

R

Last Update: 2020-09-03

Contents

1		5
1.1	.....	5
1.2	.....	6
2	R(Studio)	7
3	RStudio	9
3.1	RStudio	9
3.2	RStudio	9
3.3	RStudio	10
3.4	.....	10
3.5	.....	11
4		13
5	R	15
5.1	.....	15
5.2	.....	16
5.3	.....	17
5.4	.....	18
6		21
6.1	.....	21
6.2	.....	21
6.3	.....	22
7		23
7.1	.....	23
7.2	.....	23
7.3	.....	24
8		25
8.1	%>%	25
8.2	.....	26

8.3	. . . . .	28
8.4	. . . . .	31
8.5	. . . . .	32
8.6	. . . . .	32
9		35
9.1	. . . . .	35
9.2	. . . . .	36
10		39
10.1 1	. . . . .	39
10.2 2	. . . . .	42
11 t		49
12		51
12.1	. . . . .	51
12.2 R	. . . . .	51
12.3	. . . . .	53
12.4	. . . . .	54
12.5	. . . . .	54
12.6	. . . . .	55
12.7	. . . . .	56
13 Word		59
13.1	. . . . .	59

Chapter 1

R

- R
- Word R Word

R

1.1

- R, RStudio
- RStudio
-
-
-
- t
-

Chapter 2 R RStudio

R

- 2018 RStudio
- 2018 R RStudio[] -tidyverse —

1.2

-
-
-
- tidyverse %>%
 — tidyverse

Chapter 2

R(Studio)

R(Studio)

Windows

<http://yukiyanai.github.io/jp/resources/>

Windows

- - 1
 - 4 Rtools
 - RStudio
- →
- OneDrive →
- macOS
- - RStudio

Chapter 3

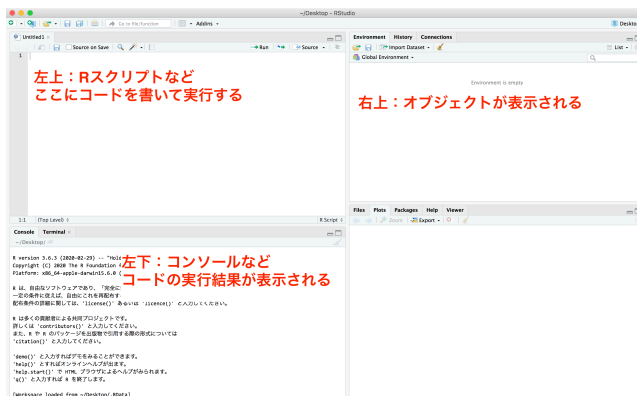
RStudio

3.1 RStudio

RStudio Windows Mac
R OK
RStudio

3.2 RStudio

RStudio



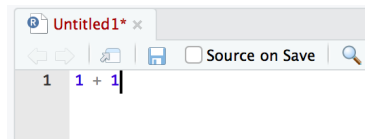
RStudio 4

- RStudio R Script
-
-

•

3.3 RStudio

R `1 + 1`

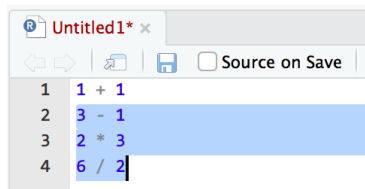


1 Windows `Ctrl + Enter` Mac `Command + Enter`
Run

```
> 1 + 1
[1] 2
```

```
> 1 + 1 [1]
```

```
3 - 1 2 * 3 6 / 2 3
```



`Ctrl + Enter` (`Command + Enter`)

```
> 3 - 1
[1] 2
> 2 * 3
[1] 6
> 6 / 2
[1] 3
```

→

3.4

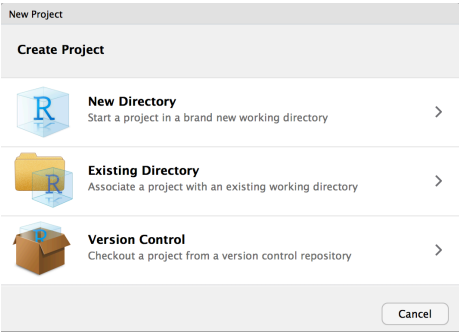
Windows `Ctrl + S` Mac `Command + S`

3.5

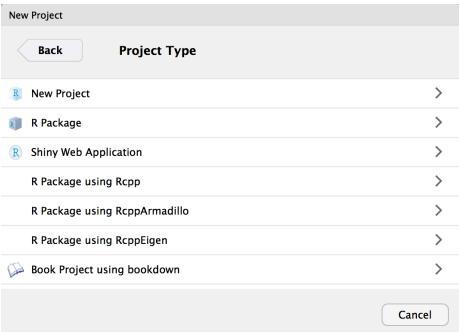
RStudio



“New Directory”



“New Project”



Create Project



[.Rproj]



Test Test.Rproj

RStudio

- .Rproj
-
- RStudio

R

R .R

Chapter 4

R tidyverse

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

install.packages() OK library() RStudio R library()

mtcars mpg

```
mtcars %>% summarize(mean_mpg = mean(mpg))
```

```
## mean_mpg  
## 1 20.09062
```

R(Studio) Chapter 2

```
library(tidyverse)
```


Chapter 5

R

5.1

```
R      object      R
first_object <- 1

      first_object    1      <-
      OK

first_object

## [1] 1
[1] 1      1
      ()      second_object 2
(second_object <- 2)

## [1] 2
      “”

first_string_object <- "Ritsumeikan University"
first_string_object

## [1] "Ritsumeikan University"
first_string_object      "Ritsumeikan University"
      1      c()
```

```

first_vector_object <- c(1, 2, 3, 4, 5)
first_vector_object

## [1] 1 2 3 4 5

first_vector_object      1 5

• third_object      10000
• my_name
• second_vector_object      1, 1, 2, 3, 5, 8

```

5.2

```

R      +, -

1 + 1

## [1] 2

5 - 2

## [1] 3

* / ^      Excel

2 * 3

## [1] 6

10 / 2

## [1] 5

4 ^ 2

## [1] 16

      'age'      10

age <- 20
age + 10

## [1] 30

      1 + 1      one_plus_one

one_plus_one <- 1 + 1
one_plus_one

## [1] 2

