Introduction to R and R Studio

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Starting in the 1980s it became possible to run data analysis software on a desktop computer. There are different styles of software that break down along two dimensions:

- **open source or proprietary?**
- **code-based or with a graphical user interface?**

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Some well known examples of data analysis software can be described by their choice of license and interface:

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		Graphical interface	Code
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	Open-source	Apache OpenOffice	R Python

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Why open-source? Why use code?

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Only a few software environments have a community this big, but R is one of these environments.

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- Sometimes there's a learning curve to get started

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Some software, like R, can only be used with code. But code also helps you automate future work, avoid big mistakes, and share your work more easily.

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Disadvantages of code:

- May take a while to learn enough to be "fluent", like a foreign language.
- Can make it tough to collaborate with people who aren't fluent in the coding language.

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R also makes it easy to clean data and to make websites that communicate your work to an audience.

Exercise

One of the most well-known metrics of the popularity of various programming languages is the TIOBE Programming Community Index. Their website is: https://www.tiobe.com/tiobe-index/.

"The ratings are based on the number of skilled engineers world-wide, courses and third party vendors. Popular search engines such as Google, Bing, Yahoo!, Wikipedia, Amazon, YouTube and Baidu are used to calculate the ratings."

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We'll be using a web-based version of R in this course. But you can always download the latest version of R on your own computer from https://cran.r-project.org/.

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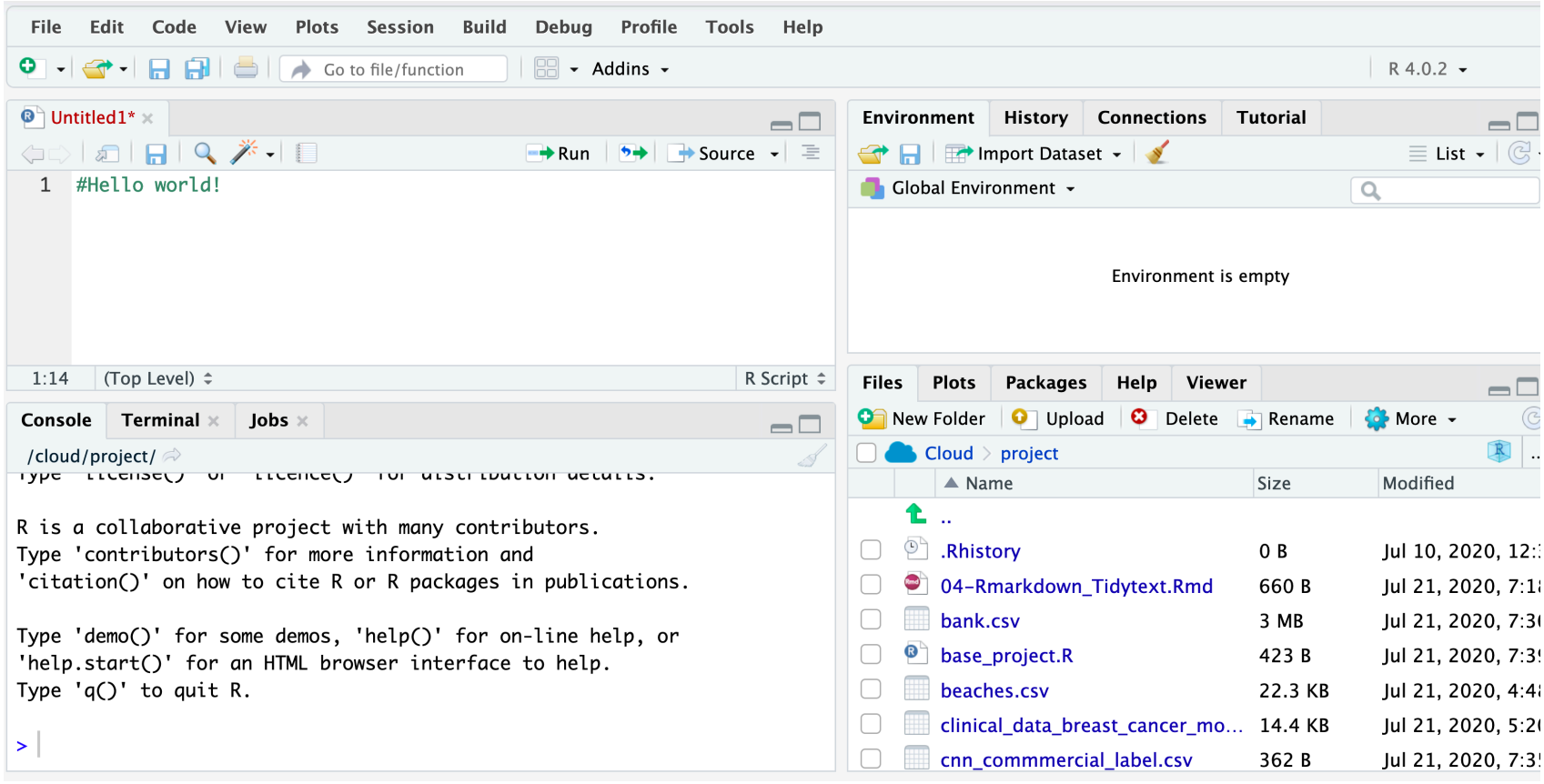
The best tool for writing R code is a program called **R Studio**.

