Social Science Research Methods

Barış Arı

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First Task

The module has two in-person teaching components:

1. Lectures (one-hour on Monday)
2. Applied data analysis: IT lab (two-hours on Wednesday/Friday)

Attendance is mandatory for all teaching sessions. If you cannot attend to any of the sessions, please make sure to submit an extenuating circumstances through eVision.

We will use this website for learning applied data analysis. **The website is not a substitute for module Blackboard.** We will use this site in conjunction with Blackboard.

Our very first task is to install R and R Studio on our laptops.

Please try do this before coming to next lab.

R and R Studio are very powerful tools for analysing data and for creating high-quality documents. I prepared this website using R Studio. It is widely used both in academic research and in commercial enterprise. Learning the fundamentals of these powerful tools gives you an advantage in the job market (or for pursuing further studies such as PhD). They are free and open source.

Make sure to install R first and then the R Studio.

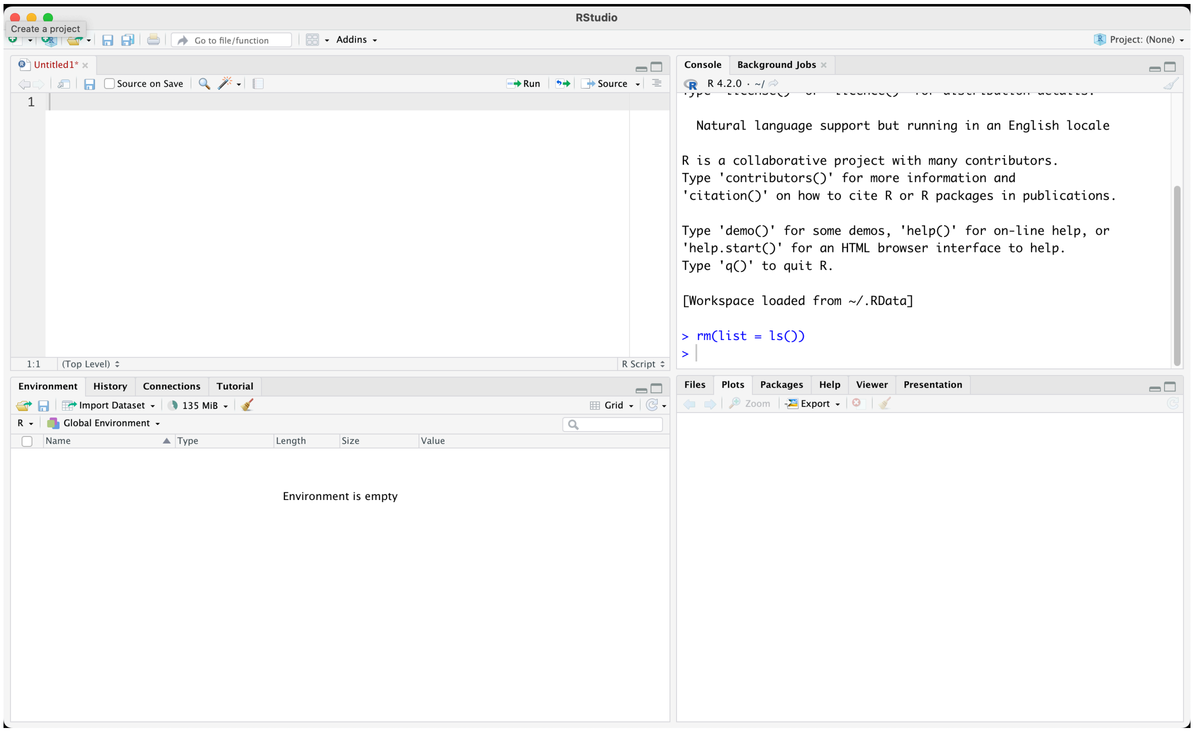
1. R can be installed here: https://cran.r-project.org/
2. R Studio can be install here: https://posit.co/downloads/

Instructions for installing R and R Studio are available in Appendix A of the Online Textbook Hands-on Programming with R.

1 R Basics

R is a free software environment for statistical computing and graphics. It is an extremely powerful tool that we will use for data analysis and visualisations.

