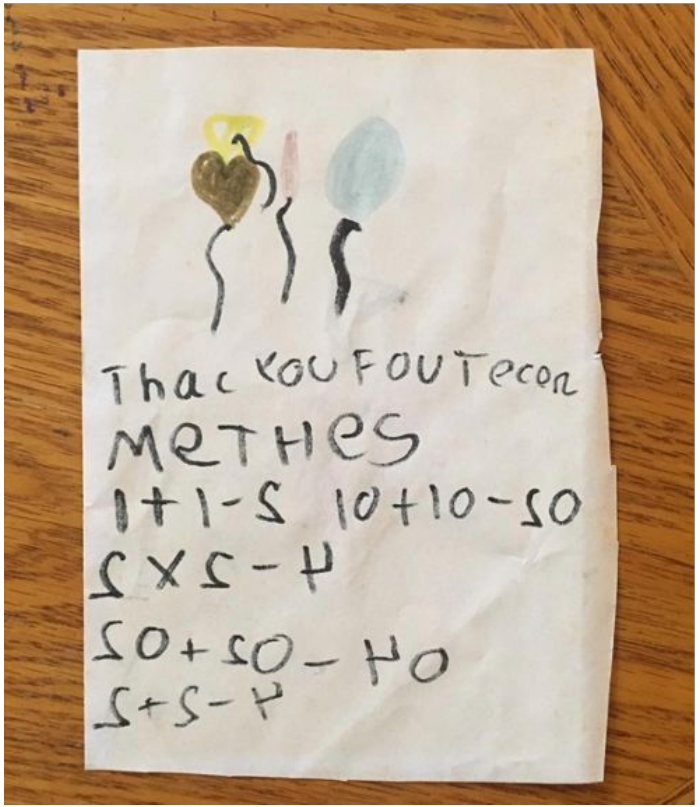
Data Science Basics in R

Day 1: Introduction to Statistical Programming

Introductions

- Your name
- What you do for school, work, and/or fun
- Why you signed up for this course
- Have you ever used R before?

Introductions



Housekeeping notes

- Take a break whenever you need one, we will also have a few structured breaks as a larger group
- Outlet locations
- Trash cans
- Try to come with a charged laptop
- If you have questions, you can find me at *sde31@georgetown.edu*
- Office hours are immediately after class

Housekeeping notes

All course materials are available on github, and we'll talk more about github in general later in this course.

https://github.com/seaneff/data-science-basics-2024

What to expect: Learning R

- Learning R is fun! And also frustrating.
- You won’t be an expert by the end of this week.
- But over time and as you practice, it gets easier!

What to expect: The next week

- We'll balance slides/demos with hands-on exercises.
- You decide how you learn best...
  - listening with your computer away
  - laptop out and typing along
  - taking notes with paper/pen
- All of these materials are publicly accessible on github.

Course goals

This course will build literacy and basic proficiency in statistical programming, with a focus on the skills needed to conduct data analyses in professional healthcare and public health workplaces.

We will cover the basics of data management, data cleaning, data visualization, and basic statistical calculations in R, and version control in github. Participants will leave with a small portfolio of relevant data visualizations and analyses completed using a real-world public health dataset.

Course goals

- Learning to program (in R) can be fun and creative, and doesn't have to be overwhelming or intimidating.
- Anyone can learn to write code.

Artwork by Allison Horst

Learning by doing

For some people, it's easier to learn by doing, typing, and making mistakes. Others prefer to listen, think, and work through problems later on their own.

In this workshop, we'll pause to do worked examples. Sometimes these will be confusing. This is the point! We will learn together by trial and error.

If you are more comfortable following along for now, feel free to just watch and try at home. But I really encourage you to try, the best way to learn R is to repeatedly do stuff wrong and then figure out the errors.


Everything hurts and I'm dying.

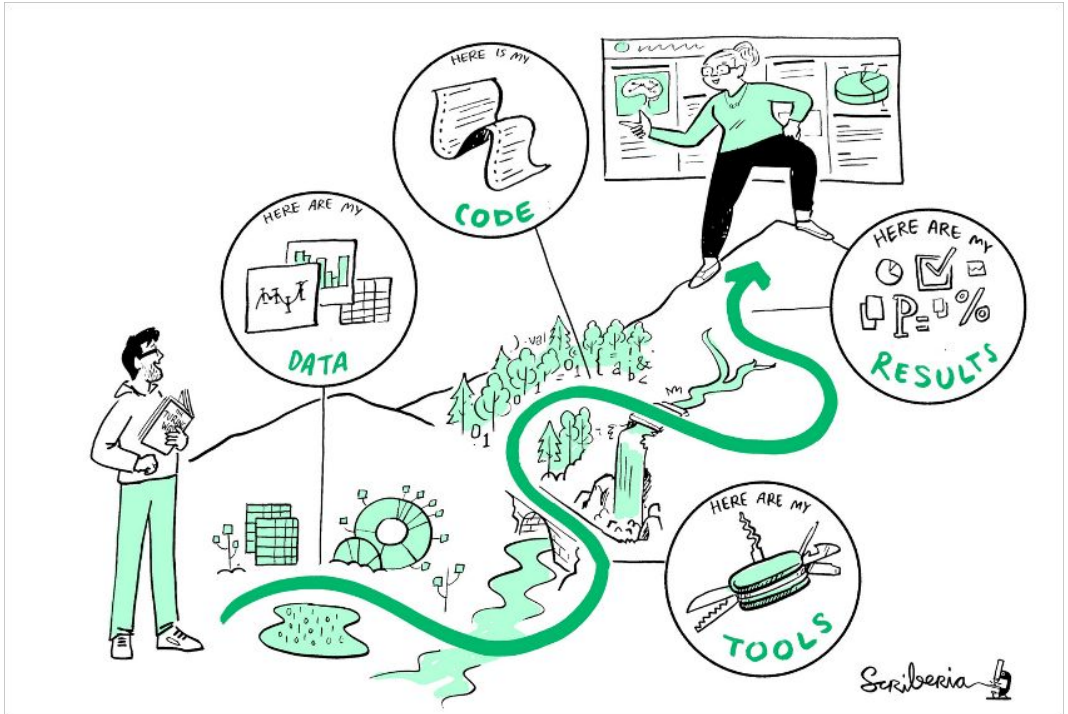
Goals for today

- Understand what statistical programming is
- Get acquainted with RStudio
- Write your very first R code (at least, of this workshop)
  - vectors
  - functions
  - accessing documentation
- Get familiar with Github (by writing poems about rainbows)

What is statistical programming, and why should I care?

What is statistical programming?

Statistical programming is using code to clean, analyze, visualize, and interpret data.



What is R?

- R is a programming language for statistical computing
- Created by Ross Ihaka and Robert Gentleman in 1996
- R is open-source and free
- Many people use R in different ways and for different purposes, but it's defined specifically for data analysis and visualization (unlike other open-source languages like python)

What is RStudio?

- R Studio is, put simply, a place to write and run R code
- It's an IDE (integrated development environment) and supports both R and python
- It's also free (with enterprise upgrades)

Why learn R?

- Learning R helps you understand your data and understand how analysis works, whether you're a researcher, a data scientist, or someone who collaborates with folks who do analysis
- Coding helps you think rigorously about your questions
- It's free (vs. other more expensive tools like SAS or SPSS)
- Shareable, reproducible code and research
- Lots of academics/companies/agencies use it
- It's fun (honestly)

Alternatives to R

Tool	Primary focus	Open source?	Great for
R	Data analysis	Yes	Statistical analysis, data visualization
Python	General-purpose programming language	Yes	Huge datasets, deploying to production, bioinformatics
Julia	General-purpose programming language	Yes	Huge datasets, time-consuming calculations
SAS	Data analysis	No	Highly regulated work (e.g., clinical trials)
SPSS	Data analysis	No	Easy to use (point and click)
Stata	Data analysis	No	Easy to use (point and click)
Matlab	Data analysis (especially engineering)	No	Mathematical programming
Excel	Data management	No	Quick pivot tables, looking at raw data

R vs. Python

Graphic from chatGPT

- Python is the primary open-source alternative to R, and some people *love* to argue about which is better
- They are both great tools. Most data analysts/data scientists I've worked with use both, for different use cases.

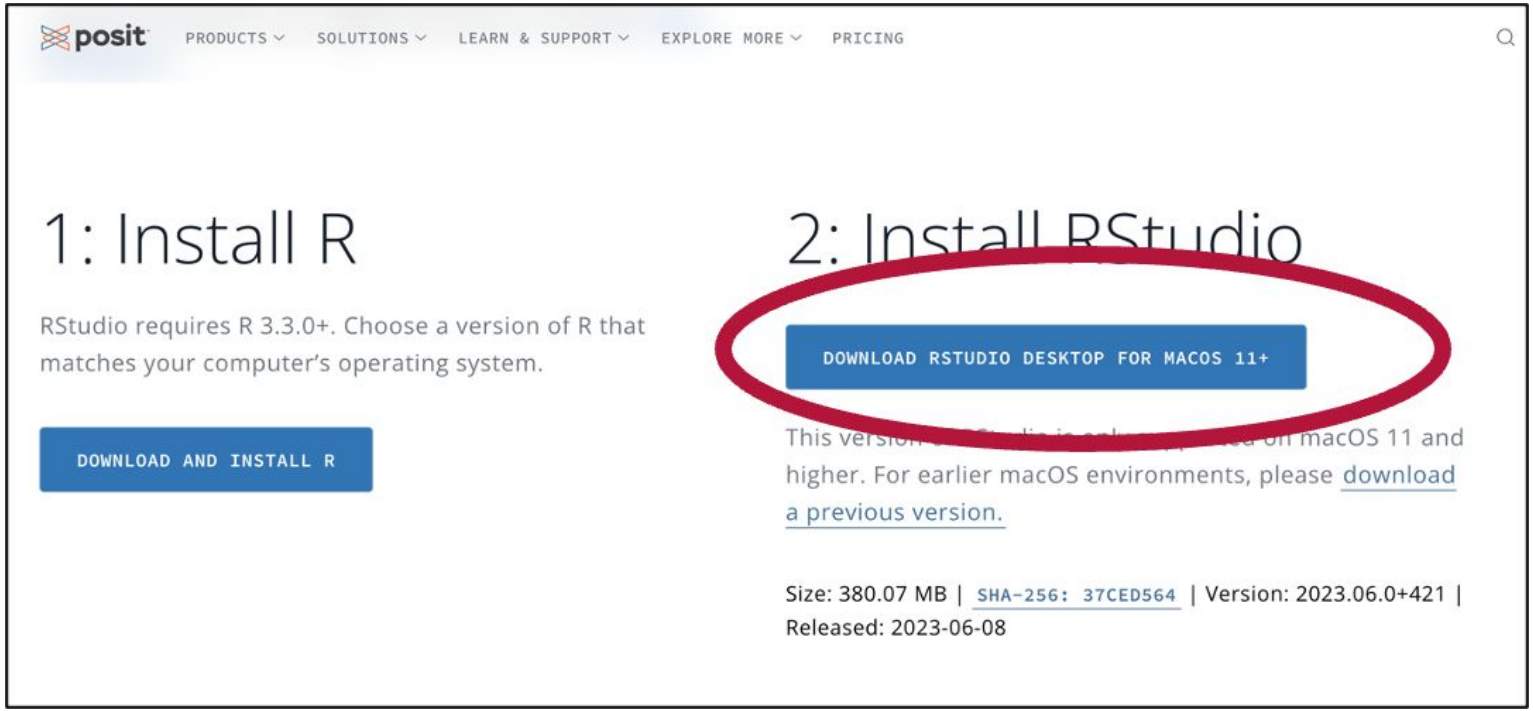
Downloading R and RStudio

Download R:

https://cran.r-project.org/

Download RStudio:

https://posit.co/download/rstudio-desktop/#download

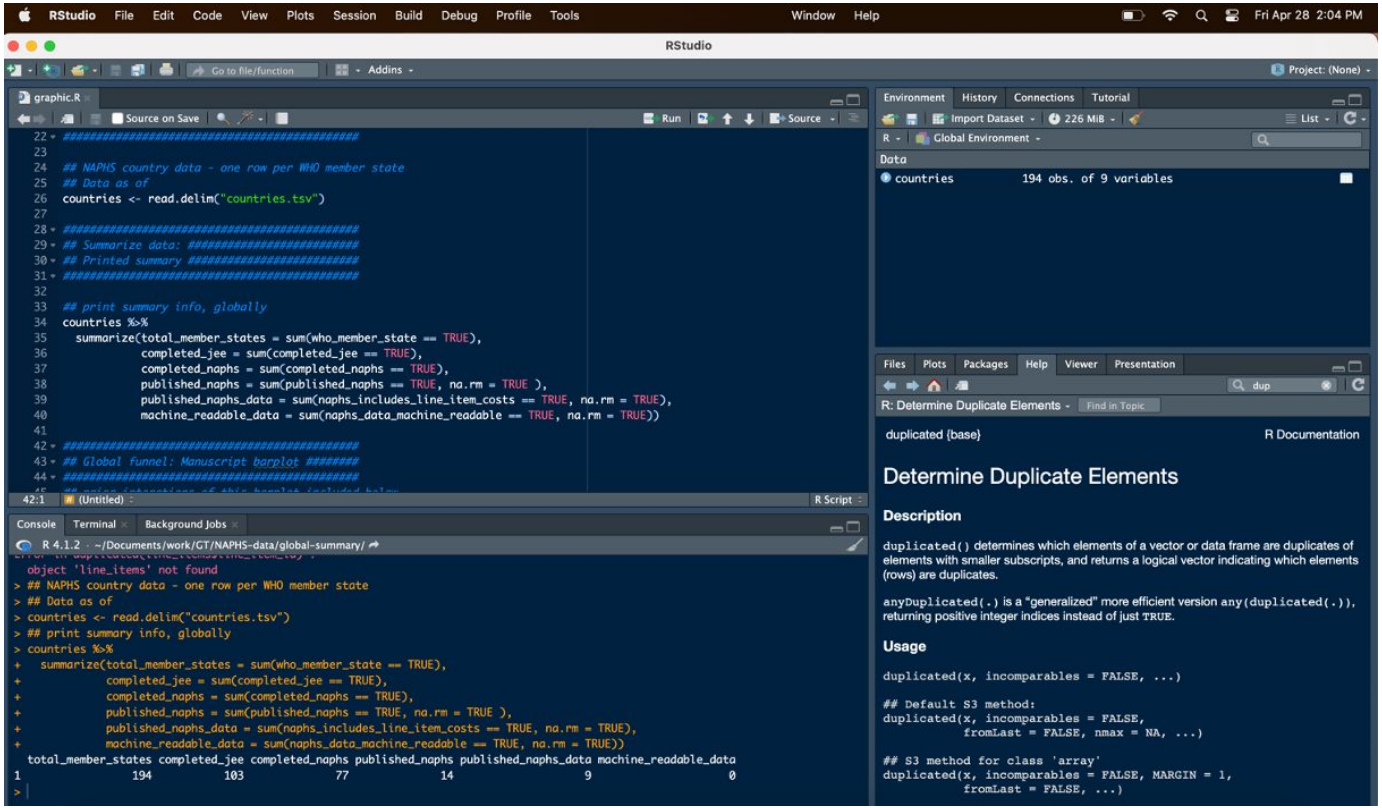


Now you try!

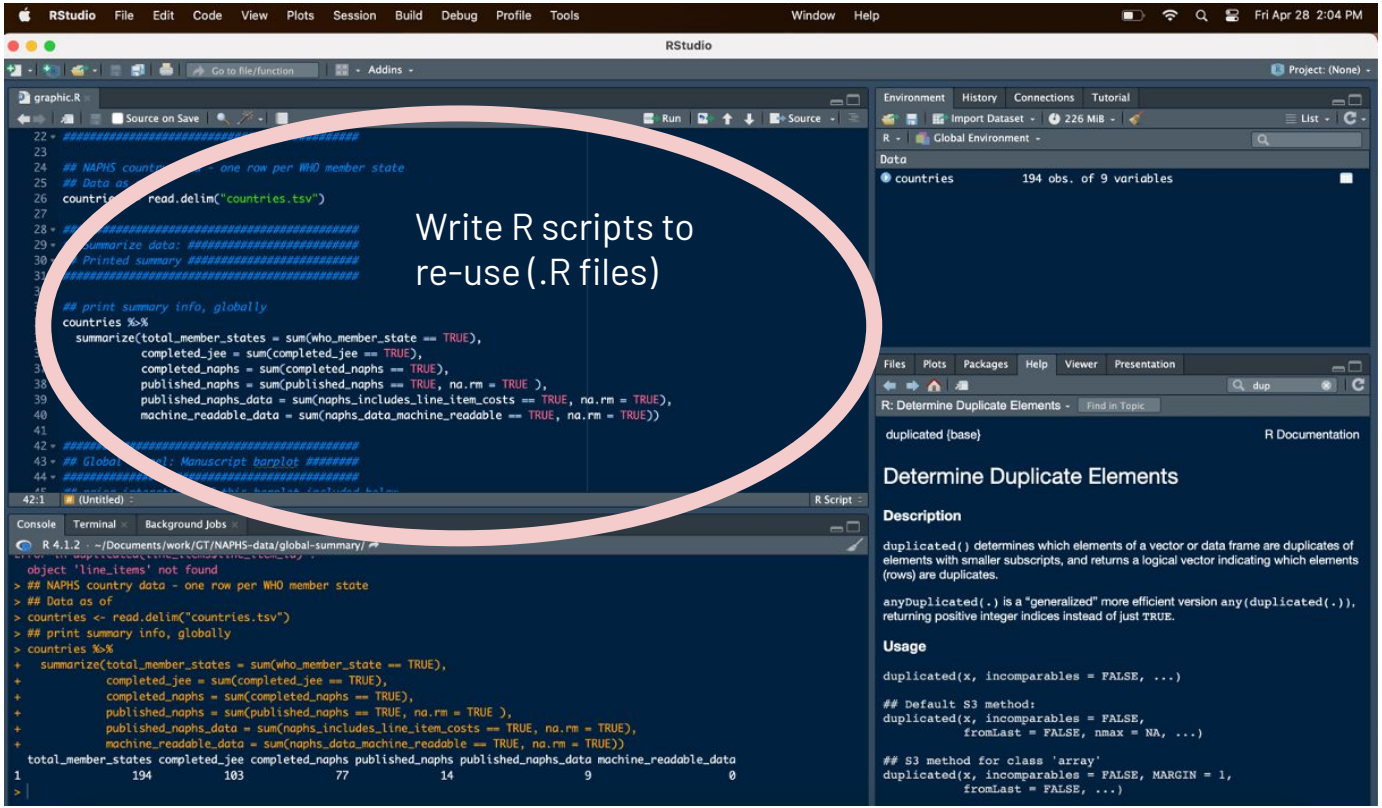
Download R and R Studio.

How do I use RStudio?

