

# Quantitative Research Methods

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# Session Outline

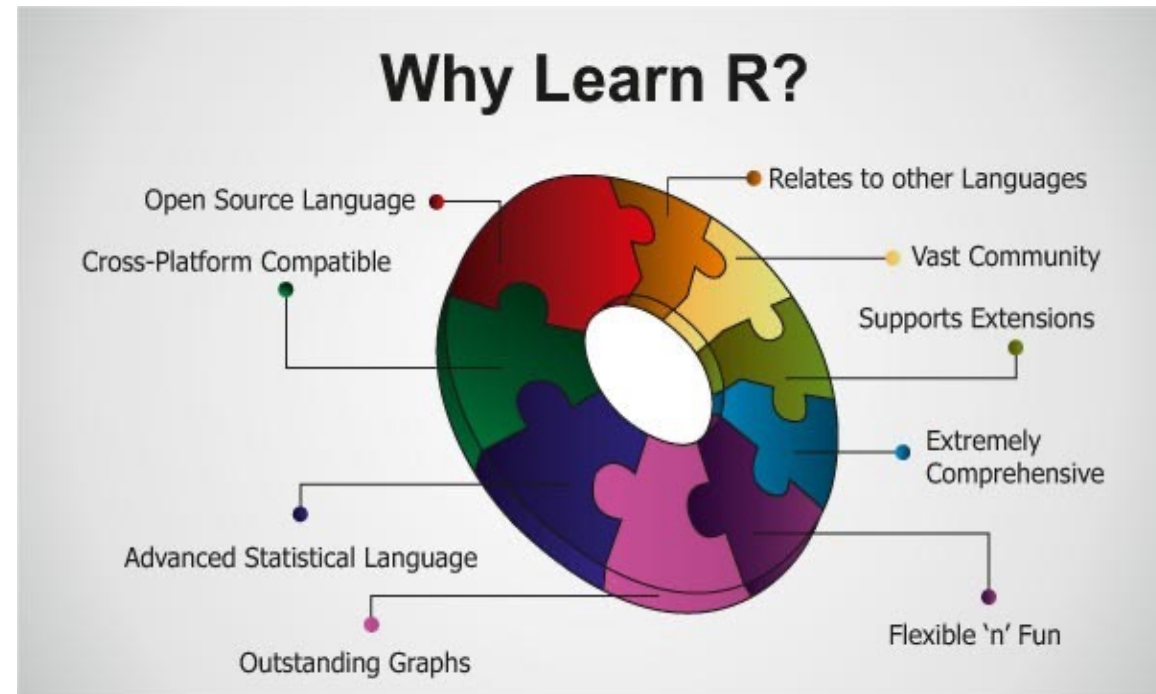
- 1. Introduction to the course
- 2. Quantitative Research
- 3. Introduction to R and Rstudio
  - First steps in R

# 1. Introduction to the course



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- A practical introduction to quantitative data analysis using R
- R is a programming language for statistical computing and graphic production. It is widely used for many reasons:



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# 1. Introduction to the course

- We will cover two things:
  1. How to design, analyse, and interpret the results of statistical inquiry
  2. How to carry this out in R
- You will need to bring a laptop to each class – there is a practical element where you will be using R and RStudio

# 1. Introduction to the course

- **Session 1: Introduction to quantitative research methods using R**
- Session 2: Data management and data wrangling
- Session 3: Exploratory data analysis
- Session 4: Data visualization
- Session 5: Mid-term assignment
- Session 6: Significance tests for continuous variables
- Session 7: Tests for discrete variables: Analysing contingency tables
- Session 8: Correlation and linear regression. Tests for categorical variables.
- Session 9: ANOVA and tests for N groups
- Session 10: Multiple regression

# 1. Introduction to the course

- Materials and files will be uploaded to Moodle
- Please keep an eye on this as items will be uploaded weekly
- Use the discussion forum to post any questions or issues you may have,
  - E.g., R errors or quantitative methods questions
  - You can help each other in providing solutions
  - I can step in to clarify and support these discussions
  - Especially useful for those taking the course asynchronously



# 1. Introduction to the course

- Sessions are recorded and will be available on Moodle – this is for those distance-learning.
- Each session will be split between lecture material (explaining the core concepts relevant to the session) and a practical element (completing worksheets in R)
- This balance will not always be 50:50.
- Some of the worksheets will intentionally be designed to take more time than the time allocated in the session. Independent research and practice is critical for your development
- Each week builds upon the previous weeks, so please ensure you complete the worksheets

# 1. Introduction to the course

- To complete the assigned tasks during class and in between classes. Most tasks will be practical, requiring the use of R to complete statistical analyses.
- To engage in small group and whole class discussions during weekly sessions.
- To provide supportive, constructive peer feedback. This means, for example, helping each other while programming in R.



