R and R Markdown Basics

Fall 2022

September 14 2022

Reproducible data science

What does it mean for a data analysis to be "reproducible"?

Short-term goals

- Are the tables and figures reproducible from the code and data?
- Does the code work as intended?
- In addition to what was done, is it clear why it was done? (e.g., how were parameter settings chosen?)

Long-term goals

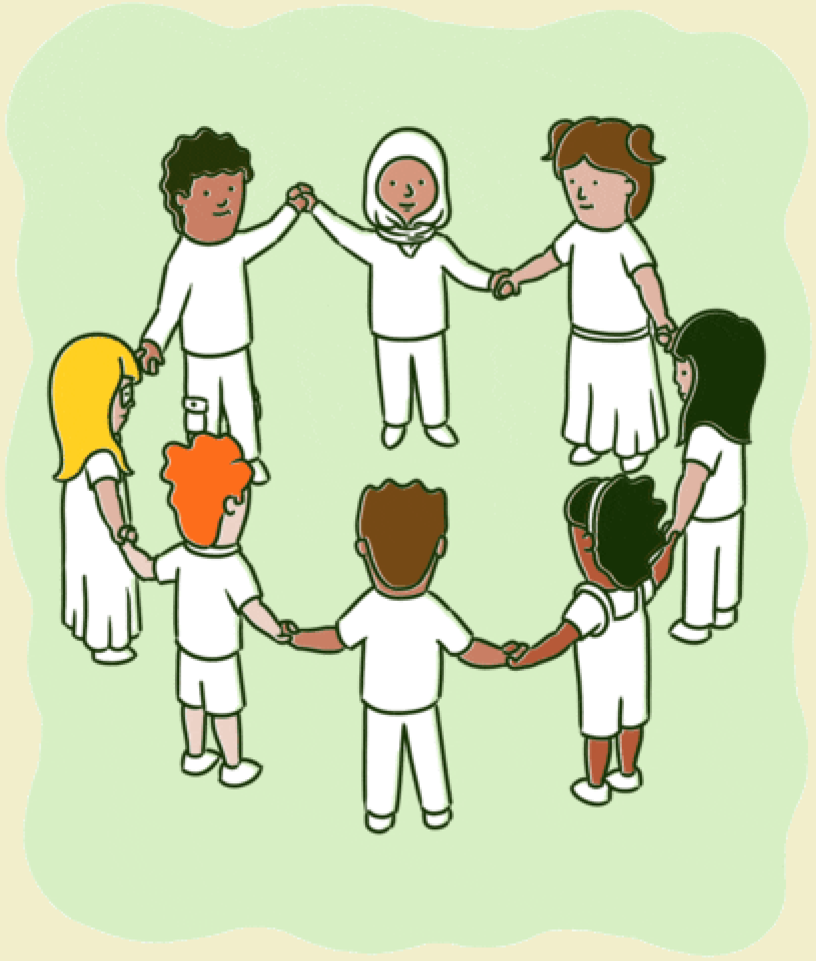
- Can the code be used for other data?
- Can you extend the code to do other things?

Toolkit for reproducibility

- Scriptability → R
- Literate programming (code, narrative, output in one place) → R Markdown
- Version control → Git / GitHub

