105-2: EE4052

計算機程式設計

Computer Programming

Unit 03: 數據處理與繪圖功能

連 豐 力

臺大電機系

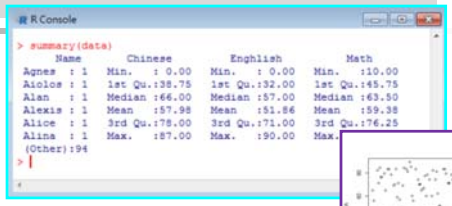
Feb 2017 - Jun 2017

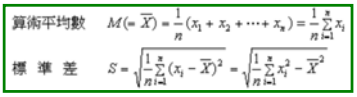
問題探索與分析

問題

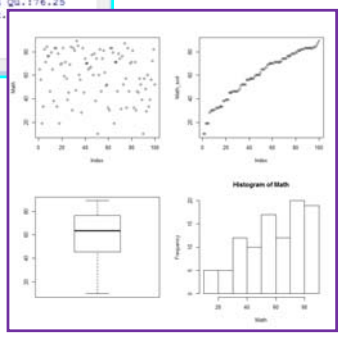
理論
（公式）

計算機
程式設計





- summary(Math)
- sort (Math)
- boxplot(Math)
- hist(Math)

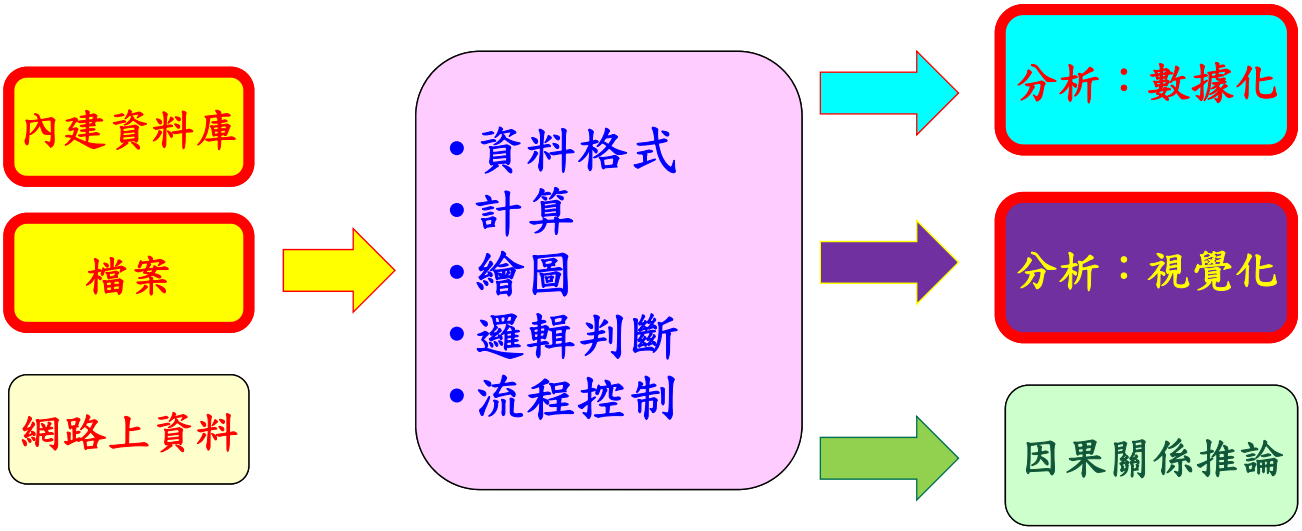


分析：數據化

分析：視覺化

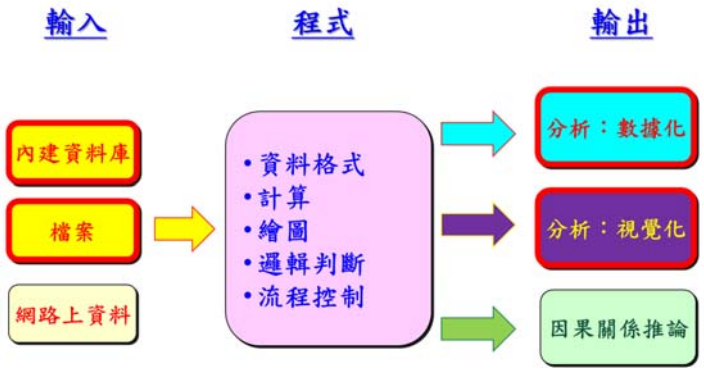
問題探索與分析

輸入 **程式** **輸出**



課程主題進度

- 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
- U10: 繪圖參數設定
- 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



