3
## 179                                   Turkmenistan    2012  -1.3
## 180                                       Tuvalu    2012   0.0
## 181                                       Uganda    2012  -3.4
## 182                                      Ukraine    2012   0.6
## 183                         United Arab Emirates    2012  -3.1
## 184                               United Kingdom    2012  -0.6
## 185                   United Republic of Tanzania    2012  -3.0
## 186                      United States of America    2012  -0.9
## 187                                      Uruguay    2012  -0.4
## 188                                   Uzbekistan    2012  -1.4
## 189                                      Vanuatu    2012  -2.0
## 190          Venezuela (Bolivarian Republic of)    2012  -1.5
## 191                                    Viet Nam    2012  -1.0
## 192                                       Yemen    2012  -2.3
## 193                                      Zambia    2012  -3.2
## 194                                    Zimbabwe    2012  -2.7
##
## [[2]]
##                                Country.or.Area Year.s. Value
## 1                                  Afghanistan    2012    60
## 2                                  Afghanistan    2011    54
## 3                                  Afghanistan    2010    41
## 4                                      Albania    2012   111
## 5                                      Albania    2011    96
## 6                                      Albania    2010   142
## 7                                      Algeria    2012    98
## 8                                      Algeria    2011    99
## 9                                      Algeria    2010    92
## 10                                     Andorra    2012    81
## 11                                     Andorra    2011    75
## 12                                     Andorra    2010    77
## 13                                      Angola    2012    47
```

```
## 14                                Angola    2011    48
## 15                                Angola    2010    47
## 16                   Antigua and Barbuda    2012   143
## 17                   Antigua and Barbuda    2011   196
## 18                   Antigua and Barbuda    2010   189
## 19                             Argentina    2012   152
## 20                             Argentina    2011   135
## 21                             Argentina    2010   142
## 22                               Armenia    2012   112
## 23                               Armenia    2011   104
## 24                               Armenia    2010   125
## 25                             Australia    2012   106
## 26                             Australia    2011   108
## 27                             Australia    2010   101
## 28                               Austria    2012   161
## 29                               Austria    2011   155
## 30                               Austria    2010   146
## 31                            Azerbaijan    2012   109
## 32                            Azerbaijan    2011   109
## 33                            Azerbaijan    2010    99
## 34                               Bahamas    2012    81
## 35                               Bahamas    2011    86
## 36                               Bahamas    2010   125
## 37                               Bahrain    2012   161
## 38                               Bahrain    2011   128
## 39                               Bahrain    2010   124
## 40                            Bangladesh    2012    63
## 41                            Bangladesh    2011    56
## 42                            Bangladesh    2010    46
## 43                              Barbados    2012   123
## 44                              Barbados    2011   127
## 45                              Barbados    2010   128
## 46                               Belarus    2012   114
## 47                               Belarus    2011   112
## 48                               Belarus    2010   108
## 49                               Belgium    2012   111
## 50                               Belgium    2011   117
## 51                               Belgium    2010   113
## 52                                Belize    2012    53
## 53                                Belize    2011    70
## 54                                Belize    2010    62
## 55                                 Benin    2012    84
## 56                                 Benin    2011    85
## 57                                 Benin    2010    80
## 58                                Bhutan    2012    76
## 59                                Bhutan    2011    66
```

```
## 60                                  Bhutan  2010   54
## 61  Bolivia (Plurinational State of)  2012   90
## 62  Bolivia (Plurinational State of)  2011   83
## 63  Bolivia (Plurinational State of)  2010   72
## 64            Bosnia and Herzegovina  2012   88
## 65            Bosnia and Herzegovina  2011   85
## 66            Bosnia and Herzegovina  2010   83
## 67                          Botswana  2012  154
## 68                          Botswana  2011  143
## 69                          Botswana  2010  118
## 70                            Brazil  2012  125
## 71                            Brazil  2011  124
## 72                            Brazil  2010  104
## 73                  Brunei Darussalam  2012  114
## 74                  Brunei Darussalam  2011  109
## 75                  Brunei Darussalam  2010  109
## 76                           Bulgaria  2012  148
## 77                           Bulgaria  2011  141
## 78                           Bulgaria  2010  136
## 79                       Burkina Faso  2012   61
## 80                       Burkina Faso  2011   45
## 81                       Burkina Faso  2010   35
## 82                            Burundi  2012   23
## 83                            Burundi  2011   22
## 84                            Burundi  2010   14
## 85                         Cabo Verde  2012   86
## 86                         Cabo Verde  2011   79
## 87                         Cabo Verde  2010   75
## 88                           Cambodia  2012  129
## 89                           Cambodia  2011   96
## 90                           Cambodia  2010   58
## 91                           Cameroon  2012   60
## 92                           Cameroon  2011   52
## 93                           Cameroon  2010   44
## 94                             Canada  2012   80
## 95                             Canada  2011   80
## 96                             Canada  2010   71
## 97          Central African Republic  2012   25
## 98          Central African Republic  2011   41
## 99          Central African Republic  2010   22
## 100                             Chad  2012   35
## 101                             Chad  2011   32
## 102                             Chad  2010   24
## 103                            Chile  2012  138
## 104                            Chile  2011  130
## 105                            Chile  2010  116
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## 106                                    China    2012    80
## 107                                    China    2011    73
## 108                                    China    2010    64
## 109                                 Colombia    2012   103
## 110                                 Colombia    2011    98
## 111                                 Colombia    2010    96
## 112                                  Comoros    2012    40
## 113                                  Comoros    2011    29
## 114                                  Comoros    2010    22
## 115                                    Congo    2012    99
## 116                                    Congo    2011    94
## 117                                    Congo    2010    94
## 118                             Cook Islands    2010    38
## 119                               Costa Rica    2012   112
## 120                               Costa Rica    2011    92
## 121                               Costa Rica    2010    65
## 122                            Côte d'Ivoire    2012    91
## 123                            Côte d'Ivoire    2011    86
## 124                            Côte d'Ivoire    2010    76
## 125                                  Croatia    2012   115
## 126                                  Croatia    2011   116
## 127                                  Croatia    2010   144
## 128                                     Cuba    2012    15
## 129                                     Cuba    2011    12
## 130                                     Cuba    2010     9
## 131                                   Cyprus    2012    98
## 132                                   Cyprus    2011    98
## 133                                   Cyprus    2010    94
## 134                           Czech Republic    2012   127
## 135                           Czech Republic    2011   123
## 136                           Czech Republic    2010   137
## 137     Democratic People's Republic of Korea    2012     7
## 138     Democratic People's Republic of Korea    2011     4
## 139     Democratic People's Republic of Korea    2010     2
## 140          Democratic Republic of the Congo    2012    31
## 141          Democratic Republic of the Congo    2011    23
## 142          Democratic Republic of the Congo    2010    18
## 143                                   Denmark    2012   118
## 144                                   Denmark    2011   128
## 145                                   Denmark    2010   125
## 146                                  Djibouti    2012    25
## 147                                  Djibouti    2011    21
## 148                                  Djibouti    2010    19
## 149                                  Dominica    2012   152
## 150                                  Dominica    2011   164
## 151                                  Dominica    2010   156
```

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## 152          Dominican Republic    2012    87
## 153          Dominican Republic    2011    87
## 154          Dominican Republic    2010    90
## 155                     Ecuador    2012   106
## 156                     Ecuador    2011   105
## 157                     Ecuador    2010   102
## 158                       Egypt    2012   120
## 159                       Egypt    2011   101
## 160                       Egypt    2010    87
## 161                 El Salvador    2012   137
## 162                 El Salvador    2011   134
## 163                 El Salvador    2010   124
## 164           Equatorial Guinea    2012    68
## 165           Equatorial Guinea    2011    59
## 166           Equatorial Guinea    2010    57
## 167                     Eritrea    2012     5
## 168                     Eritrea    2011     4
## 169                     Eritrea    2010     4
## 170                     Estonia    2012   160
## 171                     Estonia    2011   139
## 172                     Estonia    2010   123
## 173                    Ethiopia    2012    22
## 174                    Ethiopia    2011    17
## 175                    Ethiopia    2010     8
## 176                        Fiji    2012    98
## 177                        Fiji    2011    84
## 178                        Fiji    2010    81
## 179                     Finland    2012   172
## 180                     Finland    2011   166
## 181                     Finland    2010   156
## 182                      France    2012    97
## 183                      France    2011    95
## 184                      France    2010   101
## 185                       Gabon    2012   179
## 186                       Gabon    2011   117
## 187                       Gabon    2010   107
## 188                      Gambia    2012    85
## 189                      Gambia    2011    79
## 190                      Gambia    2010    86
## 191                     Georgia    2012   108
## 192                     Georgia    2011   102
## 193                     Georgia    2010    91
## 194                     Germany    2012   112
## 195                     Germany    2011   132
## 196                     Germany    2010   127
## 197                       Ghana    2012   101
```