# Learning R is like learning a new language

- This means:
  1. only you can do the learning, nobody can do this on your behalf, and
  - 2. the more you practice, the better you will become.**
- So, please complete the tasks carefully, and write down any questions you have.
- You will really only learn how to do quantitative research using R by doing it yourself **with your own data as part of your own project.**
- This course will prepare you for that, but it is impossible to prepare you for every single data challenge you will face.
- So, I am hoping that this course also further develops your ability to help yourself!

# Learning R is like learning a new language

- A note on the use of ChatGPT and other AI-powered tools
  - It exists and can be useful for carrying out basic operations in R, **but**:
  - Please don't use it
  - It is not always accurate
  - There are other, official sources that can be used
  - At this stage in your development, it is important that **you** understand what you are doing

# Assessments

- Two assignments to assess your ability to analyse and interpret datasets in R:
  1. **Mid-term assignment** (1,500 words, 30% of total mark), due Friday, Feb 16, 2023, 12pm. Descriptive data analysis, numerical summaries, tables, graphics, etc
    - For everyone – a first chance to practice what you've learnt so far together
  2. **Final assignment** (3,500 words, 70% of total mark), due Monday, April 23, 2023, 12pm. Confidence intervals and significance testing. Regression analysis and correlation.
    - For those taking the course for credit

## 2. Quantitative Research

- A research strategy that focuses on quantification in the collection and analysis of data (Bryman, 2016).
- Quantitative research relies (depends) on computational tools and statistical methods.
- We collect and analyse large amounts of data to develop and test theories.
- Quantitative research tends to be the default across the sciences (cognitive, social, natural, clinical, etc.).
- Not better than qualitative research; complementary.
- Typically adopts a realist approach

# Two basic strategies in quantitative research

## 1. Observational research

- Simply observe and describe behaviour in natural situations
- Example: Systematic reviews, corpus analyses, correlational research, etc.

## 2. Experimental research

- Systematically manipulate variables of interest and see what effect our manipulation has in the world
- Example: Experimental studies in the lab or in the wild

# Observational Research

- We measure variables in a sample without attempts to influence or manipulate these variables.
- There is no random assignment of participants to groups for comparison
- These studies can show that a relationship or association exists between variables, but it is not necessarily a cause-and-effect (causal) relationship.
- Example: more reflective styles of thinking are more “patient” and willing to delay gratification for a higher reward later (Frederick, 2005)

# Frederick (2005)

- Designed and tested the Cognitive Reflection Test; a measure of the propensity to engage in reflective/critical thinking and not use intuition
- Higher levels of CRT corresponded with
  - Willing to wait for a greater reward
  - Lower compulsiveness

Table 2

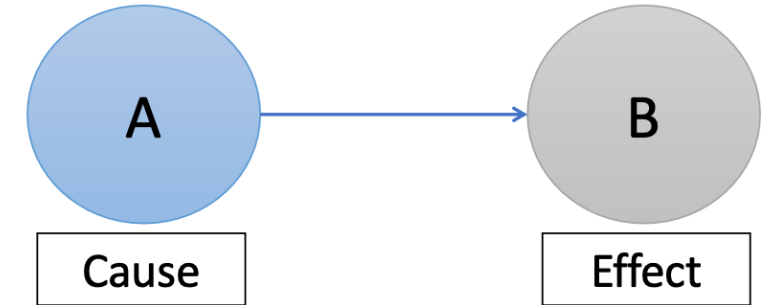
## Intertemporal Behavior for Low and High CRT Groups

(percentage choosing patient option or mean response)

