# R 統計軟體

軟體使用入門

# 教學大綱

- R軟體發展歷史
- 主要特色及功能
- 基礎操作
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# R 統計軟體發展歷史

- R 統計軟體最初是由Ross Ihaka及Robert Gentleman兩人以**統計分析**及**繪圖**為目的，仿**S語言**的架構為基礎而發展出來的統計軟體，可視為改進版本的S語言。大部分的S語言程式碼可直接或稍做修改後就在R上面執行
- R屬於**GNU**計畫中的一個項目，目前是由R Development Core Team維護及發展
- 目前R最新的版本為2.7.2版(2008年九月)

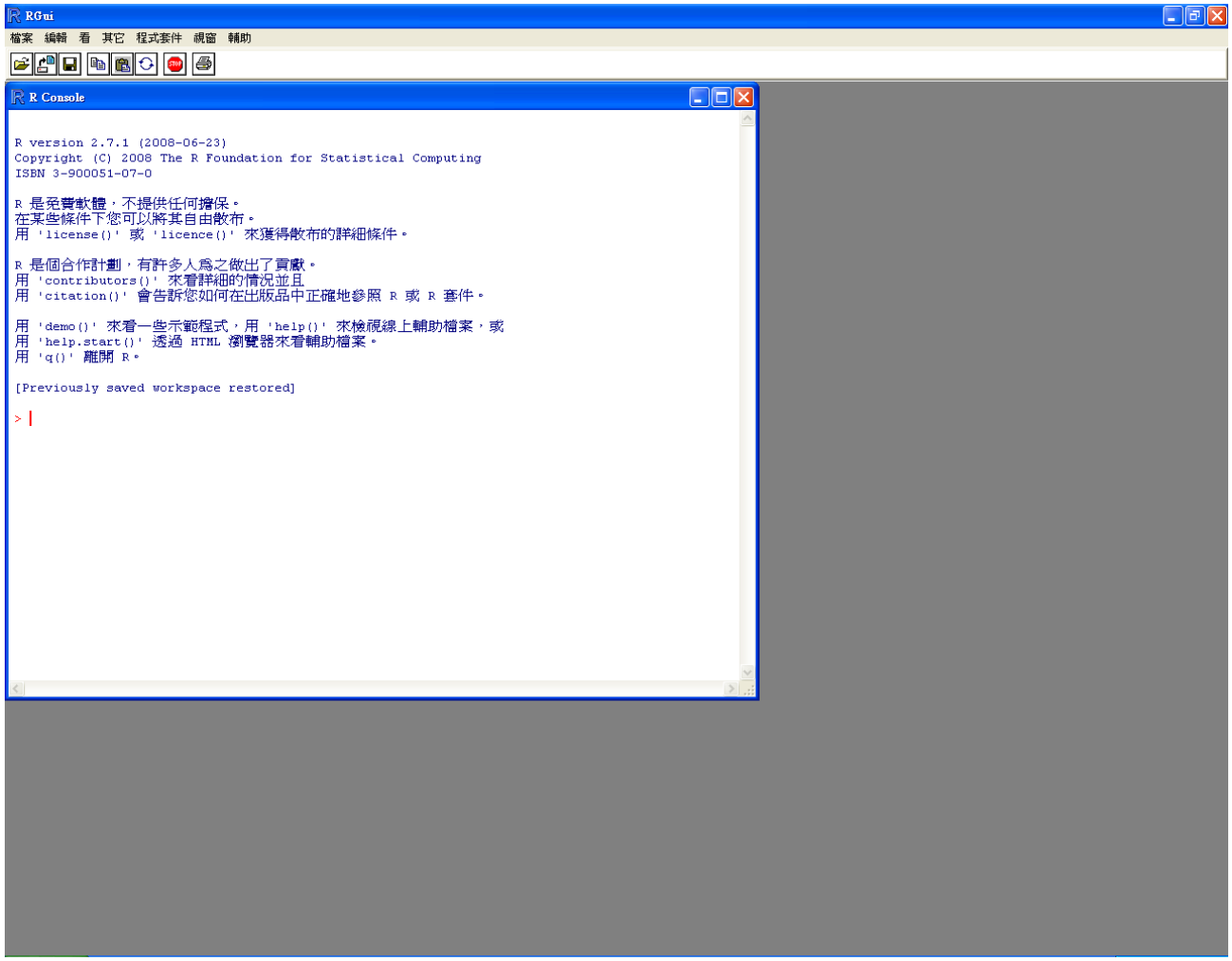
# R的特色及功能

- 有效的資料處理及存取能力
- 方便的矩陣操作與運算能力
- 完整而連貫的資料分析能力
- 強大的繪圖功能
- 簡單且發展完善的程式語言環境(S 語言)
- 免費

# 軟體下載

- Google 搜尋 “R” 第一個顯示即是R統計軟體網頁
- The R Project for Statistical Computing
- CRAN
- **選擇下載點:**http://cran.csie.ntu.edu.tw/
- Windows →base→R-2.7.2-win32.exe

# 基礎操作


RGui
檔案 編輯 看 其它 程式套件 視窗 輔助
R Console
R version 2.7.1 (2008-06-23)
Copyright (C) 2008 The R Foundation for Statistical Computing
ISBN 3-900051-07-0
R 是免費軟體，不提供任何擔保。
在某些條件下您可以將其自由散布。
用 'license()' 或 'licence()' 來獲得散布的詳細條件。
R 是個合作計劃，有許多人爲之做出了貢獻。
用 'contributors()' 來看詳細的情況並且
用 'citation()' 會告訴您如何在出版品中正確地參照 R 或 R 套件。
用 'demo()' 來看一些示範程式，用 'help()' 來檢視線上輔助檔案，或
用 'help.start()' 透過 HTML 瀏覽器來看輔助檔案。
用 'q()' 離開 R。
