

105-2: EE4052  
計算機程式設計  
Computer Programming

## Unit 09: 繪圖功能與文字

連 豐 力

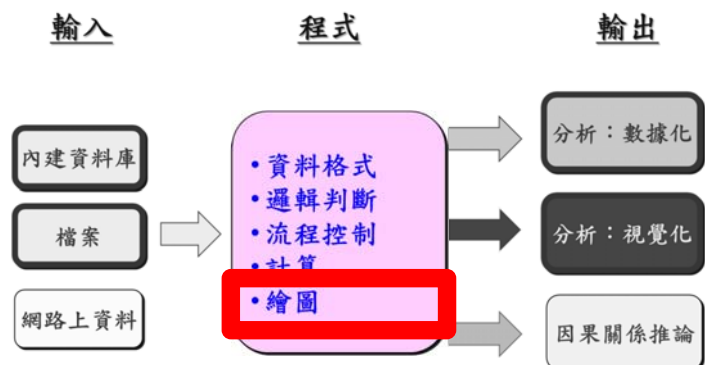
臺大電機系

Feb 2017 - Jun 2017

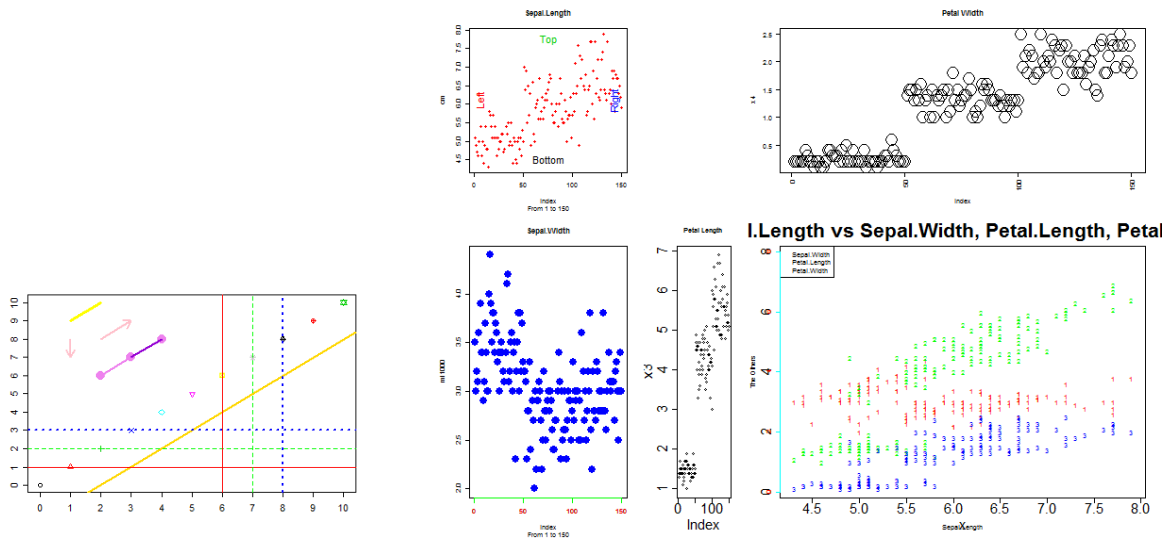
### 課程主題進度

計算機程式設計 - 2017S  
U09: 繪圖功能與文字  
Feng-Li Lian @ NTU-EE

- **U01:** 課程介紹：討論主題，作業，報告，進行方式
- **U02:** 設定軟體 R 與 Rstudio
- **U03:** 數據處理與繪圖指令功能
- **U04:** 資料類別與基本運算
- **U05:** 邏輯判斷與流程控制
- **U06:** 函數：計算與排序
- **U07:** 多維度資料格式
- **U08:** 檔案資料輸入與輸出
- **U09:** 繪圖功能與文字
- **U10:** 多重繪圖與顏色
- **U11:** 函數：動畫與動作
- **U12:** 探索性資料分析
- **U13:** 資料前置處理
- **U14:** 資料連結分析