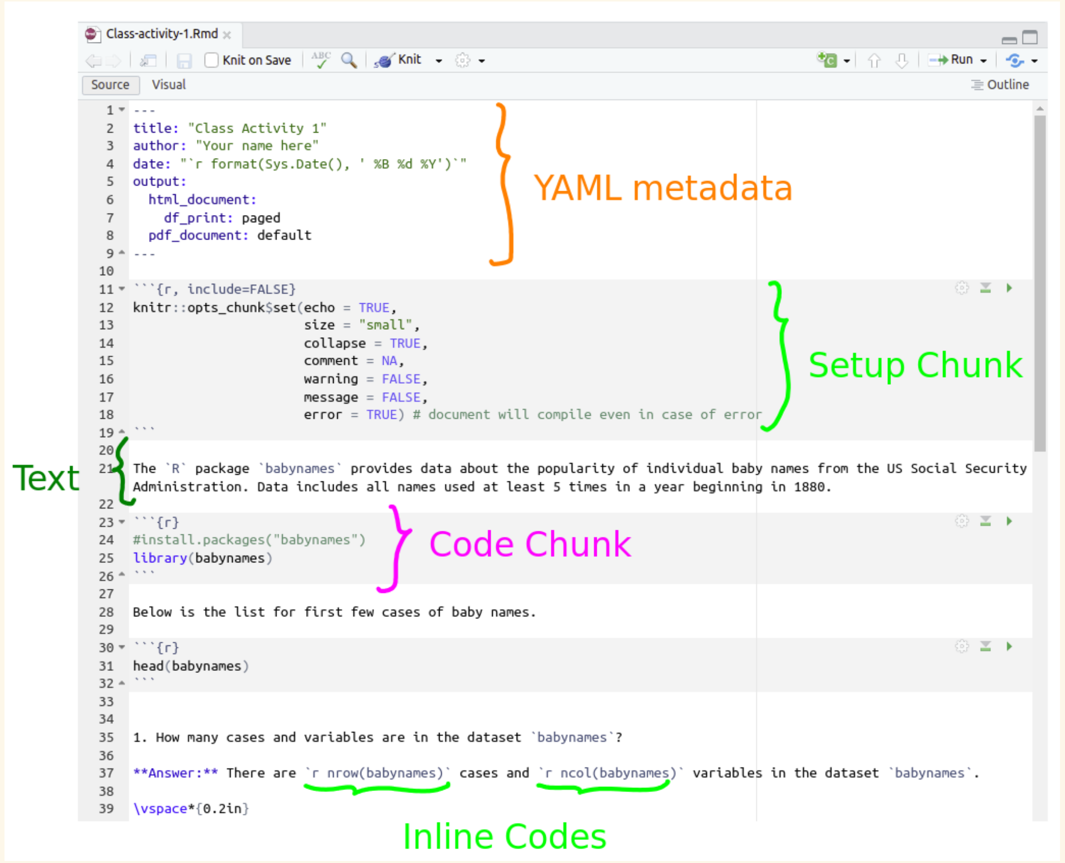
Group Activity 1

10:00

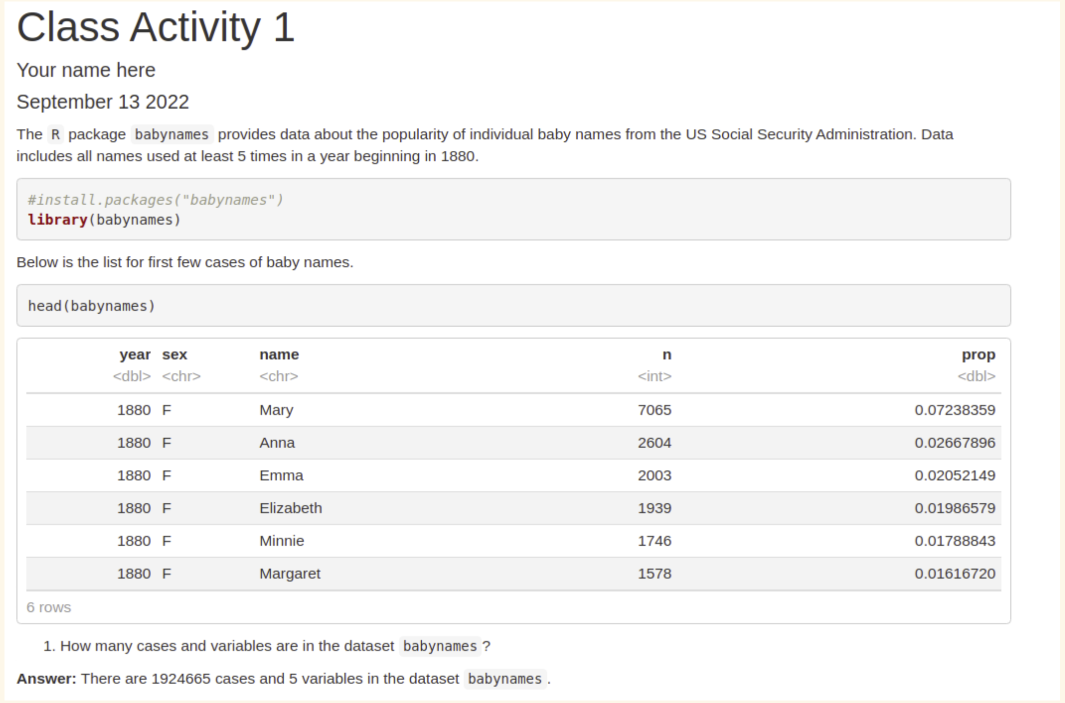


- Let's go over to maize server/ local Rstudio to connect it with the class Github repository
- Clone hw0-yourusername repository to your course folder as an R project using version control methods
- Make changes to hw and commit those changes
- Push the changes regularly back to Github