[Previously saved workspace restored]
>

# 基礎操作

```
(10+40)/2+3
10^50/10^30
y<-1/sqrt(2*pi)*exp(-1/2)

sigma<-1
mu<-0
x<-2
1/(sqrt(2*pi)* sigma)*exp(-((x - mu)^2/(2*sigma^2)))

x<-rnorm(n=32,mean=80,sd=10)
      #產生32個來自平均值為80標準偏差為10的常態分布的隨機數
x
x+5 #向量x中所有的數值+5
x
hist(x)   #畫x的直方圖
?Syntax  #查詢R基本術語
```

# 操作介面

- 編寫程式:「檔案」→「建立新的命令稿」 或直接於「>」後編寫
- 空一行或用分號 「 ; 」 將指令分開
- 套用已寫好之程式: 「檔案」→「開啟命令稿件」
- 修改或繼續編寫程式: 「檔案」→「開啟命令稿件」
- 程式套件(package)載入: 「程式套件」→「載入程式套件」
- 清理視窗: 右鍵→「清除視窗」
- 「←」、「→」或「=」表輸入
- 前面已執行完的指令:「↑」逐一顯示
- +: 程式未完結就換行會顯示「 + 」提醒，欲結束按「Esc」
- 英文字母大小寫視為**不同**的符號
- # 井字號之後為註解，程式不會執行
- 結束R程式: 直接關閉或指令「q()」

# 搜尋幫助

- 「輔助」→「Html輔助」= help.start()
- 「輔助」→「R函式」= help() 及 ?
- 「輔助」→「搜尋輔助」= help.search()

Description: brief description

Usage: for a function, details each of its arguments and the possible options (with the corresponding default values); for an operator gives the typical use.

Argument: for a function, details each of its arguments.

Details: detailed description

Value: if applicable, theh type of object returned by the function or the operator.

