R

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Outline

1. Overview
2. Quick Get Started
3. Data Visualization

Next

1. Overview
   - Data Analysis
   - Data Aanlysis and R
2. Quick Get Started
3. Data Visualization

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   - Input and Output
     - Standard Input and Output

Data Analysis

Wikipedia

Analysis of data is a process of inspecting, cleaning, transforming, and modeling data with the goal of discovering useful information, suggesting conclusions, and supporting decision making.

Data Analysis

Collecting → cleaning → transforming → modeling → visualizing

Biological Data Analysis

NGS and Complex Diseases

Sequencing → QC → Alignment and Variant Calling→ GWAS, EWAS ...→ Manhattan Plot, Q-Q plot ...

Biological Data Analysis

NGS and Complex Diseases

Sequencing → QC → Alignment and Variant Calling→ GWAS, EWAS ...→ Manhattan Plot, Q-Q plot ...
→ paper

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What is R?

R

R is a free software environment for statistical computing and graphics.
----R-project.org

History

- April 1st, 1997, R0.16，奥克兰大学的Ihaka和Gentleman发布了第一版本的R
- 1997年4月23日，0.49，CRAN网站发布，提供12个R的扩展包
- 1997年12月5日，0.60，R成文GNU项目的一部分
- 2000年2月29日，1.0，第一个可用于生产环境的版本发布
- 2010年4月22日，2.11，支持64位Windows操作系统
- 2011年10月31日，2.14，提供全新的并行计算包
- 2013年4月，3.0.0
- Now, 3.1.2

R语言在中国

- 2004年，国内专业人员开始翻译R语言官方文档
- 2006年，国内开始出版R语言书籍
- 2008年，在北京中国人民大学召开第一届中国R语言会议
- 2009年-2012年，每年分别在北京和上海举办中国R语言会议，迄今已举办五届
- 2012年，国人开发的Knitr包几乎成为R语言文档自动化的新标准，同时大量R语言畅销书籍被引进到国内翻译出版。
- 2013年，《R语言实战》、《ggplot2》、《R in a nutshell》 ...

R语言的现状

- 使用领域囊括统计分析、数据挖掘、生命科学、商业智能、数据可视化、社交网络分析、电子商务、集成电路、金融、烟草、传媒、咨询等
- 赞助R语言开发工作的机构包括AT&T、默沙东、Google、新西兰电信，以及诸多大学及科研机构。
- 在商业产品中提供R语言支持的企业包括SAP、甲骨文、Teredata、IBM、Revolution、Matlab、SAS、SPSS等。
- 2012第五届中国R语言会议（上海会场）获得大量赞助，吸引了400多人注册，到会人员几乎涉及R所有应用领域的国内知名企业。
- 2013年第六届中国R语言会议（北京，5月；上海，1112月）。

Pros and Cons

The best thing about R is that it was developed by statisticians. The worst thing about R is that...it was developed by statisticians.
--- Bo Cowgill

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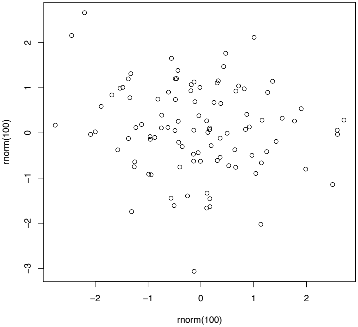
Hello R!

```
print("Hello R!")

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

Hello Plot