- 一張圖的長寬或大小，主標題，軸標題，字體等特性的設定
- 數據點的顏色要有變化
- 數據點的形式要有變化
- 數據加上不同註解



3

## 大綱

- 繪圖視窗之設定
- 常用的圖形參數
- 座標軸及邊界
- 加入文字
  
- 多張圖形
- 多張圖形之位置安排
- 加入圖形元件
- 顏色

4

## 繪圖視窗之設定

5



## 繪圖視窗

計算機程式設計 - 2017S  
U09: 繪圖功能與文字  
Feng-Li Lian @ NTU-EE

- `plot( )`
- `windows( )`
- `curve( )`

`windows( width, height, pointsize, record, rescale, xpinch, ypinch, bg, canvas, gamma, xpos, ypos, buffered, title, restoreConsole, clickToConfirm, fillOddEven, family, antialias )`

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

`curve( expr, from = NULL, to = NULL, n = 101, add = FALSE, type = "l", xname = "x", xlab = xname, ylab = NULL, log = NULL, xlim = NULL, ... )`

6

- # in Mac OS
- quartz( )

quartz( title, width, height, pointsize, family, antialias, type, file = NULL, bg, canvas, dpi )

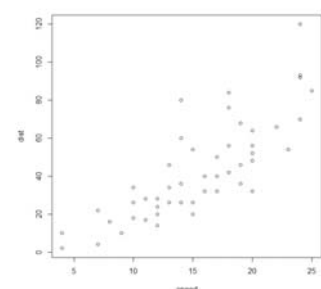
- windows( . )      -->    quartz( . )
- win.graph( . )    -->    dev.new( . )

- # in UNIX
- X11( )

X11( width, height, pointsize, bg, gamma, xpos, ypos, title )

7

- data( cars )
- summary( cars )
- cars
- head( cars )
- tail( cars )
- str( cars )
- plot ( cars )

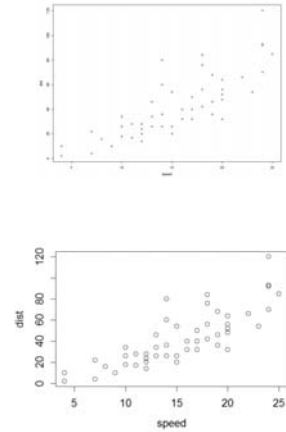


8

## 繪圖視窗之設定

計算機程式設計 - 2017S  
U09: 繪圖功能與文字  
Feng-Li Lian @ NTU-EE

- `windows( width = 4.5, height = 3.3, pointsize = 8 )`  
# pointsize: 文字或符號字體大小
- `windows( width = 8, height = 6, pointsize = 20 )`
- `old.par <- par( mex = 0.8, mar = c(5, 5, 4, 2) + 0.1 )`  
# mex: 邊界文字的縮放比  
# mar: 下 左 上 右 四個邊界之預留距離  
# 下: side=1, 左: side=2, 上: side=3, 右: side=4
- `plot ( cars )`
- `par( old.par )` # reset to previous settings



9

## 繪圖視窗之設定

計算機程式設計 - 2017S  
U09: 繪圖功能與文字  
Feng-Li Lian @ NTU-EE

- `windows( width = 4.5, height = 3.3, pointsize = 8 )`
- `old.par <- par( mex = 0.8, mar = c(5, 5, 4, 2) + 0.1 )`
- `plot ( cars )`
- `par( old.par )` # reset to previous settings
- `win.graph( width = 4.5, height = 3.3, pointsize = 8 )`
- `old.par <- par( mex = 0.8, mar = c(5, 5, 4, 2) + 0.1 )`
- `plot( cars )`
- `par( old.par )` # reset to previous settings

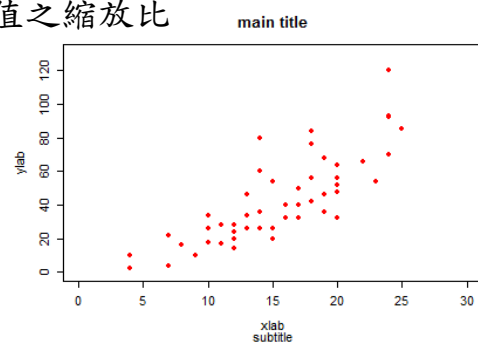
10

- `windows( width, height, pointsize, record, rescale, xpinch, ypinch, bg, canvas, gamma, xpos, ypos, buffered, title, restoreConsole, clickToConfirm, fillOddEven, family, antialias )`
- `win.graph( width, height, pointsize )`
- `x11( width, height, pointsize, bg, gamma, xpos, ypos, title )`
- `X11( width, height, pointsize, bg, gamma, xpos, ypos, title )`
- `win.metafile( filename = "", width = 7, height = 7, pointsize = 12, family, restoreConsole = TRUE )`
- `win.print( width = 7, height = 7, pointsize = 12, printer = "", family, antialias, restoreConsole = TRUE )`

