Introduction to R & Data Management

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What is R

- R is both a scripted programming language and software environment for statistical computing.
- R is widely used for statistical analysis and creation of high-quality publishable graphics.
- It's open source, free to use and supported by a large community of users and developers.
- Flexible and highly scalable via user defined packages and functions.

Why R

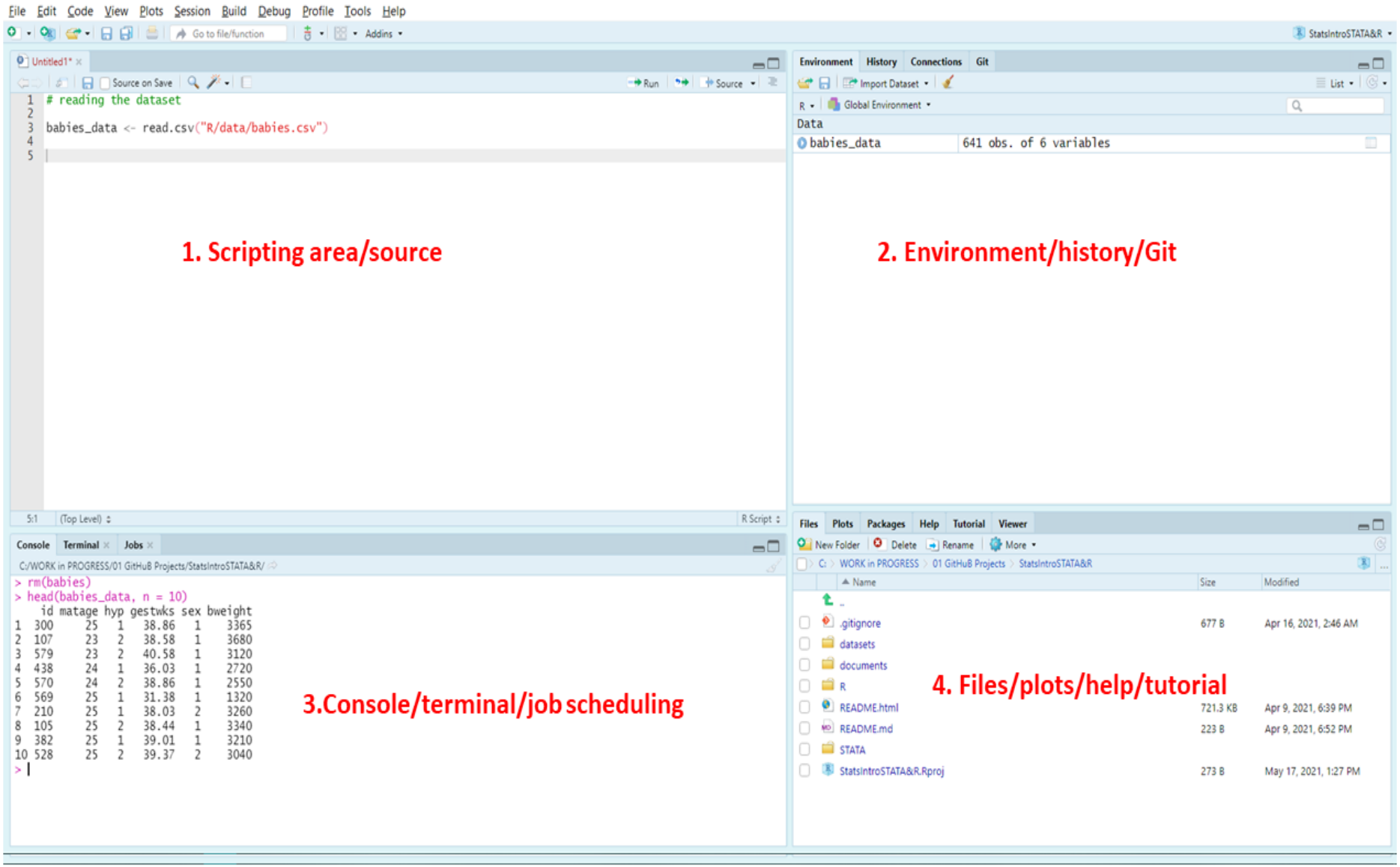
- Reproducibility - one code; multiple users and projects .
- Flexible and easy to learn.
- Scalability - You can define/customize your own functions and/or packages.
- Interoperability - same code across platforms (mac, windows, linux etc).

Getting started - Installing R and Rstudio

- You can install the latest version of R from the CRAN repository. CRAN stands for **C**omprehensive **R** **A**rchive **N**etwork
- The latest version or R is 4.0.5 as of time of the slide creation. This might change with time
- Rstudio is an IDE (Intergrated Development Environment for R). You can install the latest version of Rstudio here
  - **NOTE:** You do not need Rstudio to use R, BUT it makes things easier. So I will highly recommend you to install Rstudio for easy and efficient coding in R.

Introduction to R and Rstudio

Components of Rstudio



How R works (expression vs assignment)

- R syntax is easy to use. Type commands after the prompt > and hit enter to execute in console.
- Simple illustration, using R as an overgrown calculator to evaluate mathematical computation.
- Broad classification of R syntax:-
  - **Expression** - Commands are evaluated, printed on console and the value is lost (requires re-typing).
  - **Assignments** - Storing intermediate results of an expression to an object which can be re-used.
- Objects are created in memory and saved into a file called `.RData`.
- R commands are stored in a file names `.Rhistory`.
- R is sensitive `name` and `Name` refer to different variables

Interactive R session: 01 - How R works

We switch to R and write code to demonstrate the ideas.

