R

2020-11-10

Contents

Chapter 1

“ R”. - ,
!

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Chapter 2

R

2.1 R Rstudio

R .

- R
  - Windows, **Download R ( ) for Windows.**
  - Mac, , 5 , *.pkg . ,
    .
  - Linux, :

```
sudo apt-get install r-cran-base
```

R:

```
sessionInfo()$R.version$version.string
```

```
## [1] "R version 4.0.2 (2020-06-22)"
```

R RStudio:

- RStudio

  - ( ),
    , - :

- RStudio cloud

  : R - RStudio?
  , R — , RStudio — (IDE),
  .

  RStudio — R, , , .
  - .
  Jupyter Notebook, R

RMarkdown — - , .
RMarkdown !

2.2 RStudio

, , :

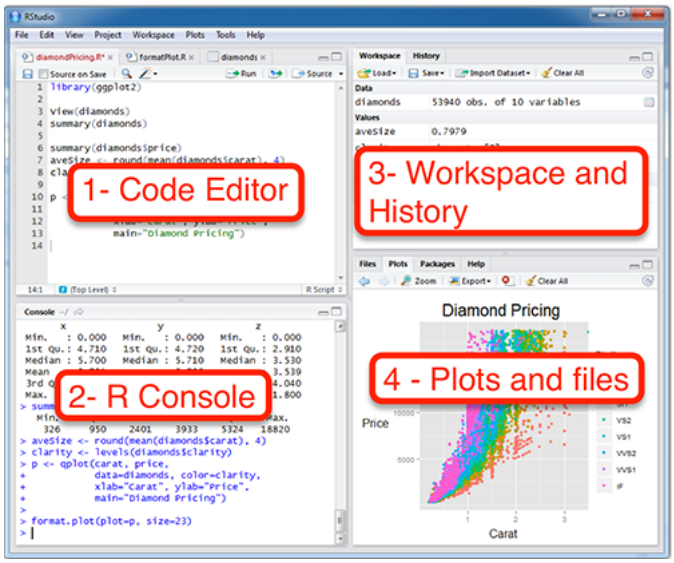


Figure 2.1:

: **1 - Code Editor** ( ) [1] **2 - R Console** ( ). .
.

2 - R Console `Enter`.
- . , .
.

1 - Code Editor `Ctrl` + `Enter` (`Cmd` + `Enter` macOS). , .
. `Ctrl` + `A` Windows Linux, `Cmd` + `A` macOS [2]. ( ), **2 - R Console**, .

[1] RStudio . , , `File - New File - R Script`.
[2] RStudio . , `Help - Keyboard Shortcuts Help`.

- , - .
. File - Save As.... R .R, ,
- “ ”.

3 - Workspace and History — .
, .
, .

4 - Plots and files. . - , , - ,
, . (Packages) Help
. .

2.3 R

R — , . R
. , R
. , , .

R +, -, *, /, ^ ( ), () ..

:

```
40+2
```

```
## [1] 42
```

```
3-2
```

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

```
5*6
```

```
## [1] 30
```

```
99/9 #
```

```
## [1] 11
```

```
2^3 #
```

```
## [1] 8
```

```
13 %/% 3 #
```

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

```
13 %% 3 #
```

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

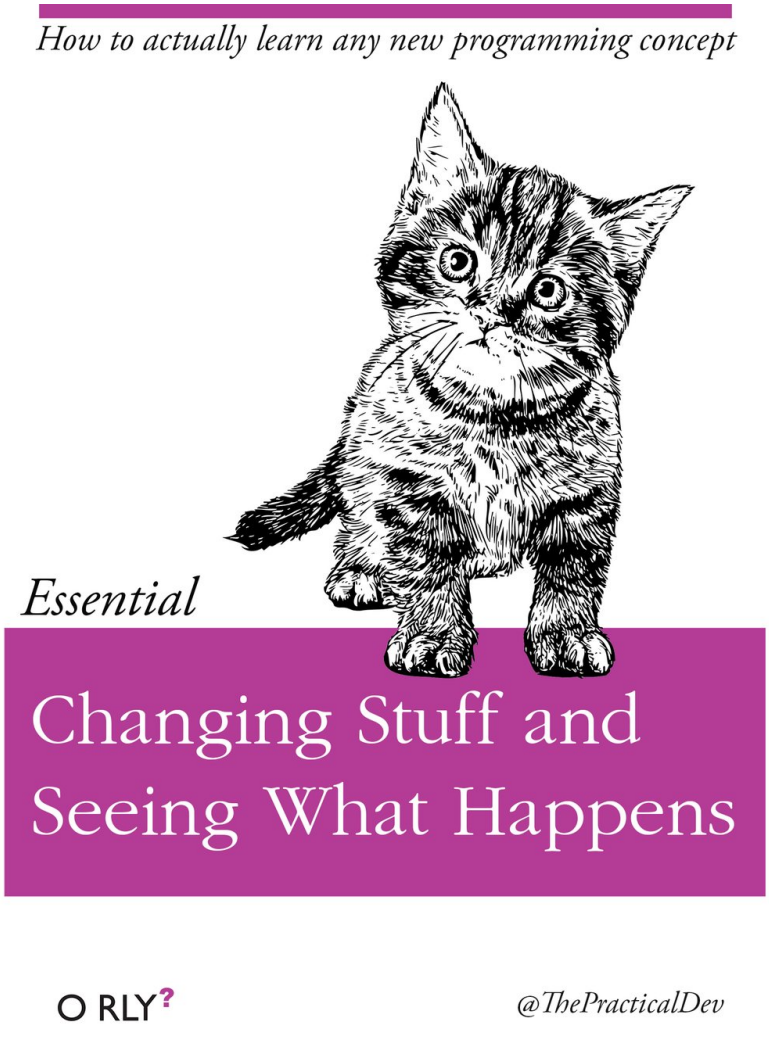

How to actually learn any new programming concept
Essential
Changing Stuff and Seeing What Happens
O RLY?
@ThePracticalDev

Figure 2.2:

- .

, ? .

, (#). , #
R .
(-), [3].
, , - ,
: “ ” - # ,
. : Ctrl + Shift + C (Cmd + Shift +
C macOS) — # .

, 14% :

```
2 + 2 * 2
```

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

, - , 6 (,
) .

(. . , *operator precedence*) R
, .

```
(2+2)*2
```

```
## [1] 8
```

, , , ,
. ?Syntax.

2.4

- . , , ,
:

```
16^0.5
```

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

, : -
. ( ) - , -
, - (, . .).

, , :

```
sqrt(16)
```

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

[3] , ,
. !

R — case-sensitive , . . . SQRT(16) .

:

```
log(8)
```

```
## [1] 2.079442
```

, , … - , , -
.

!

— , , ,
.

8 2 3:

$\log_2 8 = 3$

2 3 8:

$2^3 = 8$

- .

, , :

```
?log
```

RStudio :

, *base =*. (2.7182818…),
. . . R - —
, , ,
.

```
log(x = 8, base = 2)
```

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

… ( ):

```
log(8,2)
```

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

, :

```
log(8, sqrt(4))
```

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

, :

```
log(base = 2, x = 8)
```

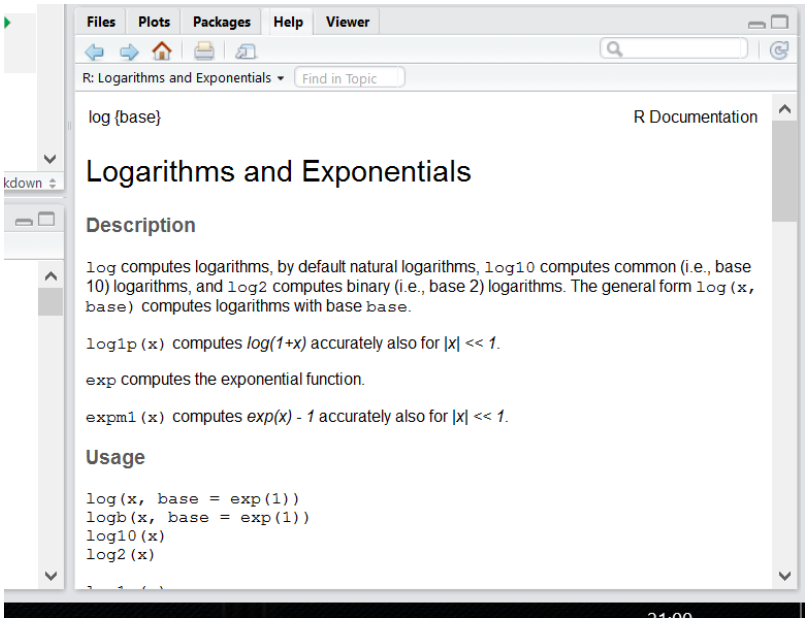


Figure 2.3:

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

, :

```
log(b = 2, x = 8)
```

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

. , — R (Python). , - . R . , .

, : +,-,/,^ . .

:

```
'+'(3,4)
```

```
## [1] 7
```

2.5 —

, , , ... !

, . .

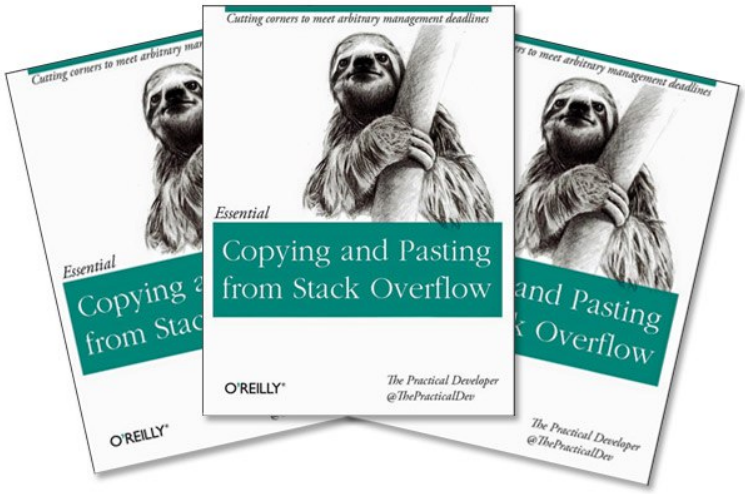


Figure 2.4:

Stackoverflow[4] R- !

Computer Programming To Be Officially Renamed "Googling Stack Overflow"Source: http://t.co/xu7acfXvFF pic.twitter.com/iJ9k7aAVhd

— Stack Exchange (**?**) July 20, 2015

, : . , .
- .

, — .

Does anyone ever get good at R or do they just get good at googling how to do things in R

— Lauren M. Seyler, Ph.D. (**?**) May 6, 2019

: — , — .

2.6

— . R
: `<-` (`=`,).
: `Alt` + `-` (`option` + `-` macOS).

[4]Stackoverflow — . *Quora*, *The Question*, *Mail.ru* .

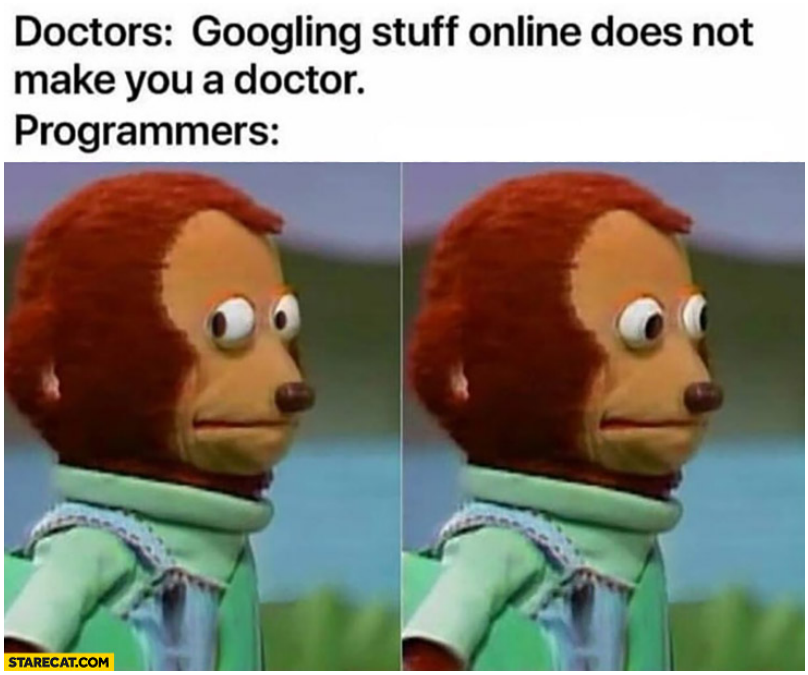

Doctors: Googling stuff online does not make you a doctor.
Programmers:
STARECAT.COM

Figure 2.5:

, !
, .

```
a <- 2
a
```

```
## [1] 2
```

<- , , - ,
5.

<- . .
: , , . _,
(,), .
, .

: - new variable - _new_variable - .1var - v-r

: - new_variable - .new.variable - var_2

!
, , (-) .
- ,
: some_variable[6].

Environment RStudio:

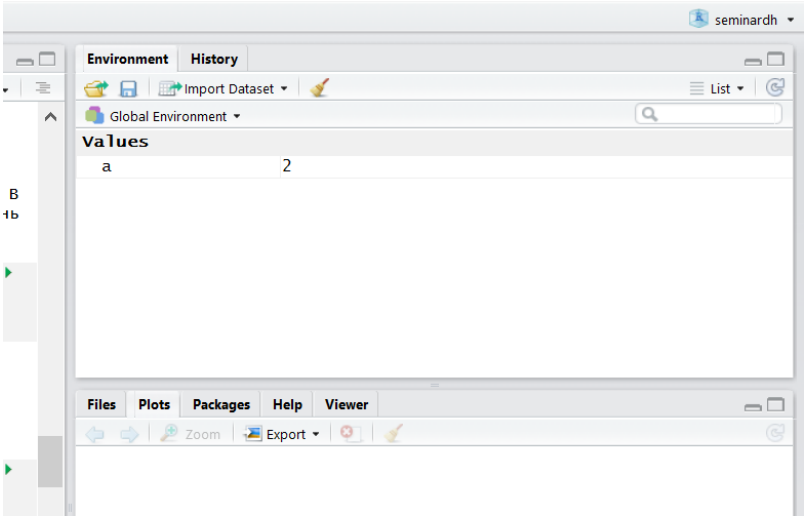


Figure 2.6:

:

5 ->, , , .
6 SomeVariable, , — , .

```
b <- a ^ a + a * a
b
```

```
## [1] 8
```

```
log(b, a)
```

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

2.7

:

```
a == b
```

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

, ==, =.
.

```
a = b
a
```

```
## [1] 8
```

(
)

, (=( ).

:

```
a <- 2
b <- 3

a == b
```

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

```
a != b
```

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

R .

/ :

```
a > b
```

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

```
a < b
```

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

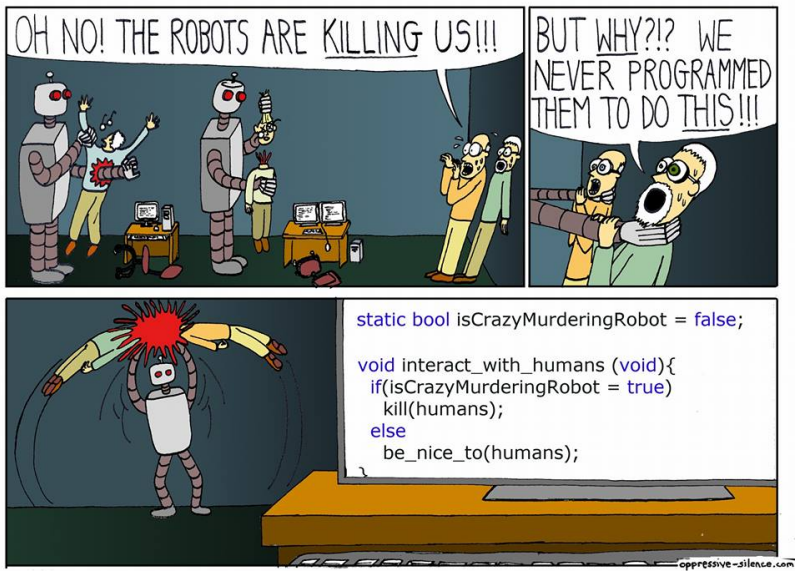


Figure 2.7:

```
a >= b
```

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

```
a <= b
```

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

!

.

2.8

(numeric):

```
class(a)
```

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

, R numeric: integer ( ), double ( ), complex ( )[7]. R numeric , .

[7] R : complexnumber <- 2+2i. i - , -1.