Item	Intertemporal Choice or Judgment	CRT group		Stat. Signif.
		Low	High	
a	\$3400 this month or \$3800 next month	35% <sub>611</sub>	60% <sub>196</sub>	$p < 0.0001$
b	\$100 now or \$140 next year	22% <sub>409</sub>	37% <sub>297</sub>	$p < 0.0001$
c	\$100 now or \$1100 in 10 years	47% <sub>283</sub>	57% <sub>208</sub>	$p < 0.05$
d	\$9 now or \$100 in 10 years	40% <sub>364</sub>	46% <sub>277</sub>	$p < 0.10$
e	\$40 immediately or \$1000 in 10 years	50% <sub>185</sub>	59% <sub>83</sub>	n.s.
f	\$100 now or \$20 every year for 7 years	28% <sub>60</sub>	43% <sub>28</sub>	n.s.
g	\$400 now or \$100 every year for 10 years	64% <sub>44</sub>	72% <sub>43</sub>	n.s.
h	\$100 now or \$100 every year for 25 years	52% <sub>295</sub>	49% <sub>99</sub>	n.s.
i	30 min. massage in 2 weeks or 45 min. massage in Nov.	28% <sub>272</sub>	27% <sub>126</sub>	n.s.
j	Lose \$1000 this year or lose \$2000 next year	78% <sub>166</sub>	73% <sub>86</sub>	n.s.
k	Tooth pulled today or tooth pulled in 2 weeks	59% <sub>430</sub>	65% <sub>242</sub>	n.s.
l	Willingness to pay for overnight shipping of chosen book	\$4.54 <sub>150</sub>	\$2.18 <sub>163</sub>	$p < 0.0001$
m	Smallest amount in 4 days preferred to \$170 in 2 months	\$116 <sub>72</sub>	\$133 <sub>82</sub>	$p < 0.01$
n	How impulsive are you?	+1.01 <sub>110</sub>	-0.21 <sub>47</sub>	$p < 0.001$
o	How much do you tend to procrastinate?	+1.05 <sub>110</sub>	+1.06 <sub>47</sub>	n.s.
p	How much do you think about your future?	+2.49 <sub>110</sub>	+1.64 <sub>47</sub>	$p < 0.01$
q	How much do you worry about inflation?	-1.16 <sub>110</sub>	+0.11 <sub>47</sub>	$p < 0.01$

# Experimental Research

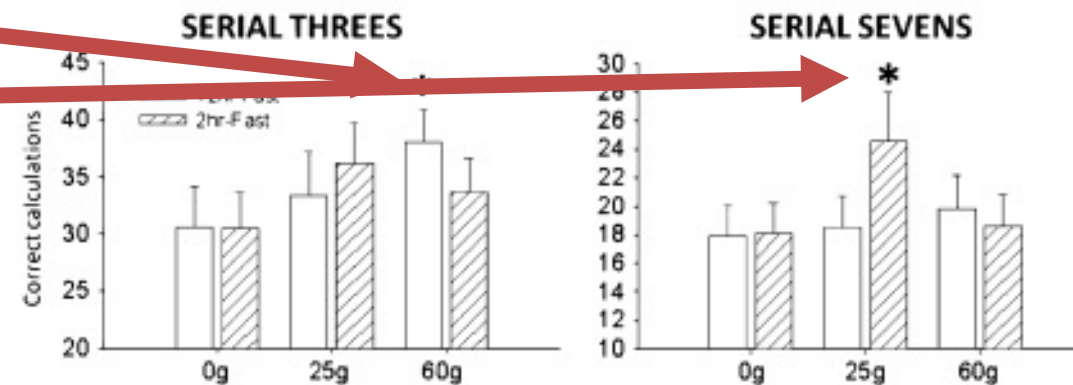
- In experimental research, we try to discover causal relationships between variables
- We do this by manipulating certain variables to test the outcome on other variables
- We randomly assign participants to groups where they experience different manipulations or their environment
- Example: higher levels of glucose improves cognitive function following an overnight fast, but lower does are better following shorter fasts (Owen et al., 2011)





# Owen et al. (2011)

- Participants were assigned to conditions that varied in the glucose dose and for fasting interval
- Tested on working memory performance
- High glucose, long fast
- Lower glucose, short fast



**Fig. 3** Performance of serial subtractions as a function of dose and fasting interval following 60 g glucose participants performance was significantly improved compared to placebo following a 12-h fast

(left). Following 25 g glucose, participants' performance was significantly improved compared to placebo following a 2-h fast (right)

Owen, L., Scholey, A. B., Finnegan, Y., Hu, H., & Sünram-Lea, S. I. (2012). The effect of glucose dose and fasting interval on cognitive function: A double-blind, placebo-controlled, six-way crossover study. *Psychopharmacology*, 220(3), 577–589.

