R

HongZde-LI

Basic

```
x=6:9
mean(x)
```

```
## [1] 7.5
```

```
var(x)
```

```
## [1] 1.666667
```

```
x=7:25
var(x)
```

```
## [1] 31.66667
```

```
ls()
```

```
## [1] "x"
```

```
objects()
```

```
## [1] "x"
```

```
c(3,6,9)
```

```
## [1] 3 6 9
```

```
x=c(3,6,9)
x
```

```
## [1] 3 6 9
```

```
number8to87=8:87
c(number8to87,x)
```

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

```
c(x,number8to87,x)
```

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

```
number8to87[7]
```

```
## [1] 14
```

```
number8to87[c(7:8,6:9)]
```

```
## [1] 14 15 13 14 15 16
```

```
x
```

```
## [1] 3 6 9
```

```
x[-2]
```

```
## [1] 3 9
```

```
x[-3]
```

```
## [1] 3 6
```

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

```
## [1] 6
```

```
x[0]
```

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

```
x[c(0,2)]
```

```
## [1] 6
```

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

x*7
```

```
## [1] 21 42 63
```

```
y=x*7-10
y
```

```
## [1] 11 32 53
```

```
x^3
```

```
## [1]  27 216 729
```

```
y^x
```

```
## [1] 1.331000e+03 1.073742e+09 3.299764e+15
```

```
c(0,0,1,1,2,2,3,3,4,4) %% 2:3
```

```
##  [1] 0 0 1 1 0 2 1 0 0 1
```

```
c(0,0,1,1,2,2,3,3,4,4,5) %% 2:3
```

```
## Warning in c(0, 0, 1, 1, 2, 2, 3, 3, 4, 4, 5)%%2:3: 較長的物件長度並非較短
## 物件長度的倍數
```

```
##  [1] 0 0 1 1 0 2 1 0 0 1 1
```

rep & seq & paste

```
rep(6,9)
```

```
## [1] 6 6 6 6 6 6 6 6 6
```

```
rep(seq(7,87,by=9),3)
```

```
##  [1]  7 16 25 34 43 52 61 70 79  7 16 25 34 43 52 61 70 79  7 16 25 34 43
## [24] 52 61 70 79
```

```
rep(c(3,6,9),each=3)
```

```
## [1] 3 3 3 6 6 6 9 9 9
```

```
rep(seq(7,87,by=9),rep(3,9))
```

```
##  [1]  7  7  7 16 16 16 25 25 25 34 34 34 43 43 43 52 52 52 61 61 61 70 70
## [24] 70 79 79 79
```

```
rep(seq(7,87,by=9),c(rep(3,2),rep(4,7)))
```

```
##  [1]  7  7  7 16 16 16 25 25 25 25 34 34 34 34 43 43 43 43 52 52 52 52 61
## [24] 61 61 61 70 70 70 70 79 79 79 79
```

```
rep(seq(7,87,by=9),c(3,3,4,4,4,4,4,4,4))
```

```
##  [1]  7  7  7 16 16 16 25 25 25 25 34 34 34 34 43 43 43 43 52 52 52 52 61
## [24] 61 61 61 70 70 70 70 79 79 79 79
```

```
x=NULL
x[seq(2,10,2)]=seq(1,10,2)
x
```

```
##  [1] NA  1 NA  3 NA  5 NA  7 NA  9
```

```
x=c(3,6,9)
x/x
```

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

```
1/x
```

```
## [1] 0.3333333 0.1666667 0.1111111
```

```
x[0.4]
```

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

```
x[0.99]
```

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

```
x[1.1]
```

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

```
x[3.4]
```

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

```
colors=c("red","blue","black")
z=c("red","blue",7)
z
```

```
## [1] "red"  "blue" "7"
```

```
substr(colors,1,3)
```

```
## [1] "red" "blu" "bla"
```

```
paste(colors,"cool")
```

```
## [1] "red cool"   "blue cool"  "black cool"
```

```
paste0(colors,"cool")
```

```
## [1] "redcool"   "bluecool"  "blackcool"
```

```
paste0(colors,"-","cool")
```

```
## [1] "red-cool"   "blue-cool"  "black-cool"
```

```
paste(colors,c(colors,"green"))
```

```
## [1] "red red"     "blue blue"   "black black" "red green"
```

fac & level & matrix

```
fac=c("A","B","A","B")
fac
```

```
## [1] "A" "B" "A" "B"
```

```
fac=factor(fac)
fac
```

```
## [1] A B A B
## Levels: A B
```

```
as.integer(fac)
```

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

```
fac2=c("AAAAAAAAAA","ABABABABAB","AAAAAAAAAA","ABABABABAB")
fac2
```

```
## [1] "AAAAAAAAAA" "ABABABABAB" "AAAAAAAAAA" "ABABABABAB"
```

```
fac2=factor(fac2)
fac2
```

```
## [1] AAAAAAAAAA ABABABABAB AAAAAAAAAA ABABABABAB
## Levels: AAAAAAAAAA ABABABABAB
```

```
as.integer(fac2)
```

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

```
fac3=fac2[-5]
fac3
```

```
## [1] AAAAAAAAAA ABABABABAB AAAAAAAAAA ABABABABAB
## Levels: AAAAAAAAAA ABABABABAB
```

```
as.integer(fac3)
```

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

```
fac4=c("AAAAAAAAAA","ABABABABAB","AAAAAAAAAA","ABABABABAB")
fac4
```

```
## [1] "AAAAAAAAAA" "ABABABABAB" "AAAAAAAAAA" "ABABABABAB"
```

```
fac4=factor(fac4)
as.integer(fac4)
```

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

```
levels(fac4)
```

```
## [1] "AAAAAAAAAA" "ABABABABAB"
```

```
levels(fac4)[as.integer(fac4)]
```

```
## [1] "AAAAAAAAAA" "ABABABABAB" "AAAAAAAAAA" "ABABABABAB"
```

```
levels(fac4)[c(1,2,1,2)]
```

```
## [1] "AAAAAAAAAA" "ABABABABAB" "AAAAAAAAAA" "ABABABABAB"
```

```
levels(fac4)[c(1,2,1,2,3)]
```

```
## [1] "AAAAAAAAAA" "ABABABABAB" "AAAAAAAAAA" "ABABABABAB" NA
```

```
is.na(levels(fac4)[c(1,2,1,2,3)])
```

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

```
!is.na(levels(fac4)[c(1,2,1,2,3)])
```

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

```
levels(fac4)[c(1,2,1,2)][!is.na(levels(fac4)[c(1,2,1,2,3)])]
```

```
## [1] "AAAAAAAAAA" "ABABABABAB" "AAAAAAAAAA" "ABABABABAB"
```

```
test=levels(fac4)[c(1,2,1,2,3)]
test[!is.na(test)]
```

```
## [1] "AAAAAAAAAA" "ABABABABAB" "AAAAAAAAAA" "ABABABABAB"
```

```
m=matrix(20:39,nrow=2,ncol=10)
m
```

```
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
## [1,]   20   22   24   26   28   30   32   34   36    38
## [2,]   21   23   25   27   29   31   33   35   37    39
```

```
m2=matrix(20:39,nrow=2,ncol=10,byrow=T)
m2
```

```
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
## [1,]   20   21   22   23   24   25   26   27   28    29
## [2,]   30   31   32   33   34   35   36   37   38    39
```

```
m2[2,5]
```

```
## [1] 34
```

```
m2[2,]
```

```
##  [1] 30 31 32 33 34 35 36 37 38 39
```

```
m2[,10]
```

```
## [1] 29 39
```

```
m2[]
```

```
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
## [1,]   20   21   22   23   24   25   26   27   28    29
## [2,]   30   31   32   33   34   35   36   37   38    39
```

```
m2[2,c(1,3,5)]
```

```
## [1] 30 32 34
```

```
m2[c(1,2),c(2,4,6)]
```

```
##      [,1] [,2] [,3]
## [1,]   21   23   25
## [2,]   31   33   35
```

```
m2[c(1,2),c(2,4,6)]*2
```

```
##      [,1] [,2] [,3]
## [1,]   42   46   50
## [2,]   62   66   70
```

```
m2[10]
```

```
## [1] 34
```

```
array(1:60,c(5,4,3))
```

```
## , , 1
##
##      [,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
##
## , , 2
##
##      [,1] [,2] [,3] [,4]
## [1,]   21   26   31   36
## [2,]   22   27   32   37
## [3,]   23   28   33   38
## [4,]   24   29   34   39
## [5,]   25   30   35   40
##
## , , 3
##
##      [,1] [,2] [,3] [,4]
## [1,]   41   46   51   56
## [2,]   42   47   52   57
## [3,]   43   48   53   58
## [4,]   44   49   54   59
## [5,]   45   50   55   60
```

```
out=array(1:120,c(5,4,3,2))
out
```

```
## , , 1, 1
##
##      [,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
##
## , , 2, 1
##
##      [,1] [,2] [,3] [,4]
## [1,]   21   26   31   36
## [2,]   22   27   32   37
## [3,]   23   28   33   38
## [4,]   24   29   34   39
## [5,]   25   30   35   40
##
## , , 3, 1
##
##      [,1] [,2] [,3] [,4]
## [1,]   41   46   51   56
## [2,]   42   47   52   57
## [3,]   43   48   53   58
## [4,]   44   49   54   59
## [5,]   45   50   55   60
##
## , , 1, 2
##
##      [,1] [,2] [,3] [,4]
## [1,]   61   66   71   76
## [2,]   62   67   72   77
## [3,]   63   68   73   78
## [4,]   64   69   74   79
## [5,]   65   70   75   80
##
## , , 2, 2
##
##      [,1] [,2] [,3] [,4]
## [1,]   81   86   91   96
## [2,]   82   87   92   97
## [3,]   83   88   93   98
## [4,]   84   89   94   99
## [5,]   85   90   95  100
##
## , , 3, 2
##
##      [,1] [,2] [,3] [,4]
## [1,]  101  106  111  116
## [2,]  102  107  112  117
## [3,]  103  108  113  118
```