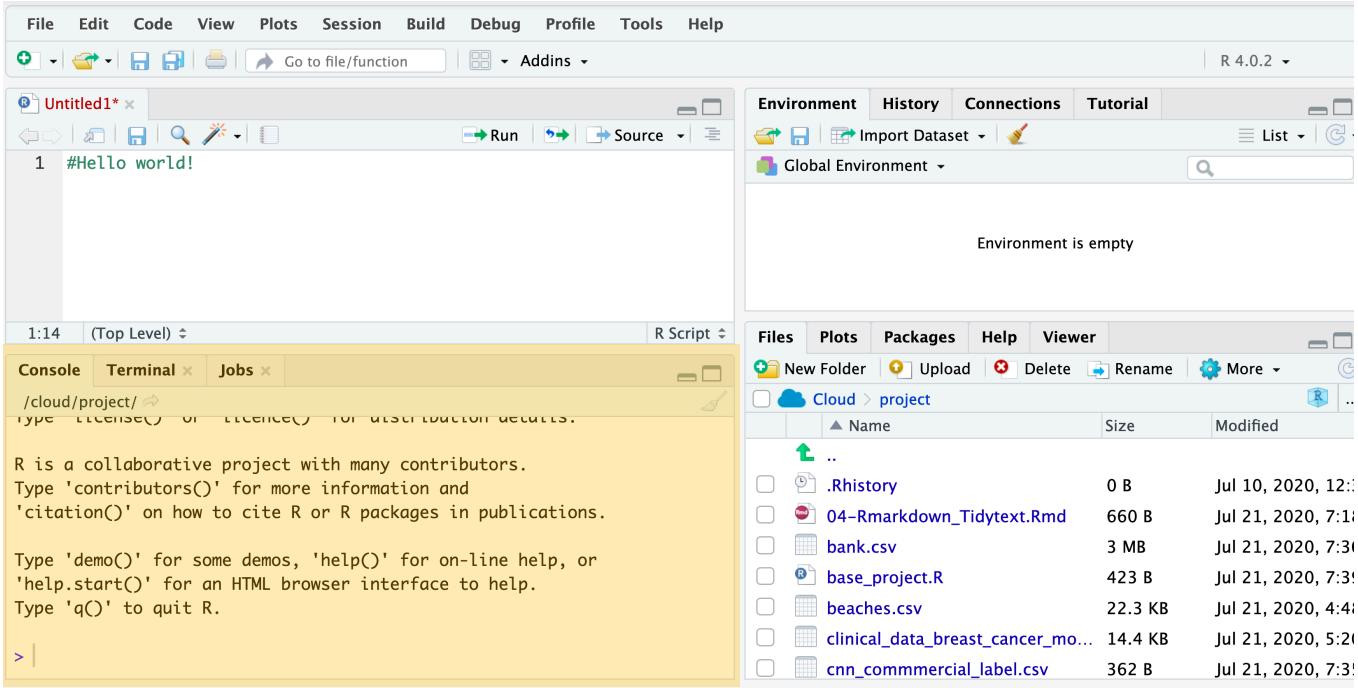
R Studio is a for profit company, but the R Studio software is free. If you want to download the latest version of R Studio on your own computer, go to https://www.rstudio.com/.

