

R

*2017-09-19*



# Contents

<b>1</b>		<b>5</b>
1.1	.....	5
1.2	.....	6
1.3	.....	6
1.4	R .....	7
1.5	.....	7
<b>2</b>	<b>R,</b>	<b>9</b>
2.1	.....	9
2.2	.....	12
2.3	.....	13
2.4	( ) .....	13
<b>3</b>		<b>15</b>
3.1	.....	15
3.2	.....	16
3.3	.....	17
3.4	.....	18
<b>4</b>	<b>,</b>	<b>19</b>
4.1	.....	19
4.2	.....	22
4.3	.....	23



# Chapter 1

- “ R”! R,
- :
- R
  - RStudio
- R. , RStudio ,

## 1.1

( ), : HTML R.

### 1.1.1 HTML

HTML 1, 2 .. , ,

:

```
a <- 5
sin(sqrt(a))
## [1] 0.7867491
sqrt(sin(a) + 2)
## [1] 1.020331
```

sin(sqrt(a)) , ## [1] 0.7867491 — ,

( RStudio).

HTML ,

( ) , (

).

### 1.1.2 R

**R** *1*, *2* . **R** **R - HTML**.

**R** , , ,

**R** ,

Windows *CP1251* , OS X — (*UTF8*).

RStudio. , *File > Open With Encoding...*

## 1.2

```

•      :                               Run           Ctrl+Enter (Cmd+Enter
OS X).

•      :                               Run           Ctrl+Enter (Cmd+Enter
OS X).

•      :

—          Run           Ctrl+Enter (Cmd+Enter   OS X)
—      Ctrl+Alt+Enter (Cmd+Alt+Enter   OS X)
—          Source

Source Ctrl+Alt+Enter    , Windows 10+ OS X,    ,
Unicode).

, Code > Run Region

, , . , — , ,
. , .
```

## 1.3

```

#
# -----
#
a <- 3 + 2 #
b <- 4 ^ 8 #
c <- b %% a #

#
d <- c / a

#
e <- d * b

```

Ctrl+Shift+R (Cmd+Shift+R OS X)

*Code > Insert Section*

## 1.4

## R

(*style guides*)

R,

R

Google,

## 1.5

R,

\$  
#  
&  
/  
\  
|  
^  
@

~
^^



## Chapter 2

# R,

### 2.1

— R. *c* . R — , .

```
2 + 3
## [1] 5
2 - 3
## [1] -1
2 * 3
## [1] 6
```

, :

```
2.5 + 3.1
## [1] 5.6
```

“ ”: (\*\*) (^),

```
2 ^ 3
## [1] 8
2 ** 3
## [1] 8
```

:

```
5 / 3
## [1] 1.666667
5 / 2.5
## [1] 2
```

( ) %/%:

```
5 %/% 3
## [1] 1
```

%%:

```
5 %% 3
## [1] 2
```

```
5%%3
## [1] 1
```

```
5 %/% 3
## [1] 1
```

```
a <- 5
b <- 3
```

```
a
## [1] 5
b
## [1] 3
```

```
a + b
## [1] 8
a - b
## [1] 2
a / b
## [1] 1.666667
a %/% b
## [1] 1
a %% b
## [1] 2
```

```
b <- 4
a + b
## [1] 9
a - b
## [1] 1
a / b
## [1] 1.25
a %/% b
## [1] 1
a %% b
## [1] 1
```

```
c <- b
d <- a+c
```

```

,      :
c
## [1] 4
d
## [1] 9

```

```

:
e <- d + 2.5
e
## [1] 11.5

```

```

-      :
f <- -2
f
## [1] -2
f <- -e
f
## [1] -11.5

```

```

2.      ,      ,      ,      c      4, d      9:      .
c %% 2
## [1] 0
d %% 2
## [1] 1