```



```
one_plus_one 2
```

- $a^3 + b^4$
- a, b^2 25

5.3

R function () argument

5.3.1

```
R sqrt()
sqrt(4)
## [1] 2
sqrt(4) 4 4 2 log()

• a 3 b 4
• a, b 2 5
  - sqrt()
```

5.3.2

```
age_vector <- c(18, 21, 22, 23,
34)
min()
age_vector <- c(18, 21, 22, 23, 34)
min(age_vector)
## [1] 18
18 max()
mean() median() sd()
mean(age_vector)
## [1] 23.6
```

```
median(age_vector)
```

```
## [1] 22
```

```
sd(age_vector)
```

```
## [1] 6.107373
```

- income_vector 10, 100, 1000, 10000, 100000
- income_vector

5.4

R

```
age_vector      gender_vector      data.frame()
age <- c(18, 21, 22, 23, 34) #
gender <- c("female", "male", "male", "female", "female") #
first_dataframe <- data.frame(age, gender)
first_dataframe
```

```
##  age gender
## 1  18 female
## 2  21  male
## 3  22  male
## 4  23 female
## 5  34 female
```

```
1 18  2 21  ...
```

Chapter @ref(#ImportData) Excel R

\$

first_dataframe

```
first_dataframe$gender
```

```
## [1] female male  male  female female
## Levels: female male
```

```
mean(first_dataframe$age)
```

```
## [1] 23.6
```

- income 10, 100, 1000, 10000, 100000
- city "ibaraki", "takatsuki", "ibaraki", "takatsuki", "takatsuki"

- `income city income_data`
- `income_data income`

Chapter 6

RStudio

6.1

Chapter 3

CSV .csv Excel .xlsx, .xls

1

6.2

6.2.1 CSV .csv

CSV read_csv sotsuron.csv

```
data_original <- read_csv("sotsuron.csv")
```

csv data_original

data_original

6.2.2 Excel .xlsx

Excel readxl

```
install.packages("readxl")  
library(readxl)
```

read_excel

```
data_original <- read_excel("sotsuron.xlsx")
```

6.2.3 Qualtrics

Qualtrics qualtrics

```
install.packages("qualtrics")  
library(qualtrics)
```

Qualtrics CSV CSV read_survey
data_original <- read_survey("sotsuron.csv")

Qualtrics

6.3

- “Data” data_original
 —
- head(data_original)
- str(data_original)

```
library(wooldridge)
```

Chapter 7

7.1

$$\begin{array}{c} 2 \\ \leftarrow \\ \\ \leftarrow \end{array}$$

7.2

$$\begin{array}{c} \cdot \\ \cdot \\ \\ 5 \quad 1 \quad 5 \\ \cdot \\ \cdot \quad 5 \\ \cdot \qquad 1, 2 \quad 3, 4, 5 \end{array}$$

7.3

```

wooldridge1      saving
install.packages("wooldridge")
library(wooldridge)

data()
data("saving")

head()
head(saving)

##      sav   inc size educ age black  cons
## 1    30  1920   4    2  40     1  1890
## 2   874 12403   4    9  33     0 11529
## 3   370  6396   2   17  31     0  6026
## 4  1200  7005   3    9  50     0  5805
## 5   275  6990   4   12  28     0  6715
## 6  1400  6500   4   13  33     0  5100

1980

• sav:
• inc:
• size:
• educ:
• age:
• black:
• cons:

•
•
•

```

```

library(tidyverse)
library(wooldridge)
data("saving")

```

¹Wooldridge

“Introductory Econometrics: A Modern Approach”

Chapter 8

... 8

dplyr dplyr tidyverse tidyverse OK

8.1 %>%

%>% magrittr tidyverse

```
saving %>% head()
```

```
##      sav   inc size educ age black  cons
## 1    30  1920    4    2  40     1  1890
## 2   874 12403    4    9  33     0 11529
## 3   370  6396    2   17  31     0  6026
## 4  1200  7005    3    9  50     0  5805
## 5   275  6990    4   12  28     0  6715
## 6  1400  6500    4   13  33     0  5100
```

Chapter head(saving)

- : saving
- : %>%
- : head()

```
saving$sav %>% mean()
```

```
## [1] 1582.51
```

```
      saving sav      saving$sav      mean() %>%
```

- 100
- saving inc

8.2

-
-
-
-
-

```
dplyr mutate()
```

8.2.1

```
mutate() sav inc      saving_rate
```

```
saving_with_rate <-
  saving %>%
    mutate(saving_rate = sav / inc)
```

```
head(saving_with_rate)
```

```
##      sav  inc size educ age black  cons saving_rate
## 1   30 1920   4   2  40    1  1890  0.01562500
## 2  874 12403   4   9  33    0 11529  0.07046682
## 3  370  6396   2  17  31    0  6026  0.05784866
## 4 1200  7005   3   9  50    0  5805  0.17130621
## 5  275  6990   4  12  28    0  6715  0.03934192
## 6 1400  6500   4  13  33    0  5100  0.21538462
```

```
1 2      saving_with_rate      2      saving mutate()
3 mutate      /      saving_rate
```

```
head(saving_with_rate)      6
```

```
1 saving saving
```

- saving age age_squared
- saving inc inc_yen
- 1 =140

8.2.2

```
mutate 1, 2, 3, 4, 5 5, 4, 3, 2, 1 5
```

- $\rightarrow (1, 2, 3, 4, 5) (-1, -2, -3, -4, -5)$
- 6 $\rightarrow (-1, -2, -3, -4, -5) (5, 4, 3, 2, 1)$

6

```
saving
```

```
data <- data.frame(Q1 = c(3, 2, 4, 1, 5)) # Q1
```

```
data_gyakuten <-
```

```
data %>%
  mutate(Q1_gyakuten = - Q1 + 6)
```

```
data_gyakuten
```

```
## Q1 Q1_gyakuten
## 1 3 3
## 2 2 4
## 3 4 2
## 4 1 5
## 5 5 1
```