R Studio is a customization of R. It runs R in the background and comes up with some additional features such as a very nice text editor.



```
Type 'license()' or 'licence()' for distribution details.

  Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[Workspace loaded from ~/.RData]

> rm(list = ls())
> 
```

Figure 1.1: R Studio screen with four panes

R Studio has four panes:

1. Console
2. Text editor to work on R scripts
3. Environment window
4. Plot display

As default, the bottom left pane shows the console. This is where you can type your commands to R. However, we will discourage directly typing into the console. Instead, we will use the text editor, which is located above the console pane. This is where we will type our commands (and also comments). We will then run our code from the text editor. This will allow us to track what we have done. We can easily edit the code if we made a mistake. We can also save the commands for future use.

The upper right pane usually shows the environment by default. This is where our objects such as our data will be shown.

Your environment would not include anything when you first open R Studio. It is the case because we have not imported any data or created any objects.

Finally, the lower right pane displays files/folders, plots (that we will prepare) and help files. We will discuss this pane more in the future.

1.1 Objectives for Week 1

1. Use R as a calculator
2. Write and execute a command by using R Studio text editor
3. Save your script
4. Use the assignment operator to create objects
5. Understand the difference between 'string' and 'numerical'
6. Create a simple dataset

1.2 Use R as a calculator

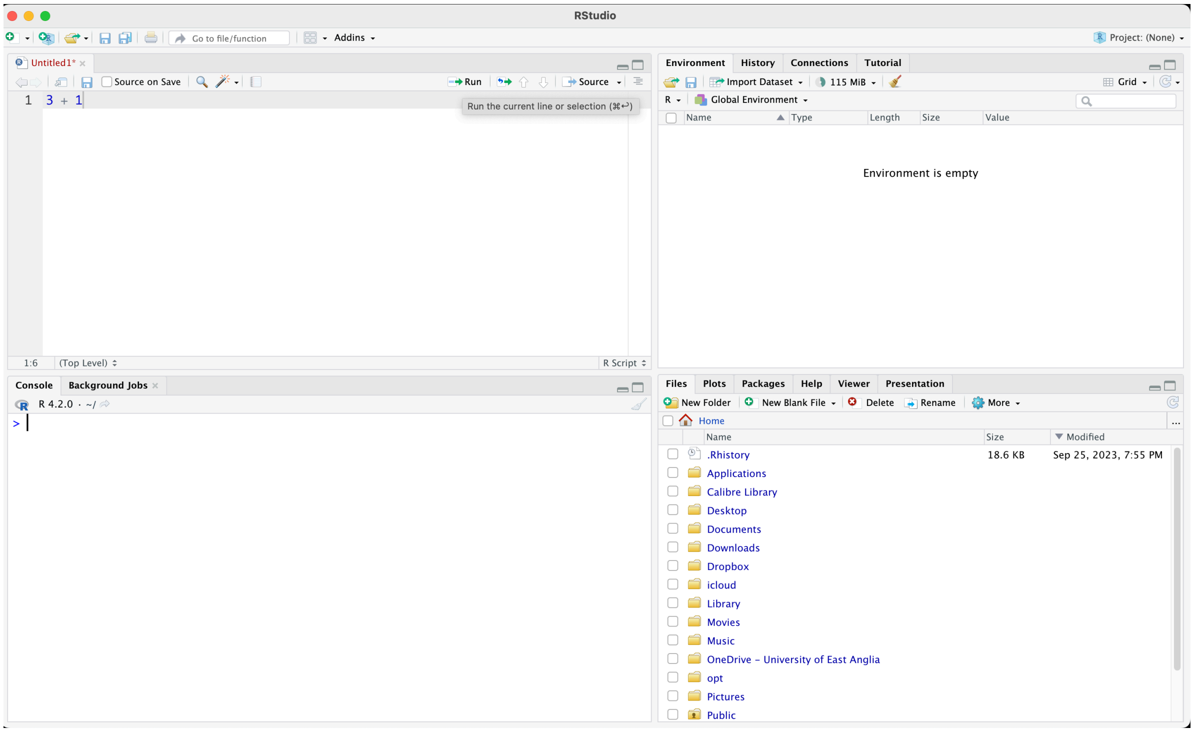
Go to the console pane and type a simple calculation.

```
1 + 3
#> [1] 4
```

As you can see, the output for `1 + 3` is `4`, which is correct. We directly did a calculation using the console.