```
plot(rnorm(100),rnorm(100))
```



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Download and Installation

Download

CRAN

Installation

- R: Linux, Mac OS, Windows
- Rtools: Windows
- packages: CRAN, devtools, github, local file

Editors and IDEs

Editors

- R terminal
- Rgui
- VIM + Vim-R-plugin
- Emacs + ESS
- Notepad++ + NppToR
- ...

R Terminal and Rgui

R

- Ctrl + R: run
- Tab: auto complete
- arrow up and down: history

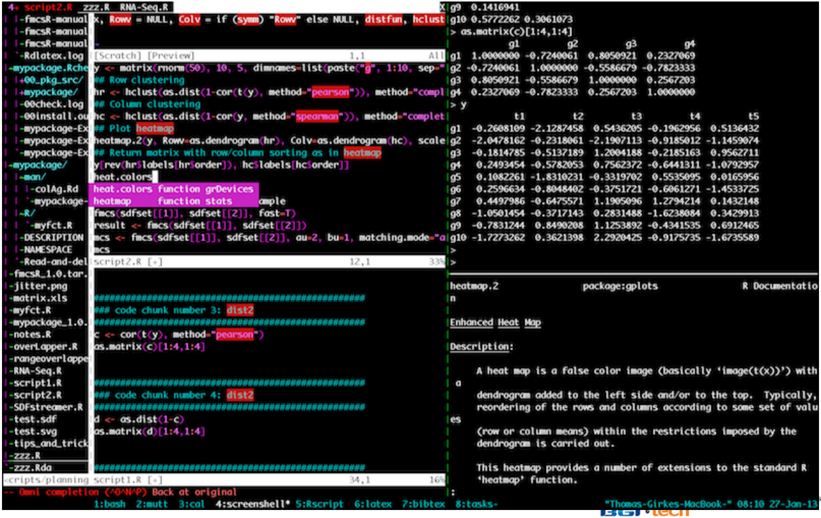
R and Texteditor

- copy and paste
- `source("source.R")`

source

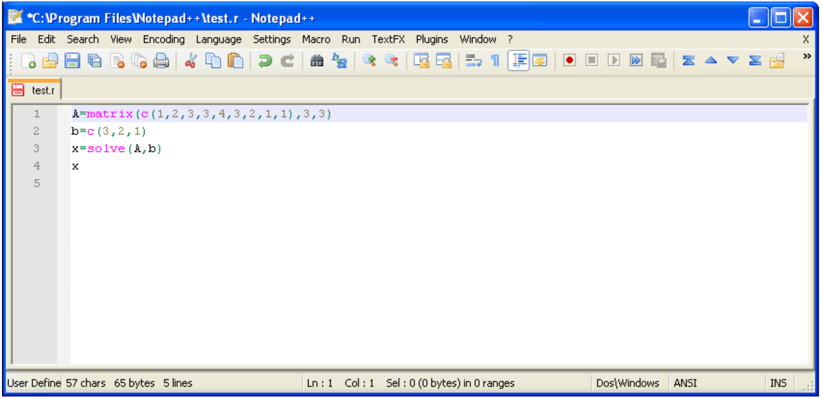
```r
sourceDir <- function(path, trace = TRUE, ...) {
       for (nm in list.files(path, pattern = "[.][RrSsQq]$")) {
          if(trace) cat(nm,":")
          source(file.path(path, nm), ...)
          if(trace) cat("\n")
       }
    }
```

VIM + Vim-R-plugin



