Week 03 Worksheet - part 1

A first gentle introduction

INSERT YOUR NAME HERE

Welcome to RStudio!

This worksheet will introduce you to the RStudio interface and the concept of literate programming using R.

The RStudio Interface (Lab Tutor Tour)

When you open RStudio, you'll see four main panes:

1. **Source Editor** (top-left): This is where you write and edit your code and text.
2. **Console** (bottom-left): This is where R commands are executed and where you see the output.
3. **Environment/History** (top-right): This shows the objects in your workspace and your command history.
4. **Files/Plots/Packages/Help** (bottom-right): This multi-purpose pane shows your files, plots, installed packages, and help documentation.

This is a .qmd file

It is markdown - a text only language that can be edited anywhere, even on your phone, because it uses commonly occurring symbols to do all the formatting. If you happen to know html, it's pretty similar. It's simple (once you get the idea), very small in terms of file-size, easily accessed, and versatile.

Understanding Literate Programming

Literate programming is a paradigm that combines explanatory text with executable code in a single document. This approach, pioneered by Donald Knuth in 1984, aims to make programming more accessible, understandable, and maintainable. When you learn about Open Science practices next week with Stacey, she will probably talk about sharing of data, replicability and other big issues. One way in which we can make Science more accessible and open is by using techniques like this.

Key Concepts

1. **Integration of Code and Documentation**: In literate programming, the code is interspersed with narrative text that explains the purpose and functionality of the code.
2. **Human-Oriented**: The primary focus is on making the program understandable to humans, rather than just computers.
3. **Executable Documents**: The resulting document can be both read as a coherent explanation and executed as a functional program.

Benefits in Data Science and Research

Literate programming is particularly valuable in data science and research for several reasons:

1. **Reproducibility**: By combining code, results, and explanations, others can easily reproduce and verify your work.
2. **Clear Communication**: It allows you to explain your thought process, methodology, and interpretation of results alongside the code that generates them.
3. **Error Checking**: The close proximity of code and explanation makes it easier to spot inconsistencies or errors.
4. **version Control**: Changes in both code and narrative can be tracked together, providing a comprehensive history of the project's evolution.

Example in R

Here's a simple example of literate programming in R using a Quarto document:

In this analysis, we'll explore the relationship between a car's horsepower and its fuel efficiency using the `mtcars` dataset (this is a commonly used dataset that comes installed in R).

"The Results of My Amazing Experiment"

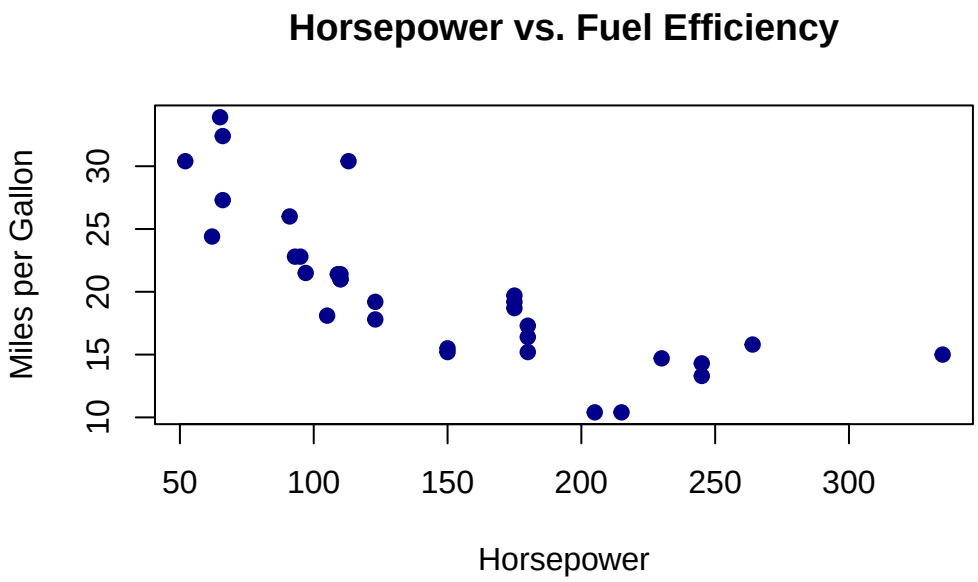
Dear Reader, be amazed at my wonderfulness! Below, I am going to walk you through the analysis. If you are reading this as a .qmd file, you will see all the code. But after I render it to html or pdf, you'll only see what I want you to see, such as just the pretty pictures, without the code! Or I can fold up the code here too!