Tour: R Markdown



~~~
---
title: "Class Activity 1"
author: "Your name here"
date: "`r format(Sys.Date(), ' %B %d %Y')`"
output:
  html_document:
    df_print: paged
  pdf_document: default
---

```{r, include=FALSE}
knitr::opts_chunk$set(echo = TRUE,
                      size = "small",
                      collapse = TRUE,
                      comment = NA,
                      warning = FALSE,
                      message = FALSE,
                      error = TRUE) # document will compile even in case of error
```

The `R` package `babynames` provides data about the popularity of individual baby names from the US Social Security
Administration. Data includes all names used at least 5 times in a year beginning in 1880.

```{r}
#install.packages("babynames")
library(babynames)
```

Below is the list for first few cases of baby names.

```{r}
head(babynames)
```


1. How many cases and variables are in the dataset `babynames`?

**Answer:** There are `r nrow(babynames)` cases and `r ncol(babynames)` variables in the dataset `babynames`.

\vspace*{0.2in}
~~~



Class Activity 1

Your name here

September 13 2022

The `R` package `babynames` provides data about the popularity of individual baby names from the US Social Security Administration. Data includes all names used at least 5 times in a year beginning in 1880.

```
#install.packages("babynames")
library(babynames)
```

Below is the list for first few cases of baby names.

```
head(babynames)
```

year	sex	name	n	prop
<dbl>	<chr>	<chr>	<int>	<dbl>
1880	F	Mary	7065	0.07238359
1880	F	Anna	2604	0.02667896
1880	F	Emma	2003	0.02052149
1880	F	Elizabeth	1939	0.01986579
1880	F	Minnie	1746	0.01788843
1880	F	Margaret	1578	0.01616720

6 rows

1. How many cases and variables are in the dataset `babynames`?

Answer: There are 1924665 cases and 5 variables in the dataset `babynames`.

Output

Metadata and output types

YAML (yet another markup language)

- data serialization language that is often used for writing configuration files.

Basic recipe:

```
---
key: value
---
```

Example:

```
---
title: My title
output:
  github_document
    toc: true
    theme: flatly
---
```

Output types

- html_document (can't view in GitHub repo)
- pdf_document (need MikTex or MacTex installed)
- github_document (creates a .md Markdown doc, viewable on GitHub)
- ioslides_presentation, beamer_presentation

```
---
title: "Baby Name Trends"
output: github_document
---
```

```
---
title: "Baby Name Trends"
output: github_document
params:
  attribute: value
---
```

Text

Simple rules for

- section headers (`#`,`##`,etc)
- lists (need ~2 tabs to create sublists)
- formatting (bold $\star\star$, italics $\star$)
- tables
- R syntax (use backward tick `` ` ``)
- web links `[linked text](url)`
- latex math equations $\beta_1 + \beta_2$
- in HTML docs, you can use HTML commands (in pdf, latex commands)

For further help, look at R Markdown Cheatsheet

Code chunks

Code goes in chunks, defined by three backticks

~~~
```{r}

filtered_names <- babynames %>% filter(name=="Amiee", year < max(year), year > min(year))

ggplot(data=filtered_names, aes(x=year, y=prop)) +
  geom_line(aes(colour=sex)) +
  xlab('Year') +
  ylab('Prop. of Babies Named Aimee')

```
~~~

Adding/running chunks

Add chunks with button or:

- Command (or Cmd) `⌘` + Option (or Alt) `⌥` + `i` (Mac)
- Ctrl + Alt + `i` (Windows/Linux)

Run chunks by:

- Run current chunk button (interactive)
- Knit button / run all chunks

Inline code

How many babies were born with name 'Aimee'?

```
`r sum(filtered_names$n)`
```

There are a total of 53228 babies.

In what year were there highest proportion of babies born with the name `Aimee`?

```
`r filtered_names$year[which.max(filtered_names$prop)]`
```

`Aimee` name was the most popular in 1973.