See Also: other help pages close or similar to the present one

Examples: some examples which can generally be executed without opening the help with the function **example**

# R 工作流程

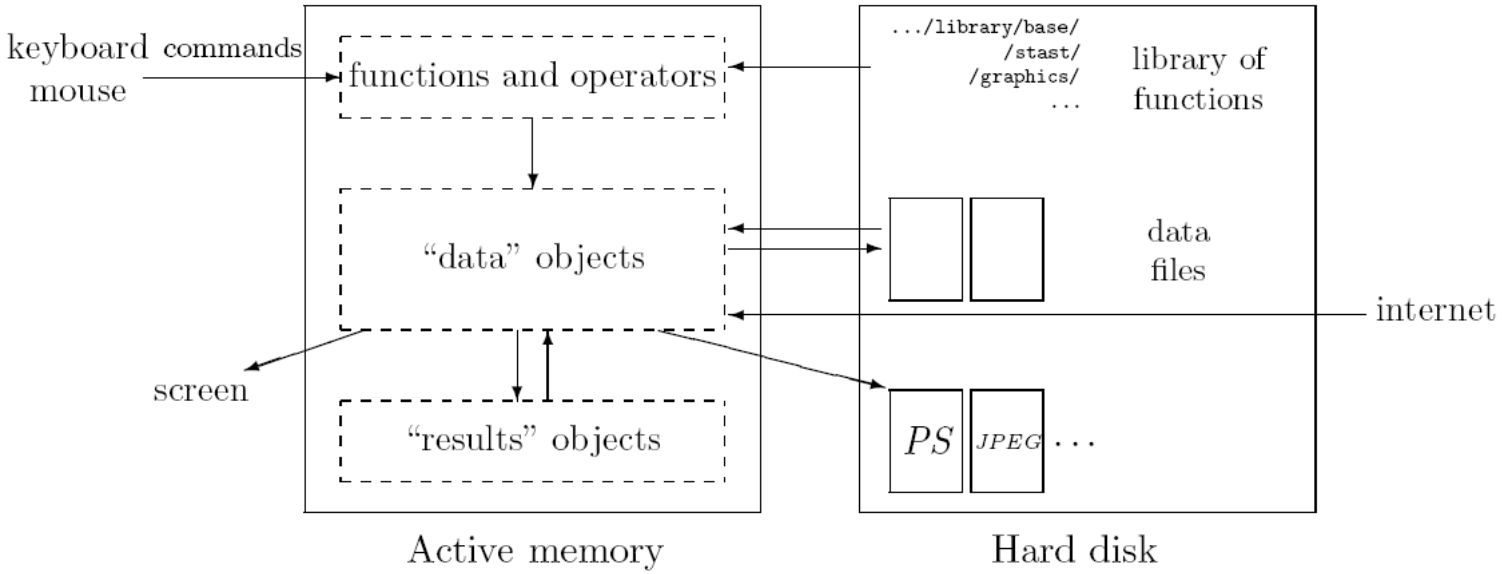



Figure 1: A schematic view of how R works.

變數(variable),資料(data),函數(function),結果(result)等在R程式運行時皆以物件(object)的形式存於電腦記憶體中。我們可以通過運算子(operators)或函數(function)對物件做操作。

# 物件 (OBJECTS)

| object | Modes | several modes possible in the same object |
|---|---|---|
| **vector** | numeric, character, complex or logical | No |
| factor | numeric or character | No |
| array matrix | numeric, character, complex or logical | No |
| **matrix** | numeric, character, complex or logical | No |
| **data frame** | numeric, character, complex or logical | Yes |
| ts | numeric, character, complex or logical | No |
| list | function, expression, … | Yes |

- 所有的物件(objects)都有兩種基本屬性(intrinsic attributes): 格式(mode)與長度(length)

```
a<-1 ; b<-"sec"; c<-1i ;d<-"TRUE"
mode(a);mode(b);mode(c);mode(d)
ls()    #列出所有物件
rm(a)  #清除物件a
```

# 運算子(OPERATORS)

| Arithmetic | | Comparison | | Logical | |
|---|---|---|---|---|---|
| + | addition | < | lesser than | !x | logical NOT |
| - | subtraction | > | greater than | x&y | logical AND |
| * | multiplication | <= | lesser than or equal to | x&&y | id. |
| / | division | >= | greater than or equal to | xly | logical OR |
| ^ | power | == | equal | xlly | id. |
| %% | modulo | != | different | xor(x,y) | exclusive OR |
| %/% | integer division | | | | |

```
x<-matrix(1:6,2,3) #製造一個2*3的矩陣x，其數值為1到6
x[2,3]==6  # x矩陣第2row第3column的值是否等於6
x[x<=3]    # 列出x矩陣內小於或等於3的數值
x[x!=6]    # 列出x矩陣內不等於6的數值
x[x<=3 & x!=2]  #列出x矩陣內小於或等於3且不等於2的值
```