## 常用的圖形參數

## 圖形參數

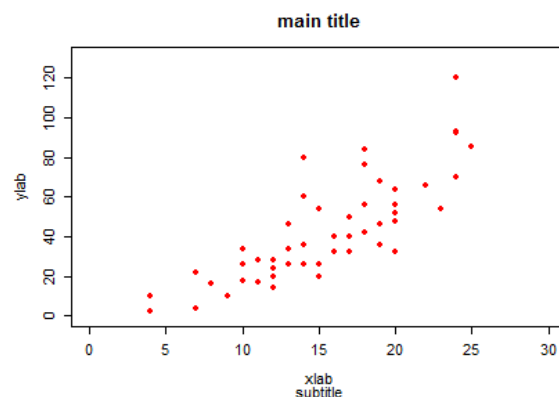
- **xlim:** # X 軸 (橫) 之範圍; **xlim[1]**: 左邊界, **xlim[2]**: 右邊界
- **ylim:** # y 軸 (縱) 之範圍; **ylim[1]**: 下邊界, **ylim[2]**: 上邊界
- **xlab:** # X 軸 (橫) 之名稱, 出現在橫軸下方
- **ylab:** # y 軸 (縱) 之名稱, 出現在橫軸左方
- **main:** # 整個圖形的之主標題, 出現在圖形的上方
- **sub:** # 副標題, 出現在橫軸下方
- **cex:** # 文字及符號相對於內定值之縮放比
- **pch:** # 點的型式
- **col:** # 繪圖的顏色



13

## 圖形參數

- **windows( width = 4.5, height = 3.3, pointsize = 8 )**
- **old.par <- par( mex = 0.8, mar = c(7, 5, 4, 2) + 0.1 )**
- **plot( cars, xlim = c(0, 30), ylim = c(0, 130), xlab = "xlab", ylab = "ylab", main = "main title", sub = "subtittle", cex = 0.8, pch = 16, col = "red")**
- **par( old.par )**  
# reset to previous settings



### Graphical Parameters

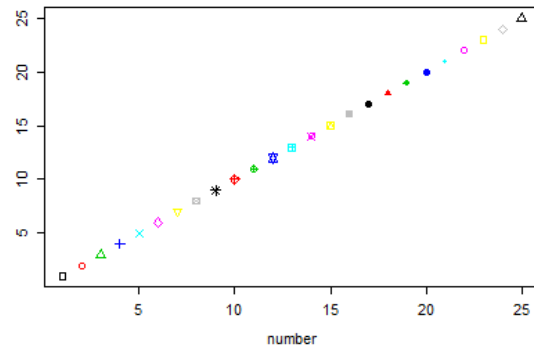
<http://www.statmethods.net/advgraphs/parameters.html>

### R Graphical Parameters Cheat Sheet

<http://gastonsanchez.com/visually-enforced/resources/2015/09/22/R-cheat-sheet-graphical-parameters/>

14

- `windows( width = 4.5, height = 3.3, pointsize = 8 )`
- `old.par <- par( mex = 0.8, mar = c(5, 5, 4, 2) + 0.1 )`
- `plot( 1:25, pch = 0:25, col = 1:8, xlab = "number", ylab = "" )`
- `par( old.par )`  
# reset to previous settings



## Graphical Parameters

<http://www.statmethods.net/advgraphs/parameters.html>

## R Graphical Parameters Cheat Sheet

<http://gastonsanchez.com/visually-enforced/resources/2015/09/22/R-cheat-sheet-graphical-parameters/>

15

## 座標軸及邊界

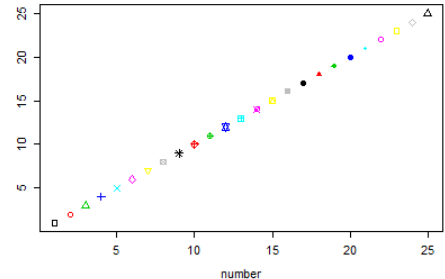
16



## 座標軸及邊界參數

計算機程式設計 - 2017S  
U09: 繪圖功能與文字  
Feng-Li Lian @ NTU-EE

- **axis:** # 設定座標軸之函數
- **axes:** # **axes = TRUE** : 要畫座標軸; **axes = FALSE** : 不要畫座標軸
- **xaxt:** # **xaxt = "n"** : 不要畫 x 軸
- **yaxt:** # **yaxt = "n"** : 不要畫 y 軸
- **col.axis:** # 座標軸之文字顏色
- **side:** # 繪圖區域邊界的編號
- **mex:** # 邊界文字之縮放比
- **mar:** # 下左上右四個邊界之預留距離