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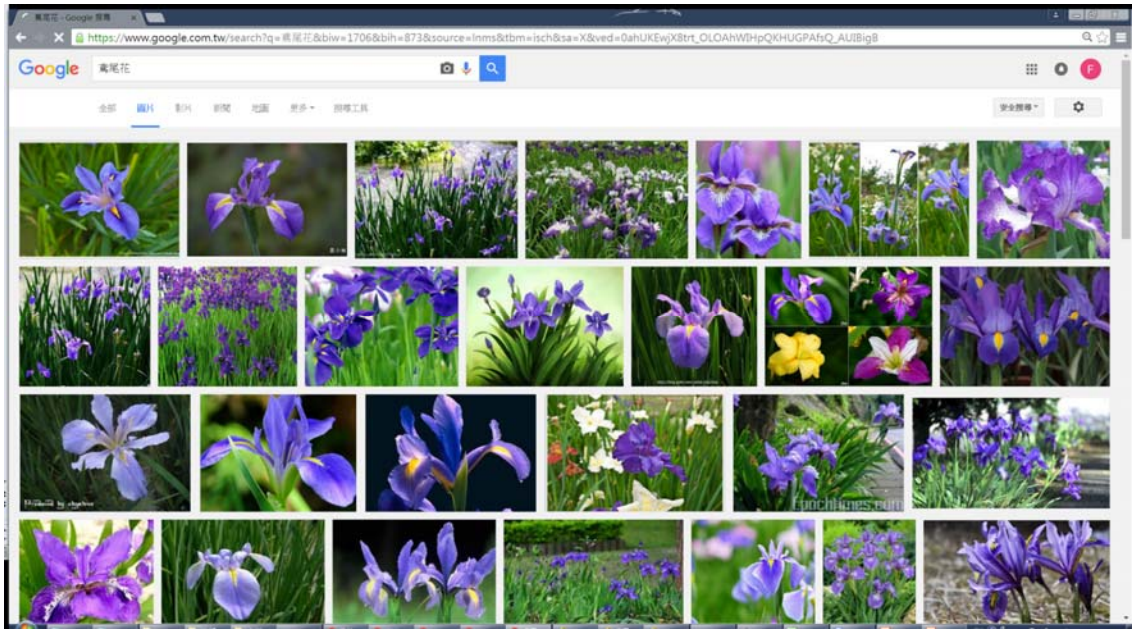
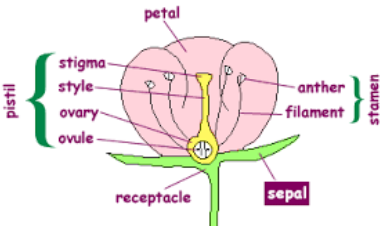
- 以 鳶尾花 - IRIS 與 課程活動時間 數據為例
- 數據所在位置與數據的內容
- 初步分析數據
- 繪製圖形 –
  - 一維圖：
    - 直方圖，盒鬚圖，莖葉圖，長條記錄圖，圓餅圖，機率分布圖，經驗累積分布圖，常態機率圖
  - 多維圖：
    - 散點圖，散點 直方 核密度，多重分布，三維散點圖

鳶尾花 - IRIS



鳶尾花 - IRIS

- 鳶尾花 (iris) 資料集
  - 非常著名的生物資訊資料集之一
  - 取自美國加州大學歐文分校的機械學習資料庫
- 資料的筆數為150筆，
  - 共有五個欄位：
    1. 花萼長度 (Sepal Length)：計算單位是公分。
    2. 花萼寬度 (Sepal Width)：計算單位是公分。
    3. 花瓣長度 (Petal Length) ：計算單位是公分。
    4. 花瓣寬度 (Petal Width)：計算單位是公分。
    5. 類別 (Class)：可分為 Setosa，Versicolor 和 Virginica 三個品種。