What's on the R Studio Screen?

The R Studio screen looks pretty crazy. Let's discuss what each window does.

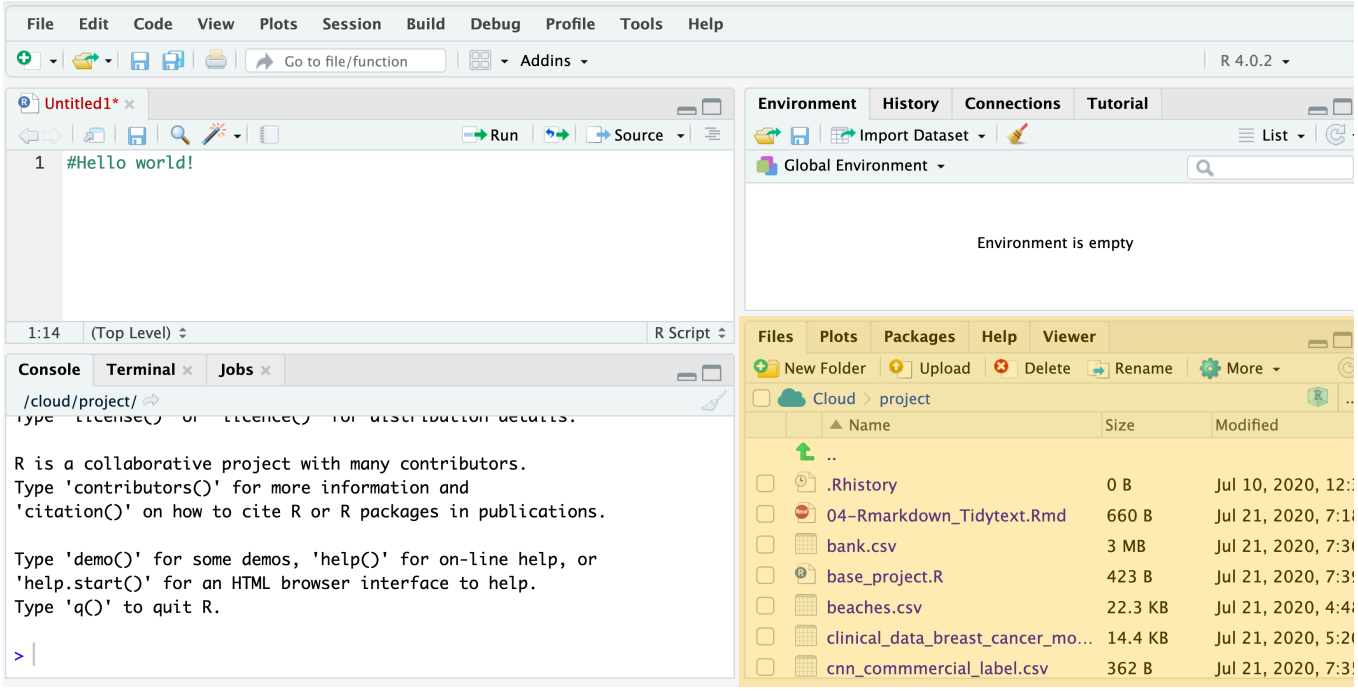


The **Console** Window



This is where R evaluates your code and displays results. You can type code (one line at a time) right in this window but most of the time we will type code in the **scripts** window just above instead.

The **Help/Plots** Window



Every command in R has a **help** page, and when you call one up it displays here. This window switches to display graphics when you use a command to produce one. You can toggle between **Help** and **Plots** by clicking on the tabs at the top of this window.