```

### 2.1.1

$Z(x,y)$ ,  $Z(x,y)^2$ ,  $x^2 + y^2$ ,  $\tan(x)$ ,  $\sin(x)$ ,  $\cos(x)$ ,  $\sqrt{x}$ ,  $\text{asin}(y)$ ,  $\text{acos}(y)$ ,  $\text{atan}(y)$ ,  $\text{abs}(x)$ .

```

sqrt(a)
## [1] 2.236068
sin(a)
## [1] -0.9589243
tan(1.5)
## [1] 14.10142
abs(a + b - 2.5)
## [1] 6.5

```

```

:
sin(sqrt(a))
## [1] 0.7867491
sqrt(sin(a) + 2)
## [1] 1.020331

```

```
b <- sin(sqrt(a))
b
## [1] 0.7867491
```

b, a —, , ., , : ,

```
b <- sin(a)
b
## [1] -0.9589243
b <- abs(b)
b
## [1] 0.9589243
```

## 2.2

—, ., , :

```
s <- " , ( . )"
s
## [1] " , ( . )"

```

nchar()

```
nchar(s)
## [1] 56
```

, ., +, , paste().

```
s1 <- " , "
s2 <- " "
s3 <- "( . )"

```

```

:
s1
## [1] " , "
s2
## [1] " "
s3
## [1] "( . )"

```

```

:
s <- paste(s1, s2)
s
## [1] " , "
s <- paste(s1, s2, s3)
s
## [1] " , ( . )"

```

( ) , 1950  
1850 . . ( ) . ,  
“ year, ”” ? pop. ,

```

year <- 1950
pop <- 1850

s1 <- " "
s2 <- " "
s3 <- " ."
s <- paste(s1, year, s2, pop, s3)
s
## [1] " 1950 1850 ."

```

## 2.3

```

as.Date().

( ):

birth <- as.Date('1986/02/18')
birth
## [1] "1986-02-18"

```

```

Sys.Date():

current <- Sys.Date()
current
## [1] "2017-09-19"

```

```

livedays <- current - birth
livedays
## Time difference of 11536 days

```

```

40 :

current + 40
## [1] "2017-10-29"

```

## 2.4 ( )

```

TRUE ( ) FALSE ( ).

T F

:

• (==) —
• (!=) —
• (<) —

```

- $(\leq)$  —
  - $(>)$  —
  - $(\geq)$  —
- , :

```
a <- 1
b <- 2
a == b
## [1] FALSE
a != b
## [1] TRUE
a > b
## [1] FALSE
a < b
## [1] TRUE
```

- $(\&\&)$  -
- $(\|\|)$  -
- $(\!)$  - ( , )

```
c <- 3
(b > a) && (c > b)
## [1] TRUE
(a > b) && (c > b)
## [1] FALSE
(a > b) || (c > b)
## [1] TRUE
!(a > b)
## [1] TRUE
```

if

# Chapter 3

R.

## 3.1

- 1.
2. (“ ”),
- 3.

c():

```
#  
colors <- c("red", "green", "blue", "yellow", "purple", "brown", "pink", "gray", "olive", "cyan")  
colors  
## [1] "red" "green" "blue" "yellow" "purple" "brown" "pink" "gray" "olive" "cyan"
```

```
#  
lengths <- c(28, 40, 45, 19, 38)  
lengths  
## [1] 28 40 45 19 38
```

```
#  
opens <- c(FALSE, TRUE, TRUE, FALSE, FALSE)  
opens  
## [1] FALSE TRUE TRUE FALSE FALSE
```

- mode  
"logical", "integer", "numeric" ( "double"),  
"complex", "character" "raw"
- length

```

:
#      5      ,
intvalues <- vector(mode = "integer", length = 5)
intvalues #
## [1] 0 0 0 0 0

#      10      ,
charvalues <- vector("character", 10)
charvalues #
## [1] "" "" "" "" "" "" "" "" "" ""

```

```

,
=
,
,
,
,
,
?vector
M N,
: M:N:

```

```

index <- 1:5 #      c(1,2,3,4,5)
index
## [1] 1 2 3 4 5
index <- 2:4 #      c(2,3,4)
index
## [1] 2 3 4