- , as.integer(), as.double() as.complex(). , L, integer:

```
is.integer(5)
```

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

```
is.integer(5L)
```

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

double . , R . , :

```
sqrt(2)^2 == 2
```

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

, R. , all.equal():

```
all.equal(sqrt(2)^2, 2)
```

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

R:

1. (**character**): , , .

```
s <- "       !"
s
```

```
## [1] "       !"
```

```
class(s)
```

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

", ' (, -).

```
"Ph'nglui mglw'nafh Cthulhu R'lyeh wgah'nagl fhtagn"
```

```
## [1] "Ph'nglui mglw'nafh Cthulhu R'lyeh wgah'nagl fhtagn"
```

2. **logical**: TRUE FALSE.

```
t1 <- TRUE
f1 <- FALSE

t1
```

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

```
f1
```

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

, T F (True False!)

```
t2 <- T
f2 <- F
```

, R TRUE FALSE, T F.

```
TRUE <- FALSE
```

```
## Error in TRUE <- FALSE:  (do_set)
```

```
TRUE
```

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

```
T <- FALSE
T
```

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

rm() :

. ,
, , , !

```
comparison <- a == b
comparison
```

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

, : -
, .
, .
— (!). ! TRUE FALSE, FALSE TRUE:

```
t1
```

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

```
!t1
```

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

```
!!t1 #  !
```

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

(TRUE TRUE):

```
t1 & t2
```

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

```
t1 & f1
```

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

(TRUE TRUE):

```
t1 | f1
```

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

```
f1 | f2
```

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

- ( ) — xor(),
TRUE , TRUE.

, ( ) - R
[8]. - R. !

[8] (integer, double, complex, character logical) — raw,
, .

Chapter 3

3.1 atomic R

( ), , (**atomic vector** **atomic**) — ( ) .

, .
{0,0} - , , {2,3}:

.
, {2,3}:

, R, , , . , R
(. .) , **1**. !

, *c()*:

```
c(4, 8, 15, 16, 23, 42)
```

```
## [1]  4  8 15 16 23 42
```

```
c("  ", "  ", " ")
```

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

```
c(TRUE, FALSE)
```

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

—
c . ? . R . :

```
 (3, 4, 5)
```

```
## Error in  (3, 4, 5):  " "
```

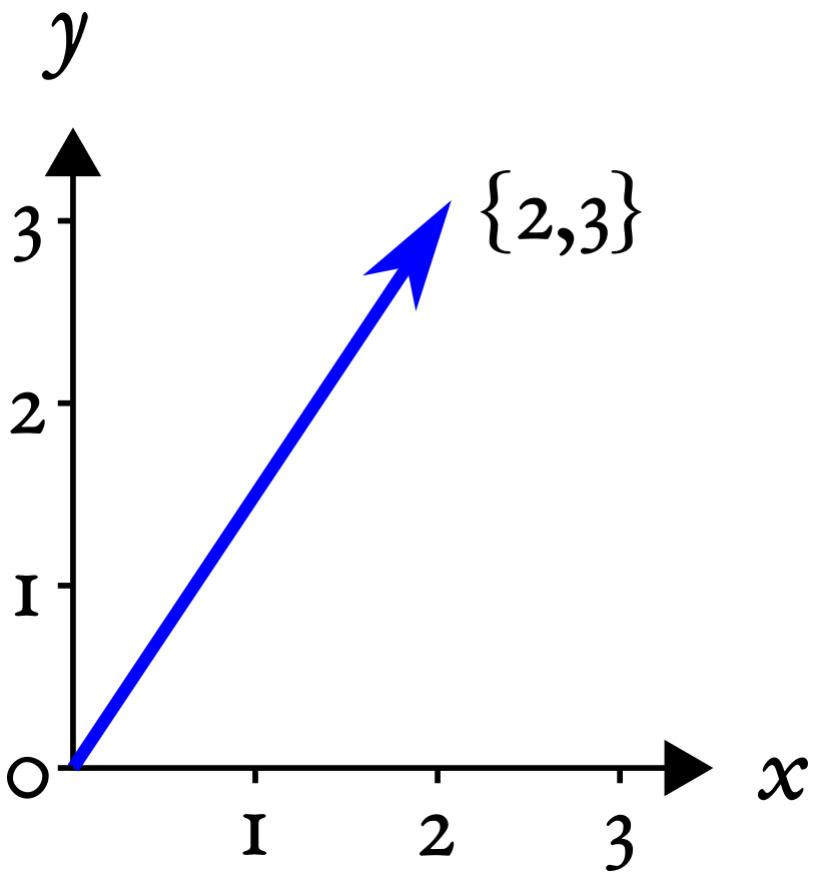


Figure 3.1:

Figure 3.2:

:

```
1:10
```

```
##  [1]  1  2  3  4  5  6  7  8  9 10
```

```
5:-3
```

```
## [1]  5  4  3  2  1  0 -1 -2 -3
```

1. ,
… , seq():

```
seq(10,100, by = 10)
```

```
##  [1]  10  20  30  40  50  60  70  80  90 100
```

, , . seq() :

```
seq(1,13, length.out = 4)
```

```
## [1]  1  5  9 13
```

— rep() — . — ,
, — .

```
rep(1, 5)
```

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

, !

```
rep(1:3, 3)
```

```
## [1] 1 2 3 1 2 3 1 2 3
```

```
rep(1:3, 1:3)
```

```
## [1] 1 2 2 3 3 3
```

(, , , 1):

```
v1 <- c("Hey", "Ho")
v2 <- c("Let's", "Go!")
c(v1, v2)
```

```
## [1] "Hey"   "Ho"    "Let's" "Go!"
```

R . , sum() ( )
mean() ( ):

```
sum(1:10)
```

```
## [1] 55
```

```
mean(1:10)
```

```
## [1] 5.5
```

3.2

, ? ?

, (*atomic*) .

. R

“ ”, “ ” (—

“ ” ,).

:

```
c(FALSE, 2)
```

```
## [1] 0 2
```

FALSE 0 (TRUE 1), .

:

```
2 + TRUE
```

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

(implicit coercion).

:

```
c(TRUE, 3, "   ")
```

```
## [1] "TRUE"   "3"      "   "
```

.

R :

```
NULL < raw < logical < integer < double < complex < character <
list < expression.
```

, , — TRUE FALSE —

0 1 , 0 1 "0" "1".

, as.

(**explicit coercion**):

```
as.numeric(c(TRUE, FALSE, FALSE))
```

```
## [1] 1 0 0
```

```
as.character(as.numeric(c(TRUE, FALSE, FALSE)))
```

```
## [1] "1" "0" "0"
```

, , .
, NA — ( ).

```
as.numeric(c("1", "2", "  "))
```

```
## Warning:                    NA
```

```
## [1]  1  2 NA
```

—
sum() mean() TRUE .
!

3.3

, , :

```
n <- 1:4
m <- 4:1
n + m
```

```
## [1] 5 5 5 5
```

```
n - m
```

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

```
n * m
```

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

```
n / m
```

```
## [1] 0.2500000 0.6666667 1.5000000 4.0000000
```

```
n ^ m + m * (n - m)
```

```
## [1] -11   5  11   7
```

,
. (**vectorization**).

- MATLAB ,
m * n (*dot product*), .
% :

```
n %*% m
```

```
##      [,1]
## [1,]   20
```

R, .

, R, , .
, , (
). “ ”
:

```
sqrt(1:10)
```

```
##  [1] 1.000000 1.414214 1.732051 2.000000 2.236068 2.449490 2.645751 2.828427
##  [9] 3.000000 3.162278
```

R .
(C, C++, FORTRAN), ,
, .

R — ,
. ,
for while ??. !
. , —
for while ??.

3.3.1

- . , ,
. ? !
(*, recycling rule*). ,
, ,
:

```
n <- 1:4
m <- 1:2
n * m
```

```
## [1] 1 4 3 8
```

, ? :
1 , , :

```
n * 2
```

```
## [1] 2 4 6 8
```

(, 3, 4), R ,
.

```
n + c(3,4,5)
```

```
## Warning in n + c(3, 4, 5):
##
```

```
## [1] 4 6 8 7
```

, .
. — ,
.

3.3.2

, . . , ,
R- !

. , R —
(,) - . [] (
— !).

— , . . .

```
n <- c(0, 1, 1, 2, 3, 5, 8, 13, 21, 34)
n[1]
```

```
## [1] 0
```

```
n[10]
```

```
## [1] 34
```

(MATLAB,)
, 0 — ( ),
R . — 1,
— length(). .

, :

```
n[3] <- 20
n
```

```
##  [1]  0  1 20  2  3  5  8 13 21 34
```

, :

```
n[4:7]
```

```
## [1] 2 3 5 8
```

```
n[10:1]
```

```
##  [1] 34 21 13  8  5  3  2 20  1  0
```

```
n[4:6] <- 0
n
```

```
##  [1]  0  1 20  0  0  0  8 13 21 34
```

:

```
n[-1]
```

```
## [1]  1 20  0  0  0  8 13 21 34
```

```
n[c(-4, -5)]
```

```
## [1]  0  1 20  0  8 13 21 34
```

“ ” , Python.

, . :

```
n[c(TRUE, FALSE, TRUE, FALSE, TRUE, FALSE, TRUE, FALSE, TRUE, FALSE)]
```

```
## [1]  0 20  0  8 21
```

: ,
TRUE, ,
FALSE.

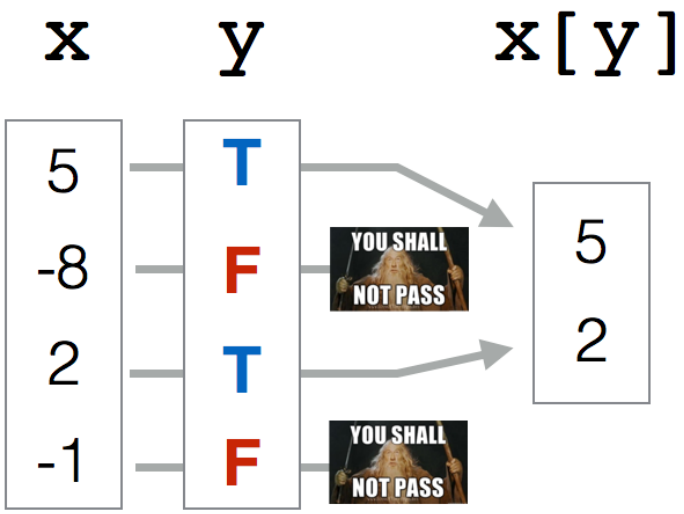


Figure 3.3:

( ) ,
!

```
n[c(TRUE, FALSE)] #       - recycling rule!
```

```
## [1]  0 20  0  8 21
```

, : . ,
( ) :

```
my_named_vector <- c(first = 1,
                     second = 2,
                     third = 3)
my_named_vector['first']
```

```
## first
##     1
```

“ ” names() .

```
d <- 1:4
names(d) <- letters[1:4]
names(d)
```

```
## [1] "a" "b" "c" "d"
```

```
d["a"]
```

```
## a
## 1
```

letters — “ ” R — a z. !
, LETTERS — , . R
pi.

n mean():

```
mean(n)
```

```
## [1] 9.7
```

, ?

— :

```
larger <- n>mean(n)
larger
```

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

n:

```
n[larger]
```

```
## [1] 20 13 21 34
```

:

```
n[n>mean(n)]
```

```
## [1] 20 13 21 34
```

, R: (subset)
.

3.4

, .

```
eyes <- c("green", "blue", "blue", "brown", "green", "blue")
```

3.4.1 mean() sum() TRUE

sum() TRUE . ,
"blue" eyes:

```
eyes == "blue"
```

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

```
sum(eyes == "blue")
```

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

mean() TRUE .

```
eyes == "blue"
```

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

```
mean(eyes == "blue")
```

```
## [1] 0.5
```

100, :

```
mean(eyes == "blue") * 100
```

```
## [1] 50
```

3.4.2 all() any()

all() TRUE TRUE:

```
all(eyes == "blue")
```

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

any() TRUE TRUE:

```
any(eyes == "blue")
```

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

! . , FALSE ?

```
any(!eyes == "blue")
```

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

```
!all(eyes == "blue")
```

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

FALSE?

```
all(!eyes == "blue")
```

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

```
!any(eyes == "blue")
```

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

3.4.3 : which()

, , .
. which()

```
which(eyes == "blue")
```

```
## [1] 2 3 6
```

3.4.4 %in% match()

: . ,
. :

```
eyes[eyes == c("green", "blue")]
```

```
## [1] "green" "blue"  "green" "blue"
```

: , !
.

, , ,
.

, , !
.

```
eyes[eyes == "green" | eyes == "blue"]
```

```
## [1] "green" "blue"  "blue"  "green" "blue"
```

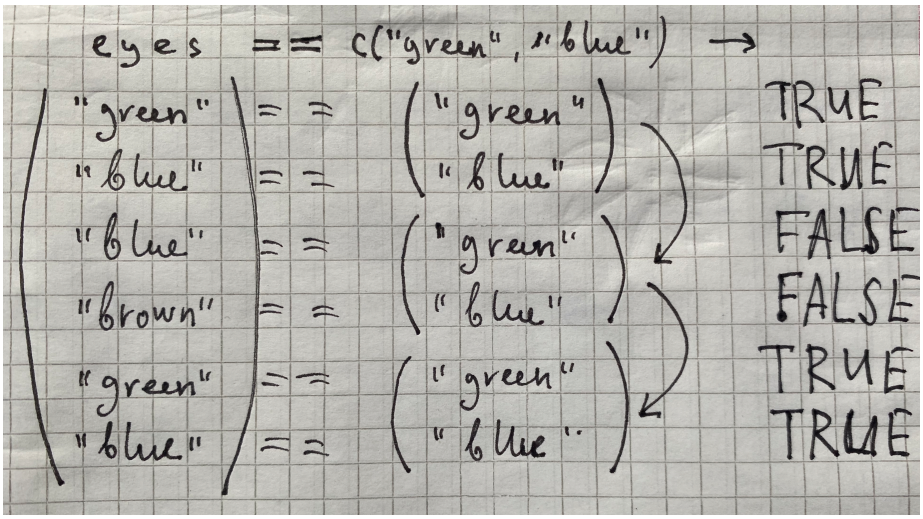


Figure 3.4:

, 2. %in%, , : , .

```
eyes[eyes %in% c("green", "blue")]
```

```
## [1] "green" "blue"  "blue"  "green" "blue"
```

%in% . %in% , . match() %in%, TRUE. , FALSE match() NA (nomatch =).

```
match(eyes, c("green", "blue"))
```

```
## [1]  1  2  2 NA  1  2
```

? - , ( ), - , NA.

```
c("green", "blue")[match(eyes, c("green", "blue"))]
```

```
## [1] "green" "blue"  "blue"  NA      "green" "blue"
```

3.5 NA -

- . , - - . R NA (

Not Available -). NA — "NA", 0, ""
FALSE. NA — NA. , NA NA:

```
missed <- NA
missed == "NA"
```

```
## [1] NA
```

```
missed == ""
```

```
## [1] NA
```

```
missed == NA
```

```
## [1] NA
```

, NA c NA NA. : , NA, NA
— , ! : NA — , ,
. (. . NA), , .

NA :

```
n[5] <- NA
n
```

```
##  [1]  0  1 20  0 NA  0  8 13 21 34
```

```
mean(n)
```

```
## [1] NA
```

, NA “ ” . ?
, NA . :

```
n == NA
```

```
##  [1] NA NA NA NA NA NA NA NA NA NA
```

, , NA c NA NA!

, is.na():

```
is.na(n)
```

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

is.na(n) FALSE , TRUE , NA.
n NA , : TRUE, NA, FALSE,
NA. ! ( ),
:

```
n[!is.na(n)]
```

```
## [1]  0  1 20  0  0  8 13 21 34
```

, !

```
mean(n[!is.na(n)])
```

```
## [1] 10.77778
```

, (!)

, , NA. *mean()*:

```
?mean()
```

na.rm =, FALSE. , !

```
mean(n, na.rm = T)
```

```
## [1] 10.77778
```

NA . , NA -
, NA NA_integer_,
NA_real_, NA_complex_ NA_character_, R
NA.

NA NaN — . NaN *Not a Number*
0 / 0. , is.na() TRUE
NaN, is.nan() TRUE NaN FALSE NA:

```
is.na(NA)
```

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

```
is.na(NaN)
```

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

```
is.nan(NA)
```

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

```
is.nan(NaN)
```

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

3.6

, - . , —
R. , . , — .
: (**list**) (**matrix**).
“ ” , . R —
data.frame.