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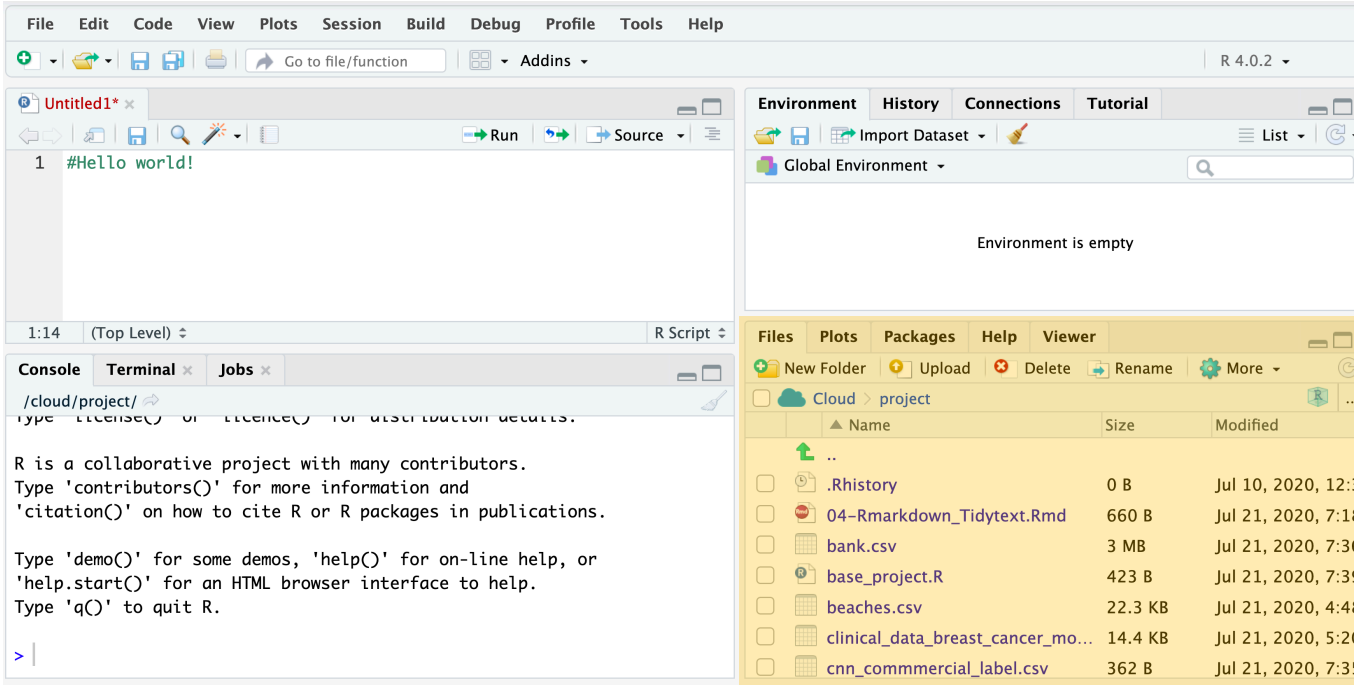
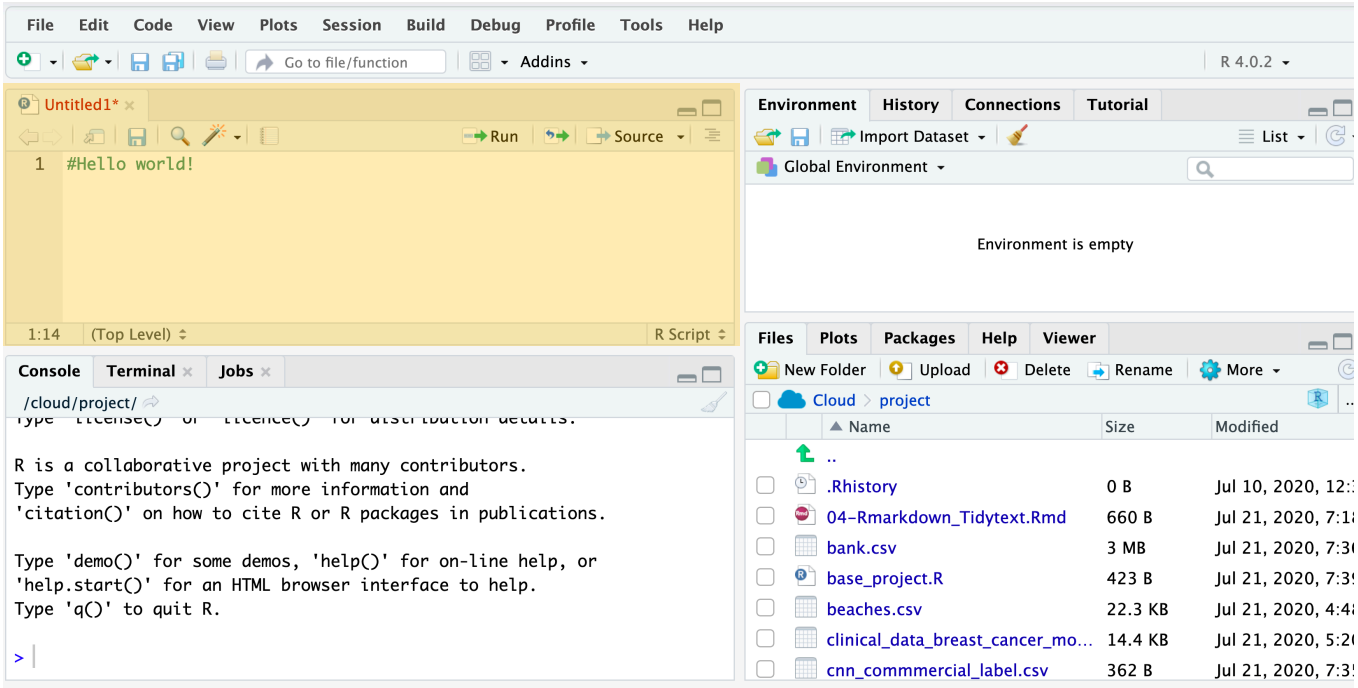


