Data Science Basics in R

Day 2: Data management and version control

Goals for today

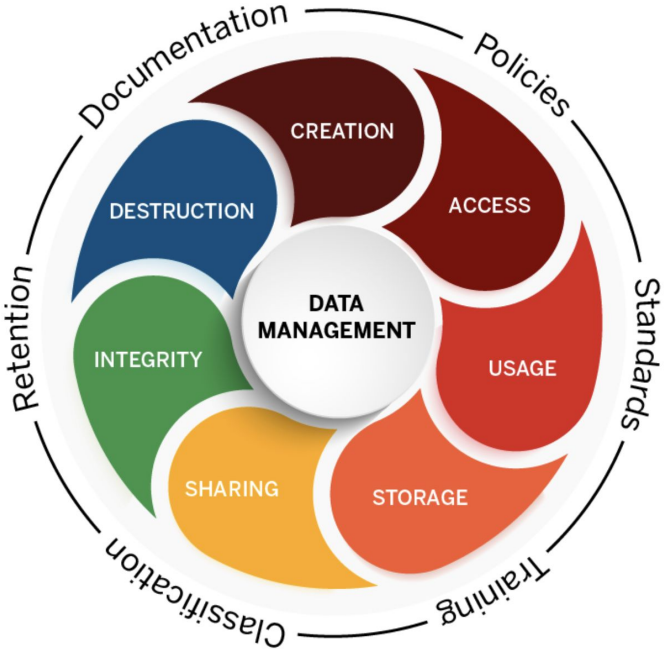
- Understand the foundations of data management
- Learn best practices for documentation
- Load and clean your first dataset in R
    - learn about data structures
    - filter data to excluding missing values
    - explore a new dataset with summary statistics and plots
- Upload your code to GitHub

What is data management?

Data management

Data management is the practice of creating, maintaining, documenting, and securing data.

It includes data cleaning, among many other tasks.



Graphic from https://datamanagement.iu.edu/

Data access

- Where do your data “live”?
  - How can you access them?
  - Who else can access them?
  - For how long will they be available?
- What format are they in?
- Where is the documentation?
- How, and with whom, can you share data, code, and/or results?
- Identifying other discrepancies…

Data management

Data cleaning tasks depending on what types of data you're working with and where you got them!

- Identifying and addressing missing values
- Fixing "weird" characters
- Combining multiple datasets
- Deduplicating lists
- Identifying other discrepancies...

Real-life examples
data entry and coding

Original research

BMJ Global Health

Global approaches to tackling antimicrobial resistance: a comprehensive analysis of water, sanitation and hygiene policies

Ciara M Weets, Rebecca Katz

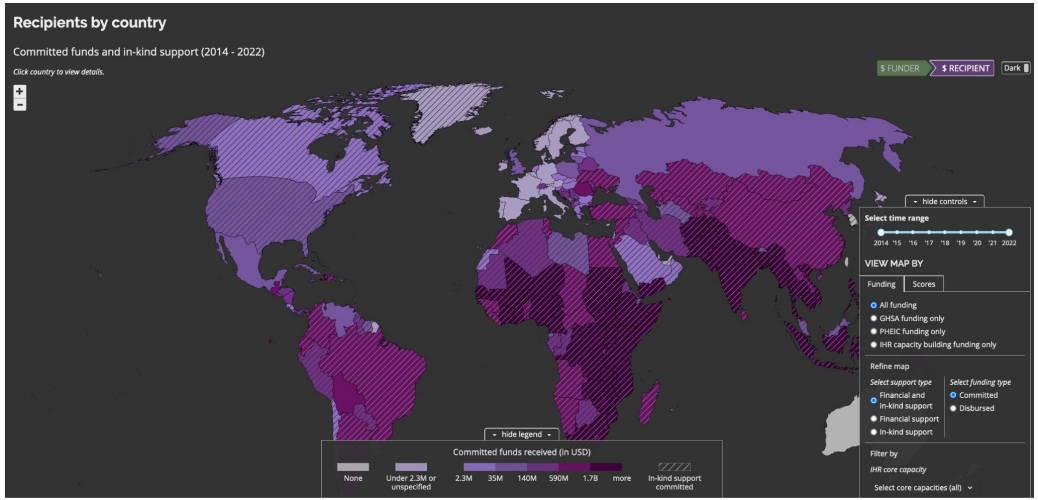
	A	B	C	D	E	F	G	H
1	Country	Topic	Status justification	Color	Level	Government	Voting	Subtopic
2	Argentina	Sewerage	There is policy that requires a competent agency within the government to regulate sewerage systems for the consumption of human waste, however, in Argentina, sanitation services are regulated at the provincial level.	Option 1	Subnational	Federal	Presidential	Sewerage
3	Australia	Water quality standards	There is policy that mandates a competent environmental agency within the governing body to control and set standards for water quality, including drinking-water quality, environmental water quality, and/or recreational water quality. This happens at the provincial level, rather than the national level in Australia.	Option 1	Subnational	Federal	Parliamentary	Water Quality Standards
4	Australia	Water quality monitoring	There is policy that grants a competent environmental agency within the governing body with a mandate to monitor residues in water sources to prevent contamination that could cover contamination with antimicrobials. This happens at the provincial level, rather than the national level in Australia.	Option 1	Subnational	Federal	Parliamentary	Water Quality Monitoring
5	Australia	Pollutant disposal in water sources	There is policy that mandates a competent environmental agency within the governing body to regulate the disposal of pollutants in freshwater sources. This happens at the provincial level, rather than the national level in Australia.	Option 1	Subnational	Federal	Parliamentary	Effluent Wastewater Disposal
6	Australia	Effluent wastewater disposal	There is policy that mandates a competent environmental agency within the governing body to regulate the disposal of effluent wastewater, however, in Australia, this regulation takes place at the subnational level.	Option 1	Subnational	Federal	Parliamentary	Pollutant Disposal in water sources
7	Australia	Sewerage	There is policy that requires a competent agency within the government to regulate sewerage systems for the consumption of human waste, however, in Australia, sanitation services are regulated at the provincial level.	Option 1	Subnational	Federal	Parliamentary	Medical Waste Disposal
8	Australia	Medical waste disposal	There is policy that requires the government to regulate the disposal of medical waste from healthcare facilities, however, in Australia, this regulation takes place at the subnational level.	Option 1	Subnational	Federal	Parliamentary	Total
			There is policy that requires a competent agency within the government to					

Weets CM, Katz R. Global approaches to tackling antimicrobial resistance: a comprehensive analysis of water, sanitation and hygiene policies. BMJ Global Health. 2024 Feb 1;9(2):e013855.

Real-life examples
data aggregation

GLOBAL HEALTH SECURITY TRACKING

Data source	Description
BWC Working Papers	Occasionally, Member States of the BWC submit national papers describing capacity building efforts for health security. Data relevant from these papers are included in GHS Tracking.
CEPI Progress Reports	The Coalition for Epidemic Preparedness Innovations (CEPI) is a partnership created in 2017 to bring together global stakeholders to develop vaccines with the goal of stopping future pandemics. During the COVID-19 pandemic that began in 2019, it operated as a facilitator in the COVAX Marketplace. CEPI announces funding calls for vaccine candidate development and coordinates partnerships to develop specific vaccines as needed. CEPI releases annual progress reports that include actual and planned donor funding amounts by year. More information about CEPI is available at https://cepi.net/.
Ebola Recovery Tracking Initiative	The Ebola Recovery Tracking Initiative tracks official development assistance towards Ebola recovery efforts in Guinea, Liberia, Sierra Leone, and the Mano River Union. The initiative is a partnership between the governments of Guinea, Liberia and Sierra Leone, the United Nations Office of the Secretary-General's Special Adviser on Community Based Medicine and Lessons from Haiti, and the United Nations Development Programme (UNDP). The Ebola Recovery Tracking Initiative is available online at: https://ebolarecovery.org/.



tracking.GHScosting.org

Real-life examples
reformatting & cleaning

patientslikeme

The Patient Voice Includes Emojis:
A case study in the use of probabilistic topic modeling to characterize patient conversations in an online community of PTSD patients

Eaneff, S

Methods

- Approximately 54% of PLM patients contribute free-text to the platform through user bios, forum conversations, or as annotations associated with structured data.
- Posts contributed by PTSD patients were pre-processed to remove HTML and stopwords, and to map emojis to text-based descriptions.
- Latent Dirichlet allocation (LDA), a form of probabilistic topic modeling, was performed to identify topics discussed among patients.
- Model parameters were selected on the basis of perplexity as measured on a 10% holdout group.

Fig 3A. "Sleep" Topic

Top 3 emojis

Sample post*

"Nightmares kicked my ass last night. Got woken up by a nightmare and stayed up for a long time feeling really freaked out."

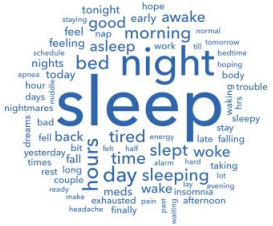
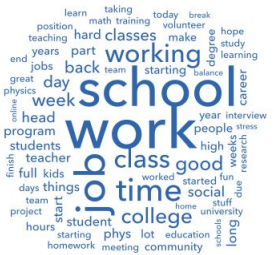


Fig 3B. "School/Work" Topic

Top 3 emojis

Sample post*

"This semester, I'm taking four classes for the first time in a long time. I've quit my factory job, which was too physically demanding, and decided to focus on finishing school."



https://patientslikeme_posters.s3.amazonaws.com/2017_The%20Patient%20Voice%20Includes%20Emojis%20A%20Case%20Study.pdf

Documenting your data, code, and results

Documentation

- Throughout your analysis, documentation might be the single most important, and also the single most under-appreciated step of the process.
- Documentation is helpful for :
  - **current you:** writing out simple, clear, documentation helps you think clearly
  - **future you:** you'll inevitably forget *why* you did certain things, even if you can see your old code
  - **others:** hopefully other people will also use your work, and they need to know about it

Documentation

Different materials, and different types of analysis benefit from different types of documentation.

- **Datasets:** Data dictionaries, rules to generate datasets
- **Code:** Comments in code, README files
- **Analysis/Results:** Methods documentation, in a word document, a google document, or in github

Documenting datasets:
Data dictionaries

The most common way to document a dataset is a data dictionary. At a minimum, data dictionaries:

- Define the columns ("fields") of a dataset
- Specify what a row corresponds to (e.g., one country)
- Give context about what the data are, including where they come from and how often they are updated

Documenting datasets:
Data dictionaries

Data dictionaries come in lots of formats and flavors. Work with the type that makes the most sense for who you are trying to communicate with.

Documenting datasets:

Example data dictionary: USGS Landsat Sata

Acquisition Date

- *Field Definition:* The year, month and day that the scene was acquired.

  Format:

  YYYY/MM/DD

Acquisition Quality

- *Field Definition:* Acquisition Quality is a value, expressed as a single digit number, based on (1) errors encountered during archive processing; and/or (2) visible artifacts in the data when manually inspected.

  Values:

  9 = Excellent (no quality issues or errors detected)

  7-8 = Good (minor quality issues and/or errors detected)

Bias Parameter File Name OLI

- *Field Definition:* The Bias Parameter File used for processing OLI.

USGS Landsat Data Dictionary. Available online: https://www.usgs.gov/centers/eros/science/landsat-data-dictionary

Documenting datasets:

Example data dictionary: US Bureau of Labor Statistics

2022 ATUS Data Dictionary: Public ATUS Interview Data

Name	Description			File
TEABSRSN	Edited: what was the main reason you were absent from your job last week?			Respondent File
	Edited Universe:	TELFS = 2		
	Valid Entries:	1	On layoff (temporary or indefinite)	
		2	Slack work/business conditions	
		3	Waiting for a new job to begin	
		4	Vacation/personal days	
		5	Own illness/injury/medical problems	
		6	Childcare problems	
		7	Other family/personal obligation	
		8	Maternity/paternity leave	
		9	Labor dispute	
		10	Weather affected job	
		11	School/training	
		12	Civic/military duty	
		13	Does not work in the business	
		14	Other	

US Bureau of Labor Statistics. American Time Use Survey. Available online: https://www.bls.gov/tus/dictionaries.htm

Documenting datasets:

Example data dictionary: WHO Case Reporting Form

	A	B	C	D	E	F	
1	**Tx section**	**Variable name**	**Short label EN**	**Short label FR**	**Description**	**Data type**	**Format**
2	Reporting	report_date	Date (DD/MM/YYYY)*: ____/___/_____	Date*: ____/___/_____	Date of reporting	Date	DD/MM/YYYY
3	Reporting	report_country	reporting country	Pays*:	Country/territory/national boundary within which the case currently/usually resides.If trar	String	Free text
4	Reporting	report_test_reason	Why the case was tested for COVID-19		Why the case was tested for COVID-19	Coded	Coded variables
5	Reporting	report_test_reason_other	Other reason the case was tested for COVID-19		Any other reason the case was tested for COVID-19	String	Free text
6	Patient information	patinfo_ID	country case ID*:	Numéro d'identification unique*:	Unique case identification number (used in country)	String	Free text
7	Patient information	patinfo_ageonset	or Age:_____	ou Age *: _____	Age in units on the date of illness onset.	Numeric	###
8	Patient information	patinfo_ageonsetunit	unit of age	Unité de l'âge	Years or months or days	Coded	Coded variables
9	Patient information	patinfo_sex	Sex at birth: Male Female	Sexe a la naissance*: Homme Femme	Biological sex. That is the biological differential characteristics (chromosomes, hormonal pr	Coded	Coded variables
10	Patient information	patinfo_idadmin0	where the case was diagnosed, admin level 0 (country)		Administrative level 0: Country where the case was diagnosed.	String	Free text
11	Patient information	patinfo_idadmin1	identified Admin Level 1 (province):	Niveau admin 1*(préfecture):	Administrative level 1: First sub-national boundary (e.g. province, state, territory prefecture	String	Free text
12	Patient information	patinfo_resadmin0	place of residence admin level 0		Administrative level 0: Country within which the case's currently/usually resides.	String	Free text
13	Clinical status	Lab_date1	Date of first laboratory confirmation	Date prélèvement1	Date of first laboratory confirmation	Date	DD/MM/YYYY
14	Clinical status	patcourse_dateonset	Date of onset of first symptoms:___/___/__	Date de début des premiers symptor	Date of first appearance of the signs or symptoms of the illness/disease.	Date	DD/MM/YYYY
15	Clinical status	patcourse_asymp	Patient asymptomatic at time of speciment cc	Patient asymptomatique	Is the case asymptomatic?	Coded	Coded variables
16	Clinical status	Comcond_present	Does the patient have any underlying conditions?		Does the patient have any underlying conditions?	Coded	Coded variables
17	Clinical status	Comcond_preg	Pregnancy	Grossesse	Is the patient pregnant?	Coded	Coded variables
18	Clinical status	Comcond_pregt	Trimester of pregancy	Trimestre de grossesse		Coded	Coded variables
19	Clinical status	Comcond_partum	Post-partum (<6 weeks)	Post-partum (<6 semaines)	Is the patient in the post partum period defined as less than 6 weeks after delivery date	Coded	Coded variables
20	Clinical status	Comcond_immuno	Immunodeficiency including HIV	Immunodéficience, y compris le VIH	has the patient an adquired immunodeficiency (HIV) or is the patient treated with drugs tha	Coded	Coded variables
21	Clinical status	Comcond_cardi	Cardiovacsular disease including hypertension		any cardiovacsular disease	Coded	Coded variables
22	Clinical status	Comcond_diabetes	Diabetes			Coded	Coded variables
23	Clinical status	Comcond_liver	Liver disease		any liver diseases	Coded	Coded variables
24	Clinical status	Comcond_renal	Renal disease		any renal diseases	Coded	Coded variables
25	Clinical status	Comcond_neuro	Chronic neurological or neuromuscular disease			Coded	Coded variables
26	Clinical status	Comcond_malig	Malignancy	Malignité		Coded	Coded variables
27	Clinical status	Comcond_lung	Chronic lung disease	Maladie aiguë ou chronique associée:		Coded	Coded variables
28	Clinical status	Comcond_other	Other, specify	Autre spécifier	Describe other underlying conditions and comorbidity	String	Free text
29	Clinical status	patcourse_admit	admission to hospital?:	Hospitalisation* ?:	Was the case hospitalized, admitted to a hospital or other health facility as an inpatient?	Coded	Coded variables
30	Clinical status	patcourse_presHCF	For this episode, date first admitted in hospit	Pour cet épisode, quelle est la date c	Date the case was first admitted to any health facility.	Date	DD/MM/YYYY

WHO Data Dictionary for Case-Based Reporting form. Available online:
https://www.who.int/publications/m/item/data-dictionary-for-case-based-reporting-form

Documenting datasets:

Example data dictionary: Game of Thrones Survival

Background

The *Game of Thrones* mortality and survival dataset (hereinafter "the dataset") was created by Dr Reidar P. Lystad and Dr Benjamin T. Brown and used in the following original research article, which was published in the journal *Injury Epidemiology* in December 2018:

> Lystad RP, Brown BT. "Death is certain, the time is not": mortality and survival in *Game of Thrones*. *Injury Epidemiology* 2018; 5: 44.