```

```

— seq(), / :
seq(from = 1, by = 2, length.out = 10) # 10 ,
## [1] 1 3 5 7 9 11 13 15 17 19
seq(from = 2, to = 20, by = 3) # 2 20 3 ( )
## [1] 2 5 8 11 14 17 20
seq(length.out = 10, to = 2, by = -2) # 10 , 2
## [1] 20 18 16 14 12 10 8 6 4 2

```

```

seq()
( = ). ,

```

```

:
seq(from = as.Date('2016/09/01'), by = 1, length.out = 7) # 2016/2017
## [1] "2016-09-01" "2016-09-02" "2016-09-03" "2016-09-04" "2016-09-05"
## [6] "2016-09-06" "2016-09-07"

seq(from = Sys.Date(), by = 7, length.out = 5) # ,
## [1] "2017-09-19" "2017-09-26" "2017-10-03" "2017-10-10" "2017-10-17"

```

## 3.2

```

:
colors[1] #
## [1] " "

```



```
colors[3] #
## [1] " "
```

```
( ) length():
```

```
length(colors)
## [1] 5
```

```
n <- length(colors)
colors[n]
## [1] " "
```

```
lengths[1:4]
## [1] 28 40 45 19
```

```
m <- 1
n <- 4
index <- m:n
lengths[index]
## [1] 28 40 45 19
```

```
index <- c(1, 3, 4) # 1, 3 4
lengths[index]
## [1] 28 45 19
```

```
index <- c(5, 1, 4, 2) #
lengths[index]
## [1] 38 28 19 40
```

### 3.3

```
min(lengths) #
## [1] 19
max(lengths) #
## [1] 45
range(lengths) # = -
## [1] 19 45
mean(lengths) #
## [1] 34
median(lengths) #
## [1] 38
var(lengths) # ( - , variation)
## [1] 108.5
sd(lengths) # (standard deviation)
```

```
## [1] 10.41633
sum(lengths) #
## [1] 170
```

```
lengths * 1000 #
## [1] 28000 40000 45000 19000 38000
sqrt(lengths) #
## [1] 5.291503 6.324555 6.708204 4.358899 6.164414

stations <- c(20, 21, 22, 12, 24) #

dens <- stations / lengths #
dens
## [1] 0.7142857 0.5250000 0.4888889 0.6315789 0.6315789
```

### 3.4

```
lengths2 <- sort(lengths) #
lengths2 #
## [1] 19 28 38 40 45
lengths #
## [1] 28 40 45 19 38

lengths2 <- sort(lengths, decreasing = TRUE) #
lengths2 #
## [1] 45 40 38 28 19
lengths #
## [1] 28 40 45 19 38

l <- max(lengths) #
idx <- match(l, lengths) #
color <- colors[idx] #
color
## [1] " "
```

```
s <- paste(color, " ", l, " ")
s
## [1] " 45 "
```

```
colors[match(max(dens), dens)]
## [1] " "
```

# Chapter 4

,

, .

## 4.1

— 2 . ( , , ..).

, , matrix, 3 : ,

```
v <- 1:12 # 1 12
m <- matrix(v, nrow = 3, ncol = 4)
m
##      [,1] [,2] [,3] [,4]
## [1,]    1    4    7   10
## [2,]    2    5    8   11
## [3,]    3    6    9   12
```

, . ,

byrow = TRUE:

```
m <- matrix(v, nrow = 3, ncol = 4, byrow = TRUE)
m
##      [,1] [,2] [,3] [,4]
## [1,]    1    2    3    4
## [2,]    5    6    7    8
## [3,]    9   10   11   12
```

, :

```
m[2,4] # 2 , 4
## [1] 8
m[3,1] # 3 , 1
## [1] 9
```

, . :

```

m[2,] # 2
## [1] 5 6 7 8
m[,3] # 3 c
## [1] 3 7 11

```

```

log(m) #
##      [,1]      [,2]      [,3]      [,4]
## [1,] 0.000000 0.6931472 1.098612 1.386294
## [2,] 1.609438 1.7917595 1.945910 2.079442
## [3,] 2.197225 2.3025851 2.397895 2.484907
sum(m) #
## [1] 78
median(m) #
## [1] 6.5