```
## [4,]  104  109  114  119
## [5,]  105  110  115  120
```

```
out[,,2,2]
```

```
##      [,1] [,2] [,3] [,4]
## [1,]   81   86   91   96
## [2,]   82   87   92   97
## [3,]   83   88   93   98
## [4,]   84   89   94   99
## [5,]   85   90   95  100
```

```
out[c(2,4),c(1,3),2,2]
```

```
##      [,1] [,2]
## [1,]   82   92
## [2,]   84   94
```

```
out[1,1,c(1,2),c(1,2)]
```

```
##      [,1] [,2]
## [1,]    1   61
## [2,]   21   81
```

```
color=c("red","red","red1","blue")
number=c(1,3,5,7)
logic=c(T,T,F,F)
out.fr=data.frame(colors=color,numbers=number,logics=logic)
out.fr
```

```
##   colors numbers logics
## 1    red       1   TRUE
## 2    red       3   TRUE
## 3   red1       5  FALSE
## 4   blue       7  FALSE
```

```
out.fr[,2]          #call by position
```

```
## [1] 1 3 5 7
```

```
out.fr[,"numbers"]  #call by name
```

```
## [1] 1 3 5 7
```

```
out.fr$numbers
```

```
## [1] 1 3 5 7
```

```
out.fr*2
```

```
## Warning in Ops.factor(left, right): '*' not meaningful for factors
```

```
##   colors numbers logics
## 1     NA       2      2
## 2     NA       6      2
## 3     NA      10      0
## 4     NA      14      0
```

```
class(out.fr)
```

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

```
class(m2)
```

```
## [1] "matrix"
```

```
class(out.fr$color)
```

```
## [1] "factor"
```

```
class(color)
```

```
## [1] "character"
```

Date

```
format(Sys.time(), "%a %b %d %X %Y %Z")
```

```
## [1] "週四 五月 16 下午 05:55:13 2019 CST"
```

```
format(Sys.time(), "%H:%M:%OS3")
```

```
## [1] "17:55:13.177"
```

```
format(Sys.time(), "%c")
```

```
## [1] "週四 五月 16 17:55:13 2019"
```

```
lct <- Sys.getlocale("LC_TIME"); Sys.setlocale("LC_TIME", "C")
```

```
## [1] "C"
```

```
x <- c("1jan1960", "2jan1960", "31mar1960", "30jul1960")
z <- strptime(x, "%d%b%Y")
z
```

```
## [1] "1960-01-01 CST" "1960-01-02 CST" "1960-03-31 CST" "1960-07-30 CDT"
```

```
dates <- c("02/27/92", "02/27/92", "01/14/92", "02/28/92", "02/01/92")
times <- c("23:03:20", "22:29:56", "01:03:30", "18:21:03", "16:56:26")
x <- paste(dates, times)
strptime(x, "%m/%d/%y %H:%M:%S")
```

```
## [1] "1992-02-27 23:03:20 CST" "1992-02-27 22:29:56 CST"
## [3] "1992-01-14 01:03:30 CST" "1992-02-28 18:21:03 CST"
## [5] "1992-02-01 16:56:26 CST"
```

```
z <- strptime("20/2/06 11:16:16.683", "%d/%m/%y %H:%M:%OS")
z # prints without fractional seconds
```

```
## [1] "2006-02-20 11:16:16 CST"
```

```
op <- options(digits.secs = 3)
z
```

```
## [1] "2006-02-20 11:16:16.683 CST"
```

```
options(op)

strptime("Tue, 23 Mar 2010 14:36:38 -0400",  "%a, %d %b %Y %H:%M:%S %z")
```

```
## [1] "2010-03-24 02:36:38"
```

```
format(seq.Date(as.Date('1978-01-01'), by = 'day', len = 7), "%a")
```

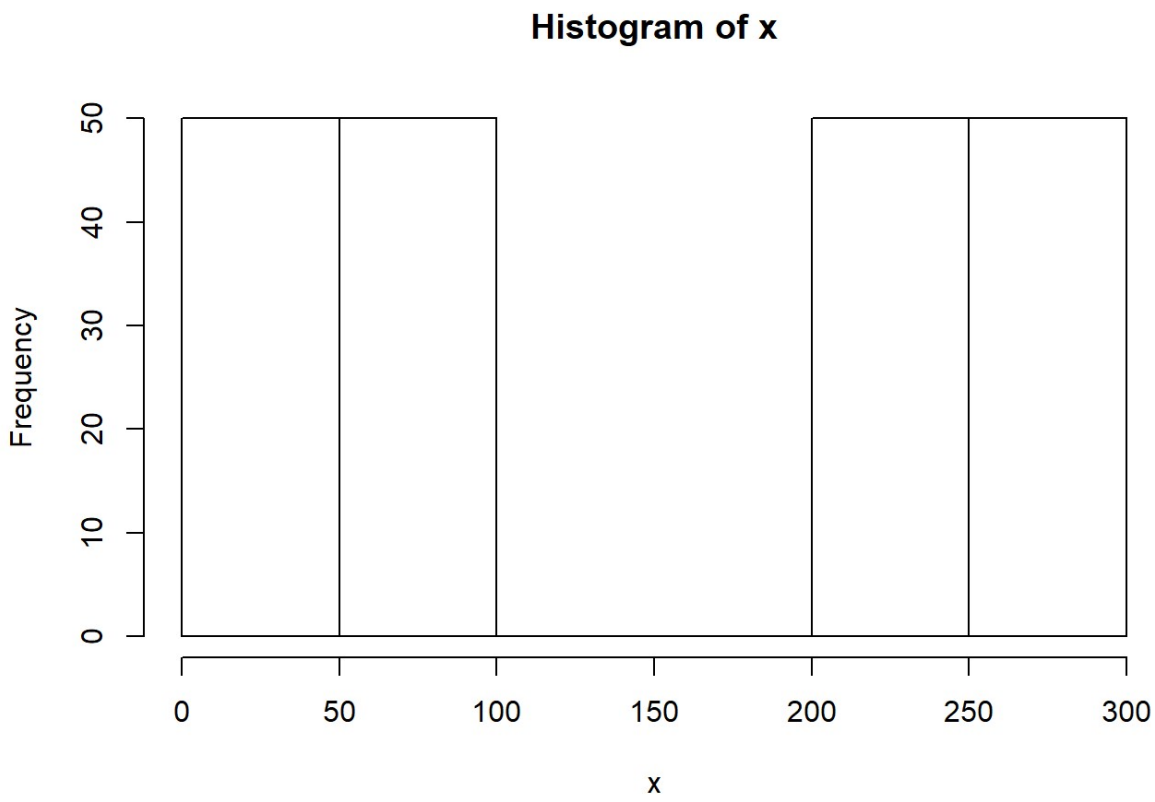
```
## [1] "Sun" "Mon" "Tue" "Wed" "Thu" "Fri" "Sat"
```

