

A Gentle Introduction to R

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Pop Quiz

We will review these *at the end*, so you can see how much you have learned.

- What does 'CRAN' stand for?
- Why is it named 'R'?
- How can you use R *interactively*?
- How do you find out what a function does & how to use it?
- How do you store values to re-use later?
- True or False: Warnings can be ignored, but an Error means I made a mistake.
- True or False: Error messages will tell me how to fix the problem.

Answer in the chat:

What emoji best describes your current mood or state of mind?

Introductions

- Name
- Pronouns
- Job Title, role
- Have you used R before?
- Have you used a programming language before?
- *optional*: a hobby or activity you enjoy?

Icebreaker activity

What is this?

1–3 word description, for example:

- “This is grey”
- “This looks uncomfortable”

On your turn:


- 1 Previous person's name
- 2 Their answer to the question
- 3 Your name
- 4 Your answer
- 5 Name of the person to go next




Figure 1: What is this?

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Learning Objectives

- Get familiar with the  ¹ *interface*
- Use technical *terms* for R concepts
- Enter *commands*
 - ▶ use R interactively: understand input & output
 - ▶ use some common *functions*
- Get familiar with 'R objects'
 - ▶ store & retrieve values
- Understand *Errors*, *Warnings*, and *Messages*
- How to get Help

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Why is it named 'R'?

- 1 R started as an *open-source* implementation of the S statistical computing language (S-PLUS)²
 - ▶ S was created at Bell Laboratories in 1976³
 - ▶ R was based on the S syntax (mostly v3), but works very differently “under the hood”.
- 2 R was created by Ross Ihaka and Robert Gentleman — aka “R & R”⁴ — at the University of Auckland in the early 1990s.

*Read more about the history of R on Wikipedia*⁵

²<https://www.r-project.org/about.html>

³[https://en.wikipedia.org/wiki/S_\(programming_language\)](https://en.wikipedia.org/wiki/S_(programming_language))

⁴<https://www.r-project.org/contributors.html>

⁵[https://en.wikipedia.org/wiki/R_\(programming_language\)#History](https://en.wikipedia.org/wiki/R_(programming_language)#History)

The Interface

- ‘base R’ has a slightly different interface for each **O**perating **S**ystem (OS)
 - ▶ GUI = **G**raphical **U**ser **I**nterface
- R can also run inside of a terminal (no GUI) or other software (different GUI).

Integrated **D**evelopment **E**nvironment (IDE)

- An IDE is like an extra interface layer on top of ‘base R’
- IDEs often add convenient tools to make writing code easier (e.g., syntax highlighting), and for developing larger projects with multiple files.
- **RStudio** is one of the most popular cross-platform IDEs for R.
 - ▶ RStudio is available in open source (free/libre) and commercial^a editions.

^afor organizations not able to use software licensed with AGPL

A quick tour of the 'base R GUI'

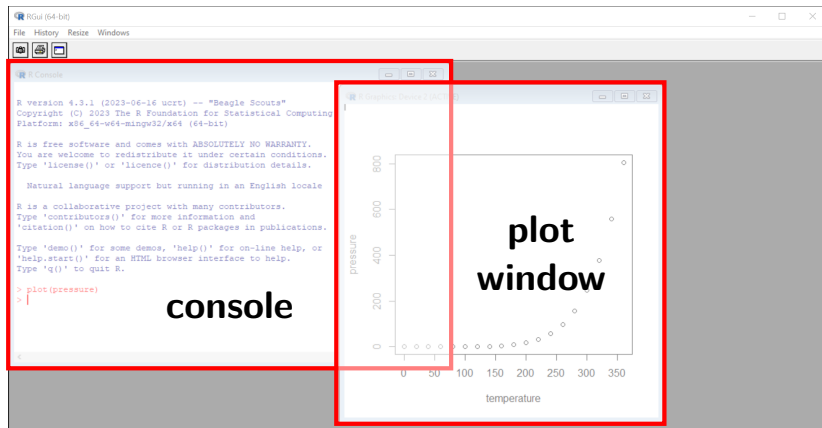


Figure 2: Screenshot of the R GUI in Windows.

A quick tour of RStudio

The RStudio GUI has 4 ‘panes’ that contain ‘tabs’.