R data structures(1/4) - Introduction

- We assign results of expressions into objects with unique names in R.
- Objects can be of different forms. Most common types include:-
  - Vectors (building block of R language)
    - Atomic vectors - Homogeneous, contains items of ONLY one data type
    - Lists - Heterogeneous, contains objects of any type
  - Matrices
  - Data frames
  - Arrays
  - Complex numbers*
  - Raw*.
- These ecosystem of different forms of objects is referred to as data structures.

R data structures(2/4) - vectors

- Vectors are the building blocks in R.
- Atomic vectors are the simplest type of objects and are classified into:-
  - Logical
  - Integer
  - Double
  - Character
- We use the function `c()` `meaning combine items` to create vectors in R
- Generic functions `ls()` and `rm()` are used to list and remove objects in the workspace.

Interactive R session: 02 - Creating vectors in R

We switch to R and write code to demonstrate the ideas.

R data structures(3/4) - Lists

A list is a generic vector containing objects/elements of different data types (heterogenous).

We construct lists using the function `list()`. Lists are also reffered to as recursive vectors because it can contain other lists.

```
my_list <- list(
  c(3,4,5,8),
  c("Mon","Tu","wed","Thur","Fri","Sat"),
  matrix(1:10, byrow = T, nrow = 5)
)

str(my_list)
```

Interactive R session: 03 - Getting to know lists

We switch to R and write code to demonstrate the ideas.

R data structures(4/4) - data frames

Data frames generally refer to tabular data (rows and coloumns). A data frame is the most common way of storing data in R.

This means that a data frame has both coloumn and row names. Basically a data frame is a list of vectors of equal length

Data frames are created using the function `data.frame()` which takes named vectors as arguments.

```
my_dataframe <- data.frame(
  col_1 = c("values_to_go_to_this_coloumn1"),
  col_2 = c("values_to_go_to_this_coloumn2")
  col_n = c("values_to_go_to_this_coloumnn")
)
```

Let's practice on data frames using other functions such as `head()` and `tail()` in addition to the now `str()` that you are familiar with.

Interactive R session: 04 - Data frames

We switch to R and write code to demonstrate the ideas.

Exercise one

Subsetting/Indexing elements of an object

More often you will want to extract elements or components of a vector, list, matrices and data frames. We apply 3 types of indexing when extracting elements of an object (where index denotes the position of the element in the vector)

- Integer vector indexing (`negative` *omits* while `positive` *retains*)
- character vector indexing
- logical vector indexing

Note: For **Integer vector indexing**, unlike other programming languages (`python, Java and C++`) that starts indexing from **0**, indexing of objects in R starts from **1**

Interactive R session: 05 - Subsetting objects

We switch to R and write code to demonstrate the ideas.

External R packages and getting help

- An R package is a collection of R functions and/or data with a well compiled code(s) that enable R users perform even more tasks with R(expand functionality).
- Examples of R packages include dplyr, ggplot2 etc. There are currently over 13,000 contributed packages in the Comprehensive R Archive Network(known as CRAN).

Common commands

- install.packages("package name") # to install a package
- library(package name) # load an R package into the workspace for use, also require(package name)
- To get help on a particular function, use ?function_name or help("function_name") and you will be presented with a documentation on arguments and use case of an R function.

Interactive R session: 06 - R packages

We switch to R and write code to demonstrate the ideas.

The concept of working directory and file paths

1. The working directory is the **specifc folder** within your computer where your live R session is hosted/pointing to. This folders by default holds all your .RData files and .Rhistory files.
    - `getwd()` to get to know where your working directory is located, get help `?getwd`
    - `setwd()` to set a new location for your working directory, get hwlp `?setwd`
2. The **file path** is the specific folder address that contains your files of interest. A file path can be a folder within the working directory or outside the working directory

NOTE: The above concepts are very key when reading data into R, therefore a clear understanding of how they work will come in handy in importing data into R suing any method defined.

Interactive R session: 07 - Working directories

We switch to R and write code to demonstrate the ideas.

Reading data into R

- Data can be read into R from various sources.
- **General way** using the command `read.table()`.

You can read a variety of file extensions into R using the function `read.table()`. Some examples of applicable files to read include csv, tab delimited(.txt), space demilited and any flat file so long as it's defined interms of what character separates its coloumns.

NOTE: Knowing the extension of the file you are reading and how its coloumns are separated is essential in using `read.table()` command.

- **More specif way** using the command `read.csv()`.

-used to read *comma separated files ONLY* otherwise reffered to as `.csv`. More convinient for csv files in that it pre-populates arguments for you which you would have specified in `read.table()` such as `header=T` or even `sep=","`.

Interactive R session: 08 - Getting data into R

We switch to R and write code to demonstrate the ideas.

Exercise Two

Introduction to `dplyr` for data management in R

- We are going to focus on the **dplyr** package which is a core member of the group of packages called `tidyverse`.
- `dplyr` package makes data transformation and manipulation easy by providing simple verbs that correspond to common data manipulation tasks which helps you translate your **thoughts** into code.

The main verbs for data manipulation provided by `dplyr` include:-

- `select()` and `rename()` to select variables based on their names/rename variables.
- `mutate()` and `transmute()` to add/create new variables.
- `filter()` to select cases/rows based on their values.
- `arrange()` to reorder the cases/rows.
- `summarise()` to condense multiple values to a single value. Can be used together with `group_by()`
- `sample_n()` and `sample_frac()` to take random samples.

Interactive R session: 09 - Data management basics

We switch to R and write code to demonstrate the ideas.

Reference material

- An introduction to R hand-out
- R for beginners
- The book R for Data Science
- Introduction to R slides by Dr. Norma Coffey
- The book R in Action for data analysis and graphics
- Quick R help.
- Extensive online help twitter, Github, StackOverflow