```
format(seq.Date(as.Date('2000-01-01'), by = 'month', len = 12), "%b")
```

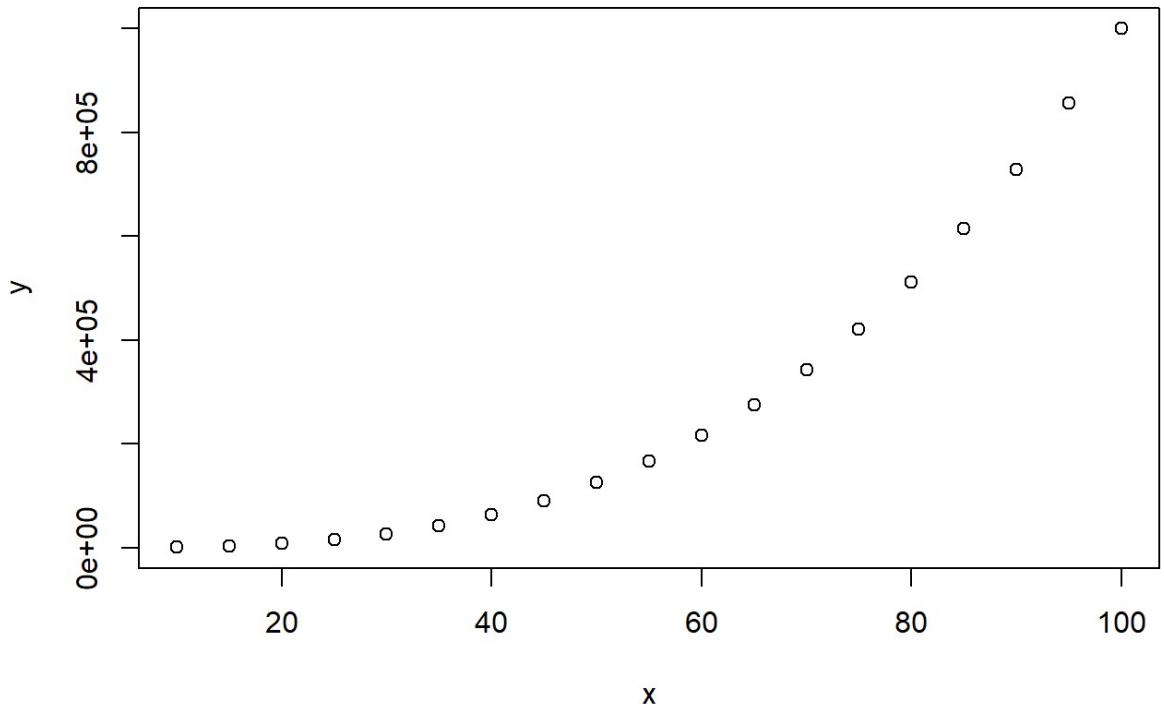
```
##  [1] "Jan" "Feb" "Mar" "Apr" "May" "Jun" "Jul" "Aug" "Sep" "Oct" "Nov"
## [12] "Dec"
```

plot

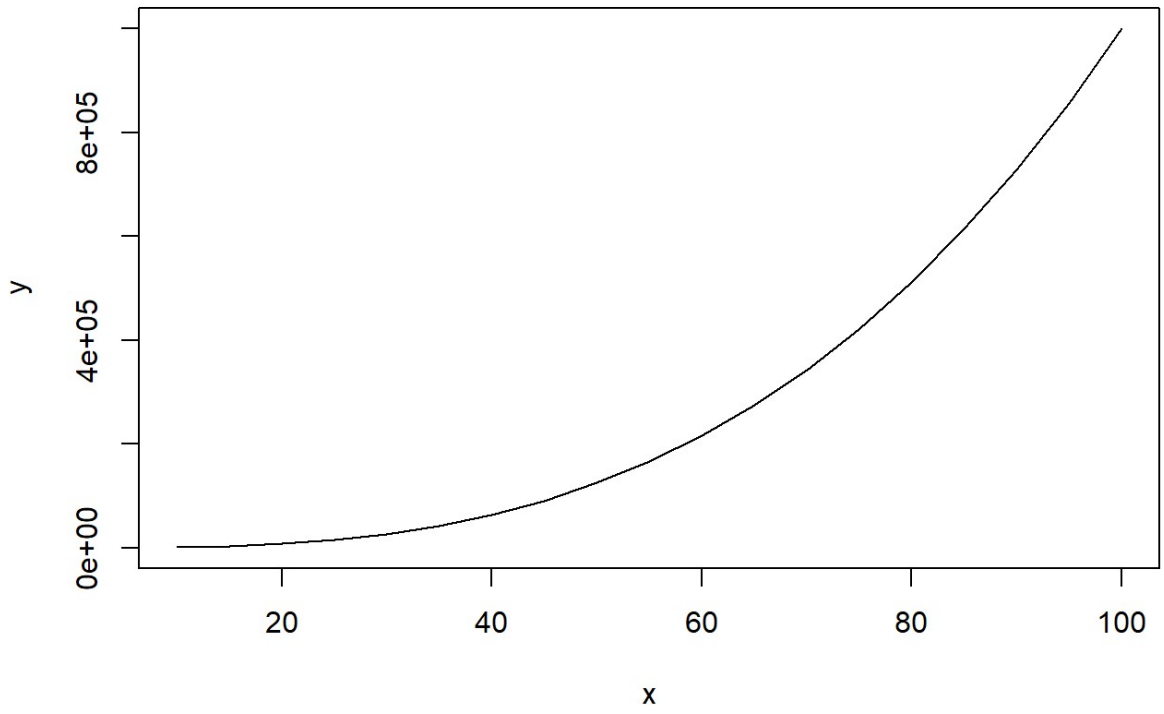
```
x=c(1:100,201:300)
hist(x)
```



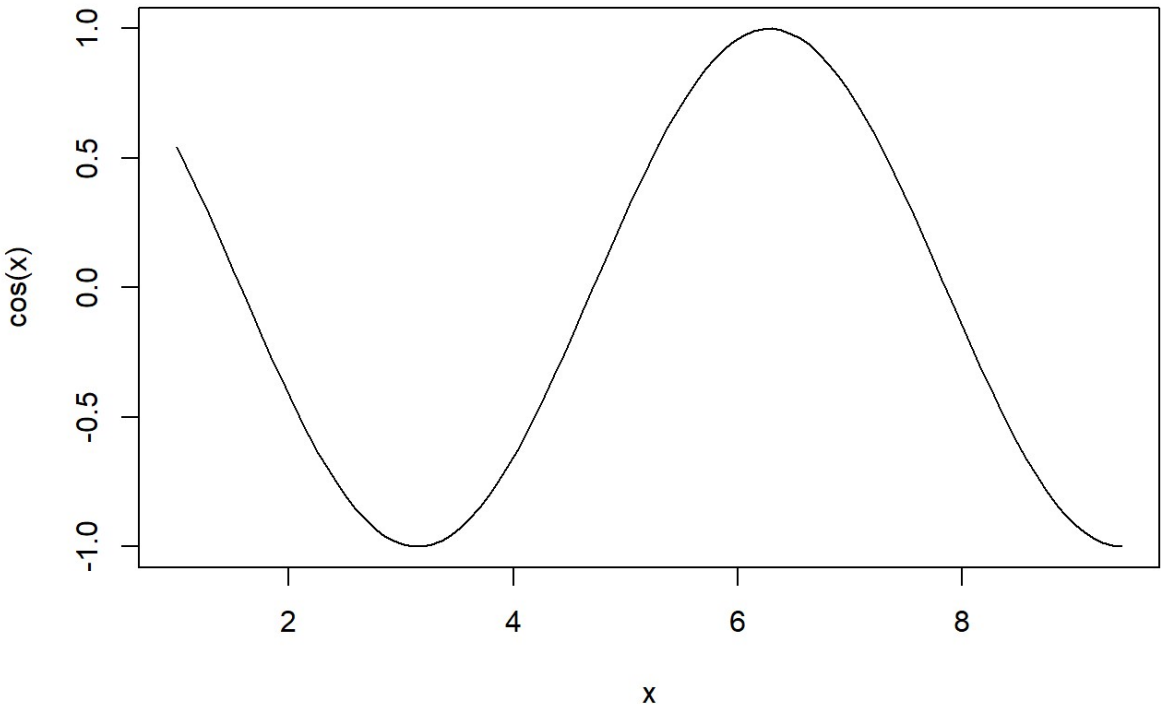

```
x=seq(10,100,5)
y=x^3-2*x
plot(x,y)
```



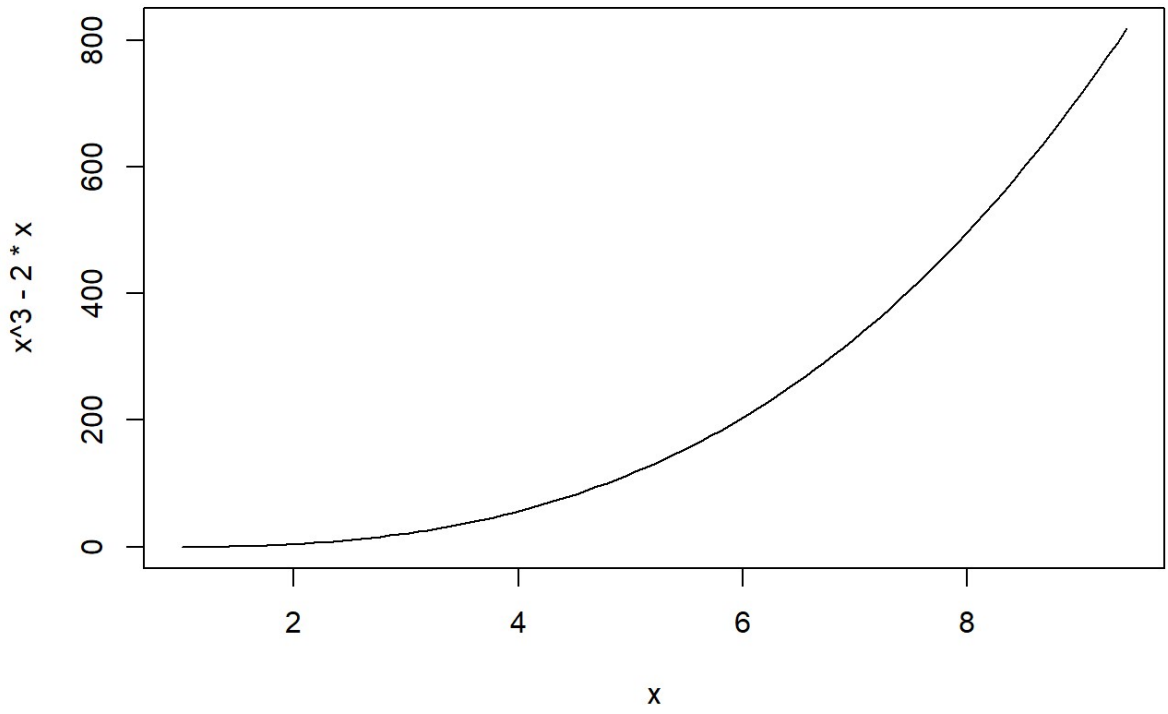

```
plot(x,y,type="l")
```



```
curve(cos,from=1,to=3*pi)
```




```
curve(x^3-2*x,from=1,to=3*pi)
```



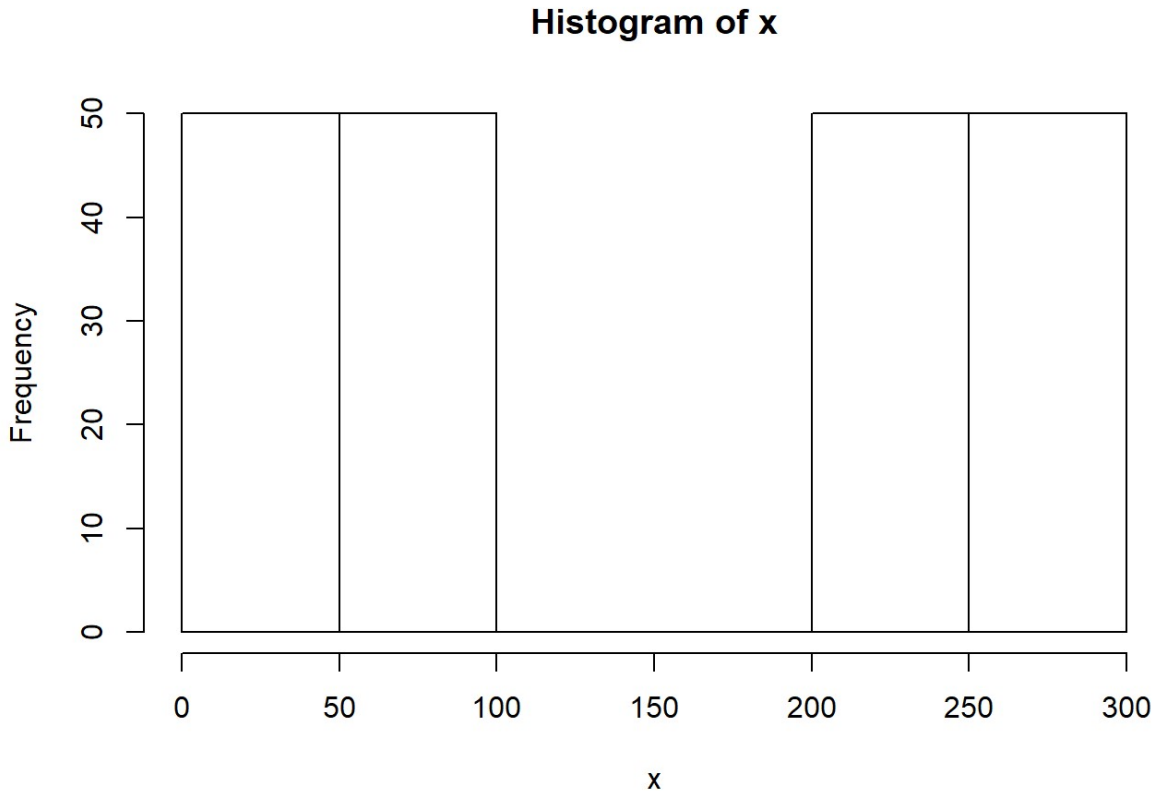