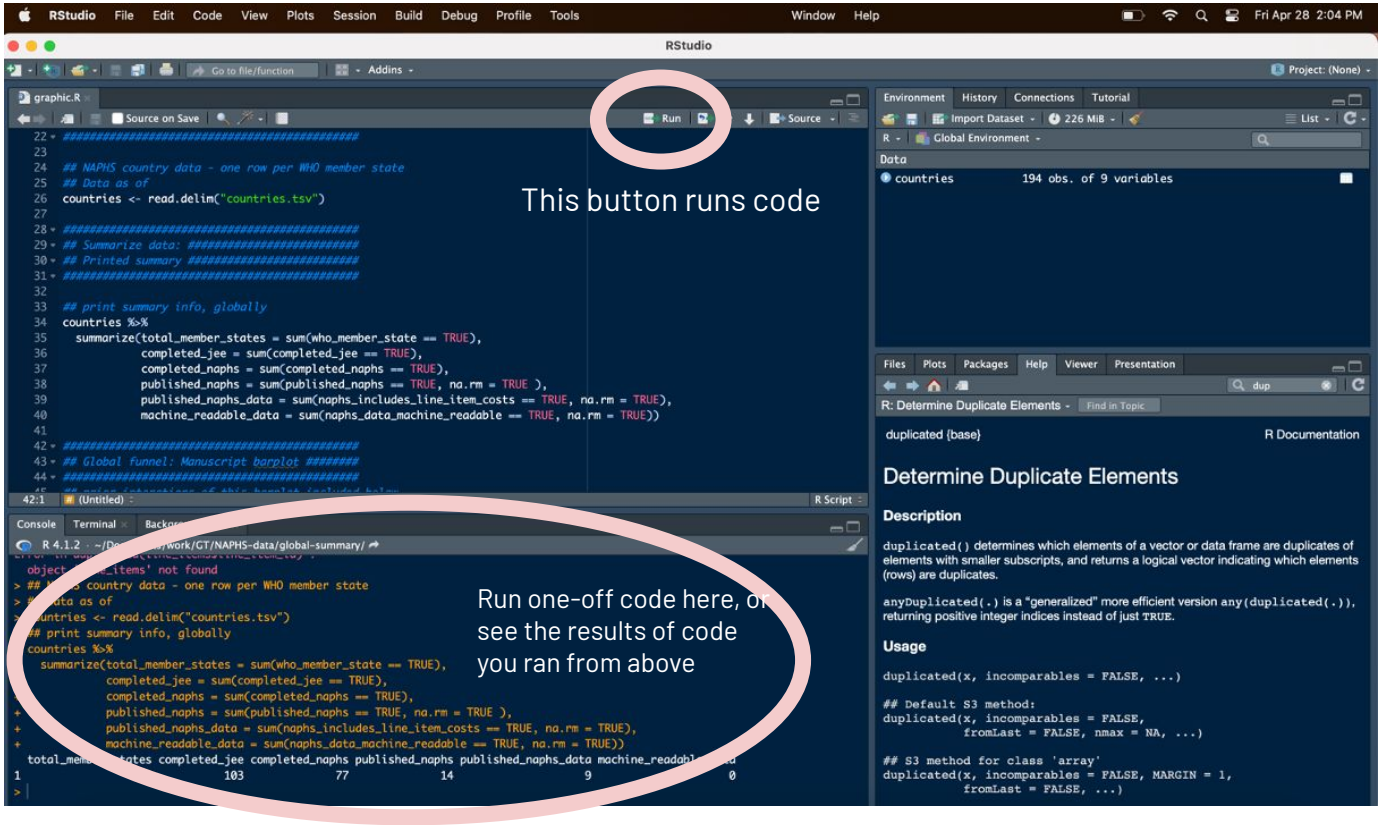
RStudio console



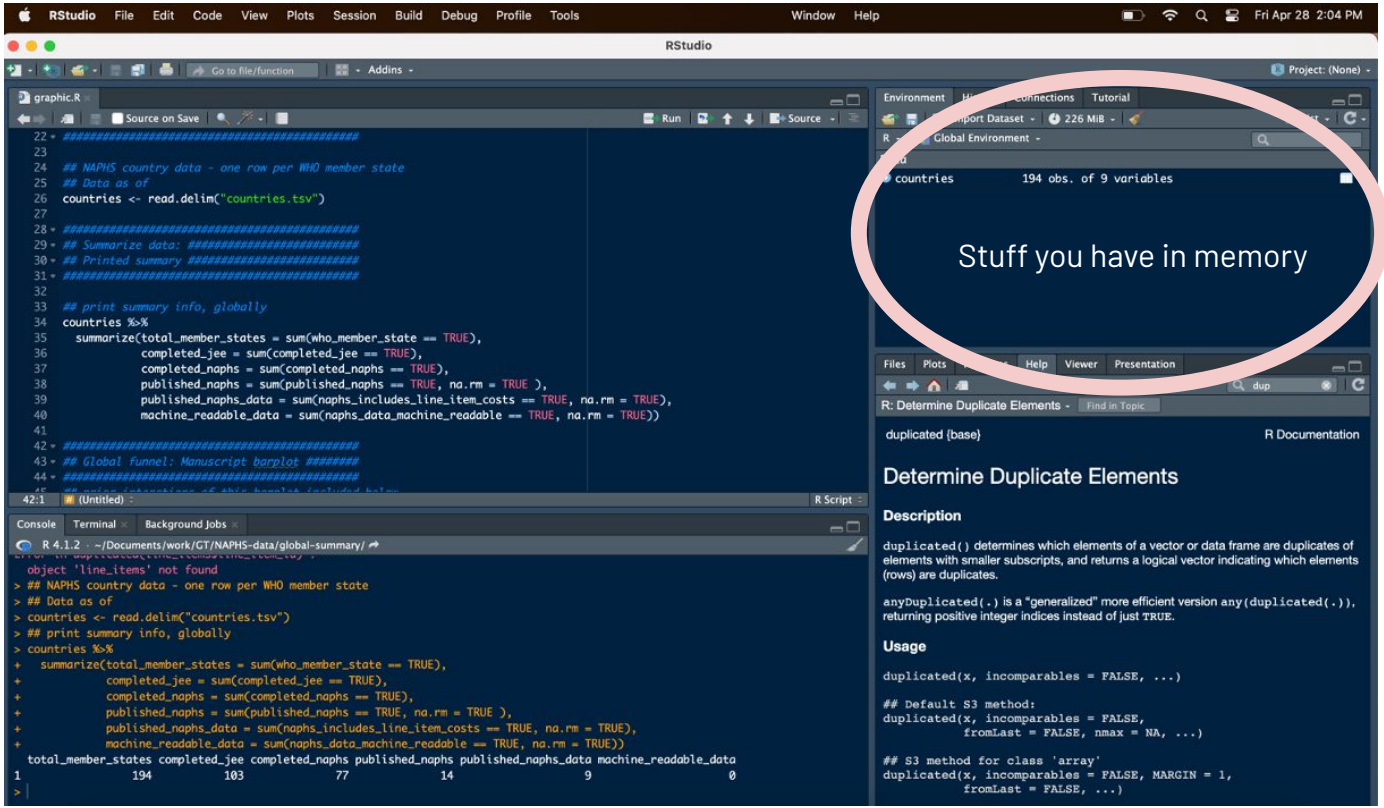
RStudio console



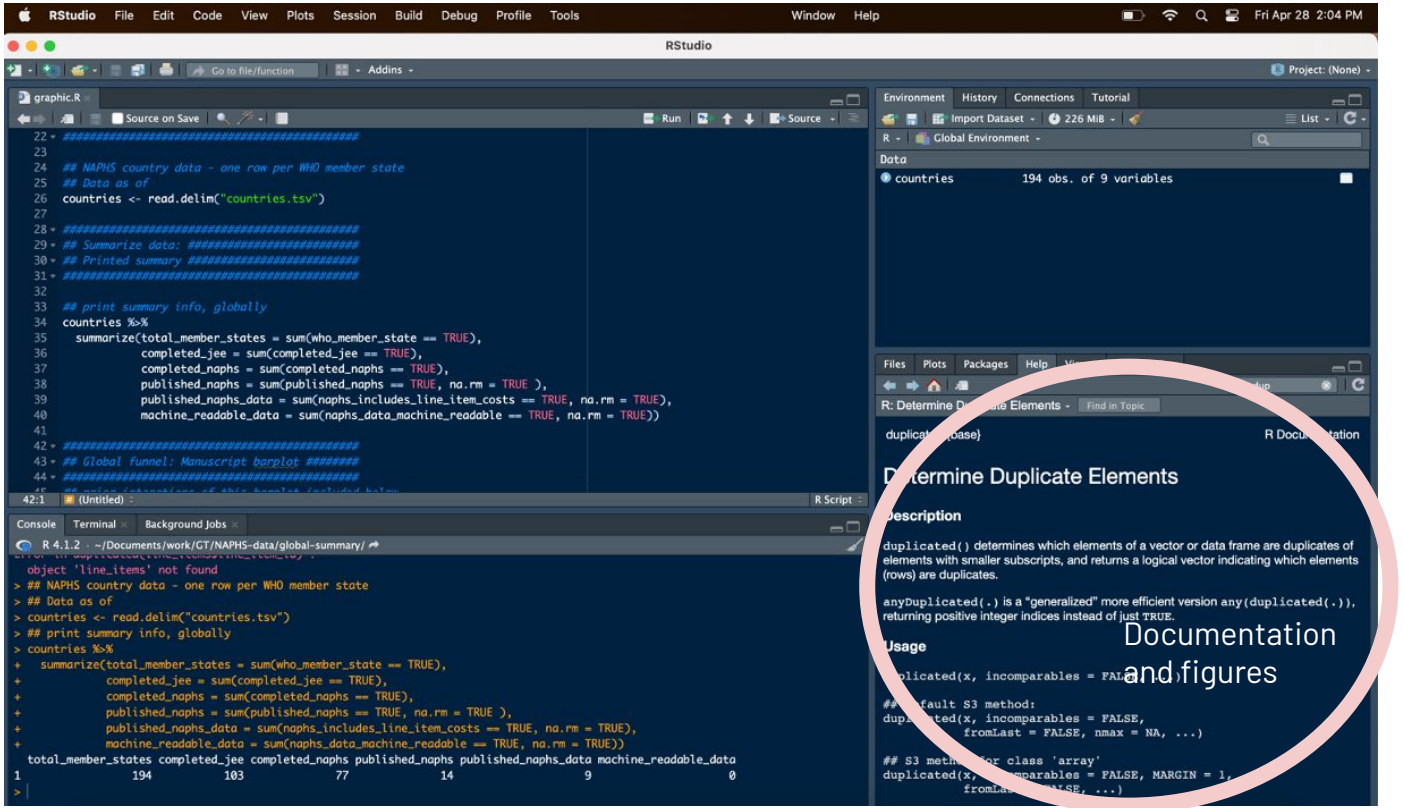
RStudio console



RStudio console



RStudio console



Now you try!

Open RStudio on your computer and click around

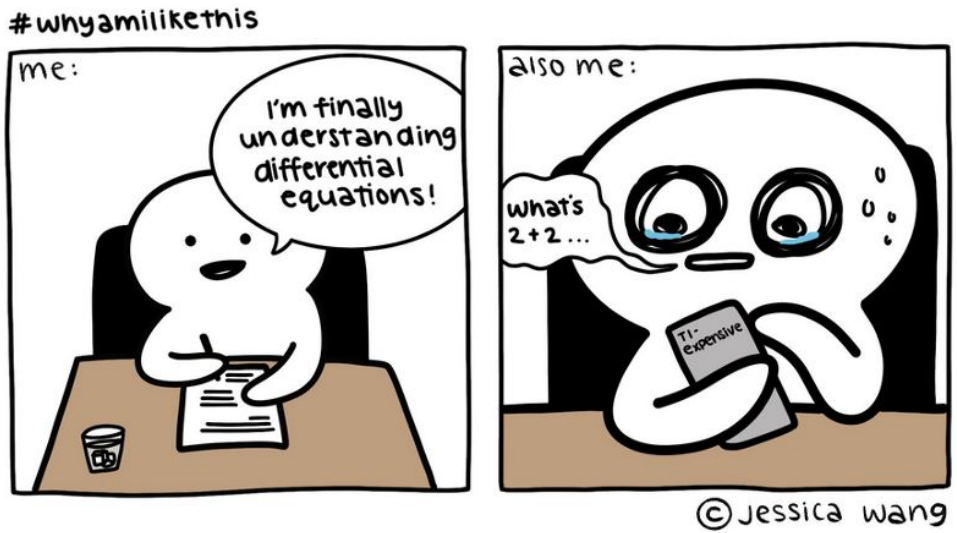
Downloading R
(and a note on worked examples)

- If you had issues downloading materials in today's class, please try to download R and Rstudio before tomorrow's class. I'll be around by email if you have any questions, and can help troubleshoot.
- Today, we'll do some worked examples sharing my laptop. If you already have R and Rstudio installed on your laptop, feel free to follow along there.

R Basics

R as a calculator

- R can do everything a basic calculator can do
- Using R as a calculator is a great first step



Comic by Jessica Wang. Accessed online: https://i.redd.it/dmayt2tc3e551.jpg

Using R as a calculator

```
1+1
```

```
## [1] 2
```

```
10-8
```

```
## [1] 2
```

```
(6-3)*4
```

```
## [1] 12
```

Using R as a calculator

```
abs(-18)
```

```
## [1] 18
```

```
log(1)
```

```
## [1] 0
```

```
log(1)
```

```
## [1] 0
```

Using R as a calculator

Symbols and syntax

- **Addition** (1+1)
- **Subtraction** (2-1)
- **Multiplication** (3*4)
- **Division** (7.2/9)
- **Exponents** (2^7)
- **Logarithms** (log(100))
- **Square root** (sqrt(9))
- **Absolute value** (abs(-10))
- **Order of operations** (7/(3*2))

Now you try!