The version of the dataset used in the original research article included data from *Game of Thrones* Seasons 1–7 only, whereas the present version of the dataset includes data from *Game of Thrones* Seasons 1–8.

The dataset comprises two separate datasets: (1) a character dataset and (2) an episode dataset. The character dataset contains 359 observations (i.e. characters) and 35 variables, including information about sociodemographics, exposures, and mortality. The episode dataset contains 73 observations (i.e. episodes) and 8 variables, including information about episode running time. Please note that the character dataset only includes "important" characters. As per the original research article:

> *An important character was defined as any individual who fulfilled each of the following criteria: human; listed in either the opening or closing credits; appeared on screen during current events (i.e. excluding flashbacks); and was not already deceased when first appearing on screen. Additional non-credited characters were included if they interacted with another character in a way that was either crucial to the storyline or character development. Having a speaking role was not an essential requirement because some characters were unable to speak for medical reasons (e.g. acquired brain injury and non-elective glossectomy).*

Data Dictionary *Version 2.0*

Variables in *Game of Thrones* character dataset

id	
Variable number:	01
Description:	Unique three-digit character identification number
Representation class:	Identifier
Data type:	String

name	
Variable number:	02
Description:	Name of character
Representation class:	Identifier
Data type:	String

Lystad RP, Brown BT. "Death is certain, the time is not": mortality and survival in Game of Thrones. Injury Epidemiology 2018;5:44.
Data Dictionary accessed via Figshare: https://figshare.com/articles/dataset/Game_of_Thrones_mortality_and_survival_dataset/8259680

Documenting datasets:

Example data dictionary template

[optional: add logo here]
This data dictionary is intended to document the dataset(s) accessible at [URL]
The data dictionary was last updated on [date]
If you have any questions, please reach out to [name] at [email or other contact information]

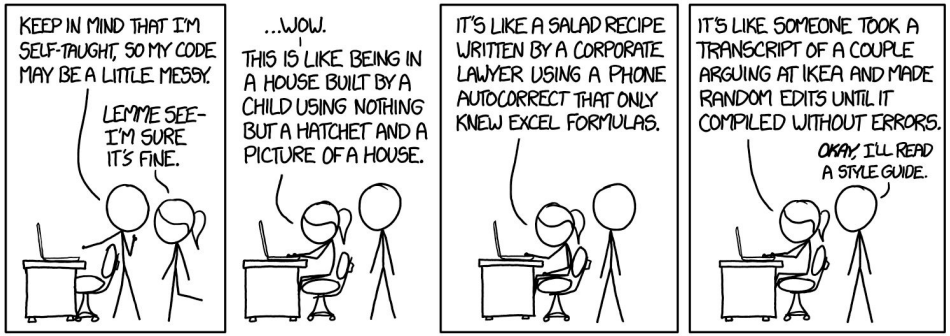
Data Dictionary - Tables/Datasets

Table	Description	Resolution(s)	Update frequency	References or other notes
example: measles_cases	example: table with information on country-level data on measles caseload, per year	example: one row per IHR member state per year	example: one-time (not updated)	example: teaching dataset

Data Science Basics in R Data Dictionary Template. Steph Eaneff.
Available online: https://github.com/seaneff/data-science-basics-2024/blob/main/extras/Data%20dictionary%20template.xlsx

Documenting code:
comments

- As we start writing code, it's helpful to leave "notes" for yourself and others reminding yourself what you did
- Comments can also help break code into sections



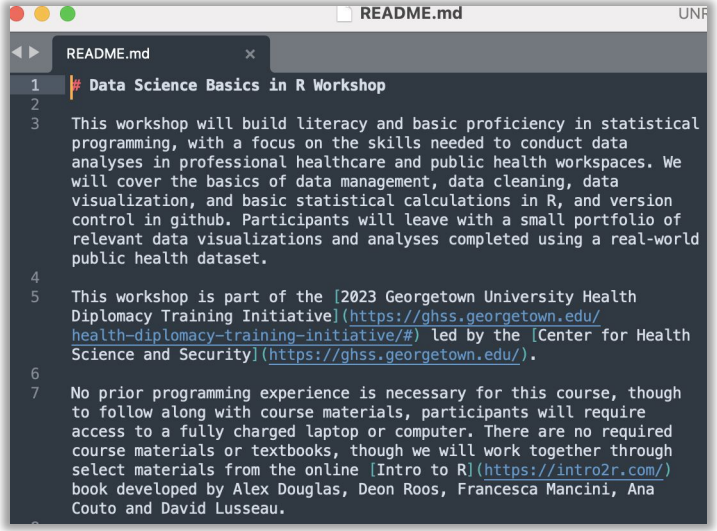
Comic by XKCD

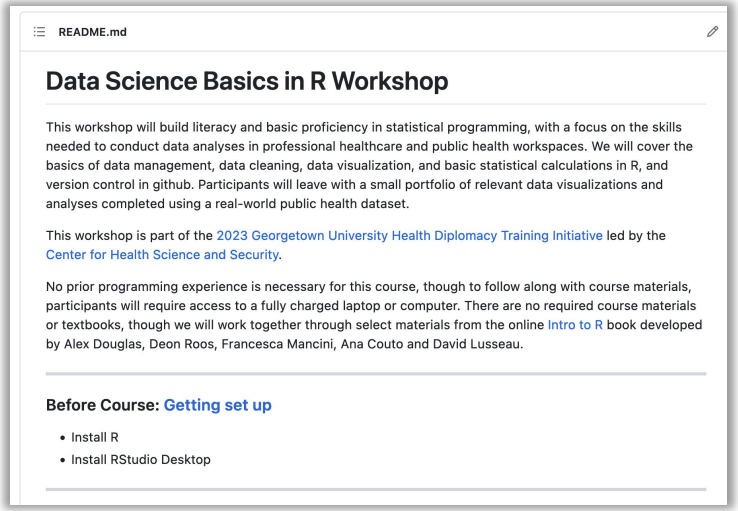
Documenting code:
comments

```
##########################################
## Setup #################################
##########################################

## Load libraries
library(dplyr) ## reshape, reformat, recode data: https://dplyr.tidyverse.org/reference/recode.html
library(ggplot2) ## for plotting: https://ggplot2.tidyverse.org/
library(scales) ## for commas on axes of plots
library(treemap) ## for treemap visual

##########################################
## Read in data ##########################
##########################################

line_items <- read_excel("calculator-tool/jee3_costing_worksheet.xlsx",
                         sheet = "Line items (JEE 3)")

unit_costs <- read_excel("calculator-tool/jee3_costing_worksheet.xlsx",
                         sheet = "Unit costs")

multipliers <- read_excel("calculator-tool/jee3_costing_worksheet.xlsx",
                         sheet = "Multipliers")
```

Documenting code:
README files

- README files summarize the contents of a specific folder
- Common in github, rendered using Markdown





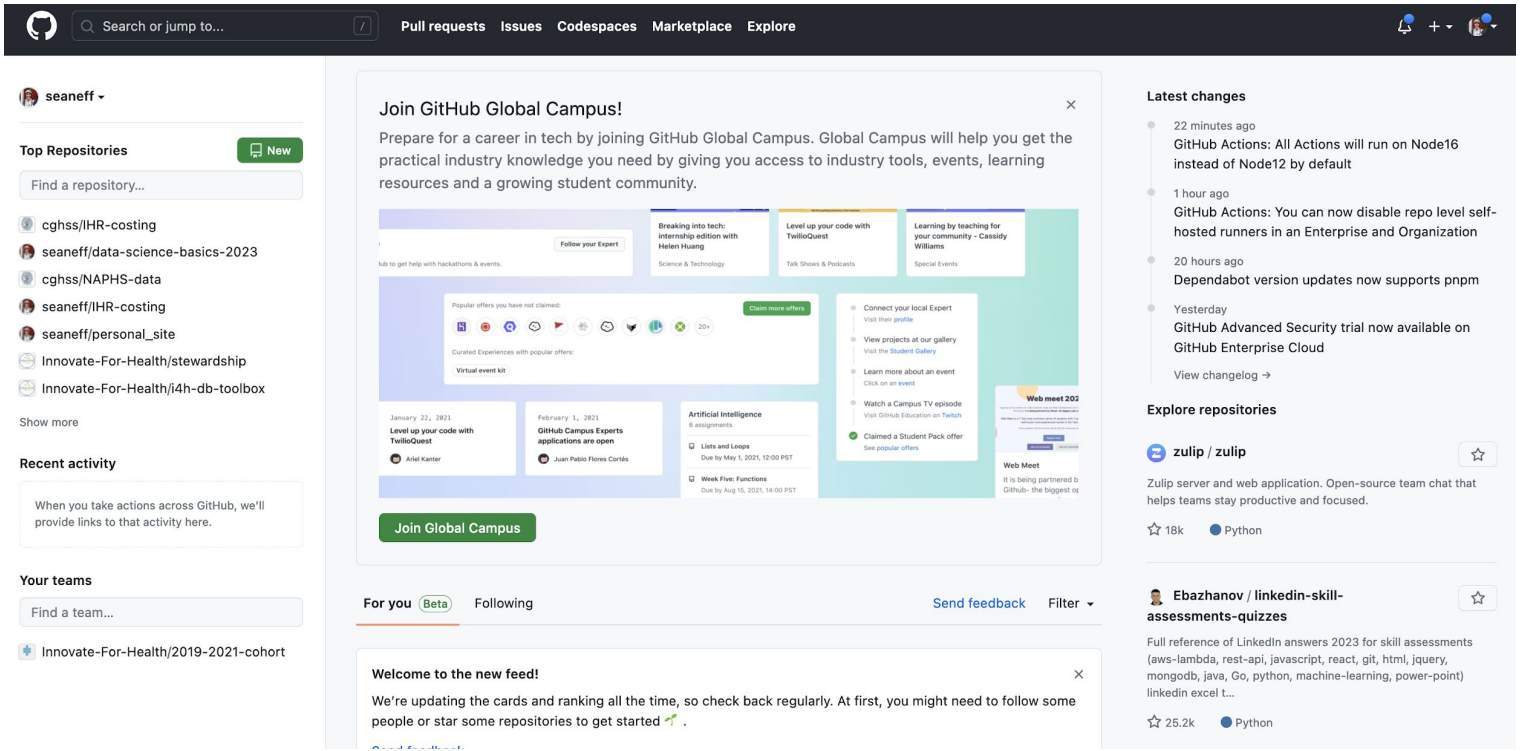
Reproducible results

We won't cover it in detail in this workshop, but R is a great way to ensure that your code, and your results, are well documented and reproducible

- Use a single version of a **clean dataset**
- Document and version your **data cleaning decisions**
- Store your **code, results, & documentation** in one spot

Reproducible results

Code versioning in github



Course datasets

Measles

WHO. Measles and rubella strategic framework: 2021-2030.
https://www.who.int/publications/i/item/measles-and-rubella-strategic-framework-2021-2030

Course datasets: Vaccination

For this course, we'll primarily use global-scale datasets related to vaccine-preventable diseases.