```
4+ script2.R  zzz.R  RNA-Seq.R                                                        X|g9  0.1416941
| |-fmcsR-manual|x, Rowv = NULL, Colv = if (symm) "Rowv" else NULL, distfun, hclust|g10 0.5772262 0.3061073
| |-fmcsR-manual|                                                                  |> as.matrix(c)[1:4,1:4]
| |-fmcsR-manual|~                                                                 |           g1         g2         g3         g4
| `-Rdlatex.log |[Scratch] [Preview]                                  1,1       All|g1  1.0000000 -0.7240061  0.8050921  0.2327069
|~mypackage.Rche|y <- matrix(rnorm(50), 10, 5, dimnames=list(paste("g", 1:10, sep="|g2 -0.7240061  1.0000000 -0.5586679 -0.7823333
| |+00_pkg_src/ |## Row clustering                                                 |g3  0.8050921 -0.5586679  1.0000000  0.2567203
| |+mypackage/  |hr <- hclust(as.dist(1-cor(t(y), method="pearson")), method="compl|g4  0.2327069 -0.7823333  0.2567203  1.0000000
| |-00check.log |## Column clustering                                              |> y
| |-00install.ou|hc <- hclust(as.dist(1-cor(y, method="spearman")), method="complet|           t1         t2         t3         t4         t5
| |-mypackage-Ex|## Plot heatmap                                                   |g1  -0.2608109 -2.1287458  0.5436205 -0.1962956  0.5136432
| |-mypackage-Ex|heatmap.2(y, Rowv=as.dendrogram(hr), Colv=as.dendrogram(hc), scale|g2  -2.0478162 -0.2318061 -2.1907113 -0.9185012 -1.1459074
| `-mypackage-Ex|## Return matrix with row/column sorting as in heatmap            |g3  -0.1814785 -0.5137189  1.2004188 -0.2185163  0.9562711
|~mypackage/    |y[rev(hr$labels[hr$order]), hc$labels[hc$order]]                  |g4   0.2493454 -0.5782053  0.7562372 -0.6441311 -1.0792957
| |~man/        |heat.colors                                                       |g5   0.1082261 -1.8310231 -0.3319702  0.5535095  0.0165956
| | |-colAg.Rd  |heat.colors function grDevices                                    |g6   0.2596634 -0.8048402 -0.3751721 -0.6061271 -1.4533725
| | `-mypackage-|heatmap     function stats    ample                               |g7   0.4497986 -0.6475571  1.1905096  1.2794214  0.1432148
| |~R/          |fmcs(sdfset[[1]], sdfset[[2]], fast=T)                            |g8  -1.0501454 -0.3717143  0.2831488 -1.6238084  0.3429913
| | `-myfct.R   |result <- fmcs(sdfset[[1]], sdfset[[2]])                          |g9  -0.7831244  0.8490208  1.1253892 -0.4341535  0.6912465
| |-DESCRIPTION |mcs <- fmcs(sdfset[[1]], sdfset[[2]], au=2, bu=1, matching.mode="a|g10 -1.7273262  0.3621398  2.2920425 -0.9175735 -1.6735589
| |-NAMESPACE   |mcs                                                               |>
| `-Read-and-del|script2.R [+]                                       12,1       33%|>
|-fmcsR_1.0.tar.|                                                                  |
|-jitter.png    |                                                                  |heatmap.2               package:gplots               R Documentatio
|-matrix.xls    |#############################################                     |n
|-myfct.R       |### code chunk number 3: dist2                                    |
|-mypackage_1.0.|#############################################                     |Enhanced Heat Map
|-notes.R       |c <- cor(t(y), method="pearson")                                  |
|-overLapper.R  |as.matrix(c)[1:4,1:4]                                             |Description:
|-rangeoverlappe|                                                                  |
|-RNA-Seq.R     |                                                                  |     A heat map is a false color image (basically 'image(t(x))') with
|-script1.R     |#############################################                     | a
|-script2.R     |### code chunk number 4: dist2                                    |     dendrogram added to the left side and/or to the top.  Typically,
|-SDFstreamer.R |#############################################                     |     reordering of the rows and columns according to some set of valu
|-test.sdf      |d <- as.dist(1-c)                                                 |es
|-test.svg      |as.matrix(d)[1:4,1:4]                                             |     (row or column means) within the restrictions imposed by the
|-tips_and_trick|                                                                  |     dendrogram is carried out.
|-zzz.R         |                                                                  |
`-zzz.Rda       |#############################################                     |     This heatmap provides a number of extensions to the standard R
<cripts/planning script1.R [+]                                       34,1       16%|     'heatmap' function.
-- Omni completion (^O^N^P) Back at original                                       |:
               1:bash  2:mutt  3:cal  4:screenshell* 5:Rscript  6:latex  7:bibtex  8:tasks-          "Thomas-Girkes-MacBook-" 08:10 27-Jan-13
```

Notepad++ + NppToR



*C:\Program Files\Notepad++\test.r - Notepad++
File Edit Search View Encoding Language Settings Macro Run TextFX Plugins Window ?
test.r

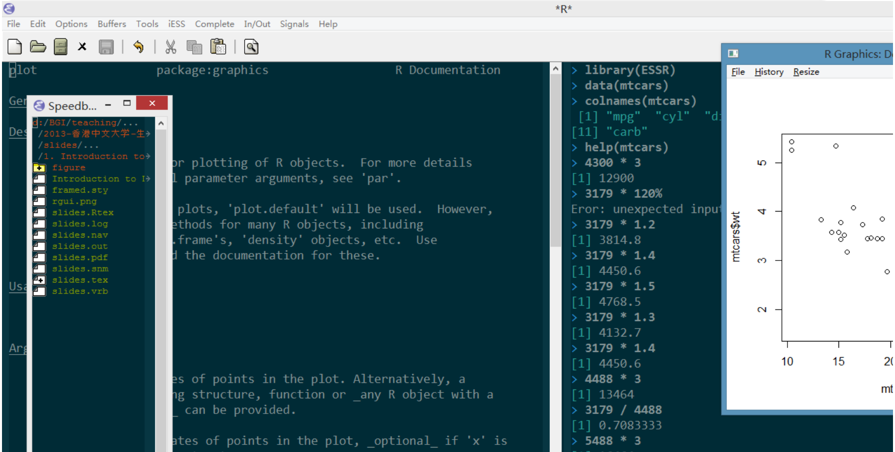
```
A=matrix(c(1,2,3,3,4,3,2,1,1),3,3)
b=c(3,2,1)
x=solve(A,b)
x
```

User Define 57 chars 65 bytes 5 lines Ln : 1 Col : 1 Sel : 0 (0 bytes) in 0 ranges Dos\Windows ANSI INS

Emacs + ESS

What is ESS?

ESS: Emacs Speak Statistics


R
File Edit Options Buffers Tools iESS Complete In/Out Signals Help
Speedb...
R Graphics: D
File History Resize
mtcars$wt
2
3
4
5
10
15
20
mt

```
plot                    package:graphics                    R Documentation

Ger
Des
                     or plotting of R objects.  For more details
                     l parameter arguments, see 'par'.

                     plots, 'plot.default' will be used.  However,
                     ethods for many R objects, including
                     .frame's, 'density' objects, etc.  Use
                     d the documentation for these.

