R Faculty Workshop

Workshop overview

Day 1: Intro to R

Intro to R

Some notes about R and its ecosystem in general

Basics of writing R code

Syntax, data types, assignment, functions

Working with data

Importing data, cleaning, graphs, analyses

Common causes of confusion

Other things to look out for that can trip up new (and experienced) users

Day 2: Teaching with R

General thoughts on teaching with R

Pedagogy, grading, generative AI

Posit Cloud

A web-based version of RStudio

Quarto

An alternative document format with advantages for teaching

Example course materials

Examples of how I use R and these additional tools in Statistics and Labs

1 Introduction to R and RStudio

1.1 Why R?

R is a coding language specialized for statistical computing and data analysis. It is free and open-source (though there is a cloud-based version which can be paid for and can have advantages especially in the classroom).

Some of R's capabilities:

- Import and create data files in various formats
- Clean and organize data
- Analyze and visualize the data
- Communicate the results in various formats (pdf research paper, website, presentation slides)
- Generate random data, execute functions repeatedly, useful for simulations, bootstrapping etc
- Other programmatic tasks, e.g. web-scraping, using APIs

1.2 The general workflow

1.2.1 Separation of data and code

It might seem daunting to learn R if you have no experience with coding, but the basic idea is that you have some data, like you are familiar with from a regular Excel or Google Sheets spreadsheet, and you perform operations on your data using functions a lot like you would in Excel/Sheets. For example, you might compute an average in Sheets by typing `=AVERAGE(A1:A10)`. In R you might type `mean(my_data$column_a)`. The specifics of the function names are different, but the basic idea is the same.

A major difference between working with data in Excel vs. R is the separation of data from code. Rather than writing functions to manipulate or analyze data directly in your spreadsheet, code is written in a separate code file, which references **but does not modify** the source data file (unless you tell it to).

Excel Spreadsheet

A
1
2
3
4
5
=AVERAGE(A2:A6)

R Data

A
1
2
3
4
5

R Code

```
mean(data$A)
```

```
[1] 3
```

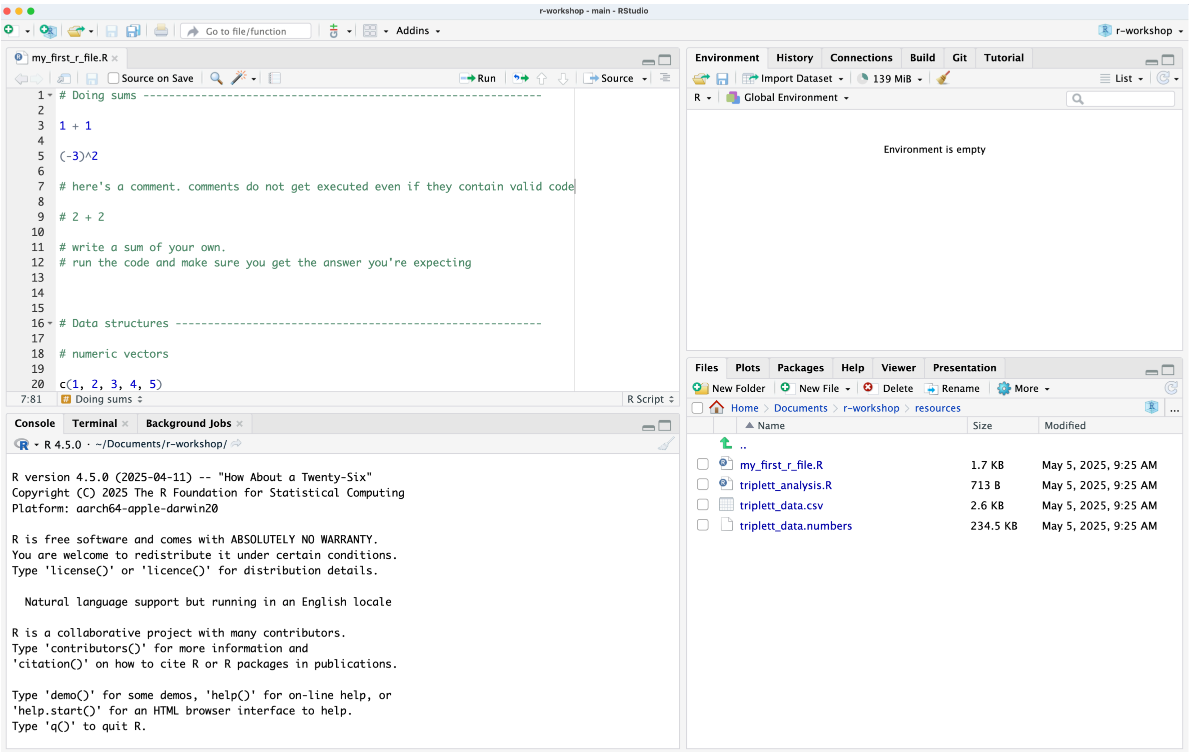
```
sum(data$A)
```

```
[1] 15
```

```
sd(data$A)
```

```
[1] 1.581139
```