Chunk options: echo

~~~
```{r echo=FALSE}
glimpse(filtered_names)
```
~~~

```
Rows: 148
Columns: 5
$ year <dbl> 1881, 1882, 1883, 1884, 1885, 1886, 1887, 1888, 1889, 1890, 1891,…
$ sex  <chr> "F", "F", "F", "F", "F", "F", "F", "F", "F", "F", "F", "F", "F", …
$ name <chr> "Aimee", "Aimee", "Aimee", "Aimee", "Aimee", "Aimee", "Aimee", "A…
$ n    <int> 11, 13, 11, 15, 17, 17, 18, 12, 16, 18, 14, 15, 17, 13, 13, 23, 1…
$ prop <dbl> 0.00011127, 0.00011236, 0.00009162, 0.00010902, 0.00011976, 0.000…
```

Chunk options: eval

~~~
```{r eval=FALSE}
glimpse(filtered_names)
```
~~~

```
> glimpse(filtered_names)
```

Chunk options: include

~~~
```{r include=FALSE}
glimpse(filtered_names)
```
~~~

Chunk options: results

~~~
```{r echo=TRUE, results='hide'}
glimpse(filtered_names)
```
~~~

```
> glimpse(filtered_names)
```

Chunk labels

~~~
```{r peek, echo=FALSE, results='hide'}
glimpse(filtered_names)
```
~~~

- Place between curly braces --> `{r label}`
- Separate options with commas --> `{r label, option1=value}`

~~~
```{r peek}
head(filtered_names)
```
~~~

```
Error in parse_block(g[-1], g[1], params.src) :
  duplicate label 'peek'
Calls: <Anonymous> ... process_file -> split_file -> lapply -> FUN -> parse_block
Execution halted
```

Careful! Don't duplicate labels

The setup chunk

~~~
```{r setup, include=FALSE}
knitr::opts_chunk$set(
  collapse = TRUE,
  comment = "#>",
  out.width = "100%"
)
```
~~~

- A special chunk label: `setup`
- Typically the first
- All following chunks will use these options (i.e., sets global chunk options)
- Tip: set `include=FALSE`
- You can (and should) use individual chunk options too

Let's talk about some R-codes and data types !!

Math in R

```
> 10^2
[1] 100
```

```
> 3 ^ 7
[1] 2187
```

```
> 6/9
[1] 0.6666667
```

```
> 9-43
[1] -34
```

- Rules for order of operations are followed
- Spaces between numbers and characters are ignored

```
> 4^3-2* 7+9 /2
[1] 54.5
```

The equation above is computed as

$$4^3 - (2 \cdot 7) + \frac{9}{2}$$

Variables

Variables are used to store data, figures, model output, etc.

- assign a variable using `<-`

Assign just one value:

```
> x <- 5
> x
[1] 5
```

Assign a **vector** of values:

```
> a <- 3:10
> a
[1]  3  4  5  6  7  8  9 10
```

Concatenate a string of numbers

```
> b <- c(5, 12, 2, 100, 8)
> b
[1]   5  12   2 100   8
```

Concatenate a string of characters

```
> names <- c("Amy", "Dee", "Lux")
> names
[1] "Amy" "Dee" "Lux"
```

Data frames (aka "tibbles" in tidyverse)

Vectors vs. data frames: a data frame is a collection (or array or table) of vectors

```
> df <- tibble(
+   IDs=1:3,
+   gender=c("Male", "Female", "Male"),
+   age=c(28, 36, 23),
+   trt = c("control", "treatment", "treat
+   Diabetes = c(FALSE, TRUE, TRUE)
+   )
> df
# A tibble: 3 × 5
    IDs gender   age trt       Diabetes
  <int> <chr>  <dbl> <chr>     <lgl>
1     1 Male      28 control   FALSE
2     2 Female    36 treatment TRUE
3     3 Male      23 treatment TRUE
```

- Allows different columns to be of different data types (i.e. numeric vs. text)
- Both numeric and text can be stored within a column (stored together as *text*).
- Vectors and data frames are examples of *objects* in R.
  - There are other types of R objects to store data, such as matrices, lists.