This would work, but it is not a good approach. **Do not write your code directly to the console.** Instead, go to the top left pane and write your 'code' into the text editor. The calculation 1 + 3 here is your code.

- Save your script by `File >> Save` OR simply by pressing `Ctrl-S` (linux), `Control-S` (windows), `Command-S` (mac). It is a good idea to create a folder/directory for this module and give your script an intuitive name such as *learn_01.R*.



```
3 + 1
```

```
R 4.2.0 · ~/
>
```

Name	Type	Length	Size	Value

Environment is empty

Name	Size	Modified
.Rhistory	18.6 KB	Sep 25, 2023, 7:55 PM
Applications		
Calibre Library		
Desktop		
Documents		
Downloads		
Dropbox		
icloud		
Library		
Movies		
Music		
OneDrive – University of East Anglia		
opt		
Pictures		
Public		

Figure 1.2: Our first calculation

1.3 Assignment operator to create objects

We can create objects in R which store our data. For example, you would like to calculate your age. Current year (i.e., 2024) - your birth year gives your age.

Let's create an object which stores your year of birth. We are going to call it my_birth_year. Each R object must be one-word only, so I use _ instead of space. We could also have used a dot or dash.

```r
# This is a comment.
# Characters after a hashtag are considered as comments by R.
# They are not executed.
# Use comments extensively to take notes
# and to remind your future self of the work you did.

# "<-" is the assignment operator
# It basically symbolizes an arrow.

my_birth_year <- 1985
```

Now the Environment should store an object called `my_birth_year`. When I run my_birth_year, R will display the information stored.

```r
my_birth_year
#> [1] 1985
```

Note that R is case sensitive. If you mistype, such as `My_birth_year`, it will give you an error message.

```r
My_birth_year
#> Error in eval(expr, envir, enclos): object 'My_birth_year' not found
```

We can find your age by subtracting current year from `my_birth_year`.

```r
2024 - my_birth_year
#> [1] 39
```

We typed 2024 manually. We might want to create another object called `current_year`. Try to do it yourself, as an exercise.

```
current_year <- 2024
```

You can do operations using objects. For example, calculate your age using the objects `current_year` and `my_birth_year`. Store this in another object called `my_age`.

```
my_age <- current_year - my_birth_year
```

Check if you did correctly.

```
my_age
#> [1] 39
```

You can also write over an object.

```
current_year <- 2030
current_year
#> [1] 2030
```

This would not change outputs previously created using the older version of the objects.

```
my_age
#> [1] 39
```

Obviously, current year is not 2030, so let's correct it back.

```
current_year <- 2024
```

1.4 Numerical and String Objects

So far, we stored numerical data. We can also have textual information, such as name of a person, or type of a medicine.

Create an object called `my_name` and store your name there.

```
my_name <- "Baris"
my_name
#> [1] "Baris"
```

As you can see, R displays textual information within quotation (“ “). Any information stored or displayed within ’ ’ is called a string and refers to text.

Create an object called `my_name_last` and store your name there.

```r
my_last_name <- "Ari"
```

Obviously, you cannot make a calculation using words. It is nonsensical to subtract two words. You cannot do any calculation with words.

```r
my_name_last - my_name
#> Error in eval(expr, envir, enclos): object 'my_name_last' not found
```

Sometimes numerical information is stored as text. In that case, R will not consider it as a number. For example, see three objects below.

```r
num1 <- 10
num2 <- 100
num3 <- "1000"
```

`num1` and `num2` are numerical values, but `num3` is text. You cannot do any calculation with that.

```r
num1
#> [1] 10

num2
#> [1] 100

num3
#> [1] "1000"

num1 + num2
#> [1] 110

num1 + num3
#> Error in num1 + num3: non-numeric argument to binary operator
```

1.5 Create a simple dataset

Imagine that we have the names and birth years of a number of people. We cannot really hold each piece of information in separate objects. We would like to store them altogether in a single object, like a spreadsheet.