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## 198                          Ghana    2011    85
## 199                          Ghana    2010    71
## 200                         Greece    2012   120
## 201                         Greece    2011   106
## 202                         Greece    2010   108
## 203                        Grenada    2012   121
## 204                        Grenada    2010   117
## 205                      Guatemala    2012   138
## 206                      Guatemala    2011   140
## 207                      Guatemala    2010   126
## 208                         Guinea    2012    42
## 209                         Guinea    2011    44
## 210                         Guinea    2010    40
## 211                  Guinea-Bissau    2012    63
## 212                  Guinea-Bissau    2011    56
## 213                  Guinea-Bissau    2010    39
## 214                         Guyana    2012    69
## 215                         Guyana    2011    70
## 216                         Guyana    2010    74
## 217                          Haiti    2012    60
## 218                          Haiti    2011    41
## 219                          Haiti    2010    40
## 220                       Honduras    2012    93
## 221                       Honduras    2011   104
## 222                       Honduras    2010   125
## 223                        Hungary    2012   116
## 224                        Hungary    2011   117
## 225                        Hungary    2010   120
## 226                        Iceland    2012   108
## 227                        Iceland    2011   106
## 228                        Iceland    2010   107
## 229                          India    2012    70
## 230                          India    2011    72
## 231                          India    2010    61
## 232                      Indonesia    2012   114
## 233                      Indonesia    2011   103
## 234                      Indonesia    2010    92
## 235 Iran (Islamic Republic of)    2012    76
## 236 Iran (Islamic Republic of)    2011    75
## 237 Iran (Islamic Republic of)    2010    91
## 238                           Iraq    2012    82
## 239                           Iraq    2011    78
## 240                           Iraq    2010    76
## 241                        Ireland    2012   107
## 242                        Ireland    2011   108
## 243                        Ireland    2010   105
```

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## 244                                 Israel    2012   121
## 245                                 Israel    2011   122
## 246                                 Israel    2010   133
## 247                                  Italy    2012   160
## 248                                  Italy    2011   158
## 249                                  Italy    2010   150
## 250                                Jamaica    2012    96
## 251                                Jamaica    2011   108
## 252                                Jamaica    2010   116
## 253                                  Japan    2012   111
## 254                                  Japan    2011   105
## 255                                  Japan    2010    95
## 256                                 Jordan    2012   128
## 257                                 Jordan    2011   118
## 258                                 Jordan    2010   107
## 259                             Kazakhstan    2012   186
## 260                             Kazakhstan    2011   156
## 261                             Kazakhstan    2010   121
## 262                                  Kenya    2012    71
## 263                                  Kenya    2011    67
## 264                                  Kenya    2010    62
## 265                               Kiribati    2012    16
## 266                               Kiribati    2011    14
## 267                               Kiribati    2010    10
## 268                                 Kuwait    2012   157
## 269                                 Kuwait    2011   175
## 270                                 Kuwait    2010   161
## 271                             Kyrgyzstan    2012   124
## 272                             Kyrgyzstan    2011   116
## 273                             Kyrgyzstan    2010    99
## 274         Lao People's Democratic Republic    2012    65
## 275         Lao People's Democratic Republic    2011    87
## 276         Lao People's Democratic Republic    2010    65
## 277                                 Latvia    2012   112
## 278                                 Latvia    2011   103
## 279                                 Latvia    2010   102
## 280                                Lebanon    2012    81
## 281                                Lebanon    2011    79
## 282                                Lebanon    2010    68
## 283                                Lesotho    2012    75
## 284                                Lesotho    2011    56
## 285                                Lesotho    2010    45
## 286                                Liberia    2012    57
## 287                                Liberia    2011    49
## 288                                Liberia    2010    39
## 289                                  Libya    2012   156
```