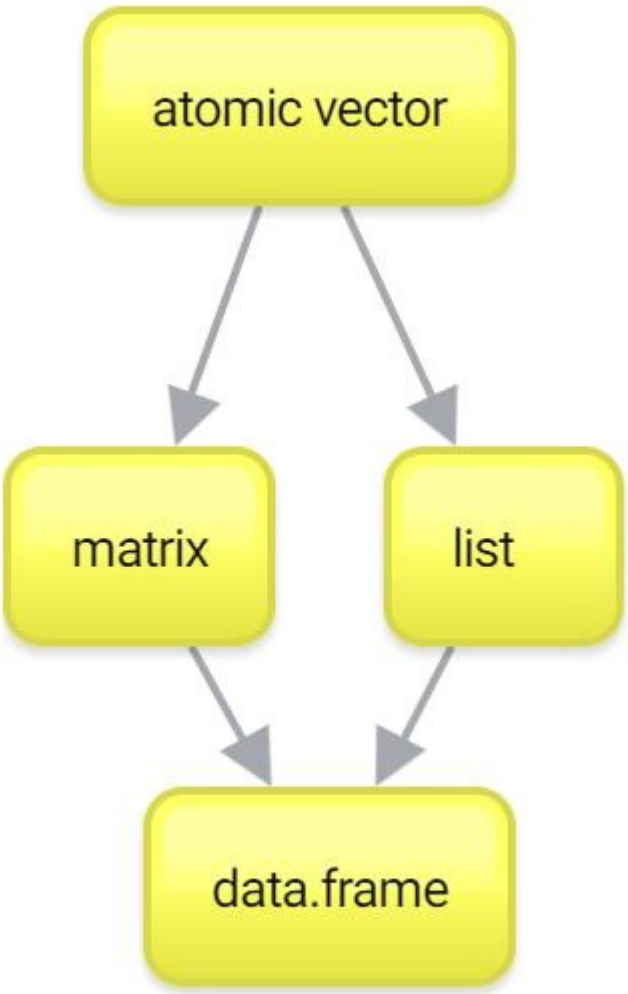


Figure 3.5:

Chapter 4

R

4.1

, . **(matrix)** — “ ” :
, , . `matrix()` ,
.

```
A <- matrix(1:20, nrow=5,ncol=4)
A
```

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

, : ,
, . .
. , R.

, :

```
A <- matrix(1:20, nrow=5)
A
```

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

: . —
, . .

```
A[2,3]
```

```
## [1] 12
```

```
A[2:4, 1:3]
```

```
##      [,1] [,2] [,3]
## [1,]    2    7   12
## [2,]    3    8   13
## [3,]    4    9   14
```

— , — . ,
/ , :

```
A[, 1:3]
```

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

```
A[2:4, ]
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    2    7   12   17
## [2,]    3    8   13   18
## [3,]    4    9   14   19
```

```
A[, ]
```

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

, :

```
A[2:4, 2:4] <- 100
A
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    1    6   11   16
## [2,]    2  100  100  100
## [3,]    3  100  100  100
```

```
## [4,]    4  100  100  100
## [5,]    5   10   15   20
```

, , . R , ,
, MATLAB. : .

, — , : R —
dim ( ) dimnames. —
, “ ”.
. :
dim .
. 99-101 “R in a Nutshell” (**?**).

4.2

— ! , ,
(array). : , ,
.

```
array_3d <- array(1:12, c(3, 2, 2))
array_3d
```

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

4.3

. **(list)**!

```
simple_list <- list(42, "    ", TRUE)
simple_list
```

```
## [[1]]
## [1] 42
```

```
##
## [[2]]
## [1] "    "
##
## [[3]]
## [1] TRUE
```

, , !

```
complex_list <- list(c("Wow", "this", "list", "is", "so", "big"), "16", simple_list)
complex_list
```

```
## [[1]]
## [1] "Wow"  "this" "list" "is"   "so"   "big"
##
## [[2]]
## [1] "16"
##
## [[3]]
## [[3]][[1]]
## [1] 42
##
## [[3]][[2]]
## [1] "    "
##
## [[3]][[3]]
## [1] TRUE
```

, , , , str():

```
str(complex_list)
```

```
## List of 3
##  $ : chr [1:6] "Wow" "this" "list" "is" ...
##  $ : chr "16"
##  $ :List of 3
##   ..$ : num 42
##   ..$ : chr "    "
##   ..$ : logi TRUE
```

, - . - -
.

:

```
named_list <- list(age = 24, PhDstudent = T, language = "Russian")
named_list
```

```
## $age
## [1] 24
```

```
##
## $PhDstudent
## [1] TRUE
##
## $language
## [1] "Russian"
```

, . :

```
named_list$age
```

```
## [1] 24
```

, . , :

```
named_list[1]
```

```
## $age
## [1] 24
```

, , — , . . :

```
class(named_list)
```

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

```
class(named_list[1])
```

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

(-), ,
:

```
named_list[[1]]
```

```
## [1] 24
```

```
class(named_list[[1]])
```

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

Indexing lists in #rstats. Inspired by the Residence Inn pic.twitter.com/YQ6axb2w7t

— Hadley Wickham (**?**) September 14, 2015

, .

```
named_list[['age']]
```

```
## [1] 24
```

— , $.

R, , Python. R,
, —

. , —
, .
.

4.4

, . - . **(data.frames)**. , ,
.

. , .

```
name <- c("Ivan", "Eugeny", "Lena", "Misha", "Sasha")
age <- c(26, 34, 23, 27, 26)
student <- c(F, F, T, T, T)
df <- data.frame(name, age, student)
df
```

```
##     name age student
## 1   Ivan  26   FALSE
## 2 Eugeny  34   FALSE
## 3   Lena  23    TRUE
## 4  Misha  27    TRUE
## 5  Sasha  26    TRUE
```

```
str(df)
```

```
## 'data.frame':    5 obs. of  3 variables:
##  $ name   : chr  "Ivan" "Eugeny" "Lena" "Misha" ...
##  $ age    : num  26 34 23 27 26
##  $ student: logi  FALSE FALSE TRUE TRUE TRUE
```

, , ? , — -
, *atomic* . , “ ”.
, “ ” 90 . , ,
. (!),
, . , .
— character, — numeric, — logical. ,
, :

```
df$age[2:3]
```

```
## [1] 34 23
```

age $. ,
, 2 3.

$:

```
df$lovesR <- T #     recycling -    ?
df
```

```
##     name age student lovesR
## 1   Ivan  26   FALSE   TRUE
## 2 Eugeny  34   FALSE   TRUE
## 3   Lena  23    TRUE   TRUE
## 4  Misha  27    TRUE   TRUE
## 5  Sasha  26    TRUE   TRUE
```

, :

```
df[3:5, 2:3]
```

```
##   age student
## 3  23    TRUE
## 4  27    TRUE
## 5  26    TRUE
```

, , — .

:

```
df[1:2,"age"]
```

```
## [1] 26 34
```

! , R , :

```
df[df$age < mean(df$age), 4]
```

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

:

```
df$lovesR[df$age < mean(df$age)]
```

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

```
df[df$age < mean(df$age), 'lovesR']
```

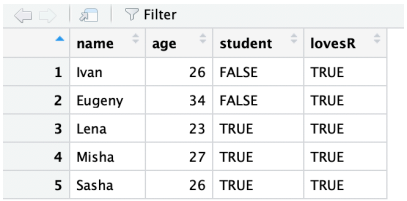
```
## [1] TRUE TRUE TRUE TRUE
```

— , .

RStudio. `View(df)` (Environment). , Excel . , ...[1]

, , , . . .

[1] , , . .



Filter

	name	age	student	lovesR
1	Ivan	26	FALSE	TRUE
2	Eugeny	34	FALSE	TRUE
3	Lena	23	TRUE	TRUE
4	Misha	27	TRUE	TRUE
5	Sasha	26	TRUE	TRUE

Figure 4.1:

Chapter 5

R

5.1

R — . , .
(packages).

. ,
.

- . ,
- . — beepr, :
beep() beep_on_error() . ,
, , .

. , stringi stringr
, R. : igraph
( ). igraph
.

, R,
. data.table tidyverse. ,
R, , , R.
, tidyverse - , , ,
tidyverse.
— mlr3 , “ ”,
.

5.2 R

, R : base , stats, utils, graphics. :

```
rownames(installed.packages(priority = "base"))
```

```
##  [1] "base"      "compiler"  "datasets"  "graphics"  "grDevices" "grid"
##  [7] "methods"   "parallel"  "splines"   "stats"     "stats4"    "tcltk"
## [13] "tools"     "utils"
```

.

5.3 CRAN

install.packages() Comprehensive R Archive Network (CRAN). CRAN 16000 .
CRAN: , - .

remotes. CRAN .

```
install.packages("remotes")
```

. , ,
. - :

!()images/install_success.png

, : -
, - - . , -
, , , ! ,
.

5.4

install.packages() , .
library().

```
library("remotes")
```

install.packages(), library()
, .

```
library(remotes)
```

, .

5.5 ::

- , ,
. ::, (::)
(::), .

package_deps() remotes,
:

```
remotes::package_deps("tidyverse")
```

:: , , .

:: , . ,
tidyverse, dplyr, filter().
R stats, . dplyr,
:: , filter() stats:

```
stats::filter(1:20, rep(1,3))
```

```
## Time Series:
## Start = 1
## End = 20
## Frequency = 1
##  [1] NA  6  9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 NA
```

, ,
, , ::.
- .
detach().

```
detach(package:remotes)
```

5.6 c Bioconductor

, CRAN, — Bioconductor.
.

Bioconductor BiocManager CRAN.

```
install.packages("BiocManager")
```

install() BiocManager flowCore
— .

```
BiocManager::install("flowCore")
```

5.7 Github

CRAN, Bioconductor. ,
- CRAN. ,
CRAN (,) CRAN
, .

Github.
(CRAN,) `remotes`[1].

```
remotes::install_github("dracor-org/rdracor")
```

, .

```
library(rdracor)
godunov <- play_igraph(corpus = "rus",
                       play = "pushkin-boris-godunov")
plot(godunov)
```

```
## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <d0>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <91>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <d0>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <be>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <d1>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <80>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <d0>
```

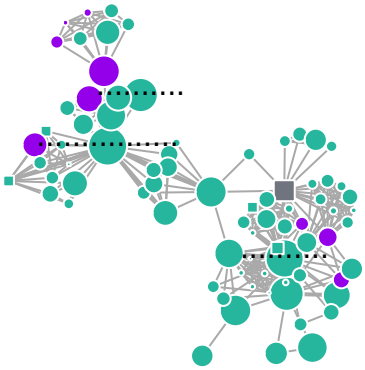
[1] `remotes` “ ” `devtools`, `remote` `devtools`. `devtools/remotes` `remotes`, `devtools::install_github()`. .

```
## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <b8>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <d1>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <81>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                U+0411

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                U+043e

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                U+0440

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                U+0438

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                U+0441

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <d0>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <9f>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <d0>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <b8>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <d0>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <bc>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
```

```
## <d0>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <b5>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <d0>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '   '   'mbcsToSbcs':
## <bd>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                U+041f

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                U+0438

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                U+043c

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                U+0435

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                U+043d

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '     '   'mbcsToSbcs':
## <d0>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '     '   'mbcsToSbcs':
## <93>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '     '   'mbcsToSbcs':
## <d1>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '     '   'mbcsToSbcs':
## <80>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '     '   'mbcsToSbcs':
## <d0>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '     '   'mbcsToSbcs':
## <b8>
```

```
## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '    '   'mbcsToSbcs':
## <d0>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '    '   'mbcsToSbcs':
## <b3>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '    '   'mbcsToSbcs':
## <d0>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '    '   'mbcsToSbcs':
## <be>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '    '   'mbcsToSbcs':
## <d1>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '    '   'mbcsToSbcs':
## <80>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '    '   'mbcsToSbcs':
## <d0>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '    '   'mbcsToSbcs':
## <b8>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '    '   'mbcsToSbcs':
## <d0>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :            '    '   'mbcsToSbcs':
## <b9>

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                U+0413

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                U+0440

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                U+0438

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                U+0433
```

```
## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                  U+043e

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                  U+0440

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                  U+0438

## Warning in text.default(x, y, labels = labels, col = label.color, family =
## label.family, :                                  U+0439
```



`remotes` Bioconductor:

```
remotes::install_bioc("flowCore")
```

5.8

, . ?

. , R , ,
. , ,
!

- . CRAN *(Task View)*
, :

https://cran.r-project.org/web/views/

, - , *Task View*,
Task View .

— , . : R
— ,
, , , .

Chapter 6

, . (
) . , -
— - . , , , [1], , , , .
, : ,
, ( ).

6.1 RStudio

, , “ ”. (,
read.csv() —), ,
:

```
read.csv("heroes_information.csv")
```

```
## Warning in file(file, "rt"):  'heroes_information.csv': No
## such file or directory
```

```
## Error in file(file, "rt"):
```

, R . - , . -
, R . .

- :

, getwd() ( ),
. :

[1] , ,
. — DC Marvel, DC Marvel.

```
heroes <- read.csv("heroes_information.csv")
```

, RStudio , (
“Console”):

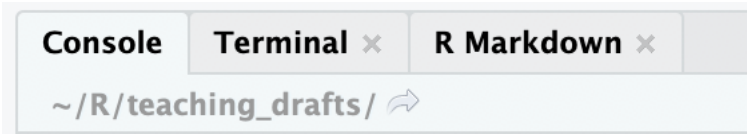


Figure 6.1:

- : .

setwd() , , .
:

```
heroes <- read.csv("heroes_information.csv")
```

! , .

- : .

```
heroes <- read.csv("/Users/Username/Some_Folder/heroes_information.csv")
```

, , !
Windows : / R,
//.

- : Import Dataset.

Environment RStudio “Import Dataset”. ,
— ,
, .

- .

R, , ,
. :

```
heroes <- read.csv("https://raw.githubusercontent.com/agricolamz/2020-2021-ds4dh/maste
```

- : RStudio.

- , . .
, , , .
— , .
— , , data .
.

, —
. , .
`Tool - Global Options...`

6.1.1 :

, - R.
, - . - ,
.

. .
. , , .
? : .

, “ ” (, TextEdit
macOS) : , .
. :
, - - .

`read.table()`.
: ! `read.csv()`, `read.csv2()`
— , `read.table()`, ,
, . .csv, “Comma Separated
Values” (,). .csv —
. .csv , ,
Microsoft Excel .

.csv — , “ ” :
, ( ).
.csv - Microsoft Excel
. !

, — —
. : (. .)
, , .
.csv, (;), - (,).
`read.csv()` `read.csv2()` — “ ” , -
( ) “ ”. .csv,
, , .

- , `read.csv()`
`read.csv2()` .

.csv . , .tsv — , .csv,
- . `read.delim()` `read.delim2()`.
, , `read.table()`.
, “ ” —
. . .

, . file =, ,
stringsAsFactors = FALSE:

```
heroes <- read.csv("data/heroes_information.csv", stringsAsFactors = FALSE)
```

stringsAsFactors = , -
. , - , character,
. - ,
. character,
factor, .
. . R
4.0, stringsAsFactors = FALSE .

View(heroes): ! -
- (read.table(), read.delim()) .
Help.

6.2

( ),
, .

, str():

```
str(heroes)
```

```
## 'data.frame':    734 obs. of  11 variables:
##  $ X         : int  0 1 2 3 4 5 6 7 8 9 ...
##  $ name      : chr  "A-Bomb" "Abe Sapien" "Abin Sur" "Abomination" ...
##  $ Gender    : chr  "Male" "Male" "Male" "Male" ...
##  $ Eye.color : chr  "yellow" "blue" "blue" "green" ...
##  $ Race      : chr  "Human" "Icthyo Sapien" "Ungaran" "Human / Radiation" ...
##  $ Hair.color: chr  "No Hair" "No Hair" "No Hair" "No Hair" ...
##  $ Height    : num  203 191 185 203 -99 193 -99 185 173 178 ...
##  $ Publisher : chr  "Marvel Comics" "Dark Horse Comics" "DC Comics" "Marvel Comics"
##  $ Skin.color: chr  "-" "blue" "red" "-" ...
##  $ Alignment : chr  "good" "good" "good" "bad" ...
##  $ Weight    : int  441 65 90 441 -99 122 -99 88 61 81 ...
```

, ,
.

?

1. NA.
"NA", .
na.strings = read.table() .

, , NA.
, .

2. , , int num. ,
chr (= "character") Factor (stringsAsFactors =
TRUE), , , , NA.

3. . ,
. , , —
(header =
FALSE)

4. . .
"UTF-8" encoding = :

```
heroes <- read.csv("data/heroes_information.csv",
                   stringsAsFactors = FALSE,
                   encoding = "UTF-8")
```

, , .

5. . , , —
sep =. , .

6. , . ,
\ ", read.csv(), read.delim(), read.csv2(),
read.delim2() . ,
, ;, .

7. - . .
. (read.table(), read.csv(), read.delim()), , (read.csv2(),
read.delim2()).

read.csv(),
, , .. .
: - ,
-99. , , ( ).
, , na.strings =
read.csv():

```
heroes <- read.csv("data/heroes_information.csv",
                   stringsAsFactors = FALSE,
                   na.strings = c("-", "-99"))
```

6.3

, DC .csv.

```
dc <- heroes[heroes$Publisher == "DC Comics",]
```

write.csv() .csv:

```
write.csv(dc, "data/dc_heroes_information.csv")
```

, , row.names = FALSE:

```
write.csv(dc, "data/dc_heroes_information.csv", row.names = FALSE)
```

read.csv2(), write.csv2() .csv ;.

```
write.csv2(dc, "data/dc_heroes_information.csv", row.names = FALSE)
```

6.4 : Excel, SPSS

, .
— Microsoft Excel. .xlsx ,
. ,
.csv.

R. ,
:

- Microsoft Excel: readxl (tidyverse), (xlsx, openxlsx).
- SPSS, SAS, Stata: — haven (tidyverse) foreign.