Another aspect of literate programming, other than narrating the larger document, you can also add comments in the code, to draw an interested reader to specialist aspects of what's happening there, or just to signal what the code is doing. When you try to work with someone else's code, comments like the ones below (but better) are really helpful!

If you are reading along in the .qmd file, press the green arrow to the right of the code cell to execute it. And bingo! R does it's work and performs the calculations.

```
# Load the mtcars dataset
data(mtcars)

# Create a scatter plot
plot(mtcars$hp, mtcars$mpg,
     main="Horsepower vs. Fuel Efficiency", # Clearly these are the most important things!
     xlab="Horsepower",
     ylab="Miles per Gallon", # Can we change this to Kilometers per Litre for other countri
     pch=19,
     col="darkblue") # The best colour for car-based statistics
```



The Visual Editor

RStudio's visual editor provides a user-friendly interface for creating Quarto documents. It allows you to write text and code in a "What You See Is What You Get" (WYSIWYG) environment.

To switch to the visual editor, click the "Visual" button at the top-left of the Source Editor.

Writing Narrative Text

In the visual editor, you can simply type your text as you would in any word processor. You can use the formatting toolbar at the top to:

- Apply **bold** or *italic* formatting
- Create bullet or numbered lists
- Add headings
- Insert links or images

Try writing a short paragraph about why you're studying Psychology below:

[Your text here]

Adding Code Cells

To add a code cell:

1. Click the "+C" button in the toolbar or use the keyboard shortcut Cmd+Option+I (Mac) or Ctrl+Alt+I (Windows/Linux)
2. You'll see a new code cell appear
3. Type your R code inside this cell

Let's try a simple calculation. Add a code cell and type the following:

```
2 + 2
```

```
[1] 4
```

Running Code

To run the code in a cell:

Click the "Run" button (green play icon) at the top-right of the cell, or Use the keyboard shortcut: Cmd+Enter (Mac) or Ctrl+Enter (Windows/Linux)

The output will appear directly below the code cell. Rendering Your Document To create the final document:

Click the "Render" button at the top of the editor Choose your desired output format (HTML or PDF) RStudio will process your document and display the result