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## 290                                 Libya    2011   156
## 291                                 Libya    2010   172
## 292                              Lithuania    2012   165
## 293                              Lithuania    2011   151
## 294                              Lithuania    2010   147
## 295                             Luxembourg    2012   145
## 296                             Luxembourg    2011   148
## 297                             Luxembourg    2010   143
## 298                             Madagascar    2012    39
## 299                             Madagascar    2011    41
## 300                             Madagascar    2010    37
## 301                                 Malawi    2012    29
## 302                                 Malawi    2011    26
## 303                                 Malawi    2010    20
## 304                               Malaysia    2012   141
## 305                               Malaysia    2011   127
## 306                               Malaysia    2010   119
## 307                               Maldives    2012   166
## 308                               Maldives    2011   166
## 309                               Maldives    2010   157
## 310                                   Mali    2012    98
## 311                                   Mali    2011    68
## 312                                   Mali    2010    48
## 313                                  Malta    2012   127
## 314                                  Malta    2011   125
## 315                                  Malta    2010   109
## 316                        Marshall Islands    2010     7
## 317                             Mauritania    2012   106
## 318                             Mauritania    2011    94
## 319                             Mauritania    2010    79
## 320                              Mauritius    2012   120
## 321                              Mauritius    2011    99
## 322                              Mauritius    2010    92
## 323                                 Mexico    2012    83
## 324                                 Mexico    2011    82
## 325                                 Mexico    2010    81
## 326          Micronesia (Federated States of)    2012    30
## 327          Micronesia (Federated States of)    2010    25
## 328                                 Monaco    2012    88
## 329                                 Monaco    2011    90
## 330                                 Monaco    2010    74
## 331                               Mongolia    2012   121
## 332                               Mongolia    2011   105
## 333                               Mongolia    2010    91
## 334                             Montenegro    2012   181
## 335                             Montenegro    2010   185
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## 336        Morocco  2012  120
## 337        Morocco  2011  113
## 338        Morocco  2010  100
## 339     Mozambique  2012   36
## 340     Mozambique  2011   33
## 341     Mozambique  2010   31
## 342        Myanmar  2012   10
## 343        Myanmar  2011    3
## 344        Myanmar  2010    1
## 345        Namibia  2012   95
## 346        Namibia  2011   96
## 347        Namibia  2010   67
## 348          Nauru  2012   68
## 349          Nauru  2011   65
## 350          Nauru  2010   60
## 351          Nepal  2012   60
## 352          Nepal  2011   44
## 353          Nepal  2010   31
## 354    Netherlands  2012  118
## 355    Netherlands  2010  115
## 356    New Zealand  2012  110
## 357    New Zealand  2011  109
## 358    New Zealand  2010  115
## 359      Nicaragua  2012   86
## 360      Nicaragua  2011   82
## 361      Nicaragua  2010   65
## 362          Niger  2012   31
## 363          Niger  2011   30
## 364          Niger  2010   25
## 365        Nigeria  2012   67
## 366        Nigeria  2011   59
## 367        Nigeria  2010   55
## 368           Niue  2010    0
## 369         Norway  2012  117
## 370         Norway  2011  116
## 371         Norway  2010  116
## 372           Oman  2012  159
## 373           Oman  2011  169
## 374           Oman  2010  166
## 375       Pakistan  2012   67
## 376       Pakistan  2011   62
## 377       Pakistan  2010   57
## 378          Palau  2012   83
## 379          Palau  2011   75
## 380          Palau  2010   71
## 381         Panama  2012  178
```

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## 382                                 Panama    2011   189
## 383                                 Panama    2010   185
## 384                       Papua New Guinea    2012    38
## 385                       Papua New Guinea    2011    34
## 386                       Papua New Guinea    2010    28
## 387                               Paraguay    2012   102
## 388                               Paraguay    2011    99
## 389                               Paraguay    2010    92
## 390                                   Peru    2012    98
## 391                                   Peru    2011   110
## 392                                   Peru    2010   100
## 393                            Philippines    2012   107
## 394                            Philippines    2011    99
## 395                            Philippines    2010    86
## 396                                 Poland    2012   140
## 397                                 Poland    2011   131
## 398                                 Poland    2010   123
## 399                               Portugal    2012   116
## 400                               Portugal    2011   115
## 401                               Portugal    2010   142
## 402                                  Qatar    2012   127
## 403                                  Qatar    2011   123
## 404                                  Qatar    2010   132
## 405                         Republic of Korea    2012   109
## 406                         Republic of Korea    2011   109
## 407                         Republic of Korea    2010   105
## 408                       Republic of Moldova    2012   102
## 409                       Republic of Moldova    2011   105
## 410                       Republic of Moldova    2010    89
## 411                                 Romania    2012   105
## 412                                 Romania    2011   109
## 413                                 Romania    2010   115
## 414                      Russian Federation    2012   183
## 415                      Russian Federation    2011   179
## 416                      Russian Federation    2010   166
## 417                                  Rwanda    2012    50
## 418                                  Rwanda    2011    41
## 419                                  Rwanda    2010    33
## 420                   Saint Kitts and Nevis    2012   157
## 421                   Saint Kitts and Nevis    2010   153
## 422                             Saint Lucia    2012   126
## 423                             Saint Lucia    2011   123
## 424                             Saint Lucia    2010   114
## 425         Saint Vincent and the Grenadines    2012   124
## 426         Saint Vincent and the Grenadines    2011   121
## 427         Saint Vincent and the Grenadines    2010   121
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## 428                    Samoa  2010  91
## 429               San Marino  2012 115
## 430               San Marino  2011 112
## 431               San Marino  2010  76
## 432 Sao Tome and Principe     2012  65
## 433 Sao Tome and Principe     2011  68
## 434 Sao Tome and Principe     2010  62
## 435             Saudi Arabia  2012 187
## 436             Saudi Arabia  2011 191
## 437             Saudi Arabia  2010 188
## 438                  Senegal  2012  84
## 439                  Senegal  2011  73
## 440                  Senegal  2010  67
## 441                   Serbia  2012  96
## 442                   Serbia  2011 125
## 443                   Serbia  2010 129
## 444               Seychelles  2012 148
## 445               Seychelles  2011 146
## 446               Seychelles  2010 136
## 447             Sierra Leone  2012  37
## 448             Sierra Leone  2011  36
## 449             Sierra Leone  2010  34
## 450                Singapore  2012 152
## 451                Singapore  2011 150
## 452                Singapore  2010 145
## 453                 Slovakia  2012 112
## 454                 Slovakia  2011 109
## 455                 Slovakia  2010 108
## 456                 Slovenia  2012 109
## 457                 Slovenia  2011 107
## 458                 Slovenia  2010 105
## 459          Solomon Islands  2012  55
## 460          Solomon Islands  2011  50
## 461          Solomon Islands  2010   6
## 462                  Somalia  2012  23
## 463                  Somalia  2011   7
## 464                  Somalia  2010   7
## 465             South Africa  2012 131
## 466             South Africa  2011 127
## 467             South Africa  2010 100
## 468              South Sudan  2012  21
## 469                    Spain  2012 108
## 470                    Spain  2011 113
## 471                    Spain  2010 112
## 472                Sri Lanka  2012  92
## 473                Sri Lanka  2011  87
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## 474                                  Sri Lanka    2010    83
## 475                                      Sudan    2012    74
## 476                                      Sudan    2011    56
## 477                                      Sudan    2010    41
## 478                                   Suriname    2012   106
## 479                                   Suriname    2011   179
## 480                                   Suriname    2010   170
## 481                                  Swaziland    2012    65
## 482                                  Swaziland    2011    64
## 483                                  Swaziland    2010    62
## 484                                     Sweden    2012   125
## 485                                     Sweden    2011   119
## 486                                     Sweden    2010   116
## 487                                Switzerland    2012   130
## 488                                Switzerland    2011   131
## 489                                Switzerland    2010   124
## 490                       Syrian Arab Republic    2012    59
## 491                       Syrian Arab Republic    2011    63
## 492                       Syrian Arab Republic    2010    58
## 493                                 Tajikistan    2012    82
## 494                                 Tajikistan    2011    91
## 495                                 Tajikistan    2010    86
## 496                                   Thailand    2012   127
## 497                                   Thailand    2011   112
## 498                                   Thailand    2010   104
## 499 The former Yugoslav Republic of Macedonia    2012   106
## 500 The former Yugoslav Republic of Macedonia    2011   107
## 501 The former Yugoslav Republic of Macedonia    2010   105
## 502                                 Timor-Leste    2012    56
## 503                                 Timor-Leste    2011    53
## 504                                 Timor-Leste    2010    53
## 505                                        Togo    2012    50
## 506                                        Togo    2011    50
## 507                                        Togo    2010    41
## 508                                       Tonga    2012    53
## 509                                       Tonga    2011    53
## 510                                       Tonga    2010    52
## 511                         Trinidad and Tobago    2012   141
## 512                         Trinidad and Tobago    2011   136
## 513                         Trinidad and Tobago    2010   141
## 514                                     Tunisia    2012   118
## 515                                     Tunisia    2011   117
## 516                                     Tunisia    2010   106
## 517                                      Turkey    2012    91
## 518                                      Turkey    2011    89
## 519                                      Turkey    2010    85
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## 520                          Turkmenistan    2012    76
## 521                          Turkmenistan    2011    69
## 522                          Turkmenistan    2010    63
## 523                                Tuvalu    2012    28
## 524                                Tuvalu    2011    22
## 525                                Tuvalu    2010    25
## 526                                Uganda    2012    45
## 527                                Uganda    2011    48
## 528                                Uganda    2010    38
## 529                               Ukraine    2012   130
## 530                               Ukraine    2011   123
## 531                               Ukraine    2010   119
## 532                  United Arab Emirates    2012   150
## 533                  United Arab Emirates    2011   149
## 534                  United Arab Emirates    2010   145
## 535                        United Kingdom    2012   135
## 536                        United Kingdom    2011   131
## 537                        United Kingdom    2010   131
## 538            United Republic of Tanzania    2012    57
## 539            United Republic of Tanzania    2011    56
## 540            United Republic of Tanzania    2010    47
## 541               United States of America    2012    95
## 542               United States of America    2011    93
## 543               United States of America    2010    90
## 544                              Uruguay    2012   147
## 545                              Uruguay    2011   141
## 546                              Uruguay    2010   132
## 547                           Uzbekistan    2012    71
## 548                           Uzbekistan    2011    92
## 549                           Uzbekistan    2010    76
## 550                              Vanuatu    2012    59
## 551                              Vanuatu    2011    56
## 552                              Vanuatu    2010   119
## 553       Venezuela (Bolivarian Republic of)    2012   102
## 554       Venezuela (Bolivarian Republic of)    2011    98
## 555       Venezuela (Bolivarian Republic of)    2010    96
## 556                            Viet Nam    2012   148
## 557                            Viet Nam    2011   143
## 558                            Viet Nam    2010   175
## 559                               Yemen    2012    58
## 560                               Yemen    2011    47
## 561                               Yemen    2010    46
## 562                              Zambia    2012    75
## 563                              Zambia    2011    61
## 564                              Zambia    2010    42
## 565                            Zimbabwe    2012    92
```