- 7 17

8.2.3

```
0 1 scale() mutate() educ educ_standardized
saving_standardized_educ <-
  saving %>%
    mutate(educ_standardized = scale(educ))
head(saving_standardized_educ)
```

```
##      sav   inc size educ age black  cons educ_standardized
## 1    30  1920   4   2  40     1  1890          -2.7886549
## 2   874 12403   4   9  33     0 11529          -0.7510156
## 3    370  6396   2  17  31     0  6026           1.5777150
## 4   1200  7005   3   9  50     0  5805          -0.7510156
## 5    275  6990   4  12  28     0  6715           0.1222584
## 6   1400  6500   4  13  33     0  5100           0.4133497
```

- inc inc_standardized

8.3

8.3.1

```
R                                                                    str()
str(saving)

## 'data.frame':   100 obs. of  7 variables:
## $ sav : int  30 874 370 1200 275 1400 3159 1766 3984 1017 ...
## $ inc : int 1920 12403 6396 7005 6990 6500 26007 15363 14999 9185 ...
## $ size : int  4 4 2 3 4 4 5 5 5 5 ...
## $ educ : int  2 9 17 9 12 13 17 16 9 16 ...
## $ age : int  40 33 31 50 28 33 36 44 48 31 ...
## $ black: int  1 0 0 0 0 0 0 0 1 0 ...
## $ cons : int 1890 11529 6026 5805 6715 5100 22848 13597 11015 8168 ...
## - attr(*, "time.stamp")= chr "25 Jun 2011 23:03"

$      int      int      (integer)
• int: integer,
• dbl: double,
• num: numeric,
```

8.3.2

```
fct (factor) saving      as_factor() integer black as_factor() xxx
as_factor() integer black
saving_with_factor <-
  saving %>%
    mutate(black_factor = as_factor(black))
str(saving_with_factor)
```

```
## 'data.frame':    100 obs. of  8 variables:
## $ sav      : int  30 874 370 1200 275 1400 3159 1766 3984 1017 ...
## $ inc      : int 1920 12403 6396 7005 6990 6500 26007 15363 14999 9185 ...
## $ size     : int   4 4 2 3 4 4 5 5 5 5 ...
## $ educ     : int   2 9 17 9 12 13 17 16 9 16 ...
## $ age      : int  40 33 31 50 28 33 36 44 48 31 ...
## $ black    : int   1 0 0 0 0 0 0 0 1 0 ...
## $ cons     : int 1890 11529 6026 5805 6715 5100 22848 13597 11015 8168 ...
## $ black_factor: Factor w/ 2 levels "0","1": 2 1 1 1 1 1 1 2 1 ...
```

```
mutate      black_factor      str()      Factor
           as_factor
(chr, character)           as_factor
```

- size

8.3.3

```
if_else() if_else( , 12 , 2 , 2 if_else )
```

```
table(saving$educ) #
```

```
##
##  2  3  4  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
##  1  1  1  1  4 10 11  9  4 32  2  4  1  9  6  2  1  1
```

```
saving_with_hsdummy <-
  saving %>%
    mutate(highschool = if_else(educ >= 12, 1, 0))
head(saving_with_hsdummy)
```

```
##      sav    inc size educ age black  cons highschool
## 1    30   1920    4   2  40     1  1890           0
## 2   874  12403    4   9  33     0 11529           0
## 3   370   6396    2  17  31     0  6026           1
## 4  1200   7005    3   9  50     0  5805           0
## 5   275   6990    4  12  28     0  6715           1
## 6  1400   6500    4  13  33     0  5100           1
```

```
table(saving_with_hsdummy$highschool) #
```

```
##
## 0 1
```

```
## 42 58
```

```
highschool    12    1    12    0                                as_factor()
```

```
saving_with_hsdummy <-
  saving %>%
    mutate(highschool = if_else(educ >= 12, 1, 0),
           highschool = as_factor(highschool)) #highschool factor
head(saving_with_hsdummy)
```

```
##      sav   inc size educ age black  cons highschool
## 1    30  1920   4    2  40     1  1890           0
## 2   874 12403   4    9  33     0 11529           0
## 3   370  6396   2   17  31     0  6026           1
## 4  1200  7005   3    9  50     0  5805           0
## 5   275  6990   4   12  28     0  6715           1
## 6  1400  6500   4   13  33     0  5100           1
```

- 40 over40

8.3.4

```
2      if_else  3      case_when      age      case_when case_when( A
~      , B ~      ...
```

```
summary(saving$age) #
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## 26.00   33.00   38.50   38.77   44.00   54.00
```

```
saving_with_age_category <-
  saving %>%
    mutate(age_category = case_when(age < 30 ~ "20s",
                                   age >= 30 & age < 40 ~ "30s",
                                   age >= 40 & age < 50 ~ "40s",
                                   age >= 50 ~ "50s"
                                   )
  )
head(saving_with_age_category)
```

```
##      sav   inc size educ age black  cons age_category
## 1    30  1920   4    2  40     1  1890           40s
## 2   874 12403   4    9  33     0 11529           30s
## 3   370  6396   2   17  31     0  6026           30s
```

```
## 4 1200 7005 3 9 50 0 5805 50s
## 5 275 6990 4 12 28 0 6715 20s
## 6 1400 6500 4 13 33 0 5100 30s
```

chr(character) as_factor

- 6000 “poor” 6000 12000 “middle” 12000 “rich” inc_category

8.4

```
                                dplyr select()
saving inc age
saving_selected <-
  saving %>%
    select(inc, age)
head(saving_selected)
```

```
##      inc age
## 1  1920  40
## 2 12403  33
## 3  6396  31
## 4  7005  50
## 5  6990  28
## 6  6500  33
```

2

```
-                                saving cons
saving_deleted <-
  saving %>%
    select(-cons)
head(saving_deleted)
```

```
##      sav  inc size educ age black
## 1    30 1920   4    2  40     1
## 2   874 12403   4    9  33     0
## 3   370  6396   2   17  31     0
## 4  1200  7005   3    9  50     0
## 5   275  6990   4   12  28     0
## 6  1400  6500   4   13  33     0
```