1.2.2 RStudio Interface



```
# Doing sums -------------------------------------------------------------

1 + 1

(-3)^2

# here's a comment. comments do not get executed even if they contain valid code

# 2 + 2

# write a sum of your own.
# run the code and make sure you get the answer you're expecting



# Data structures --------------------------------------------------------

# numeric vectors

c(1, 2, 3, 4, 5)
```

```
R version 4.5.0 (2025-04-11) -- "How About a Twenty-Six"
Copyright (C) 2025 The R Foundation for Statistical Computing
Platform: aarch64-apple-darwin20

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
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.
```

Name	Size	Modified
..		
my_first_r_file.R	1.7 KB	May 5, 2025, 9:25 AM
triplett_analysis.R	713 B	May 5, 2025, 9:25 AM
triplett_data.csv	2.6 KB	May 5, 2025, 9:25 AM
triplett_data.numbers	234.5 KB	May 5, 2025, 9:25 AM

RStudio is the interface we'll use to write and run R code and see its output. The basic interface has 4 panels, each with a few tabs:

- Top-left: Code editor / data viewer
  - Open, edit, and save code documents
  - Execute code within files
  - View data
  - You can have multiple 'tabs' open at once,
- Bottom-left: R console
  - You can type code directly and run it by pressing enter.
  - You won't be saving your code as a document like when you type in in the editor, so this is useful for testing something simple out
- Top-right: Environment
  - As you execute code you may be creating objects like sets of numbers of data.frames. Those objects will appear here.
  - You can click the name of some objects, like data.frames, and it will open a view of the data as a tab in the editor pane

- Bottom-right: Files/folders, Plots, Viewer, help window
  - You can navigate the file tree
  - And get Help with functions
  - As well as seeing plots and other kinds of output

1.3 Additional packages

The R language has many functions built in. Generally speaking, you can find a way to do pretty much anything you would like to do using just ‘base’ R.

However there are many common tasks that are a bit tedious or unintuitive to do using base R. One of R’s strengths is how extensible it is: anyone can write their own functions, turn the code into an R package, and make that package available to other R users.

1.3.1 Tidyverse

The tidyverse package is a container for multiple individual packages. The whole family of tidyverse packages are written with a consistent syntax and logic, and are widely used for data analysis. `readr` handles importing data, `dplyr` and `tidyr` have many functions for data cleaning and manipulation, `stringr`, `lubridate`, and `forcats` are specialized for working with text, dates, and categorical variables respectively; `ggplot2` makes graphs; and `tidymodels` is for modelling.

1.3.2 Specialized analyses

The extended ecosystem includes packages specialized for almost any kind of analysis you can think of. To give a few examples…

- Structural equation modeling (`lavaan`)
- Meta-analysis (`metafor`)
- Linear mixed effects models (`lme4`, `simr`)
- Bootstrapping (`boot`)
- Bayesian models (`brms`, `rstanarm`)
- Network analyses (`igraph`, `ggraph`, `tidygraph`, `qgraph`, `bootnet`)
- Language analysis (`tidytext`, `quanteda`)
- Audio analysis (`tuneR`, `seewave)`
- Machine learning (`tidymodels`)

1.3.3 Additional capabilities

E.g. maps (`sf`, `leaflet`)

```r
library(leaflet)

leaflet() |>
  addProviderTiles("NASAGIBS.ViirsEarthAtNight2012") |>
  addMarkers(lng = -73.96339268916061,
             lat = 40.80949994182454,
             popup = "Hello from Barnard!")
```