- Use R to do some basic math
  - Add two numbers together
  - Multiply three or more numbers
  - Take the square root of a number

Objects

- An object is something you save to R's working memory
- It can be almost anything
  - A string (e.g., your name)
  - A number (e.g., 3.14)
  - A dataset (e.g., that file you have in Excel)
- We assign objects using a little arrow with the syntax (<-)
- When doing data analysis, the most common object you'll probably save is a dataframe, like an Excel or .csv file that you can access from within R (more on this later)

Objects

```
my_first_object <- 3
```

```
my_first_object
```

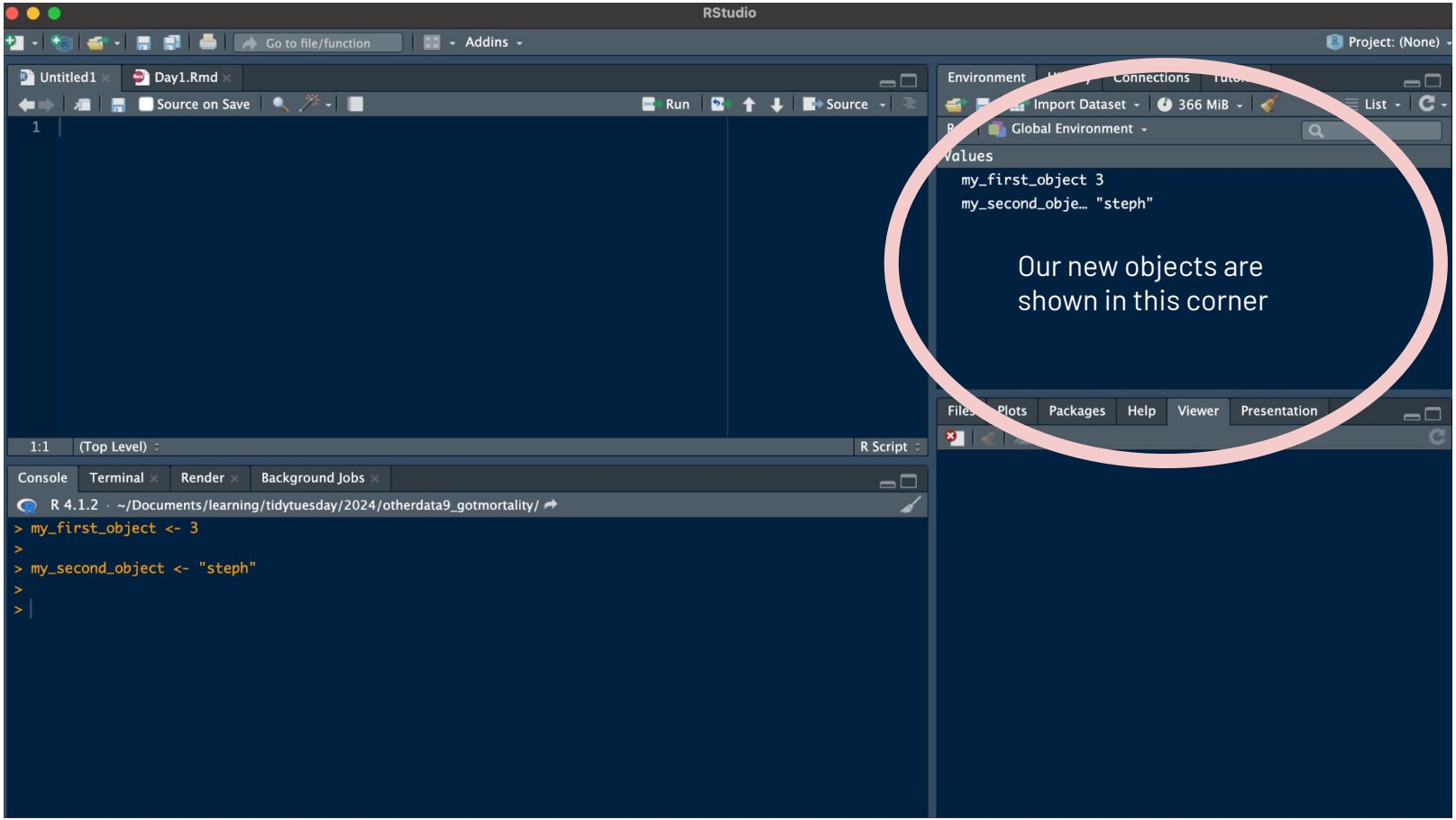
```
## [1] 3
```

```
my_second_object <- "steph"
```

```
my_second_object
```

```
## [1] "steph"
```

Objects


RStudio
Go to file/function
Addins
Project: (None)
Untitled1
Day1.Rmd
Source on Save
Run
Source
1
1:1
(Top Level)
R Script
Console
Terminal
Render
Background Jobs
R 4.1.2 · ~/Documents/learning/tidytuesday/2024/otherdata9_gotmortality/
> my_first_object <- 3
>
> my_second_object <- "steph"
>
>
Environment
Connections
Import Dataset
366 MiB
List
Global Environment
Values
my_first_object 3
my_second_obje… "steph"
Our new objects are shown in this corner
Files
Plots
Packages
Help
Viewer
Presentation

Using (numeric) objects to do math

- Just like we did when we used R as a calculator, you can also use numeric objects to do math
- When you do this, the objects themselves don't change unless you explicitly re-assign them to new variables

Using (numeric) objects to do math

```
my_first_object
```

```
## [1] 3
```

```
my_first_object*2
```

```
## [1] 6
```

```
my_first_object * my_first_object
```

```
## [1] 9
```

Now you try!

- Pick your favorite number, and save it as an object
- Pick another number, and save it as another object
- Do one basic calculation (e.g., addition) with your objects
- You may run into issues. That's okay! We'll talk them through.

Source: XKCD

Data types in R

- **numeric:** a number (e.g., -1, 0, 893243.343)
- **logical:** TRUE or FALSE (no quotations)
- **character:** letters and words (tricky: or a number stored as letter!)
- The function is() helps us figure out what type of data we have

```
is(-1)
```

```
## [1] "numeric" "vector"
```

```
is(TRUE)
```

```
## [1] "logical" "vector"
```

```
is("What is this?")
```

```
## [1] "character"          "vector"             "data.frameRowLabels"
## [4] "SuperClassMethod"
```

Numeric data

```
my_favorite_number <-  3
my_favorite_number
```

```
## [1] 3
```

```
my_house_number <-  1416
my_house_number
```

```
## [1] 1416
```

```
example_result <-  3*4
example_result
```

```
## [1] 12
```

Character data

```
policy <-  "International Health Regulations (2005)"
policy
```

```
## [1] "International Health Regulations (2005)"
```

```
organization <-  "UNAIDS"
organization
```

```
## [1] "UNAIDS"
```

Logical data

```
logical_example <-  TRUE
logical_example
```

```
## [1] TRUE
```

```
second_logical_example <-  FALSE
second_logical_example
```

```
## [1] FALSE
```

Check your understanding!

```
is(5)
```

```

```

```
is(FALSE)
```

```

```

```
is("Georgetown")
```

```

```

Check your understanding!

```
is(5)
```

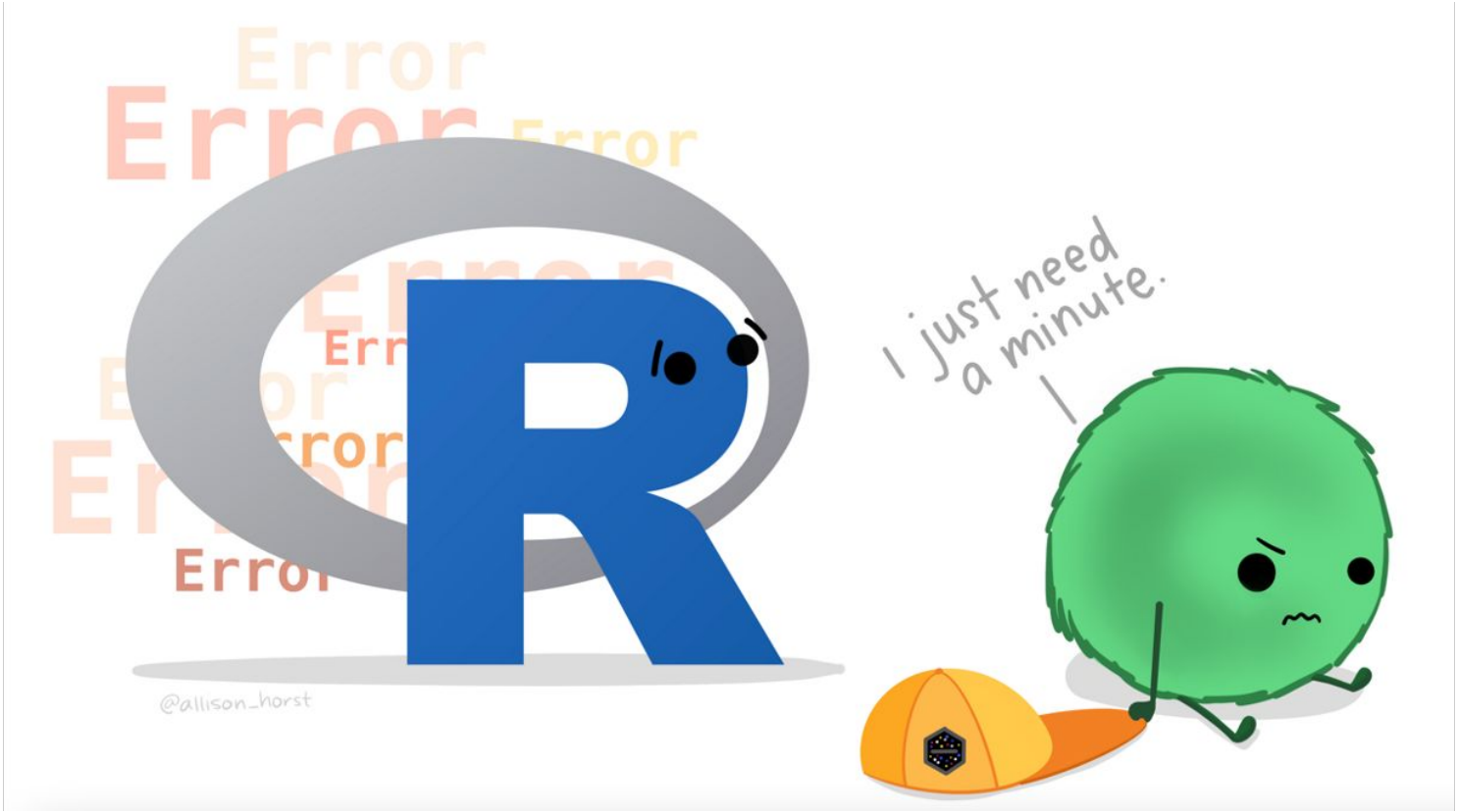
```
## [1] "numeric" "vector"
```

```
is(FALSE)
```

```
## [1] "logical" "vector"
```

```
is("Georgetown")
```

```
## [1] "character"           "vector"              "data.frameRowLabels"
## [4] "SuperClassMethod"
```