- sav size black 3
- educ age

8.5

```
dplyr arrange() saving inc

saving_arranged <-
  saving %>%
    arrange(inc)

head(saving_arranged)

##      sav  inc size educ age black cons
## 1     0  750    2    4  49      0   750
## 2    30 1920    4    2  40      1  1890
## 3    50 2340    2    6  46      1  2290
## 4  -112 2936    7   10  39      0  3048
## 5  2575 3941    4    9  34      0  1366
## 6  2483 4091    6    8  44      0  1608
```

```
desc()

saving_arranged_desc <-
  saving %>%
    arrange(desc(inc))

head(saving_arranged_desc)

##      sav  inc size educ age black cons
## 1  1800 32080    2   16  54      0 30280
## 2 10668 30996    4   12  41      0 20328
## 3  4115 30610    4   16  44      0 26495
## 4  3159 26007    5   17  36      0 22848
## 5 -2749 24226    5   17  44      0 26975
## 6  5082 19362    3   11  48      0 14280
```

8.6

- ```
%>%
```
- saving\_rate
  - size
  - inc



```
saving_handled <-
 saving %>%
 mutate(saving_rate = sav / inc) %>%
 select(-size) %>%
 arrange(desc(inc))

head(saving_handled)
```

```
sav inc educ age black cons saving_rate
1 1800 32080 16 54 0 30280 0.05610973
2 10668 30996 12 41 0 20328 0.34417344
3 4115 30610 16 44 0 26495 0.13443319
4 3159 26007 17 36 0 22848 0.12146730
5 -2749 24226 17 44 0 26975 -0.11347313
6 5082 19362 11 48 0 14280 0.26247289
```

```
#
```

```
saving_handled
 saving %>%
 mutate(saving_rate = sav / inc) %>% #
 select(-size) %>% #
 arrange(desc(inc)) #
```



# Chapter 9

```
summarytools
install.packages("summarytools")
library(summarytools)
```

Chapter                      Word                      Chapter ??Word)

## 9.1

```
summarytools descr() saving
saving %>%
 descr()
```

```
Descriptive Statistics
saving
N: 100
##
age black cons educ inc sav size

Mean 38.77 0.07 8358.73 11.58 9941.24 1582.51 4.35
Std.Dev 7.40 0.26 5729.53 3.44 5584.00 3284.90 1.49
Min 26.00 0.00 -13055.00 2.00 750.00 -5577.00 2.00
Q1 33.00 0.00 5726.00 9.00 6508.00 189.00 3.00
Median 38.50 0.00 7561.50 12.00 8776.50 982.00 4.00
Q3 44.00 0.00 9987.00 13.00 11965.00 1838.50 5.00
Max 54.00 1.00 30280.00 20.00 32080.00 25405.00 10.00
MAD 8.15 0.00 3092.70 2.97 3463.35 1235.75 1.48
```

```
IQR 11.00 0.00 4131.50 4.00 5393.00 1640.25 2.00
CV 0.19 3.66 0.69 0.30 0.56 2.08 0.34
Skewness 0.24 3.32 0.91 0.05 1.98 4.15 0.84
SE.Skewness 0.24 0.24 0.24 0.24 0.24 0.24 0.24
Kurtosis -0.96 9.11 4.31 0.05 4.96 26.31 1.57
N.Valid 100.00 100.00 100.00 100.00 100.00 100.00 100.00
Pct.Valid 100.00 100.00 100.00 100.00 100.00 100.00 100.00
```

- stats
  - mean sd min max n.valid
- transpose TRUE
- heading FALSE

```
saving %>%
```

```
descr(stats = c("mean", "sd", "min", "max", "n.valid"), transpose = TRUE, headings =
```

```
##
Mean Std.Dev Min Max N.Valid

age 38.77 7.40 26.00 54.00 100.00
black 0.07 0.26 0.00 1.00 100.00
cons 8358.73 5729.53 -13055.00 30280.00 100.00
educ 11.58 3.44 2.00 20.00 100.00
inc 9941.24 5584.00 750.00 32080.00 100.00
sav 1582.51 3284.90 -5577.00 25405.00 100.00
size 4.35 1.49 2.00 10.00 100.00
```

## 9.2

2

- descr()
  - black
- summarytools freq()

Chapter ??DataHandling) age\_category

```
age_category <-
```

```
saving %>%
```

```
mutate(age_category = case_when(age < 30 ~ "20s",
 age >= 30 & age < 40 ~ "30s",
 age >= 40 & age < 50 ~ "40s",
 age >= 50 ~ "50s"
)
)
```

```
) %>%
select(age_category)
```

```
age_category freq()
```

```
age_category %>%
freq()
```

```
Frequencies
age_category$age_category
Type: Character
##
Freq % Valid % Valid Cum. % Total % Total Cum.

20s 12 12.00 12.00 12.00 12.00
30s 44 44.00 56.00 44.00 56.00
40s 31 31.00 87.00 31.00 87.00
50s 13 13.00 100.00 13.00 100.00
<NA> 0 0.00 0.00 0.00 100.00
Total 100 100.00 100.00 100.00 100.00
```

```
age_category %>%
freq(report.nas = FALSE, totals = FALSE, cumul = FALSE, headings = FALSE)
```

```
##
Freq %

20s 12 12.00
30s 44 44.00
40s 31 31.00
50s 13 13.00
```

- report.nas = FALSE: NA
- totals = FALSE:
- cumul = FALSE:
- headings = FALSE:



# Chapter 10

R ggplot2 ggplot2 tidyverse

ggplot2 ggplot2

```
%>%
ggplot(aes(x = x , y = y)) +
geom_ ()
```

- 1
- 2 +  
– aes aesthetic
- 3  
– geom\_bar:  
– geom\_histogram:  
– geom\_boxplot:  
– geom\_point:  
– geom\_smooth:

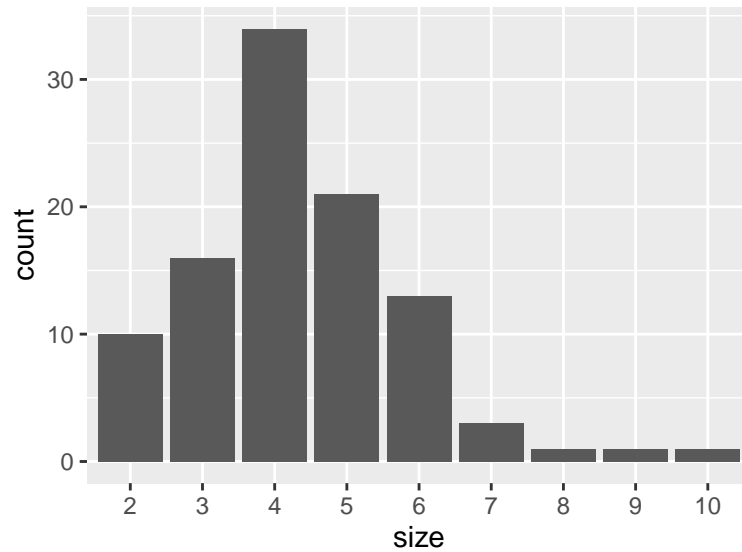
## 10.1 1

1

### 10.1.1

1 saving size

```
saving %>%
 mutate(size = as_factor(size)) %>% #size
 ggplot(aes(x = size)) +
 geom_bar()
```

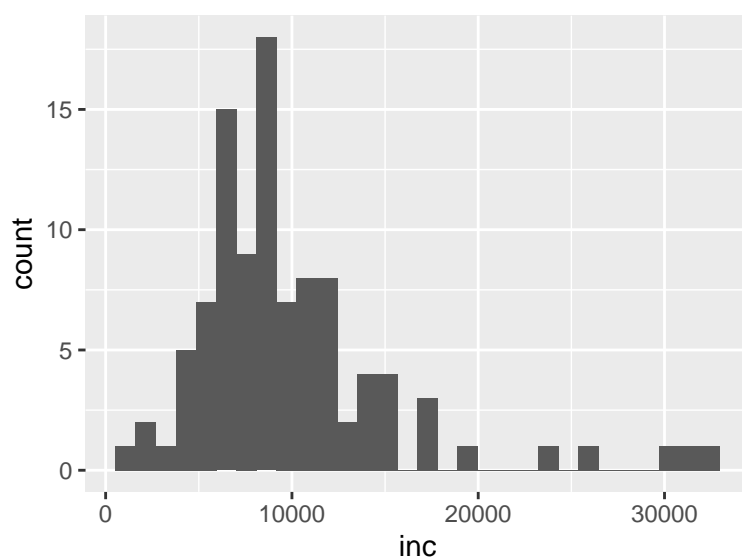


```
1 x y geom_bar() count 4 5 3 ...
```

### 10.1.2

```
1 saving inc
saving %>%
 ggplot(aes(x = inc)) +
 geom_histogram()
```



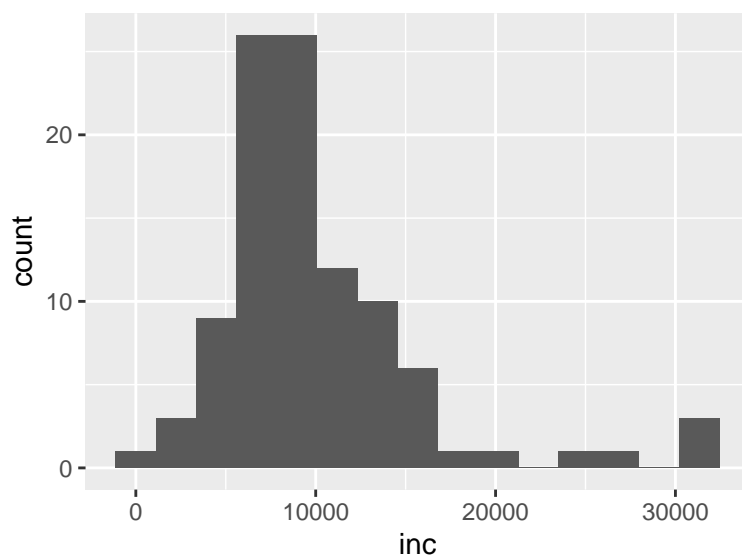


```

x geom_histogram bins 30
bins 15

saving %>%
 ggplot(aes(x = inc)) +
 geom_histogram(bins = 15) # 15