https://extension.illinois.edu/gpe/glossary/sepal.html

計算機程式設計 – 2017S
U03: 數據處理-繪圖功能
Feng-Li Lian @ NTU-EE

鳶尾花 - IRIS

```
> iris
    Sepal.Length Sepal.Width Petal.Length Petal.Width    Species
1            5.1         3.5          1.4         0.2     setosa
2            4.9         3.0          1.4         0.2     setosa
3            4.7         3.2          1.3         0.2     setosa
4            4.6         3.1          1.5         0.2     setosa
5            5.0         3.6          1.4         0.2     setosa
6            5.4         3.9          1.7         0.4     setosa
7            4.6         3.4          1.4         0.3     setosa
8            5.0         3.4          1.5         0.2     setosa
9            4.4         2.9          1.4         0.2     setosa
10           4.9         3.1          1.5         0.1     setosa
11           5.4         3.7          1.5         0.2     setosa
12           4.8         3.4          1.6         0.2     setosa
13           4.8         3.0          1.4         0.1     setosa
14           4.3         3.0          1.1         0.1     setosa
15           5.8         4.0          1.2         0.2     setosa
16           5.7         4.4          1.5         0.4     setosa
17           5.4         3.9          1.3         0.4     setosa
18           5.1         3.5          1.4         0.3     setosa
19           5.7         3.8          1.7         0.3     setosa
20           5.1         3.8          1.5         0.3     setosa
21           5.4         3.4          1.7         0.2     setosa
22           5.1         3.7          1.5         0.4     setosa
23           4.6         3.6          1.0         0.2     setosa
24           5.1         3.3          1.7         0.5     setosa
25           4.8         3.4          1.9         0.2     setosa
26           5.0         3.0          1.6         0.2     setosa
27           5.0         3.4          1.6         0.4     setosa
28           5.2         3.5          1.5         0.2     setosa
29           5.2         3.4          1.4         0.2     setosa
30           4.7         3.2          1.6         0.2     setosa
31           4.8         3.1          1.6         0.2     setosa
32           5.4         3.4          1.5         0.4     setosa
33           5.2         4.1          1.5         0.1     setosa
34           5.5         4.2          1.4         0.2     setosa
35           4.9         3.1          1.5         0.2     setosa
36           5.0         3.2          1.2         0.2     setosa
37           5.5         3.5          1.3         0.2     setosa
38           4.9         3.6          1.4         0.1     setosa
39           4.4         3.0          1.3         0.2     setosa
40           5.1         3.4          1.5         0.2     setosa
41           5.0         3.5          1.3         0.3     setosa
42           4.5         2.3          1.3         0.3     setosa
43           4.4         3.2          1.3         0.2     setosa
44           5.0         3.5          1.6         0.6     setosa
45           5.1         3.8          1.9         0.4     setosa
46           4.8         3.0          1.4         0.3     setosa
47           5.1         3.8          1.6         0.2     setosa
48           4.6         3.2          1.4         0.2     setosa
49           5.3         3.7          1.5         0.2     setosa
50           5.0         3.3          1.4         0.2     setosa
51           7.0         3.2          4.7         1.4 versicolor
52           6.4         3.2          4.5         1.5 versicolor
53           6.9         3.1          4.9         1.5 versicolor
54           5.5         2.3          4.0         1.3 versicolor
55           6.5         2.8          4.6         1.5 versicolor
56           5.7         2.8          4.5         1.3 versicolor
57           6.3         3.3          4.7         1.6 versicolor
58           4.9         2.4          3.3         1.0 versicolor
59           6.6         2.9          4.6         1.3 versicolor
60           5.2         2.7          3.9         1.4 versicolor
61           5.0         2.0          3.5         1.0 versicolor
```

```
91           5.5         2.6          4.4         1.2 versicolor
92           6.1         3.0          4.6         1.4 versicolor
93           5.8         2.6          4.0         1.2 versicolor
94           5.0         2.3          3.3         1.0 versicolor
95           5.6         2.7          4.2         1.3 versicolor
96           5.7         3.0          4.2         1.2 versicolor
97           5.7         2.9          4.2         1.3 versicolor
98           6.2         2.9          4.3         1.3 versicolor
99           5.1         2.5          3.0         1.1 versicolor
100          5.7         2.8          4.1         1.3 versicolor
101          6.3         3.3          6.0         2.5  virginica
102          5.8         2.7          5.1         1.9  virginica
103          7.1         3.0          5.9         2.1  virginica
104          6.3         2.9          5.6         1.8  virginica
105          6.5         3.0          5.8         2.2  virginica
106          7.6         3.0          6.6         2.1  virginica
107          4.9         2.5          4.5         1.7  virginica
108          7.3         2.9          6.3         1.8  virginica
109          6.7         2.5          5.8         1.8  virginica
110          7.2         3.6          6.1         2.5  virginica
111          6.5         3.2          5.1         2.0  virginica
112          6.4         2.7          5.3         1.9  virginica
113          6.8         3.0          5.5         2.1  virginica
114          5.7         2.5          5.0         2.0  virginica
115          5.8         2.8          5.1         2.4  virginica
116          6.4         3.2          5.3         2.3  virginica
117          6.5         3.0          5.5         1.8  virginica
118          7.7         3.8          6.7         2.2  virginica
119          7.7         2.6          6.9         2.3  virginica
120          6.0         2.2          5.0         1.5  virginica
121          6.9         3.2          5.7         2.3  virginica
122          5.6         2.8          4.9         2.0  virginica
123          7.7         2.8          6.7         2.0  virginica
124          6.3         2.7          4.9         1.8  virginica
125          6.7         3.3          5.7         2.1  virginica
126          7.2         3.2          6.0         1.8  virginica
127          6.2         2.8          4.8         1.8  virginica
128          6.1         3.0          4.9         1.8  virginica
129          6.4         2.8          5.6         2.1  virginica
130          7.2         3.0          5.8         1.6  virginica
131          7.4         2.8          6.1         1.9  virginica
132          7.9         3.8          6.4         2.0  virginica
133          6.4         2.8          5.6         2.2  virginica
134          6.3         2.8          5.1         1.5  virginica
135          6.1         2.6          5.6         1.4  virginica
136          7.7         3.0          6.1         2.3  virginica
137          6.3         3.4          5.6         2.4  virginica
138          6.4         3.1          5.5         1.8  virginica
139          6.0         3.0          4.8         1.8  virginica
140          6.9         3.1          5.4         2.1  virginica
141          6.7         3.1          5.6         2.4  virginica
142          6.9         3.1          5.1         2.3  virginica
143          5.8         2.7          5.1         1.9  virginica
144          6.8         3.2          5.9         2.3  virginica
145          6.7         3.3          5.7         2.5  virginica
146          6.7         3.0          5.2         2.3  virginica
147          6.3         2.5          5.0         1.9  virginica
148          6.5         3.0          5.2         2.0  virginica
149          6.2         3.4          5.4         2.3  virginica
150          5.9         3.0          5.1         1.8  virginica
```