<https://doi.org/10.1007/s00213-011-2510-2>

# Introduction to R and RStudio

- R is a programming language and environment doing statistics and data analysis.
- There are many programming languages that could do the trick (e.g., Python).
- But R is the particularly well-suited to perform the major components outlined in the data science workflow.

# Introduction to R and RStudio

- A very powerful tool for data analysis
- Range and depth of statistical analyses that can be done in R are immense.
- R has a standard set of “packages” that contains the entire repertoire of widely used statistical methods.
- R has an extensive graphics library for visualizing your data.
- R is extensible. You can add over 16,000 packages, which allow you to do more things and more easily.

# Introduction to R and RStudio

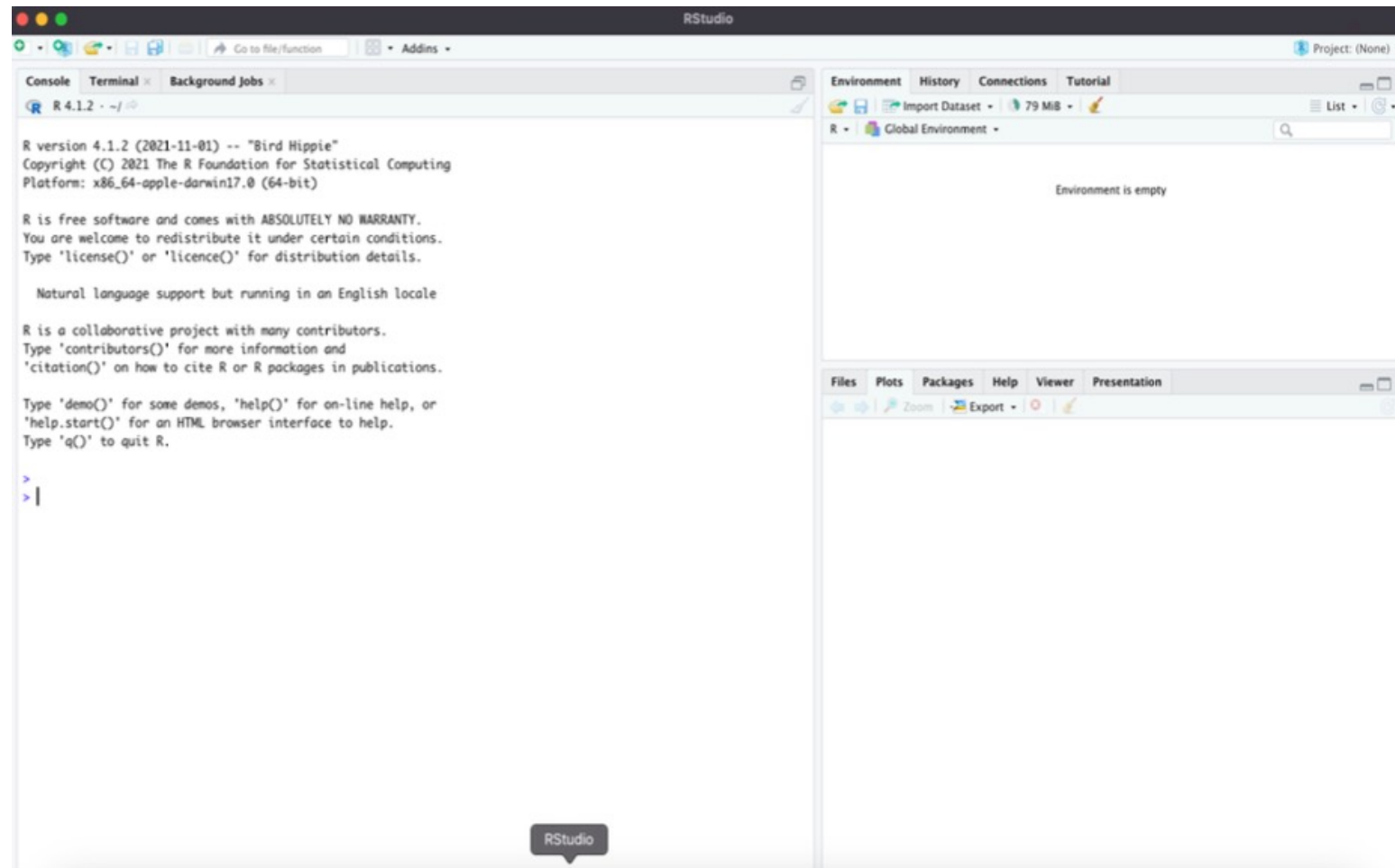
- Open-source software
- R is free and open-source software. Anyone can use it and develop it further.
- R, like many other open-source software, has a large and self-sustaining community of users and developers.
- Very widely used (the new standard)
- R is the standard computing platform in statistics. Almost every new or existing technique developed by statisticians is made available as a package in R.
- As a result, R has become the new standard in data science and in the social and behavioural sciences.