Exercise

Load the data Gordon has been using today. https://github.com/DrDeception/Week0203/blob/3276cb8fa56a466a3e25761523cea475ed4ee4bd/materials/data/Y1W3_data.csv

```
# Welcome to R! This is a comment. R doesn't run anything on a line after a '#'.

# Before we can read our data, we need a special tool called 'readr'.
# Think of this like buying a book from a bookstore.
# We only need to do this once, just like you only need to buy a book once.
install.packages("readr")
```

```
The following package(s) will be installed:
- readr [2.1.5]
These packages will be installed into "~/Week0203/renv/library/macos/R-4.4/x86_64-apple-darwi

# Installing packages --------------------------------------------------------
- Installing readr ...                          OK [linked from cache]
Successfully installed 1 package in 6.5 milliseconds.
```

```r
# Now that we've bought the book (installed the package), we need to take it off our shelf to
# In R, we do this by 'loading' the library. We'll need to do this each time we start a new l
# It's like taking the book off your shelf each time you want to read it.
library(readr)  # This is like opening the book 'readr' to use its contents

# Now let's specify where our data is located. This is like writing down the address of a lib
url <- "https://raw.githubusercontent.com/DrDeception/Week0203/3276cb8fa56a466a3e25761523cea4

# We use the read_csv() function from our 'readr' book to load the data.
# This is like using the skills we learned from the book to read a document in the library.
data <- read_csv(url)
```

```
Rows: 109 Columns: 27
-- Column specification --------------------------------------------------------
Delimiter: ","
chr  (13): PokeName, PokeImage, Q_Scale, Q_choice, Q_option, A-Level, Coin, ...
dbl  (13): PokeNumber, LoginCount, EyeContact, Psy4me, DrWho, Maths, E_TIPI,...
time  (1): CompTime

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
# Let's take a quick look at the first few rows of our data.
# This is like skimming the first page of the document.
print(head(data))
```

```
# A tibble: 6 x 27
  PokeNumber PokeName   PokeImage  LoginCount Q_Scale Q_choice Q_option CompTime
       <dbl> <chr>      <chr>           <dbl> <chr>   <chr>    <chr>    <time>
1          1 bulbasaur  https://r~         NA <NA>    <NA>     <NA>        NA
2          2 ivysaur    https://r~         NA <NA>    <NA>     <NA>        NA
3          3 venusaur   https://r~         NA <NA>    <NA>     <NA>        NA
4          4 charmander https://r~         NA <NA>    <NA>     <NA>        NA
```

```
5          5 charmeleon https://r~         61 Do you~ How oft~ Why did~ 10'00"
6          6 charizard  https://r~         58 How of~ What ty~ Describ~ 18'00"
# i 19 more variables: `A-Level` <chr>, Coin <chr>, EyeContact <dbl>,
#   Psy4me <dbl>, DrWho <dbl>, Maths <dbl>, InsectApocalypse <chr>,
#   DogCatBoth <chr>, LarkorOwl <chr>, E_TIPI <dbl>, A_TIPI <dbl>,
#   C_TIPI <dbl>, ES_TIPI <dbl>, O_TIPI <dbl>, MBTI <chr>, Image <chr>,
#   Commentary <chr>, Row <dbl>, Column <dbl>
```

```
# Now, let's get a summary of our data.
# This is like reading the table of contents and index to get an overview.
print(summary(data))
```

```
   PokeNumber    PokeName           PokeImage           LoginCount
 Min.   :  1   Length:109         Length:109         Min.   : 1.00
 1st Qu.: 28   Class :character   Class :character   1st Qu.:10.00
 Median : 55   Mode  :character   Mode  :character   Median :15.00
 Mean   : 55                                        Mean   :19.43
 3rd Qu.: 82                                        3rd Qu.:25.00
 Max.   :109                                        Max.   :61.00
                                                    NA's   :12
   Q_Scale            Q_choice           Q_option           CompTime