Let's start with names. We have five people:

1. Keir Starmer
2. Rishi Sunak
3. Liz Truss
4. Boris Johnson
5. Theresa May
6. David Cameron

We can store their full names in a single object using the combine function `c()`.

```
names_pm <- c("Keir Starmer",
              "Rishi Sunak",
              "Liz Truss",
              "Boris Johnson",
              "Theresa May",
              "David Cameron",
              "Gordon Brown",
              "Tony Blair")
```

Note that each PMs name is written within quotation and they are combined together with the function `c()`. Each item within `c()` is separated with a comma. Let's see the object:

```
names_pm
#> [1] "Keir Starmer"  "Rishi Sunak"   "Liz Truss"     "Boris Johnson"
#> [5] "Theresa May"   "David Cameron" "Gordon Brown"  "Tony Blair"
```

Great! We have the names of the last six UK PMs.

You may have realized that there are numbers in squared brackets in the beginning of each line.

These numbers refer to the order in the sequence. For example, "Keir Starmer" is the first item whereas "Theresa May" is the fifth.

You can recall a particular item in the object using square brackets. Let's print the first item in `names_pm`.

```r
names_pm[1]
#> [1] "Keir Starmer"
```

Similarly, for the third item, you would use [3]:

```r
names_pm[3]
#> [1] "Liz Truss"
```

Find the fifth name in the object.

```r
names_pm[5]
#> [1] "Theresa May"
```

You can add more than one number into the square brackets using the `c()` function. For example, who are the second and fourth names?

```r
names_pm[c(2,4)]
#> [1] "Rishi Sunak"   "Boris Johnson"
```

Next, let's write down their birth year. The order is important! You need to keep the same order with PMs.

```r
birth_years <- c(1962, # Keir Starmer
                 1980, # Rishi Sunak
                 1975, # Liz Truss
                 1964, # Boris Johnson
                 1956, # Theresa May
                 1966, # David Cameron
                 1951, # Gordon Brown
                 1953  # Tony Blair)
                 )
```

Check the object we just created.

```r
birth_years
#> [1] 1962 1980 1975 1964 1956 1966 1951 1953
```

Let's put them together in a spreadsheet. What we would like to do is to vertically bind the two objects, which is called column bind and denoted with `cbind()`.

```
cbind(names_pm, birth_years)
#>      names_pm        birth_years
#> [1,] "Keir Starmer"  "1962"
#> [2,] "Rishi Sunak"   "1980"
#> [3,] "Liz Truss"     "1975"
#> [4,] "Boris Johnson" "1964"
#> [5,] "Theresa May"   "1956"
#> [6,] "David Cameron" "1966"
#> [7,] "Gordon Brown"  "1951"
#> [8,] "Tony Blair"    "1953"
```

So far, we just printed this on our screen but we have not stored it in an object. Put this into an object.

```
my_data <- cbind(names_pm, birth_years)
```

Check `my_data`.

```
my_data
#>      names_pm        birth_years
#> [1,] "Keir Starmer"  "1962"
#> [2,] "Rishi Sunak"   "1980"
#> [3,] "Liz Truss"     "1975"
#> [4,] "Boris Johnson" "1964"
#> [5,] "Theresa May"   "1956"
#> [6,] "David Cameron" "1966"
#> [7,] "Gordon Brown"  "1951"
#> [8,] "Tony Blair"    "1953"
```

Note that birth_years are stored as text, not numbers. I know this because they are within quotation marks.

It is customary to keep spreadsheets as something called "data frames" in R. This will not change our data, but makes further operations easier by unlocking some of the features of R.

```
my_data <- as.data.frame(my_data)
```

We can take a better look at the dataset using `View()` function.

```
View(my_data)
```

Let's save our script.

1.5.1 Variables in a data frame

Columns in a data frame are also called variables. We have two variables in the dataset:

- names_pm : Name of the UK PM
- birth_years: Birth year of the PM

There are a few ways to access a variable. A straightforward approach is to use the `$` notation:

```
# 'name of the data frame'$'name of the variable'
my_data$names_pm
#> [1] "Keir Starmer"  "Rishi Sunak"   "Liz Truss"     "Boris Johnson"
#> [5] "Theresa May"   "David Cameron" "Gordon Brown"  "Tony Blair"
```

Now it is your turn. Display the `birth_years` variable.

```
my_data$birth_years
#> [1] "1962" "1980" "1975" "1964" "1956" "1966" "1951" "1953"
```

You can think this expression as a sentence in R. In plain English, this expression tells R to bring the variable `names_pm` within the data frame `my_data`. The symbol `$` refers to the 'within' part of this sentence.