```

```

sort(m)
## [1] 1 2 3 4 5 6 7 8 9 10 11 12

```

```

t(m) #
##      [,1] [,2] [,3]
## [1,]    1    5    9
## [2,]    2    6   10
## [3,]    3    7   11
## [4,]    4    8   12
m2<-matrix(-3:3,nrow = 3, ncol = 3)
## Warning in matrix(-3:3, nrow = 3, ncol = 3):
##      [3]
m2
##      [,1] [,2] [,3]
## [1,]   -3    0    3
## [2,]   -2    1   -3
## [3,]   -1    2   -2
det(m2) #
## [1] -21
det(m) # !
## Error in determinant.matrix(x, logarithm = TRUE, ...): 'x' must be a square matrix

```

```

%%%.
:
m2 %*% m
##      [,1] [,2] [,3] [,4]
## [1,]   24   24   24   24
## [2,]  -24  -28  -32  -36
## [3,]   -9  -10  -11  -12
m %*% m2 # !
## Error in m %*% m2:

```

```

match(),
m      8,
which().

```

```
which(m == 8, arr.ind = TRUE)
##      row col
## [1,]    2   4
```

```

,      ,      1 × 2.      ,      .
,      :
indexes <- which(m == 8, arr.ind = TRUE)
row <- indexes[1,1]
col <- indexes[1,2]
m[row,col]
## [1] 8
```

```
!      8.
—      ,      .      cbind()
rbind().      :
lengths <- c(28, 40, 45, 19, 38)
stations <- c(20, 21, 22, 12, 24)
cbind(lengths, stations) #
##      lengths stations
## [1,]      28        20
## [2,]      40        21
## [3,]      45        22
## [4,]      19        12
## [5,]      38        24
rbind(lengths, stations) #
##      [,1] [,2] [,3] [,4] [,5]
## lengths  28  40  45  19  38
## stations 20  21  22  12  24
```

```
C      :
mm <- cbind(lengths, stations)
mm[,2]/mm[,1] #      1
## [1] 0.7142857 0.5250000 0.4888889 0.6315789 0.6315789
```

```

:
dens <- mm[,2]/mm[,1]
mm<-cbind(mm, dens)
mm
##      lengths stations      dens
## [1,]      28        20 0.7142857
## [2,]      40        21 0.5250000
## [3,]      45        22 0.4888889
## [4,]      19        12 0.6315789
## [5,]      38        24 0.6315789
```

### Environment

#### Data

```

,      ,      , ,      - ,      (      ).
,      ,      ,
:
colors <- c("      ", "      ", "      ", "      ", "      ", "      ")
mm2<-cbind(mm,colors)
```

```
mm2 #
##      lengths stations dens      colors
## [1,] "28"      "20"      "0.714285714285714" " "
## [2,] "40"      "21"      "0.525"           " "
## [3,] "45"      "22"      "0.488888888888889" " "
## [4,] "19"      "12"      "0.631578947368421" " "
## [5,] "38"      "24"      "0.631578947368421" " "
```

```
mm2[,2]/mm2[,1]
## Error in mm2[, 2]/mm2[, 1]:
```

## 4.2

(data frame). `data.frame()`: . R

```
t<-data.frame(colors,lengths,stations)
t #
##      colors lengths stations
## 1          28      20
## 2          40      21
## 3          45      22
## 4          19      12
## 5          38      24
```

```
t<-cbind(t, dens)
t
##      colors lengths stations      dens
## 1          28      20 0.7142857
## 2          40      21 0.5250000
## 3          45      22 0.4888889
## 4          19      12 0.6315789
## 5          38      24 0.6315789
```

`data.frame()` `cbind()` , — :

```
t[2,2]
## [1] 40
t[,3]
## [1] 20 21 22 12 24
t[4,]
##      colors lengths stations      dens
## 4          19      12 0.6315789
```