Usa

Arg

                     es of points in the plot. Alternatively, a
                     ng structure, function or _any R object with a
                     _ can be provided.

                     ates of points in the plot, _optional_ if 'x' is
```

```
d:/BGI/teaching/...
 /2013-香港中文大学-生>
 /slides/...
 /1. Introduction to>
 figure
 Introduction to I>
 framed.sty
 rgui.png
 slides.Rtex
 slides.log
 slides.nav
 slides.out
 slides.pdf
 slides.snm
 slides.tex
 slides.vrb
```

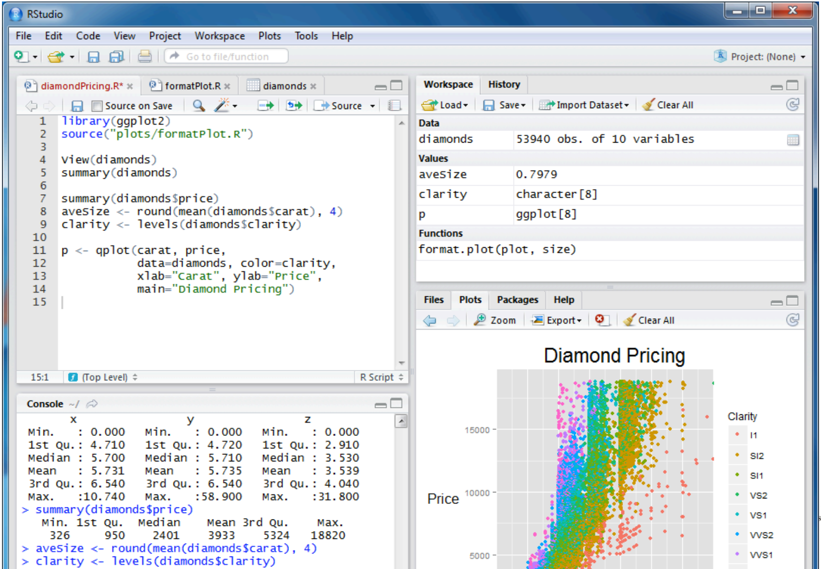
```
> library(ESSR)
> data(mtcars)
> colnames(mtcars)
 [1] "mpg"  "cyl"  "d
[11] "carb"
> help(mtcars)
> 4300 * 3
[1] 12900
> 3179 * 120%
Eror: unexpected input
> 3179 * 1.2
[1] 3814.8
> 3179 * 1.4
[1] 4450.6
> 3179 * 1.5
[1] 4768.5
> 3179 * 1.3
[1] 4132.7
> 3179 * 1.4
[1] 4450.6
> 4488 * 3
[1] 13464
> 3179 / 4488
[1] 0.7083333
> 5488 * 3
```

IDEs

IDEs

- RStudio: local and cloud-based
- TinnR
- StatET: eclipse for R
- ...

RStudio


RStudio
File Edit Code View Project Workspace Plots Tools Help
Go to file/function
Project: (None)
diamondPricing.R* formatPlot.R diamonds
Source on Save
Source
15:1 (Top Level) R Script
Workspace History
Load Save Import Dataset Clear All
Files Plots Packages Help
Zoom Export Clear All
Console ~/
Diamond Pricing
Price
15000
10000
5000
Clarity
I1
SI2
SI1
VS2
VS1
VVS2
VVS1

```r
library(ggplot2)
source("plots/formatPlot.R")

View(diamonds)
summary(diamonds)

summary(diamonds$price)
aveSize <- round(mean(diamonds$carat), 4)
clarity <- levels(diamonds$clarity)

p <- qplot(carat, price,
           data=diamonds, color=clarity,
           xlab="Carat", ylab="Price",
           main="Diamond Pricing")
```

```
Data
diamonds        53940 obs. of 10 variables
Values
aveSize         0.7979
clarity         character[8]
p               ggplot[8]
Functions
format.plot(plot, size)
```