Just like you can convey the same meaning using different sentence structures, there are different ways to do the same thing in R. This is because R is working exactly like a language: it is a language to communicate with the computer.

Another way is using the square brackets notation `[]`. `names_pm` is the first column in the data frame. To get the variable, you could type the following:

```
my_data[,1]
#> [1] "Keir Starmer"  "Rishi Sunak"   "Liz Truss"     "Boris Johnson"
#> [5] "Theresa May"   "David Cameron" "Gordon Brown"  "Tony Blair"
```

Note that we did not simply write `my_data[1]`. There is a comma: `my_data[,1]`

In a spreadsheet, we have two dimensions: rows and columns. By convention, rows are considered as the first dimension, and columns are considered as the second. This is why we had to use a comma to designate that we are interested in columns. If left the first dimension unspecified, which tells R to bring everything.

If you want to get the first row, you would type the following:

```
my_data[1, ]
#>       names_pm birth_years
#> 1 Keir Starmer        1962
```

Try it yourself; get the fourth row.

```
my_data[4,]
#>        names_pm birth_years
#> 4 Boris Johnson        1964
```

Let's put these together: you can tell R to bring a specific observation. For example, third row of second column.

```
my_data[3,2]
#> [1] "1975"
```

You can also ask for multiple items by plugging in the combine function.

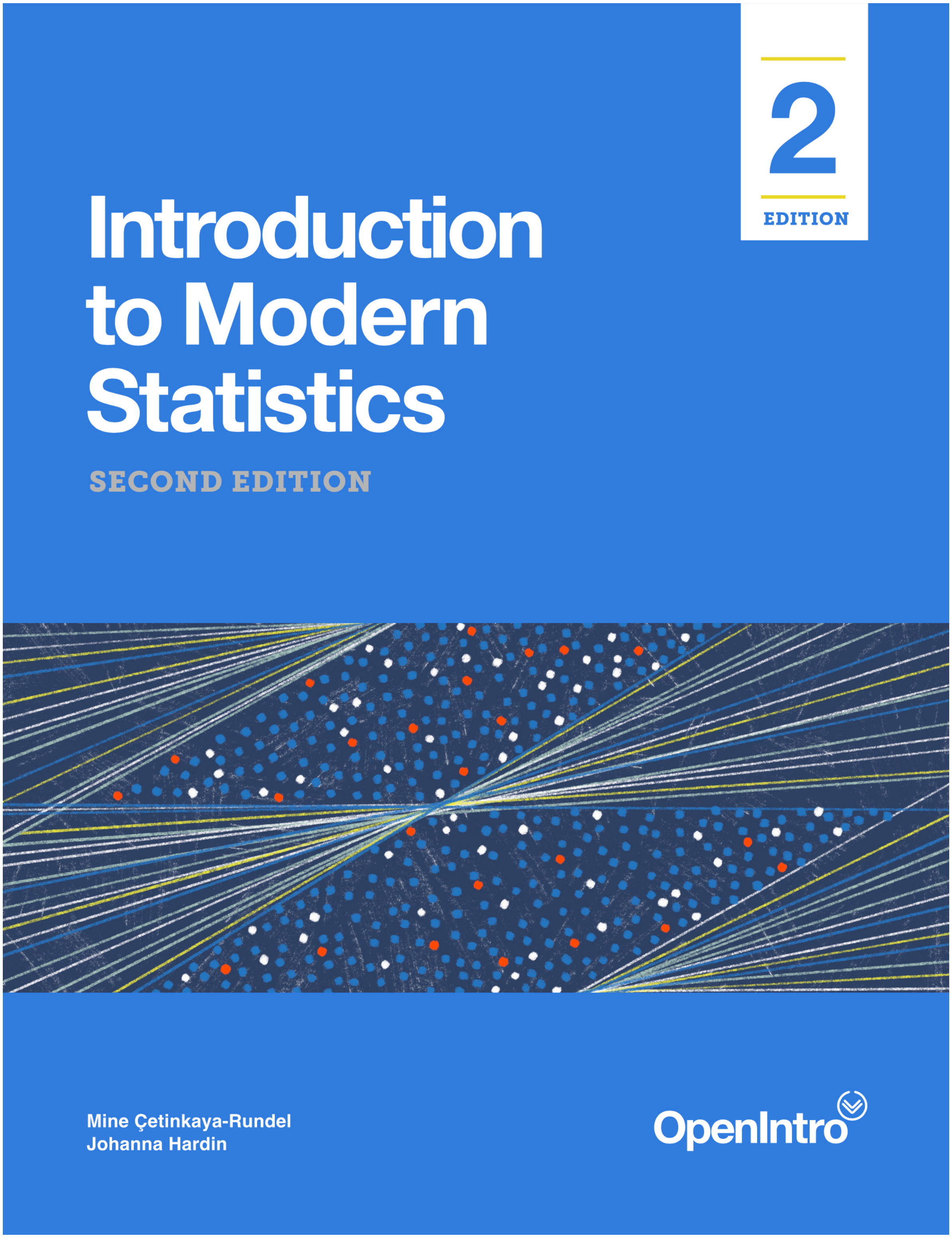
```
my_data[c(3,4), 2]
#> [1] "1975" "1964"
```