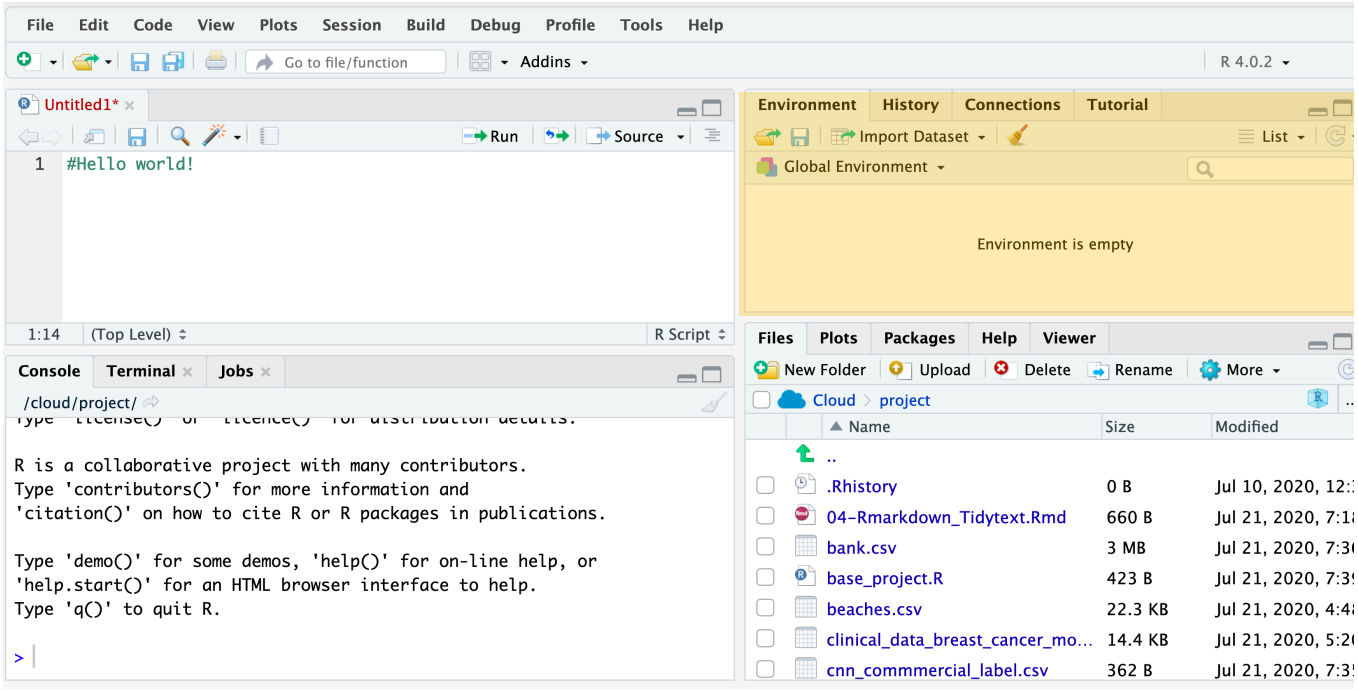
The **Files** tab shows you the files and folders that we've uploaded to R Studio Cloud for you to use. **Packages** and **Viewer** aren't used much. **Packages** shows you some of the libraries you can load. **Viewer** is a simple web browser for looking at HTML pages and graphics you might make.