.

6.5

. ,
. read.csv() , ,
. , .

- readr (tidyverse) ,
read.csv(), read.csv2() , :
read_csv() read_csv2(). ,
tidyverse.

```
readr::read_csv("data/heroes_information.csv",
        na = c("-", "-99"))
```

```
## Warning: Missing column names filled in: 'X1' [1]
```

```
##
## -- Column specification --------------------------------------------------------
## cols(
##   X1 = col_double(),
##   name = col_character(),
##   Gender = col_character(),
##   `Eye color` = col_character(),
##   Race = col_character(),
##   `Hair color` = col_character(),
##   Height = col_double(),
##   Publisher = col_character(),
##   `Skin color` = col_character(),
##   Alignment = col_character(),
##   Weight = col_double()
## )
```

```
## # A tibble: 734 x 11
##       X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##    <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
##  1     0 A-Bo~ Male   yellow      Human No Hair         203 Marvel C~
##  2     1 Abe ~ Male   blue        Icth~ No Hair         191 Dark Hor~
##  3     2 Abin~ Male   blue        Unga~ No Hair         185 DC Comics
##  4     3 Abom~ Male   green       Huma~ No Hair         203 Marvel C~
##  5     4 Abra~ Male   blue        Cosm~ Black            NA Marvel C~
##  6     5 Abso~ Male   blue        Human No Hair         193 Marvel C~
##  7     6 Adam~ Male   blue        <NA>  Blond            NA NBC - He~
##  8     7 Adam~ Male   blue        Human Blond           185 DC Comics
##  9     8 Agen~ Female blue        <NA>  Blond           173 Marvel C~
## 10     9 Agen~ Male   brown       Human Brown           178 Marvel C~
## # ... with 724 more rows, and 3 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>
```

- vroom - tidyverse. readr tidyverse, ( ).

```
vroom::vroom("data/heroes_information.csv")
```

```
## New names:
## * `` -> ...1
```

```
## Rows: 734
## Columns: 11
## Delimiter: ","
## chr [8]: name, Gender, Eye color, Race, Hair color, Publisher, Skin color, Alignment
## dbl [3]: ...1, Height, Weight
##
## Use `spec()` to retrieve the guessed column specification
## Pass a specification to the `col_types` argument to quiet this message
```

```
## # A tibble: 734 x 11
##     ...1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##    <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
##  1     0 A-Bo~ Male   yellow      Human No Hair         203 Marvel C~
##  2     1 Abe ~ Male   blue        Icth~ No Hair         191 Dark Hor~
##  3     2 Abin~ Male   blue        Unga~ No Hair         185 DC Comics
##  4     3 Abom~ Male   green       Huma~ No Hair         203 Marvel C~
##  5     4 Abra~ Male   blue        Cosm~ Black           -99 Marvel C~
##  6     5 Abso~ Male   blue        Human No Hair         193 Marvel C~
##  7     6 Adam~ Male   blue        -     Blond           -99 NBC - He~
##  8     7 Adam~ Male   blue        Human Blond           185 DC Comics
##  9     8 Agen~ Female blue        -     Blond           173 Marvel C~
## 10     9 Agen~ Male   brown       Human Brown           178 Marvel C~
## # ... with 724 more rows, and 3 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>
```

- `data.table` - , R, tidyverse. `data.table` - . , . `data.table` - : `fread()` `fwrite()`, **f** **f**ast[2].

```
data.table::fread("data/heroes_information.csv")
```

```
##       V1            name Gender Eye color              Race       Hair color
##   1:   0          A-Bomb   Male    yellow             Human          No Hair
##   2:   1      Abe Sapien   Male      blue     Icthyo Sapien          No Hair
##   3:   2        Abin Sur   Male      blue           Ungaran          No Hair
##   4:   3     Abomination   Male     green Human / Radiation          No Hair
##   5:   4         Abraxas   Male      blue     Cosmic Entity            Black
##  ---
## 730: 729 Yellowjacket II Female      blue             Human Strawberry Blond
## 731: 730            Ymir   Male     white       Frost Giant          No Hair
## 732: 731            Yoda   Male     brown    Yoda's species            White
## 733: 732         Zatanna Female      blue             Human            Black
## 734: 733            Zoom   Male       red                 -            Brown
##      Height         Publisher Skin color Alignment Weight
##   1:  203.0     Marvel Comics          -      good    441
##   2:  191.0 Dark Horse Comics       blue      good     65
##   3:  185.0         DC Comics        red      good     90
##   4:  203.0     Marvel Comics          -       bad    441
##   5:  -99.0     Marvel Comics          -       bad    -99
##  ---
## 730:  165.0     Marvel Comics          -      good     52
## 731:  304.8     Marvel Comics      white      good    -99
```

[2] **f**riendly: `fread()` . `vroom` .

```
## 732:   66.0      George Lucas      green      good     17
## 733:  170.0         DC Comics          -      good     57
## 734:  185.0         DC Comics          -       bad     81
```

? [3] , vroom data.table.

,

read.csv() (R) readr::read_csv() (tidyverse) .

, (!) :

```
readr::write_csv(dc, "data/dc_heroes_information.csv")
readr::write_excel_csv(dc, "data/dc_heroes_information.csv") #     Excel
vroom::vroom_write(dc, "data/dc_heroes_information.csv", delim = ",")
data.table::fwrite(dc, "data/dc_heroes_information.csv")
```

, : vroom data.table

, readr, - R.

[3] — , — .

Chapter 7

7.1 if, else, else if

— . R .
. . c :

```
if (    )
```

:

```
number <- 1
if (number > 0) "           "
```

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

(expression) , . ,
, .

```
number <- 1
if (number > 0) {
  "           "
}
```

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

. [1], ,
. [2], .

else :

```
if (    )       else
```

[1] , , TRUE.
[2] , FALSE.

:

```
number <- -3
if (number > 0) {
  "           "
} else {
  "                "
}
```

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

. else if.

:

```
number <- 0
if (number > 0) {
  "           "
} else if (number < 0){
  "           "
} else {
  "   "
}
```

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

, R — , . —
R! , .

```
number <- -2:2
if (number > 0) {
  "           "
} else if (number < 0){
  "           "
} else {
  "   "
}
```

```
## Warning in if (number > 0) {: > 1,
##
```

```
## Warning in if (number < 0) {: > 1,
##
```

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

R , .
. ?

7.2 for

- , for. for .

for(in)

for. , :

```
for (i in number) {
  if (i > 0) {
    print("           ")
  } else if (i < 0) {
    print("           ")
  } else {
    print("  ")
  }
}
```

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

for, print().

, for R . for
. R ,
. - ,
. , .
. - , -
- .
( ), for .

, , for
, , cumsum() .

```
cumsum(1:10)
```

```
##  [1]  1  3  6 10 15 21 28 36 45 55
```

, apply() (.
@ref(apply_f)).

- , .
- for ,
. , .

for? , , ,
, .
for . , ,

for - (, ,) .
, :

```
number_descriptions <- character(length(number)) #                    ,
for (i in 1:length(number)) {
  if (number[i] > 0) {
    number_descriptions[i] <- "           "
  } else if (number[i] < 0) {
    number_descriptions[i] <- "           "
  } else {
    number_descriptions[i] <- "   "
  }
}
number_descriptions
```

```
## [1] "           " " "           " " "   "
## [4] "           " " "           "
```

, for .
, , , , . ,
for , ,
, tidyverse (. [pipe]).

7.3 : ifelse() dplyr::case_when()

for ifelse().
ifelse() - 1) (. . , TRUE FALSE), 2) TRUE, 3) FALSE.
, ( ).

```
ifelse(number > 0, "           ", "                ")
```

```
## [1] "                " " "                "
## [3] "                " " "           "
## [5] "           "
```

: ifelse(, TRUE, FALSE).
, . . , TRUE FALSE
TRUE FALSE . ,
!

ifelse() : else if.
ifelse() ifelse():

```
ifelse(number > 0,
       "           ",
```

```
       ifelse(number < 0, "           ", "   "))
```

```
## [1] "           " " "           " "   "
## [4] "           " " "           "
```

dplyr (tidyverse) — case_when(),
:

```
dplyr::case_when(
  number > 0 ~ "           ",
  number < 0 ~ "           ",
  number == 0 ~ "   ")
```

```
## [1] "           " " "           " "   "
## [4] "           " " "           "
```

Chapter 8

R

8.1

, R. , ,
, ! .
. function,
, - . ,
. — , .
“ ”
, , , ,
. , ,
. . ,
return(). return() ,
return(), .

```
pow <- function(x, p) {
  power <- x ^ p
  return(power)
}
pow(3, 2)
```

```
## [1] 9
```

, return() ,
.

```
pow <- function(x, p) {
  x ^ p
}
pow(3, 2)
```

```
## [1] 9
```

, . :
, . ,
.

```
pow <- function(x, p) {
  power <- x ^ p #                ,                    !
}
pow(3, 2) #
```

, .

```
pow <- function(x, p) x ^ p
pow(3, 2)
```

```
## [1] 9
```

, , ,
. , .

.

```
pow <- function(x, p = 2) x ^ p
pow(3)
```

```
## [1] 9
```

```
pow(3, 3)
```

```
## [1] 27
```

R **(lazy evaluations)**. ,
, . , ,
we_will_not_use_this_parameter =, .

```
pow <- function(x, p = 2, we_will_not_use_this_parameter) x ^ p
pow(x = 3)
```

```
## [1] 9
```

8.2

— .
, , ,
, .

,
. ,
, . ,
,

. ,
(sanity check).

imt(), , (
weight =) (height =) .

```
imt <- function(weight, height) weight / height ^ 2
```

, :

```
w <- c(60, 80, 120)
h <- c(1.6, 1.7, 1.8)
imt(weight = w, height = h)
```

```
## [1] 23.43750 27.68166 37.03704
```

. ,
, , , , 3. warning()

```
imt <- function(weight, height) {
  if (height > 3) warning("          height     3:     ,          ,          \n")
  weight / height ^ 2
}
imt(78, 167)
```

```
## Warning in imt(78, 167):          height     3:     ,          ,
```

```
## [1] 0.002796802
```

, ,
. , - imt() 0.
, , .

```
imt <- function(weight, height) {
  if (any(weight <= 0 | height <= 0)) stop("                                    ")
  if (height > 3) warning("          height     3:     ,          ,          \n")
  weight / height ^ 2
}
imt(-78, 167)
```

```
## Error in imt(-78, 167):
```

, , -
, - - . ,
- - , , .

R ( ) , ,
. ,
. -
R.

R ,
.

8.3 ?

? “ ” — ,
. , , , .
, .

: , ,
, .
, , (, - ,
R), . ,
, . ,
— R.

, — . , , .

8.4

, — . , R —
. function — function(). (, { — !

— R. ,
, R (, . .). ,
:

```
list(mean, min, `{`)
```

```
## [[1]]
## function (x, ...)
## UseMethod("mean")
## <bytecode: 0x7ff0cd8f9c08>
## <environment: namespace:base>
##
## [[2]]
## function (..., na.rm = FALSE)  .Primitive("min")
##
## [[3]]
## .Primitive("{")
```

! — , !

[1], ,

[1] , , .

. , - , .
, , .
apply() (@ref(apply_f) tidyverse.

Python : ,
(,) .

8.5 apply()

8.5.1 apply()

? , : apply(), lapply(),sapply(), vapply(),tapply(),mapply(), rapply()… , , . - .
:

```
A <- matrix(1:12, 3, 4)
A
```

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

apply() ( ).
apply() , .
, , ,
. ,
, .

, - (,) . apply()
“ ” . : apply(X, MARGIN, FUN, ...), X — , MARGIN 1 ( ), 2 ( ), c(1,2) (. .), FUN — , ! apply()
/ X .

, . ,
, .

:

```
apply(A, 1, sum) #
```

```
## [1] 22 26 30
```

```
apply(A, 2, sum) #
```

```
## [1]  6 15 24 33
```

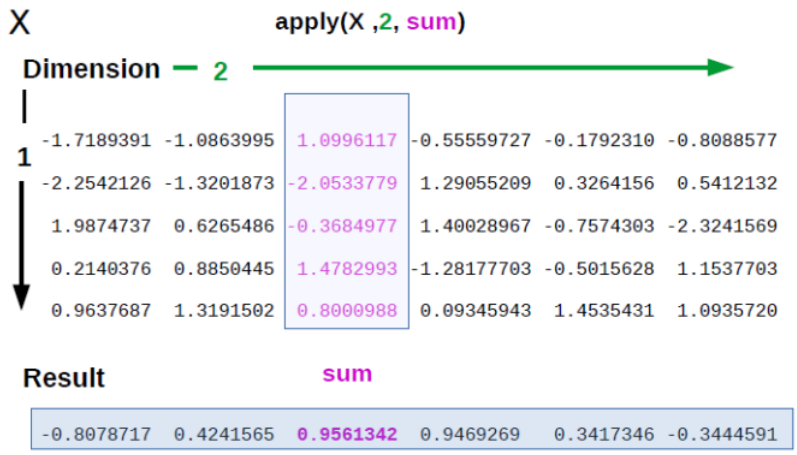


Figure 8.1: apply

```
apply(A, c(1,2), sum) # ...
```

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

R colSums(), rowSums(), colMeans() rowMeans(), apply() .

, :

```
apply(A, 1, sum, na.rm = TRUE)
```

```
## [1] 22 26 30
```

```
apply(A, 1, weighted.mean, w = c(0.2, 0.4, 0.3, 0.1))
```

```
## [1] 4.9 5.9 6.9
```

8.5.2

, - , ?
, ? .

- , .

- . , .

, :

```
apply(A, 1, function(x) x - mean(x)) #
```

```
##      [,1] [,2] [,3]
## [1,] -4.5 -4.5 -4.5
## [2,] -1.5 -1.5 -1.5
## [3,]  1.5  1.5  1.5
## [4,]  4.5  4.5  4.5
```

```
apply(A, 2, function(x) x - mean(x)) #
```

```
##      [,1] [,2] [,3] [,4]
## [1,]   -1   -1   -1   -1
## [2,]    0    0    0    0
## [3,]    1    1    1    1
```

```
apply(A, c(1,2), function(x) x - mean(x)) #                , . .
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    0    0    0    0
## [2,]    0    0    0    0
## [3,]    0    0    0    0
```

, x , - ,
, . , , :

```
apply(A, 1, function(whatevername) whatevername - mean(whatevername))
```

```
##      [,1] [,2] [,3]
## [1,] -4.5 -4.5 -4.5
## [2,] -1.5 -1.5 -1.5
## [3,]  1.5  1.5  1.5
## [4,]  4.5  4.5  4.5
```

8.5.3 apply()

, apply() . ? , ,
lapply ( ) sapply() - lapply(),
“ ” .

```
some_list <- list(some = 1:10, list = letters)
lapply(some_list, length)
```

```
## $some
## [1] 10
##
## $list
## [1] 26
```

```
sapply(some_list, length)
```

```
## some list
##   10   26
```

sapply() ,
.

```
sapply(1:10, sqrt)
```

```
##  [1] 1.000000 1.414214 1.732051 2.000000 2.236068 2.449490 2.645751 2.828427
##  [9] 3.000000 3.162278
```

```
sqrt(1:10)
```

```
##  [1] 1.000000 1.414214 1.732051 2.000000 2.236068 2.449490 2.645751 2.828427
##  [9] 3.000000 3.162278
```

sapply(), ?
. , sapply() ,
for.

- Vectorize().
apply().