 Length:109         Length:109         Length:109         Length:109
 Class :character   Class :character   Class :character   Class1:hms
 Mode  :character   Mode  :character   Mode  :character   Class2:difftime
                                                          Mode  :numeric


   A-Level              Coin             EyeContact         Psy4me
 Length:109         Length:109         Min.   : 1.000   Min.   :1.000
 Class :character   Class :character   1st Qu.: 5.000   1st Qu.:4.000
 Mode  :character   Mode  :character   Median : 7.000   Median :4.000
                                       Mean   : 6.314   Mean   :4.114
                                       3rd Qu.: 8.000   3rd Qu.:5.000
                                       Max.   :10.000   Max.   :5.000
                                       NA's   :39       NA's   :39
    DrWho            Maths       InsectApocalypse    DogCatBoth
 Min.   : 0.000   Min.   :1.000   Length:109         Length:109
 1st Qu.: 1.000   1st Qu.:2.250   Class :character   Class :character
 Median : 1.500   Median :3.000   Mode  :character   Mode  :character
 Mean   : 3.471   Mean   :2.986
 3rd Qu.: 5.000   3rd Qu.:4.000
```

```
 Max.   :10.000   Max.   :5.000
 NA's   :39       NA's   :39
  LarkorOwl            E_TIPI          A_TIPI          C_TIPI
 Length:109         Min.   :2.000   Min.   :2.000   Min.   :2.000
 Class :character   1st Qu.:3.000   1st Qu.:3.500   1st Qu.:3.000
 Mode  :character   Median :3.000   Median :4.000   Median :3.500
                    Mean   :3.179   Mean   :3.814   Mean   :3.221
                    3rd Qu.:3.500   3rd Qu.:4.500   3rd Qu.:3.500
                    Max.   :4.500   Max.   :5.500   Max.   :5.000
                    NA's   :39      NA's   :39      NA's   :39
    ES_TIPI          O_TIPI          MBTI              Image
 Min.   :2.000   Min.   :2.000   Length:109         Length:109
 1st Qu.:2.500   1st Qu.:4.000   Class :character   Class :character
 Median :3.000   Median :4.500   Mode  :character   Mode  :character
 Mean   :2.993   Mean   :4.243
 3rd Qu.:3.500   3rd Qu.:5.000
 Max.   :5.000   Max.   :5.500
 NA's   :39      NA's   :39
  Commentary             Row             Column
 Length:109         Min.   : 1.000   Min.   : 1.000
 Class :character   1st Qu.: 4.000   1st Qu.: 3.000
 Mode  :character   Median : 5.500   Median : 5.000
                    Mean   : 5.357   Mean   : 5.386
                    3rd Qu.: 7.000   3rd Qu.: 7.000
                    Max.   :10.000   Max.   :10.000
                    NA's   :39       NA's   :39
```

```r
# We can check how big our dataset is.
# This is like counting the pages and chapters in our document.
cat("Our dataset has", dim(data)[1], "rows (like pages) and", dim(data)[2], "columns (like ch
```

```
Our dataset has 109 rows (like pages) and 27 columns (like chapters)
```

```r
# Finally, let's see what information (columns) we have in our dataset.
# This is like looking at the headings in our document.
cat("Our dataset contains information about:\n")
```

```
Our dataset contains information about:
```

```r
print(colnames(data))
```

```
 [1] "PokeNumber"       "PokeName"         "PokeImage"        "LoginCount"
 [5] "Q_Scale"          "Q_choice"         "Q_option"         "CompTime"
 [9] "A-Level"          "Coin"             "EyeContact"       "Psy4me"
[13] "DrWho"            "Maths"            "InsectApocalypse" "DogCatBoth"
[17] "LarkorOwl"        "E_TIPI"           "A_TIPI"           "C_TIPI"
[21] "ES_TIPI"          "O_TIPI"           "MBTI"             "Image"
[25] "Commentary"       "Row"              "Column"
```

```r
# Congratulations! You've just used R to bring in data from the internet and take a first lo
# It's like you've gone to a digital library, found a document, and skimmed through its cont
```