數據所在位置與數據的內容

- iris[i, j] # 某一個位置的數據
  - iris[1, 1]
  - iris[1, 2]
  - iris[1, 3]
  - iris[1, 4]
  - iris[1, 5]
  - iris[2, 1]
  - iris[2, 2]
  - iris[1,]
  - iris[2,]
  - iris[3,]
  - iris[, 1]
  - iris[, 2]
  - iris[, 3]

數據所在位置與數據的內容

- iris[, j] # 某一個直行的數據
  - iris[, 1]
  - iris[, 2]
  - iris[, 3]
  - iris[, 4]
  - iris[, 5]
  - iris$Sepal.Length
  - iris$Sepal.Width
  - iris$Petal.Length
  - iris$Petal.Width
  - iris$Species

重新指定一個數據

- mydata <- iris
- mydata

- mydata[i, j]
  - mydata[1, 1]
  - mydata[3,]

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初步分析數據

初步分析數據

- mydata <- iris
- mydata
- str(mydata) # Display the Structure

```
> str( mydata )
'data.frame':   150 obs. of  5 variables:
 $ Sepal.Length: num  5.1 4.9 4.7 4.6 5 5.4 4.6 5 4.4 4.9 ...
 $ Sepal.Width : num  3.5 3 3.2 3.1 3.6 3.9 3.4 3.4 2.9 3.1 ...
 $ Petal.Length: num  1.4 1.4 1.3 1.5 1.4 1.7 1.4 1.5 1.4 1.5 ...
 $ Petal.Width : num  0.2 0.2 0.2 0.2 0.2 0.4 0.3 0.2 0.2 0.1 ...
 $ Species     : Factor w/ 3 levels "setosa","versicolor",..: 1 1 1 1 1 1 1 1 1 1 ...
```

- summary(mydata) # Object Summaries

```
> summary( mydata )
  Sepal.Length    Sepal.Width     Petal.Length    Petal.Width          Species
 Min.   :4.300   Min.   :2.000   Min.   :1.000   Min.   :0.100   setosa     :50
 1st Qu.:5.100   1st Qu.:2.800   1st Qu.:1.600   1st Qu.:0.300   versicolor:50
 Median :5.800   Median :3.000   Median :4.350   Median :1.300   virginica :50
 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
```