# 函數(FUNCTION)

- function.name(object, argument, option)
  函數名稱　　物件　　指令　　選項

- 數學及簡單函數
  sum(),mean(),max(),length()
- 產生隨機變數
  rnorm(),runiform(),rbinom()
- 初統常用分析函數
  t.test(),aova(),lm()

# 物件_序列(VECTOR)

- n1:n2, seq(), c(), rep(), sequence()

```
s1<-1:10 ; s1   #產生一個1到10的序列;
seq(from=1,to=5,length=0.5)  #產生一個序列從1到5間隔為0.5的序列;
s2<-c(1,3,5); s2  #產生數值序列1,3,5
s3<-c("a","b","c"); s3 #產生文字序列1,3,5
rep(1,10)   #產生數值1重複10次的序列;
rep("M",10) #產生文字序列 重複"M" 10次
sequence(c(3,5))  #產生1到3接連1到5的序列;
```

# 產生隨機序列

*3.4.2 Random sequences*

| law | function |
|---|---|
| Gaussian (normal) | `rnorm(n, mean=0, sd=1)` |
| exponential | `rexp(n, rate=1)` |
| gamma | `rgamma(n, shape, scale=1)` |
| Poisson | `rpois(n, lambda)` |
| Weibull | `rweibull(n, shape, scale=1)` |
| Cauchy | `rcauchy(n, location=0, scale=1)` |
| beta | `rbeta(n, shape1, shape2)` |
| 'Student' ($t$) | `rt(n, df)` |
| Fisher–Snedecor ($F$) | `rf(n, df1, df2)` |
| Pearson ($\chi^2$) | `rchisq(n, df)` |
| binomial | `rbinom(n, size, prob)` |
| multinomial | `rmultinom(n, size, prob)` |
| geometric | `rgeom(n, prob)` |
| hypergeometric | `rhyper(nn, m, n, k)` |
| logistic | `rlogis(n, location=0, scale=1)` |
| lognormal | `rlnorm(n, meanlog=0, sdlog=1)` |
| negative binomial | `rnbinom(n, size, prob)` |
| uniform | `runif(n, min=0, max=1)` |
| Wilcoxon's statistics | `rwilcox(nn, m, n)`, `rsignrank(nn, n)` |

rnorm() → 產生常態分布的隨機變數

dnorm() → probability density

pnorm() → cumulative probability function

qnorm() → the value of quantile

```
rnorm(n=30,mean=0,sd=1)
dnorm(1)== 1/sqrt(2*pi)*exp(-1/2)
pnorm(1.645, mean=0,sd=1)
qnorm(0.95,mean=0,sd=1)
```

# 物件_因子(FACTOR)

```
f1<-factor(1:3); f1;
f2<-factor(1:3,level=1:5); f2; #產生三個因子1,2,3 有五個等級
f3<-factor(rep(1:3,5)); f3;
f4<-factor(c(3,5),level=1:5); f4

gl(3, 5)  #產生一組factor, 有3個等級，每個等級重複5次;
gl(3,5,label=c("a","b","c") ) # 同上，另將此三個等級分別命名為
"a","b","c";
gl(3,5,length=30)
gl(2,10)
gl(2,1,length=20)  #區分不同
expand.grid(h=c(60,80),w=c(100,300),sex=c("Male","Female"))
```

# 物件_資料框(DATA.FRAME)

- 從Excel建立資料→檔案→存成.csv檔

| male | female |
|---|---|
| 176 | 156 |
| 168 | 162 |
| 175 | 157 |
| 181 | 163 |
| 177 | 170 |
| 165 | 161 |
| 172 | 154 |
| 170 | 155 |
| 173 | 162 |
| 169 | 167 |
| 186 | 163 |
| 163 | 160 |
| 175 | 162 |
| 174 | 159 |
| 169 | 158 |
| 170 | 163 |
| 172 | 160 |
| 176 | 161 |
| 172 | 158 |
| 171 | 160 |