```
rm(x)


a=c(3,5,7)
a>4
```

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

```
b=c(1,5,7)
a[a>b]
```

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

```
x=c(1:100,201:300)
hist.x=hist(x)
```




```
hist.x
```

```
## $breaks
## [1]   0  50 100 150 200 250 300
##
## $counts
## [1] 50 50  0  0 50 50
##
## $density
## [1] 0.005 0.005 0.000 0.000 0.005 0.005
##
## $mids
## [1]  25  75 125 175 225 275
##
## $xname
## [1] "x"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
```

```
dump("hist.x","hist.x.out")
ls()
```

```
##  [1] "a"           "b"           "color"       "colors"      "dates"
##  [6] "fac"         "fac2"        "fac3"        "fac4"        "hist.x"
## [11] "lct"         "logic"       "m"           "m2"          "number"
## [16] "number8to87" "op"          "out"         "out.fr"      "test"
## [21] "times"       "x"           "y"           "z"
```

```
rm(hist.x)
ls()
```

```
##  [1] "a"           "b"           "color"       "colors"      "dates"
##  [6] "fac"         "fac2"        "fac3"        "fac4"        "lct"
## [11] "logic"       "m"           "m2"          "number"      "number8to87"
## [16] "op"          "out"         "out.fr"      "test"        "times"
## [21] "x"           "y"           "z"
```

```
source("hist.x.out")
ls()
```

```
##  [1] "a"           "b"           "color"       "colors"      "dates"
##  [6] "fac"         "fac2"        "fac3"        "fac4"        "hist.x"
## [11] "lct"         "logic"       "m"           "m2"          "number"
## [16] "number8to87" "op"          "out"         "out.fr"      "test"
## [21] "times"       "x"           "y"           "z"
```

```
dump(objects(),"all.r")
#L=integer , which makes R store easily


sink("try2.txt")
y=1:10
y
```

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

```
x=sin(y)
x
```

```
##  [1]  0.8414710  0.9092974  0.1411200 -0.7568025 -0.9589243 -0.2794155
##  [7]  0.6569866  0.9893582  0.4121185 -0.5440211
```

```
sink()

ls()
```

```
##  [1] "a"           "b"           "color"       "colors"      "dates"
##  [6] "fac"         "fac2"        "fac3"        "fac4"        "hist.x"
## [11] "lct"         "logic"       "m"           "m2"          "number"
## [16] "number8to87" "op"          "out"         "out.fr"      "test"
## [21] "times"       "x"           "y"           "z"
```

```
save.image("new.RData")
save.image("new.xxx")
rm(list=ls())
load("new.RData")
ls()
```

```
##  [1] "a"           "b"           "color"       "colors"      "dates"
##  [6] "fac"         "fac2"        "fac3"        "fac4"        "hist.x"
## [11] "lct"         "logic"       "m"           "m2"          "number"
## [16] "number8to87" "op"          "out"         "out.fr"      "test"
## [21] "times"       "x"           "y"           "z"
```

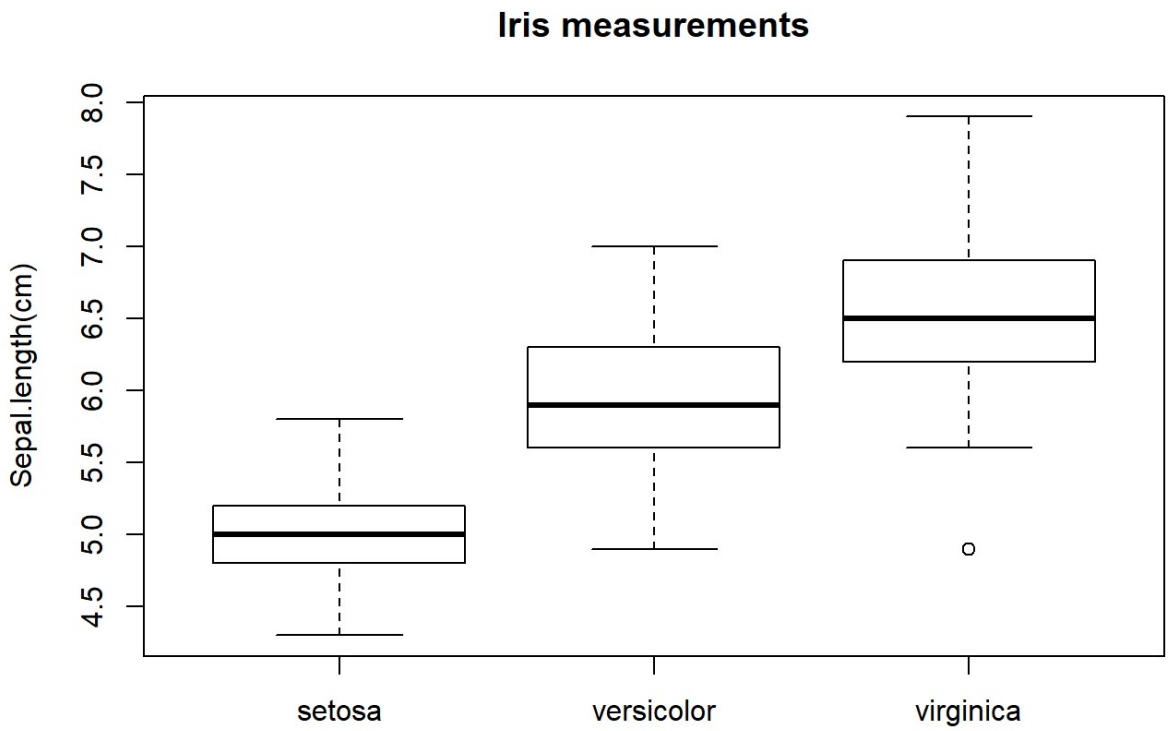
```
x=c(3,2,3)
y=c(7,7)
xy=list(xx=x,yy=y)
xy
```