```



```

binwidth center boundary

```

## 10.2 2

2

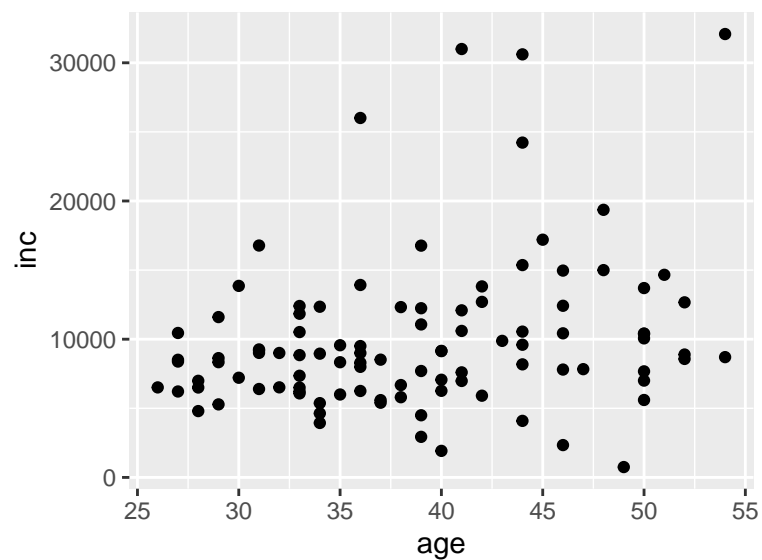
•  
•  
•

### 10.2.1

```

 geom_point() age inc
saving %>%
 ggplot(aes(x = age, y = inc)) +
 geom_point()

```



```

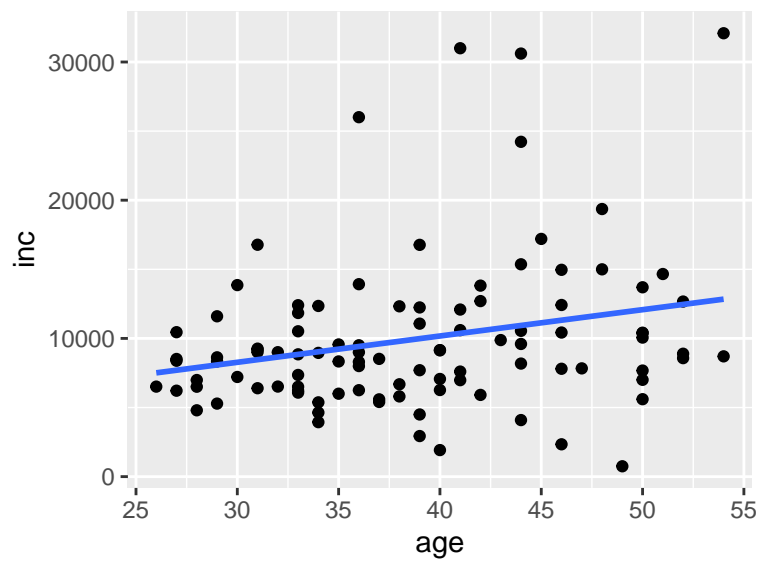
2 x y x y x y

```

```

 geom_smooth
saving %>%
 ggplot(aes(x = age, y = inc)) +
 geom_point() +
 geom_smooth(method = "lm", se = FALSE)

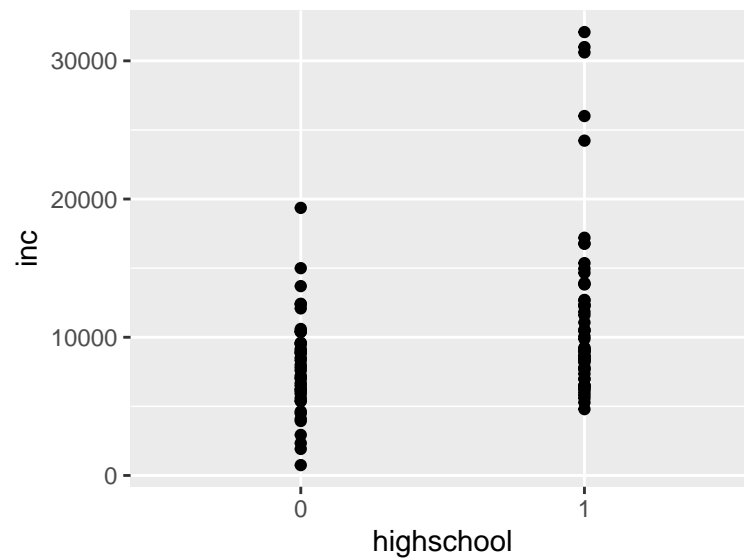
```



```
ggplot + geom_point() geom_smooth()
geom_smooth() method lm linear model
se FALSE
```

educ      highschool      inc

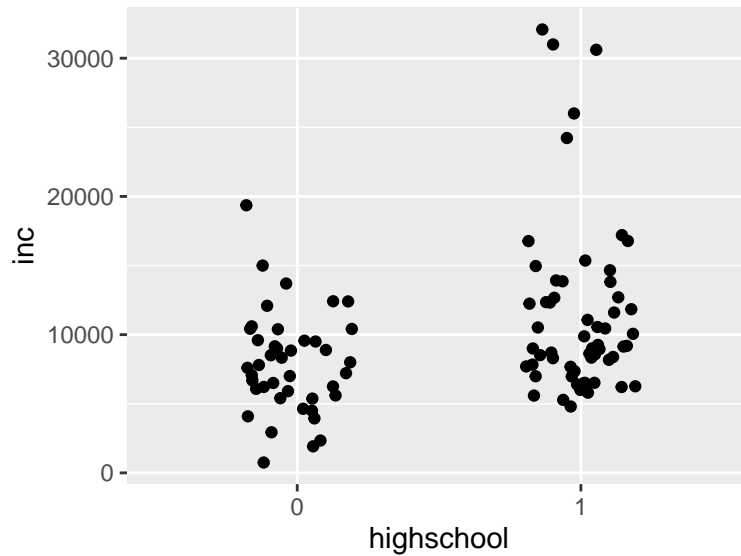
```
saving %>%
 mutate(highschool = if_else(educ >= 12, 1, 0),
 highschool = as_factor(highschool)) %>%
 ggplot(aes(x = highschool, y = inc)) +
 geom_point()
```



```
• geom_point() geom_jitter()
•
```

```
geom_jitter()
```

```
saving %>%
 mutate(highschool = if_else(educ >= 12, 1, 0),
 highschool = as_factor(highschool)) %>%
 ggplot(aes(x = highschool, y = inc)) +
 geom_jitter(width = 0.2)
```