# 物件_資料框(DATA.FRAME)

- 輸入外部資料(.txt檔或.csv檔)

  read.table()

  read.csv()　#預設讀取.csv檔

```
test1<-read.table("c:/test.csv", header=T, sep=",")
#讀取C:\test.csv檔案，有標題，分隔符號為 “,”
test2<-read.csv("c:/test.csv", header=T , col.names=c("M","F"))
#讀取C:\test.csv檔案，有標題，將column 1 ,2分別命名為 “M”及 “F”
```

- 外部輸入資料為**data.frame**物件

# 物件_資料框(DATA.FRAME)

- data.frame() 自行產生資料框物件

```
x<-1:4 ; n<-10; M<-c(10,35); y<-2:4
data.frame(x,n)
data.frame(x,M)
data.frame(x,y)
z<-c("a","b","c","d")
data.frame(x,n,row.names=z)
```

# 資料輸入

- scan() 逐行讀入資料
  - 讀取外部資料

```
data2<-scan("c:/test.csv", sep=", " ,skip=1); data2
```

  - 直接輸入資料

```
data3<-scan()
1 2 3 4 5
6 7 8 9 10

data3
```

# 儲存資料框物件

- 將資料存成.txt或.csv檔

  write.table()

```
write.table(file=test2,"c:/test2.csv", sep=",")
#輸出物件test資料框物件到C:\test2.csv
```

# 物件_矩陣(MATRIX)

- 產生矩陣

```
m1<-matrix(1,nr=2,nc=3); m1
m2<-matrix(c(1,2,3,4,5,6),nr=2,nc=3); m2
m3<-matrix(c(1,2,3,4,5,6),2,3,byrow=T);m3
m4<-c(1,2,3,4,5,6); dim(m4)
dim(m4)<-c(2,3); m4
```

- 矩陣操作

```
cbind(m1,m2)
rbind(m1,m2)
m2[,2] ; m2[2,2]
m5<-matrix(c(2,0,0,2),2,2);
m6<-solve(m5); m6
m5%*%m6
diag(m5); diag(m5)<-3; m5
```

# 物件_EXPRESSION

- Expression 為一連串**對R有意義**的**文字**所組成物件

```
x<-3; y<-2.5; z<-1
exp1<-expression(x/(y+exp(z))
exp1
expression(x/(y+exp(z))
eval(exp1)

D(exp1, "x")  #對x偏微分
D(exp1, "y")
```

# 物件操作

- [ ] index
- :: access variables in a name space
- @ $ component / slot extraction
- attach()
- names()

```
test1<-read.table("c:/test.csv", header=T, sep=",");
test1[1,] ; test1[,2];
test1[,2, drop=F ]
test1[-1,]
test1[test1>=170]
```

# 練習

- 產生2組長度為10的隨機序列，然後將此兩個序列合併成為1*2的矩陣

- 模擬1組電腦選號的樂透號碼

- 將2008奧運比賽台灣棒球隊的打擊成績輸入R
- 輸入後更改陳金鋒的姓名為 “不動的第四棒”
- 列出打擊率為零的球員，再將其更改為0.01
- 將更改後的資料框輸出成.csv檔

# 常用函數

| | |
|---|---|
| sum(x) | sum of the elements of **x** |
| prod(x) | product of the elements of **x** |
| max(x) | maximum of the elements of **x** |
| min(x) | minimum of the elements of **x** |
| which.max(x) | returns the index of the greatest element of **x** |
| which.min(x) | returns the index of the smallest element of x |
| range(x) | in. than c(min(**x**),max(**x**)) |
| length(x) | number of elements of **x** |
| mean(x) | mean of the elements of **x** |
| median(x) | median of the elements of **x** |
| var(x) or cov(x) | variance of the elements of **x** (calculated on n-1);if **x** is a matrix or a data frame, the variance-covariance matrix is calculated |
| cor(x) | correlation matrix of x if it is a matrix or a data frame(1 if **x** is a vector) |
| var(x,y) or cov(x,y) | covariance between **x** and **y**, or between the columns of **x** and those of **y** if they are matrices or data frames |
| cor(x,y) | linear correlation between **x** and **y**, or correlation matrix if they are matrices or data frames |