```
        x                 y                 z
 Min.   : 0.000   Min.   : 0.000   Min.   : 0.000
 1st Qu.: 4.710   1st Qu.: 4.720   1st Qu.: 2.910
 Median : 5.700   Median : 5.710   Median : 3.530
 Mean   : 5.731   Mean   : 5.735   Mean   : 3.539
 3rd Qu.: 6.540   3rd Qu.: 6.540   3rd Qu.: 4.040
 Max.   :10.740   Max.   :58.900   Max.   :31.800
> summary(diamonds$price)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
    326     950    2401    3933    5324   18820
> aveSize <- round(mean(diamonds$carat), 4)
> clarity <- levels(diamonds$clarity)
```

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Books

- R in action (also in Chinese)
- Introduction to R (also in Chinese)
- R for beginner (also in Chinese)
- R in a Nutshell (also in Chinese)
- The art of R programming (also in Chinese)
- ggplot2. Elegant Graphics for Data Analysis (also in Chinese)

Websites

- R-project and CRAN
- COS.name (Chinese)
- Quick-R
- http://had.co.nz/, Hadley Wickham
- Twitter, github, RForge
- Google

Websites

- R-project and CRAN
- COS.name (Chinese)
- Quick-R
- http://had.co.nz/, Hadley Wickham
- Twitter, github, RForge
- Google Baidu?

Journals

- The R Journal
- Journal of Statistical Software

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Class, Type and Dimension

Class, Type and Dimension

Everything in R is a object, every object has class, type and dimension.

```
class(obj)
typeof(obj)
dim(obj)
```

Data Types

```
## Error in library(GenomicRanges): there is no
package called 'GenomicRanges'
```

```
obj <- 1
class(obj)
```

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

```
obj <- "Gang Chen"
class(obj)
```

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

```
obj <- 1:3
class(obj)
```

```
## [1] "integer"
```

```
ranges <- GRanges(seqnames = c("chr1", "chr2"),
ranges = IRanges(start = c(1013, 4351),
end = c(2314, NA), width = c(NA, 1)),
strand = c("+", "-"))
```

```
class(list(a = 1, b = 2))
```

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

```
class(matrix(1:16, ncol=4))
```

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

```
class(array(1:64, c(4,4,4)))
```

```
## [1] "array"
```

```
obj <- as.data.frame(obj)
class(obj)
```

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

```
obj <- as.factor(c("male", "female"))
```

Types

```
 obj <- 1
 class(obj)
## [1] "numeric"
 obj <- 1:3
 class(obj)
## [1] "integer"
 obj <- 1+2i
 class(obj)
## [1] "complex"
```

Operations

Operators

- `+, -, *, /, ==, =, <-`
- `^`
- `exp(), log(), log10(), log2()`
- `sqrt(), abs(), sin(), cos()`
- `round(), floor(), ceriling()`
- `factorial()`

Character

A character object is used to represent string values in R.

```
fname <- "Gang"
lname <- "Chen"
class(fname)

## [1] "character"
```

```
myPI <- 3.14
class(myPI)

## [1] "numeric"

myPI <- as.character(myPI)
class(myPI)

## [1] "character"
```

Character Operators

```
paste(fname, lname)

## [1] "Gang Chen"

substr("I am learning R", start=6, stop=13)

## [1] "learning"

sub("I am", "We are", "I am learning R")

## [1] "We are learning R"
```

Regular Expression

Regular Expressions == Problem

Some people,
when confronted with a problem,
think "I know, I'll use regular expressions."
Now they have two problems.

Regular Expression in R

Regular Expression Functions

```
help(regex)
grep(), grepl(), regexpr(), gregexpr(), sub(), gsub()
```

Example

```
grep("a.", c("Gang","Chen","aab", "Ag","ga"))
```

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

Logical

```
u = TRUE; v = FALSE
u & v # u AND v

## [1] FALSE

u | v # u OR v

## [1] TRUE

!u # negation of u

## [1] FALSE
```

?

```
4.3 - 0.7

## [1] 3.6

4.3 - 0.7 == 3.6

## [1] FALSE

0.7 + 3.6 == 4.3

## [1] TRUE
```

```
4.2 / 6

## [1] 0.7

0.7 * 6

## [1] 4.2

4.2 / 6 == 0.7

## [1] FALSE
```

Vector

A vector is a sequence of data elements of the same basic type.

```r
a = c(1,2,3)
b = c(T, F, F, T)
chars = c("Gang", "Chen", "AA", "Aa","aB")
```

Arithmetic operations of vectors are performed memberwise.

All operators are applied to vectors

```
 a^2

## [1] 1 4 9

 !b

## [1] FALSE  TRUE  TRUE FALSE

 grep("a.",chars)

## [1] 1 5
```

Vector Arithmetic

```
 a = c(1,2,3,4,5)
 b = c(5,4,3,2,1)
 c(a, b)

##  [1] 1 2 3 4 5 5 4 3 2 1

 a + b

## [1] 6 6 6 6 6

 a * b

## [1] 5 8 9 8 5
```

Recycling Rule:

```
 d = c(1,2)
 a + d

## Warning in a + d:


## [1] 2 4 4 6 6
```

Vector Index

```
 a = c("one", "two", "three", "four", "five")
 a[3]