The **Script** Window



This window is the one we use to write code and to save our code in a document. There are two kinds of code documents. An **R script** is a plain text file that can only contain R code. An **R Markdown file** is a more advanced file that also contains text to be displayed on a webpage. We will discuss both in more detail this afternoon.

The **Environment/History** Window



The **Environment** tab lists all of the objects that you've created in R since starting the session. **History** lists the last several commands you ran. This is the least important of the four windows.

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R scripts are saved with the extension **.R**

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Sometimes I put # *after* some code, to make a specific note about that line.

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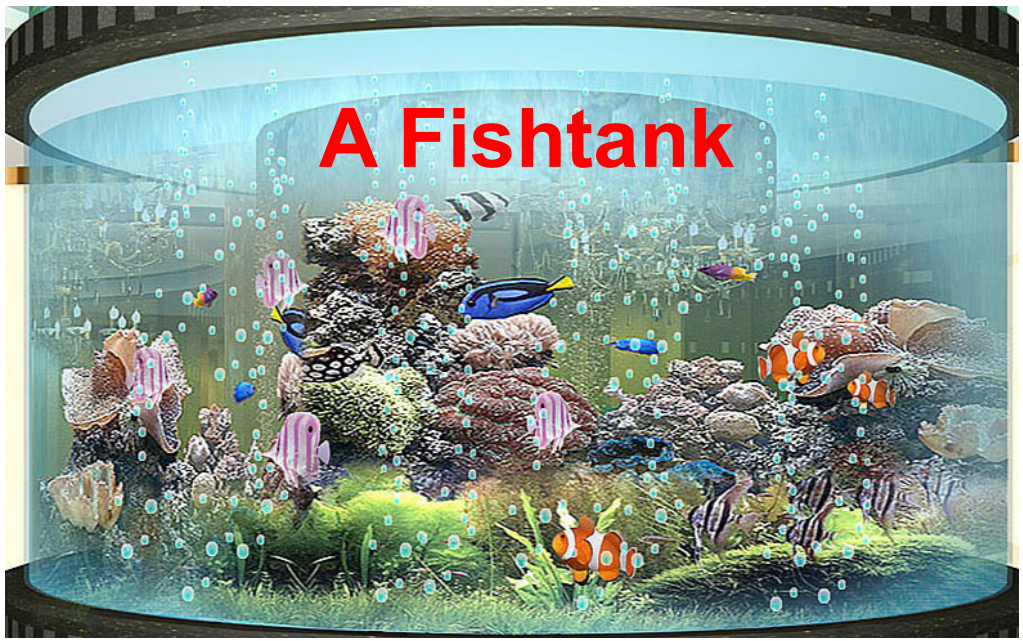

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Objects can be

- numbers
- words
- logical values
- lists
- vectors
- matrices
- tables of results
- whole datasets
- graphics

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Some people use equal signs instead, `name = information`, but I recommend against that. It's too easy to confuse this equal sign with the ones we use for function arguments and logic.

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- `y <- -3`
- `z <- 2.134`
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- `theAnswer <- 42`
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Chose names that are descriptive but not too hard to type.

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- `+` addition
- `-` subtraction or negation
- `*` multiplication
- `/` division
- `^` exponentiation
- `sqrt()` square root
- `log()` natural log
- `log10()` log-base-10
- `exp()` *e* to the power of

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- `log()` natural log
- `log10()` log-base-10
- `exp()` *e* to the power of

```
> theAnswer*problems
[1] 4158
```

Vectors

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```

To refer to a particular value, use brackets around the position of the value you want. For example, the 4th Star Wars movie was Episode 1:

```
> starWarsEps[4]
[1] 1
```

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- `data.frame` — a matrix or spreadsheet that contains a dataset. **This is the most important kind of object in this course.**
- `list` — a loose, ordered collection of other objects