- **policy data:** national policies related to vaccination
- **coverage data:** % of relevant populations vaccinated
- **caseload data:** information on the number of cases per year

Course datasets: Vaccination

Policy data

Categorical

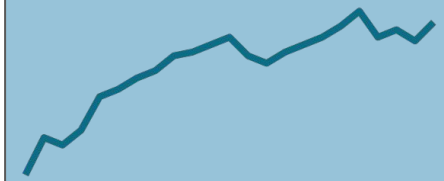
Current national policies related to measles vaccination, per country:

- Required
- Not required
- No data

Coverage data

Continuous

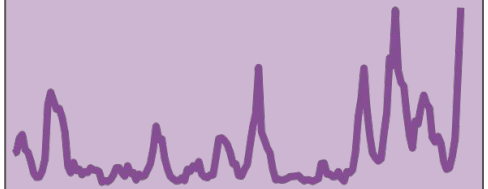
Yearly measles containing vaccine first-dose (MCV1) immunization coverage among 1-year-olds, per country, over time



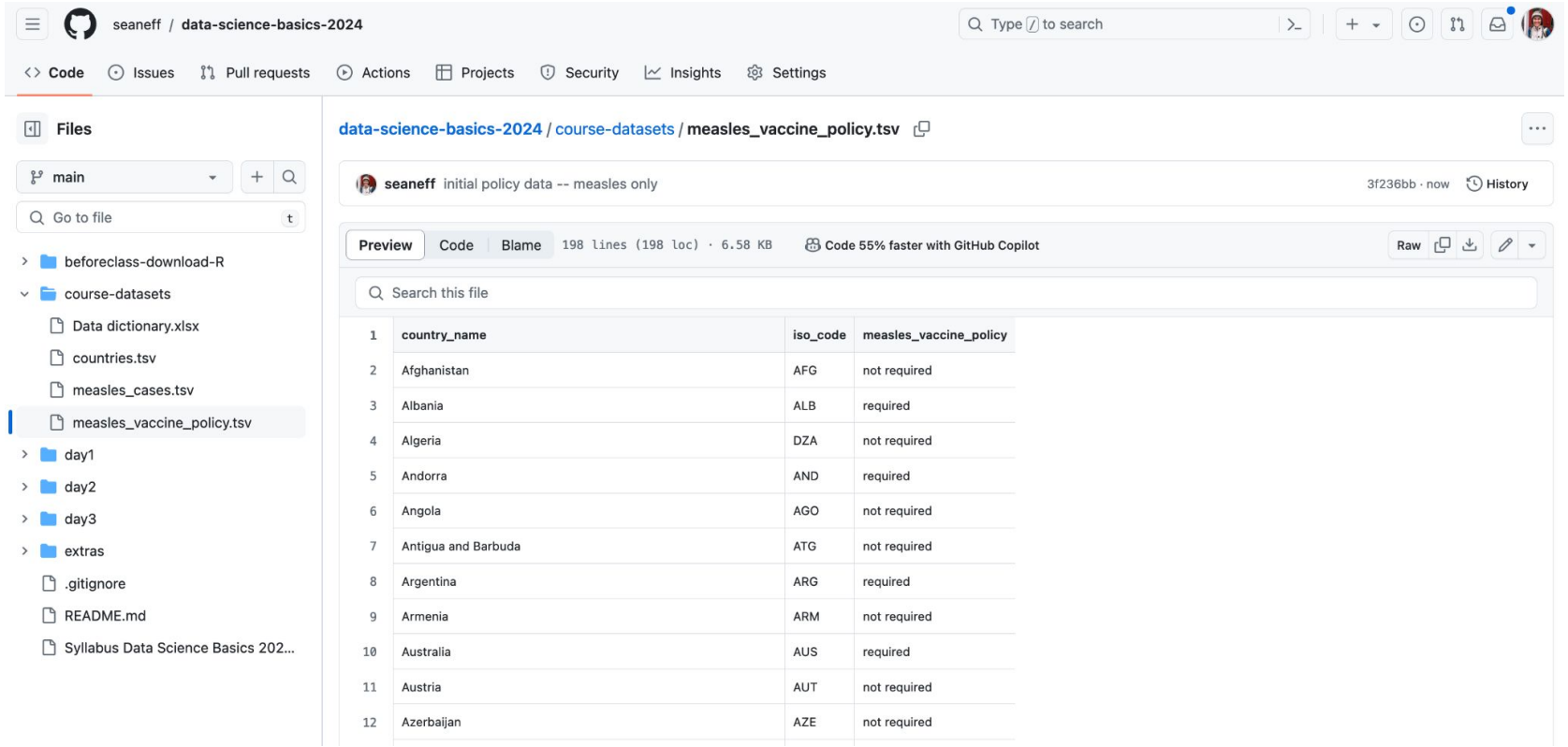
Caseload data

Continuous

Monthly data on laboratory confirmed, epidemiologically linked, and/or clinical measles cases reported to WHO per country, over time

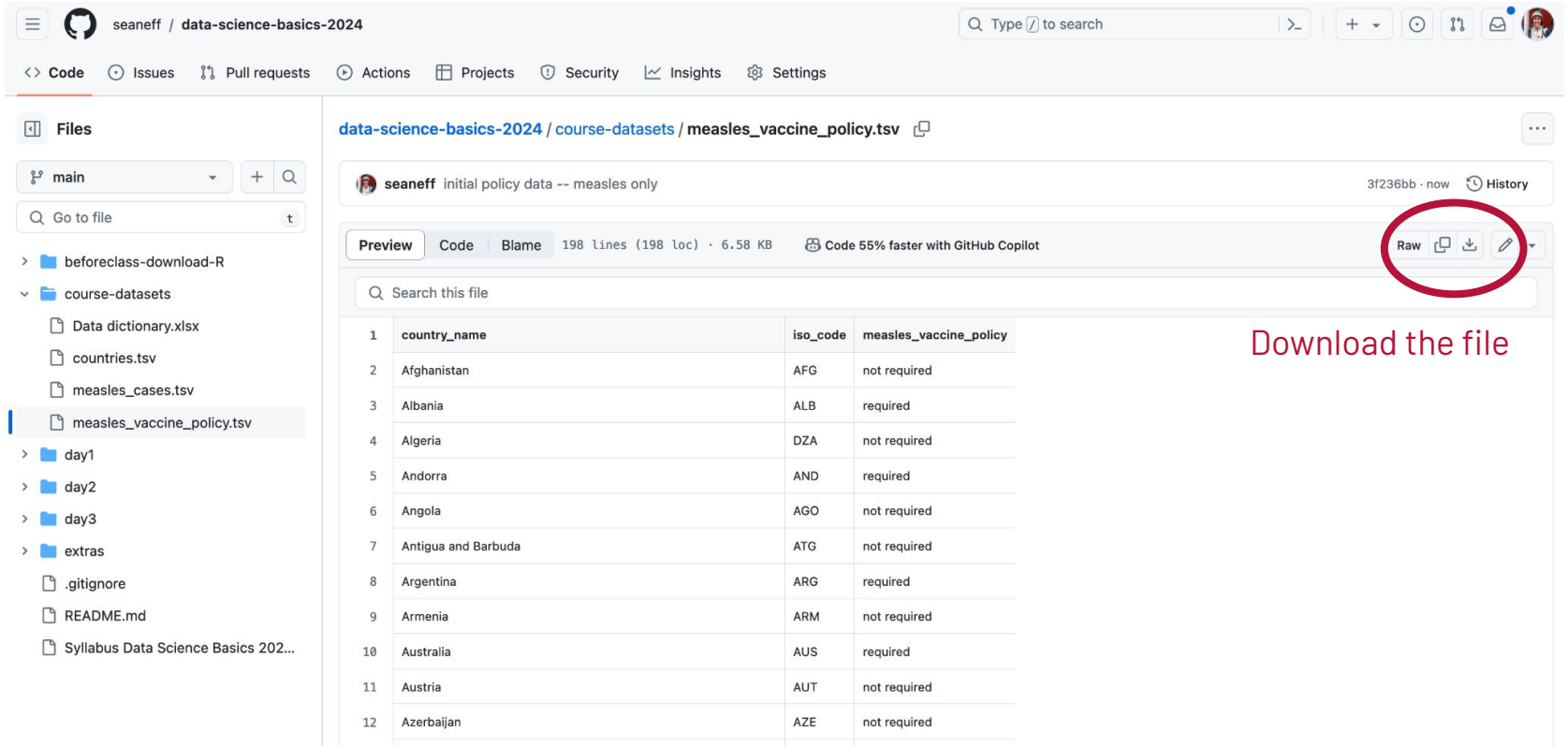


Course datasets: Vaccination



1	country_name	iso_code	measles_vaccine_policy
2	Afghanistan	AFG	not required
3	Albania	ALB	required
4	Algeria	DZA	not required
5	Andorra	AND	required
6	Angola	AGO	not required
7	Antigua and Barbuda	ATG	not required
8	Argentina	ARG	required
9	Armenia	ARM	not required
10	Australia	AUS	required
11	Austria	AUT	not required
12	Azerbaijan	AZE	not required

Course datasets: Vaccination

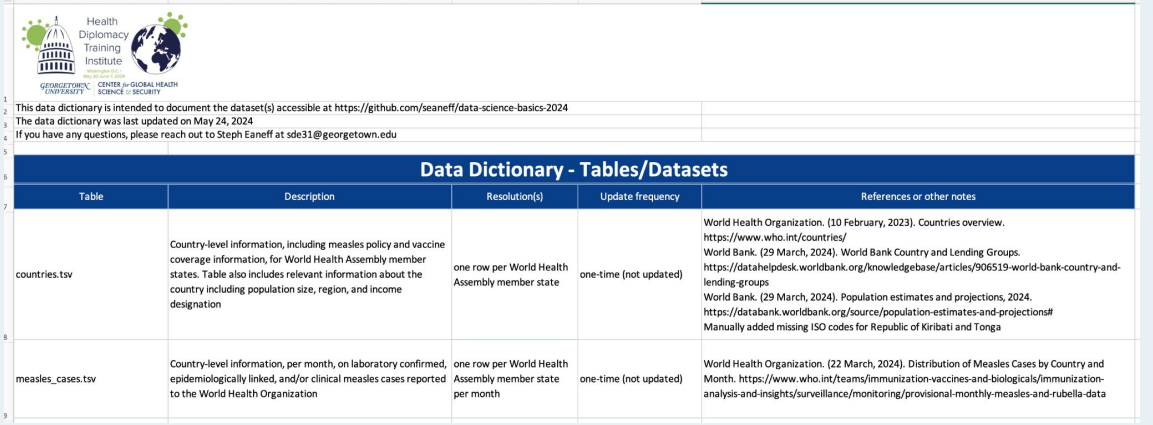


	country_name	iso_code	measles_vaccine_policy
2	Afghanistan	AFG	not required
3	Albania	ALB	required
4	Algeria	DZA	not required
5	Andorra	AND	required
6	Angola	AGO	not required
7	Antigua and Barbuda	ATG	not required
8	Argentina	ARG	required
9	Armenia	ARM	not required
10	Australia	AUS	required
11	Austria	AUT	not required
12	Azerbaijan	AZE	not required

Your turn!

Explore the data dictionary for this course at:

bit.ly/data-dictionary-gt2024



Health Diplomacy Training Institute

GEORGETOWN UNIVERSITY | CENTER for GLOBAL HEALTH SCIENCE & SECURITY

This data dictionary is intended to document the dataset(s) accessible at https://github.com/seaneff/data-science-basics-2024

The data dictionary was last updated on May 24, 2024

If you have any questions, please reach out to Steph Eaneff at sde31@georgetown.edu

Data Dictionary - Tables/Datasets

Table	Description	Resolution(s)	Update frequency	References or other notes
countries.tsv	Country-level information, including measles policy and vaccine coverage information, for World Health Assembly member states. Table also includes relevant information about the country including population size, region, and income designation	one row per World Health Assembly member state	one-time (not updated)	World Health Organization. (10 February, 2023). Countries overview. https://www.who.int/countries/ World Bank. (29 March, 2024). World Bank Country and Lending Groups. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups World Bank. (29 March, 2024). Population estimates and projections, 2024. https://databank.worldbank.org/source/population-estimates-and-projections# Manually added missing ISO codes for Republic of Kiribati and Tonga
measles_cases.tsv	Country-level information, per month, on laboratory confirmed, epidemiologically linked, and/or clinical measles cases reported to the World Health Organization	one row per World Health Assembly member state per month	one-time (not updated)	World Health Organization. (22 March, 2024). Distribution of Measles Cases by Country and Month. https://www.who.int/teams/immunization-vaccines-and-biologicals/immunization-analysis-and-insights/surveillance/monitoring/provisional-monthly-measles-and-rubella-data

Loading and cleaning datasets in R

Raw data files

We're going to talk about structured, flat files today, but there are many types of data that R can work with!

- **Excel:** proprietary file format (Microsoft), but common (.xls files)
- **CSV:** comma-separated value files
- **TSV:** tab-separated value files
- **RData:** data saved from within your R environment
- **SPSS or SAS:** data from other statistical programming tools
- **Shapefiles:** geospatial or mapping data

Functions to load data

- **Excel:** read_excel(“countries.xls”)
- **CSV:** read.csv(“countries.csv”)
- **TSV:** read.delim(“countries.tsv”)
- **RData:** load(“countries.RData”)
- **SPSS or SAS:** use the ‘foreign’ package
- **Shapefiles:** use the ‘sf’ or other geopsatial data packages

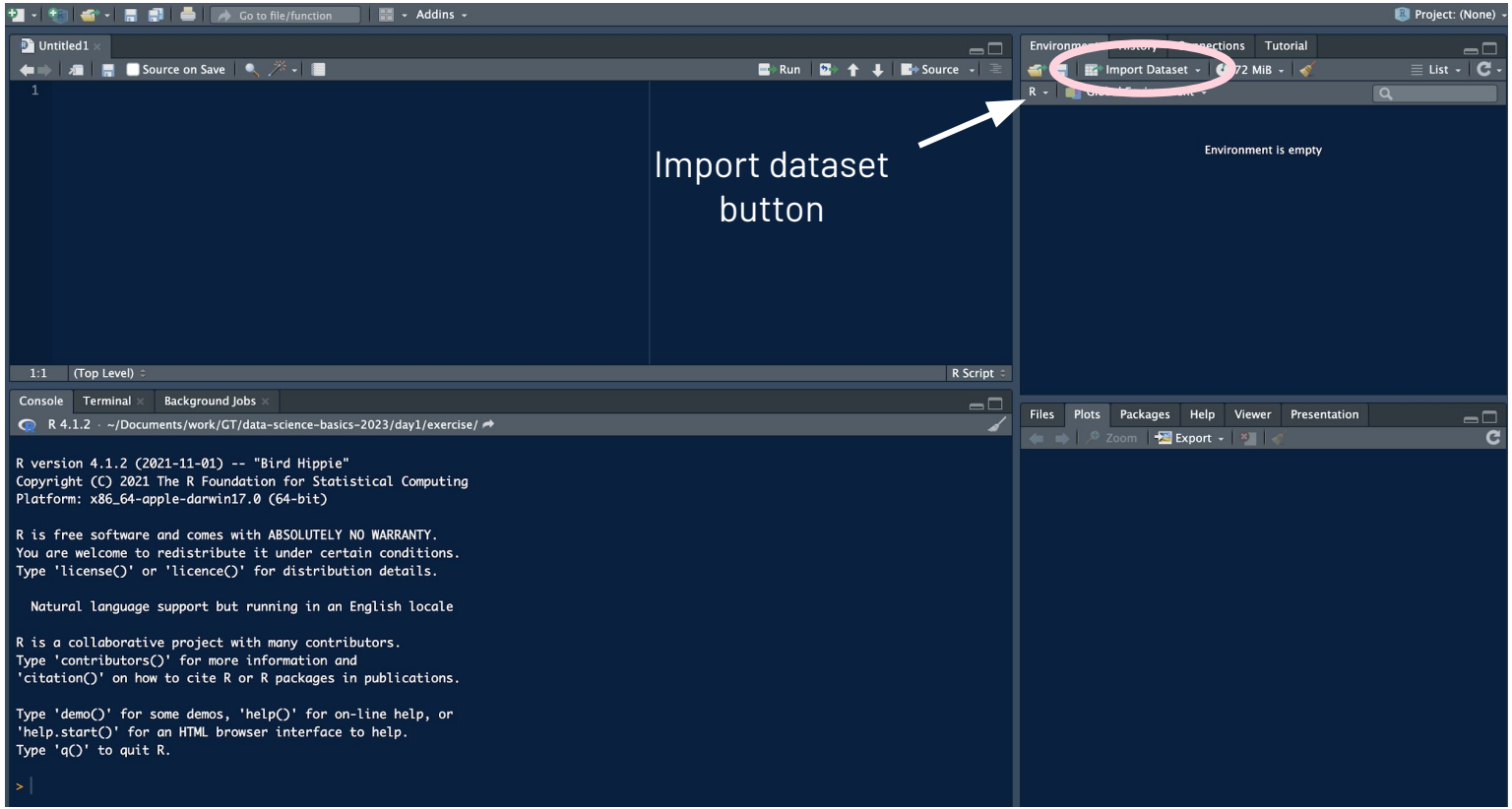
A note on Excel files and libraries in R