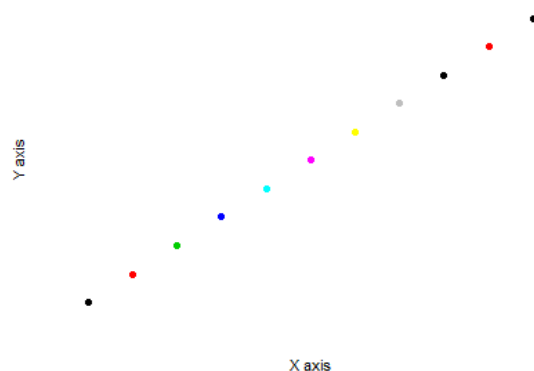


17

## 座標軸及邊界參數

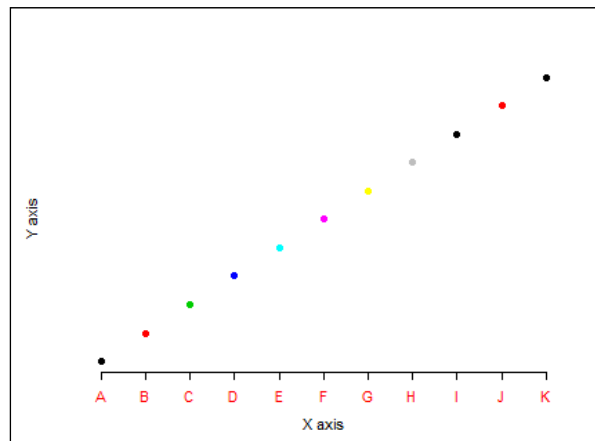
計算機程式設計 - 2017S  
U09: 繪圖功能與文字  
Feng-Li Lian @ NTU-EE

- **windows( width = 4.5, height = 3.3, pointsize = 8 )**
- **old.par <- par( mex = 0.8, mar = c(5, 5, 4, 3) + 0.1 )**
- **plot( 0:10, 0:10, col = 1:10, pch = 16, xlab = "X axis", ylab = "Y axis", axes = FALSE )**



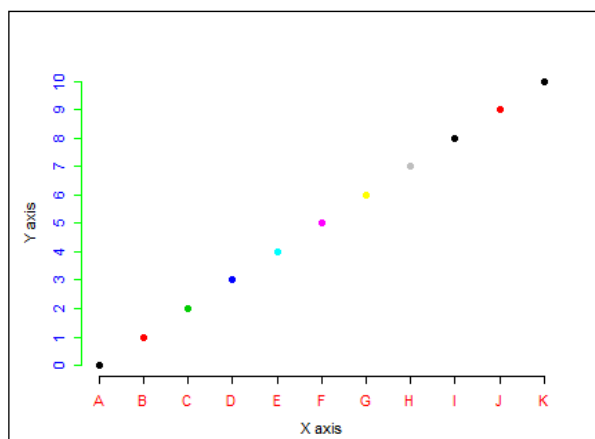
18

- `plot( 0:10, 0:10, col = 1:10, pch = 16, xlab = "X axis", ylab = "Y axis", axes = FALSE )`
- `axis( side = 1, col = "black", col.axis = "red", at = 0:10, label = LETTERS[1:11] )`



19

- `plot( 0:10, 0:10, col = 1:10, pch = 16, xlab = "X axis", ylab = "Y axis", axes = FALSE )`
- `axis( side = 1, col = "black", col.axis = "red", at = 0:10, label = LETTERS[1:11] )`
- `axis( side = 2, col = "green", col.axis = "blue", at = seq(from = 0, to = 10, by = 1) )`