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## 566                                  Zimbabwe    2011    72
## 567                                  Zimbabwe    2010    61
##
## [[3]]
##                               Country.or.Area   Year.s. Value
## 1                                 Afghanistan 2010-2011  37.4
## 2                                     Albania 2008-2009  98.6
## 3                                     Algeria      2006  99.3
## 4                                     Andorra      2010   >90
## 5                         Antigua and Barbuda      2010   >90
## 6                                   Argentina      2010   >90
## 7                                     Armenia      2010  99.6
## 8                                   Australia      2010   >90
## 9                                     Austria      2011   >90
## 10                                 Azerbaijan      2006  93.6
## 11                                    Bahrain      2009   >90
## 12                                 Bangladesh      2006   9.8
## 13                                   Barbados      2007   >90
## 14                                    Belarus      2011   >90
## 15                                    Belgium      2011   >90
## 16                                     Belize      2011  95.2
## 17                                      Benin      2006  60.3
## 18                                     Bhutan      2010  99.9
## 19           Bolivia (Plurinational State of)      2008  75.8
## 20                     Bosnia and Herzegovina      2006  99.5
## 21                                   Botswana 2007-2008  72.2
## 22                                     Brazil      2010  93.4
## 23                          Brunei Darussalam      2008   >90
## 24                                   Bulgaria      2011   >90
## 25                               Burkina Faso      2010  76.9
## 26                                    Burundi      2010  75.2
## 27                                 Cabo Verde      2010  91.4
## 28                                   Cambodia      2010  62.1
## 29                                   Cameroon      2006  70.1
## 30                                     Canada      2009   >90
## 31                    Central African Republic      2010    61
## 32                                       Chad      2010  15.7
## 33                                      Chile      2009  99.5
## 34                                   Colombia      2010  96.5
## 35                                      Congo      2005  81.1
## 36                                Cook Islands      2010   >90
## 37                                  Costa Rica      2011   >90
## 38                               Côte d'Ivoire      2006  54.9
## 39                                     Croatia      2011   >90
## 40                                        Cuba      2011   100
## 41                                      Cyprus      2011   >90
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## 42                            Czech Republic      2011   >90
## 43     Democratic People's Republic of Korea      2009   100
## 44          Democratic Republic of the Congo      2010  27.8
## 45                                   Denmark      2011   >90
## 46                                  Djibouti      2006  89.2
## 47                                  Dominica      2010   >90
## 48                        Dominican Republic 2009-2010  79.2
## 49                                   Ecuador      2010    90
## 50                                     Egypt      2005    99
## 51                               El Salvador      2008  98.6
## 52                                   Estonia      2011   >90
## 53                                  Ethiopia      2005   6.6
## 54                                      Fiji      2009   >90
## 55                                   Finland      2011   >90
## 56                                    France      2011   >90
## 57                                    Gambia      2010  52.5
## 58                                   Georgia      2011  98.5
## 59                                   Germany      2011   >90
## 60                                     Ghana      2011  62.5
## 61                                    Greece      2011   >90
## 62                                 Guatemala      2008  96.7
## 63                                    Guinea      2005  43.2
## 64                             Guinea-Bissau      2010  24.1
## 65                                    Guyana      2009  87.9
## 66                                     Haiti 2005-2006  81.1
## 67                                  Honduras 2005-2006  93.5
## 68                                   Hungary      2011   >90
## 69                                   Iceland      2011   >90
## 70                                     India 2005-2006  41.1
## 71                                 Indonesia      2007  53.1
## 72               Iran (Islamic Republic of)      2008   >90
## 73                                      Iraq      2006    95
## 74                                   Ireland      2011   >90
## 75                                    Israel      2011   >90
## 76                                     Italy      2011   >90
## 77                                   Jamaica      2008  97.8
## 78                                     Japan      2010   >90
## 79                                    Jordan      2010   >90
## 80                                Kazakhstan 2010-2011  99.7
## 81                                     Kenya 2008-2009    60
## 82                                  Kiribati      2009  93.5
## 83                                    Kuwait      2010   >90
## 84                                Kyrgyzstan 2005-2006  94.2
## 85          Lao People's Democratic Republic      2006  71.5
## 86                                   Latvia      2011   >90
## 87                                  Lebanon      2009  99.5
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## 88                                 Lesotho      2009  45.1
## 89                                 Liberia      2007   3.6
## 90                               Lithuania      2011   >90
## 91                              Luxembourg      2011   >90
## 92                              Madagascar 2008-2009  79.7
## 93                                Malaysia      2010   >90
## 94                                Maldives      2009  92.5
## 95                                    Mali      2010  80.8
## 96                                   Malta      2011   >90
## 97                         Marshall Islands      2007  95.9
## 98                              Mauritania      2007  55.9
## 99                               Mauritius      2011   >90
## 100                               Mongolia      2010    99
## 101                             Montenegro 2005-2006  97.9
## 102                             Mozambique      2008  30.8
## 103                                Myanmar 2009-2010  72.4
## 104                                Namibia 2006-2007  67.1
## 105                                  Nauru      2007  82.6
## 106                                  Nepal      2011  42.3
## 107                            Netherlands      2011   >90
## 108                            New Zealand      2011   >90
## 109                              Nicaragua      2006  81.3
## 110                                  Niger      2006  31.8
## 111                                Nigeria      2008    30
## 112                                   Niue      2009   >90
## 113                                 Norway      2011   >90
## 114                               Pakistan 2006-2007  26.5
## 115                                 Panama      2011   >90
## 116                                   Peru      2007  92.9
## 117                            Philippines      2009   >90
## 118                                 Poland      2011   >90
## 119                               Portugal      2011   >90
## 120                                  Qatar      2011   >90
## 121                          Republic of Korea      2010   >90
## 122                        Republic of Moldova      2011   >90
## 123                                Romania      2011   >90
## 124                         Russian Federation      2011   >90
## 125                                 Rwanda      2010  63.2
## 126          Saint Vincent and the Grenadines      2009   >90
## 127                                  Samoa      2009  47.7
## 128                             San Marino      2011   >90
## 129                   Sao Tome and Principe 2008-2009  75.1
## 130                                Senegal 2010-2011  74.6
## 131                                 Serbia      2010  98.9
## 132                             Seychelles      2011   >90
## 133                           Sierra Leone      2010    78
```