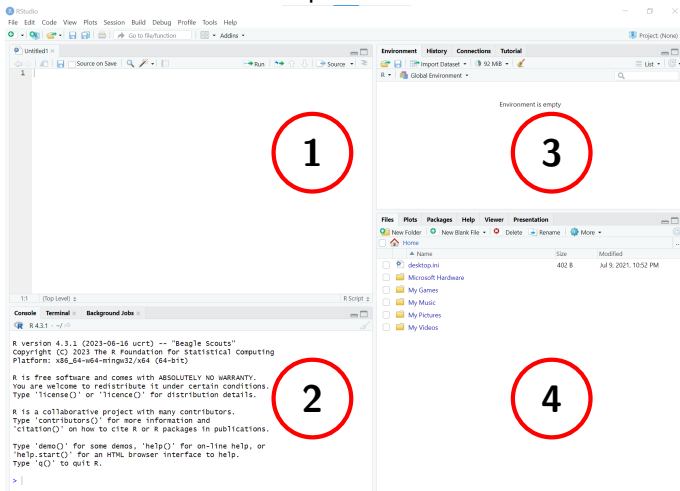


Figure 3: Screenshot of RStudio (default layout).

left:

- 1 top: **Source**^a
- 2 bottom: **Console, Terminal, ...**

right:

- 3 top: **Environment, History, ...**
- 4 bottom: **Files, Plots, Help, ...**

^aempty until you create or open a file

- Regardless of the GUI, you interact with R primarily using a *command line*
 - ▶ aka a command line interface (cli)
 - ▶ the command line is usually in the *console*
- “Question-and-Answer Model”
 - ▶ You ask R to do something (a *command*),
and R tells you the answer (*result*).
- Instructions are given to R using the *R language*.

The *console* is a window or pane where you will find:

- The *command line*
 - ▶ where you will enter commands for R to run
- Results of commands and other output
- Messages, Warnings, and Errors

The command-line

- The command *prompt* normally looks like this:

```
>
```

(the colour varies depending on the interface)

- ▶ This is R's way of saying "I am ready to accept new commands".
- ▶ Type a new command on the line after this prompt (i.e., *input*).
- Press **return/enter** to *run* the current *command*
- If you can still edit the command next to the prompt, then it has not been submitted to R to execute (it is still waiting for input).
- If the last prompt is not empty (i.e., there is text beside it) *and* you cannot edit what is beside the prompt, it means R is still running the last command and is not ready to accept a new command yet.
 - ▶ Wait for a new empty prompt to appear before entering the next command.

The command-line (continued)

- If the prompt looks like this:

```
+
```

it means the last command was *incomplete* and R is waiting for more input.

R will not do anything until the command is completed or cancelled.

- ▶ This usually means you forgot a closing
quote `"`, parenthesis `(`, bracket `[`, or brace `{`
- You can *cancel* the current command at any time by pressing escape
(`esc`)

Input & Output

In this presentation,

- *commands* that can be entered in the *command-line* look like this:

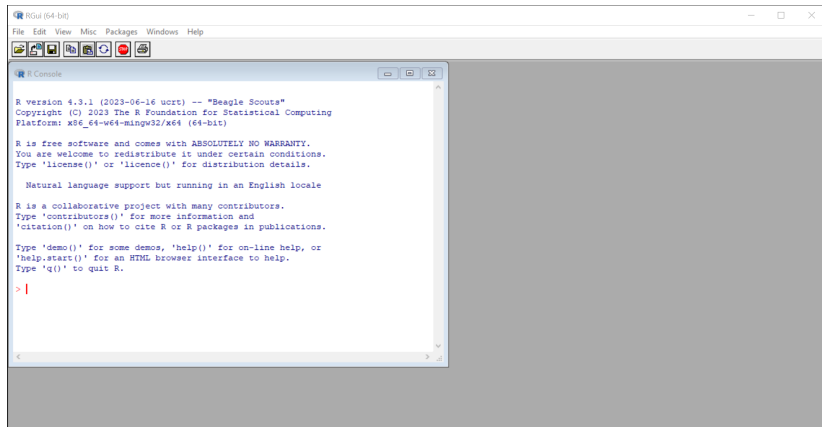
```
Input (commands)
```

- ▶ You can try these yourself!

- Expected output (results) look like this:

```
## Output (results)
```

Read the opening message carefully.