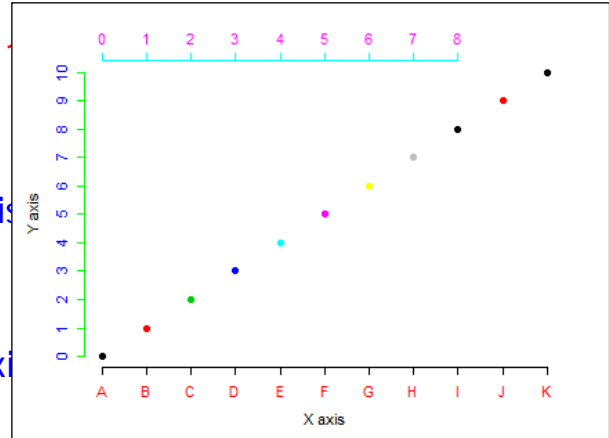


20

## 座標軸及邊界參數

計算機程式設計 - 2017S  
U09: 繪圖功能與文字  
Feng-Li Lian @ NTU-EE

- `plot( 0:10, 0:10, col = 1:10, pch = 1, axes = FALSE )`
- `axis( side = 1, col = "black", col.axis = "black", at = LETTERS[1:11] )`
- `axis( side = 2, col = "green", col.axis = "green", at = 0:10, by = 1 )`
- `axis( side = 3, col = "cyan", col.axis = "magenta", at = seq(from = 0, to = 8, by = 1) )`

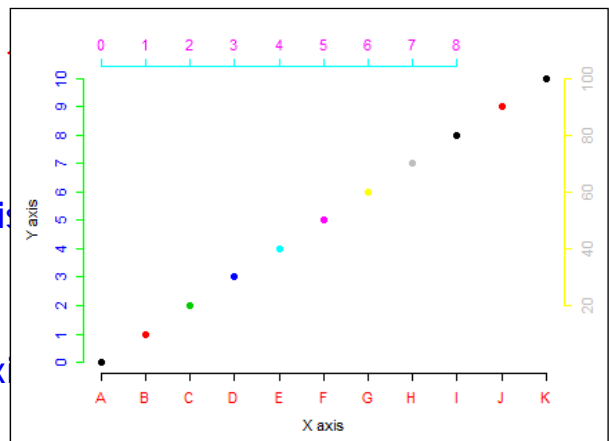


21

## 座標軸及邊界參數

計算機程式設計 - 2017S  
U09: 繪圖功能與文字  
Feng-Li Lian @ NTU-EE

- `plot( 0:10, 0:10, col = 1:10, pch = 1, axes = FALSE )`
- `axis( side = 1, col = "black", col.axis = "black", at = LETTERS[1:11] )`
- `axis( side = 2, col = "green", col.axis = "green", at = 0:10, by = 1 )`
- `axis( side = 3, col = "cyan", col.axis = "magenta", at = seq(from = 0, to = 8, by = 1) )`
- `axis( side = 4, col = "yellow", col.axis = "gray", at = seq(from = 2, to = 10, by = 2), label = c(20, 40, 60, 80, 100) )`
- `par( old.par )`



22

## 加入文字

23



## 加入文字

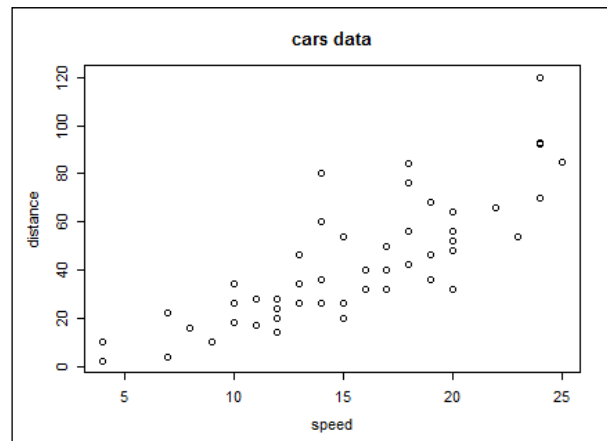
計算機程式設計 - 2017S  
U09: 繪圖功能與文字  
Feng-Li Lian @ NTU-EE

- **text:** # 加入文字
- **title:** # 加入註解
- **legend:** # 加入圖標，圖例，備註
- **mtext:** # 在邊界加入文字