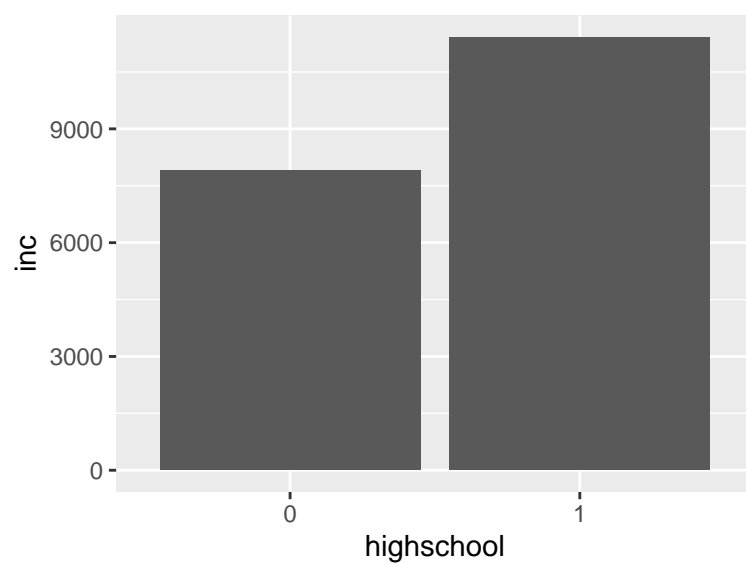
```
width = 0.2
```

### 10.2.2

```
geom_bar() stat_summary() stat_summary() fun.y
```

```
mean geom
```

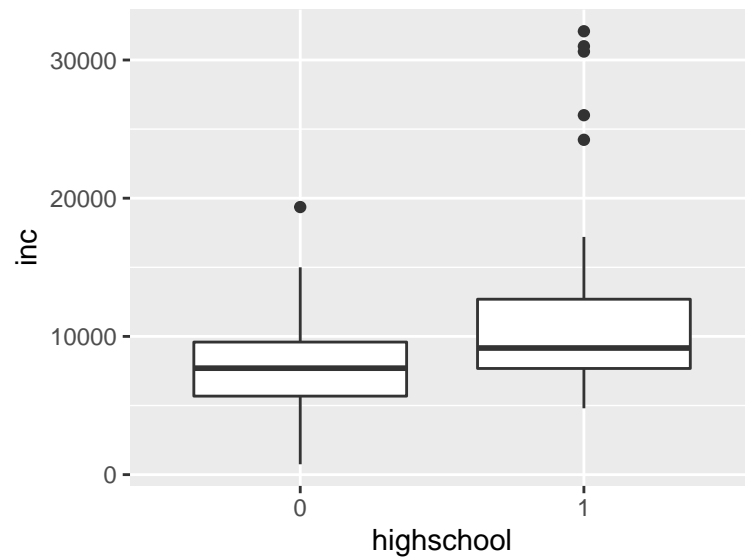
```
saving %>%
 mutate(highschool = if_else(educ >= 12, 1, 0),
 highschool = as_factor(highschool)) %>%
 ggplot(aes(x = highschool, y = inc)) +
 stat_summary(fun.y = "mean", geom = "bar")
```



### 10.2.3

geom\_boxplot

```
saving %>%
 mutate(highschool = if_else(educ >= 12, 1, 0),
 highschool = as_factor(highschool)) %>%
 ggplot(aes(x = highschool, y = inc)) +
 geom_boxplot()
```

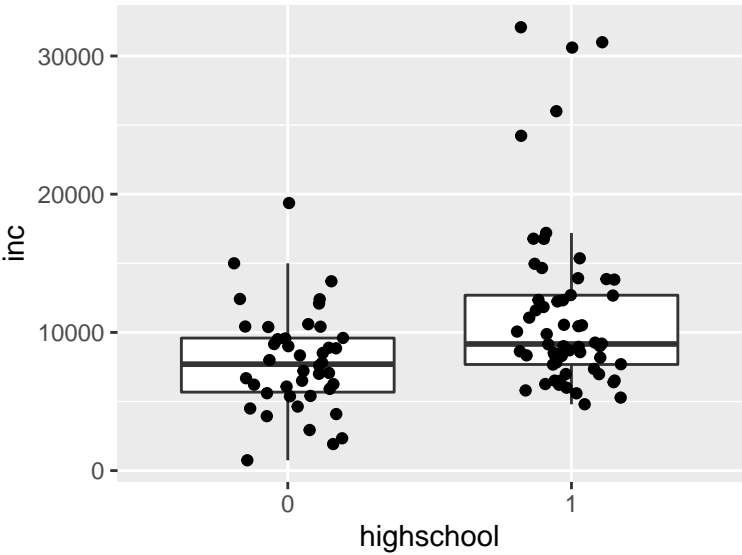


- 25%
- 50%
- 75%
- $1.5 \times \text{IQR}$  -
- 

```

 geom_jitter() ggplot2 geom_xxxx +
saving %>%
 mutate(highschool = if_else(educ >= 12, 1, 0),
 highschool = as_factor(highschool)) %>%
 ggplot(aes(x = highschool, y = inc)) +
 geom_boxplot(outlier.shape = NA) + #
 geom_jitter(width = 0.2)

```







# Chapter 11

## t

```
2 t t t.test() t.test()
t.test(~ , data =)

black inc
t.test(inc ~ black, data = saving)

##
Welch Two Sample t-test
##
data: inc by black
t = 1.8562, df = 7.3906, p-value = 0.1036
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
-890.170 7726.938
sample estimates:
mean in group 0 mean in group 1
10180.527 6762.143

t p 0.103
t.test() 2 Welch t var.equal = TRUE t Welch t
t broom tidy bloom
install.packages("broom")

tidy() t.test tidy()
library(broom)
t.test(inc ~ black, data = saving) %>%
tidy()
```

```
A tibble: 1 x 10
estimate estimate1 estimate2 statistic p.value parameter conf.low conf.high
<dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
1 3418. 10181. 6762. 1.86 0.104 7.39 -890. 7727.
... with 2 more variables: method <chr>, alternative <chr>
```

- estimate:
- estimate1: 1
- estimate2: 2
- statistic: t
- p.value: p
- parameter:
- conf.low, conf.high:
- method:
- alternative:

# Chapter 12

## Linear Regression

### 12.1

$$y = \alpha + \beta x$$

$$y = \beta_0 + \beta_1 x$$

$$\alpha = \beta_0$$
$$\beta = \beta_1$$

OLS

R

Coefficient

$x$

$y$

### 12.2 R

R  $y \sim x$  Chapter 11  $t$  `lm()` lm linear model

```
lm(, data =)
```

$inc$

$educ$

$inc = \alpha + \beta educ$

```
lm(inc ~ educ, data = saving)
```

```
##
Call:
lm(formula = inc ~ educ, data = saving)
##
Coefficients:
(Intercept) educ
```

```
1342.7 742.5
Coefficients: (Intercept) educ
lm() t p lm() summary()
lm(inc ~ educ, data = saving) %>%
 summary()

##
Call:
lm(formula = inc ~ educ, data = saving)
##
Residuals:
Min 1Q Median 3Q Max
-7570 -3297 -1288 1617 20743
##
Coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) 1342.7 1763.5 0.761 0.448
educ 742.5 146.1 5.084 1.78e-06 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
Residual standard error: 4993 on 98 degrees of freedom
Multiple R-squared: 0.2087, Adjusted R-squared: 0.2006
F-statistic: 25.84 on 1 and 98 DF, p-value: 1.777e-06

Coefficients
 • Estimate:
 • Std. Error:
 • t value: t
 • Pr(>|t|): p

educ p 1.78e-06 $1.78 \times 10^{-6} = 1.78 \times 0.000001 = 0.00000178$
educ β

 R^2

summary() Chapter 11 broom tidy()
lm(inc ~ educ, data = saving) %>%
 tidy()

A tibble: 2 x 5
term estimate std.error statistic p.value
<chr> <dbl> <dbl> <dbl> <dbl>
1 (Intercept) 1343. 1764. 0.761 0.448
2 educ 743. 146. 5.08 0.00000178
```

- inc size

## 12.3

$x_1, x_2$

$$y = \alpha + \beta_1 x_1 + \beta_2 x_2$$

R `y ~ x1 + x2 + inc educ size`

```
lm(inc ~ educ + size, data = saving) %>%
 tidy()
```

```
A tibble: 3 x 5
term estimate std.error statistic p.value
<chr> <dbl> <dbl> <dbl> <dbl>
1 (Intercept) 3027. 2283. 1.33 0.188
2 educ 743. 146. 5.10 0.00000171
3 size -389. 335. -1.16 0.249
```

3 4 ... R `y ~ x1 + x2 + x3 + x4 + ... +`

`age black`

```
equation <- inc ~ educ + size + age + black
lm(equation, data = saving) %>%
 tidy()
```

```
A tibble: 5 x 5
term estimate std.error statistic p.value
<chr> <dbl> <dbl> <dbl> <dbl>
1 (Intercept) -10005. 3934. -2.54 0.0126
2 educ 857. 144. 5.97 0.0000000408
3 size -101. 320. -0.317 0.752
4 age 271. 66.3 4.09 0.0000917
5 black -553. 1878. -0.294 0.769
```

4

- sav educ size age

## 12.4

```

 1 0
 inc black
lm(inc ~ black, data = saving)

##
Call:
lm(formula = inc ~ black, data = saving)
##
Coefficients:
(Intercept) black
10181 -3418
-3418 3418

```

## 12.5

```

 -1 A, B, C 3
 • B 1 0 B
 • C 1 0 C

 • B B A
 • C C A
 B C
R factor
 age_category inc
saving_with_age_category <-
 saving %>%
 mutate(age_category = case_when(age < 30 ~ "20s",
 age >= 30 & age < 40 ~ "30s",
 age >= 40 & age < 50 ~ "40s",
 age >= 50 ~ "50s"
)
)
lm(inc ~ age_category, data = saving_with_age_category)

##
Call:

```

```
lm(formula = inc ~ age_category, data = saving_with_age_category)
##
Coefficients:
(Intercept) age_category30s age_category40s age_category50s
7685 1330 3761 3885
##
"20s" 20
##
• 30 20 1330
• 40 20 3761
• 50 20 3885
##
20 <30 <40 <50 40 50
```

## 12.6

R 2 :

R

```
lm(inc ~ educ + black + educ:black, data = saving) %>%
 tidy()
```

```
A tibble: 4 x 5
term estimate std.error statistic p.value
<chr> <dbl> <dbl> <dbl> <dbl>
1 (Intercept) 1595. 1926. 0.828 0.410
2 educ 727. 157. 4.63 0.0000115
3 black -525. 5773. -0.0909 0.928
4 educ:black -63.1 615. -0.103 0.918
##
educ 727 1 727
##
educ:black-63 727-63=664 1 664
##
p
```

\*

```
lm(inc ~ educ*black, data = saving) %>%
 tidy()
```

```
A tibble: 4 x 5
term estimate std.error statistic p.value
<chr> <dbl> <dbl> <dbl> <dbl>
1 (Intercept) 1595. 1926. 0.828 0.410
2 educ 727. 157. 4.63 0.0000115
3 black -525. 5773. -0.0909 0.928
4 educ:black -63.1 615. -0.103 0.918
```

- inc age

## 12.7

```

tidy()

 stargazer

2

1. inc educ
2. inc educ age

stargazer()
regression1 <- lm(inc ~ educ, data = saving) #
regression2 <- lm(inc ~ educ + age, data = saving) #
stargazer(regression1, regression2, type = "html", out = "test.doc")

```

Dependent variable:

inc

(1)

(2)

educ

742.530\*\*\*

869.852\*\*\*

(146.062)

(137.566)

age

276.677\*\*\*

(63.872)

Constant

1,342.745

-10,858.410\*\*\*

(1,763.546)

(3,250.631)

Observations



100  
100  
R2  
0.209  
0.337  
Adjusted R2  
0.201  
0.323  
Residual Std. Error  
4,992.593 (df = 98)  
4,593.594 (df = 97)  
F Statistic  
25.844\*\*\* (df = 1; 98)  
24.646\*\*\* (df = 2; 97)

Note:  
 $p<0.1$ ;  $p<0.05$ ;  $p<0.01$

| 1    | 2 | lm()  | regression1,regression2 | stargazer() |
|------|---|-------|-------------------------|-------------|
| type |   | LaTeX | HTML                    | out         |
|      |   |       |                         | *           |
|      |   |       |                         | ***         |
|      |   |       |                         | 1%          |
|      |   |       |                         | **          |
|      |   |       |                         | 5%          |
|      |   |       |                         | *           |
|      |   |       |                         | 10%         |

- Observation:
- $R^2$ :
- Adjusted  $R^2$ :
- Residual Std. Error:
- F Statistic: F F



# Chapter 13

## Word

Word Word R Word

### 13.1

Word Excel

- R Excel
- 
- 
- — → Word →

R Word flextable