# 常用函數

| | |
|---|---|
| round(x,n) | rounds the elements of **x** to n decimals |
| rev(x) | reverses the elements of **x** |
| sort(x) | sorts the elements of **x** in increasing order:rev(sort(**x**)) |
| rank(x) | ranks of the elements of **x** |
| log(x,base) | computes the logarithm of x with base **base** |
| scale(x) | if **x** is matrix, centers and reduces the data; to center only use the option **center=FALSE**, to reduce only **scale=FALSE** (by default **center=TRUE, sacle=TRUE**) |
| pmin(x,y,⋯) | a vector which ith element is the minimum of **x[1], y[1],⋯** |
| pmax(x,y,⋯) | id. for the maximun |
| cumsum(x) | a vector which ith element is the sum from **x[1]** to **x[i]** |
| sumprod(x) | id. For the product |
| cummin(x) | id. For the minimun |
| cummax(x) | id. For the maximun |
| match(x,y,⋯) | returns a vector of the same length than **x** with the element of **x** which are in **y**(**NA** otherwise) |
| which(x==a) | return a vector of the indicies of x if the comparison operation is true (**TRUE**), in this example the values of I for which **x[i]**==a(the argument of this function must be a variable of mode logical |

# 常用函數

| | |
|---|---|
| choose(n,k) | computes the combinations of k event among n repetitions = n! / [(n-k)!k!] |
| na.omit(x) | suppresses the observations with missing data(**NA**) (suppresses the corresponding line if **x** is a matrix or a data frame) |
| na.fail(x) | returns an error message if **x** contains at least one **NA** |
| unique(x) | if **x** is vector or a data frame, return a similar object but with the duplicate elements suppressed |
| table(x) | returns a table with the numbers of the differents values of **x** (typically for integers or factors) |
| table(x,y) | contingency table of **x** and y |
| subset(x,…) | returns a selection of **x** with respect to criteria (…, typically comparison: **x$v1 < 10**); if **x** is a data frame, the option **select** gives the variables to be kept (or dropped using a minus sign) |
| sample(x,size) | resample randomly and without replacement **size** elements in the vector x, the option **replace = TRUE** allows to resample with replacement |

# 基礎繪圖

- demo(graphics) #展示圖例
- High-level plotting function: 產生新的繪圖
- Low-level plotting function: 對已繪製完成的圖片增加點,線條或說明
- par(): 調整繪圖的參數

# 基礎繪圖_GRAPHICAL FUNCTION

| | |
|---|---|
| plot(x) | plot of the values of x (on the y-axis) ordered on the x-axis |
| plot(x,y) | bivariate plot of x (on the x-axis) and y (on the y-axis) |
| sunflowerplot(x,y) | id. but the points with similar coordinates are drawn as a flower which petal number represents the number of points |
| pie(x) | circular pie-chart |
| boxplot(x) | box-and-whiskers plot |
| stripchart(x) | plot of the values of x on a line (an alternative to boxplot() for small sample sizes) |
| coplot(x~y j z) | bivariate plot of x and y for each value (or interval of values) of z |
| interaction.plot(f1, f2, y) | if f1 and f2 are factors, plots the means of y (on the y-axis) with respect to the values of f1 (on the x-axis) and of f2 (different curves); the option fun allows to choose the summary statistic of y (by default fun=mean) |
| matplot(x,y) | bivariate plot of the first column of x vs. the first one of y, the second one of x vs. the second one of y, etc. |
| dotchart(x) | if x is a data frame, plots a Cleveland dot plot (stacked plots line-by-line and column-by-column) |
| fourfoldplot(x) | visualizes, with quarters of circles, the association between two dichotomous variables for different populations (x must be an array with dim=c(2, 2, k), or a matrix with dim=c(2, 2) if k = 1) |
| assocplot(x) | Cohen-Friendly graph showing the deviations from independence of rows and columns in a two dimensional contingency table |