, \$ ( ):

```
t$lengths
## [1] 28 40 45 19 38
```

```
t$stations
## [1] 20 21 22 12 24

max(t$stations)
## [1] 24
t$lengths / t$stations
## [1] 1.400000 1.904762 2.045455 1.583333 1.583333
```

```
colnames(t)

colnames(t)
## [1] "colors" "lengths" "stations" "dens"
```

```
row<-data.frame(" ", 40.5, 22, 22/45)
```

```
colnames(row) <- colnames(t)
```

```
t<-rbind(t,row)
```

```
colnames(t)<-c(" ", " ", " ", " ", " ", " ")
colnames(t)
## [1] " " " " " " " " "
```

```
t$
## [1] 28.0 40.0 45.0 19.0 38.0 40.5
t
##
## 1      28.0      20 0.7142857
## 2      40.0      21 0.5250000
## 3      45.0      22 0.4888889
## 4      19.0      12 0.6315789
## 5      38.0      24 0.6315789
## 6      40.5      22 0.4888889
```

## 4.3

```
d <- " 6 "
s <- summary(t) # summary()
```

```

:
metrolist <- list(d,t,s)
metrolist
## [[1]]
## [1] "          6          "
##
## [[2]]
##
## 1      28.0      20 0.7142857
## 2      40.0      21 0.5250000
## 3      45.0      22 0.4888889
## 4      19.0      12 0.6315789
## 5      38.0      24 0.6315789
## 6      40.5      22 0.4888889
##
## [[3]]
##
##      :1  Min.   :19.00  Min.   :12.00  Min.   :0.4889
##      :1  1st Qu.:30.50  1st Qu.:20.25  1st Qu.:0.4979
##      :1  Median :39.00  Median :21.50  Median :0.5783
##      :1  Mean   :35.08  Mean   :20.17  Mean   :0.5800
##      :1  3rd Qu.:40.38  3rd Qu.:22.00  3rd Qu.:0.6316
##      :1  Max.   :45.00  Max.   :24.00  Max.   :0.7143

```

```

:
metrolist <- list(desc = d, table = t, summary = s)
metrolist
## $desc
## [1] "          6          "
##
## $table
##
## 1      28.0      20 0.7142857
## 2      40.0      21 0.5250000
## 3      45.0      22 0.4888889
## 4      19.0      12 0.6315789
## 5      38.0      24 0.6315789
## 6      40.5      22 0.4888889
##
## $summary
##
##      :1  Min.   :19.00  Min.   :12.00  Min.   :0.4889
##      :1  1st Qu.:30.50  1st Qu.:20.25  1st Qu.:0.4979
##      :1  Median :39.00  Median :21.50  Median :0.5783
##      :1  Mean   :35.08  Mean   :20.17  Mean   :0.5800
##      :1  3rd Qu.:40.38  3rd Qu.:22.00  3rd Qu.:0.6316
##      :1  Max.   :45.00  Max.   :24.00  Max.   :0.7143

```

```

:
metrolist$summary
##
##      :1  Min.   :19.00  Min.   :12.00  Min.   :0.4889
##      :1  1st Qu.:30.50  1st Qu.:20.25  1st Qu.:0.4979

```



```
##      :1  Median :39.00  Median :21.50  Median :0.5783
##      :1  Mean   :35.08  Mean   :20.17  Mean   :0.5800
##      :1  3rd Qu.:40.38  3rd Qu.:22.00  3rd Qu.:0.6316
##      :1  Max.   :45.00  Max.   :24.00  Max.   :0.7143
```

```
summary      ,      :
```

```
metrolist$summary[,3]
```

```
##
## "Min.      :12.00  " "1st Qu.:20.25  " "Median :21.50  " "Mean      :20.17  "
##
## "3rd Qu.:22.00  " "Max.      :24.00  "
```

```
,      :
```

```
metrolist[[1]]
```

```
## [1] "              6              "
metrolist[["desc"]]
## [1] "              6              "
```

```
.
```