# A first look at RStudio

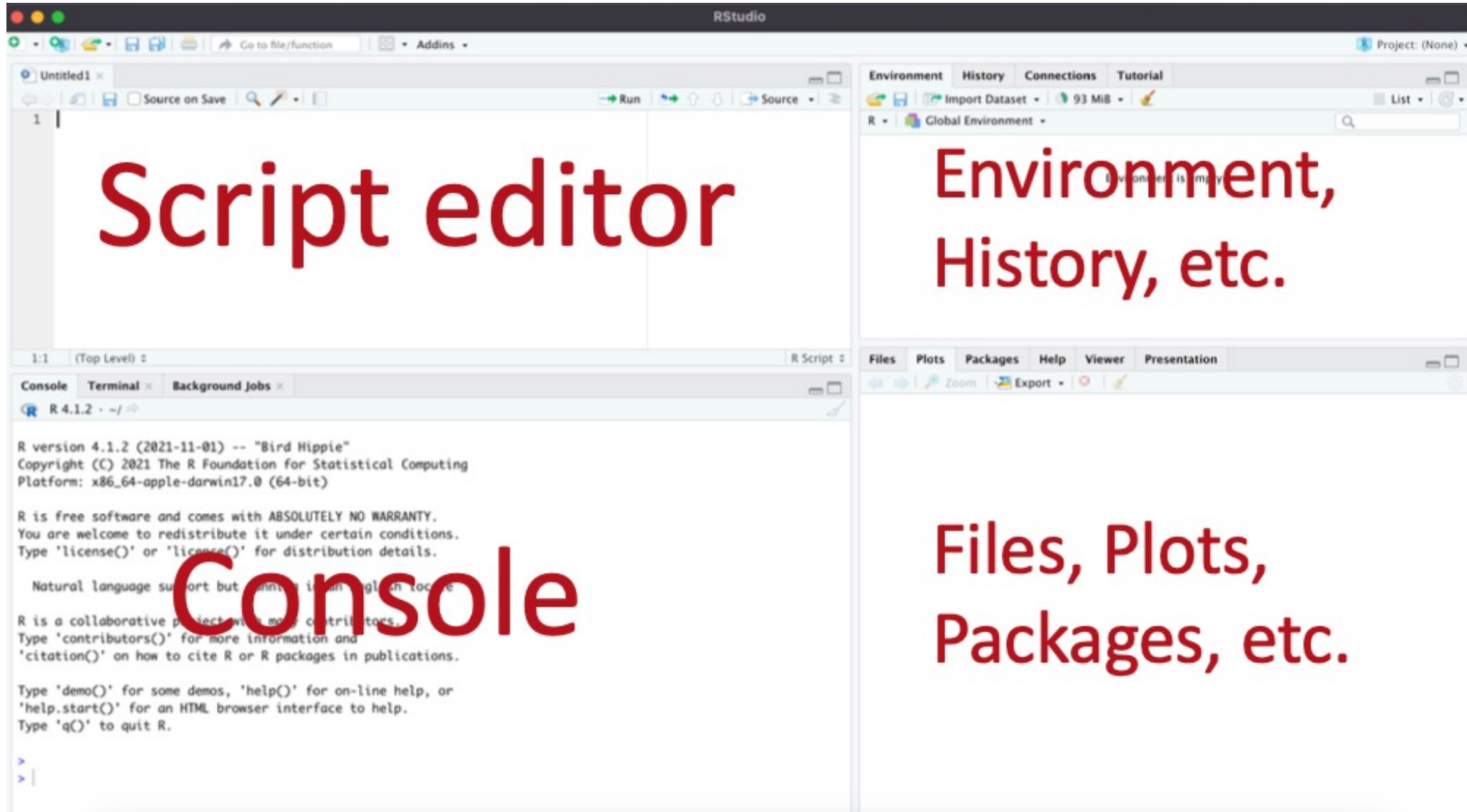
- Once you have installed R and RStudio, all of your computing will be done via RStudio.
- We don't use R directly, it just runs in the background while we work with RStudio.
- Rstudio is a Graphical User Interface (GUI; goo-ey) and helps make some actions and operations simpler to use