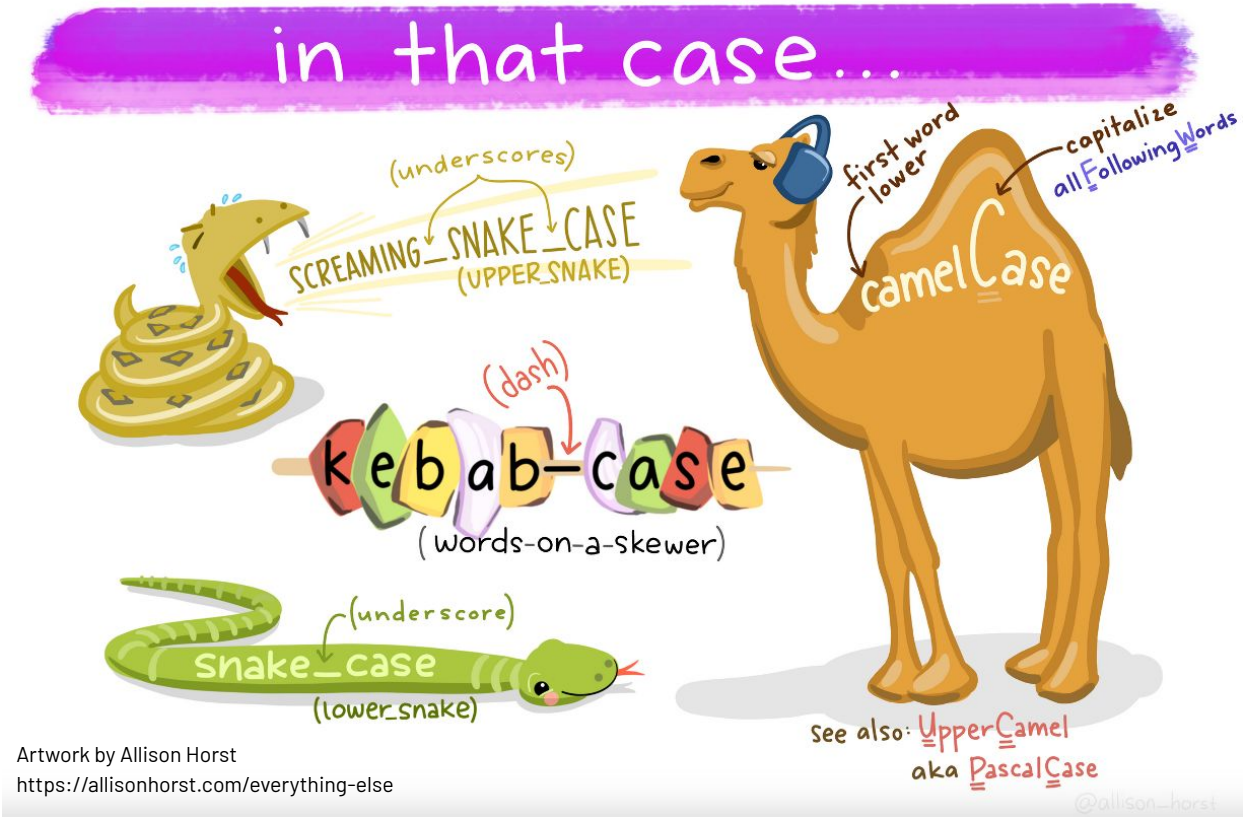


Artwork by Allison Horst
https://allisonhorst.com/everything-else

Rules for naming objects

- General naming requirement: a variable name can’t start with a number or a dot (.)
- R is case sensitive (‘A’ is different than ‘a’)
- General rules of thumb: aim for consistency
    - snake_case
    - camelCase
    - whatever.this.is
- Chose a name you’ll understand when you open your code the next day, or when someone else reviews it

Rules for naming objects



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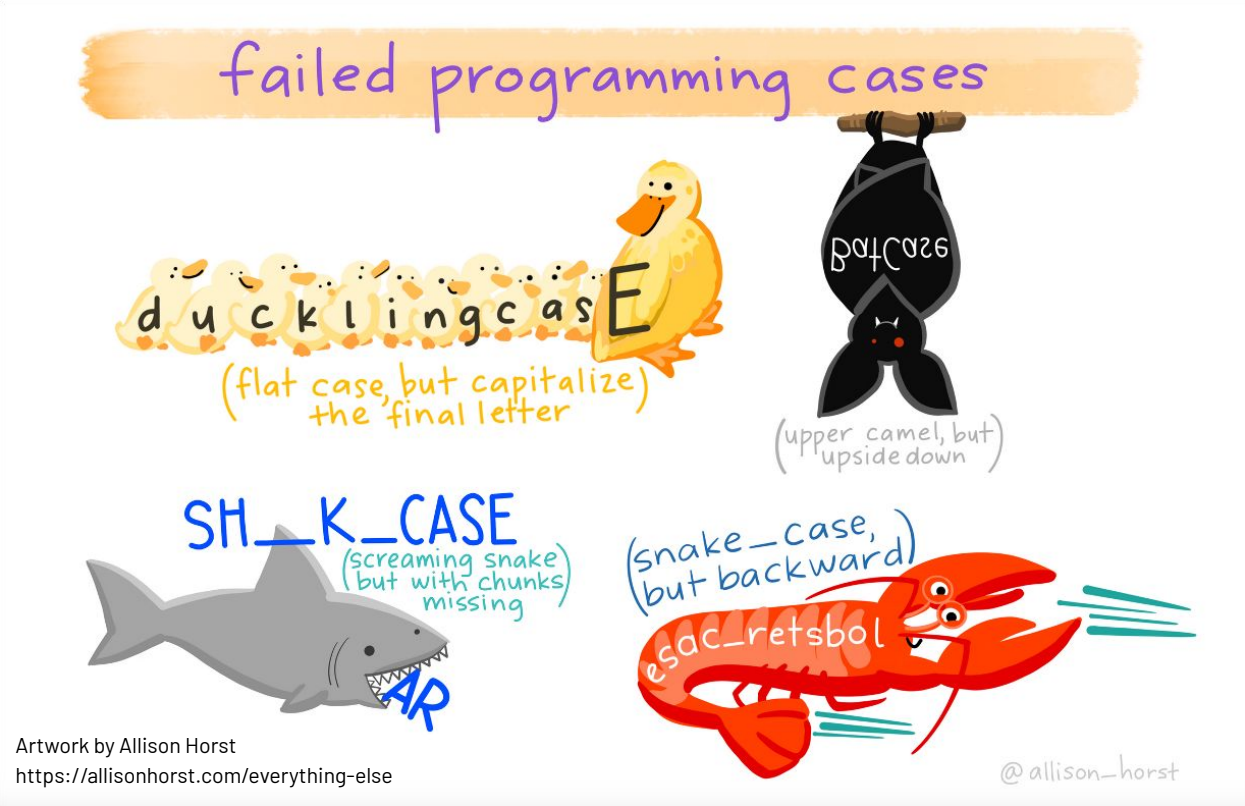
Rules for naming objects



Artwork by Allison Horst
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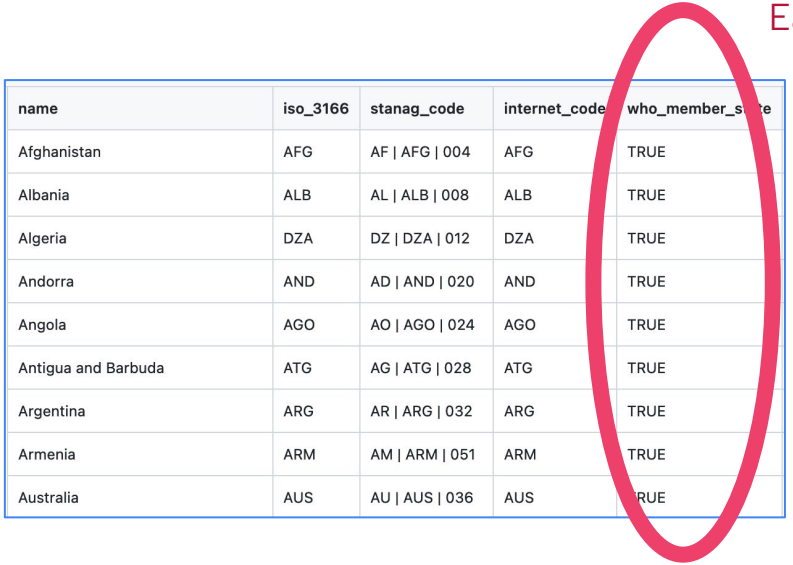
Now you try!

- Create three new objects, with any allowable names you want. Try to use a consistent naming style.
  - Numeric (we already did this, but practice is good)
  - Character
  - Logical

10 minute break

Vectors

- Vectors are grouped data elements in a specific order
- For example, data in a specific column in Excel



name	iso_3166	stanag_code	internet_code	who_member_s[illegible]e
Afghanistan	AFG	AF | AFG | 004	AFG	TRUE
Albania	ALB	AL | ALB | 008	ALB	TRUE
Algeria	DZA	DZ | DZA | 012	DZA	TRUE
Andorra	AND	AD | AND | 020	AND	TRUE
Angola	AGO	AO | AGO | 024	AGO	TRUE
Antigua and Barbuda	ATG	AG | ATG | 028	ATG	TRUE
Argentina	ARG	AR | ARG | 032	ARG	TRUE
Armenia	ARM	AM | ARM | 051	ARM	TRUE
Australia	AUS	AU | AUS | 036	AUS	TRUE

- When you've thought previously about data analysis, you probably think about vectors, even if you didn't use that name

Vectors

```
c("HIV", "TB", "malaria")
```

```
## [1] "HIV"     "TB"      "malaria"
```

```
c(1, 2, 6, 87)
```

```
## [1]  1  2  6 87
```

Vectors

The c() stands for “concatenate”

```
c("HIV", "TB", "malaria")
```

```
## [1] "HIV"     "TB"      "malaria"
```

```
c(1, 2, 6, 87)
```

```
## [1]  1  2  6 87
```

Vectors

```
c("HIV", "TB", "malaria")
```

Vectors can contain strings

```
## [1] "HIV"     "TB"      "malaria"
```

```
c(1, 2, 6, 87)
```

Or numbers

```
## [1]  1  2  6 87
```

Vectors

```
c("HIV", "TB", "malaria")
```

Vectors can contain strings

```
## [1] "HIV"     "TB"      "malaria"
```

```
c(1, 2, 6, 87)
```

Or numbers

```
## [1]  1  2  6 87
```

```
c("CDC", "FDA", 897)
```

... but not both

What happened here?

```
## [1] "CDC" "FDA" "897"
```

Now you try!