24

# 加入文字

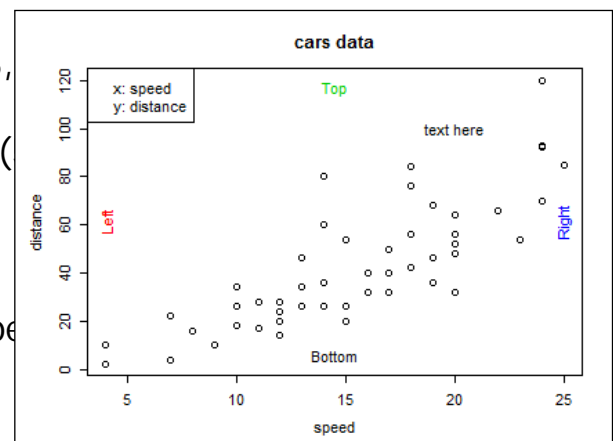
- `windows( width = 4.5, height = 3.3, pointsize = 8 )`
- `old.par <- par( mex = 0.8, mar = c(5, 5, 4, 2) + 0.1 )`
- `plot( cars, xlab = "", ylab = "" )`
- `title( main = "cars data", xlab = "speed", ylab = "distance" )`



25

# 加入文字

- `windows( width = 4.5, height = 3.3,`
- `old.par <- par( mex = 0.8, mar = c(`
- `plot( cars, xlab = "", ylab = "" )`
- `title( main = "cars data", xlab = "spe`
- `text( 20, 100, label = "text here" )`
- `legend( "topleft", legend = c("x: speed", "y: distance" ) )`
- `mtext( text = c("Bottom", "Left", "Top", "Right"), side = 1:4, col = 1:4,`  
`line = -2 )`



# line = -2: 往內移動兩個線寬度

- `par(old.par)`

26

- legend 位置 :

topleft,	top,	topright
left,	center,	right
bottomleft,	bottom,	bottomright

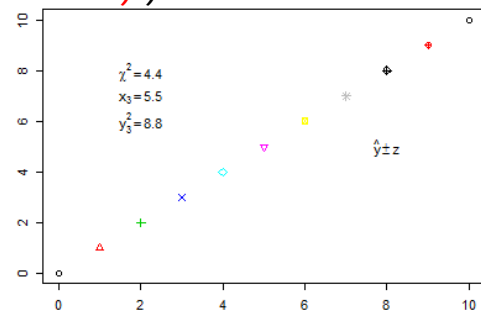
# 加入文字 - 用滑鼠

- `windows( width = 4.5, height = 3.3, pointsize = 8 )`
- `old.par <- par( mex = 0.8, mar = c(5, 5, 4, 2) + 0.1 )`
- `plot( cars, xlab = "", ylab = "" )`
- `title( main = "cars data", xlab = "speed", ylab = "distance" )`
- `text( 20, 100, label = "text here" )`
- `legend( locator(1), legend = c("x: speed", "y: distance") )`
- `mtext( text = c("Bottom", "Left", "Top", "Right"), side = 1:4, col = 1:4, line = -2 )`
- `par(old.par)`

## 加入數學符號

計算機程式設計 - 2017S  
U09: 繪圖功能與文字  
Feng-Li Lian @ NTU-EE

- `windows( width = 4.5, height = 3.3, pointsize = 8 )`
- `old.par <- par( mex = 0.8, mar = c(5, 5, 4, 2) + 0.1 )`
- `plot(0:10, 0:10, xlab = "", ylab = "", pch = 1:10, col = 1:10)`
- `text( 2, 8, label = expression( chi^2 == "4.4" ) )`
- `text( 2, 7, label = expression( x[3] == "5.5" ) )`
- `text( 2, 6, label = expression( y[3]^2 == "8.8" ) )`
- `text( 8, 5, label = expression( hat(y) %+-% z ) )`



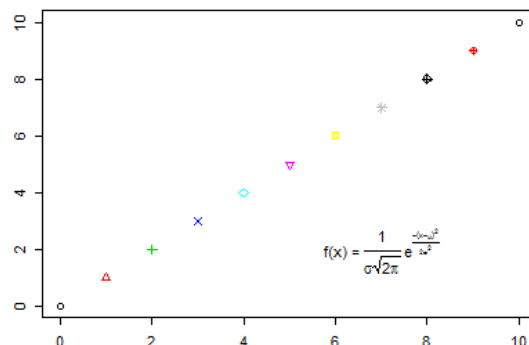
29

## 加入數學符號

計算機程式設計 - 2017S  
U09: 繪圖功能與文字  
Feng-Li Lian @ NTU-EE

- `label.eq <- expression( paste( "f(x) = ", frac(1, sigma*sqrt(2 * pi)), " ", e^{frac(-(x - mu)^2, 2*sigma^2)} ) )`
- `text( 7, 2, label = label.eq )`

