

Data I/O, Part 1

Data Wrangling in R

Explaining output on slides

In slides, a command (we'll also call them code or a code chunk) will look like this

```
print("I'm code")
```

```
[1] "I'm code"
```

And then directly after it, will be the output of the code.

So `print("I'm code")` is the code chunk and `[1] "I'm code"` is the output.

These slides were made in R using `knitr` and R Markdown which is covered in later today when we discuss reproducible research.

Data Input

- 'Reading in' data is the first step of any real project/analysis
- R can read almost any file format, especially via add-on packages
- We are going to focus on simple delimited files first
 - tab delimited (e.g. '.txt')
 - comma separated (e.g. '.csv')
 - Microsoft excel (e.g. '.xlsx')

Data Input

UFO Sightings via Kaggle.com: "Reports of unidentified flying object reports in the last century".

"There are two versions of this dataset: scrubbed and complete. The complete data includes entries where the location of the sighting was not found or blank (0.8146%) or have an erroneous or blank time (8.0237%). Since the reports date back to the 20th century, some older data might be obscured. Data contains city, state, time, description, and duration of each sighting."

<https://www.kaggle.com/NUFORC/ufo-sightings>

Data Input

- Download data from http://sisbid.github.io/Module1/data/ufo/ufo_data_complete.csv.gz
- Upload the data to RStudio Cloud

Data Input

Easy way: R Studio features some nice “drop down” support, where you can run some tasks by selecting them from the toolbar.

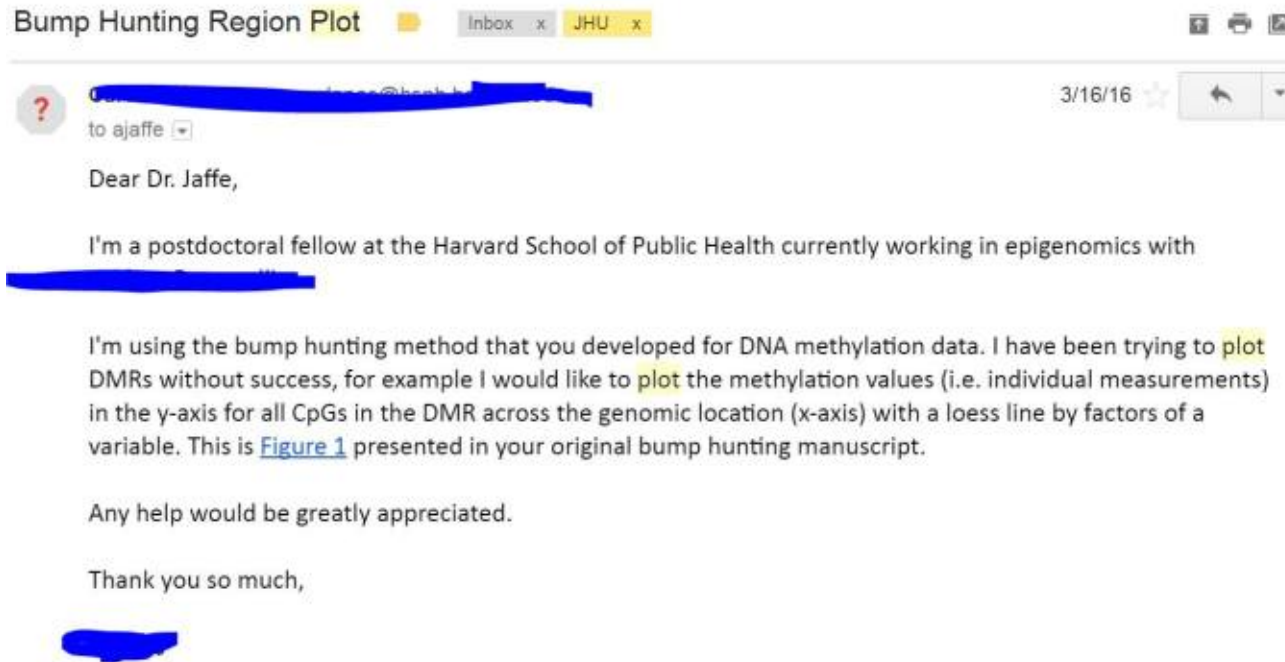
For example, you can easily import text datasets using the “Tools → Import Dataset → From Text (readr)” command. Selecting this will bring up a new screen that lets you specify the formatting of your text file.

After importing a dataset, you get the corresponding R commands that you can enter in the console if you want to re-import data.