```
## 134                                  Singapore      2011   >90
## 135                                   Slovakia      2011   >90
## 136                                   Slovenia      2011   >90
## 137                                    Somalia      2006     3
## 138                               South Africa      2008  91.8
## 139                                South Sudan      2010  35.4
## 140                                      Spain      2011   >90
## 141                                  Sri Lanka 2006-2007  97.2
## 142                                      Sudan      2010  59.3
## 143                                   Suriname      2006  96.6
## 144                                  Swaziland      2010  49.5
## 145                                     Sweden      2011   >90
## 146                                Switzerland      2011   >90
## 147                       Syrian Arab Republic      2006  95.2
## 148                                 Tajikistan      2005  88.3
## 149                                   Thailand 2005-2006  99.4
## 150 The former Yugoslav Republic of Macedonia      2011  99.7
## 151                                Timor-Leste 2009-2010  55.2
## 152                                       Togo      2010  77.9
## 153                        Trinidad and Tobago      2006  95.8
## 154                                    Tunisia      2008   >90
## 155                                     Turkey      2008  93.7
## 156                                 Turkmenistan      2006  95.5
## 157                                     Tuvalu      2007  49.9
## 158                                     Uganda      2011  29.9
## 159                                    Ukraine      2005  99.8
## 160                             United Kingdom      2010   >90
## 161                United Republic of Tanzania      2010  16.3
## 162                   United States of America      2009   >90
## 163                                    Uruguay      2010   >90
## 164                                 Uzbekistan      2006  99.9
## 165                                    Vanuatu      2007  25.6
## 166        Venezuela (Bolivarian Republic of)      2008   >90
## 167                                   Viet Nam      2011    95
## 168                                      Yemen      2006  22.3
## 169                                     Zambia      2007    14
## 170                                   Zimbabwe 2010-2011  48.8
```

```
# combine data
x = df[[1]]
for(i in 2:length(NN)){
  x = merge.data.frame(x,df[[i]],by="Country.or.Area")
}
head(x)
```

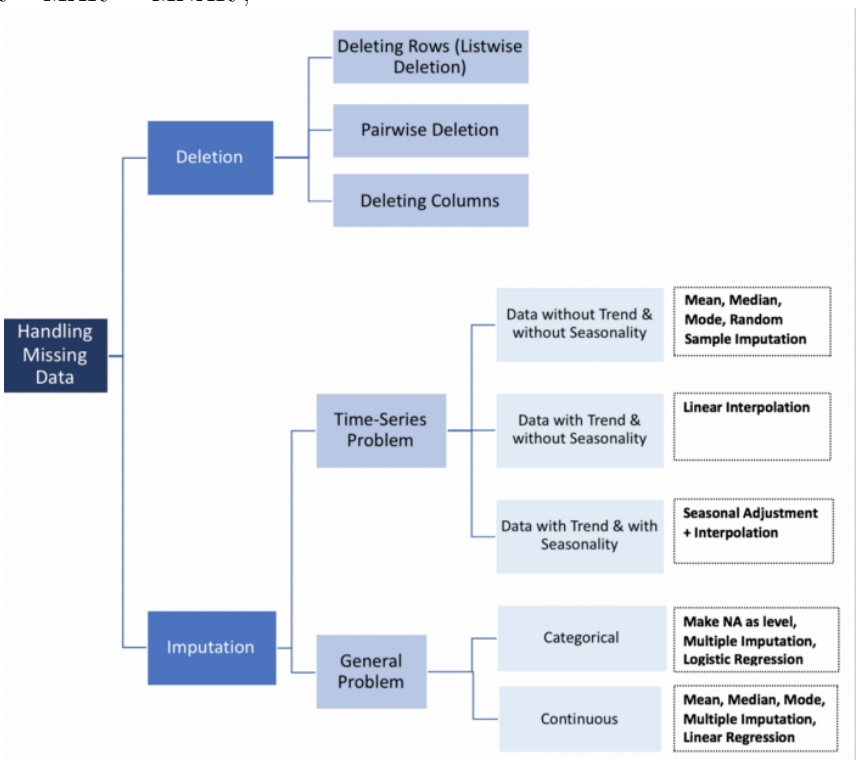
```
##   Country.or.Area Year.s..x Value.x Year.s..y Value.y   Year.s. Value
```