# 基礎繪圖_GRAPHICAL FUNCTION

| | |
|---|---|
| mosaicplot(x) | 'mosaic' graph of the residuals from a log-linear regression of a contingency table |
| pairs(x) | if x is a matrix or a data frame, draws all possible bivariate plots between the columns of x |
| plot.ts(x) | if x is an object of class "ts", plot of x with respect to time, x may be multivariate but the series must have the same frequency and dates |
| ts.plot(x) | id. but if x is multivariate the series may have different dates and must have the same frequency |
| hist(x) | histogram of the frequencies of x |
| barplot(x) | histogram of the values of x |
| qqnorm(x) | quantiles of x with respect to the values expected under a normal law |
| qqplot(x, y) | quantiles of y with respect to the quantiles of x |

# LOW-LEVEL PLOTTING COMMANDS

| | |
|---|---|
| points(x, y) | adds points (the option type= can be used) |
| lines(x, y) | id. but with lines |
| text(x, y, labels,...) | adds text given by labels at coordinates (x,y); a typical use is:plot(x, y, type="n"); text(x, y, names) |
| mtext(text,side=3, line=0,...) | adds text given by text in the margin specified by side (see axis() below); line specifies the line from the plotting area |
| segments(x0, y0, x1, y1) | draws lines from points (x0,y0) to points (x1,y1) |
| arrows(x0, y0, x1, y1, angle= 30, code=2) | id. with arrows at points (x0,y0) if code=2, at points (x1,y1) if code=1, or both if code=3; angle controls the angle from the shaft of the arrow to the edge of the arrow head |
| abline(a,b) | draws a line of slope b and intercept a |
| abline(h=y) | draws a horizontal line at ordinate y |
| abline(v=x) | draws a vertical line at abcissa x |
| abline(lm.obj) | draws the regression line given by lm.obj (see section 5) |
| rect(x1, y1, x2,y2) | draws a rectangle which left, right, bottom, and top limits are x1, x2, y1, and y2, respectively |

# LOW-LEVEL PLOTTING COMMANDS

| | |
|---|---|
| polygon(x, y) | draws a polygon linking the points with coordinates given by x and y |
| legend(x, y,legend) | adds the legend at the point (x,y) with the symbols given by legend |
| title() | adds a title and optionally a sub-title |
| axis(side, vect) | adds an axis at the bottom (side=1), on the left (2), at the top(3), or on the right (4); vect (optional) gives the abcissa (or ordinates) where tick-marks are drawn |
| box() | adds a box around the current plot |
| rug(x) | draws the data x on the x-axis as small vertical lines |
| locator(n, type="n", ...) | returns the coordinates (x; y) after the user has clicked n times on the plot with the mouse; also draws symbols (type="p") or lines (type="l") with respect to optional graphic parameters(...); by default nothing is drawn (type="n") |

# 繪圖控制參數

| | |
|---|---|
| adj | controls text justification with respect to the left border of the text so that 0 is left-justified, 0.5 is centred, 1 is right-justified, values > 1 move the text further to the left, and negative values further to the right; if two values are given (e.g., c(0, 0)) the second one controls vertical justification with respect to the text baseline |
| bg | specifies the colour of the background (e.g., bg="red", bg="blue"; the list of the 657 available colours is displayed with colors()) |
| bty | controls the type of box drawn around the plot, allowed values are: "o", "l", "7", "c", "u" ou "]" (the box looks like the corresponding character); if bty="n" the box is not drawn |
| cex | a value controlling the size of texts and symbols with respect to the default; the following parameters have the same control for numbers on the axes, cex.axis, the axis labels, cex.lab, the title, cex.main, and the sub-title, cex.sub |
| col | controls the colour of symbols; as for cex there are: col.axis, col.lab, col.main, col.sub |
| font | an integer which controls the style of text (1: normal, 2: italics, 3: bold, 4: bold italics); as for cex there are: font.axis, font.lab, font.main, font.sub |
| las | an integer which controls the orientation of the axis labels (0: parallel to the axes, 1: horizontal, 2: perpendicular to the axes, 3: vertical) |