Consider the command above. Try to formulate it in plain English. What does it tell to do R?

Resources

Here are some resources that are very useful for learning R and quantitative research methods.

Introduction to Modern Statistics (2e)



2

EDITION

Introduction to Modern Statistics

SECOND EDITION

Mine Çetinkaya-Rundel
Johanna Hardin

OpenIntro

Introduction to Modern Statistics by Mine Çetinkaya-Rundel and Johanna Hardin is an excellent textbook for learning foundational concepts in statistics and data analysis while learning R.

The online textbook is free and available at https://openintro-ims.netlify.app/.

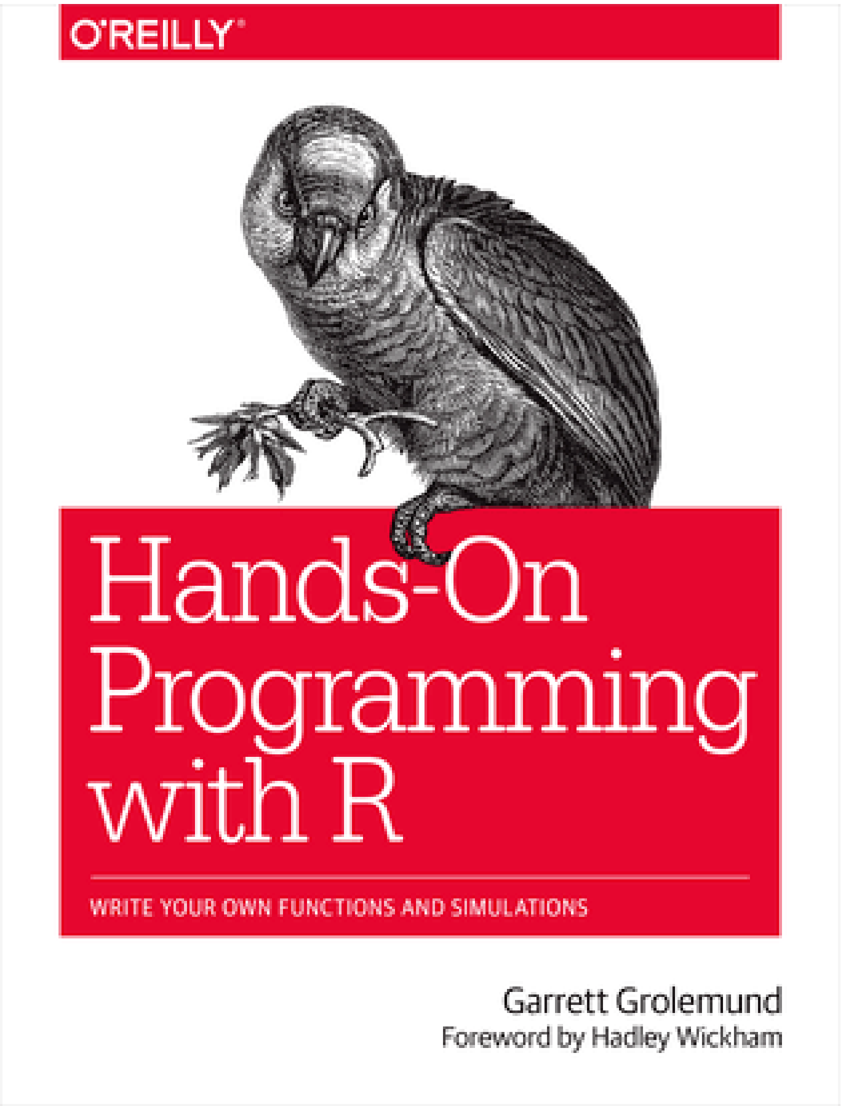
Also see http://openintro.org/book/ims for supplementary materials and additional resources.