To use the function read_excel(), we need to have installed the package readxl into R. You (usually) only need to install it once, and then you will need to re-load it every new R session

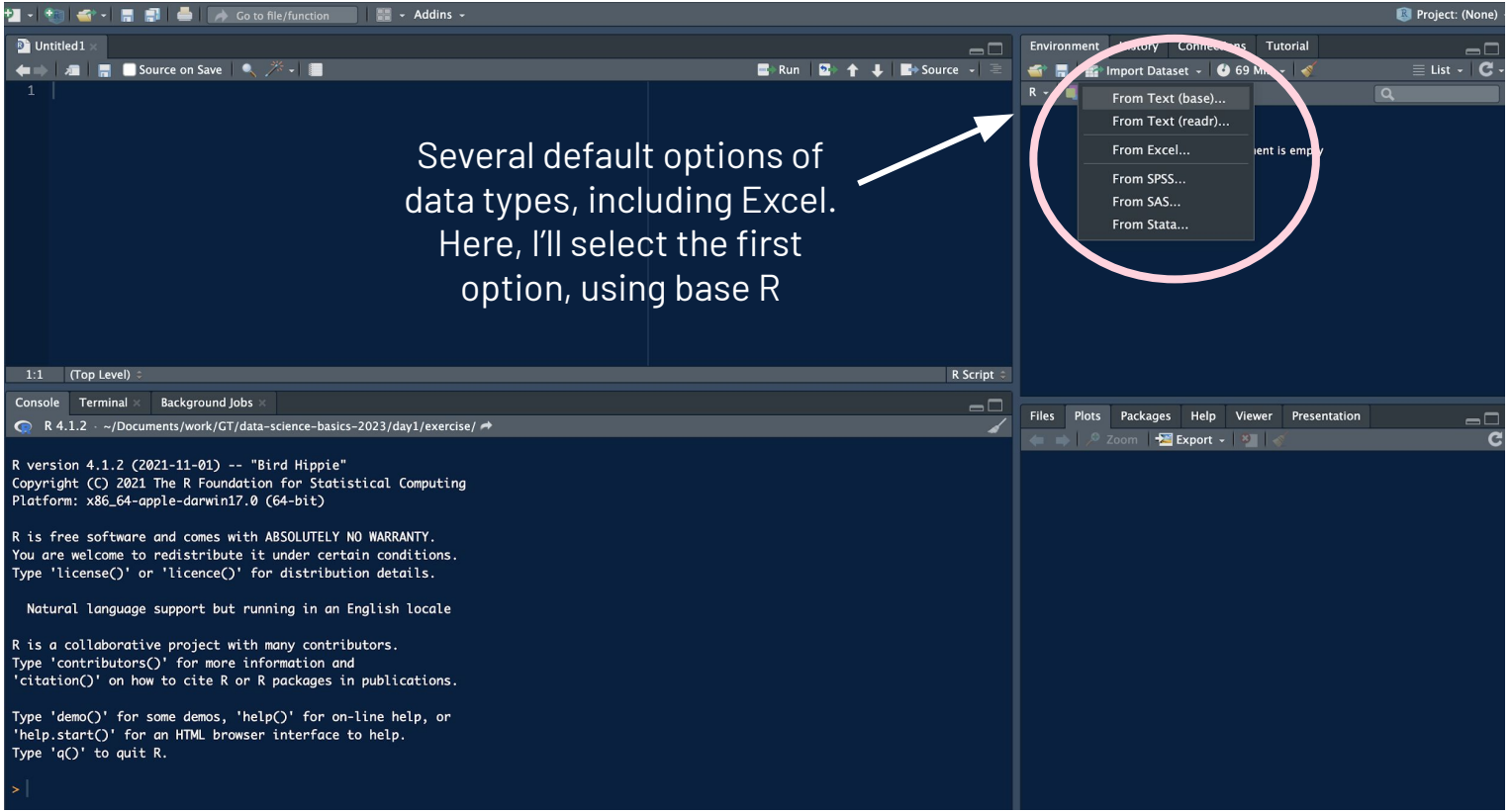
- **Installing:** install.packages("readxl")
- **Loading:** library("readxl")

If you are working with RStudio and using the workflow in the next slides, you will automatically be prompted to do these things if they are required