## [1] "three"

 a[2:4]

## [1] "two"   "three" "four"

 a[-3]

## [1] "one"  "two"  "four" "five"

 a[8]

## [1] NA
```

Matrix Construction

```
mat = matrix(1:24, ncol=6, nrow=4, byrow=T)
mat

##      [,1] [,2] [,3] [,4] [,5] [,6]
## [1,]    1    2    3    4    5    6
## [2,]    7    8    9   10   11   12
## [3,]   13   14   15   16   17   18
## [4,]   19   20   21   22   23   24
```

Matrix Index

```
mat[3,3]
```

```
## [1] 15
```

```
mat[2,]
```

```
## [1]  7  8  9 10 11 12
```

```
mat[,4]
```

```
## [1]  4 10 16 22
```

```
mat[2:3, 3:4]
```

```
##      [,1] [,2]
## [1,]    9   10
## [2,]   15   16
```

```
dim(mat)
```

```
## [1] 4 6
```

```
ncol(mat)
```

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

```
nrow(mat)
```

Matrix Arithmetic

```
A
```

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

```
A * B
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    1   25   81  169
## [2,]    4   36  100  196
## [3,]    9   49  121  225
## [4,]   16   64  144  256
```

```
B
```

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

```
A %*% B
```

```
##      [,1] [,2] [,3] [,4]
## [1,]   90  202  314  426
## [2,]  100  228  356  484
## [3,]  110  254  398  542
## [4,]  120  280  440  600
```

List

A list is a generic vector containing other objects.

```
n = c(2, 3, 5)
s = c("aa", "bb", "cc", "dd", "
b = c(TRUE, FALSE, TRUE, FALSE,
x = list(n, s, b, 3)
```

```
x

## [[1]]
## [1] 2 3 5
##
## [[2]]
## [1] "aa" "bb" "cc" "dd" "ee"
##
## [[3]]
## [1]  TRUE FALSE  TRUE FALSE FA
##
## [[4]]
## [1] 3
```

List Slice

```
 x[1]

## [[1]]
## [1] 2 3 5

 x[c(2,4)]

## [[1]]
## [1] "aa" "bb" "cc" "dd" "ee"
##
## [[2]]
## [1] 3
```

List Member

```
x[[3]]

## [1]  TRUE FALSE  TRUE FALSE FALSE

x[3]

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

Data Frame

A data frame is used for storing data tables. It is a list of vectors of equal length.

```r
head(mtcars)
```

```
##                    mpg cyl disp  hp drat    wt  qsec vs am gear car
## Mazda RX4         21.0   6  160 110 3.90 2.620 16.46  0  1    4
## Mazda RX4 Wag     21.0   6  160 110 3.90 2.875 17.02  0  1    4
## Datsun 710        22.8   4  108  93 3.85 2.320 18.61  1  1    4
## Hornet 4 Drive    21.4   6  258 110 3.08 3.215 19.44  1  0    3
## Hornet Sportabout 18.7   8  360 175 3.15 3.440 17.02  0  0
## Valiant           18.1   6  225 105 2.76 3.460 20.22  1  0    3
```

Data Frame

```
 mtcars[1,2]

## [1] 6

 mtcars["Mazda RX4", "wt"]

## [1] 2.62

 ncol(mtcars)

## [1] 11

 nrow(mtcars)

## [1] 32
```

Factor

```
 gender <- c("male", "female")
 class(gender)

## [1] "character"

 gender <- as.factor(gender)
 class(gender)

## [1] "factor"
```

Factor

```
 group <- c(1, 2)
 group[1] < group[2]

## [1] TRUE

 class(group)

## [1] "numeric"

 group <- as.factor(group)
 group[1] < group[2]

## Warning in Ops.factor(group[1], group[2]): '<' not
meaningful for factors

## [1] NA
```

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If else

```
 if(something){
       # do something
 }else if(something){
       # do something
}else{
       # do something
}
```

ifelse

```
ifelse(test, yes, no)
```

```
a <- c(2,3,4,2,5,6,7,12)
ifelse(a%%2==0, a+1, 0)

## [1]  3  0  5  3  0  7  0 13
```

Loop

```
for (var in seq) expr
while(cond) expr
repeat
break
next
```

Loop

```r
for(i in a){
  if(i %% 2 == 0){
    print(i + 1)
  }else{
    print(0)
  }
}
```

```
## [1] 3
## [1] 0
## [1] 5
## [1] 3
## [1] 0
## [1] 7
## [1] 0
```

apply functions

```
apply()
lapply()
sapply()
tapply()
```

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Function

```
 add <- function(a, b){
   a+b
}
 add(1, 2)

## [1] 3

 sapply(1:8, add, 3)

## [1]  4  5  6  7  8  9 10 11
```