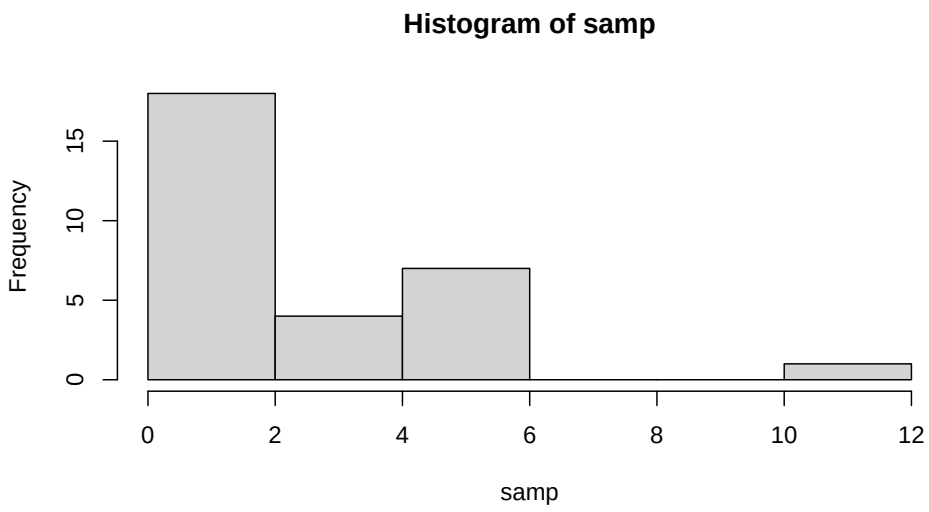
lapply() sapply() . -
(. ??), :

```
heroes <- read.csv("data/heroes_information.csv",
                   na.strings = c("-", "-99"))
sapply(heroes, class)
```

```
##           X        name      Gender   Eye.color        Race  Hair.color
##   "integer" "character" "character" "character" "character" "character"
##      Height   Publisher  Skin.color   Alignment      Weight
##   "numeric" "character" "character" "character"   "integer"
```

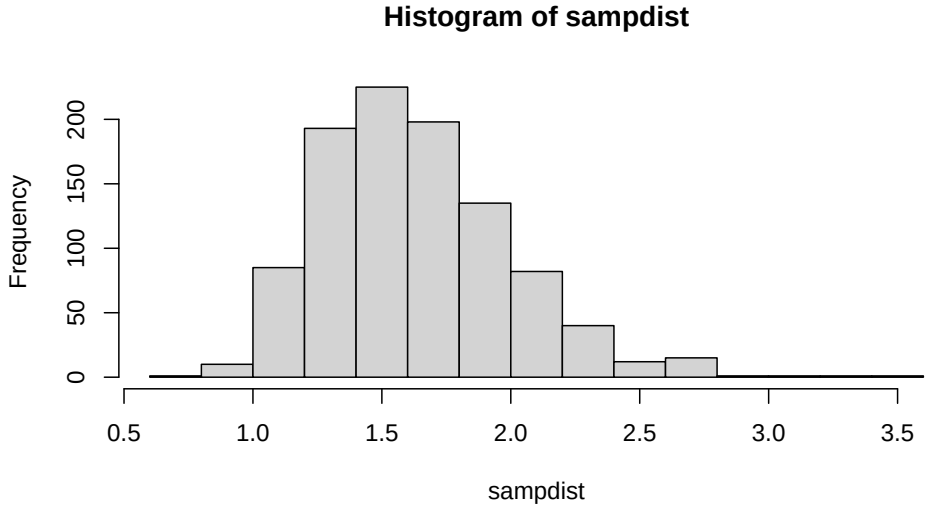
apply() - replicate() -
. . ,
:

```
samp <- rlnorm(30)
hist(samp)
```



1000 :

```
sampdist <- replicate(1000, mean(rlnorm(30)))
hist(sampdist)
```



.

apply() , .

, apply() — , tidyverse purrr. , apply(), purrr.

Chapter 9

tidyverse

9.1 tidyverse

tidyverse - , . ( ), -
.

tidyverse — :

- *ggplot2*,
- *tibble*, ,
- *tidyr*, tidy data
- *readr*, R
- *purrr*, (*apply())
- *dplyr*,
- *stringr*,
- *forcats*, -

, , :

- *vroom*,
- *readxl*, .xls .xlsx
- *jsonlite*, JSON
- *xml*, XML
- *DBI*,
- *rvest*, -
- *lubridate*,
- *tidytext*,
- *glue*,
- *magrtittr*, pipe
- *tidymodels*, [1]

[1] `tidyverse`, `tidymodels` — .

- *dtplyr*, dplyr data.table

tidyverse! , tidyverse.
tidyverse , tidyverse
.

tidyverse tidy . , ,
, .

tidyverse.

```
install.packages("tidyverse")
```

tidyverse — .

```
library("tidyverse")
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.0 --
## v ggplot2 3.3.2     v purrr   0.3.4
## v tibble  3.0.4     v dplyr   1.0.2
## v tidyr   1.1.2     v stringr 1.4.0
## v readr   1.4.0     v forcats 0.5.0
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

tidyverse tidyverse,
.

9.2 readr

.csv R read.csv(),
read_csv() readr. read_csv() read.csv():
(URL), .

```
heroes <- read_csv("data/heroes_information.csv",
                   na = c("-", "-99"))
```

```
## Warning: Missing column names filled in: 'X1' [1]
##
## -- Column specification --------------------------------------------------------
## cols(
##   X1 = col_double(),
##   name = col_character(),
##   Gender = col_character(),
##   `Eye color` = col_character(),
##   Race = col_character(),
```

```
##   `Hair color` = col_character(),
##   Height = col_double(),
##   Publisher = col_character(),
##   `Skin color` = col_character(),
##   Alignment = col_character(),
##   Weight = col_double()
## )
```

, tidyverse, @ref(real_data).

9.3 tibble

read_csv(), tibble, data.frame:

```
class(heroes)
```

```
## [1] "spec_tbl_df" "tbl_df"      "tbl"         "data.frame"
```

(tibble) - “ ” data.frame. , data.frame,
. . -
:

```
heroes
```

```
## # A tibble: 734 x 11
##       X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##    <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
##  1     0 A-Bo~ Male   yellow      Human No Hair         203 Marvel C~
##  2     1 Abe ~ Male   blue        Icth~ No Hair         191 Dark Hor~
##  3     2 Abin~ Male   blue        Unga~ No Hair         185 DC Comics
##  4     3 Abom~ Male   green       Huma~ No Hair         203 Marvel C~
##  5     4 Abra~ Male   blue        Cosm~ Black            NA Marvel C~
##  6     5 Abso~ Male   blue        Human No Hair         193 Marvel C~
##  7     6 Adam~ Male   blue        <NA>  Blond            NA NBC - He~
##  8     7 Adam~ Male   blue        Human Blond           185 DC Comics
##  9     8 Agen~ Female blue        <NA>  Blond           173 Marvel C~
## 10     9 Agen~ Male   brown       Human Brown           178 Marvel C~
## # ... with 724 more rows, and 3 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>
```

10 , - , .
.

tidyverse .
, :

```
heroes_df <- as.data.frame(heroes) #
class(heroes_df)
```

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

```
as_tibble(heroes_df) #
```

```
## # A tibble: 734 x 11
##       X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##    <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
##  1     0 A-Bo~ Male   yellow      Human No Hair         203 Marvel C~
##  2     1 Abe ~ Male   blue        Icth~ No Hair         191 Dark Hor~
##  3     2 Abin~ Male   blue        Unga~ No Hair         185 DC Comics
##  4     3 Abom~ Male   green       Huma~ No Hair         203 Marvel C~
##  5     4 Abra~ Male   blue        Cosm~ Black            NA Marvel C~
##  6     5 Abso~ Male   blue        Human No Hair         193 Marvel C~
##  7     6 Adam~ Male   blue        <NA>  Blond            NA NBC - He~
##  8     7 Adam~ Male   blue        Human Blond           185 DC Comics
##  9     8 Agen~ Female blue        <NA>  Blond           173 Marvel C~
## 10     9 Agen~ Male   brown       Human Brown           178 Marvel C~
## # ... with 724 more rows, and 3 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>
```

tidyverse, , ,
. , .

tibble(), data.frame():

```
tibble(
  a = 1:3,
  b = letters[1:3]
)
```

```
## # A tibble: 3 x 2
##       a b
##   <int> <chr>
## 1     1 a
## 2     2 b
## 3     3 c
```

9.4 magrittr::%>%

%>% “ ” (pipe), . . “ ”. , ( )
(,). ,
, .
. ,
. , - , .

magrittr[2]. , tidyverse,
.

, - [3].
.

...

```
sum(sqrt(abs(sin(1:22))))
```

```
## [1] 16.72656
```

... :

```
1:22 %>%
  sin() %>%
  abs() %>%
  sqrt() %>%
  sum()
```

```
## [1] 16.72656
```

(
). ., ,
%>%.

```
"       !" %>%
  c("--", ., "--")
```

```
## [1] "--"            "       !" "--"
```

9.5 tidyverse: dplyr tidyr

dplyr[4] — tidyverse.
. dplyr plyr,
plyr, , , .

tidyr dplyr, .
(“ ”) , :

-
-
-

, dplyr , tidyr
. ,
,

[2] , %>% tidyverse, magrittr
tidyverse. , magrittr .
[3] , .
[4] , . : , , .

. , ( ),
::,
, .

tidyr — reshape2,
reshape. plyr, ,
, .

dplyr tidyr , . dplyr
tidyr , .
, .
, .

9.6

9.6.1 : dplyr::select()

dplyr::select() ( ).

```
heroes %>%
  select(1,5)
```

```
## # A tibble: 734 x 2
##       X1 Race
##    <dbl> <chr>
##  1     0 Human
##  2     1 Icthyo Sapien
##  3     2 Ungaran
##  4     3 Human / Radiation
##  5     4 Cosmic Entity
##  6     5 Human
##  7     6 <NA>
##  8     7 Human
##  9     8 <NA>
## 10     9 Human
## # ... with 724 more rows
```

```
heroes %>%
  select(name, Race, Publisher, `Hair color`)
```

```
## # A tibble: 734 x 4
##    name          Race             Publisher         `Hair color`
##    <chr>         <chr>            <chr>             <chr>
##  1 A-Bomb        Human            Marvel Comics     No Hair
##  2 Abe Sapien    Icthyo Sapien    Dark Horse Comics No Hair
##  3 Abin Sur      Ungaran          DC Comics         No Hair
```

```
##  4 Abomination   Human / Radiation Marvel Comics     No Hair
##  5 Abraxas       Cosmic Entity     Marvel Comics     Black
##  6 Absorbing Man Human             Marvel Comics     No Hair
##  7 Adam Monroe   <NA>              NBC - Heroes      Blond
##  8 Adam Strange  Human             DC Comics         Blond
##  9 Agent 13      <NA>              Marvel Comics     Blond
## 10 Agent Bob     Human             Marvel Comics     Brown
## # ... with 724 more rows
```

, , , ,
(??). ,
‘ (, ~).

, tidyverse / . ,
, :

```
heroes_some_cols <- heroes %>%
  select(name, Race, Publisher, `Hair color`)
heroes_some_cols
```

```
## # A tibble: 734 x 4
##    name          Race              Publisher         `Hair color`
##    <chr>         <chr>             <chr>             <chr>
##  1 A-Bomb        Human             Marvel Comics     No Hair
##  2 Abe Sapien    Icthyo Sapien     Dark Horse Comics No Hair
##  3 Abin Sur      Ungaran           DC Comics         No Hair
##  4 Abomination   Human / Radiation Marvel Comics     No Hair
##  5 Abraxas       Cosmic Entity     Marvel Comics     Black
##  6 Absorbing Man Human             Marvel Comics     No Hair
##  7 Adam Monroe   <NA>              NBC - Heroes      Blond
##  8 Adam Strange  Human             DC Comics         Blond
##  9 Agent 13      <NA>              Marvel Comics     Blond
## 10 Agent Bob     Human             Marvel Comics     Brown
## # ... with 724 more rows
```

9.6.2 - tidyselect

(select(), tidyverse)
- tidyselect [5]. tidyselect .

: (
1).

```
heroes %>%
  select(name:Publisher)
```

[5] magrittr, tidyselect tidyverse,
tidyverse.

```
## # A tibble: 734 x 7
##    name       Gender `Eye color` Race          `Hair color` Height Publisher
##    <chr>      <chr>  <chr>       <chr>         <chr>         <dbl> <chr>
##  1 A-Bomb     Male   yellow      Human         No Hair         203 Marvel Comics
##  2 Abe Sapien Male   blue        Icthyo Sapien No Hair         191 Dark Horse C~
##  3 Abin Sur   Male   blue        Ungaran       No Hair         185 DC Comics
##  4 Abominati~ Male   green       Human / Radi~ No Hair         203 Marvel Comics
##  5 Abraxas    Male   blue        Cosmic Entity Black            NA Marvel Comics
##  6 Absorbing~ Male   blue        Human         No Hair         193 Marvel Comics
##  7 Adam Monr~ Male   blue        <NA>          Blond            NA NBC - Heroes
##  8 Adam Stra~ Male   blue        Human         Blond           185 DC Comics
##  9 Agent 13   Female blue        <NA>          Blond           173 Marvel Comics
## 10 Agent Bob  Male   brown       Human         Brown           178 Marvel Comics
## # ... with 724 more rows
```

```
heroes %>%
  select(name:`Eye color`, Publisher:Weight)
```

```
## # A tibble: 734 x 7
##    name         Gender `Eye color` Publisher       `Skin color` Alignment Weight
##    <chr>        <chr>  <chr>       <chr>           <chr>        <chr>      <dbl>
##  1 A-Bomb       Male   yellow      Marvel Comics   <NA>         good         441
##  2 Abe Sapien   Male   blue        Dark Horse Com~ blue         good          65
##  3 Abin Sur     Male   blue        DC Comics       red          good          90
##  4 Abomination  Male   green       Marvel Comics   <NA>         bad          441
##  5 Abraxas      Male   blue        Marvel Comics   <NA>         bad           NA
##  6 Absorbing M~ Male   blue        Marvel Comics   <NA>         bad          122
##  7 Adam Monroe  Male   blue        NBC - Heroes    <NA>         good          NA
##  8 Adam Strange Male   blue        DC Comics       <NA>         good          88
##  9 Agent 13     Female blue        Marvel Comics   <NA>         good          61
## 10 Agent Bob    Male   brown       Marvel Comics   <NA>         good          81
## # ... with 724 more rows
```

     !   .

```
heroes %>%
  select(!X1)
```

```
## # A tibble: 734 x 10
##    name  Gender `Eye color` Race  `Hair color` Height Publisher `Skin color`
##    <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>     <chr>
##  1 A-Bo~ Male   yellow      Human No Hair         203 Marvel C~ <NA>
##  2 Abe ~ Male   blue        Icth~ No Hair         191 Dark Hor~ blue
##  3 Abin~ Male   blue        Unga~ No Hair         185 DC Comics red
##  4 Abom~ Male   green       Huma~ No Hair         203 Marvel C~ <NA>
##  5 Abra~ Male   blue        Cosm~ Black            NA Marvel C~ <NA>
##  6 Abso~ Male   blue        Human No Hair         193 Marvel C~ <NA>
##  7 Adam~ Male   blue        <NA>  Blond            NA NBC - He~ <NA>
```

```
##  8 Adam~ Male   blue        Human Blond           185 DC Comics <NA>
##  9 Agen~ Female blue        <NA>  Blond           173 Marvel C~ <NA>
## 10 Agen~ Male   brown       Human Brown           178 Marvel C~ <NA>
## # ... with 724 more rows, and 2 more variables: Alignment <chr>, Weight <dbl>
```

```
heroes %>%
  select(!(Gender:Height))
```

```
## # A tibble: 734 x 6
##       X1 name          Publisher         `Skin color` Alignment Weight
##    <dbl> <chr>         <chr>             <chr>        <chr>      <dbl>
##  1     0 A-Bomb        Marvel Comics     <NA>         good         441
##  2     1 Abe Sapien    Dark Horse Comics blue         good          65
##  3     2 Abin Sur      DC Comics         red          good          90
##  4     3 Abomination   Marvel Comics     <NA>         bad          441
##  5     4 Abraxas       Marvel Comics     <NA>         bad           NA
##  6     5 Absorbing Man Marvel Comics     <NA>         bad          122
##  7     6 Adam Monroe   NBC - Heroes      <NA>         good          NA
##  8     7 Adam Strange  DC Comics         <NA>         good          88
##  9     8 Agent 13      Marvel Comics     <NA>         good          61
## 10     9 Agent Bob     Marvel Comics     <NA>         good          81
## # ... with 724 more rows
```

(& |) tidyselect.

:, tidyselect ,
tidyselect.

last_col() :

```
heroes %>%
  select(name:last_col())
```

```
## # A tibble: 734 x 10
##    name  Gender `Eye color` Race  `Hair color` Height Publisher `Skin color`
##    <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>     <chr>
##  1 A-Bo~ Male   yellow      Human No Hair         203 Marvel C~ <NA>
##  2 Abe ~ Male   blue        Icth~ No Hair         191 Dark Hor~ blue
##  3 Abin~ Male   blue        Unga~ No Hair         185 DC Comics red
##  4 Abom~ Male   green       Huma~ No Hair         203 Marvel C~ <NA>
##  5 Abra~ Male   blue        Cosm~ Black            NA Marvel C~ <NA>
##  6 Abso~ Male   blue        Human No Hair         193 Marvel C~ <NA>
##  7 Adam~ Male   blue        <NA>  Blond            NA NBC - He~ <NA>
##  8 Adam~ Male   blue        Human Blond           185 DC Comics <NA>
##  9 Agen~ Female blue        <NA>  Blond           173 Marvel C~ <NA>
## 10 Agen~ Male   brown       Human Brown           178 Marvel C~ <NA>
## # ... with 724 more rows, and 2 more variables: Alignment <chr>, Weight <dbl>
```

everything() .