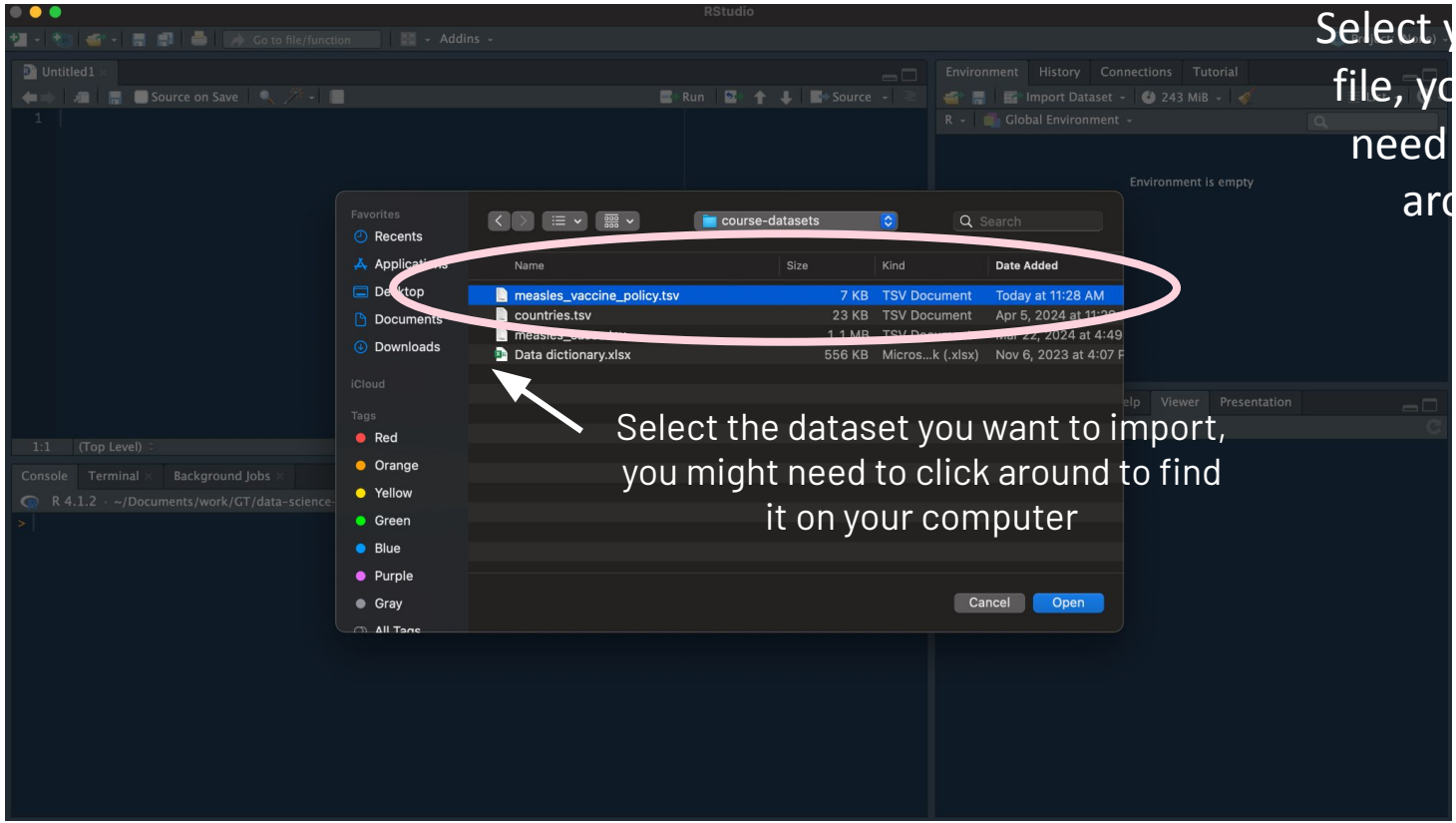
Loading data with RStudio



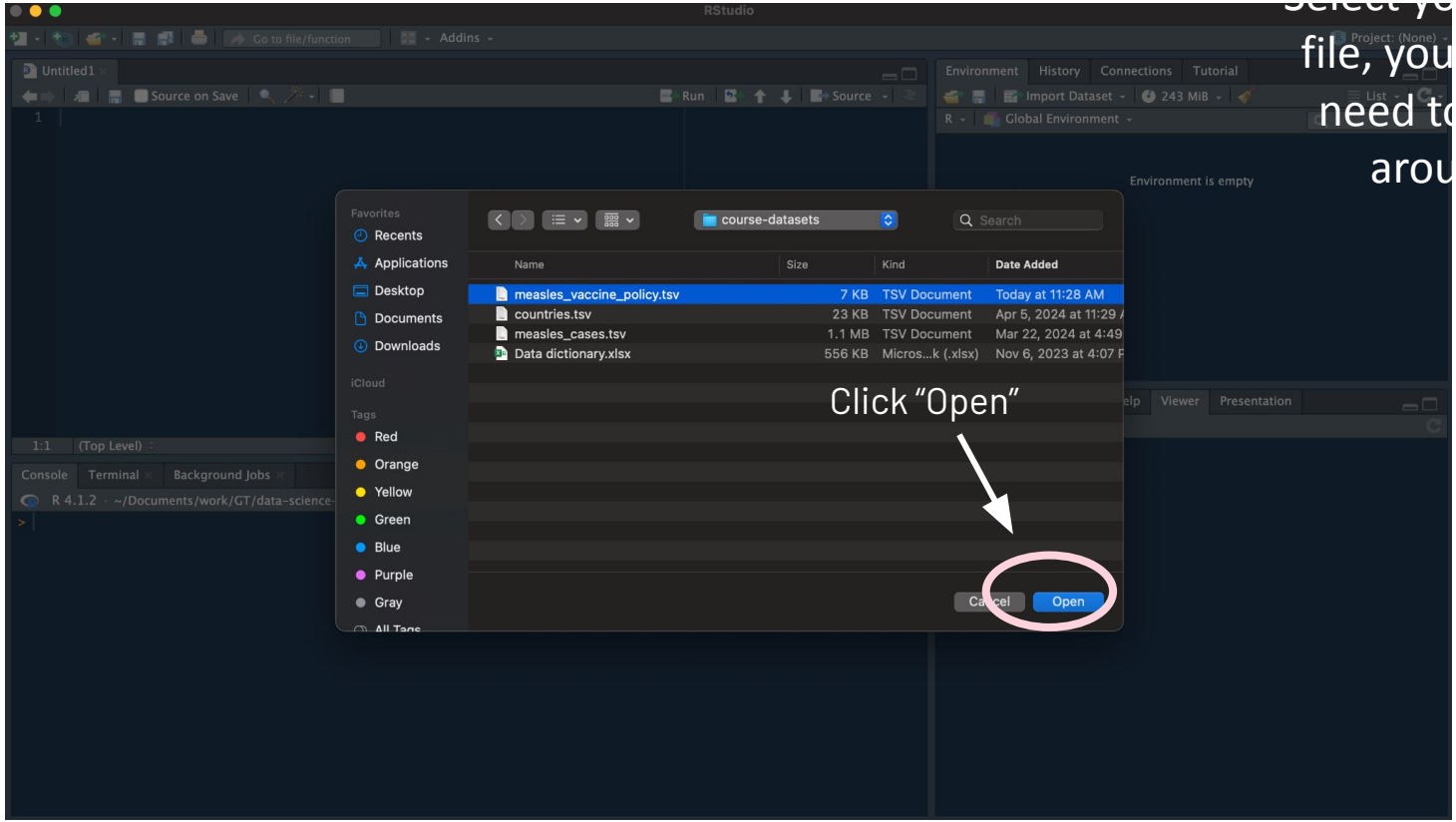
Loading data with RStudio



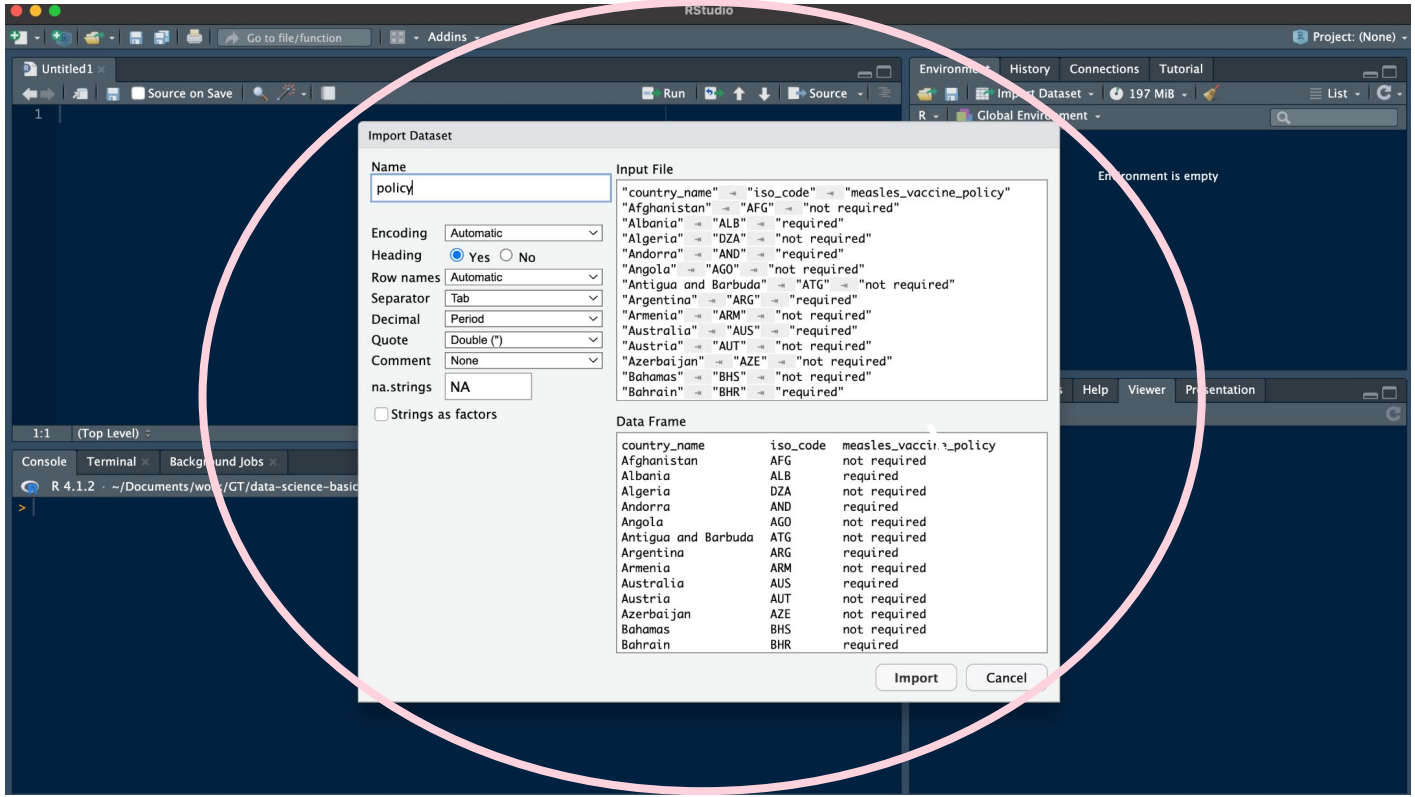
Loading data with RStudio



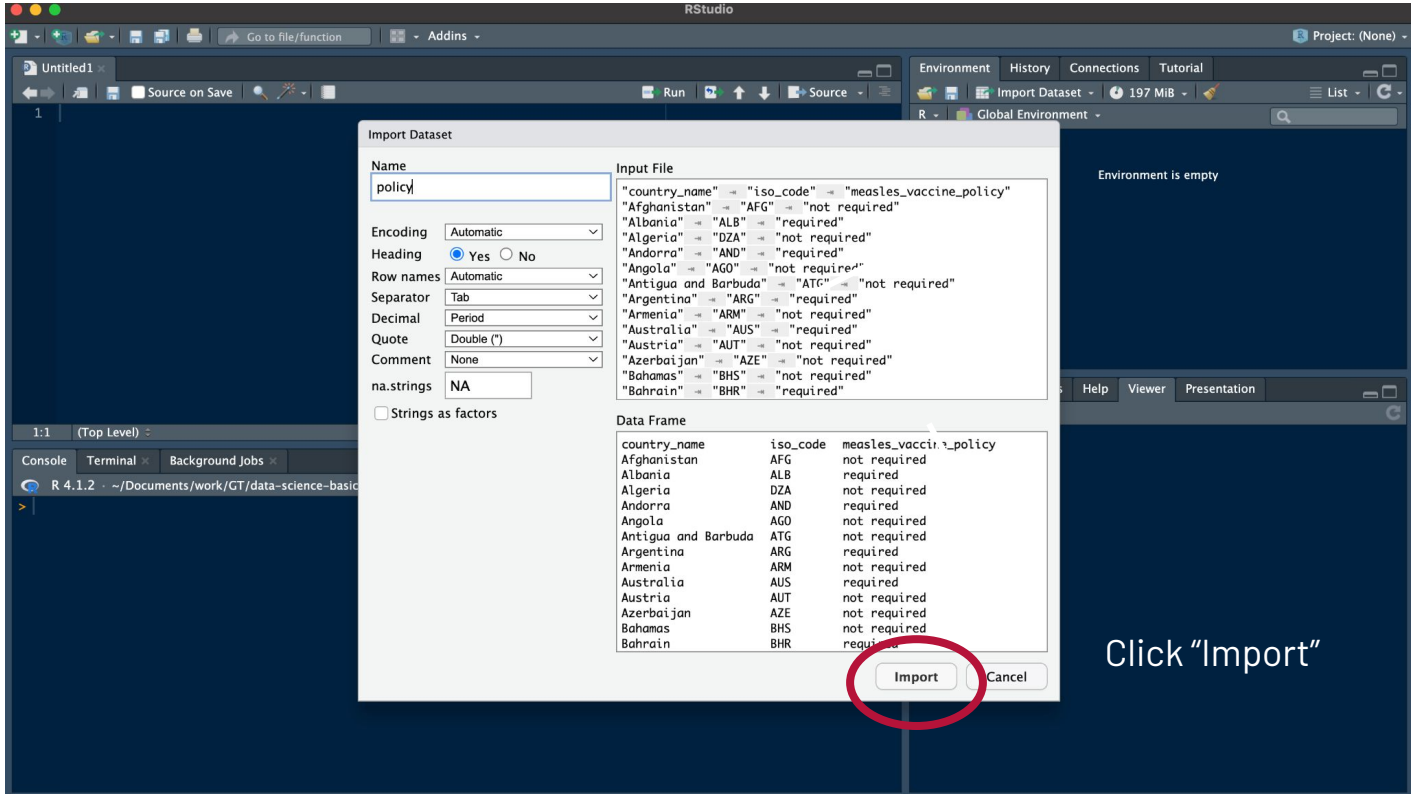
Loading data with RStudio



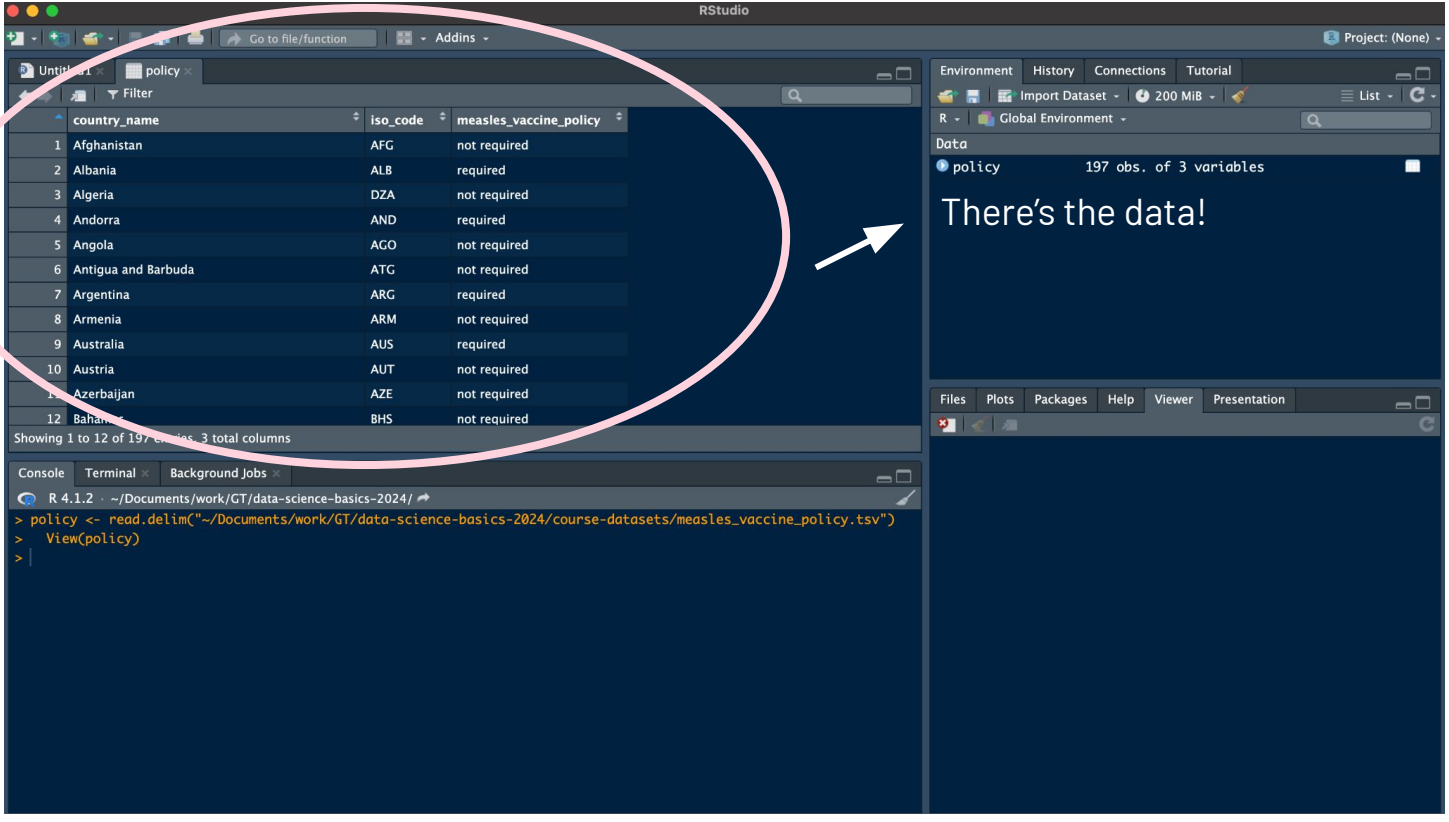
Loading data with RStudio



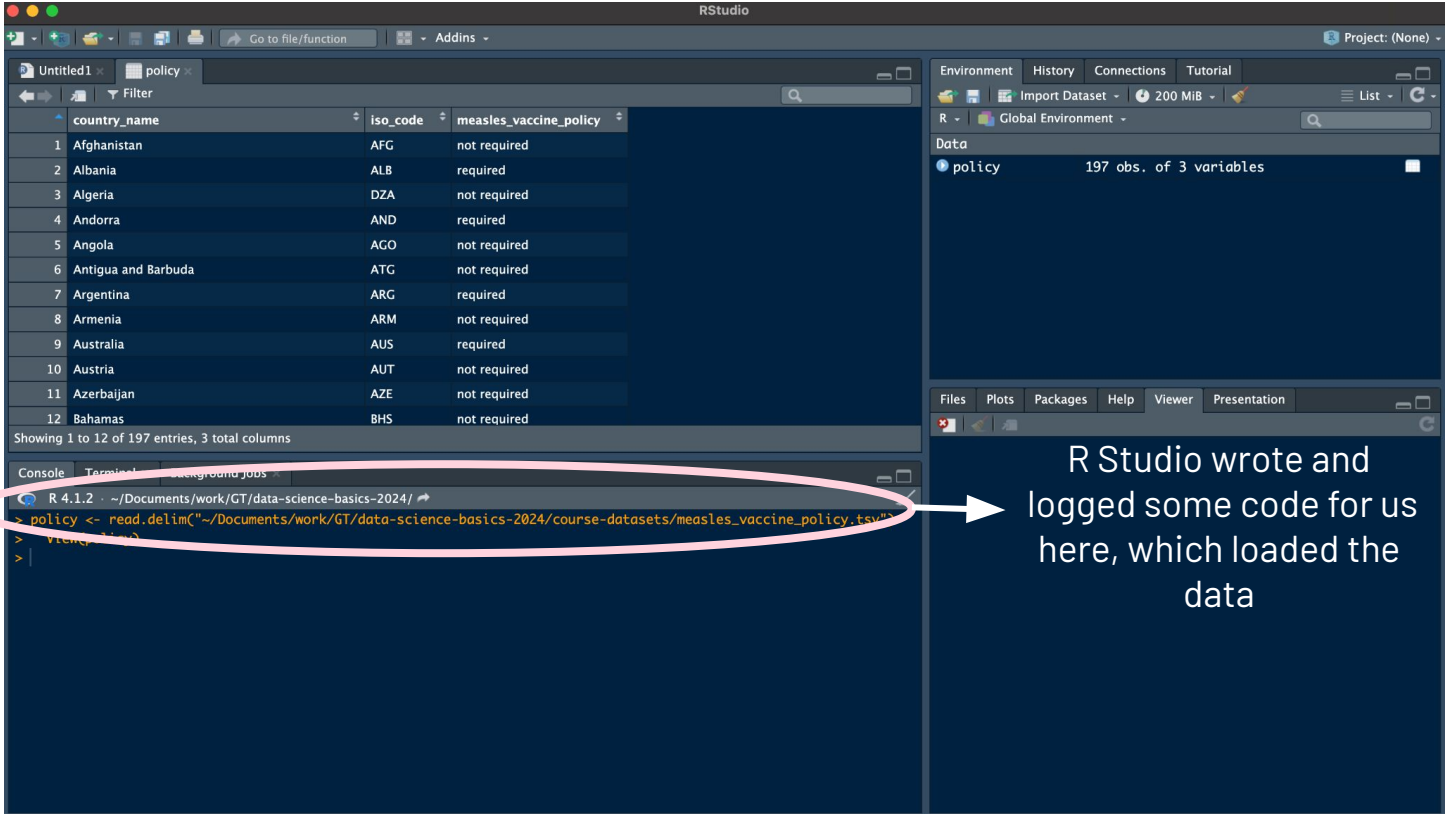
Loading data with RStudio



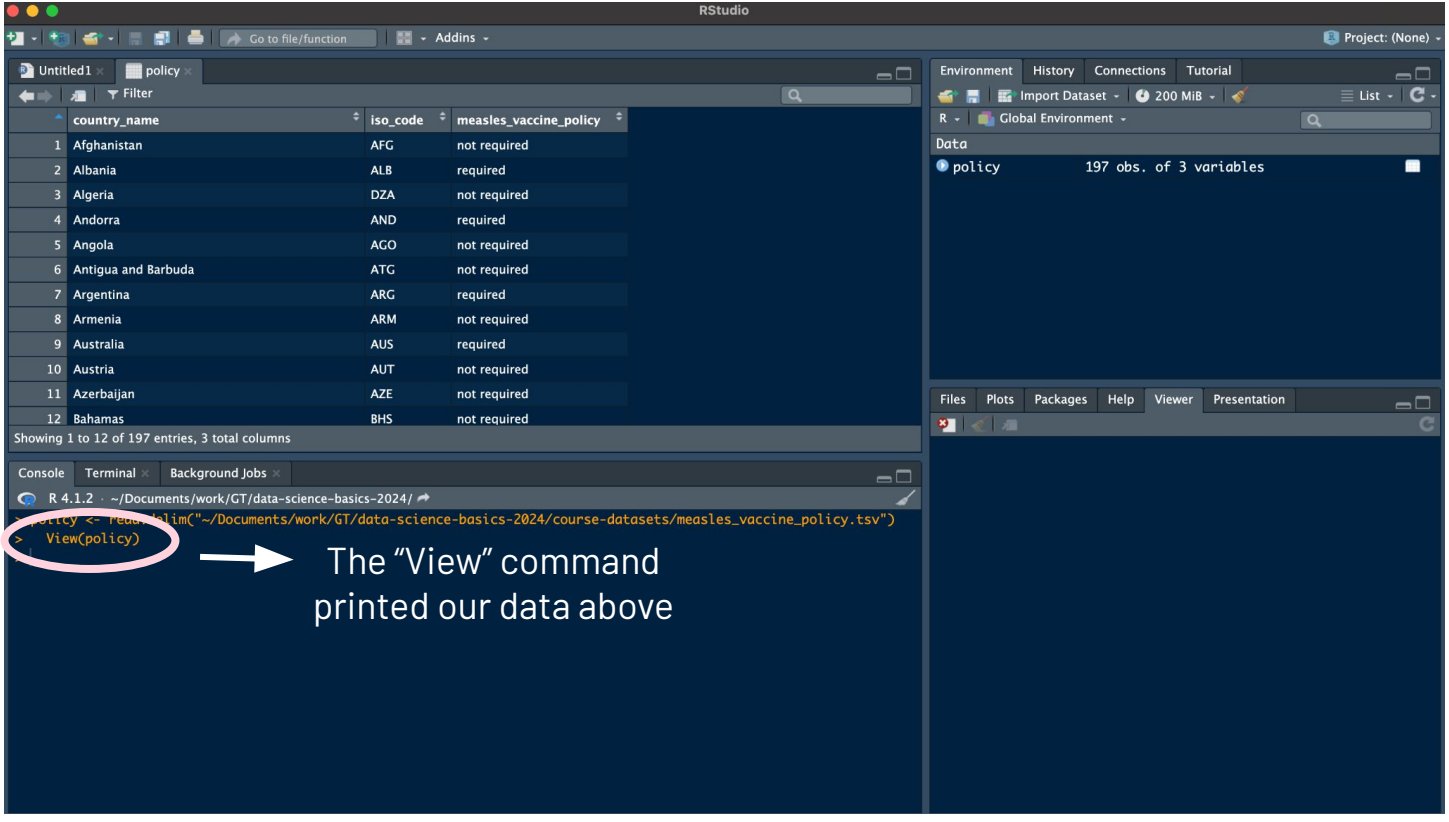
Loading data with RStudio



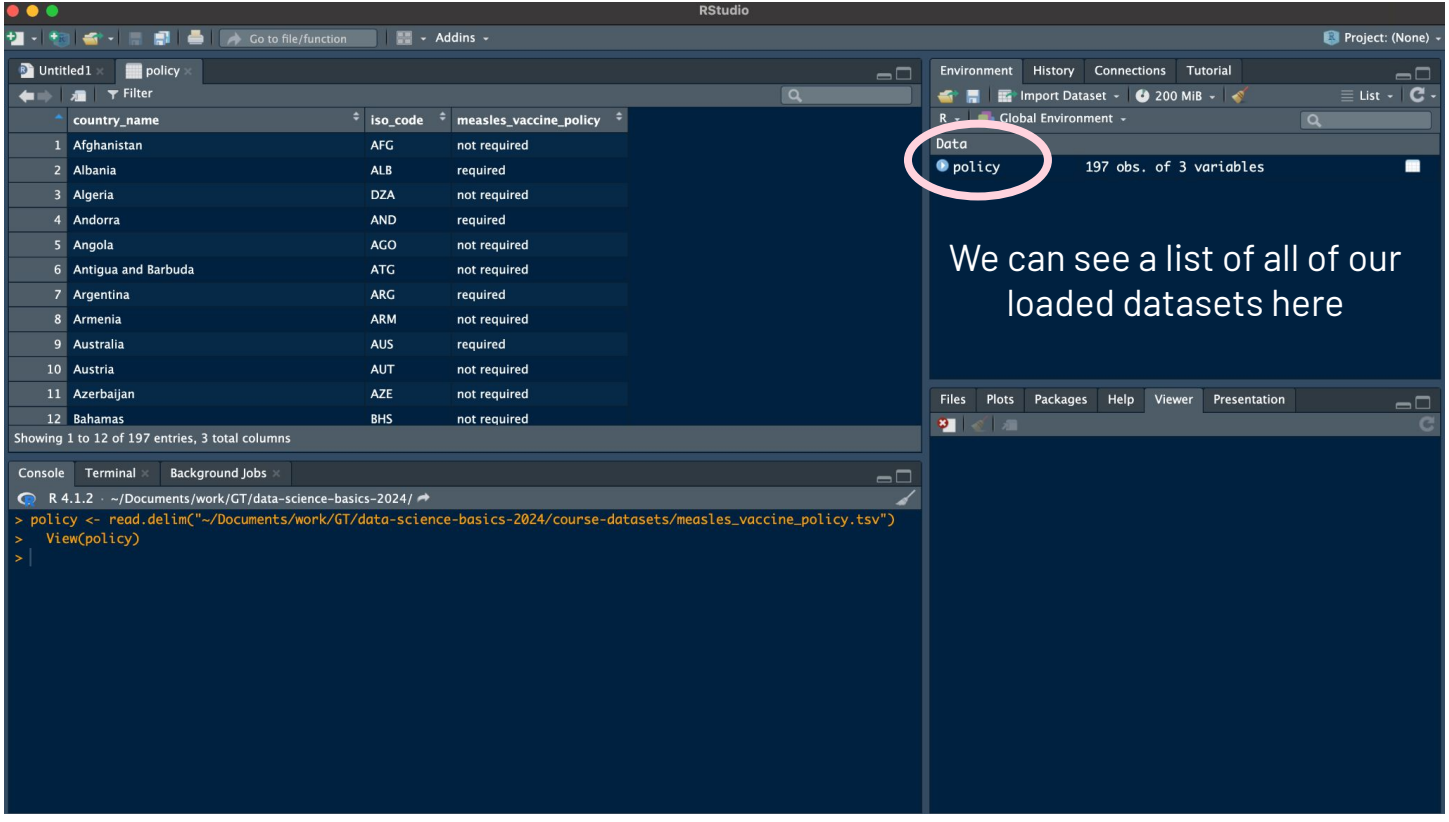
Loading data with RStudio



Loading data with RStudio



Loading data with RStudio



Loading data directly from a website

- Go to bit.ly/measles-policy-data
- Copy URL
- Read data into R

```
policy_data <-
read.delim("https://github.com/seaneff/data-science-basics-2024/blob/
main/course-datasets/measles_vaccine_policy.tsv")
```

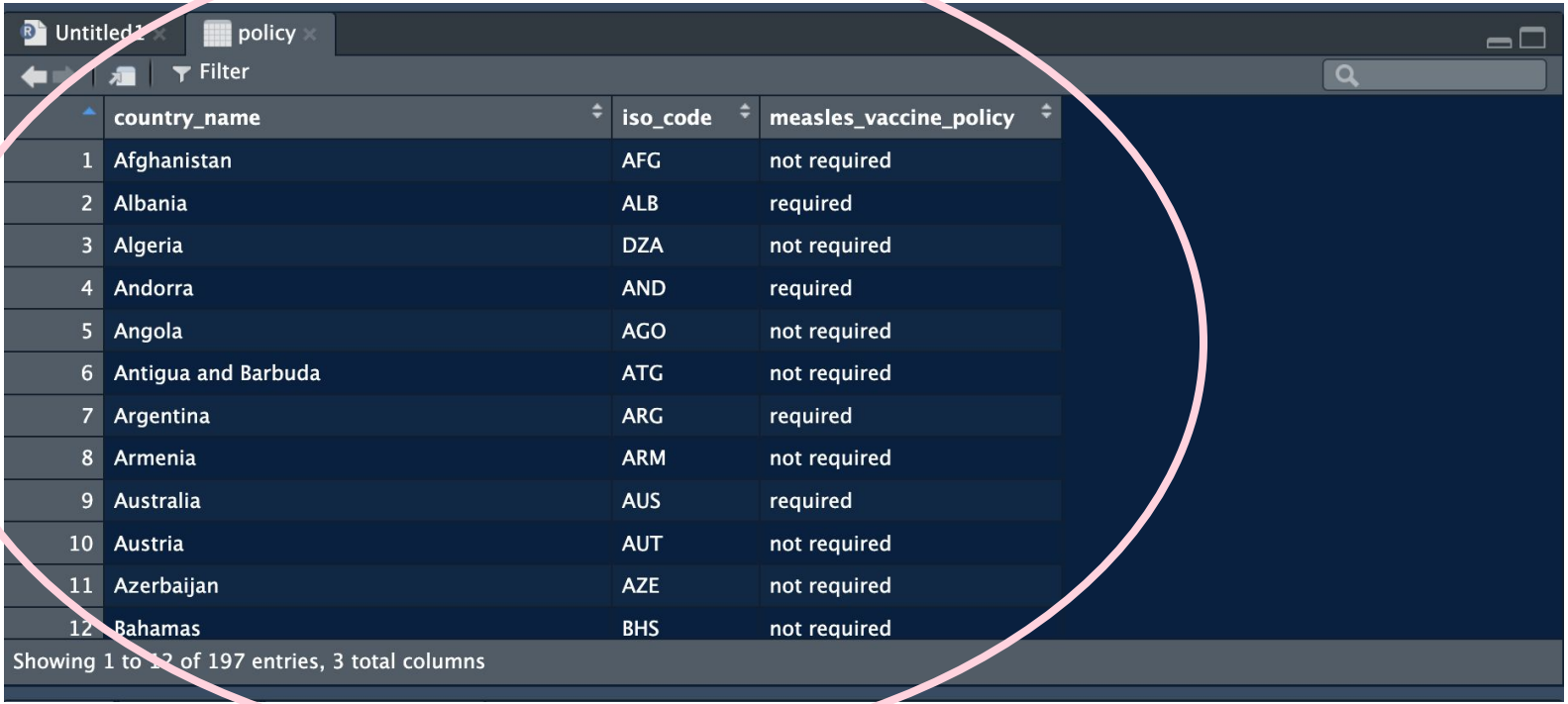
Data structures in R