Hands-On Programming with R

Hands-on Programming with R by Garrett Grolemund is a straightforward introduction to R. It is useful to learn the basics of R notation.

We cover most of the content in Part 1 & 2 in the first four weeks, but if you want to approach the same content from a different angle, you will find this textbook useful.

It is freely available here: https://rstudio-education.github.io/hopr/



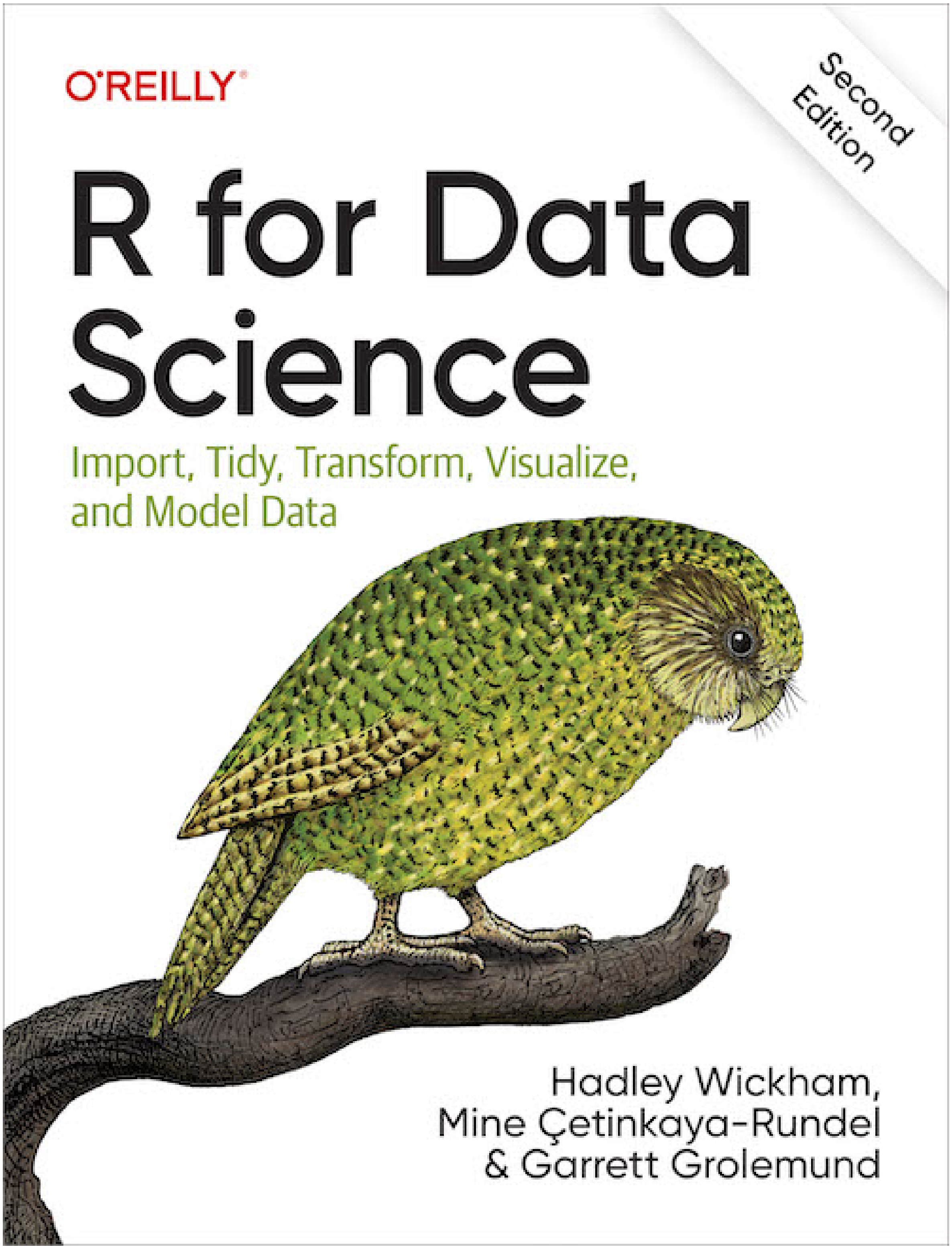
O'REILLY

Hands-On Programming with R

WRITE YOUR OWN FUNCTIONS AND SIMULATIONS

Garrett Grolemund
Foreword by Hadley Wickham

R for Data Science (2e)



O'REILLY
Second Edition
R for Data Science
Import, Tidy, Transform, Visualize, and Model Data
Hadley Wickham, Mine Çetinkaya-Rundel & Garrett Grolemund