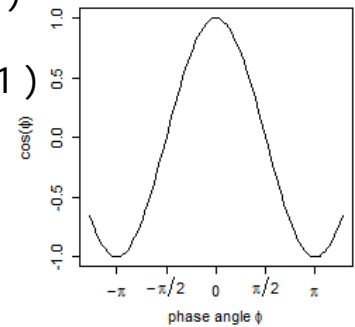
- `par( old.par )`



30

## 加入數學符號

- `x <- seq( from = -4, to = 4, length = 101 )`
- `win.graph( width = 2.8, height = 2.8, pointsize = 8 )`
- `old.par <- par( mex = 0.8, mar = c(5, 5, 3, 2) + 0.1 )`
- `xlab <- expression( paste( "phase angle ", phi ) )`
- `ylab <- expression( paste( "cos(", phi, ")" ) )`
- `plot( x, cos(x), type = "l", xaxt = "n", xlab = xlab, ylab = ylab )`
- `label <- expression( -pi, -pi / 2, 0, pi / 2, pi )`
- `axis( side = 1, at = c(-pi, -pi / 2, 0, pi / 2, pi), label = label )`
- `par(old.par)`



31

## 數學符號 expression( )

- `?plotmath`
- `demo( plotmath )`

32



- **font:** # 文字及符號之字型
  - **font.axis:** # 座標軸數字，文字及符號之字型
  - **font.lab:** # 座標軸標記之字型
  - **font.main:** # 主標題文字及符號之字型
  - **font.sub:** # 副標題文字及符號之字型
- 
- demo( Hershey )

## Graphical Parameters Cheat Sheet

**par () Graphical Parameters** Visual cheat sheet for some plot parameters in R. See `?par` for more information.

Symbol Styles	Axes	Text and Labels												
<p><b>pch   Point Types</b></p> <ul style="list-style-type: none"> <li>○ 1</li> <li>△ 2</li> <li>+ 3</li> <li>× 4</li> <li>◇ 5</li> <li>▽ 6</li> <li>⊗ 7</li> <li>* 8</li> <li>⊕ 9</li> <li>⊙ 10</li> <li>⊗ 11</li> <li>⊠ 12</li> <li>⊡ 13</li> </ul> <p>you can also use any character</p> <p><b>lty   Line Types</b></p> <ul style="list-style-type: none"> <li>1</li> <li>2</li> <li>3</li> <li>4</li> <li>5</li> <li>6</li> </ul> <p><b>lwd   Line Width</b></p> <ul style="list-style-type: none"> <li>.1</li> <li>.25</li> <li>.5</li> <li>1</li> <li>3</li> <li>6</li> </ul>	<p><b>lab   Tick Placement</b></p> <ul style="list-style-type: none"> <li>10,10</li> <li>1,10</li> <li>10,1</li> <li>2,2</li> </ul> <p><b>tck   Tick Length</b></p> <ul style="list-style-type: none"> <li>-0.1</li> <li>0.1</li> <li>1</li> </ul> <p><b>bty   Box Type</b></p> <ul style="list-style-type: none"> <li>'o'</li> <li>'l'</li> <li>'7'</li> <li>'c'</li> <li>'u'</li> <li>']'</li> </ul>	<p><b>family, font   Typeface and Font Style</b></p> <table border="0"> <tr> <td>family: mono font: 1</td> <td>family: serif font: 1</td> <td>family: sans font: 1</td> </tr> <tr> <td>family: mono font: 2</td> <td>family: serif font: 2</td> <td>family: sans font: 2</td> </tr> <tr> <td>family: mono font: 3</td> <td>family: serif font: 3</td> <td>family: sans font: 3</td> </tr> <tr> <td>family: mono font: 4</td> <td>family: serif font: 4</td> <td>family: sans font: 4</td> </tr> </table> <p>Also available: <b>font.main</b> (main title), <b>font.lab</b> (axis labels), <b>font.sub</b> (subtitle)</p> <p><b>las   Label Orientation</b></p> <ul style="list-style-type: none"> <li>0: Parallel to axes</li> <li>1: Horizontal</li> <li>2: Perpendicular to axes</li> <li>3: Vertical</li> </ul> <p><b>ann   Plot Annotation</b></p> <p>TRUE: Some Title</p> <p>FALSE: The quick brown fox jumps over the lazy dog and runs away with all the food</p> <p><b>lheight   Line Height</b></p> <p>1: The quick brown fox jumps over the lazy dog and runs away with all the food</p> <p>1.5: The quick brown fox jumps over the lazy dog and runs away with all the food</p> <p><b>srt   String Rotation</b></p> <ul style="list-style-type: none"> <li>0</li> <li>45</li> <li>90</li> <li>135</li> </ul> <p>text text text text</p>	family: mono font: 1	family: serif font: 1	family: sans font: 1	family: mono font: 2	family: serif font: 2	family: sans font: 2	family: mono font: 3	family: serif font: 3	family: sans font: 3	family: mono font: 4	family: serif font: 4	family: sans font: 4
family: mono font: 1	family: serif font: 1	family: sans font: 1												
family: mono font: 2	family: serif font: 2	family: sans font: 2												
family: mono font: 3	family: serif font: 3	family: sans font: 3												
family: mono font: 4	family: serif font: 4	family: sans font: 4												
<p><b>Figures Arrangement</b></p> <p><b>mflow   Multiple Figures by Row</b></p> <p>2, 3</p> <table border="1"> <tr> <td>1</td> <td>2</td> <td>3</td> </tr> <tr> <td>4</td> <td>5</td> <td>6</td> </tr> </table> <p>Also available <b>mfcol</b> for multiple figures by column</p>	1	2	3	4	5	6								
1	2	3												
4	5	6												