Data Structures in R

Yesterday we discussed vectors, today, we're going to talk about other types of data structures in R. There are a few different types, but the ones we'll talk about this week are:

- **vectors:** group of data elements of a certain type (1D)
- **matrix:** group of data elements of a certain type (2D)
- **data frame:** group of data elements with different types

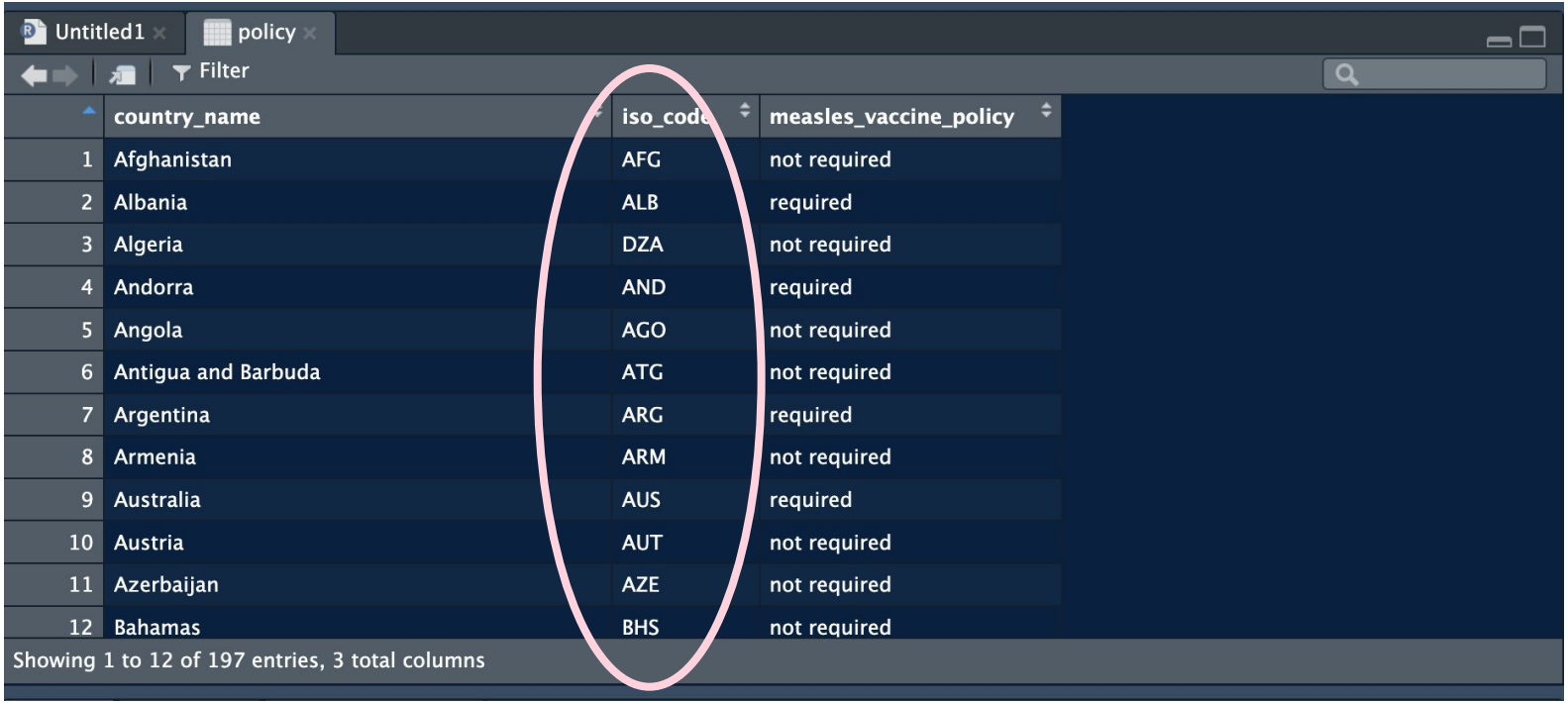
Data frame



	country_name	iso_code	measles_vaccine_policy
1	Afghanistan	AFG	not required
2	Albania	ALB	required
3	Algeria	DZA	not required
4	Andorra	AND	required
5	Angola	AGO	not required
6	Antigua and Barbuda	ATG	not required
7	Argentina	ARG	required
8	Armenia	ARM	not required
9	Australia	AUS	required
10	Austria	AUT	not required
11	Azerbaijan	AZE	not required
12	Bahamas	BHS	not required

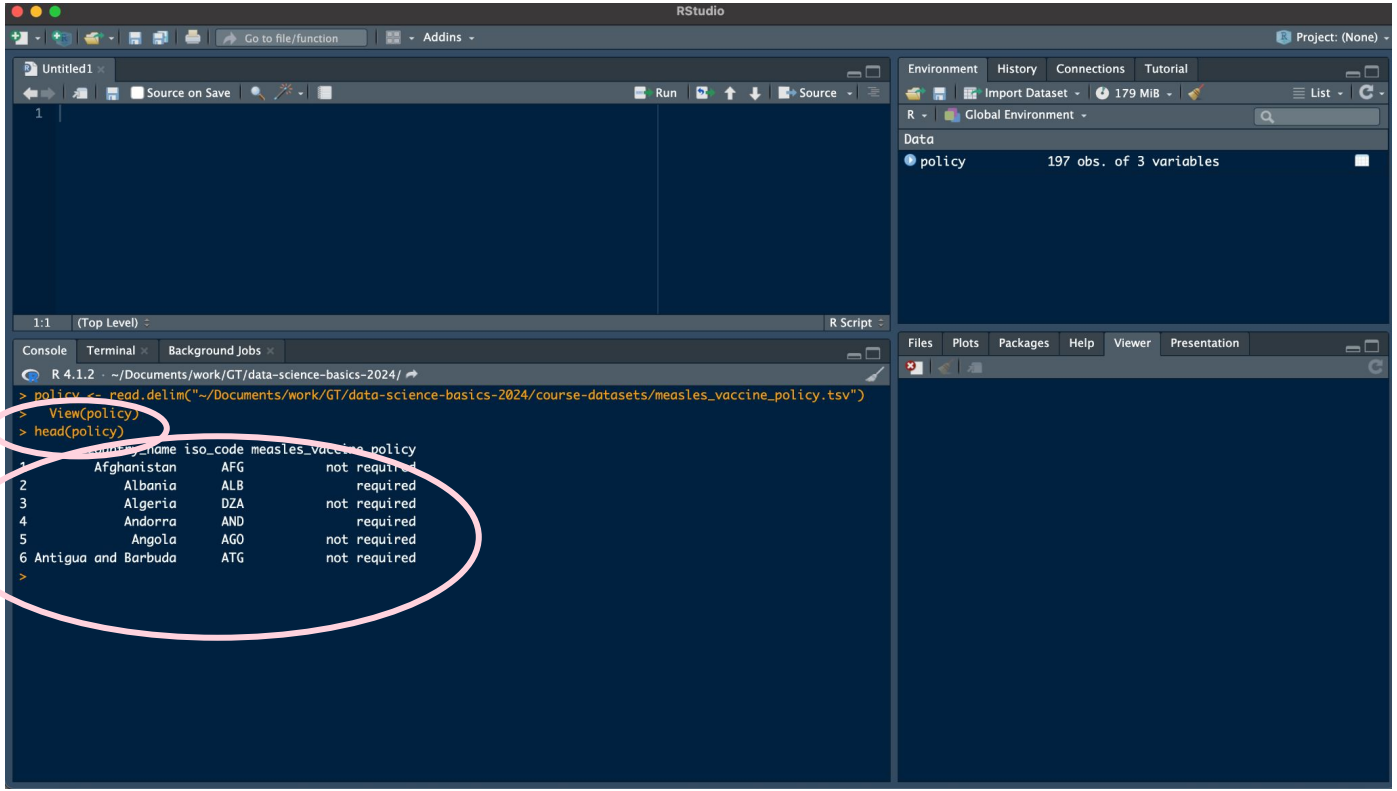
Showing 1 to 12 of 197 entries, 3 total columns