Commenting in Scripts

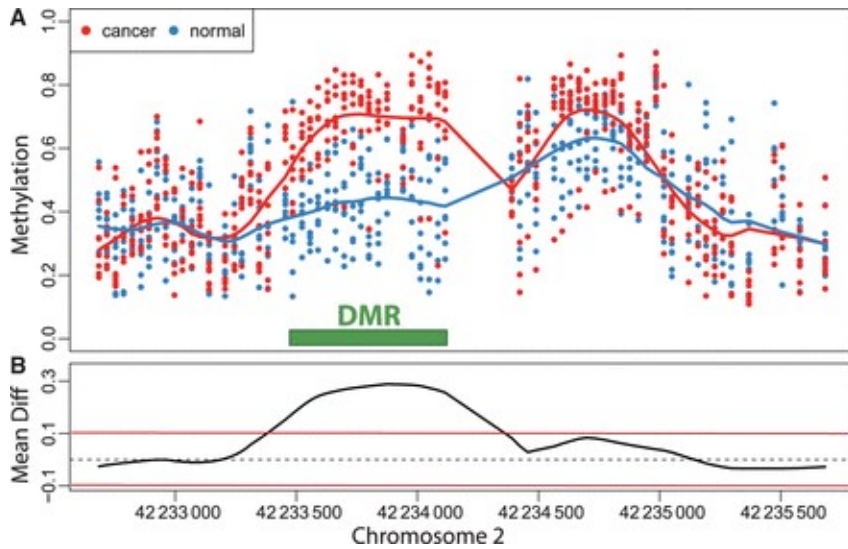
Commenting in code is super important. You should be able to go back to your code years after writing it and figure out exactly what the script is doing. Commenting helps you do this. This happens to me often...

Commenting in Scripts



The paper came out January 2012 with code made in 2011

Commenting in Scripts



This was the figure...

Commenting in Scripts

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3/16/16



to [redacted]

that plot was just made using the `matplot` function in base R, the code from the paper is attached.

you can check out the `derfinderPlot` package on bioconductor - that's the latest implementation of the code that adds gene annotation information



After some digging, I found the code

Commenting in Scripts

Add a comment header to your script from today: # is the comment symbol

```
#####  
# Title: Demo R Script  
# Author: Andrew Jaffe  
# Date: 7/13/2020  
# Purpose: Demonstrate comments in R  
#####  
  
# nothing to its right is evaluated  
  
# this # is still a comment  
### you can use many #'s as you want  
  
# sometimes you have a really long comment,  
#     like explaining what you are doing  
#     for a step in analysis.  
# Take it to another line
```

R variables

- You can create variables from within the R environment and from files on your computer
- R uses "=" or "<-" to assign values to a variable name
- Variable names are case-sensitive, i.e. X and x are different

```
x = 2 # Same as: x <- 2  
x
```

```
[1] 2
```

```
x * 4
```

```
[1] 8
```

```
x + 2
```

```
[1] 4
```

Help

For any function, you can write `?FUNCTION_NAME`, or `help("FUNCTION_NAME")` to look at the help file:

```
?dir  
help("dir")
```

Data Input

Initially-harder-but-gets-way-easier method: Utilizing functions in the `readr` package called `read_delim()` and `read_csv()` with code.

Data Input

So what is going on “behind the scenes”?

`read_delim()`: Read a delimited file into a data frame.

```
function (file, delim, quote = "\"", escape_backslash = FALSE,
  escape_double = TRUE, col_names = TRUE, col_types = NULL,
  locale = default_locale(), na = c("", "NA"), quoted_na = TRUE,
  comment = "", trim_ws = FALSE, skip = 0, n_max = Inf, guess_max = min(1000
    n_max), progress = show_progress(), skip_empty_rows = TRUE)
NULL

# for example: read_delim("file.txt", delim="\t")
```

Data Input

- The filename is the path to your file, in quotes
- The function will look in your “working directory” if no absolute file path is given
- Note that the filename can also be a path to a file on a website (e.g. 'www.someurl.com/table1.txt')

Data Input

There is another convenient function for reading in CSV files, where the delimiter is assumed to be a comma:

```
read_csv
```

```
function (file, col_names = TRUE, col_types = NULL, locale = default_locale(),  
  na = c("", "NA"), quoted_na = TRUE, quote = "\"", comment = "",  
  trim_ws = TRUE, skip = 0, n_max = Inf, guess_max = min(1000,  
    n_max), progress = show_progress(), skip_empty_rows = TRUE)  
{  
  tokenizer <- tokenizer_csv(na = na, quoted_na = quoted_na,  
    quote = quote, comment = comment, trim_ws = trim_ws,  
    skip_empty_rows = skip_empty_rows)  
  read_delimited(file, tokenizer, col_names = col_names, col_types = col_types,  
    locale = locale, skip = skip, skip_empty_rows = skip_empty_rows,  
    comment = comment, n_max = n_max, guess_max = guess_max,  
    progress = progress)  
}  
<bytecode: 0x7f9e41f64738>  
<environment: namespace:readr>
```

Data Input

- Here would be reading in the data from the command line, specifying the file path:

```
ufo = read_csv("../data/ufo/ufo_data_complete.csv")
```

Parsed with column specification:

```
cols(
  datetime = col_character(),
  city = col_character(),
  state = col_character(),
  country = col_character(),
  shape = col_character(),
  `duration (seconds)` = col_double(),
  `duration (hours/min)` = col_character(),
  comments = col_character(),
  `date posted` = col_character(),
  latitude = col_character(),
  longitude = col_double()
)
```