```
## $xx
## [1] 3 2 3
##
## $yy
## [1] 7 7
```

```
xy2=list(xx=x,yy=y,xy1=xy)
xy2
```

```
## $xx
## [1] 3 2 3
##
## $yy
## [1] 7 7
##
## $xy1
## $xy1$xx
## [1] 3 2 3
##
## $xy1$yy
## [1] 7 7
```

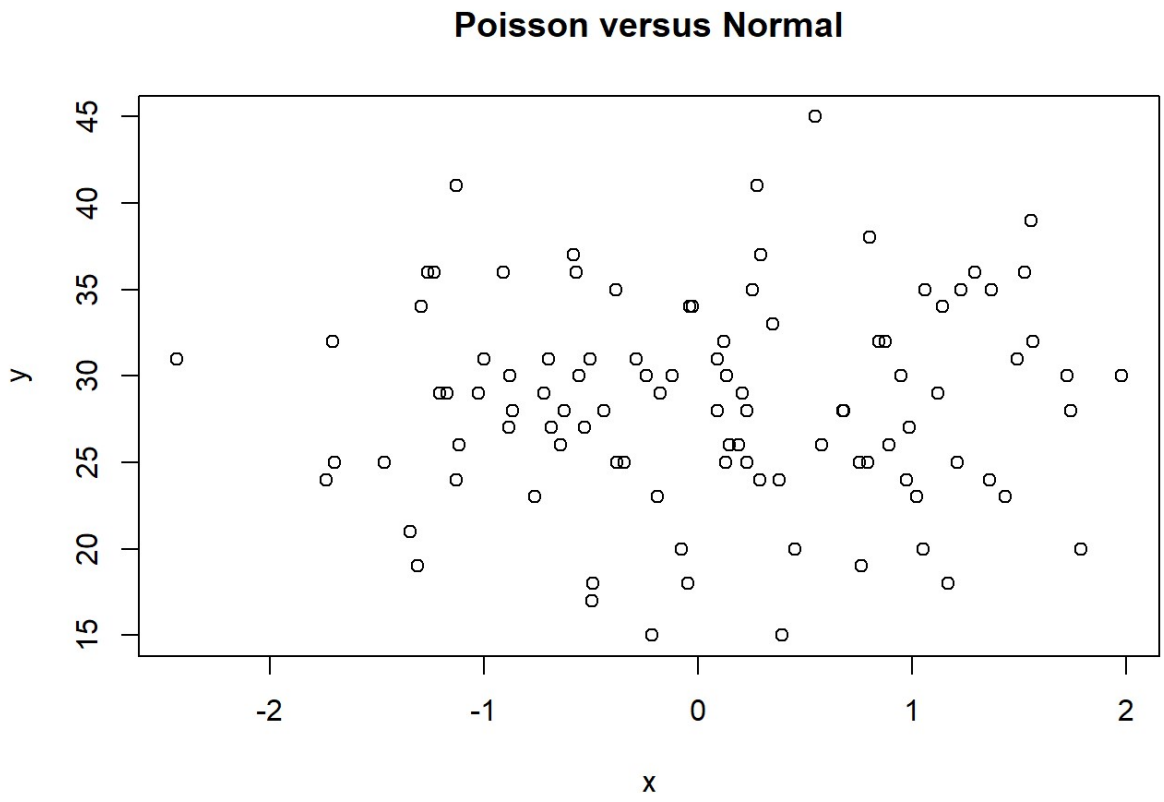
```
boxplot(Sepal.Length~Species,data=iris,ylab="Sepal.length(cm)",main="Iris measuremen
ts",boxwen=0.5)
boxplot(Sepal.Length~Species,data=iris,ylab="Sepal.length(cm)",main="Iris measuremen
ts",boxwen=0.1)
```



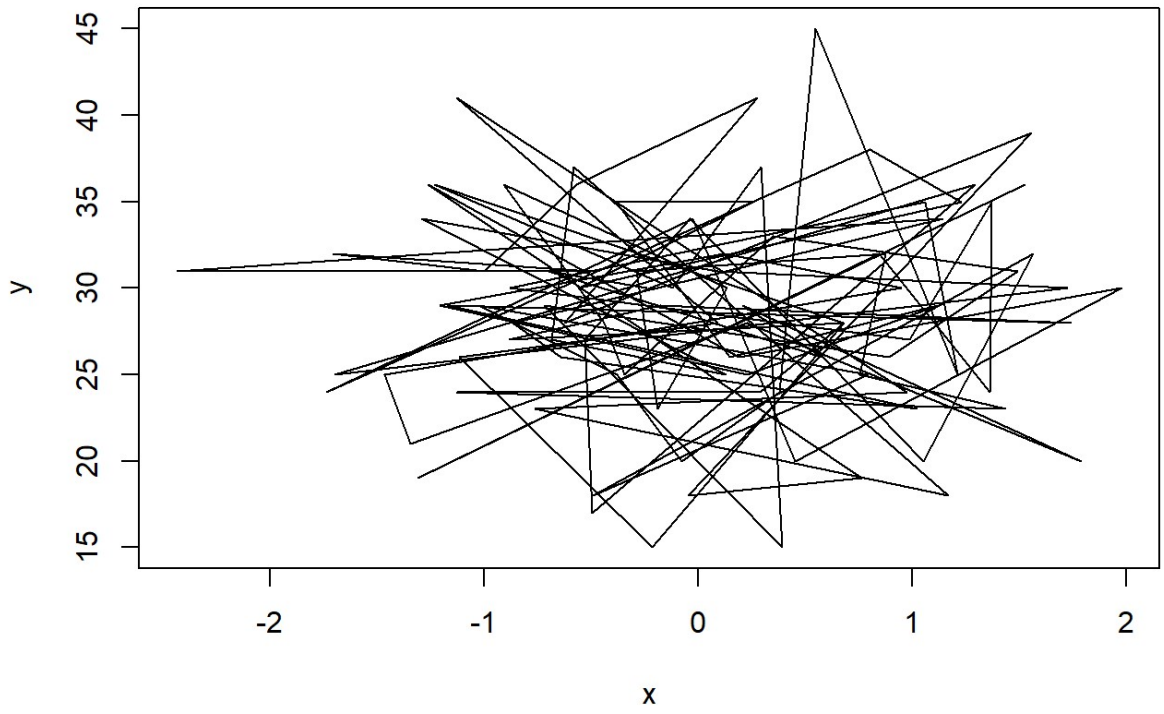

```
x=rnorm(100)
y=rpois(100,30)

mean(y)
```

```
## [1] 28.47
```

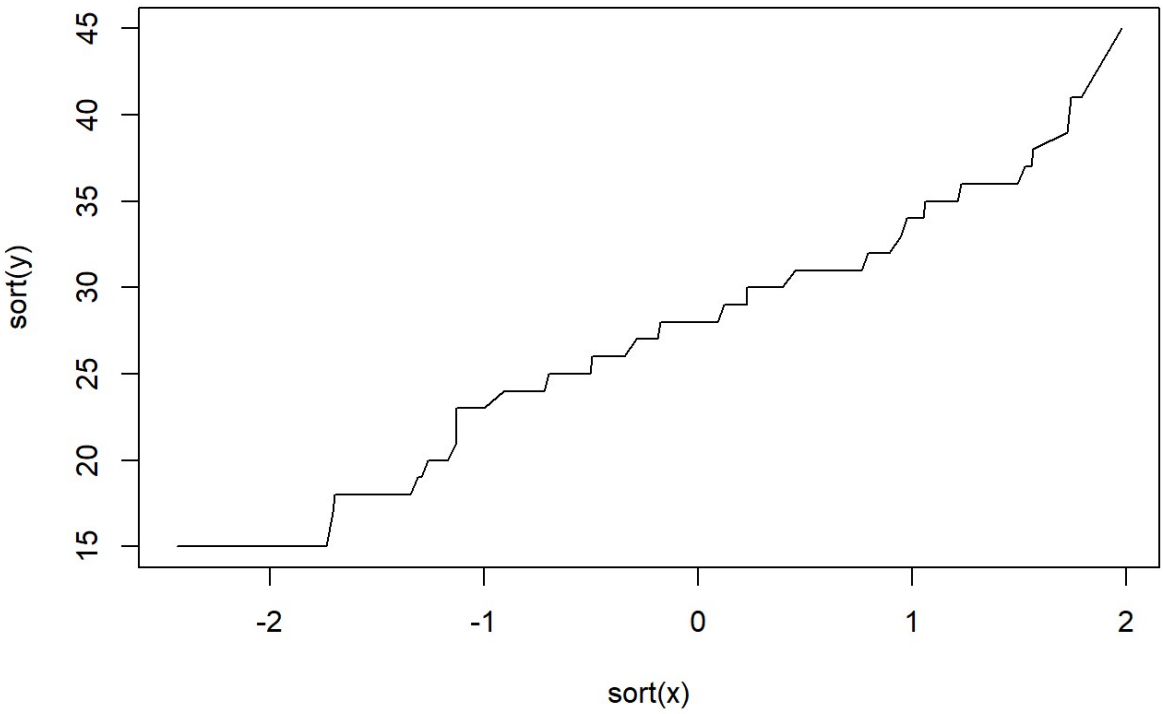
```
plot(x,y,main="Poisson versus Normal")
```




```
plot(x,y,type="l")
```



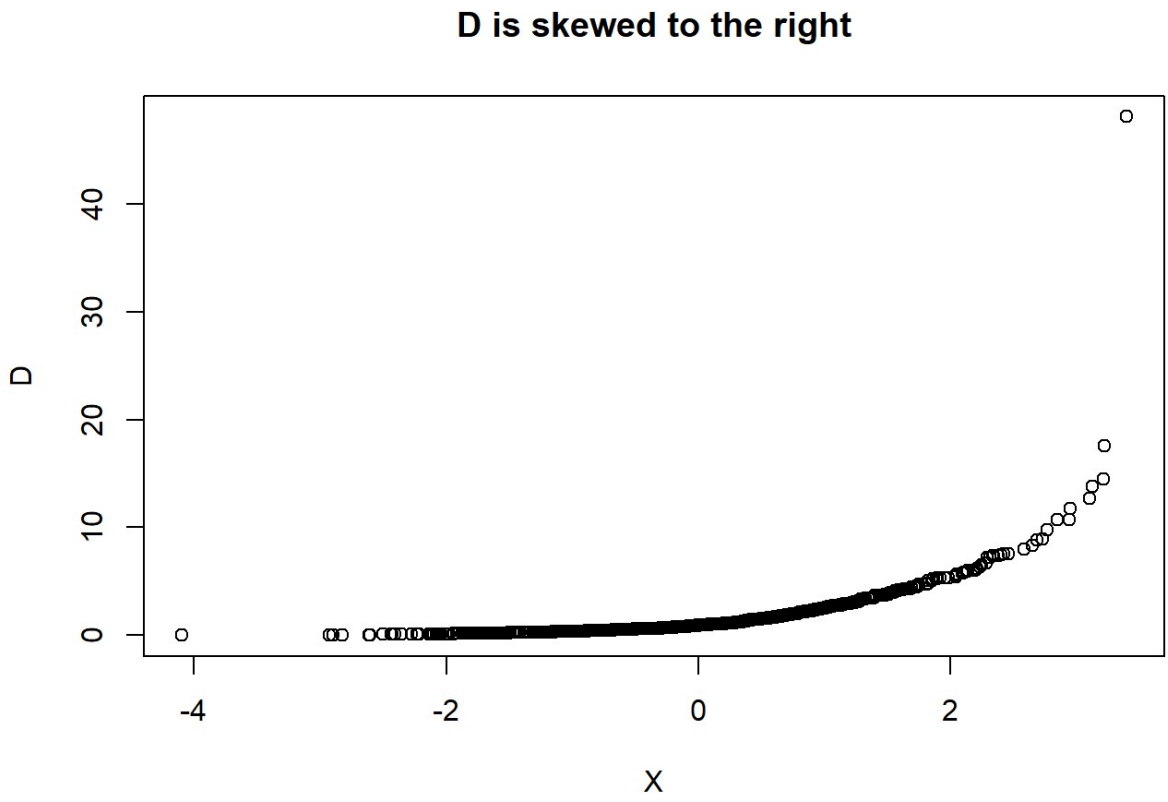
```
plot(sort(x),sort(y),type="l")
```



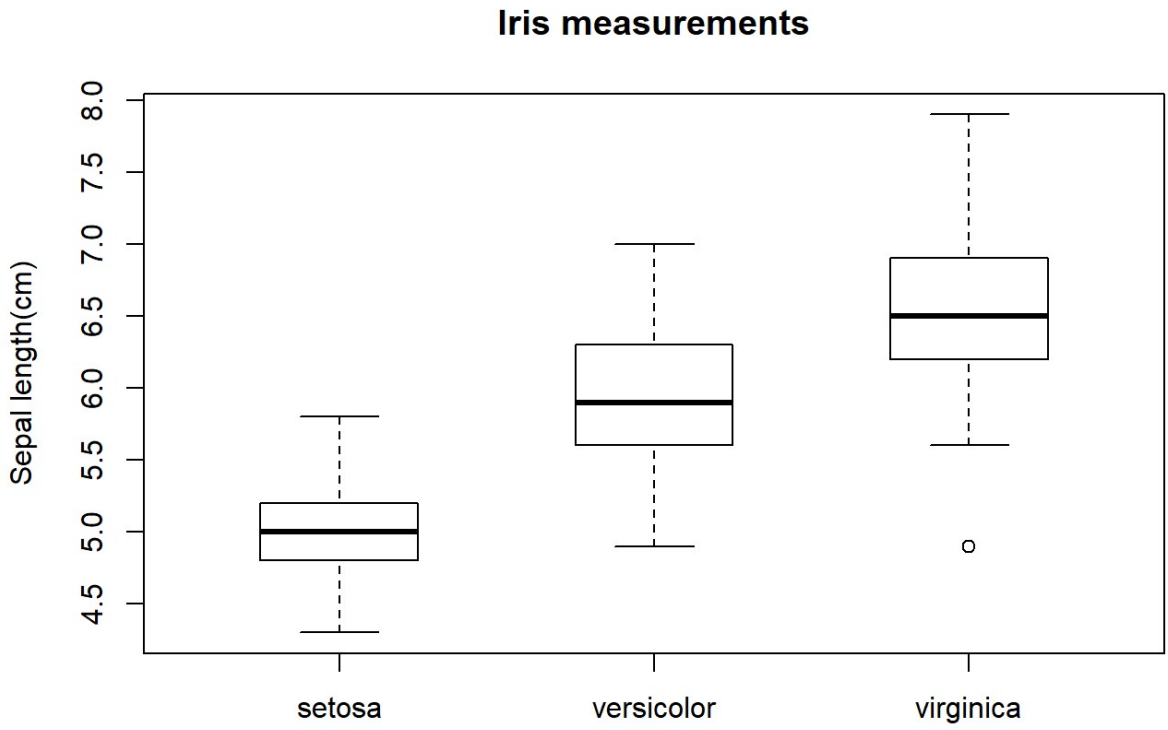