- Make two vectors in R and assign them to objects.
  - Numeric
  - String

Vectorized calculations

```
c(1, 2, 3, 4) + 1
```

```
## [1] 2 3 4 5
```

```
c(1, 2, 3, 4) * 2
```

```
## [1] 2 4 6 8
```

```
c(1, 2, 3, 4) + c(5, 6, 7, 8)
```

```
## [1]  6  8 10 12
```

Functions

- Functions are instructions to perform a task
  - They are *algorithms*, or consistent set of rules
- R has built-in functions for many basic things
- Functions generally look like this: *function(object)*
- We can also “add on” extra functions by loading new libraries (we’ll get to this later), or we can write our own functions to do whatever we want

Functions

- Most functions in R are vectorized
  - This means they act on all items in a vector
- Why does this matter?
  - If you misunderstand it, your math will be wrong
  - It's useful for basic calculations and analysis:
    - divide all numbers by 100 to calculate a %
    - multiply per-capita rates by total population

Functions

```
mean(c(1, 2, 3, 4, 5))
```

```
## [1] 3
```

```
sd(c(1, 2, 3, 4, 5))
```

```
## [1] 1.581139
```

```
summary(c(1, 2, 3, 4, 5))
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       1       2       3       3       4       5
```

Functions

```
mean(c(1, 2, 3, 4, 5))
```

```
## [1] 3
```

```
sd(c(1, 2, 3, 4, 5))
```

```
## [1] 1.581139
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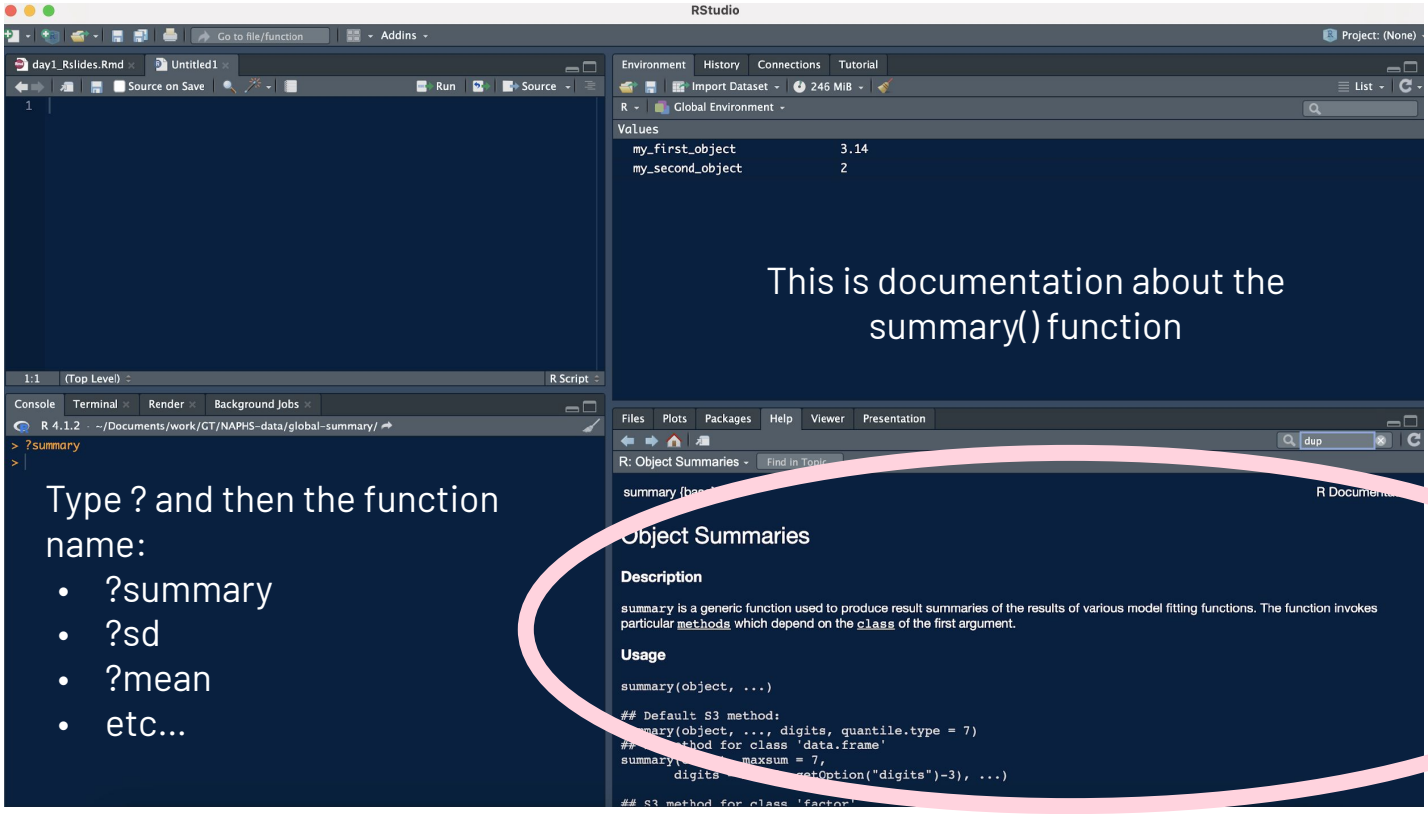
```
summary(c(1, 2, 3, 4, 5))
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       1       2       3       3       4       5
```

Learn more about functions

?function or help(function)



Now you try!

- Take the average of three or more numbers
- Use “?” to learn more about the function sd()

What is github?

What is github?

- Have you ever saved a bunch of versions of a paper on your computer with different file names at different dates or times of day?
- Backups are useful to save progress, understand what we've done before, and look into problems/bugs
- Github is a tool do help do this with code

What is github?

We'll talk more about github later in this workshop. For now, I'd like you to be able to use it to access course materials any time you'd like to.

https://github.com/seaneff/data-science-basics-2024

seaneff add mcv1 data — 9e8e441 · 2 weeks ago — 21 Commits

course-datasets	add mcv1 data	2 weeks ago
day1	add new dataset on measles vaccine coverage	2 weeks ago
day2	add information on organizing github repos	2 weeks ago
day3	add new dataset on measles vaccine coverage	2 weeks ago
extras	add mcv1 data	2 weeks ago
.gitignore	figuring out how to host slides	6 months ago
README.md	reorganize files	last month

README

Data Science Basics in R Workshop

This workshop will build literacy and basic proficiency in statistical programming, with a focus on the skills needed to conduct data analyses in professional healthcare and public health workspaces. We will cover the basics of data management, data cleaning, data visualization, and basic statistical calculations in R, and version control in github. Participants will leave with a small portfolio of relevant data visualizations and analyses completed using a real-world public health dataset.

This workshop is part of the 2024 Georgetown University Health Diplomacy Training Initiative led by the Center for Health Science and Security.