Vector


Untitled1
policy
Filter
country_name
iso_code
measles_vaccine_policy
1 Afghanistan AFG not required
2 Albania ALB required
3 Algeria DZA not required
4 Andorra AND required
5 Angola AGO not required
6 Antigua and Barbuda ATG not required
7 Argentina ARG required
8 Armenia ARM not required
9 Australia AUS required
10 Austria AUT not required
11 Azerbaijan AZE not required
12 Bahamas BHS not required
Showing 1 to 12 of 197 entries, 3 total columns

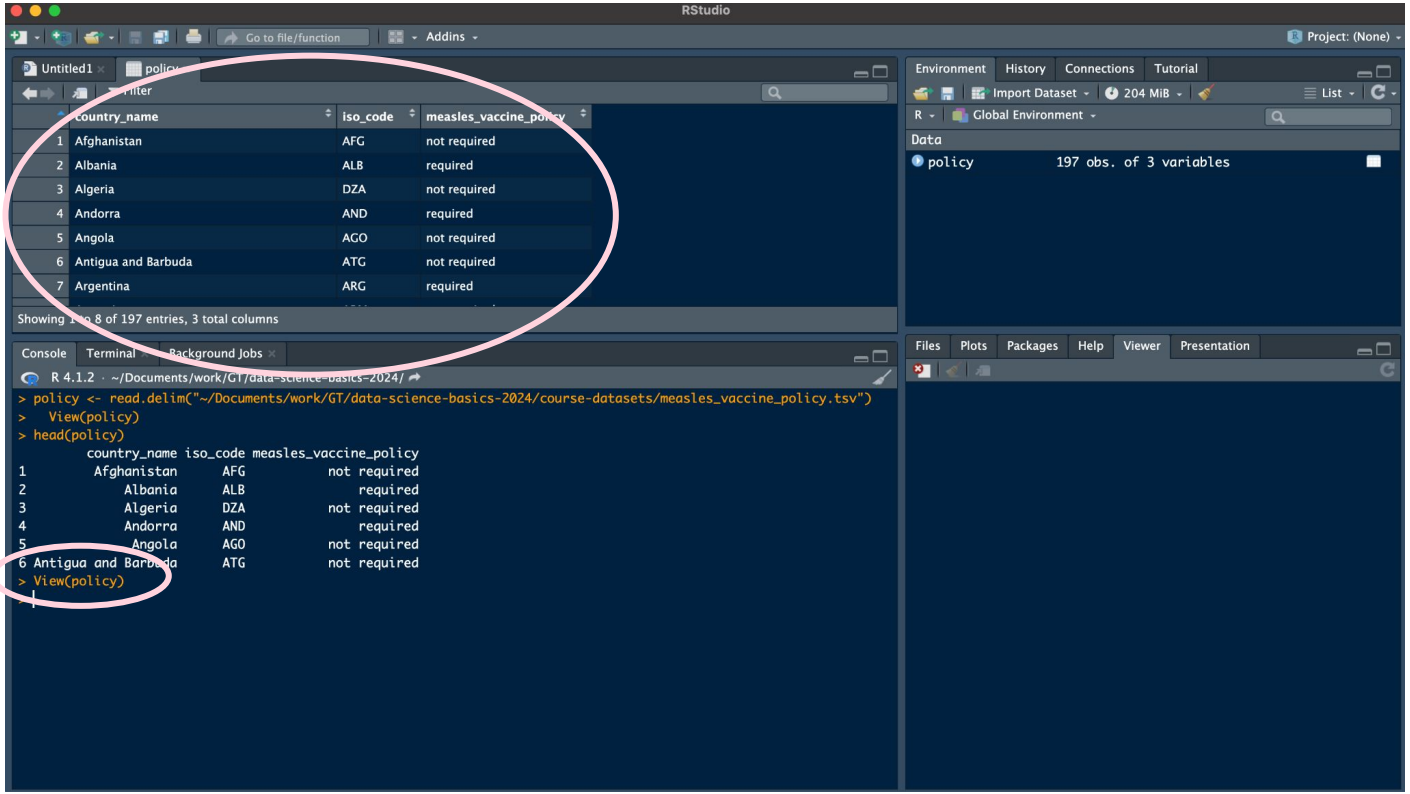
Exploring your dataset

head() function



Exploring your dataset

View() function



Exploring your dataset

Dimensions and field names

```
dim(policy)
```

```
## [1] 197   3
```

```
names(policy)
```

```
## [1] "country_name"          "iso_code"              "measles_vaccine_policy"
```

Exploring your dataset

Use anyNA() to check for missing values

```
anyNA(policy)
```

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

```
anyNA(policy$country_name)
```

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

Accessing subsets of data

selecting specific columns

```
policy$country_name
```

```
##   [1] "Afghanistan"
##   [2] "Albania"
##   [3] "Algeria"
##   [4] "Andorra"
##   [5] "Angola"
##   [6] "Antigua and Barbuda"
##   [7] "Argentina"
##   [8] "Armenia"
##   [9] "Australia"
##  [10] "Austria"
##  [11] "Azerbaijan"
##  [12] "Bahamas"
##  [13] "Bahrain"
##  [14] "Bangladesh"
##  [15] "Barbados"
##  [16] "Belarus"
##  [17] "Belgium"
##  [18] "Belize"
##  [19] "Benin"
##  [20] "Bhutan"
##  [21] "Bolivia (Plurinational State of)"
##  [22] "Bosnia and Herzegovina"
##  [23] "Botswana"
```

Your turn!

Select a different column from the policy dataset

Accessing subsets of data

selecting specific rows

```
policy[which(policy$country_name == "Angola"),]
```

```
##   country_name iso_code measles_vaccine_policy
## 5       Angola      AGO           not required
```

```
library(dplyr)

policy %>%
  filter(country_name == "Angola")
```

```
##   country_name iso_code measles_vaccine_policy
## 1       Angola      AGO           not required
```

Your turn!

Select a different row from the policy dataset

Accessing subsets of data

counts of categories with table()

```
table(policy$measles_vaccine_policy)
```

```
##
##      no data not required     required
##            2           113           82
```

Let’s switch to R

Your turn!

Go to the course github, and copy-paste the code from the **day2/** folder into the top left corner of RStudio

Live demo

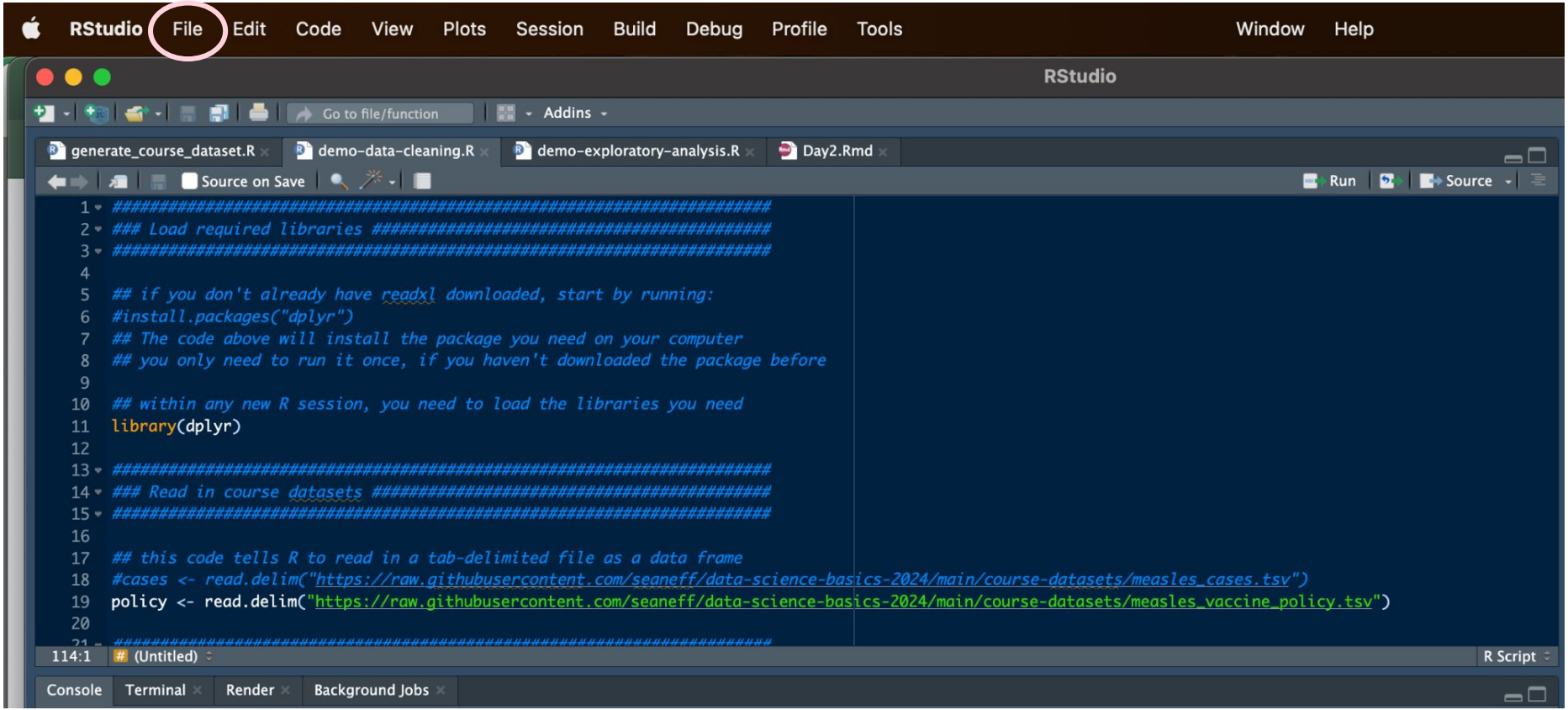
Your turn!

Pick a dataset (or a set of datasets) you'd like to work with today and tomorrow for your worked examples.

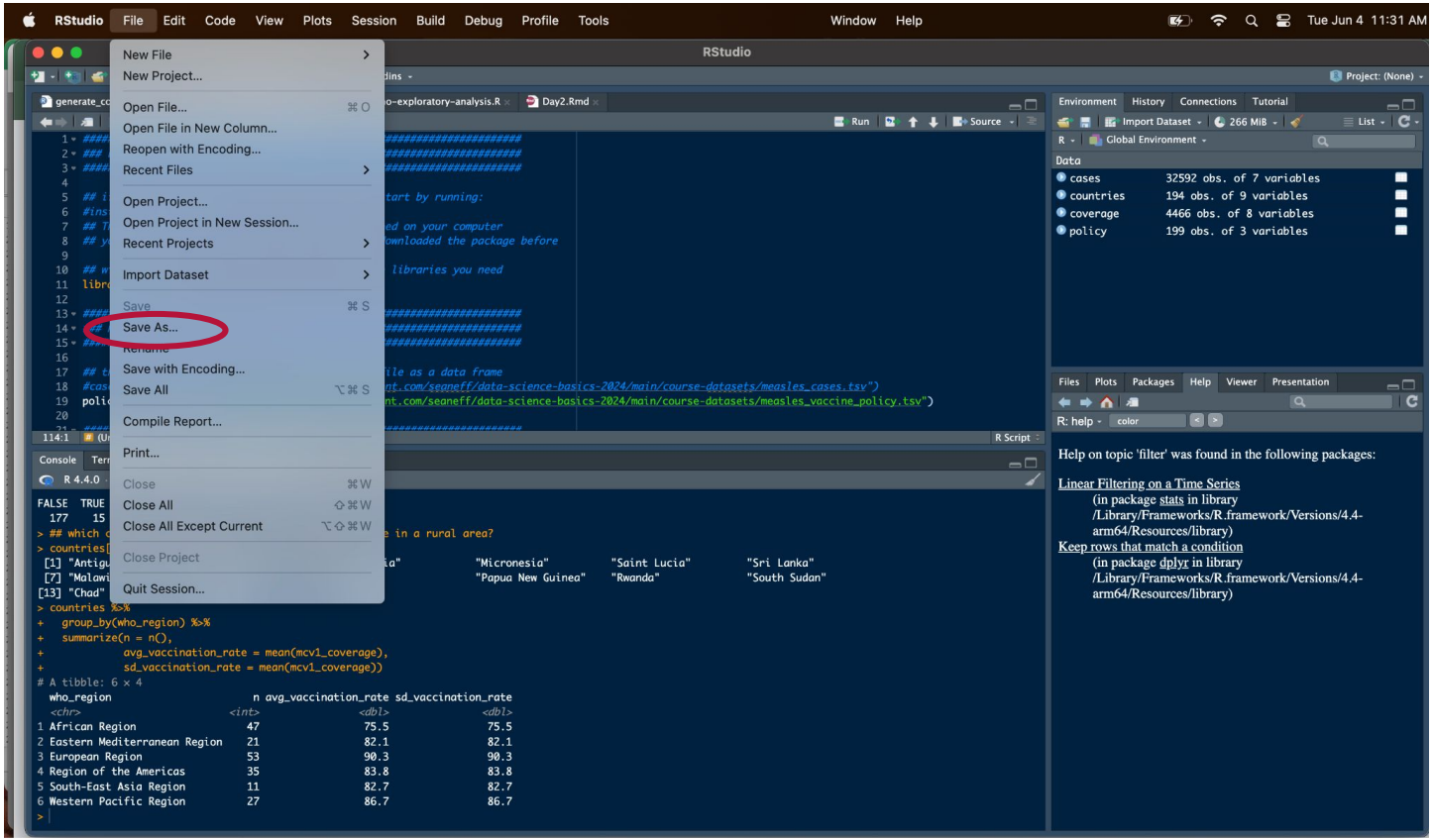
In the next 15 minutes, please draft 5-10 research or operational questions that you could explore using the dataset you selected. You can work alone or with a small group.