```
X=rnorm(1000)
A=rnorm(1000)

D=exp(rnorm(1000))
exp(1)
```

```
## [1] 2.718282
```

```
qqplot(X,D,main="D is skewed to the right")
```



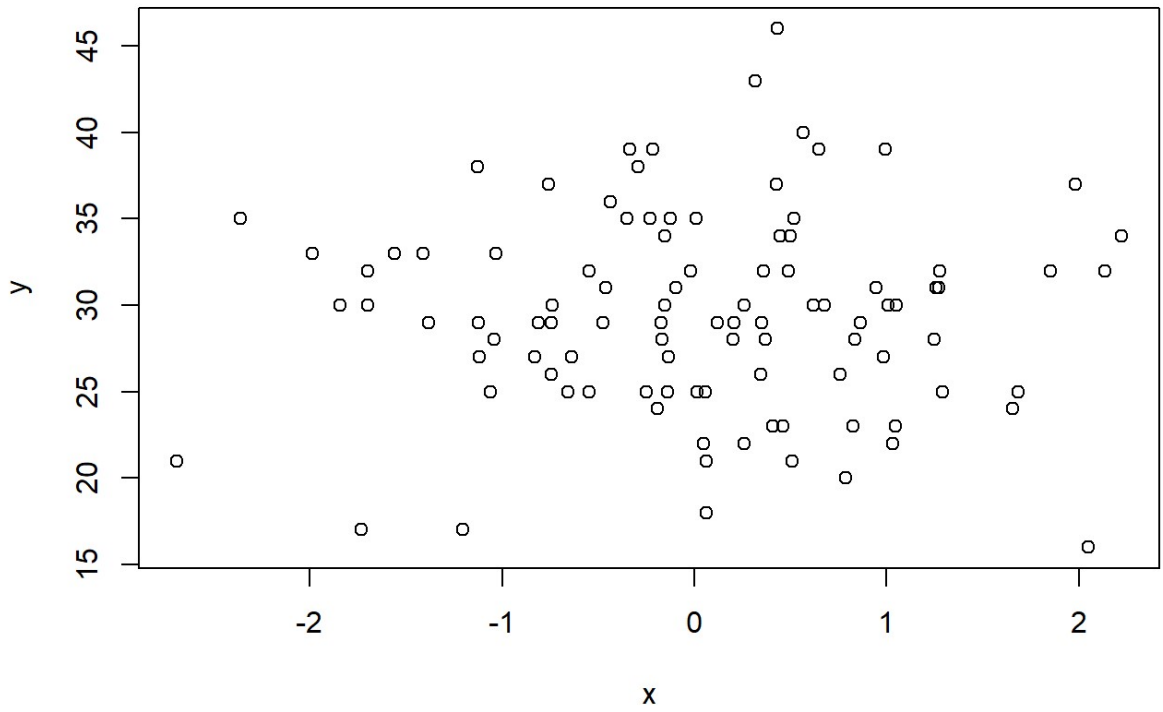

```
boxplot(Sepal.Length~Species,data=iris,ylab="Sepal length(cm)",main="Iris measuremen
ts",boxwex=0.5)
```



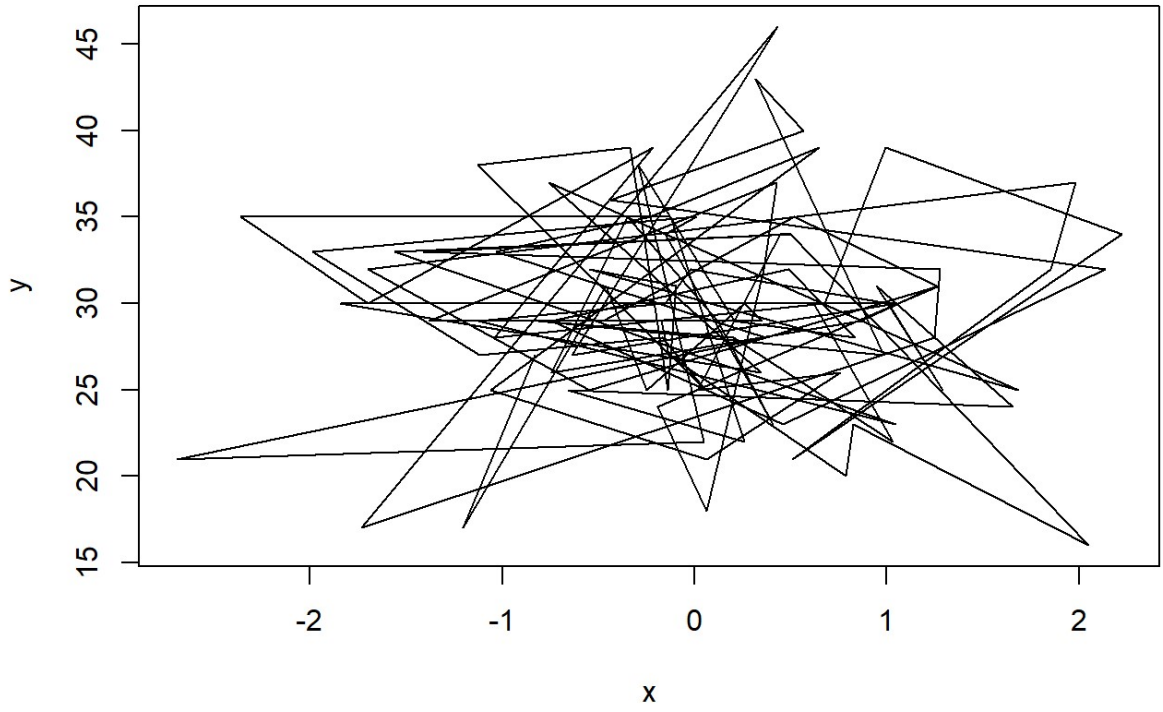
```
x=rnorm(100)
y=rpois(100,30)
mean(y)
```