# 繪圖控制參數

| | |
|---|---|
| lty | controls the type of lines, can be an integer (1: solid, 2: dashed, 3: dotted, 4: dotdash, 5: longdash, 6: twodash), or a string of up to eight characters (between "0" and "9") which specifies alternatively the length, in points or pixels, of the drawn elements and the blanks, for example lty="44" will have the same effet than lty=2 |
| lwd | a numeric which controls the width of lines |
| mar | a vector of 4 numeric values which control the space between the axes and the border of the graph of the form c(bottom, left, top, right), the default values are c(5.1, 4.1, 4.1, 2.1) |
| mfcol | a vector of the form c(nr,nc) which partitions the graphic window as a matrix of nr lines and nc columns, the plots are then drawn in columns (see section 4.1.2) |
| mfrow | id. but the plots are then drawn in line (see section 4.1.2) |
| pch | controls the type of symbol, either an integer between 1 and 25, or any single character within "" (Fig. 2) |
| ps | an integer which controls the size in points of texts and symbols |
| pty | a character which specifies the type of the plotting region, "s": square, "m": maximal |
| tck | a value which specifies the length of tick-marks on the axes as a fraction of the smallest of the width or height of the plot; if tck=1 a grid is drawn |
| tcl | id. but as a fraction of the height of a line of text (by default tcl=-0.5) xaxt if xaxt="n" the x-axis is set but not drawn (useful in conjunction with axis(side=1, ...)) |
| yaxt | if yaxt="n" the y-axis is set but not drawn (useful in conjunction with axis(side=2, ...)) |

# 撰寫程式及函數

- ?Control

```
x<-numeric(10)
for(i in 1:10)
{
  x[i]<-i*rnorm(1,mean=0,sd=5)
}
x

for(i in 1:10)
{
  if (x[i]<0)
   {x[i]<-0}
 else
   {x[i]<-1}
}
fun<-function(x,mu,sigma)
{ 1/(sqrt(2*pi)* sigma)*exp(-((x - mu)^2/(2*sigma^2))) }
fun(1,0,1)
```

# 基礎資料分析

- 阿匾將錢匯往國外100次，且其中有20次匯往英屬維京群島，若檢方隨機抽查阿匾的10次匯款紀錄，則: 至少檢查到3筆匯往國外的紀錄的機率為?

```
binomial<-function(x,n,p)
{choose(n,x)*p^x*(1-p)^(n-x)}
p<-20/100
n<-10
sum(binomial(3:10,n,p))

binomial(2,10,0.2)
dbinom(2,10,0.2)
1-pbinom(2,10,0.2)
```

# 基礎資料分析

- 假設南韓人與臺灣人的平均壽命分別為75歲及80歲，標準偏差均為10， 今分別隨機挑出30名南韓人與台灣人(男女各半)，試作t-test 比較南韓人與台灣人平均壽命是否有差異?

```
T<-rnorm(30,mean=80,sd=10)
K<-rnorm(30,mean=75,sd=10)
sex<-c(rep("Man",15),rep("Female",15))
data1<-data.frame(sex,T,K)

ttest1<-t.test(T,K,alternative="two.sided",var.equal=T,conf.level=0.95)
print(ttest1)
ttest2<-t.test(T,K,alternative="greater",var.equal=T,conf.level=0.95)
print(ttest2)
ttest3<-t.test(T~sex,alternative="two.sided",var.equal=T,conf.level=0.95)
#注意 taiwan~sex 表示taiwan這向量內的值根據sex因子分類做t-test
print(ttest3)
```

# 基礎資料分析

- 迴歸分析

```
regression<-function(x,y)
{
 ex.lm<-lm(y~x)
 print(summary(ex.lm))
 print(anova(ex.lm))
 win.graph()
 plot(x,y)
 abline(lm(y~x))
 res<-ex.lm$residuals  #residual plot
 yhat<-predict(ex.lm)
 win.graph()
 plot(yhat,res,main="residuals against fit value")
 abline(h=0)
 win.graph()
 qqnorm(res)
 qqline(res)
}
x<-rnorm(20)
y<-2*x+rnorm(20)
regression(x,y)
```