Normally...

That code chunk would only be like this:

```r
install.packages("readr")
```

```
The following package(s) will be installed:
- readr [2.1.5]
These packages will be installed into "~/Week0203/renv/library/macos/R-4.4/x86_64-apple-darwi

# Installing packages --------------------------------------------------------
- Installing readr ...                          OK [linked from cache]
Successfully installed 1 package in 5.3 milliseconds.
```

```r
library(readr)
data <- read_csv("https://raw.githubusercontent.com/DrDeception/Week0203/3276cb8fa56a466a3e25
```

```
Rows: 109 Columns: 27
-- Column specification --------------------------------------------------------
Delimiter: ","
chr  (13): PokeName, PokeImage, Q_Scale, Q_choice, Q_option, A-Level, Coin, ...
dbl  (13): PokeNumber, LoginCount, EyeContact, Psy4me, DrWho, Maths, E_TIPI,...
time  (1): CompTime

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
summary(data) # Even this isn't necessary if you know what the data includes already!
```

```
  PokeNumber    PokeName           PokeImage           LoginCount
Min.   :  1   Length:109         Length:109         Min.   : 1.00
1st Qu.: 28   Class :character   Class :character   1st Qu.:10.00
Median : 55   Mode  :character   Mode  :character   Median :15.00
Mean   : 55                                        Mean   :19.43
3rd Qu.: 82                                        3rd Qu.:25.00
Max.   :109                                        Max.   :61.00
                                                   NA's   :12
  Q_Scale            Q_choice           Q_option           CompTime
Length:109         Length:109         Length:109         Length:109
Class :character   Class :character   Class :character   Class1:hms
Mode  :character   Mode  :character   Mode  :character   Class2:difftime
                                                         Mode  :numeric


  A-Level              Coin             EyeContact         Psy4me
Length:109         Length:109         Min.   : 1.000   Min.   :1.000
Class :character   Class :character   1st Qu.: 5.000   1st Qu.:4.000
Mode  :character   Mode  :character   Median : 7.000   Median :4.000
                                      Mean   : 6.314   Mean   :4.114
                                      3rd Qu.: 8.000   3rd Qu.:5.000
                                      Max.   :10.000   Max.   :5.000
                                      NA's   :39       NA's   :39
    DrWho            Maths       InsectApocalypse    DogCatBoth
Min.   : 0.000   Min.   :1.000   Length:109         Length:109
1st Qu.: 1.000   1st Qu.:2.250   Class :character   Class :character
Median : 1.500   Median :3.000   Mode  :character   Mode  :character
Mean   : 3.471   Mean   :2.986
3rd Qu.: 5.000   3rd Qu.:4.000
Max.   :10.000   Max.   :5.000
NA's   :39       NA's   :39
 LarkorOwl            E_TIPI          A_TIPI          C_TIPI
Length:109         Min.   :2.000   Min.   :2.000   Min.   :2.000
Class :character   1st Qu.:3.000   1st Qu.:3.500   1st Qu.:3.000
Mode  :character   Median :3.000   Median :4.000   Median :3.500
                   Mean   :3.179   Mean   :3.814   Mean   :3.221
                   3rd Qu.:3.500   3rd Qu.:4.500   3rd Qu.:3.500
                   Max.   :4.500   Max.   :5.500   Max.   :5.000
                   NA's   :39      NA's   :39      NA's   :39
```

```
    ES_TIPI          O_TIPI          MBTI               Image
 Min.   :2.000   Min.   :2.000   Length:109         Length:109
 1st Qu.:2.500   1st Qu.:4.000   Class :character   Class :character
 Median :3.000   Median :4.500   Mode  :character   Mode  :character
 Mean   :2.993   Mean   :4.243
 3rd Qu.:3.500   3rd Qu.:5.000
 Max.   :5.000   Max.   :5.500
 NA's   :39      NA's   :39
  Commentary             Row             Column
 Length:109         Min.   : 1.000   Min.   : 1.000
 Class :character   1st Qu.: 4.000   1st Qu.: 3.000
 Mode  :character   Median : 5.500   Median : 5.000
                    Mean   : 5.357   Mean   : 5.386
                    3rd Qu.: 7.000   3rd Qu.: 7.000
                    Max.   :10.000   Max.   :10.000
                    NA's   :39       NA's   :39
```

```
dim(data) # or this
```

```
[1] 109  27
```

```
colnames(data) # or this.
```

```
 [1] "PokeNumber"       "PokeName"         "PokeImage"        "LoginCount"
 [5] "Q_Scale"          "Q_choice"         "Q_option"         "CompTime"
 [9] "A-Level"          "Coin"             "EyeContact"       "Psy4me"
[13] "DrWho"            "Maths"            "InsectApocalypse" "DogCatBoth"
[17] "LarkorOwl"        "E_TIPI"           "A_TIPI"           "C_TIPI"
[21] "ES_TIPI"          "O_TIPI"           "MBTI"             "Image"
[25] "Commentary"       "Row"              "Column"
```

Data Viewer

If you look in the Environment panel to the right, you will see `data` and if you click on the little spreadsheet icon to the right, you can look at it like a spreadsheet!

My First Plot

```
# COPY SOME CODE IN HERE from the slides from this morning - choose one of the early, simple
```

Run the code cell

Render your document to html (website) or pdf (document) and view the results!

Conclusion

You've now learned the basics of:

> **Note**
>
> - Navigating the RStudio interface Using the visual editor for Quarto documents
> - Writing narrative text and adding formatted elements
> - Inserting and running code cells to do sums and create graphs
> - Rendering your document

Keep practicing these skills as you continue your journey with R and data analysis!