```
## 1     Afghanistan      2012    -2.4      2011       54 2010-2011  37.4
## 2     Afghanistan      2012    -2.4      2012       60 2010-2011  37.4
## 3     Afghanistan      2012    -2.4      2010       41 2010-2011  37.4
## 4         Albania      2012    -0.3      2010      142 2008-2009  98.6
## 5         Albania      2012    -0.3      2011       96 2008-2009  98.6
## 6         Albania      2012    -0.3      2012      111 2008-2009  98.6
```

```
write.csv(x,"./data/dp.csv",row.names = FALSE)
```

4.3

- CMAR MAR MNAR ;



- R NA(not available)

List wise deletion

Gender	Manpower	Sales
M	25	343
F	.	280
M	33	332
M	.	272
F	25	.
M	29	326
	26	259
M	32	297

Pair wise deletion

Gender	Manpower	Sales
M	25	343
F	.	280
M	33	332
M	.	272
F	25	.
M	29	326
	26	259
M	32	297

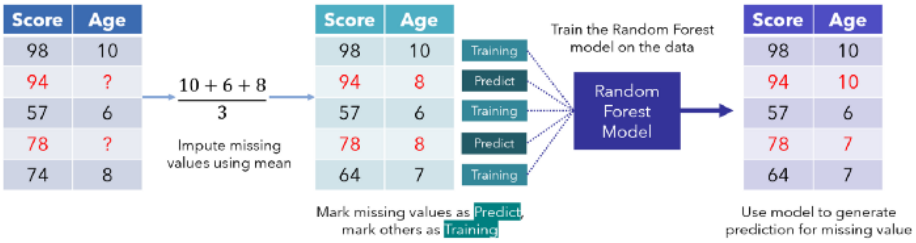
Figure 4.1: msdelete

4.3.1

4.3.2

4.3.3

First, the missing values are filled in using median/mode imputation. Then, we mark the missing values as 'Predict' and the others as training rows, which are fed into a Random Forest model trained to predict, in this case, Age based on Score. The generated prediction for that row is then filled in to produce a transformed dataset.



4.3.4 R

1. MICE (Multivariate Imputation via Chained Equations) is one of the commonly used package by R users. Creating multiple imputations as compared to a single imputation (such as mean) takes care of uncertainty in missing values. MICE assumes that the missing data are Missing at Random (MAR), which means that the probability that a value is missing depends only on observed value and can be predicted using them. It

imputes data on a variable by variable basis by specifying an imputation model per variable. For example: Suppose we have X1, X2….Xk variables. If X1 has missing values, then it will be regressed on other variables X2 to Xk. The missing values in X1 will be then replaced by predictive values obtained. Similarly, if X2 has missing values, then X1, X3 to Xk variables will be used in prediction model as independent variables. Later, missing values will be replaced with predicted values. By default, linear regression is used to predict continuous missing values. Logistic regression is used for categorical missing values. Once this cycle is complete, multiple data sets are generated. These data sets differ only in imputed missing values. Generally, it's considered to be a good practice to build models on these data sets separately and combining their results.

2. Amelia
3. missForest
4. Hmisc
5. mi

4.3.5

```
#install.packages("mice")
#install.packages("missForest")
library(mice)
```

```
##
## Attaching package: 'mice'

## The following object is masked from 'package:stats':
##
##     filter

## The following objects are masked from 'package:base':
##
##     cbind, rbind
```

```
library(missForest)
```

```
## Loading required package: randomForest

## randomForest 4.7-1

## Type rfNews() to see new features/changes/bug fixes.
```

```
##
## Attaching package: 'randomForest'

## The following object is masked from 'package:dplyr':
##
##     combine

## The following object is masked from 'package:ggplot2':
##
##     margin

## Loading required package: foreach

##
## Attaching package: 'foreach'

## The following objects are masked from 'package:purrr':
##
##     accumulate, when

## Loading required package: itertools

## Loading required package: iterators
```

```
#load data
data <- iris
# Get summary
summary(data)
```

```
##   Sepal.Length    Sepal.Width     Petal.Length    Petal.Width
##  Min.   :4.300   Min.   :2.000   Min.   :1.000   Min.   :0.100
##  1st Qu.:5.100   1st Qu.:2.800   1st Qu.:1.600   1st Qu.:0.300
##  Median :5.800   Median :3.000   Median :4.350   Median :1.300
##  Mean   :5.843   Mean   :3.057   Mean   :3.758   Mean   :1.199
##  3rd Qu.:6.400   3rd Qu.:3.300   3rd Qu.:5.100   3rd Qu.:1.800
##  Max.   :7.900   Max.   :4.400   Max.   :6.900   Max.   :2.500
##        Species
##  setosa    :50
##  versicolor:50
##  virginica :50
##
##
##
```

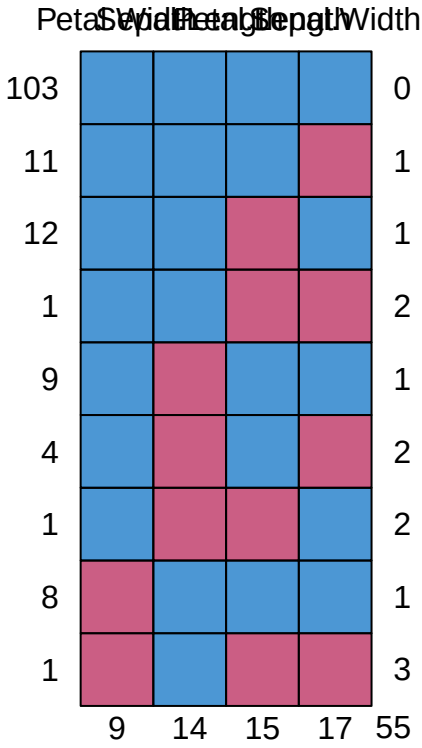
```
#Generate 10% missing values at Random
iris.mis <- prodNA(data, noNA = 0.1)
#Check missing values introduced in the data
summary(iris.mis)
```