初步分析數據

- mydata <- iris
- mydata
- head(mydata, n = 5) # the first part of an object

```
> head( mydata, n = 5 )
  Sepal.Length Sepal.Width Petal.Length Petal.Width Species
1          5.1         3.5          1.4         0.2  setosa
2          4.9         3.0          1.4         0.2  setosa
3          4.7         3.2          1.3         0.2  setosa
4          4.6         3.1          1.5         0.2  setosa
5          5.0         3.6          1.4         0.2  setosa
```

- tail(mydata, n = 5) # the last part of an object

```
> tail( mydata, n = 5 )
    Sepal.Length Sepal.Width Petal.Length Petal.Width   Species
146          6.7         3.0          5.2         2.3 virginica
147          6.3         2.5          5.0         1.9 virginica
148          6.5         3.0          5.2         2.0 virginica
149          6.2         3.4          5.4         2.3 virginica
150          5.9         3.0          5.1         1.8 virginica
```

初步分析數據

- mydata <- iris
- mydata

- mydata[, 1] # the n-th column of an object
- mydata[, 2]
- mydata[, 3]
- mydata[, 4]
- mydata[, 5]

- mydata$Sepal.Length # the data with the NAME
- mydata$Sepal.Width
- mydata$Petal.Length
- mydata$Petal.Width
- mydata$Species

初步分析數據

- mydata <- iris
- mydata

- mydata$Species == "setosa“ # find the data with the NAME
- mydata$Species == "versicolor"
- mydata$Species == "virginica"

- mydata[mydata$Species == "setosa" ,]
- mydata[mydata$Species == "versicolor" ,]
- mydata[mydata$Species == "virginica" ,]

- mydata[mydata$Species == "setosa", 1]
- mydata[mydata$Species == "versicolor", 1]
- mydata[mydata$Species == "virginica", 1]

初步分析數據

- mydata <- iris
- mydata

- mydata[mydata$Species == "setosa", 1:2]
- mydata[mydata$Species == "setosa", 1:3]
- mydata[mydata$Species == "setosa", 2:4]

find the subset of the data with the property

- subset(mydata, Species == "setosa", select = Sepal.Length)

- subset(mydata, Species == "setosa", select = c(Sepal.Length, Sepal.Width))

初步分析數據

- data1 <- iris[, 1]
- data1

- max(data1) # max, min, range, mean, median, sd
- min(data1)
- c(max(data1), min(data1))
- MinMax <- c(min(data1), max(data1))
- range(data1)
- mean(data1)
- sd(data1)
- median(data1)

- mystat <- c(min(data1), median(data1), mean(data1), max(data1), sd(data1))
- summary(data1)

初步分析數據

- data1 <- iris[, 1]
- data1

- mysort <- sort(data1) # sort the data

- mysort[150*0.5] # the 50% data
- mysort[150*0.25] # the 50% data
- mysort[150*0.75] # the 75% data

- mystat <- c(min(data1), mysort[150*0.25], median(data1), mean(data1), mysort[150*0.75], max(data1), sd(data1))

- summary(data1)

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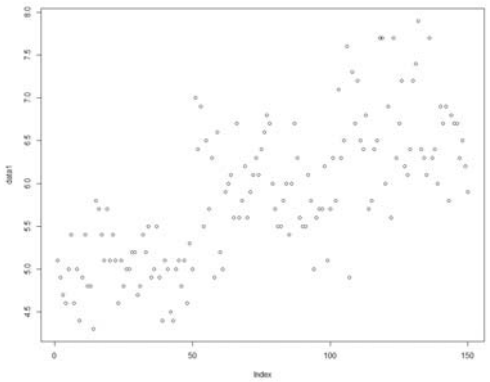
繪製圖形

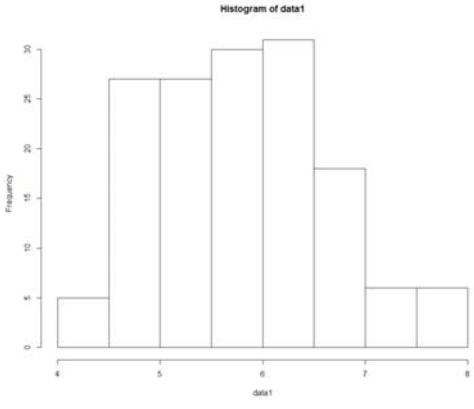
繪製圖形

- plot(data)
  - # 個別繪製圖形
  - data1 <- iris[, 1]
  - plot(data1)
  - data2 <- iris[, 2]
  - plot(data2)
  - data3 <- iris[, 3]
  - plot(data3)
  - data4 <- iris[, 4]
  - plot(data4)
  - data5 <- iris[, 5]
  - plot(data5)