# Opening RStudio for the first time

- If RStudio looks like this, then please open a fourth important window, the script editor.
- To open the script editor, please go to File > New File > R script.

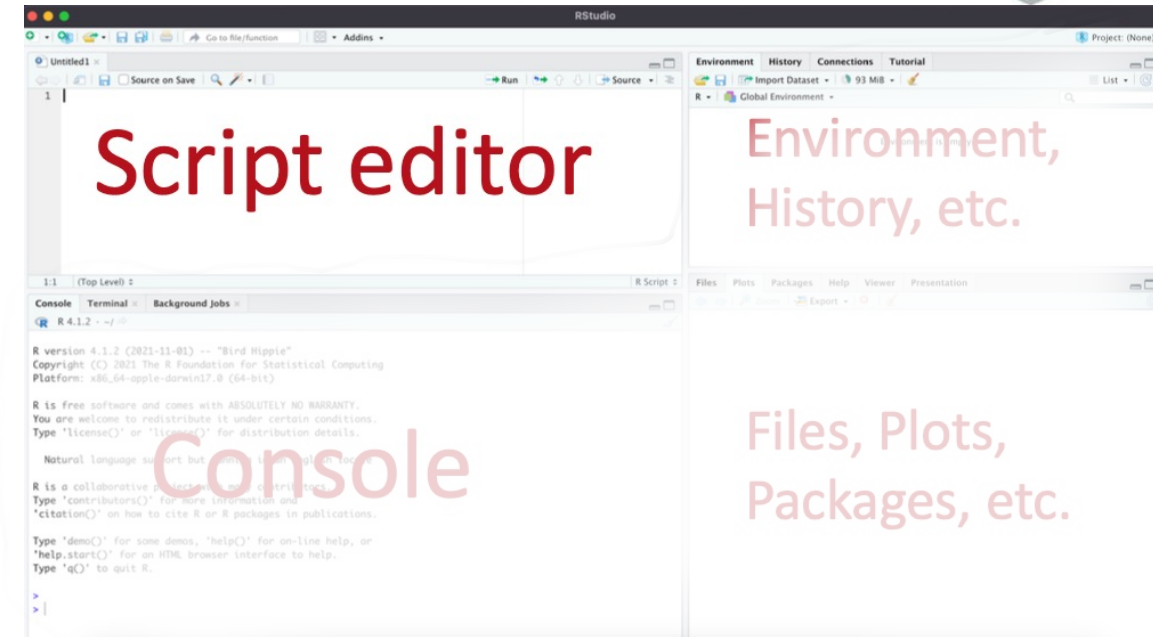


RStudio should now look like this:



# Script Editor

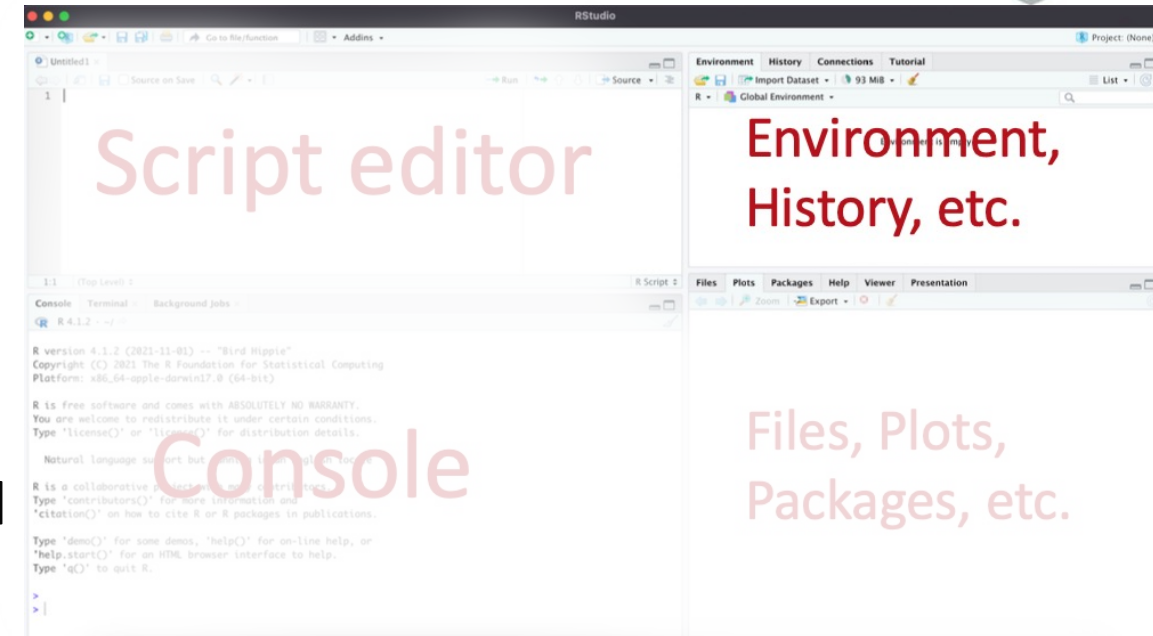
- This is where we write **scripts** of R commands.
- Scripts are a sequence of commands; these can be saved for
- later use and for sharing with other researchers.
- In the script editor, you can execute individual lines of R commands, specific sections of R commands, i.e. several lines, or the entire scripts (all the commands).





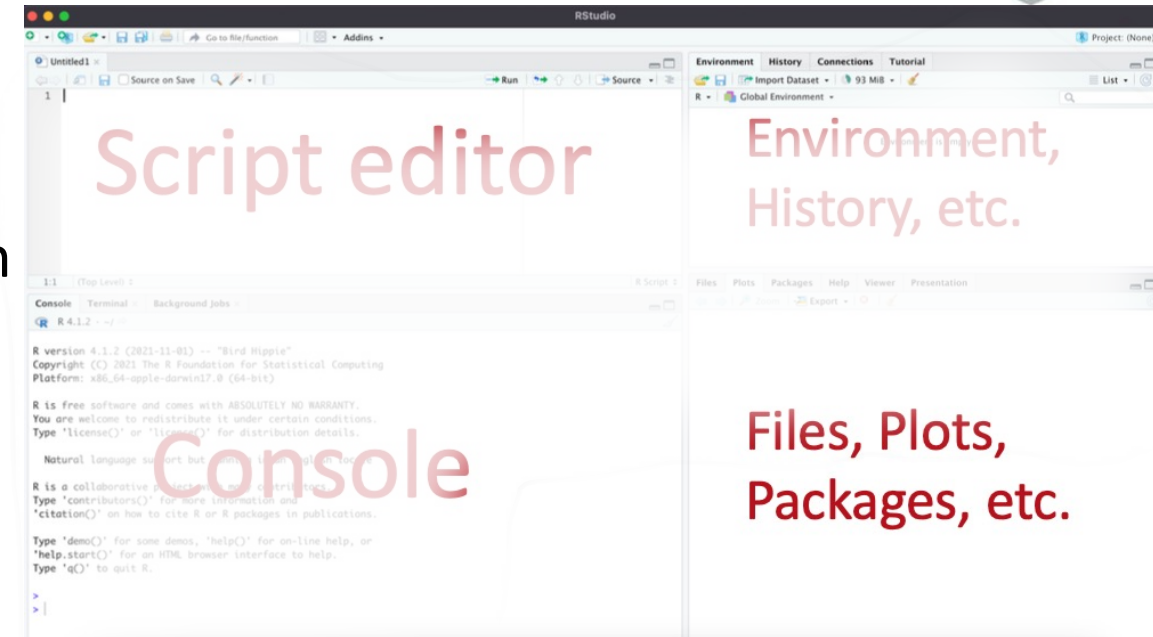
# Environment, History, etc.