Anonymous Function

```
sapply(1:8, function(a, b){a+b}, 3)

## [1]  4  5  6  7  8  9 10 11
```

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S4 Classes and methods

History

- 1976, Rick Becker and John Chambers, S on Honeywell OS
- Ported to UNIX, S2
- Around 1986, functional programming and object self-description, S3
- 1992, concept of classes and methods, S4
- 2010, Reference Classes (RC), R 2.12

appendix in Software for Data Analysis by Chambers

S4 Classes and methods

OO Systems in R

- S3
- S4
- RC
- Base Types

Best Reference: http://adv-r.had.co.nz/OO-essentials.html

S3

S4 Classes and methods

S4 in R

```
library(stats4)
library(pryr)
y <- c(26, 17, 13, 12, 20, 5, 9, 8, 5, 4, 8)
nLL <- function(lambda) -sum(dpois(y, lambda, log = TRUE))
fit <- mle(nLL, start = list(lambda = 5), nobs = length(y))
isS4(fit)
```

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

```
otype(fit)
```

```
## [1] "S4"
```

```
isS4(nobs)
```

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

```
ftype(nobs)
```

S4 Classes and methods

Defining classes and creating objects

```r
setClass("Person",
 slots = list(name = "character", age = "numeric"))
setClass("Employee",
 slots = list(boss = "Person"),
 contains = "Person")

alice <- new("Person", name = "Alice", age = 40)
john <- new("Employee", name = "John", age = 20, boss = alice)
```

S4 Classes and methods

access slots of an S4 object

```
alice@age
slot(john, "boss")
```

S4 Classes and methods

Creating new methods and generics

```r
setGeneric("union")
setMethod("union",
 c(x = "data.frame", y = "data.frame"),
 function(x, y) {
   unique(rbind(x, y))
 }
)
setGeneric("myGeneric", function(x) {
 standardGeneric("myGeneric")
})
```

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Standard I/O

```
scan()
print()
cat()
```

File I/O

Input

```
read.table()
readLines()
readChar()
readBin()
scan()
```

Output

```
write.table()
write()
```

Database I/O

```
library(RMySQL) # for MySQL
library(RPostgreSQL) # for PostgreSQL
library(XLConnect) # for Excel
```

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1 Overview

2 Quick Get Started

3 Data Visualization

- Scatter Plot
- 时间序列
- 柱状图
- 饼图
- 分类数据绘图
- 绘制分布
- 箱线图

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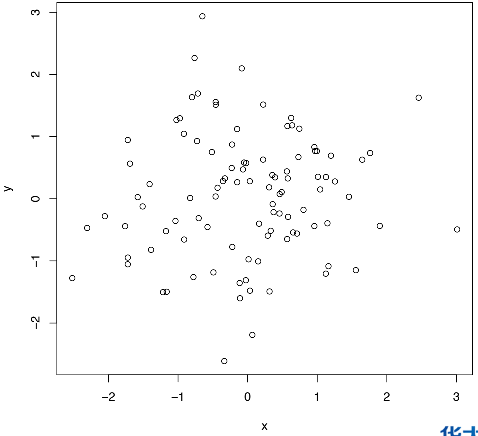
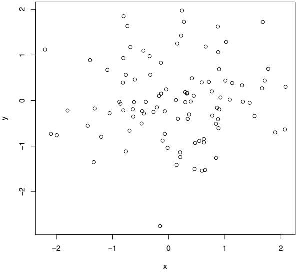
plot



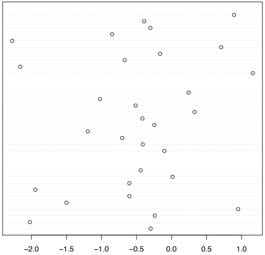
plot

```
x = rnorm(100)
y = rnorm(100)
plot(x, y)
```



dotchart

```
x = rnorm(30)
dotchart(x, groups = rep(1:3,10))
```



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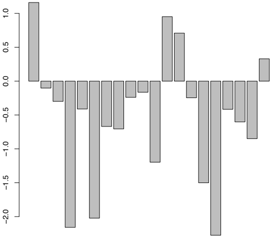
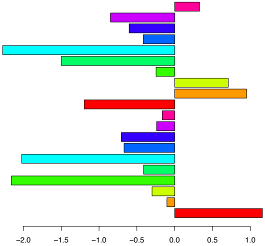
barplot

```
barplot(x[1:20])
```



barplot

```
barplot(x[1:20], width=2, horiz=T, col=rainbow(10))
```



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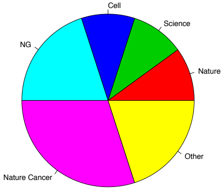
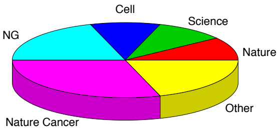
pie

```
pie(c(10,10,10,20,30,20), c("Nature","Science","Cell","NG",
Cancer","Other"),col=2:7)
```



pie

```
library(plotrix)
pie3D(c(10,10,10,20,30,20), labels=c("Nature","Science","Ce
Cancer","Other"),col=2:7)
```