No prior programming experience is necessary for this course, though to follow along with course materials, participants will require access to a fully charged laptop or computer. There are no required course materials or textbooks, though we will work together through select materials from the online Intro to R book developed by Alex Douglas, Deon Roos, Francesca Mancini, Ana Couto and David Lusseau.

If you have questions, feel free to reach out at sde31@georgetown.edu.

About

In progress materials for the data science basics course in 2024

Readme
Activity
0 stars
1 watching
0 forks

Releases

No releases published
Create a new release

Packages

No packages published
Publish your first package

Languages

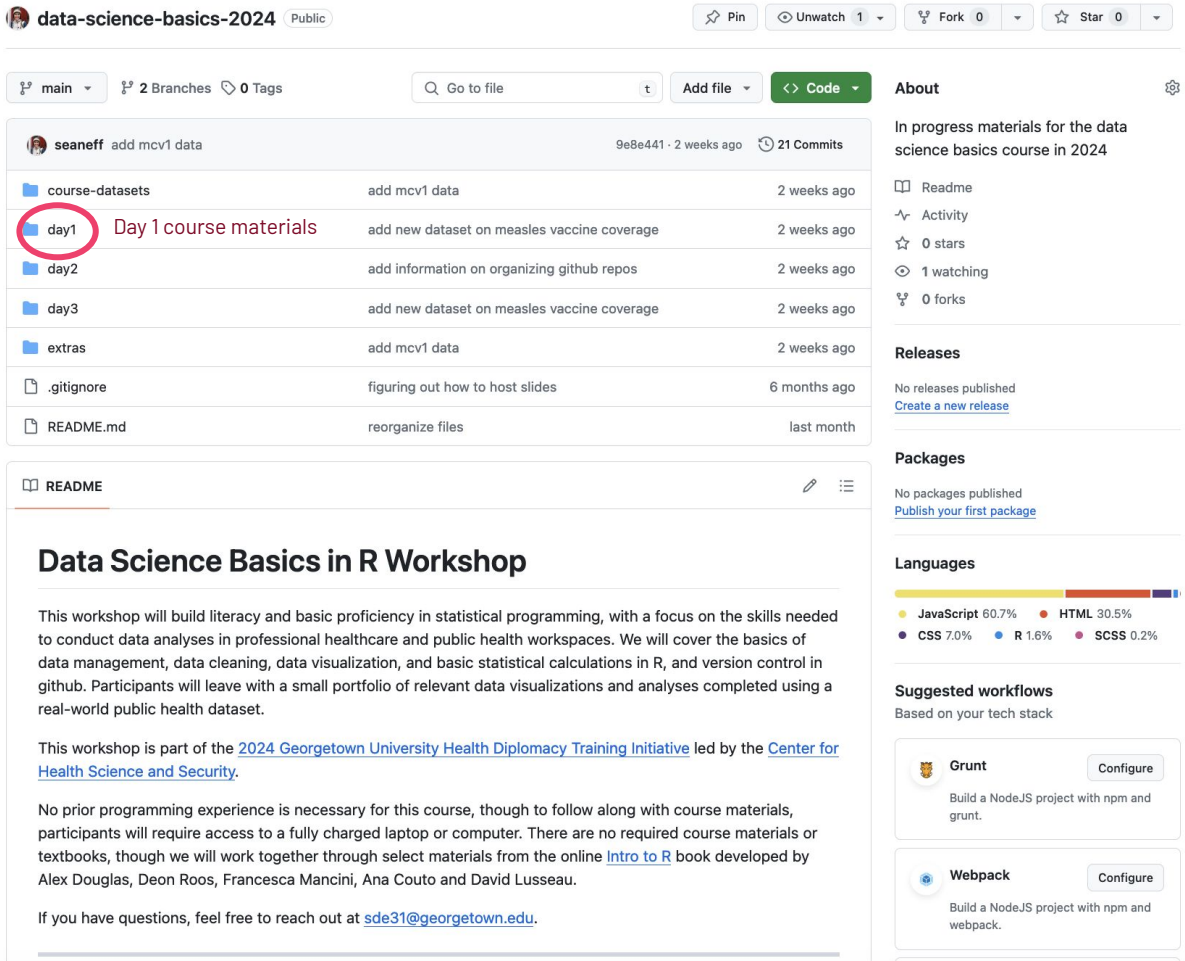
JavaScript 60.7% HTML 30.5% CSS 7.0% R 1.6% SCSS 0.2%

Suggested workflows

Based on your tech stack

Grunt Configure
Build a NodeJS project with npm and grunt.

Webpack Configure
Build a NodeJS project with npm and webpack.


data-science-basics-2024
Public
Pin
Unwatch 1
Fork 0
Star 0
main
2 Branches
0 Tags
Go to file
t
Add file
Code
seaneff add mcv1 data
9e8e441 · 2 weeks ago
21 Commits
course-datasets
add mcv1 data
2 weeks ago
day1
Day 1 course materials
add new dataset on measles vaccine coverage
2 weeks ago
day2
add information on organizing github repos
2 weeks ago
day3
add new dataset on measles vaccine coverage
2 weeks ago
extras
add mcv1 data
2 weeks ago
.gitignore
figuring out how to host slides
6 months ago
README.md
reorganize files
last month
README
Data Science Basics in R Workshop
This workshop will build literacy and basic proficiency in statistical programming, with a focus on the skills needed to conduct data analyses in professional healthcare and public health workspaces. We will cover the basics of data management, data cleaning, data visualization, and basic statistical calculations in R, and version control in github. Participants will leave with a small portfolio of relevant data visualizations and analyses completed using a real-world public health dataset.
This workshop is part of the 2024 Georgetown University Health Diplomacy Training Initiative led by the Center for Health Science and Security.
No prior programming experience is necessary for this course, though to follow along with course materials, participants will require access to a fully charged laptop or computer. There are no required course materials or textbooks, though we will work together through select materials from the online Intro to R book developed by Alex Douglas, Deon Roos, Francesca Mancini, Ana Couto and David Lusseau.
If you have questions, feel free to reach out at sde31@georgetown.edu.
About
In progress materials for the data science basics course in 2024
Readme
Activity
0 stars
1 watching
0 forks
Releases
No releases published
Create a new release
Packages
No packages published
Publish your first package
Languages
JavaScript 60.7%
HTML 30.5%
CSS 7.0%
R 1.6%
SCSS 0.2%
Suggested workflows
Based on your tech stack
Grunt
Configure
Build a NodeJS project with npm and grunt.
Webpack
Configure
Build a NodeJS project with npm and webpack.

Now you try!

Open the course github and click around for a few minutes

https://github.com/seaneff/data-science-basics-2024

Github, poetry, and unicorns

A brief adventure on youtube

https://www.youtube.com/watch?v=BCQHnInPusY

Github organization

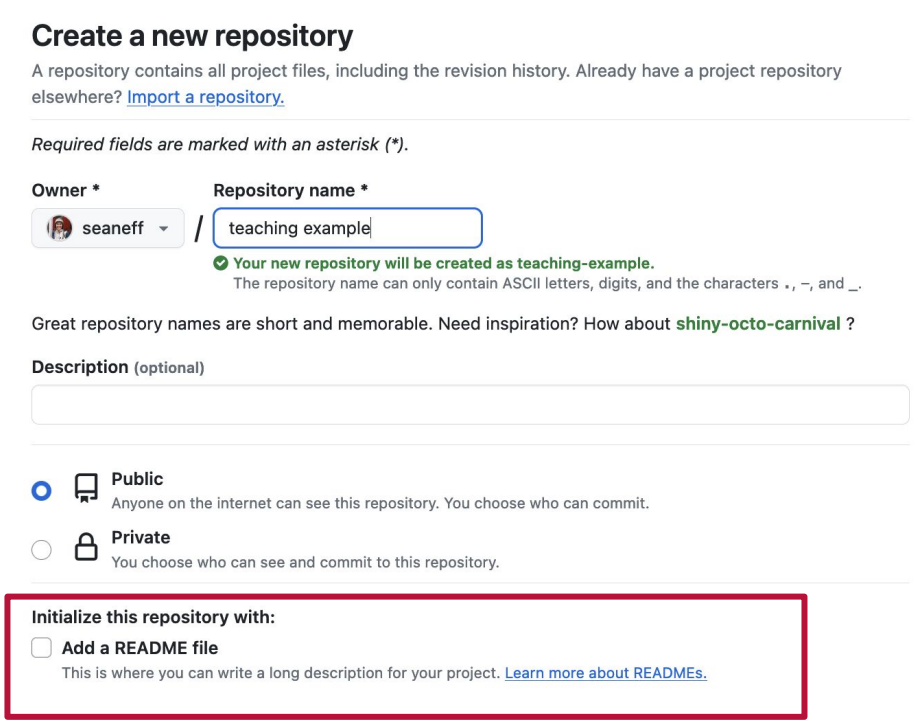
README files

- README files make it easier for your collaborators to find and understand work within your github repository
- In general, readme files should contain:
  - What the project/code does