繪製圖形 – histogram 直方圖

- hist(data)
  - # 個別繪製圖形
  - hist(data1)
  - hist(data2)
  - hist(data3)
  - hist(data4)
  - hist(data5)



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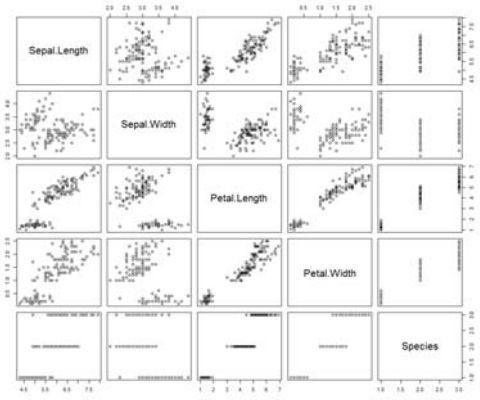
基本數據圖示法

繪圖 – boxplot 盒鬚圖

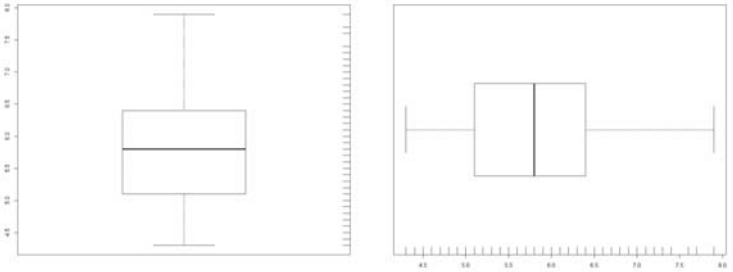
- mydata <- iris



- plot(mydata)
- plot(mydata[, 1:4])

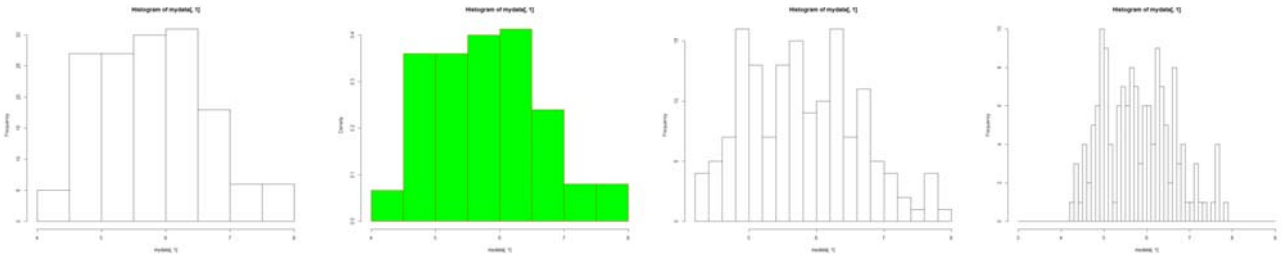
- boxplot(mydata[, 1])
- rug(mydata[, 1], side = 4)

- boxplot(mydata[, 1], horizontal = TRUE)
- rug(mydata[, 1], side = 1)



繪圖 – histogram 直方圖

- hist(mydata[, 1])
- hist(mydata[, 1], freq = TRUE)
- hist(mydata[, 1], freq = TRUE, breaks = "Sturges")
- hist(mydata[, 1], prob = TRUE, breaks = "Sturges", col = "green", border = "red")
- hist(mydata[, 1], freq = TRUE, breaks = 20)
- hist(mydata[, 1], freq = TRUE, breaks = seq(from=3, to=9, by=0.1))



繪圖 – stem-leaf 莖葉圖

- stem(mydata[, 1], scale = 1.0)
- stem(mydata[, 1], scale = 0.5)
- sum(mydata[, 1] == 4.4)
- sum(mydata[, 1] == 4.6)