Variable (column) types

type	description
integer	integer-valued numbers
numeric	numbers that are decimals
factor	categorical variables stored with levels (groups)
character	text, "strings"
logical	boolean (TRUE, FALSE)

- View the structure of our data frame to see what the variable types are:

```
> str(df)
tibble [3 × 5] (S3: tbl_df/tbl/data.frame)
 $ IDs     : int [1:3] 1 2 3
 $ gender  : chr [1:3] "Male" "Female" "Male"
 $ age     : num [1:3] 28 36 23
 $ trt     : chr [1:3] "control" "treatment" "treatment"
 $ Diabetes: logi [1:3] FALSE TRUE TRUE
```

Data frame cells, rows, or columns

Show whole data frame

```
> df
# A tibble: 3 × 5
    IDs gender    age trt       Diabetes
  <int> <chr>   <dbl> <chr>     <lgl>
1     1 Male       28 control   FALSE
2     2 Female     36 treatment TRUE
3     3 Male       23 treatment TRUE
```

Specific cell: `DataSetName[row#, column#]`

```
> # Second row, Third column
> df[2, 3]
# A tibble: 1 × 1
    age
  <dbl>
1    36
```

Entire col: `DataSetName[, column#]`

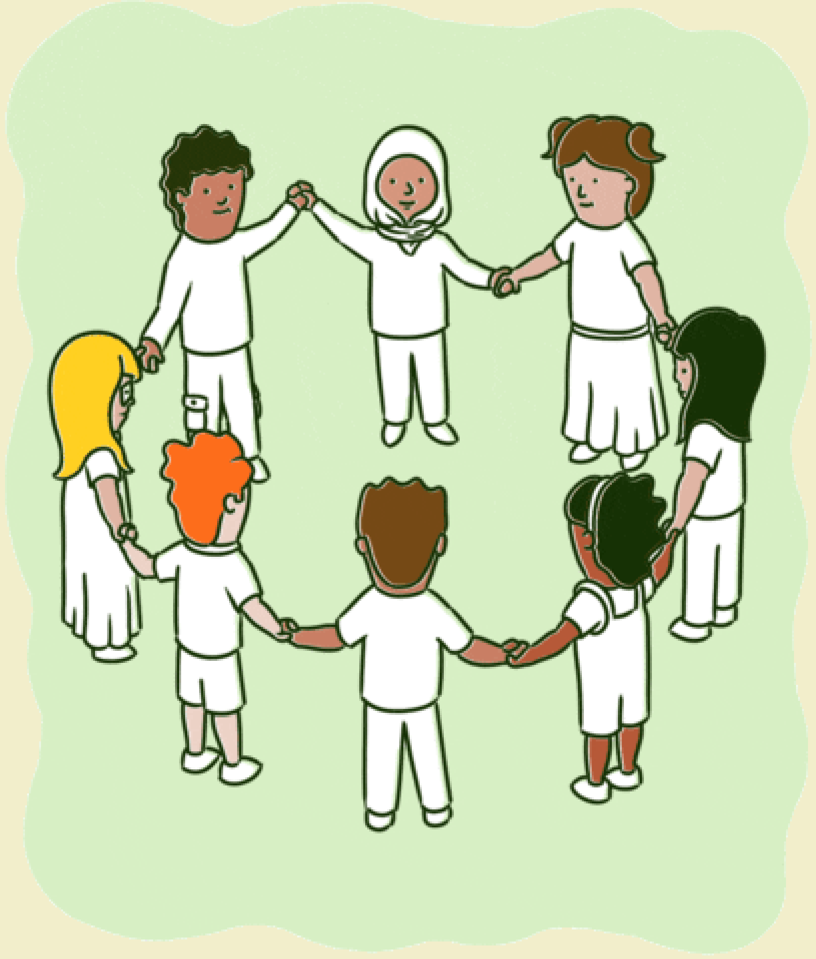
```
> # Third column
> df[, 3]
# A tibble: 3 × 1
    age
  <dbl>
1    28
2    36
3    23
```

Entire row: `DataSetName[row#, ]`

```
> # Second row
> df[2,]
# A tibble: 1 × 5
    IDs gender    age trt       Diabetes
  <int> <chr>   <dbl> <chr>     <lgl>
1     2 Female     36 treatment TRUE
```

Group Activity 2

10:00



Go to class-activity-2.Rmd in moodle

1. Read through the activity answering any questions asked
2. Add `fig.path = "figs/"` as a knitr code chunk option for a single plot. What happened? What happens if you don't include the forward slash?
3. Add it to a global setup chunk instead
4. Work on the data types questions and submit to moodle when done.