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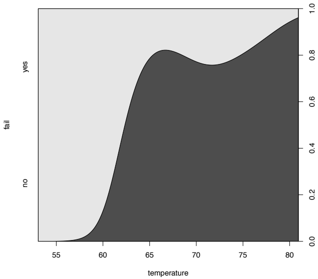
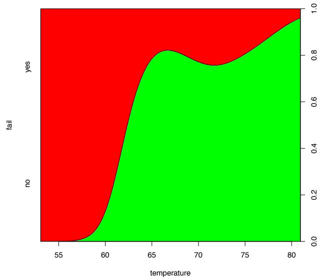
cdplot

```
cdplot(temperature, fail)
```



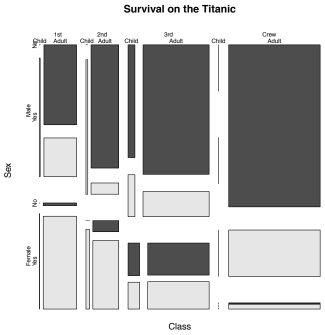
cdplot

```
cdplot(temperature, fail, col=c("green", "red"))
```



mosaicplot

```r
require(stats)
mosaicplot(Titanic, main = "Survival on the Titanic",
color = TRUE)
```



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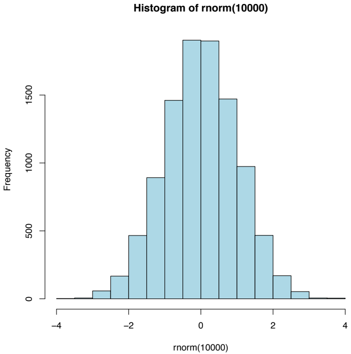
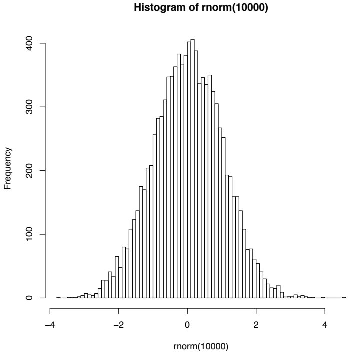
hist

```
hist(rnorm(10000), col="lightblue")
```



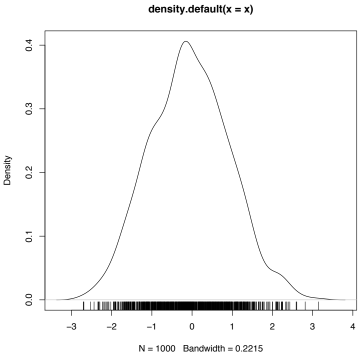
hist

```
hist(rnorm(10000), breaks=100)
```



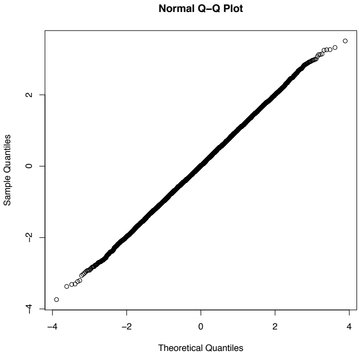
density + rug

```
x = rnorm(1000)
plot(density(x))
rug(x)
```



Q-Q plot

```
qqnorm(rnorm(10000))
```



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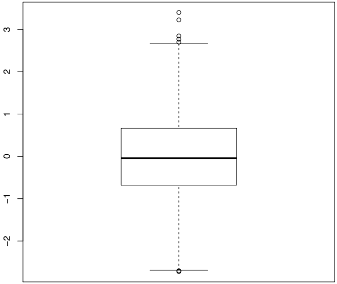
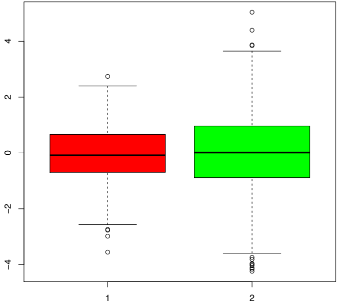
boxplot

```
boxplot(rnorm(1000))
```



boxplot

```
boxplot(cbind(rnorm(1000),rnorm(1000)+rnorm(1000)), col=c('
```



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- Advanced Topics
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