```
heroes %>%
  select(everything())
```

```
## # A tibble: 734 x 11
##       X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##    <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
##  1     0 A-Bo~ Male   yellow      Human No Hair         203 Marvel C~
##  2     1 Abe ~ Male   blue        Icth~ No Hair         191 Dark Hor~
##  3     2 Abin~ Male   blue        Unga~ No Hair         185 DC Comics
##  4     3 Abom~ Male   green       Huma~ No Hair         203 Marvel C~
##  5     4 Abra~ Male   blue        Cosm~ Black            NA Marvel C~
##  6     5 Abso~ Male   blue        Human No Hair         193 Marvel C~
##  7     6 Adam~ Male   blue        <NA>  Blond            NA NBC - He~
##  8     7 Adam~ Male   blue        Human Blond           185 DC Comics
##  9     8 Agen~ Female blue        <NA>  Blond           173 Marvel C~
## 10     9 Agen~ Male   brown       Human Brown           178 Marvel C~
## # ... with 724 more rows, and 3 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>
```

everything() , everything()
:

```
heroes %>%
  select(name, Publisher, everything())
```

```
## # A tibble: 734 x 11
##    name  Publisher    X1 Gender `Eye color` Race  `Hair color` Height
##    <chr> <chr>     <dbl> <chr>  <chr>       <chr> <chr>         <dbl>
##  1 A-Bo~ Marvel C~     0 Male   yellow      Human No Hair         203
##  2 Abe ~ Dark Hor~     1 Male   blue        Icth~ No Hair         191
##  3 Abin~ DC Comics     2 Male   blue        Unga~ No Hair         185
##  4 Abom~ Marvel C~     3 Male   green       Huma~ No Hair         203
##  5 Abra~ Marvel C~     4 Male   blue        Cosm~ Black            NA
##  6 Abso~ Marvel C~     5 Male   blue        Human No Hair         193
##  7 Adam~ NBC - He~     6 Male   blue        <NA>  Blond            NA
##  8 Adam~ DC Comics     7 Male   blue        Human Blond           185
##  9 Agen~ Marvel C~     8 Female blue        <NA>  Blond           173
## 10 Agen~ Marvel C~     9 Male   brown       Human Brown           178
## # ... with 724 more rows, and 3 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>
```

, relocate() (@ref(tidy_relocate))
. , ends_with() ,
:

```
heroes %>%
  select(ends_with("color"))
```

```
## # A tibble: 734 x 3
##    `Eye color` `Hair color` `Skin color`
##    <chr>       <chr>        <chr>
##  1 yellow      No Hair      <NA>
##  2 blue        No Hair      blue
##  3 blue        No Hair      red
##  4 green       No Hair      <NA>
##  5 blue        Black        <NA>
##  6 blue        No Hair      <NA>
##  7 blue        Blond        <NA>
##  8 blue        Blond        <NA>
##  9 blue        Blond        <NA>
## 10 brown       Brown        <NA>
## # ... with 724 more rows
```

, starts_with() , contains() — [6].

```
heroes %>%
  select(starts_with("Eye") & ends_with("color"))
```

```
## # A tibble: 734 x 1
##    `Eye color`
##    <chr>
##  1 yellow
##  2 blue
##  3 blue
##  4 green
##  5 blue
##  6 blue
##  7 blue
##  8 blue
##  9 blue
## 10 brown
## # ... with 724 more rows
```

```
heroes %>%
  select(contains("eight"))
```

```
## # A tibble: 734 x 2
##    Height Weight
##     <dbl>  <dbl>
##  1    203    441
##  2    191     65
##  3    185     90
```

[6] , , contains() matches().

```
##  4    203    441
##  5     NA     NA
##  6    193    122
##  7     NA     NA
##  8    185     88
##  9    173     61
## 10    178     81
## # ... with 724 more rows
```

, where().
sapply()(@ref(apply_other)) :
where , , ,
TRUE.

```
heroes %>%
  select(where(is.numeric))
```

```
## # A tibble: 734 x 3
##       X1 Height Weight
##    <dbl>  <dbl>  <dbl>
##  1     0    203    441
##  2     1    191     65
##  3     2    185     90
##  4     3    203    441
##  5     4     NA     NA
##  6     5    193    122
##  7     6     NA     NA
##  8     7    185     88
##  9     8    173     61
## 10     9    178     81
## # ... with 724 more rows
```

where() . , NA:

```
heroes %>%
  select(where(function(x) !any(is.na(x))))
```

```
## # A tibble: 734 x 3
##       X1 name          Publisher
##    <dbl> <chr>         <chr>
##  1     0 A-Bomb        Marvel Comics
##  2     1 Abe Sapien    Dark Horse Comics
##  3     2 Abin Sur      DC Comics
##  4     3 Abomination   Marvel Comics
##  5     4 Abraxas       Marvel Comics
##  6     5 Absorbing Man Marvel Comics
##  7     6 Adam Monroe   NBC - Heroes
##  8     7 Adam Strange  DC Comics
```

```
##  9     8 Agent 13      Marvel Comics
## 10     9 Agent Bob     Marvel Comics
## # ... with 724 more rows
```

9.6.3 : dplyr::rename()

select() , :

```
heroes %>%
  select(id = X1)
```

```
## # A tibble: 734 x 1
##       id
##    <dbl>
##  1     0
##  2     1
##  3     2
##  4     3
##  5     4
##  6     5
##  7     6
##  8     7
##  9     8
## 10     9
## # ... with 724 more rows
```

dplyr::rename(). ,
select(), rename() , .

```
heroes %>%
  rename(id = X1)
```

```
## # A tibble: 734 x 11
##       id name  Gender `Eye color` Race  `Hair color` Height Publisher
##    <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
##  1     0 A-Bo~ Male   yellow      Human No Hair         203 Marvel C~
##  2     1 Abe ~ Male   blue        Icth~ No Hair         191 Dark Hor~
##  3     2 Abin~ Male   blue        Unga~ No Hair         185 DC Comics
##  4     3 Abom~ Male   green       Huma~ No Hair         203 Marvel C~
##  5     4 Abra~ Male   blue        Cosm~ Black            NA Marvel C~
##  6     5 Abso~ Male   blue        Human No Hair         193 Marvel C~
##  7     6 Adam~ Male   blue        <NA>  Blond            NA NBC - He~
##  8     7 Adam~ Male   blue        Human Blond           185 DC Comics
##  9     8 Agen~ Female blue        <NA>  Blond           173 Marvel C~
## 10     9 Agen~ Male   brown       Human Brown           178 Marvel C~
## # ... with 724 more rows, and 3 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>
```

rename_with().
tidyselect ( ) ,

```
heroes %>%
  rename_with(make.names)
```

```
## # A tibble: 734 x 11
##       X1 name  Gender Eye.color Race  Hair.color Height Publisher Skin.color
##    <dbl> <chr> <chr>  <chr>     <chr> <chr>       <dbl> <chr>     <chr>
##  1     0 A-Bo~ Male   yellow    Human No Hair       203 Marvel C~ <NA>
##  2     1 Abe ~ Male   blue      Icth~ No Hair       191 Dark Hor~ blue
##  3     2 Abin~ Male   blue      Unga~ No Hair       185 DC Comics red
##  4     3 Abom~ Male   green     Huma~ No Hair       203 Marvel C~ <NA>
##  5     4 Abra~ Male   blue      Cosm~ Black          NA Marvel C~ <NA>
##  6     5 Abso~ Male   blue      Human No Hair       193 Marvel C~ <NA>
##  7     6 Adam~ Male   blue      <NA>  Blond          NA NBC - He~ <NA>
##  8     7 Adam~ Male   blue      Human Blond         185 DC Comics <NA>
##  9     8 Agen~ Female blue      <NA>  Blond         173 Marvel C~ <NA>
## 10     9 Agen~ Male   brown     Human Brown         178 Marvel C~ <NA>
## # ... with 724 more rows, and 2 more variables: Alignment <chr>, Weight <dbl>
```

9.6.4 : dplyr::relocate()

relocate().
select() rename()[7]. rename(), relocate()
:

```
heroes %>%
  relocate(Publisher)
```

```
## # A tibble: 734 x 11
##    Publisher    X1 name  Gender `Eye color` Race  `Hair color` Height
##    <chr>     <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl>
##  1 Marvel C~     0 A-Bo~ Male   yellow      Human No Hair         203
##  2 Dark Hor~     1 Abe ~ Male   blue        Icth~ No Hair         191
##  3 DC Comics     2 Abin~ Male   blue        Unga~ No Hair         185
##  4 Marvel C~     3 Abom~ Male   green       Huma~ No Hair         203
##  5 Marvel C~     4 Abra~ Male   blue        Cosm~ Black            NA
##  6 Marvel C~     5 Abso~ Male   blue        Human No Hair         193
##  7 NBC - He~     6 Adam~ Male   blue        <NA>  Blond            NA
##  8 DC Comics     7 Adam~ Male   blue        Human Blond           185
##  9 Marvel C~     8 Agen~ Female blue        <NA>  Blond           173
## 10 Marvel C~     9 Agen~ Male   brown       Human Brown           178
## # ... with 724 more rows, and 3 more variables: `Skin color` <chr>,
```

[7] relocate() select() rename()

```
## #   Alignment <chr>, Weight <dbl>
```

relocate() .after = .before =, ,
.

```
heroes %>%
  relocate(Publisher, .after = name)
```

```
## # A tibble: 734 x 11
##       X1 name  Publisher Gender `Eye color` Race  `Hair color` Height
##    <dbl> <chr> <chr>     <chr>  <chr>       <chr> <chr>         <dbl>
##  1     0 A-Bo~ Marvel C~ Male   yellow      Human No Hair         203
##  2     1 Abe ~ Dark Hor~ Male   blue        Icth~ No Hair         191
##  3     2 Abin~ DC Comics Male   blue        Unga~ No Hair         185
##  4     3 Abom~ Marvel C~ Male   green       Huma~ No Hair         203
##  5     4 Abra~ Marvel C~ Male   blue        Cosm~ Black            NA
##  6     5 Abso~ Marvel C~ Male   blue        Human No Hair         193
##  7     6 Adam~ NBC - He~ Male   blue        <NA>  Blond            NA
##  8     7 Adam~ DC Comics Male   blue        Human Blond           185
##  9     8 Agen~ Marvel C~ Female blue        <NA>  Blond           173
## 10     9 Agen~ Marvel C~ Male   brown       Human Brown           178
## # ... with 724 more rows, and 3 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>
```

relocate() tidyselect. ,
:

```
heroes %>%
  relocate(Publisher, where(is.numeric), .after = name)
```

```
## # A tibble: 734 x 11
##    name  Publisher    X1 Height Weight Gender `Eye color` Race  `Hair color`
##    <chr> <chr>     <dbl>  <dbl>  <dbl> <chr>  <chr>       <chr> <chr>
##  1 A-Bo~ Marvel C~     0    203    441 Male   yellow      Human No Hair
##  2 Abe ~ Dark Hor~     1    191     65 Male   blue        Icth~ No Hair
##  3 Abin~ DC Comics     2    185     90 Male   blue        Unga~ No Hair
##  4 Abom~ Marvel C~     3    203    441 Male   green       Huma~ No Hair
##  5 Abra~ Marvel C~     4     NA     NA Male   blue        Cosm~ Black
##  6 Abso~ Marvel C~     5    193    122 Male   blue        Human No Hair
##  7 Adam~ NBC - He~     6     NA     NA Male   blue        <NA>  Blond
##  8 Adam~ DC Comics     7    185     88 Male   blue        Human Blond
##  9 Agen~ Marvel C~     8    173     61 Female blue        <NA>  Blond
## 10 Agen~ Marvel C~     9    178     81 Male   brown       Human Brown
## # ... with 724 more rows, and 2 more variables: `Skin color` <chr>,
## #   Alignment <chr>
```

— pull(). ,
$, .. . tidyverse,
:

```
heroes %>%
  select(Height) %>%
  pull() %>%
  head()
```

```
## [1] 203 191 185 203  NA 193
```

```
heroes %>%
  pull(Height) %>%
  head()
```

```
## [1] 203 191 185 203  NA 193
```

pull() name =, :

```
heroes %>%
  pull(Height, name) %>%
  head()
```

```
##        A-Bomb    Abe Sapien      Abin Sur   Abomination       Abraxas
##           203           191           185           203            NA
## Absorbing Man
##           193
```

R, tidyverse ,
pull() - .

9.7

9.7.1 : dplyr::slice()

. dplyr::slice() .

```
heroes %>%
  slice(1:3)
```

```
## # A tibble: 3 x 11
##      X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##   <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
## 1     0 A-Bo~ Male   yellow      Human No Hair         203 Marvel C~
## 2     1 Abe ~ Male   blue        Icth~ No Hair         191 Dark Hor~
## 3     2 Abin~ Male   blue        Unga~ No Hair         185 DC Comics
## # ... with 3 more variables: `Skin color` <chr>, Alignment <chr>, Weight <dbl>
```

9.7.2 : dplyr::filter()

dplyr::filter() , slice(), .
, ( ) .

```
heroes %>%
  filter(Publisher == "DC Comics")
```

```
## # A tibble: 215 x 11
##       X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##    <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
##  1     2 Abin~ Male   blue        Unga~ No Hair         185 DC Comics
##  2     7 Adam~ Male   blue        Human Blond           185 DC Comics
##  3    13 Alan~ Male   blue        <NA>  Blond           180 DC Comics
##  4    16 Alfr~ Male   blue        Human Black           178 DC Comics
##  5    19 Amazo Male   red         Andr~ <NA>            257 DC Comics
##  6    27 Anim~ Male   blue        Human Blond           183 DC Comics
##  7    31 Anti~ Male   yellow      God ~ No Hair          61 DC Comics
##  8    35 Aqua~ Male   blue        <NA>  Blond            NA DC Comics
##  9    36 Aqua~ Male   blue        Atla~ Black           178 DC Comics
## 10    37 Aqua~ Male   blue        Atla~ Blond           185 DC Comics
## # ... with 205 more rows, and 3 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>
```

9.7.3 slice()

slice() , slice() filter().
, dplyr::slice_max() dplyr::slice_min()
, :

```
heroes %>%
  slice_max(Weight, n = 3)
```

```
## # A tibble: 3 x 11
##      X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##   <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
## 1   575 Sasq~ Male   red         <NA>  Orange          305 Marvel C~
## 2   373 Jugg~ Male   blue        Human Red             287 Marvel C~
## 3   203 Dark~ Male   red         New ~ No Hair         267 DC Comics
## # ... with 3 more variables: `Skin color` <chr>, Alignment <chr>, Weight <dbl>
```

```
heroes %>%
  slice_min(Weight, n = 3)
```

```
## # A tibble: 3 x 11
##      X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##   <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
```

```
## 1   346 Iron~ Male   blue        <NA>  No Hair          NA Marvel C~
## 2   302 Groot Male   yellow      Flor~ <NA>            701 Marvel C~
## 3   350 Jack~ Male   blue        Human Brown            71 Dark Hor~
## # ... with 3 more variables: `Skin color` <chr>, Alignment <chr>, Weight <dbl>
```

slice_sample() :

```
heroes %>%
  slice_sample(n = 3)
```

```
## # A tibble: 3 x 11
##      X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##   <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
## 1   167 Cere~ Female <NA>        Muta~ <NA>             NA Marvel C~
## 2   373 Jugg~ Male   blue        Human Red             287 Marvel C~
## 3   564 Robi~ Male   blue        Human Red             183 DC Comics
## # ... with 3 more variables: `Skin color` <chr>, Alignment <chr>, Weight <dbl>
```

:

```
heroes %>%
  slice_sample(prop = .01)
```

```
## # A tibble: 7 x 11
##      X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##   <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
## 1   534 Pyro  Male   blue        <NA>  Blond           178 Marvel C~
## 2   123 Blue~ Male   <NA>        <NA>  <NA>             NA DC Comics
## 3   541 Rach~ Female <NA>        Alpha <NA>             NA SyFy
## 4   383 Kick~ Male   blue        Human Blond            NA Icon Com~
## 5   239 Elon~ Male   blue        <NA>  Red             185 DC Comics
## 6   461 Mist~ Male   blue        Human Blond            NA DC Comics
## 7   186 Cors~ Male   brown       <NA>  Brown           191 Marvel C~
## # ... with 3 more variables: `Skin color` <chr>, Alignment <chr>, Weight <dbl>
```

prop = 1, :

```
heroes %>%
  slice_sample(prop = 1)
```

```
## # A tibble: 734 x 11
##       X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##    <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
##  1   358 Jess~ Female <NA>        Human <NA>             NA DC Comics
##  2   402 Leech Male   <NA>        <NA>  <NA>             NA Marvel C~
##  3   160 Capt~ <NA>   <NA>        God ~ <NA>             NA Marvel C~
##  4   664 Thun~ Male   <NA>        <NA>  <NA>             NA Marvel C~
##  5    11 Air-~ Male   blue        <NA>  White           188 Marvel C~
##  6    59 Bane  Male   <NA>        Human <NA>            203 DC Comics
```

```
##  7    99 Blac~ Male   <NA>        God ~ <NA>             NA DC Comics
##  8   201 Dark~ Male   brown       Human Brown           185 Marvel C~
##  9   428 Man-~ Male   red         <NA>  No Hair        213 Marvel C~
## 10   728 Yell~ Male   blue        Human Blond           183 Marvel C~
## # ... with 724 more rows, and 3 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>
```

9.7.4 NA: tidyr::drop_na()

,

tidyr::drop_na().