  - Why the project/code is useful
  - Where people can get help or find more info

Read more on github

Github organization

creating a README file

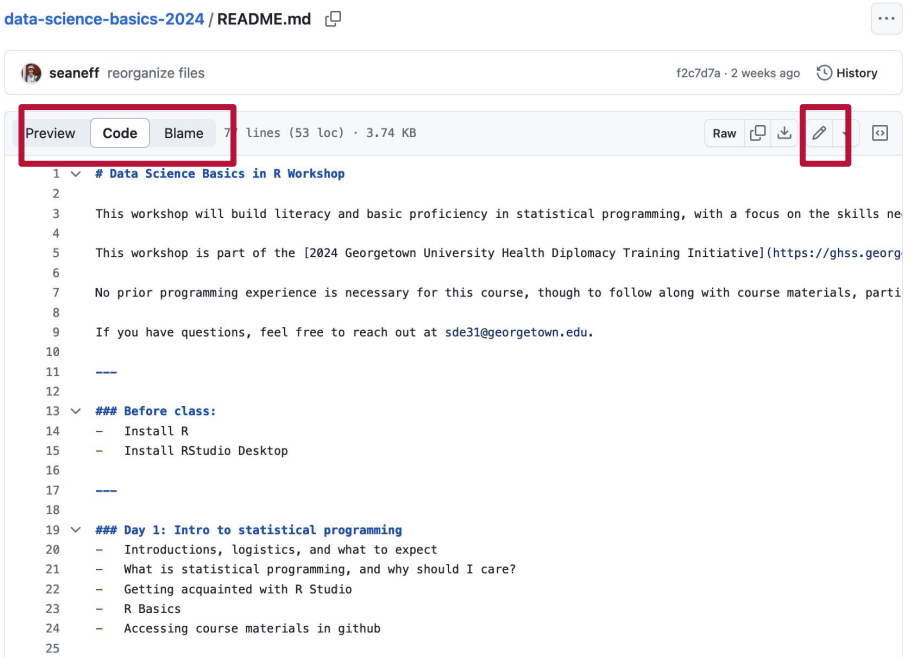


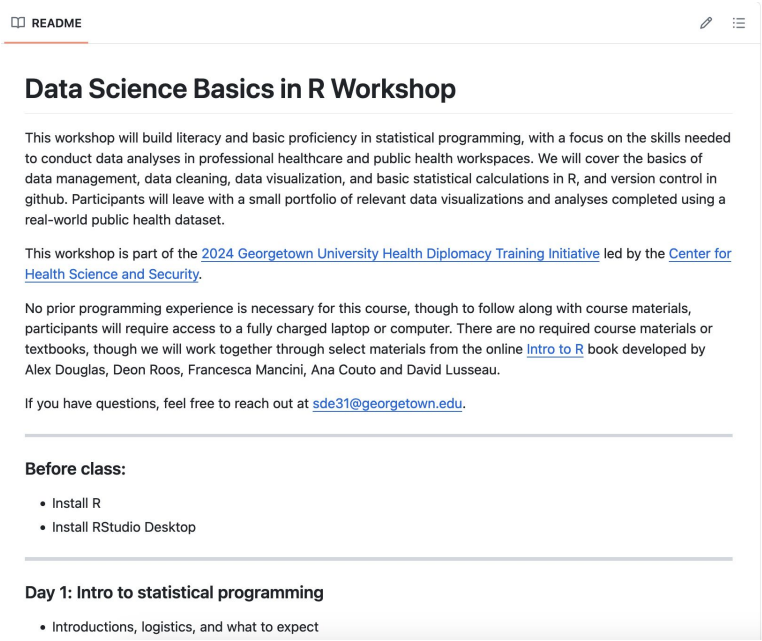
- When you create a new github repository, you can click a box to add a README file
- If you forget to do this, you can always simply add a new file to your repo and title it README.md, github will recognize this

Read more on github

Github organization

Editing a README file





Course readme file
Main course github page

Github organization

Organizing files in github

- There are lots of different ways to organize files in github, and there's no one *best* solution. You should think about who is using the repo, and how, when you decide how to structure it.
- One common approach is to use different folders within one repo:
  - **data/** for datasets that open/sharable and small enough for git
  - **code/** for your analysis code, which may be split up further
  - **results/** for key outputs
  - **figures/** for figures, especially if you're publishing

Your turn!

Create a github account at https://github.com/

OPTIONAL homework

choose your own dataset

- Tomorrow, we will begin using worked examples with **real data**
- The materials I have prepared focus on measles and vaccine policy
- If you have other datasets you know you want to explore, let me know!
  - We'll still focus primarily on the measles dataset as a class
  - There is also room to explore other areas! Last year students explored sanctions, extinction-risk, and public safety datasets
- Please email me before tomorrow's class if there is a dataset you are interested in (limit 1 per person), and I will do my best to work it in! **sde31@georgetown.edu**

OPTIONAL homework

choose your own dataset: options to explore

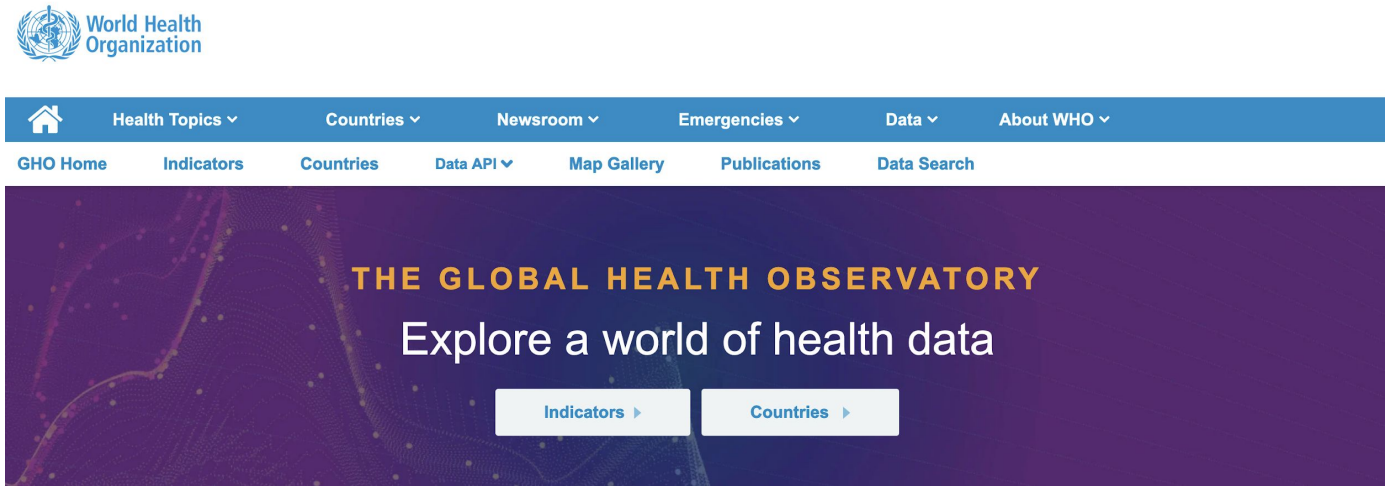
- TidyTuesday: https://github.com/rfordatascience/tidytuesday
- Security Studies: https://guides.library.georgetown.edu/Security/data
- Spotify: www.kaggle.com/datasets/iamsumat/spotify-top-2000s-mega-dataset

The world is your oyster. Datasets don't need to be related to your major, they can also be other things you find interesting or fun!

Explore some useful sources of health diplomacy data

WHO Global Health Observatory

https://www.who.int/data/gho

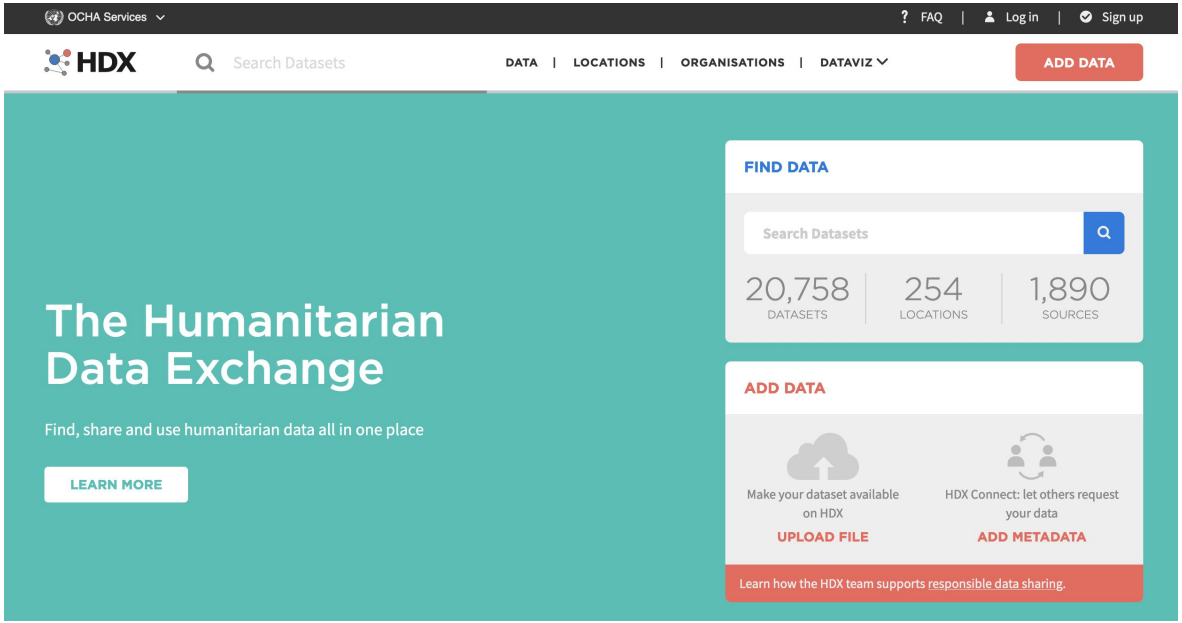


OECD Health Data Repository

https://data.oecd.org/health.htm

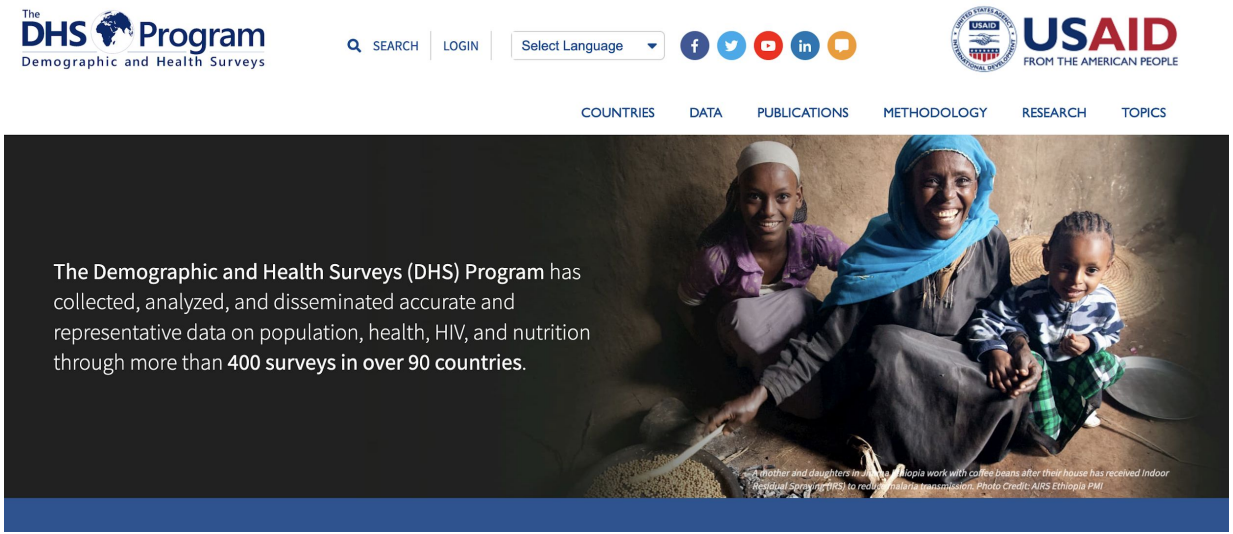
OCHA Humanitarian Data Exchange

https://data.humdata.org/



Demographic and Health Surveys

https://dhsprogram.com/

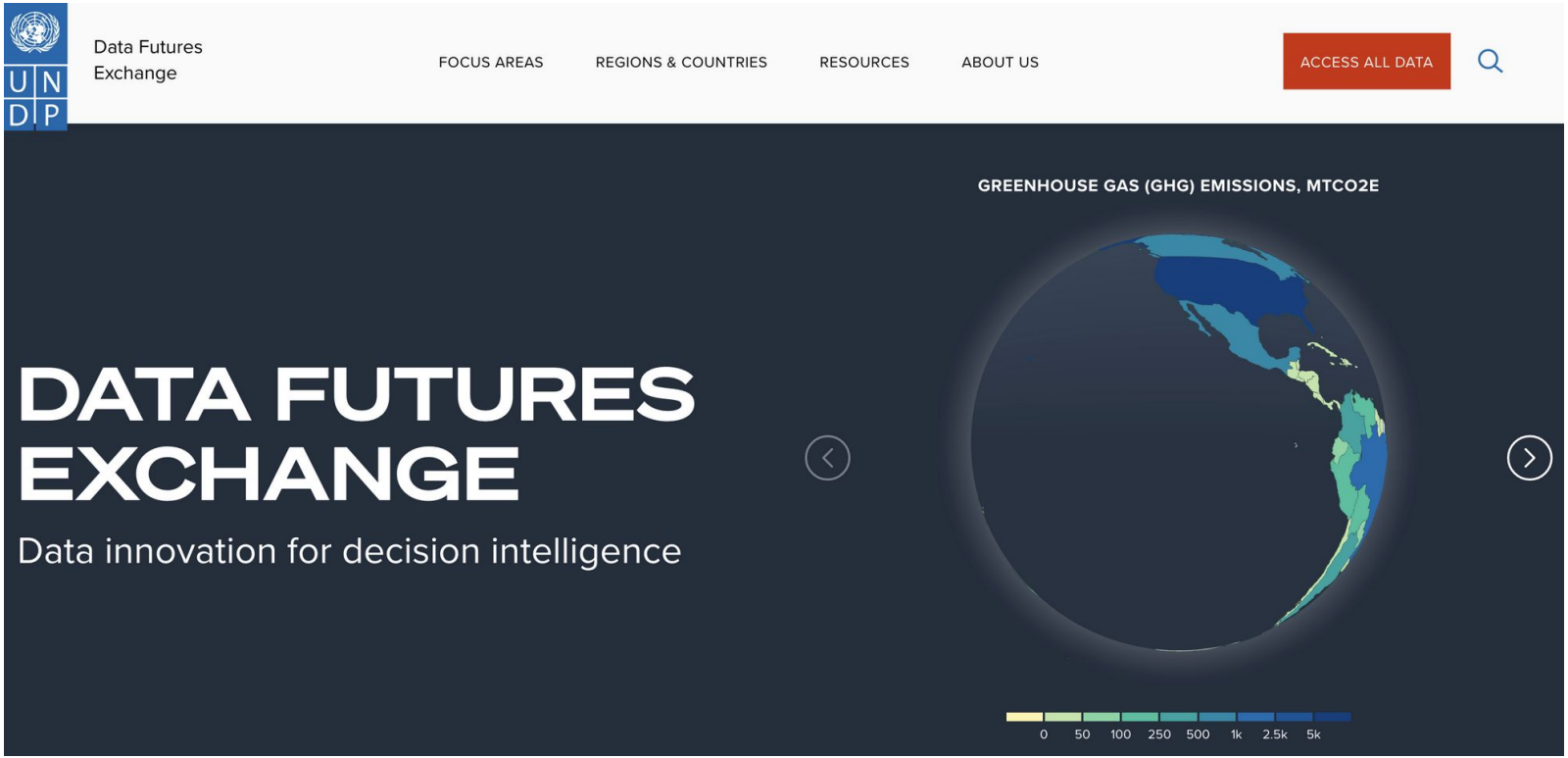


UN SDG Global Database

https://unstats.un.org/sdgs/dataportal

UNDP Data Futures Platform

data.undp.org



IPUMS

www.idhsdata.org/idhs/index.shtml

IDEA

https://ghssidea.org/

Recap for today

What we talked about

- Understand what statistical programming is
- Get acquainted with Rstudio
- Write your very first R code (at least, of this workshop)
  - vectors
  - functions
  - accessing documentation
- Get familiar with Github (by writing poems about rainbows)

Plan for tomorrow

Data management and version control

- Understand the foundations of data management
- Load and clean your first dataset in R
  - explore a new dataset while learning about data structures
  - practice generating summary tables
- Learn best practices for documentation

Thank you!

See you tomorrow.

Please come with a fully charged laptop.