- This has several tabs. The most important ones are:
- Environment (lists variables and data structures from our current work session and allows us to easily import data files) and
- History (lists all the R commands we have typed in the session).



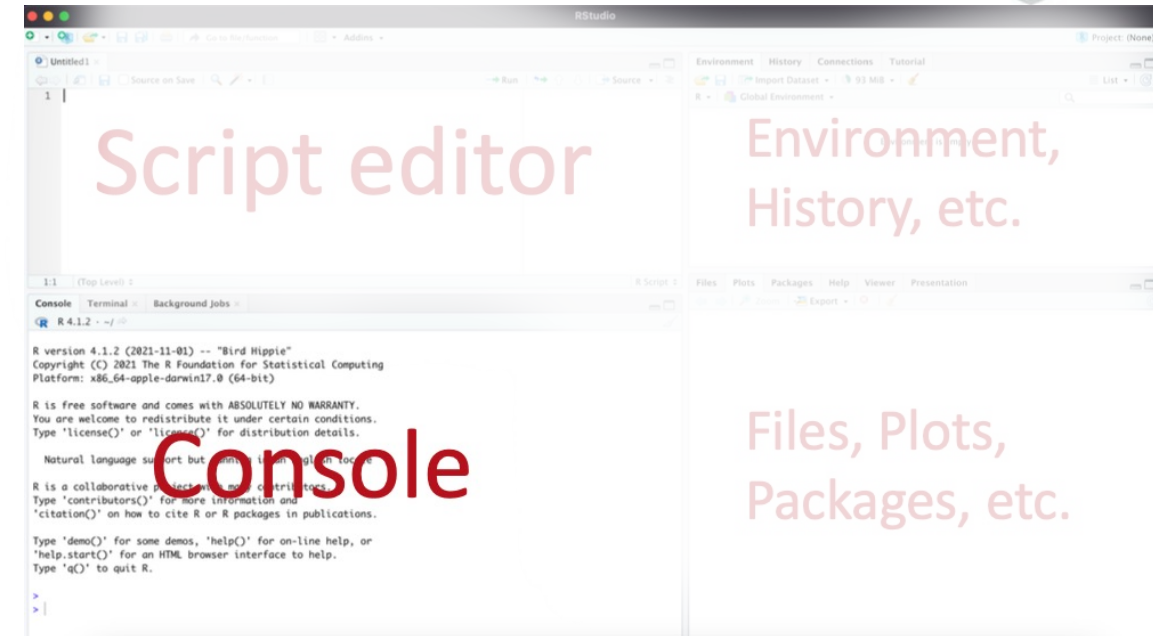
# Files, Plots, Packages, Help, etc.

- The Files tab is a file browser in which we can create, delete, view files and directories.
- The Plots tab is where our graphics will appear.
- The Packages tab shows us the packages we have installed in our session.
- Importantly, The Help tab displays help pages for an R command or package.



# Console

- This is the most important window.
- It also has multiple tabs, but we'll be mostly using the
- Console tab.
- This is where we can type our R commands next to the `>`, press Enter to execute them and see the output just below.
- Today, we will just use the Console, not the Script editor.



# First steps in using R

1. Download the worksheet from Moodle
2. Go through each step at your own pace
3. Type each command in the worksheet, don't just copy-paste
  - This is important: Learning to program is like practicing a conversation in a new language. You will improve gradually, but only if you practice.
  - Copy-paste will be used in later weeks, but for now, type it all out.
4. If you get stuck on a problem
  - Ask those around you for support
  - Use the help pages in RStudio and use online resources too (this will be covered properly next session)
5. Complete the worksheet, finish it at home if you need to

# Questions?

- I will be walking around while you work through the worksheet