```
##   Sepal.Length    Sepal.Width     Petal.Length    Petal.Width
##  Min.   :4.300   Min.   :2.000   Min.   :1.000   Min.   :0.100
##  1st Qu.:5.100   1st Qu.:2.800   1st Qu.:1.600   1st Qu.:0.300
##  Median :5.800   Median :3.000   Median :4.300   Median :1.300
##  Mean   :5.821   Mean   :3.048   Mean   :3.747   Mean   :1.204
##  3rd Qu.:6.325   3rd Qu.:3.300   3rd Qu.:5.100   3rd Qu.:1.800
##  Max.   :7.900   Max.   :4.400   Max.   :6.700   Max.   :2.500
##  NA's   :14      NA's   :17      NA's   :15      NA's   :9
##        Species
##  setosa    :41
##  versicolor:46
##  virginica :43
##  NA's      :20
##
##
##
```

```
# Removing categorical data
iris.mis <- subset(iris.mis, select = -c(Species))
summary(iris.mis)
```

```
##   Sepal.Length    Sepal.Width     Petal.Length    Petal.Width
##  Min.   :4.300   Min.   :2.000   Min.   :1.000   Min.   :0.100
##  1st Qu.:5.100   1st Qu.:2.800   1st Qu.:1.600   1st Qu.:0.300
##  Median :5.800   Median :3.000   Median :4.300   Median :1.300
##  Mean   :5.821   Mean   :3.048   Mean   :3.747   Mean   :1.204
##  3rd Qu.:6.325   3rd Qu.:3.300   3rd Qu.:5.100   3rd Qu.:1.800
##  Max.   :7.900   Max.   :4.400   Max.   :6.700   Max.   :2.500
##  NA's   :14      NA's   :17      NA's   :15      NA's   :9
```

```
md.pattern(iris.mis)
```




```
##     Petal.Width Sepal.Length Petal.Length Sepal.Width
## 103           1            1            1           1  0
## 11            1            1            1           0  1
## 12            1            1            0           1  1
## 1             1            1            0           0  2
## 9             1            0            1           1  1
## 4             1            0            1           0  2
## 1             1            0            0           1  2
## 8             0            1            1           1  1
## 1             0            1            0           0  3
##               9           14           15          17 55
```

```
# make it beautiful missing pattern
#install.packages("VIM")
library(VIM)
```

```
## Loading required package: colorspace
```

```
## Loading required package: grid
```

```
## VIM is ready to use.
```

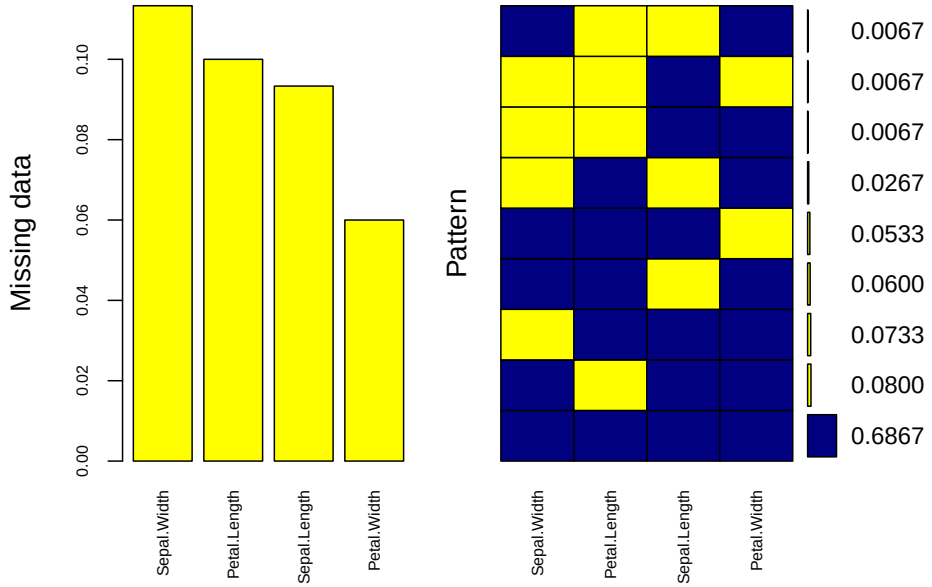
```
## Suggestions and bug-reports can be submitted at: https://github.com/statistikat/VIM/issues

##
## Attaching package: 'VIM'

## The following object is masked from 'package:missForest':
##
##     nrmse

## The following object is masked from 'package:datasets':
##
##     sleep
```

```
mice_plot <- aggr(iris.mis, col=c('navyblue','yellow'),
numbers=TRUE, sortVars=TRUE,
labels=names(iris.mis), cex.axis=.7,
gap=3, ylab=c("Missing data","Pattern"))
```




```
##
##  Variables sorted by number of missings:
##       Variable      Count
##    Sepal.Width 0.11333333
##   Petal.Length 0.10000000
##   Sepal.Length 0.09333333
##    Petal.Width 0.06000000
```

```r
# impute the missing data using mice
imputed_Data <- mice(iris.mis, m=5, maxit = 50, method = 'pmm', seed = 500)
```

```
##
##  iter imp variable
##   1   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   1   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   1   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   1   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   1   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   2   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   2   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   2   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   2   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   2   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   3   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   3   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   3   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   3   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   3   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   4   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   4   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   4   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   4   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   4   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   5   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   5   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   5   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   5   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   5   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   6   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   6   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   6   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   6   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   6   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   7   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   7   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   7   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   7   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   7   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   8   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   8   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   8   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   8   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   8   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
```

```
##    9   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    9   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    9   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    9   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    9   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    10   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    10   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    10   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    10   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    10   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    11   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    11   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    11   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    11   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    11   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    12   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    12   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    12   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    12   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    12   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    13   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    13   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    13   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    13   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    13   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    14   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    14   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    14   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    14   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    14   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    15   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    15   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    15   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    15   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    15   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    16   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    16   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    16   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    16   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    16   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    17   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    17   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    17   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    17   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    17   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##    18   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
```

```
##   18   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   18   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   18   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   18   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   19   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   19   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   19   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   19   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   19   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   20   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   20   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   20   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   20   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   20   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   21   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   21   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   21   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   21   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   21   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   22   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   22   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   22   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   22   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   22   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   23   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   23   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   23   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   23   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   23   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   24   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   24   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   24   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   24   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   24   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   25   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   25   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   25   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   25   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   25   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   26   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   26   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   26   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   26   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   26   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   27   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   27   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
```