The screenshot shows the R GUI (54-bit) window. The title bar reads "RGui (54-bit)". The menu bar includes "File", "Edit", "View", "Misc", "Packages", "Windows", and "Help". Below the menu bar is a toolbar with icons for file operations and running code. The main area contains an "R Console" window. The console displays the following text:

```
R version 4.3.1 (2023-06-16 ucrt) -- "Beagle Scouts"
Copyright (C) 2023 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

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.

> |
```

Figure 4: R offers suggestions of commands to try in the console when it starts.

`demo(graphics)`

- some plots and graphs that can be made with R

`demo(image)`

- image-like graphics and maps that can be produced with R

`demo(lm.glm)`

- a demonstration of linear modelling & GLMs

`demo()`

- a list of available demos

`help.start()`

- ← A great place to start, especially if you are comfortable reading documentation for a programming language. More on this later.
-

Note

R will not only show the output, but also *the code used to produce it*.

R is a show-off (alt)

`demo(graphics)`

`demo(image)`

`demo(lm.glm)`

`demo()`

`help.start()`

- some plots and graphs that can be made with R
- image-like graphics and maps that can be made with R
- a demonstration of linear modelling & GLMs
- a list of available demos

↑
A great place to start,
especially if you are
comfortable reading
documentation for a
programming language.
More on this later.

Note

R will not only show the output, but also
the code used to produce it.

```
1 + 1
```

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

```
2 * 2
```

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

```
2 ^ 3
```

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

```
10 - 1
```

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

```
8 / 2
```

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

```
sqrt(9)
```

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

- These are *expressions*
- *Expressions* are *evaluated*, and the *value* (result) is *returned* (sometimes *invisibly*)

- With the cursor next to the empty prompt (`>`), use the up & down **arrow keys** (`↑↓`) to re-produce previous commands.
- This lets you “scroll through your *command history*”.
- Press **up** (`↑`) once, and you get the last command you entered without having to copy & paste.

Symbolic *variables*

- You can store values (*objects*) in symbolic variables (*names*) using an *assignment operator*:

`<-` assign the *value* on the **right** to the *name* on the **left**

- Names can include:

letters	a-z A-Z
numbers	0-9
periods	.
underscores	_

```
A <- 10
B <- 10 * 10
A_log <- log(A)
B.seq <- 1:B

assign('x', 3)
```

- Names *should begin with a letter*.

Retrieve values

When a variable *name* is evaluated, it returns the stored *value*.

A	B
## [1] 10	## [1] 100
A_log	x
## [1] 2.303	## [1] 3
B.seq	

```
##      [1]      1      2      3      4      5      6      7      8      9     10     11     12
##    [13]     13     14     15     16     17     18     19     20     21     22     23     24
##    [25]     25     26     27     28     29     30     31     32     33     34     35     36
##    [37]     37     38     39     40     41     42     43     44     45     46     47     48
##    [49]     49     50     51     52     53     54     55     56     57     58     59     60
##    [61]     61     62     63     64     65     66     67     68     69     70     71     72
##    [73]     73     74     75     76     77     78     79     80     81     82     83     84
##    [85]     85     86     87     88     89     90     91     92     93     94     95     96
##    [97]     97     98     99    100
```

Built-in variables

Some words and letters already have values in R
and should **never be used as variable names**.

```
pi                                version
## [1] 3.142                      ## ... information about
                                ## this version of R ...

letters

## [1] "a" "b" "c" "d" "e" "f" "g" "h" "i" "j" "k" "l" "m"
## [14] "n" "o" "p" "q" "r" "s" "t" "u" "v" "w" "x" "y" "z"

LETTERS

## [1] "A" "B" "C" "D" "E" "F" "G" "H" "I" "J" "K" "L" "M"
## [14] "N" "O" "P" "Q" "R" "S" "T" "U" "V" "W" "X" "Y" "Z"
```

Reserved words

Some words and letters already have special meaning in the R language (*keywords*) and should **never be used as variable names**.

Quiz Review



References & More Information

```
help.start()
```

Accessible from the screen above (offline):

- An Introduction to R
- The R Language Definition

Online:

- RStudio Education (education.rstudio.com)
 - ▶ tutorials, workshop materials, and other resources.
-  Manuals (<https://cran.r-project.org/manuals.html>)
-  Contributed Documentation
 - ▶ e.g., <http://cran.r-project.org/doc/contrib/usingR.pdf>
- Internet search
 - ▶ Stack Overflow (stackoverflow.com)
 - ▶ Cookbook for R (www.cookbook-r.com)