R

Contents

Chapter 1

“ R”! R,
. .

:

- R
- RStudio

,   .   ,   RStudio   ,
R.   .

1.1

(   ),   : **HTML** **R**.

1.1.1   HTML

HTML   *1,*   *2* . .
.   ,   ,
.

:

```r
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
```

,   ,   ,   .

,   ,   .

,   ,   *Code > Insert Section*

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

1.4   R

,   R.

,   .

.   (   )

(*style guides*)

R,   R   Google,

.   .   ,

(   )   :   ,   ,   ,   -

.

1.5

R,   .   ,

,

```
$
#
&
/
\
|
^
@
```

Figure 1.1:

1.6

R (   )   .   R,   CRAN (Comprehensive R Archive Network).   ,   ,   openxlsx, **Microsoft Excel**.

RStudio.

-      ,   ,   *Install   Packages* (
).   *Install*:

-      ,   install.packages(),   ,   :

```
install.packages("openxlsx")
```

             :   install.packages()   .   , **RStudio**   ,   .   .

                    -   **RStudio** (,   -
                ,   *Program   Files*   **Windows**),

( ) lib install.packages(). :
```
install.packages("xlsx", lib = "C:/Rlib/")
```

library(), :

```
library(openxlsx)
```

, — , :/Rlib/ (.) —
library() lib.loc: library(xlsx, lib.loc =
"C:/Rlib")

Chapter 2

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
```

. " ".
— . , . .
:

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

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

, . .
3. , , , 3 4.
. , , - . , ,
? . ,
. <-

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

, :

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

:

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

3 4 .

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

, , !
:

```r
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, 2 : x y.
Z(x,y). , x y . ,
, , . .
— . sqrt(x), abs(x), sin(x), cos(x),
tan(x) asin(y), acos(y), atan(y) . , ,
:

```
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.   ,
     .   "   ””   ?   .

,

```r
year <- 1950
pop <- 1850
```

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

.   .   ,

.

2.3

.   .

.   .   ,   .   as.Date().

—   ,   -   .   ,

.   (   ):

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

Sys.Date():

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

.   ,   , ,   . .   ,

:

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

.   ,   ,   40   :

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

.

2.4   (   )

,   .   TRUE (   )   FALSE ( ).

T F   .

:

- (==) —
- (!=) —
- (<) —

-        (<=) —
-   (>) —
-       (>=) —

,   :

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

,   .   :

- (&&) -
-   (||) -
-   (!) -   (,   )

```r
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("     ", "      ", "    ", "        ", "      ")
colors
## [1] "     "  "     "  "    "  "      "  "      "
```

```
#            -                       (                    )
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
```

,   ,   ,   —   ,
.   .
,   vector().   2   :

- 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] "      "
```

.   ,   4   .   :

```
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
```

R   .   R   ,
1 (11).   ,   ,   ,   :

```
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) #                              .                        decreasing
lengths2 #
## [1] 45 40 38 28 19
lengths #
## [1] 28 40 45 19 38
```

—   .   ,   ,   (   )
.   ,   ,   max(lengths).   ,
,   .   ,   ,
lengths   ,   .
match():

```
l <- max(lengths) #
idx <- match(l, lengths) #                      ,        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):            [7]
##                    [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(),   ,   .   which().
              m   8,   :

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

, $1 \times 2.$,   .
    ,   :

```
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():

```
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()

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

, :

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

, - , . ,
colnames()

```
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

— R. , .
, , , , — .
. .

, , :

```
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                "
```

                              .