```
heroes %>%
  drop_na()
```

```
## # A tibble: 50 x 11
##       X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##    <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
##  1     1 Abe ~ Male   blue        Icth~ No Hair         191 Dark Hor~
##  2     2 Abin~ Male   blue        Unga~ No Hair         185 DC Comics
##  3    34 Apoc~ Male   red         Muta~ Black           213 Marvel C~
##  4    39 Arch~ Male   blue        Muta~ Blond           183 Marvel C~
##  5    41 Ardi~ Female white       Alien Orange          193 Marvel C~
##  6    56 Azaz~ Male   yellow      Neya~ Black           183 Marvel C~
##  7    74 Beast Male   blue        Muta~ Blue            180 Marvel C~
##  8    75 Beas~ Male   green       Human Green           173 DC Comics
##  9    92 Biza~ Male   black       Biza~ Black           191 DC Comics
## 10   108 Blac~ Male   red         Demon White           191 Marvel C~
## # ... with 40 more rows, and 3 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>
```

, NA (
, NA).

```
heroes %>%
  drop_na(Weight)
```

```
## # A tibble: 495 x 11
##       X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##    <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
##  1     0 A-Bo~ Male   yellow      Human No Hair         203 Marvel C~
##  2     1 Abe ~ Male   blue        Icth~ No Hair         191 Dark Hor~
##  3     2 Abin~ Male   blue        Unga~ No Hair         185 DC Comics
##  4     3 Abom~ Male   green       Huma~ No Hair         203 Marvel C~
##  5     5 Abso~ Male   blue        Human No Hair         193 Marvel C~
##  6     7 Adam~ Male   blue        Human Blond           185 DC Comics
##  7     8 Agen~ Female blue        <NA>  Blond           173 Marvel C~
```

```
##  8     9 Agen~ Male   brown       Human Brown           178 Marvel C~
##  9    10 Agen~ Male   <NA>        <NA>  <NA>            191 Marvel C~
## 10    11 Air-~ Male   blue        <NA>  White           188 Marvel C~
## # ... with 485 more rows, and 3 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>
```

drop_na() tidyselect, (??).

9.7.5 : dplyr::arrange()

dplyr::arrange() (-)
.

```
heroes %>%
  arrange(Weight)
```

```
## # A tibble: 734 x 11
##       X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##    <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
##  1   346 Iron~ Male   blue        <NA>  No Hair          NA Marvel C~
##  2   302 Groot Male   yellow      Flor~ <NA>            701 Marvel C~
##  3   350 Jack~ Male   blue        Human Brown            71 Dark Hor~
##  4   272 Gala~ Male   black       Cosm~ Black           876 Marvel C~
##  5   731 Yoda  Male   brown       Yoda~ White            66 George L~
##  6   255 Fin ~ Male   red         Kaka~ No Hair         975 Marvel C~
##  7   330 Howa~ Male   brown       <NA>  Yellow           79 Marvel C~
##  8   396 Kryp~ Male   blue        Kryp~ White            64 DC Comics
##  9   568 Rock~ Male   brown       Anim~ Brown           122 Marvel C~
## 10   208 Dash  Male   blue        Human Blond           122 Dark Hor~
## # ... with 724 more rows, and 3 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>
```

, desc().

```
heroes %>%
  arrange(desc(Weight))
```

```
## # A tibble: 734 x 11
##       X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##    <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
##  1   575 Sasq~ Male   red         <NA>  Orange        305   Marvel C~
##  2   373 Jugg~ Male   blue        Human Red           287   Marvel C~
##  3   203 Dark~ Male   red         New ~ No Hair       267   DC Comics
##  4   283 Giga~ Female green       <NA>  Red            62.5 DC Comics
##  5   331 Hulk  Male   green       Huma~ Green         244   Marvel C~
##  6   549 Red ~ Male   yellow      Huma~ Black         213   Marvel C~
##  7   119 Bloo~ Female blue        Human Brown         218   Marvel C~
```

```
##  8   718 Wolf~ Female green       <NA>  Auburn        366   Marvel C~
##  9   657 Than~ Male   red         Eter~ No Hair       201   Marvel C~
## 10     0 A-Bo~ Male   yellow      Human No Hair       203   Marvel C~
## # ... with 724 more rows, and 3 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>
```

. ,
, — :

```
heroes %>%
  arrange(Gender, desc(Weight))
```

```
## # A tibble: 734 x 11
##       X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##    <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
##  1   283 Giga~ Female green       <NA>  Red            62.5 DC Comics
##  2   119 Bloo~ Female blue        Human Brown         218   Marvel C~
##  3   718 Wolf~ Female green       <NA>  Auburn        366   Marvel C~
##  4   591 She-~ Female green       Human Green         201   Marvel C~
##  5   320 Hela  Female green       Asga~ Black         213   Marvel C~
##  6   686 Valk~ Female blue        <NA>  Blond         191   Marvel C~
##  7   596 Sif   Female blue        Asga~ Black         188   Marvel C~
##  8   271 Frig~ Female blue        <NA>  White         180   Marvel C~
##  9   667 Thun~ Female green       <NA>  Red           218   Marvel C~
## 10   592 She-~ Female blue        Huma~ No Hair       183   Marvel C~
## # ... with 724 more rows, and 3 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>
```

9.8 : dplyr::mutate() dplyr::transmute()

dplyr::mutate() .

```
heroes %>%
  mutate(imt = Weight/(Height/100)^2) %>%
  select(name, imt) %>%
  arrange(desc(imt))
```

```
## # A tibble: 734 x 2
##    name          imt
##    <chr>       <dbl>
##  1 Utgard-Loki 2510.
##  2 Giganta     1613.
##  3 Red Hulk     139.
##  4 Darkseid     115.
##  5 Machine Man  114.
##  6 Thanos       110.
```

```
##  7 Destroyer    108.
##  8 A-Bomb       107.
##  9 Abomination  107.
## 10 Hulk         106.
## # ... with 724 more rows
```

dplyr::transmute() - mutate(), ,
:

```
heroes %>%
  transmute(imt = Weight/(Height/100)^2)
```

```
## # A tibble: 734 x 1
##      imt
##    <dbl>
##  1 107.
##  2  17.8
##  3  26.3
##  4 107.
##  5  NA
##  6  32.8
##  7  NA
##  8  25.7
##  9  20.4
## 10  25.6
## # ... with 724 more rows
```

mutate() transmute() (
), , .
, .. (??):

```
heroes %>%
  transmute(name, weight_mean = mean(Weight, na.rm = TRUE))
```

```
## # A tibble: 734 x 2
##    name          weight_mean
##    <chr>               <dbl>
##  1 A-Bomb               112.
##  2 Abe Sapien           112.
##  3 Abin Sur             112.
##  4 Abomination          112.
##  5 Abraxas              112.
##  6 Absorbing Man        112.
##  7 Adam Monroe          112.
##  8 Adam Strange         112.
##  9 Agent 13             112.
## 10 Agent Bob            112.
## # ... with 724 more rows
```

mutate() transmute() :
1 , .

```
heroes %>%
  mutate(one_and_two = 1:2)
```

```
## Error: Problem with `mutate()` input `one_and_two`.
## x Input `one_and_two` can't be recycled to size 734.
## i Input `one_and_two` is `1:2`.
## i Input `one_and_two` must be size 734 or 1, not 2.
```

, : dplyr , —
. dplyr rep(),
(??).

```
heroes %>%
  mutate(one_and_two = rep(1:2, length.out = nrow(.)))
```

```
## # A tibble: 734 x 12
##       X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##    <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
##  1     0 A-Bo~ Male   yellow      Human No Hair         203 Marvel C~
##  2     1 Abe ~ Male   blue        Icth~ No Hair         191 Dark Hor~
##  3     2 Abin~ Male   blue        Unga~ No Hair         185 DC Comics
##  4     3 Abom~ Male   green       Huma~ No Hair         203 Marvel C~
##  5     4 Abra~ Male   blue        Cosm~ Black            NA Marvel C~
##  6     5 Abso~ Male   blue        Human No Hair         193 Marvel C~
##  7     6 Adam~ Male   blue        <NA>  Blond            NA NBC - He~
##  8     7 Adam~ Male   blue        Human Blond           185 DC Comics
##  9     8 Agen~ Female blue        <NA>  Blond           173 Marvel C~
## 10     9 Agen~ Male   brown       Human Brown           178 Marvel C~
## # ... with 724 more rows, and 4 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>, one_and_two <int>
```

9.9

9.9.1 : summarise()

- , ,
. dplyr,
plyr. dplyr . dplyr
: (group_by()) (summarise()). .

dplyr::summarise()[8] .

[8] dplyr::summarise() dplyr::summarize(), .
- .

mutate(), mutate() , ,
, , summarise() ,
1. , min(), mean(), max() . . (
mutate()).

```
heroes %>%
  mutate(imt = Weight/(Height/100)^2) %>%
  summarise(min(imt, na.rm = TRUE),
            max(imt, na.rm = TRUE))
```

```
## # A tibble: 1 x 2
##   `min(imt, na.rm = TRUE)` `max(imt, na.rm = TRUE)`
##                      <dbl>                    <dbl>
## 1                   0.0814                    2510.
```

dplyr tidyverse. ,
dplyr::nth(), dplyr::first() dplyr::last(),
(- slice(),)

```
heroes %>%
  mutate(imt = Weight/(Height/100)^2) %>%
  arrange(imt) %>%
  summarise(first = first(imt),
            tenth = nth(imt, 10),
            last = last(imt))
```

```
## # A tibble: 1 x 3
##    first tenth  last
##    <dbl> <dbl> <dbl>
## 1 0.0814  16.7    NA
```

mutate(), summarise()
, , .

```
heroes %>%
  mutate(imt = Weight/(Height/100)^2) %>%
  summarise(imt_range = range(imt, na.rm = TRUE)) #     range()                    :
```

```
## # A tibble: 2 x 1
##   imt_range
##       <dbl>
## 1    0.0814
## 2 2510.
```

9.9.2 : group_by()

dplyr::group_by() -
summarise(). group_by() ,

groups[9]:

```
heroes %>%
  group_by(Gender)
```

```
## # A tibble: 734 x 11
## # Groups:   Gender [3]
##       X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##    <dbl> <chr> <chr>  <chr>       <chr> <chr>         <dbl> <chr>
##  1     0 A-Bo~ Male   yellow      Human No Hair         203 Marvel C~
##  2     1 Abe ~ Male   blue        Icth~ No Hair         191 Dark Hor~
##  3     2 Abin~ Male   blue        Unga~ No Hair         185 DC Comics
##  4     3 Abom~ Male   green       Huma~ No Hair         203 Marvel C~
##  5     4 Abra~ Male   blue        Cosm~ Black            NA Marvel C~
##  6     5 Abso~ Male   blue        Human No Hair         193 Marvel C~
##  7     6 Adam~ Male   blue        <NA>  Blond            NA NBC - He~
##  8     7 Adam~ Male   blue        Human Blond           185 DC Comics
##  9     8 Agen~ Female blue        <NA>  Blond           173 Marvel C~
## 10     9 Agen~ Male   brown       Human Brown           178 Marvel C~
## # ... with 724 more rows, and 3 more variables: `Skin color` <chr>,
## #   Alignment <chr>, Weight <dbl>
```

summarise(), ,

.

```
heroes %>%
  mutate(imt = Weight/(Height/100)^2) %>%
  group_by(Gender) %>%
  summarise(min(imt, na.rm = TRUE),
            max(imt, na.rm = TRUE))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## # A tibble: 3 x 3
##   Gender `min(imt, na.rm = TRUE)` `max(imt, na.rm = TRUE)`
##   <chr>                     <dbl>                     <dbl>
## 1 Female                  15.5                      1613.
## 2 Male                     0.0814                   2510.
## 3 <NA>                    16.3                       114.
```

:

9.9.3 : dplyr::n(), dplyr::count()

n().

[9] ungroup().

Figure 9.1:

```
heroes %>%
  group_by(Gender) %>%
  summarise(n = n())
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## # A tibble: 3 x 2
##   Gender     n
##   <chr>  <int>
## 1 Female   200
## 2 Male     505
## 3 <NA>      29
```

n() group_by() filter() “ ”

…

```
heroes %>%
  group_by(Race) %>%
  filter(n() > 10) %>%
  select(name, Race)
```

```
## # A tibble: 611 x 2
## # Groups:   Race [6]
##    name          Race
##    <chr>         <chr>
##  1 A-Bomb        Human
##  2 Abomination   Human / Radiation
##  3 Absorbing Man Human
##  4 Adam Monroe   <NA>
##  5 Adam Strange  Human
##  6 Agent 13      <NA>
##  7 Agent Bob     Human
##  8 Agent Zero    <NA>
##  9 Air-Walker    <NA>
## 10 Ajax          Cyborg
## # ... with 601 more rows
```

, :

```
heroes %>%
  group_by(Race) %>%
  filter(n() == 1) %>%
  select(name, Race)
```

```
## # A tibble: 34 x 2
## # Groups:   Race [34]
##    name          Race
##    <chr>         <chr>
##  1 Abe Sapien    Icthyo Sapien
##  2 Abin Sur      Ungaran
##  3 Alien         Xenomorph XX121
##  4 Azazel        Neyaphem
##  5 Bizarro       Bizarro
##  6 Boba Fett     Human / Clone
##  7 Darth Maul    Dathomirian Zabrak
##  8 Fin Fang Foom Kakarantharaian
##  9 Gamora        Zen-Whoberian
## 10 Gladiator     Strontian
## # ... with 24 more rows
```

group_by() summarise(n = n()). count()

:

```
heroes %>%
  count(Gender)
```

```
## # A tibble: 3 x 2
##   Gender     n
##   <chr>  <int>
## 1 Female   200
## 2 Male     505
## 3 <NA>      29
```

, sort = TRUE.

```
heroes %>%
  count(Gender, sort = TRUE)
```

```
## # A tibble: 3 x 2
##   Gender     n
##   <chr>  <int>
## 1 Male     505
## 2 Female   200
## 3 <NA>      29
```

count(), , tidyverse.

9.9.4 : dplyr::distinct()

dplyr::distinct() - unique(),
.

```
heroes %>%
  distinct(Gender)
```

```
## # A tibble: 3 x 1
##   Gender
##   <chr>
## 1 Male
## 2 Female
## 3 <NA>
```

```
heroes %>%
  distinct(Gender, Race)
```

```
## # A tibble: 81 x 2
##    Gender Race
##    <chr>  <chr>
##  1 Male   Human
##  2 Male   Icthyo Sapien
##  3 Male   Ungaran
##  4 Male   Human / Radiation
##  5 Male   Cosmic Entity
##  6 Male   <NA>
##  7 Female <NA>
##  8 Male   Cyborg
##  9 Male   Xenomorph XX121
## 10 Male   Android
## # ... with 71 more rows
```

, . ,
.

9.9.5

tidyverse group_by() mutate() (summarise()):

```
heroes %>%
  group_by(Race) %>%
  mutate(Race_n = n()) %>%
  select(Race, name, Gender, Race_n)
```

```
## # A tibble: 734 x 4
## # Groups:   Race [62]
##    Race              name          Gender Race_n
```

```
##    <chr>             <chr>         <chr>   <int>
##  1 Human             A-Bomb        Male      208
##  2 Icthyo Sapien     Abe Sapien    Male        1
##  3 Ungaran           Abin Sur      Male        1
##  4 Human / Radiation Abomination   Male       11
##  5 Cosmic Entity     Abraxas       Male        4
##  6 Human             Absorbing Man Male      208
##  7 <NA>              Adam Monroe   Male      304
##  8 Human             Adam Strange  Male      208
##  9 <NA>              Agent 13      Female    304
## 10 Human             Agent Bob     Male      208
## # ... with 724 more rows
```

, :

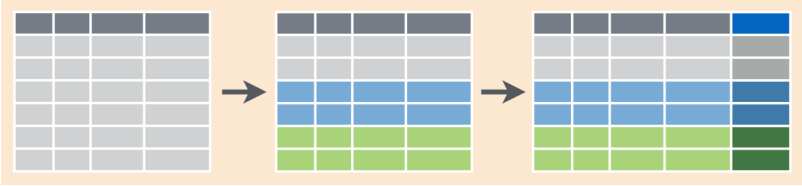


Figure 9.2:

Chapter 10

tidyverse

10.1 : dplyr::across()

, , .
summarise(), :

```
heroes %>%
  group_by(Gender) %>%
  summarise(height = mean(Height, na.rm = TRUE),
            weight = mean(Weight, na.rm = TRUE))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## # A tibble: 3 x 3
##   Gender height weight
##   <chr>   <dbl>  <dbl>
## 1 Female   175.   78.8
## 2 Male     192.  126.
## 3 <NA>     177.  129.
```

, , ,
.

dplyr : dplyr::across()[1].
apply() tidyselect .

, across() :

[1] across() dplyr , tidyverse
*_at(), *_if(), *_all(), , summarise_at(), summarise_if(),
summarize_all(). dplyr, . -
purrr (??) apply() (@ref(apply_f)).

1. tidyselect. ,
   (??).
2. across(). .col — ,
   tidyselect, everything(), ...fns
   — , .
   , across().
3. summarise() dplyr.
   across().

. ,
Height Weight.