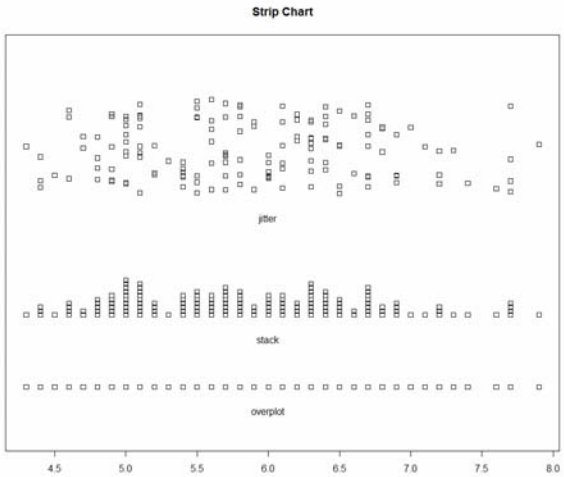
```
> stem( mydata[ , 1 ], scale = 1.0 )

  The decimal point is 1 digit(s) to the left of the |

  42 | 0
  44 | 0000
  46 | 000000
  48 | 00000000000
  50 | 00000000000000000000
  52 | 00000
  54 | 0000000000000
  56 | 000000000000000
  58 | 0000000000
  60 | 000000000000
  62 | 0000000000000
  64 | 000000000000
  66 | 0000000000
  68 | 0000000
  70 | 00
  72 | 0000
  74 | 0
  76 | 00000
  78 | 0
```

繪圖 – strip chart 長條記錄圖

- stripchart(mydata[, 1], method = "overplot", at = 0.7)
- stripchart(mydata[, 1], method = "stack", add = TRUE, at = 0.85)
- stripchart(mydata[, 1], method = "jitter", add = TRUE, at = 1.2)

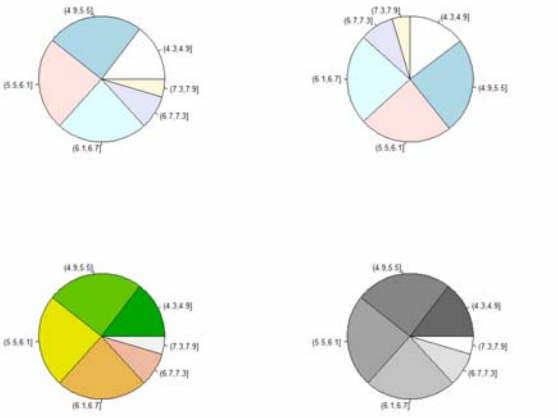
- text(6, 0.65, "overplot")
- text(6, 0.8, "stack")
- text(6, 1.05, "jitter")

- title(main = "Strip Chart")



繪圖 – pie chart 圓餅圖

- x <- cut(mydata[, 1], breaks = 6)
- y <- table(x)
-
- pie(y)

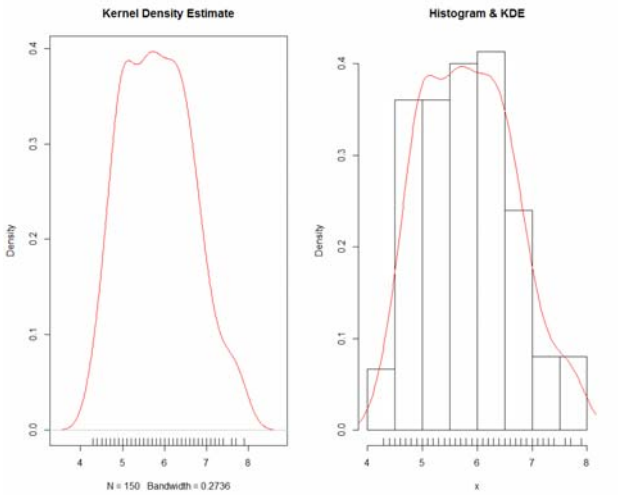


- par(mfrow = c(2,2))

- pie(y)
- pie(y, clockwise = TRUE)
- pie(y, col = terrain.colors(6))
- pie(y, col = gray(seq(from = 0.4, to = 1.0, length = 6)))

繪圖 – density 機率分布圖

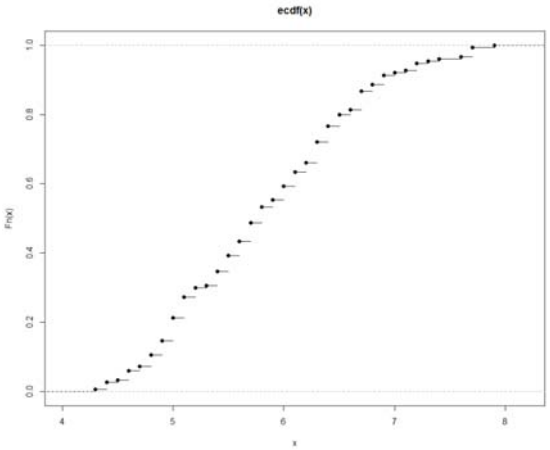
- x <- mydata[, 1]
- par(mfrow = c(1,2))