Based on Flowing Data's cheat sheet

## 作業

35

## HW08：繪圖功能與文字

計算機程式設計 - 2017S  
U09: 繪圖功能與文字  
Feng-Li Lian @ NTU-EE

On 5/2, 2017

- 請使用 iris 的第一組數據 (Sepal.Length)，繪製一張圖，符合下面的要求：
  - 邊界文字縮放比：mex = 0.8
  - 下左上右四個邊界之預留距離：mar = c(6, 6, 3, 3)
  - x 軸（橫）之範圍：(-10, 160)
  - y 軸（縱）之範圍：(4, 8)
  - x 軸（橫）之名稱：Plant ID
  - y 軸（縱）之名稱：Length of Sepal
  - 整個圖形的主標題：IRIS Data
  - 繪製顏色：blue
  - 點的型式：2 號，三角形
  - 文字及符號相對於內定值之縮放比：cex = 2
  - 在下面座標軸 (side=1)，座標線為綠色，座標數字為紅色
  - 在左上角加上標記：Plant ID vs Sepal.Length
  - 在 (120, 4) 的地方，放入文字：Plot the IRIS data, Sepal.Length
  - 在 (120, 4.5) 的地方，放入數學符號： $y = x^2 + 5$

36

# HW08：繪圖功能與文字

計算機程式設計 - 2017S

U09: 繪圖功能與文字

Feng-Li Lian @ NTU-EE

On 5/2, 2017

- 繳交下面檔案，檔案名稱：[HW08\\_學號\\_關鍵字.xxx](#)
  - 主要指定檔案：[HW08\\_B01921001\\_PlotFigure.R](#)
  - 報告檔案：[HW08\\_B01921001\\_PlotFigure.pdf](#) 或者 [.pptx](#)
  - 或者是：[R Markdown](#) 等整合式的檔案，[.Rmd](#) 與 [.pdf](#)
    - 有關 R Markdown 的使用方式，可以參考下面說明：
      - <http://rmarkdown.rstudio.com/lesson-1.html>
      - [http://rmarkdown.rstudio.com/articles\\_intro.html](http://rmarkdown.rstudio.com/articles_intro.html)
- 繳交方式與期限：
  - E-mail 上面兩個檔案到：[ntucp105s@gmail.com](mailto:ntucp105s@gmail.com)
  - E-mail 主旨：[HW08\\_B01921001\\_PlotFigure](#)  
(就是，作業編號\_您的學號\_關鍵字)
  - 繳交期限：[5/7 \(Sun\), 2017, 11pm 以前](#)
- 學習方式：請至下面網址輸入此次的學習方式所花的時間：
  - <https://goo.gl/L157kQ>