Object Classes

The `class()` command lets you see the class of an object. R will try to guess the object's class when you define it:

```
> CLEcavs <- c("LeBron", "Kyrie", "KLove", "JR", "TT")
> class(CLEcavs)
[1] "character"
```

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[1] "character"
```

Sometimes R gets it wrong. I want the following **categorical** object to be read as a `factor`:

```
> dem.types <- c("FPTP", "PR", "PR", "FPTP")
> class(dem.types)
[1] "character"
```

Object Classes

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To coerce a character vector to a factor, use the `as.factor()` command:

```
> dem.types <- as.factor(dem.types)
> class(dem.types)
[1] "factor"
> dem.types
[1] FPTP PR   PR   FPTP
Levels: FPTP PR
```

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To coerce a character vector to a factor, use the `as.factor()` command:

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> class(dem.types)
[1] "factor"
> dem.types
[1] FPTP PR   PR   FPTP
Levels: FPTP PR
```

If you coerce an object, ALWAYS CHECK TO MAKE SURE IT WORKED. Sometimes R can't coerce. You might get an error. You might not get an error but the object will be wonky and wrong.

Object Classes: Data frames

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You can define a data frame directly with the `data.frame()` command.

```
> sandwich <- data.frame(grp=c("sweet", "savory", "French"),
        type=c("PBJ", "Hoogie", "Croque Monsieur"),
        rating=c(10,7,8))
> sandwich
     grp             type rating
1  sweet              PBJ     10
2 savory           Hoogie      7
3 French Croque Monsieur      8
```

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If the data is saved as a text file, you can use the `read.csv()` command to open it. We will get into more detail later, but here's a simple example:

```
nats <- read.csv("nationals.csv")
```

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These are not all designed to be pretty, but they all are useful for quick information.

I usually work through all of these as soon as I load a new dataset.

R Packages

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This is one of the greatest things about R. R's functionality increases VERY rapidly. New packages are released every day, so often it is hard to keep up. There are reputable journals devoted entirely to documentation for new R packages.

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To load an installed package into your R session type

```
library(package)
```

in your script, console, or markdown file. You need to do this **once for every R session**.

R Packages

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To see the commands available in a package you've installed, use the `help()` command in the console, like this:

```
help(package="fivethirtyeight")
```

Getting Help: R Help and R Search

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The command to run a regression is `lm()`. To see the help page for this command, type `?lm`. If you didn't know about `lm()`, you could discover it by typing something like `??linearmodel`.

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The search page shows you commands from different packages, code demonstrations (example R scripts), and vignettes (short papers).

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Part 1: command name and package

The name in the curly braces is the name of the package that provides this command to R. We will talk later about getting new packages. The `lm()` command, for example, comes from the **stats** package, which is one of the ones that is included with R when you first download it.

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Part 2: short and long description

There will be a few words in bold that give you a short description of the command. Then a brief paragraph summarizing what this command does.

Getting Help: Reading an R Help Page

Part 3: usage

This is the "full" version of the command, complete with every single option available for the command, and the default values if you don't change the option.
(Some commands also have "..." as an option — which just means that it can accept arguments from other commands that call this one. That's not something we need to worry about now.)

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Part 4: arguments

Every argument is listed here with a sentence or two describing what the option does and what values the option can be set to.

Getting Help: Reading an R Help Page

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Many commands, like `lm()`, will output results in a big list, with many components. The items of this list are described here.

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Part 7: additional details and notes.

If there are particular dangers or problems to be aware of, the authors of the command will discuss those here.

Getting Help: Reading an R Help Page

Part 8: authors and references

Getting Help: Reading an R Help Page

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A list of similar commands, in case this one isn't quite right. It includes hyperlinks to the help pages for these other commands.

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Examples are designed to be run, not looked at. Copy and paste the code into the console and see what happens. Unless otherwise stated, these examples are completely self-contained and are ready to run.

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Part 11: index. There is a link to the package itself. If you click on it, you will see an index of help pages for every command in this package.

Exercise

I know that the `write.table()` function can be used to output data to a external file to share with other people. But I don't yet know *how* to use this function.

1. Call up the help page for the `write.table()` function.

2. Suppose I want to label the rows in the data file I save. Does there appear to be a way to do that with this function?