R for Data Science (2e) by Hadley Wickham, Mine Çetinkaya-Rundel, and Garrett Grolemund is an introductory textbook on getting started with R and tidyverse for data management, analysis and visualisation. It is an excellent source to learn the basics of R, R Studio and tidyverse.

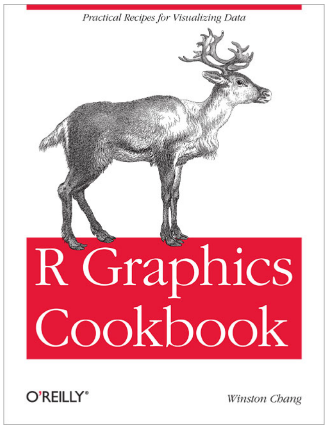
It can be used as a reference textbook, especially when you are struggling to recall the syntax. It has many examples to get a grasp (or remember) how to use many base R and tidyverse functions.

It is free and available here: https://r4ds.hadley.nz/

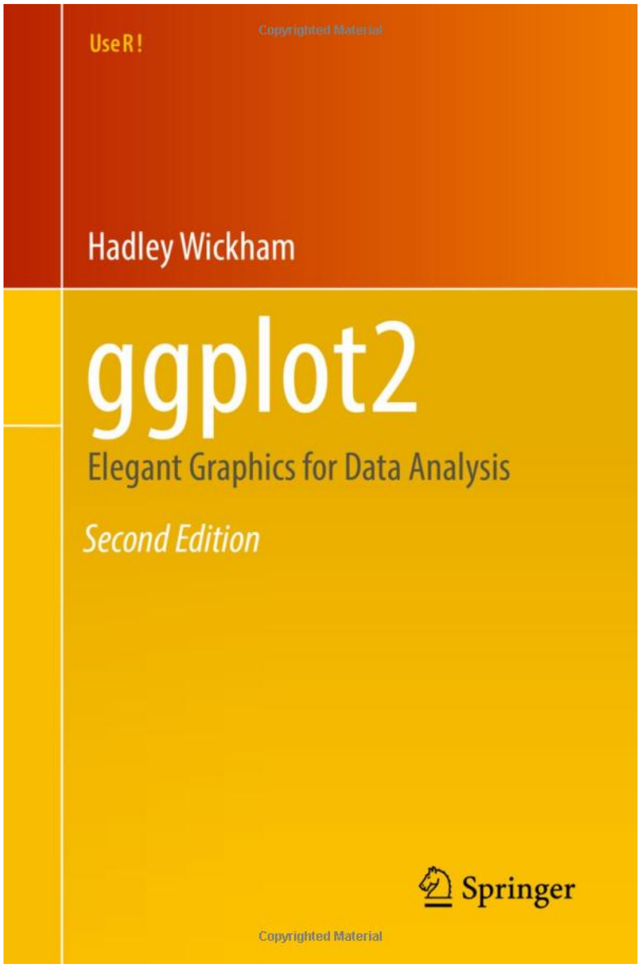
R Graphics Cookbook

R Graphics Cookbook by Winston Chang is a detailed textbook on creating visualisations in R via using ggplot2.

It is free and available here: https://r-graphics.org/



ggplot2: Elegant Graphics for Data Analysis (3e)



This book explains the underlying theory behind ggplot2. It is available here: https://ggplot2-book.org/