```
## [1] 29.54
```

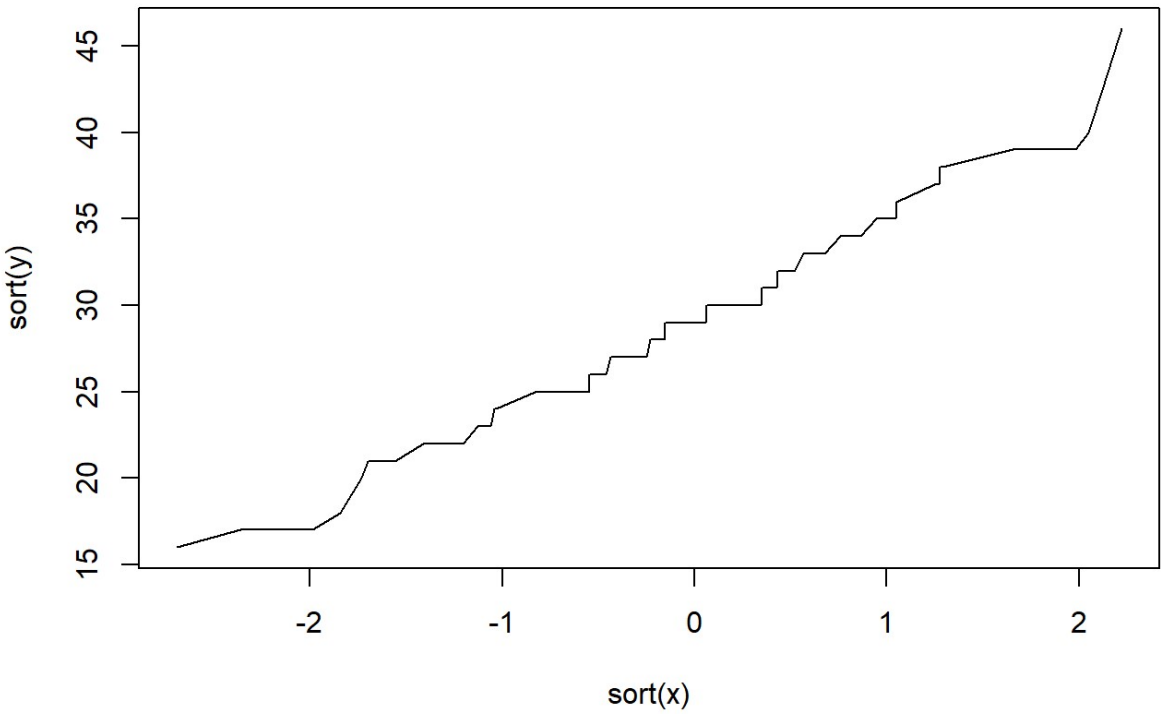
```
plot(x,y)
```




```
plot(x,y,type="l")
```

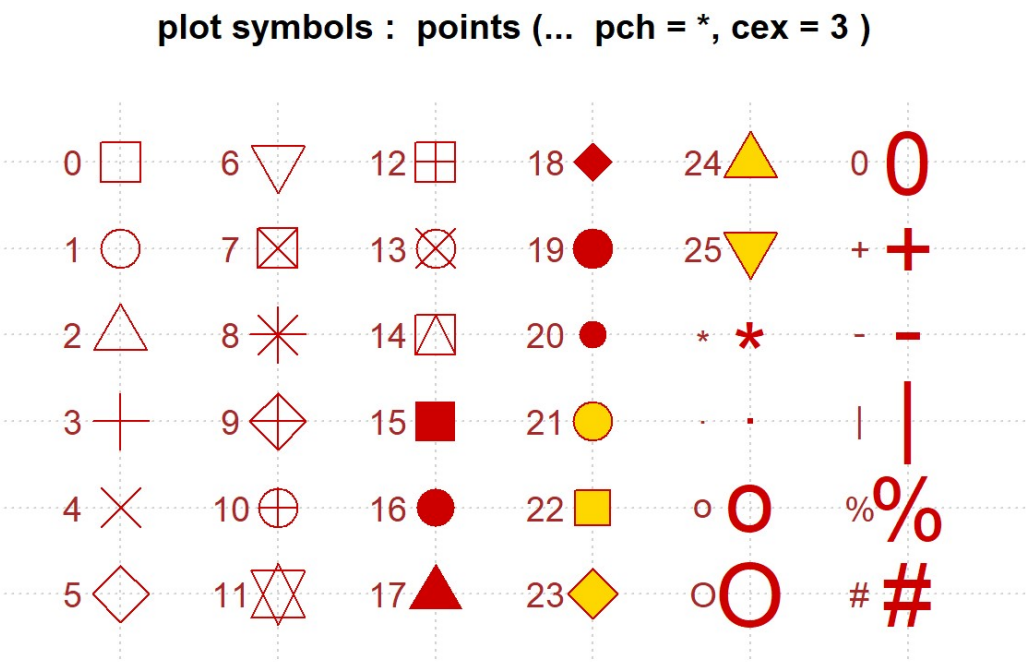



```
plot(sort(x),sort(y),type="l")
```

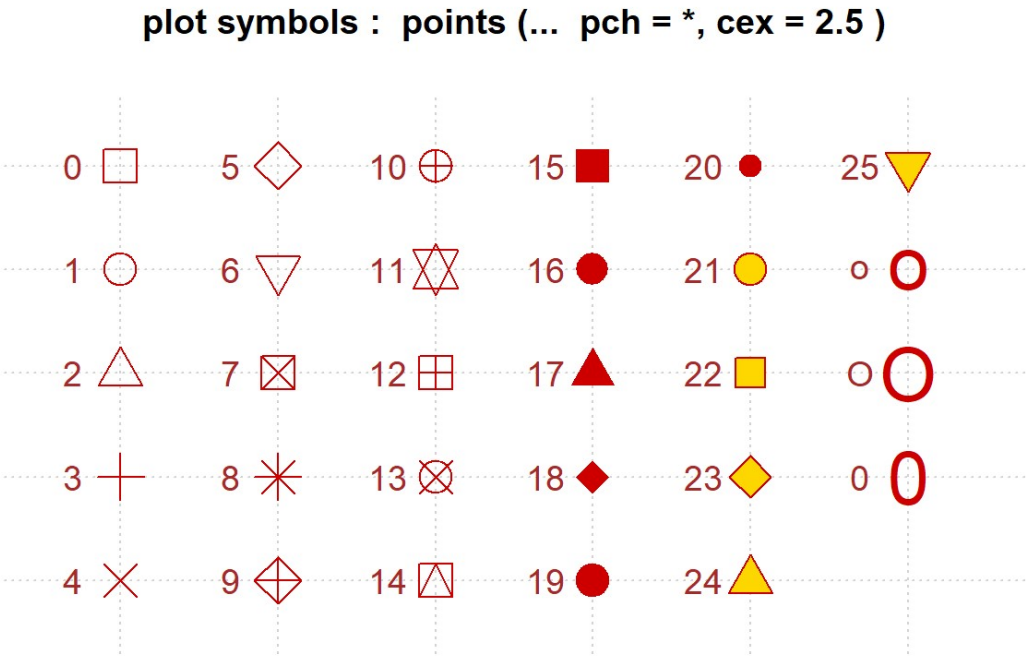


- plot(2)

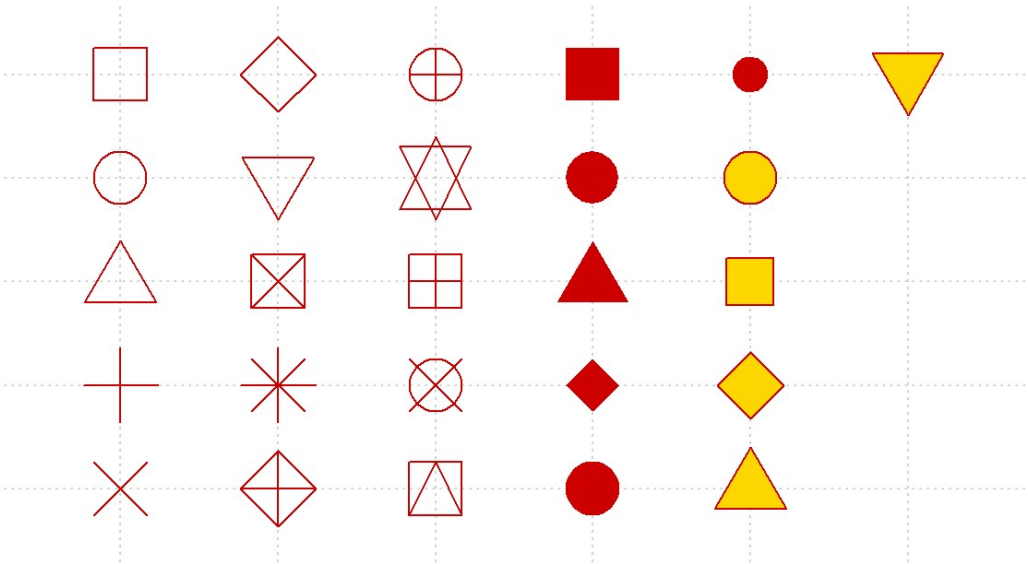
```
##-------- Showing all the extra & some char graphics symbols ---------
pchShow <-
  function(extras = c("*",".", "o","O","0","+","-","|","%","#"),
           cex = 3, ## good for both .Device=="postscript" and "x11"
           col = "red3", bg = "gold", coltext = "brown", cextext = 1.2,
           main = paste("plot symbols :  points (...  pch = *, cex =",
                        cex,")"))
  {
    nex <- length(extras)
    np  <- 26 + nex
    ipch <- 0:(np-1)
    k <- floor(sqrt(np))
    dd <- c(-1,1)/2
    rx <- dd + range(ix <- ipch %/% k)
    ry <- dd + range(iy <- 3 + (k-1)- ipch %% k)
    pch <- as.list(ipch) # list with integers & strings
    if(nex > 0) pch[26+ 1:nex] <- as.list(extras)
    plot(rx, ry, type = "n", axes  =  FALSE, xlab = "", ylab = "", main = main)
    abline(v = ix, h = iy, col = "lightgray", lty = "dotted")
    for(i in 1:np) {
      pc <- pch[[i]]
      ## 'col' symbols with a 'bg'-colored interior (where available) :
      points(ix[i], iy[i], pch = pc, col = col, bg = bg, cex = cex)
      if(cextext > 0)
          text(ix[i] - 0.3, iy[i], pc, col = coltext, cex = cextext)
    }
  }