- plot(density(x), col = "red", main = "Kernel Density Estimate")
- rug(x, side = 1)
- hist(x, prob = TRUE, breaks = "Sturges", main = "Histogram & KDE")
- lines(density(x), col = "red")
- rug(x, side = 1)

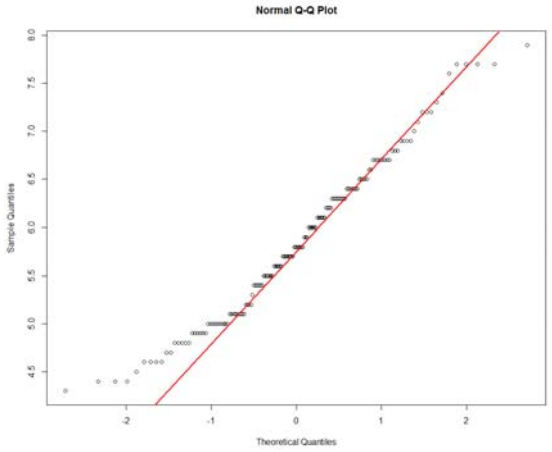
繪圖 – ECDF 經驗累積分布圖

- x <- mydata[, 1]
- plot.ecdf(x)



繪圖 – normal QQ 常態機率圖

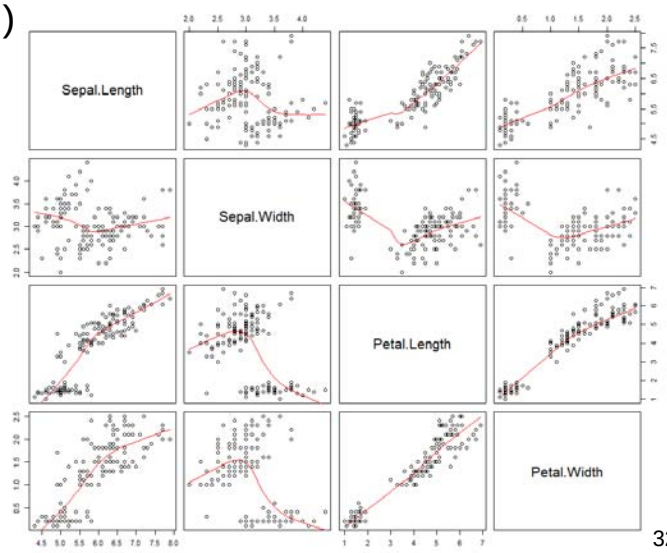
- x <- mydata[, 1]
- qqnorm(x)
- qqline(x, col = "red", lwd = 2)



多維數據繪圖 – 散點圖

scatterplot

- iris
- x <- iris[, 1:4]
- plot(x)
- pairs(x)
- pairs(x, panel = panel.smooth)



大綱

作業

HW02：數據處理與繪圖功能

On 3/7, 2017

- 請參考 U03 講義，以及 R code 檔案
- 請從下面資料中，自行挑選一組數據：iris, cars, women, or CO2
- 然後，請用三個以上的指令計算分析一下這組數據，
- 以及挑選三個繪製指令繪製三個圖，
- 請把從頭到尾的執行過程，編輯於 .R 檔之中，並且依序執行這些指令
- 把執行的過程，或者是產生的數據/圖形等，整理到報告檔 (pdf or pptx)
- 報告檔中，請編輯：
  - 描述進行的計算或繪圖工作名稱，
  - 所使用的的指令，
  - 產生的結果，數據 and/or 圖形
  - 解釋說明該指令的功能，產生的結果，該結果的意義，特點等

HW02：數據處理與繪圖功能

- 繳交下面檔案，檔案名稱：HW02_學號_關鍵字.xxx
  - R 程式檔案：　HW02_B01921001_ComputePlot.R
  - 報告檔案：　HW02_B01921001_ComputePlot.pdf 或者 .pptx

- 繳交方式與期限：
  - E-mail 上面兩個檔案到：ntucp105s@gmail.com
  - E-mail 主旨：HW02_B01921001_ComputePlot
    (就是，作業編號_您的學號_關鍵字)
  - 繳交期限：3/12 (Sun), 2017, 11pm 以前

- 學習方式：請註明此次的學習方式所花的時間，例如：

作業編號	現場上課	同步觀看	事後觀看	閱讀講義	編纂程式	整理作業	
HW02	40	60	40	25	40	20	(分鐘)