```
heroes %>%
  group_by(Gender) %>%
  summarise(across(c(Height,Weight), mean))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## # A tibble: 3 x 3
##   Gender Height Weight
##   <chr>   <dbl>  <dbl>
## 1 Female     NA     NA
## 2 Male       NA     NA
## 3 <NA>       NA     NA
```

: mean() NA
NA, na.rm =. apply()
(@ref(apply_f)), :

```
heroes %>%
  group_by(Gender) %>%
  summarise(across(c(Height, Weight), mean, na.rm = TRUE))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## # A tibble: 3 x 3
##   Gender Height Weight
##   <chr>   <dbl>  <dbl>
## 1 Female   175.   78.8
## 2 Male     192.  126.
## 3 <NA>     177.  129.
```

. across() tidyselect
. , numeric
:

```
heroes %>%
  drop_na(Height, Weight) %>%
  group_by(Gender) %>%
  summarise(across(where(is.numeric), mean, na.rm = TRUE))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## # A tibble: 3 x 4
##   Gender    X1 Height Weight
##   <chr>  <dbl>  <dbl>  <dbl>
## 1 Female  394.   174.   78.3
## 2 Male    369.   193.  126.
## 3 <NA>    375.   182   129.
```

. ,
(@ref(anon_f)).

```
heroes %>%
  group_by(Gender) %>%
  summarise(across(where(is.character),
                   function(x) mean(nchar(x), na.rm = TRUE)))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## # A tibble: 3 x 8
##   Gender  name `Eye color`  Race `Hair color` Publisher `Skin color` Alignment
##   <chr>  <dbl>       <dbl> <dbl>        <dbl>     <dbl>        <dbl>     <dbl>
## 1 Female  9.04        4.68  6.42         5.05      11.5         4.57      3.88
## 2 Male    9.05        4.53  6.75         5.48      11.4         5.02      3.78
## 3 <NA>    9.48        5.16 10.1          6.44      11.9         4         3.96
```

, summarise()!

```
heroes %>%
  group_by(Gender) %>%
  summarise(across(where(is.numeric), mean, na.rm = TRUE),
            across(where(is.character),
                   function(x) mean(nchar(x), na.rm = TRUE)))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## # A tibble: 3 x 11
##   Gender    X1 Height Weight  name `Eye color`  Race `Hair color` Publisher
##   <chr>  <dbl>  <dbl>  <dbl> <dbl>       <dbl> <dbl>        <dbl>     <dbl>
## 1 Female  395.   175.   78.8  9.04        4.68  6.42         5.05      11.5
## 2 Male    357.   192.  126.   9.05        4.53  6.75         5.48      11.4
## 3 <NA>    329    177.  129.   9.48        5.16 10.1          6.44      11.9
## # ... with 2 more variables: `Skin color` <dbl>, Alignment <dbl>
```

across() ,
. (-).

```
heroes %>%
  group_by(Gender) %>%
  summarise(across(c(Height, Weight),
                   list(minimum = min,
```

```
                        average = mean,
                        maximum = max),
                    na.rm = TRUE))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## # A tibble: 3 x 7
##   Gender Height_minimum Height_average Height_maximum Weight_minimum
##   <chr>           <dbl>          <dbl>          <dbl>          <dbl>
## 1 Female           62.5           175.            366             41
## 2 Male             15.2           192.            975              2
## 3 <NA>            108             177.            198             39
## # ... with 2 more variables: Weight_average <dbl>, Weight_maximum <dbl>
```

(@ref(functions_objects))!

```
heroes %>%
  group_by(Gender) %>%
  summarise(across(c(Height, Weight),
                   list(min = function(x) min(x, na.rm = TRUE),
                        mean = function(x) mean(x, na.rm = TRUE),
                        max = function(x) max(x, na.rm = TRUE),
                        na_n = function(x, ...) sum(is.na(x)))
                   )
            )
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## # A tibble: 3 x 9
##   Gender Height_min Height_mean Height_max Height_na_n Weight_min Weight_mean
##   <chr>       <dbl>       <dbl>      <dbl>       <int>      <dbl>       <dbl>
## 1 Female       62.5        175.        366          56         41        78.8
## 2 Male         15.2        192.        975         147          2       126.
## 3 <NA>        108          177.        198          14         39       129.
## # ... with 2 more variables: Weight_max <dbl>, Weight_na_n <int>
```

across() — summarise(), across() dplyr. , mutate():

```
heroes %>%
  mutate(across(where(is.character), as.factor))
```

```
## # A tibble: 734 x 11
##       X1 name  Gender `Eye color` Race  `Hair color` Height Publisher
##    <dbl> <fct> <fct>  <fct>       <fct> <fct>         <dbl> <fct>
##  1     0 A-Bo~ Male   yellow      Human No Hair         203 Marvel C~
##  2     1 Abe ~ Male   blue        Icth~ No Hair         191 Dark Hor~
##  3     2 Abin~ Male   blue        Unga~ No Hair         185 DC Comics
```

```
##  4     3 Abom~ Male   green       Huma~ No Hair         203 Marvel C~
##  5     4 Abra~ Male   blue        Cosm~ Black            NA Marvel C~
##  6     5 Abso~ Male   blue        Human No Hair         193 Marvel C~
##  7     6 Adam~ Male   blue        <NA>  Blond            NA NBC - He~
##  8     7 Adam~ Male   blue        Human Blond           185 DC Comics
##  9     8 Agen~ Female blue        <NA>  Blond           173 Marvel C~
## 10     9 Agen~ Male   brown       Human Brown           178 Marvel C~
## # ... with 724 more rows, and 3 more variables: `Skin color` <fct>,
## #   Alignment <fct>, Weight <dbl>
```

across() - across() count()
n_distinct(), .
:

```
heroes %>%
  select(where(function(x) n_distinct(x) <= 6))
```

```
## # A tibble: 734 x 2
##    Gender Alignment
##    <chr>  <chr>
##  1 Male   good
##  2 Male   good
##  3 Male   good
##  4 Male   bad
##  5 Male   bad
##  6 Male   bad
##  7 Male   good
##  8 Male   good
##  9 Female good
## 10 Male   good
## # ... with 724 more rows
```

```
heroes %>%
  count(across(where(function(x) n_distinct(x) <= 6)))
```

```
## # A tibble: 11 x 3
##    Gender Alignment     n
##    <chr>  <chr>     <int>
##  1 Female bad          35
##  2 Female good        161
##  3 Female neutral       4
##  4 Male   bad         165
##  5 Male   good        316
##  6 Male   neutral      18
##  7 Male   <NA>          6
##  8 <NA>   bad           7
##  9 <NA>   good         19
## 10 <NA>   neutral       2
```

```
## 11 <NA>   <NA>          1
```

10.2

10.2.1 : bind_rows(), bind_cols()

dc, marvel other_publishers:

```
dc <- heroes %>%
  filter(Publisher == "DC Comics") %>%
  group_by(Gender) %>%
  summarise(weight_mean = mean(Weight, na.rm = TRUE))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
dc
```

```
## # A tibble: 3 x 2
##   Gender weight_mean
##   <chr>        <dbl>
## 1 Female        76.8
## 2 Male         113.
## 3 <NA>         NaN
```

```
marvel <- heroes %>%
  filter(Publisher == "Marvel Comics") %>%
  group_by(Gender) %>%
  summarise(weight_mean = mean(Weight, na.rm = TRUE))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
marvel
```

```
## # A tibble: 3 x 2
##   Gender weight_mean
##   <chr>        <dbl>
## 1 Female        80.1
## 2 Male         134.
## 3 <NA>         129.
```

```
other_publishers <- heroes %>%
  filter(!(Publisher %in% c("DC Comics","Marvel Comics"))) %>%
  group_by(Gender) %>%
  summarise(weight_mean = mean(Weight, na.rm = TRUE))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
other_publishers
```

```
## # A tibble: 3 x 2
##   Gender weight_mean
##   <chr>        <dbl>
## 1 Female        70.8
## 2 Male         111.
## 3 <NA>         NaN
```

bind_rows().

.

```
bind_rows(dc, marvel)
```

```
## # A tibble: 6 x 2
##   Gender weight_mean
##   <chr>        <dbl>
## 1 Female        76.8
## 2 Male         113.
## 3 <NA>         NaN
## 4 Female        80.1
## 5 Male         134.
## 6 <NA>         129.
```

, bind_cols().

```
bind_cols(dc, marvel)
```

```
## New names:
## * Gender -> Gender...1
## * weight_mean -> weight_mean...2
## * Gender -> Gender...3
## * weight_mean -> weight_mean...4
```

```
## # A tibble: 3 x 4
##   Gender...1 weight_mean...2 Gender...3 weight_mean...4
##   <chr>                <dbl> <chr>                <dbl>
## 1 Female                76.8 Female                80.1
## 2 Male                 113.  Male                 134.
## 3 <NA>                 NaN   <NA>                 129.
```

bind_rows() bind_cols() , .

```
bind_rows(dc, marvel, other_publishers)
```

```
## # A tibble: 9 x 2
##   Gender weight_mean
##   <chr>        <dbl>
## 1 Female        76.8
## 2 Male         113.
```

```
## 3 <NA>         NaN
## 4 Female        80.1
## 5 Male         134.
## 6 <NA>         129.
## 7 Female        70.8
## 8 Male         111.
## 9 <NA>         NaN
```

bind_rows() bind_cold() ,
/ .

```
heroes_list_of_df <- list(DC = dc,
                          Marvel = marvel,
                          Other = other_publishers)
bind_rows(heroes_list_of_df)
```

```
## # A tibble: 9 x 2
##   Gender weight_mean
##   <chr>        <dbl>
## 1 Female        76.8
## 2 Male         113.
## 3 <NA>         NaN
## 4 Female        80.1
## 5 Male         134.
## 6 <NA>         129.
## 7 Female        70.8
## 8 Male         111.
## 9 <NA>         NaN
```

, , ( )
.id =.

```
bind_rows(heroes_list_of_df, .id = "Publisher")
```

```
## # A tibble: 9 x 3
##   Publisher Gender weight_mean
##   <chr>     <chr>        <dbl>
## 1 DC        Female        76.8
## 2 DC        Male         113.
## 3 DC        <NA>         NaN
## 4 Marvel    Female        80.1
## 5 Marvel    Male         134.
## 6 Marvel    <NA>         129.
## 7 Other     Female        70.8
## 8 Other     Male         111.
## 9 Other     <NA>         NaN
```

bind_rows() , .
,

`bind_rows()`.

10.2.2 : `*_join()`

, , (
), . , ,
, - , “ ”
. ,
. .

`bind_rows()` `bind_cols()` .

(*join*). , -
, ,
. , , . dplyr
- `*_join()`.

`band_members` `band_instruments`, dplyr
`*_join()`.

```
band_members
```

```
## # A tibble: 3 x 2
##   name  band
##   <chr> <chr>
## 1 Mick  Stones
## 2 John  Beatles
## 3 Paul  Beatles
```

```
band_instruments
```

```
## # A tibble: 3 x 2
##   name  plays
##   <chr> <chr>
## 1 John  guitar
## 2 Paul  bass
## 3 Keith guitar
```

, .
. [2].

`band_members` `band_instruments` `*_join()`
, . (`x` = `y` =)
/ .
, , `x` `y` .

[2] , `*_join()` .
. , , - , ,
- , . `*_join()` .

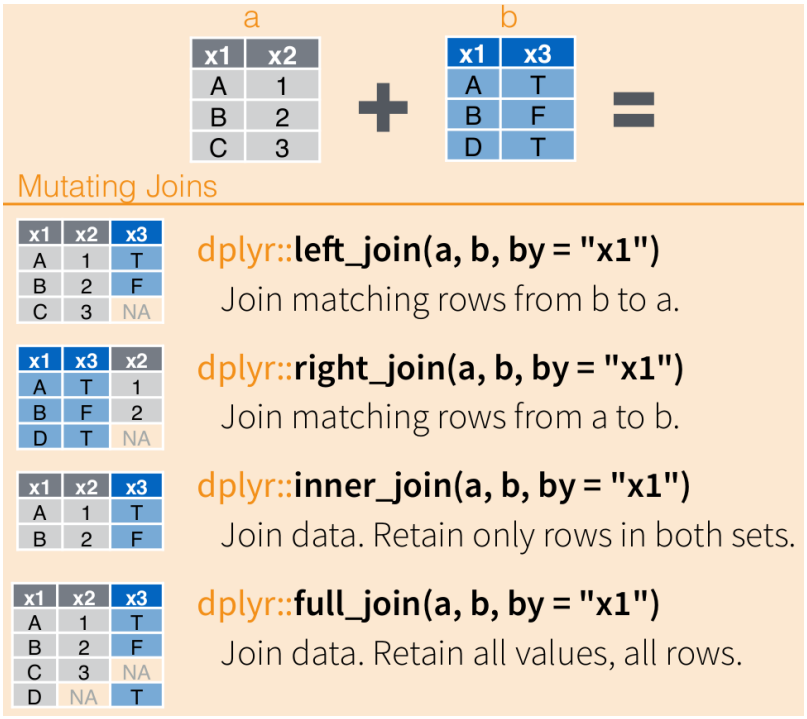

a
x1 x2
A 1
B 2
C 3
b
x1 x3
A T
B F
D T
Mutating Joins
x1 x2 x3
A 1 T
B 2 F
C 3 NA
dplyr::left_join(a, b, by = "x1")
Join matching rows from b to a.
x1 x3 x2
A T 1
B F 2
D T NA
dplyr::right_join(a, b, by = "x1")
Join matching rows from a to b.
x1 x2 x3
A 1 T
B 2 F
dplyr::inner_join(a, b, by = "x1")
Join data. Retain only rows in both sets.
x1 x2 x3
A 1 T
B 2 F
C 3 NA
D NA T
dplyr::full_join(a, b, by = "x1")
Join data. Retain all values, all rows.

Figure 10.1:

- left_join():

```
band_members %>%
  left_join(band_instruments)
```

```
## Joining, by = "name"
```

```
## # A tibble: 3 x 3
##   name  band    plays
##   <chr> <chr>   <chr>
## 1 Mick  Stones  <NA>
## 2 John  Beatles guitar
## 3 Paul  Beatles bass
```

left_join() - *_join().
“ ” . x,
y. , y, ,
y, NA.

- by =,
.

```
band_members %>%
  left_join(band_instruments, by = "name")
```

```
## # A tibble: 3 x 3
##   name  band    plays
##   <chr> <chr>   <chr>
## 1 Mick  Stones  <NA>
## 2 John  Beatles guitar
## 3 Paul  Beatles bass
```

, - - . ,
:

```
band_members %>%
  left_join(band_instruments2, by = c("name" = "artist"))
```

```
## # A tibble: 3 x 3
##   name  band    plays
##   <chr> <chr>   <chr>
## 1 Mick  Stones  <NA>
## 2 John  Beatles guitar
## 3 Paul  Beatles bass
```

- right_join():

```
band_members %>%
  right_join(band_instruments)
```

```
## Joining, by = "name"
```

```
## # A tibble: 3 x 3
##   name  band    plays
##   <chr> <chr>   <chr>
## 1 John  Beatles guitar
## 2 Paul  Beatles bass
## 3 Keith <NA>    guitar
```

right_join() x, y, y - left_join() .

- full_join():

```
band_members %>%
  full_join(band_instruments)
```

```
## Joining, by = "name"
```

```
## # A tibble: 4 x 3
##   name  band    plays
##   <chr> <chr>   <chr>
## 1 Mick  Stones  <NA>
## 2 John  Beatles guitar
## 3 Paul  Beatles bass
## 4 Keith <NA>    guitar
```

full_join() x y. , left_join() — full_join() .

- inner_join():

```
band_members %>%
  inner_join(band_instruments)
```

```
## Joining, by = "name"
```

```
## # A tibble: 2 x 3
##   name  band    plays
##   <chr> <chr>   <chr>
## 1 John  Beatles guitar
## 2 Paul  Beatles bass
```

full_join() , x, y.

- semi_join():

```
band_members %>%
  semi_join(band_instruments)
```

```
## Joining, by = "name"
```

```
## # A tibble: 2 x 2
##   name  band
```

```
##   <chr> <chr>
## 1 John  Beatles
## 2 Paul  Beatles
```

- anti_join():

```
band_members %>%
  anti_join(band_instruments)
```

```
## Joining, by = "name"
```

```
## # A tibble: 1 x 2
##   name  band
##   <chr> <chr>
## 1 Mick  Stones
```

semi_join() anti_join() / (y) . - x, y (semi_join()) , , y (anti_join()).

10.3 Tidy data: tidyr::pivot_longer(), tidyr::pivot_wider()

tidy data , , - . , , . ( ) : - , - .

. , . - (-) “ ” , , - (-)?

- :

R	R
70	63
80	74
86	71

- ” :

	( )
R	70
R	80
R	86
R	63
R	74