pchShow()
```



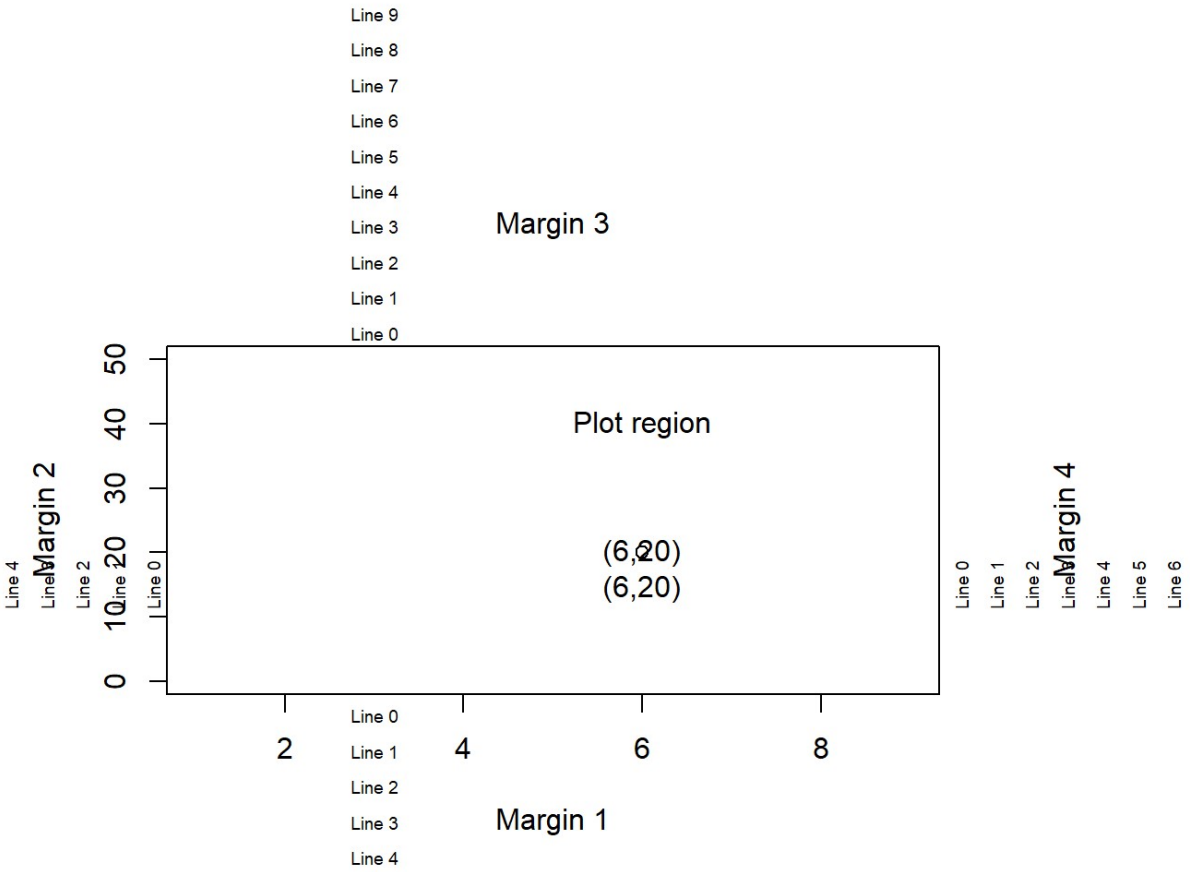

```
pchShow(c("o","O","0"), cex = 2.5)
```



```
pchShow(NULL, cex = 4, cextext = 0, main = NULL)
```



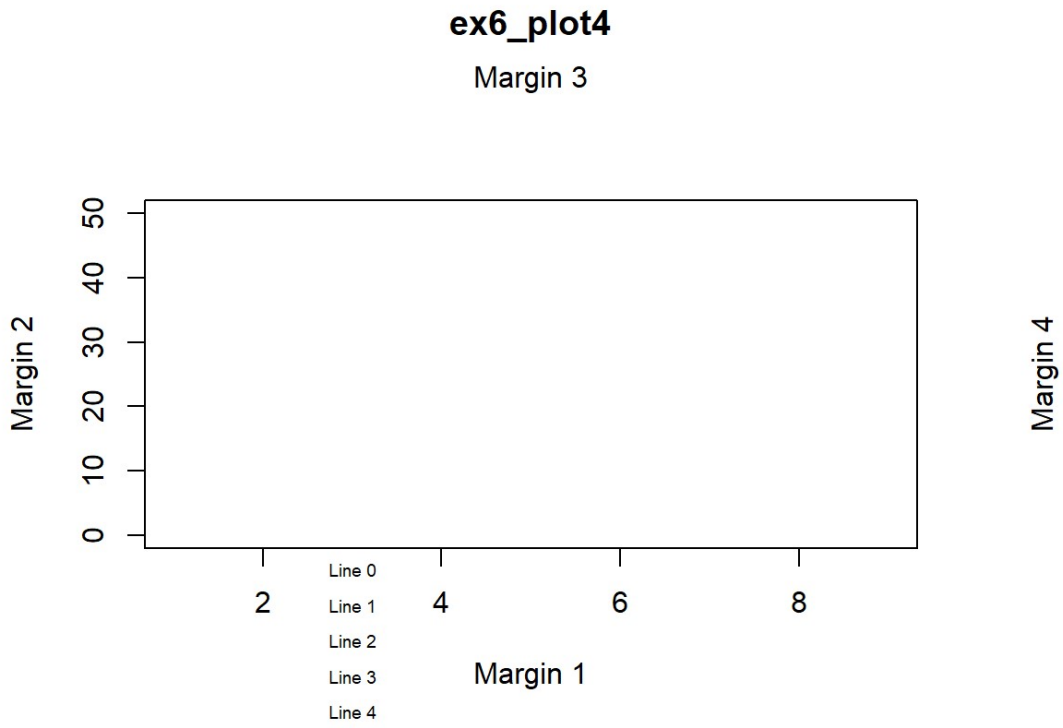
```
par(mar=c(5,6,10,7)+0.1)
plot(c(1,9),c(0,50),type="n",xlab="",ylab="")

text(6,40,"Plot region")
points(6,20)
text(6,20,"(6,20)",adj=c(0.5,2))
text(6,20,"(6,20)")
mtext(paste("Margin",1:4),side=1:4,line=3)
mtext(paste("Line",0:4),side=1,line=0:4,at=3,cex=0.6)
mtext(paste("Line",0:4),side=2,line=0:4,at=15,cex=0.6)
mtext(paste("Line",0:10),side=3,line=0:10,at=3,cex=0.6)
mtext(paste("Line",0:7),side=4,line=0:7,at=15,cex=0.6)
```




```
pdf(file="C:/Users/YanFO/workspace/ex_6.plot1.pdf")
dev.off()
```

```
## png
##   2
```

```
plot(c(1,9),c(0,50),type="n",xlab="",ylab="")
title("ex6_plot4")
mtext(paste("Margin",1:4),side=1:4,line=3)
mtext(paste("Line",0:4),side=1,line=0:4,at=3,cex=0.6)
```



Fibonacci

```
Fibonacci=numeric(120)
Fibonacci[1]=Fibonacci[2]=1
for(i in 3:120)Fibonacci[i]=Fibonacci[i-2]+Fibonacci[i-1]
Fibonacci
```

```
##   [1] 1.000000e+00 1.000000e+00 2.000000e+00 3.000000e+00 5.000000e+00
##   [6] 8.000000e+00 1.300000e+01 2.100000e+01 3.400000e+01 5.500000e+01
##  [11] 8.900000e+01 1.440000e+02 2.330000e+02 3.770000e+02 6.100000e+02
##  [16] 9.870000e+02 1.597000e+03 2.584000e+03 4.181000e+03 6.765000e+03
##  [21] 1.094600e+04 1.771100e+04 2.865700e+04 4.636800e+04 7.502500e+04
##  [26] 1.213930e+05 1.964180e+05 3.178110e+05 5.142290e+05 8.320400e+05
##  [31] 1.346269e+06 2.178309e+06 3.524578e+06 5.702887e+06 9.227465e+06
##  [36] 1.493035e+07 2.415782e+07 3.908817e+07 6.324599e+07 1.023342e+08
##  [41] 1.655801e+08 2.679143e+08 4.334944e+08 7.014087e+08 1.134903e+09
##  [46] 1.836312e+09 2.971215e+09 4.807527e+09 7.778742e+09 1.258627e+10
##  [51] 2.036501e+10 3.295128e+10 5.331629e+10 8.626757e+10 1.395839e+11
##  [56] 2.258514e+11 3.654353e+11 5.912867e+11 9.567220e+11 1.548009e+12
##  [61] 2.504731e+12 4.052740e+12 6.557470e+12 1.061021e+13 1.716768e+13
##  [66] 2.777789e+13 4.494557e+13 7.272346e+13 1.176690e+14 1.903925e+14
##  [71] 3.080615e+14 4.984540e+14 8.065155e+14 1.304970e+15 2.111485e+15
##  [76] 3.416455e+15 5.527940e+15 8.944394e+15 1.447233e+16 2.341673e+16
##  [81] 3.788906e+16 6.130579e+16 9.919485e+16 1.605006e+17 2.596955e+17
##  [86] 4.201961e+17 6.798916e+17 1.100088e+18 1.779979e+18 2.880067e+18
##  [91] 4.660047e+18 7.540114e+18 1.220016e+19 1.974027e+19 3.194043e+19
##  [96] 5.168071e+19 8.362114e+19 1.353019e+20 2.189230e+20 3.542248e+20
## [101] 5.731478e+20 9.273727e+20 1.500521e+21 2.427893e+21 3.928414e+21
## [106] 6.356307e+21 1.028472e+22 1.664103e+22 2.692575e+22 4.356678e+22
## [111] 7.049252e+22 1.140593e+23 1.845518e+23 2.986111e+23 4.831630e+23
## [116] 7.817741e+23 1.264937e+24 2.046711e+24 3.311648e+24 5.358359e+24
```

```
i=0.006
for(j in 1:1000){
i=(1-(1+i)^(-20))/19
}
i
```

```
## [1] 0.004935593
```

```
index.v=seq(3,100,by=2)
Fibonacci=numeric(120)
Fibonacci[1]=Fibonacci[2]=1
for(i in index.v)Fibonacci[i]=Fibonacci[i-2]+Fibonacci[i-1]
Fibonacci
```

```
##   [1] 1 1 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2
##  [36] 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0
##  [71] 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 0 0 0 0 0
## [106] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
```

function

```
#參數於不同層級間不會互相干擾
q<- function(){
 x<-2#this changes g's local x, not the one in f
}
f<- function(){
 x<-1
 q()#q will have no effect on our local x
 return(x)
}
x=10
q<- function(){
 x<- 10*x #this chsnges g's iocal x, not the one in f
 return(x)
}
q()
```

```
## [1] 100
```

```
X=rnorm(100000)
Y=rnorm(100000)
z=c()
for(i in 1:100000){
z=c(z,X[i]+Y[i])
}

z=rep(NA,100000)
for(i in 1:100000)
z[i]=X[i]+Y[i]

z=X+Y

z1=X*Y
z2=X/Y
z3=abs(log(X))
```

```
## Warning in log(X): 產生了 NaNs
```

```
z4=exp(X-Y)
z5=1/X
z6=sum((X-mean(X))*(Y-mean(Y)))/(length(X)-1)
z6
```

```
## [1] -0.003481334
```

```
system.time({
    for(i in 1:100000){
        z[i]=X[i]+Y[i]
    }
})
```

```
##    user  system elapsed
##    0.02    0.00    0.01
```