Warning: 199 parsing failures.

row	col	expected	actual	file
877	--	11 columns	12 columns	'../data/ufo/ufo_data_complete.csv'
1712	--	11 columns	12 columns	'../data/ufo/ufo_data_complete.csv'
1814	--	11 columns	12 columns	'../data/ufo/ufo_data_complete.csv'
2857	--	11 columns	12 columns	'../data/ufo/ufo_data_complete.csv'
3733	--	11 columns	12 columns	'../data/ufo/ufo_data_complete.csv'

Data Input

The `read_delim()` and related functions returns a “tibble” is a `data.frame` with special printing, which is the primary data format for most data cleaning and analyses.

```
head(ufo)
```

```
# A tibble: 6 x 11
  datetime city state country shape `duration (seco...` `duration (hour... comment
  <chr>      <chr> <chr> <chr>   <chr>      <dbl> <chr>          <chr>
1 10/10/1... san ... tx      us      cyli...    2700 45 minutes    This ev
2 10/10/1... lack... tx      <NA>    light    7200 1-2 hrs      1949 La
3 10/10/1... ches... <NA>    gb      circ...     20 20 seconds    Green/O
4 10/10/1... edna   tx      us      circ...     20 1/2 hour      My olde
5 10/10/1... kane... hi      us      light     900 15 minutes    AS a Ma
6 10/10/1... bris... tn      us      sphe...     300 5 minutes     My fath
# ... with 3 more variables: `date posted` <chr>, latitude <chr>, longitude <dbl>
```

```
class(ufo)
```

```
[1] "spec_tbl_df" "tbl_df"      "tbl"         "data.frame"
```

Data Input

ufo

```
# A tibble: 88,875 x 11
  datetime city state country shape `duration (seco...` `duration (hour... commen
  <chr>      <chr> <chr> <chr> <chr> <dbl> <chr> <chr>
1 10/10/1... san ... tx us cyli... 2700 45 minutes This e
2 10/10/1... lack... tx <NA> light 7200 1-2 hrs 1949 I
3 10/10/1... ches... <NA> gb circ... 20 20 seconds Green/
4 10/10/1... edna tx us circ... 20 1/2 hour My old
5 10/10/1... kane... hi us light 900 15 minutes AS a M
6 10/10/1... bris... tn us sphe... 300 5 minutes My fat
7 10/10/1... pena... <NA> gb circ... 180 about 3 mins penart
8 10/10/1... norw... ct us disk 1200 20 minutes A brig
9 10/10/1... pell... al us disk 180 3 minutes Strobe
10 10/10/1... live... fl us disk 120 several minutes Saucer
# ... with 88,865 more rows, and 3 more variables: `date posted` <chr>,
# latitude <chr>, longitude <dbl>
```

Data Input

There are also data importing functions provided in base R (rather than the `readr` package), like `read.delim` and `read.csv`.

These functions have slightly different syntax for reading in data, like `header` and `as.is`.

However, while many online resources use the base R tools, recent versions of RStudio switched to use these new `readr` data import tools, so we will use them in the class for slides. They are also up to two times faster for reading in large datasets, and have a progress bar which is nice.

Data Input - Excel

Many data analysts collaborate with researchers who use Excel to enter and curate their data. Often times, this is the input data for an analysis. You therefore have two options for getting this data into R:

- Saving the Excel sheet as a .csv file, and using `read.csv()`
- Using an add-on package, like `readxl`

For single worksheet .xlsx files, I often just save the spreadsheet as a .csv file (because I often have to strip off additional summary data from the columns)

For an .xlsx file with multiple well-formatted worksheets, I use the `readxl` package for reading in the data.

Data Input - Other Software

- **haven** package (<https://cran.r-project.org/web/packages/haven/index.html>) reads in SAS, SPSS, Stata formats
- **sas7bdat** reads .sas7bdat files
- **foreign** package - can read all the formats as **haven**. Around longer (aka more testing), but not as maintained (bad for future).

Common new user mistakes we have seen

1. Working directory problems: trying to read files that R “can’t find”

- RStudio can help, and so do RStudio Projects
- discuss in this Data Input/Output lecture

2. Lack of comments in code

3. Typos (R is **case sensitive**, x and X are different)

- RStudio helps with “tab completion”
- discussed throughout

4. Data type problems (is that a string or a number?)

5. Open ended quotes, parentheses, and brackets

6. Different versions of software

Working Directories

- R “looks” for files on your computer (or cloud) relative to the “working” directory
- Many people recommend not setting a directory in the scripts
 - assume you’re in the directory the script is in
 - If you open an R file with a new RStudio session, it does this for you.
- If you do set a working directory, do it at the beginning of your script.
- Example of getting and setting the working directory:

```
## get the working directory  
getwd()  
setwd("~/Lectures")
```