```
##   27   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   27   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   27   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   28   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   28   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   28   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   28   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   28   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   29   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   29   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   29   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   29   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   29   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   30   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   30   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   30   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   30   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   30   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   31   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   31   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   31   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   31   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   31   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   32   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   32   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   32   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   32   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   32   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   33   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   33   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   33   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   33   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   33   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   34   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   34   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   34   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   34   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   34   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   35   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   35   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   35   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   35   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   35   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   36   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   36   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   36   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
```

```
##   36   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   36   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   37   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   37   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   37   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   37   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   37   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   38   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   38   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   38   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   38   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   38   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   39   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   39   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   39   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   39   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   39   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   40   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   40   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   40   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   40   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   40   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   41   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   41   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   41   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   41   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   41   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   42   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   42   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   42   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   42   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   42   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   43   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   43   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   43   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   43   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   43   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   44   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   44   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   44   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   44   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   44   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   45   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   45   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   45   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   45   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
```

```
##   45   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   46   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   46   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   46   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   46   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   46   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   47   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   47   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   47   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   47   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   47   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   48   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   48   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   48   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   48   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   48   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   49   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   49   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   49   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   49   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   49   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   50   1  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   50   2  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   50   3  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   50   4  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
##   50   5  Sepal.Length  Sepal.Width  Petal.Length  Petal.Width
```

```
#m - Refers to 5 imputed data sets;maxit - Refers to no. of iterations taken to impute missing va
summary(imputed_Data)
```

```
## Class: mids
## Number of multiple imputations:  5
## Imputation methods:
## Sepal.Length  Sepal.Width Petal.Length  Petal.Width
##        "pmm"        "pmm"        "pmm"        "pmm"
## PredictorMatrix:
##              Sepal.Length Sepal.Width Petal.Length Petal.Width
## Sepal.Length            0           1            1           1
## Sepal.Width             1           0            1           1
## Petal.Length            1           1            0           1
## Petal.Width             1           1            1           0
```

```
#check imputed values
imputed_Data$imp$Sepal.Width
```

```
##       1   2   3   4   5
## 3   3.6 3.1 3.8 3.2 3.0
## 5   3.5 3.8 3.1 3.1 3.0
## 19  3.7 3.9 3.5 3.7 3.5
## 23  3.3 3.4 3.2 3.4 3.8
## 30  3.0 3.0 3.6 3.0 3.3
## 32  3.5 3.9 3.3 3.3 3.5
## 34  4.1 3.3 3.5 3.8 3.0
## 55  2.8 3.1 3.1 3.3 3.2
## 68  2.8 2.4 2.5 3.0 2.4
## 75  2.8 3.1 3.2 2.5 3.0
## 88  2.8 2.7 3.1 2.6 2.2
## 95  2.5 2.9 2.3 2.8 2.5
## 104 2.6 2.8 2.7 3.0 2.2
## 118 3.4 3.0 3.0 3.0 3.0
## 123 3.4 3.3 2.0 2.6 2.6
## 129 2.3 3.0 3.3 3.4 2.5
## 147 3.3 3.0 2.5 3.4 2.5
```

```
#get complete data ( 2nd out of 5)
completeData <- complete(imputed_Data,2)
#build predictive model
library(dplyr)
fit <- with(data = iris.mis, exp = lm(Sepal.Width ~ Sepal.Length + Petal.Width))
#combine results of all 5 models
#combine <- pool(fit)
summary(fit)
```

```
##
## Call:
## lm(formula = Sepal.Width ~ Sepal.Length + Petal.Width)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.99024 -0.23721 -0.00313  0.22600  1.02767
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   2.02653    0.38337   5.286 6.24e-07 ***
## Sepal.Length  0.26676    0.07830   3.407 0.000913 ***
## Petal.Width  -0.43687    0.08227  -5.310 5.61e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3852 on 112 degrees of freedom
```

```
##   (35 observations deleted due to missingness)
## Multiple R-squared:  0.2154, Adjusted R-squared:  0.2014
## F-statistic: 15.38 on 2 and 112 DF,  p-value: 1.255e-06
```

Chapter 5

Some *significant* applications are demonstrated in this chapter.

5.1 Example one

5.2 Example two

Chapter 6

Final Words

We have finished a nice book.

Chapter 7

Logistic

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see http://rmarkdown.rstudio.com.

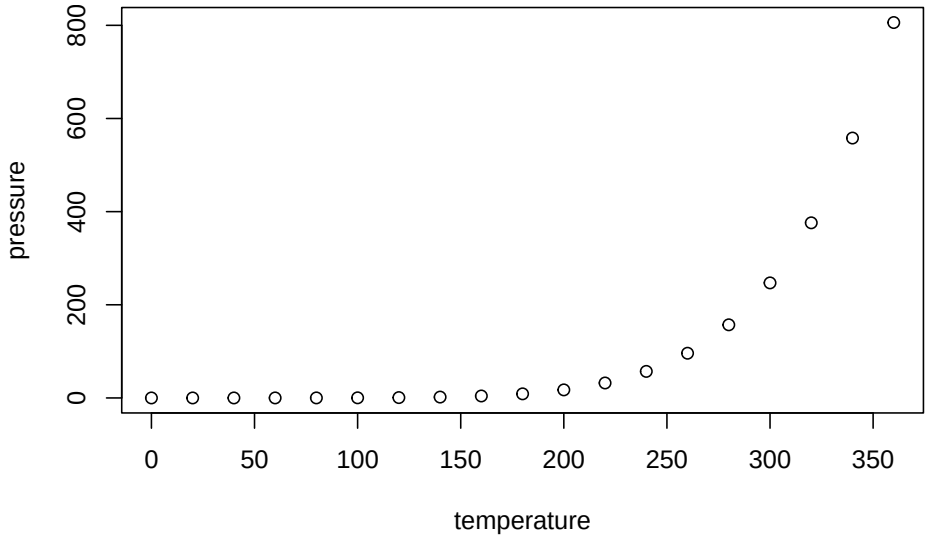
When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
summary(cars)
```

```
##      speed           dist       
##  Min.   : 4.0   Min.   :  2.00  
##  1st Qu.:12.0   1st Qu.: 26.00  
##  Median :15.0   Median : 36.00  
##  Mean   :15.4   Mean   : 42.98  
##  3rd Qu.:19.0   3rd Qu.: 56.00  
##  Max.   :25.0   Max.   :120.00
```

7.1 Including Plots

You can also embed plots, for example:



Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.