Add your code from today to github

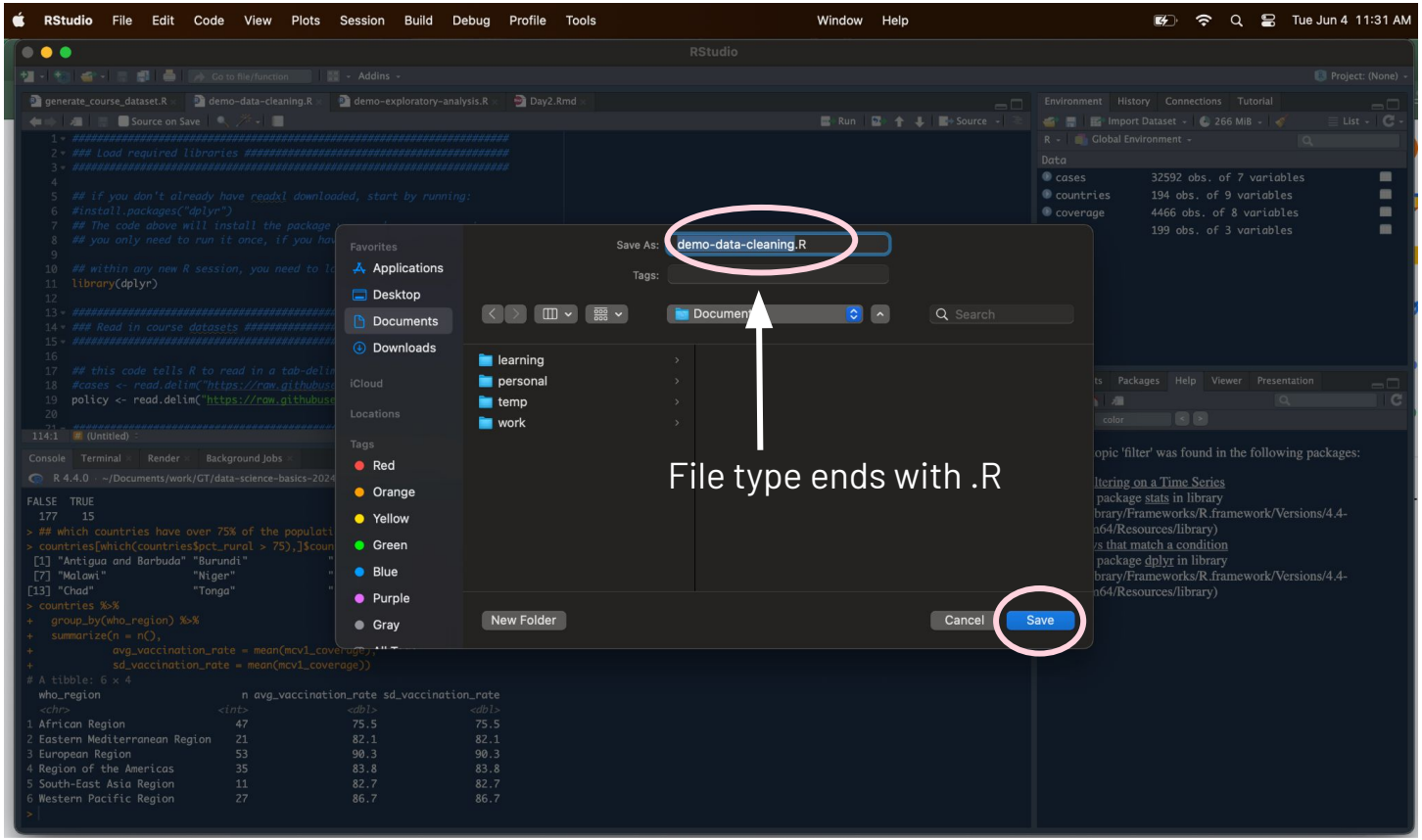
Save your R code



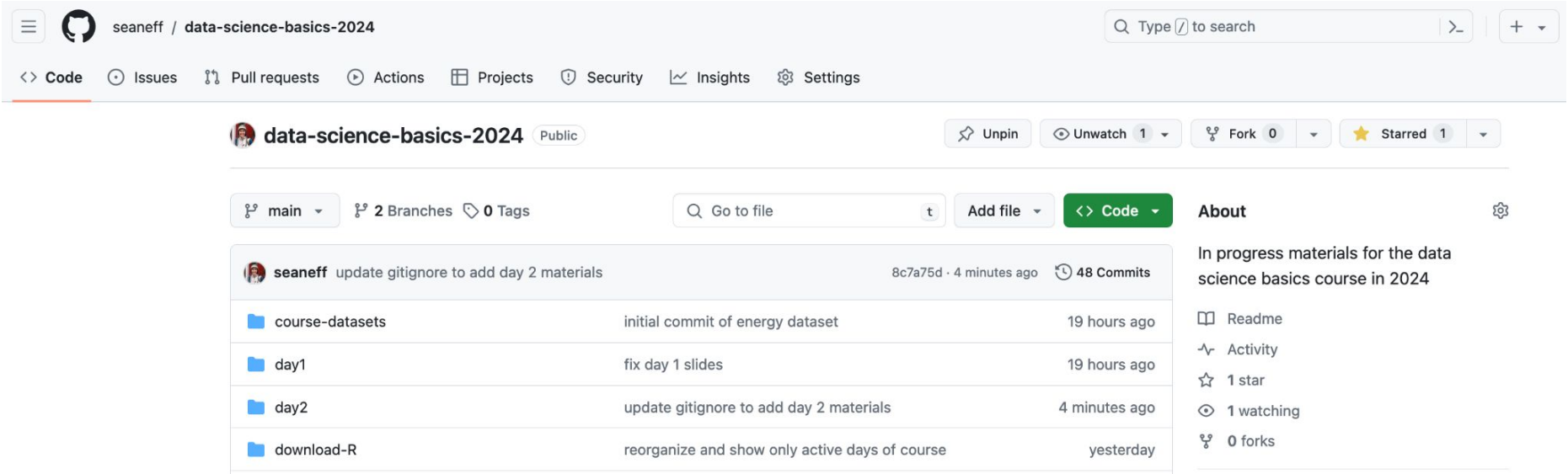
Save your R code



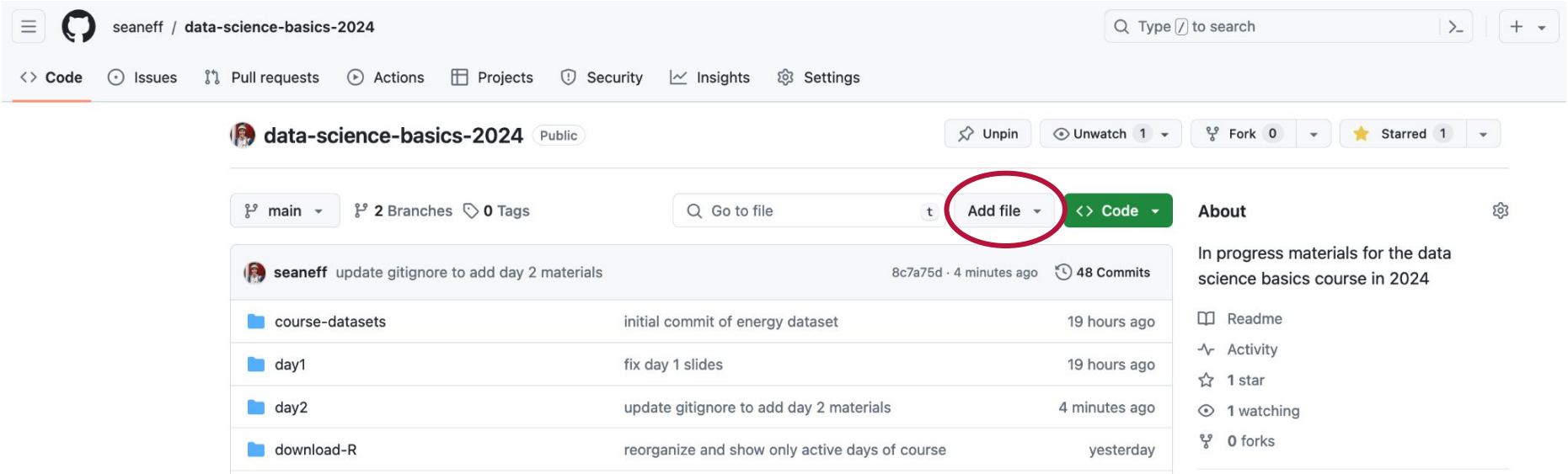
Save your R code



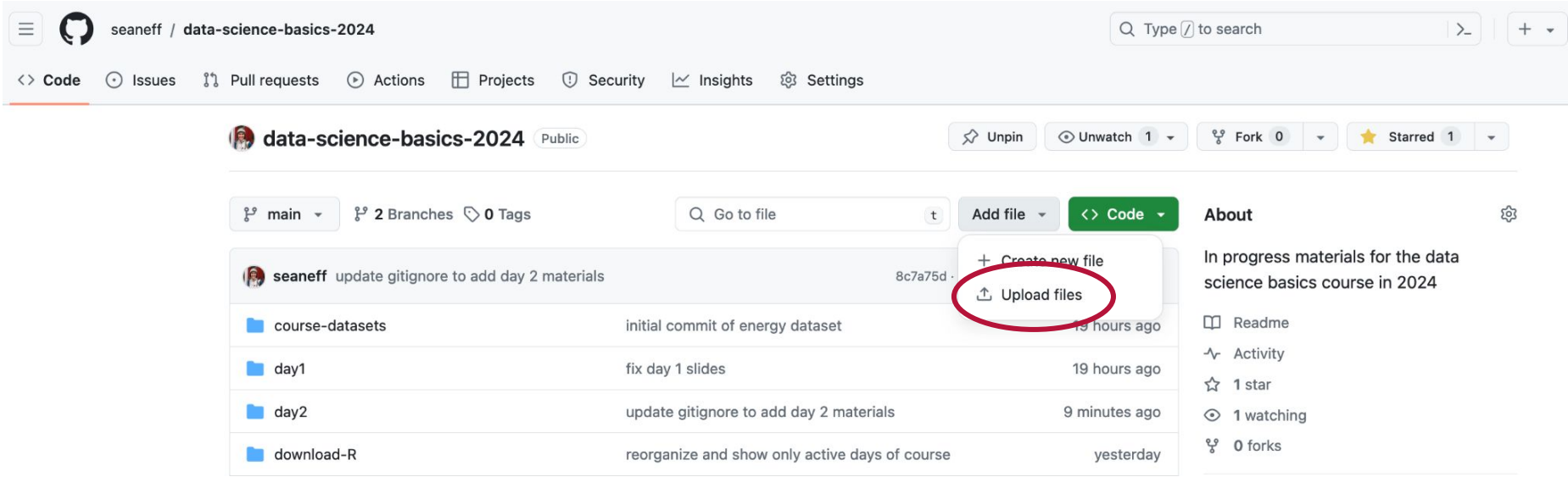
Upload your code to GitHub



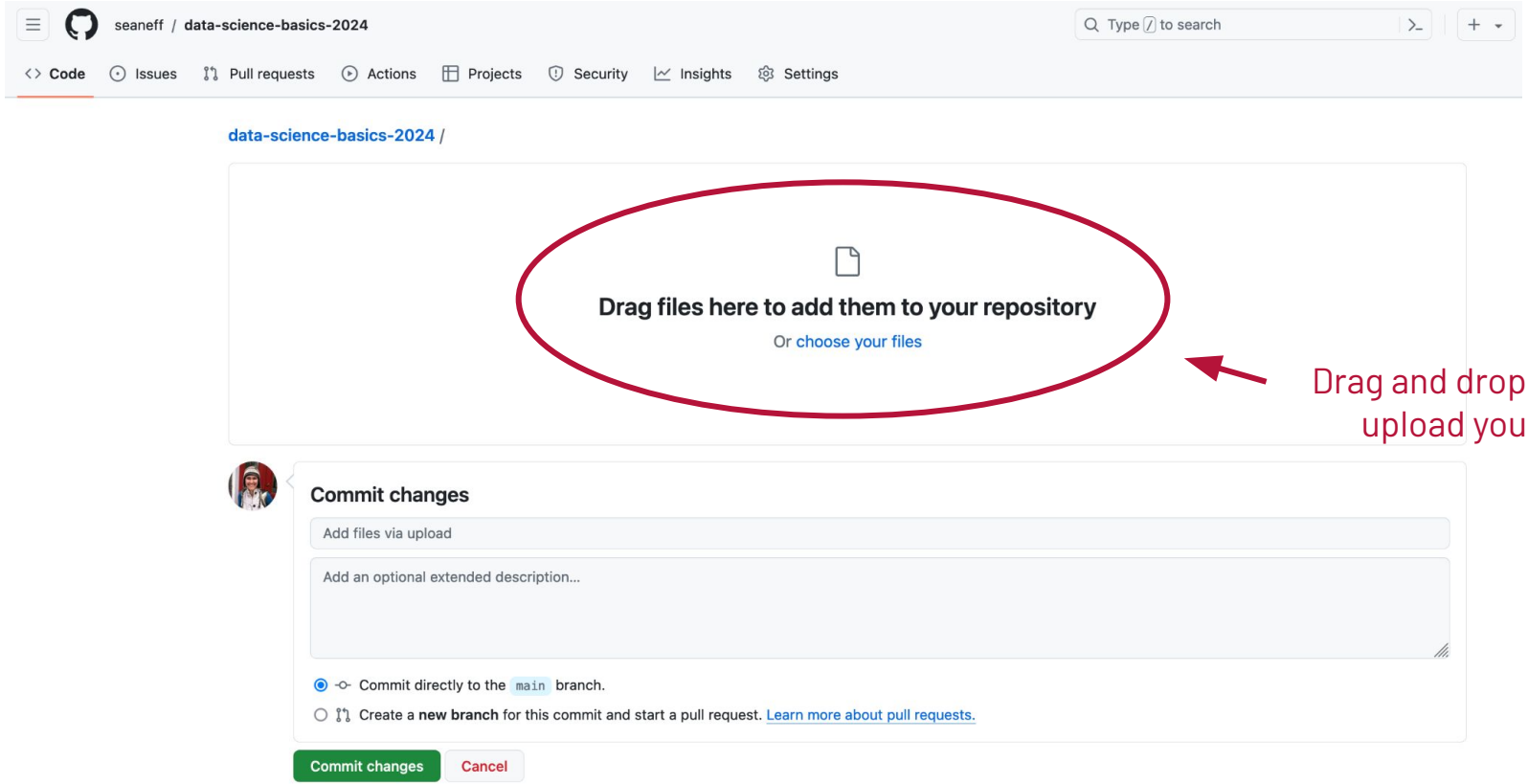
Upload your code to GitHub



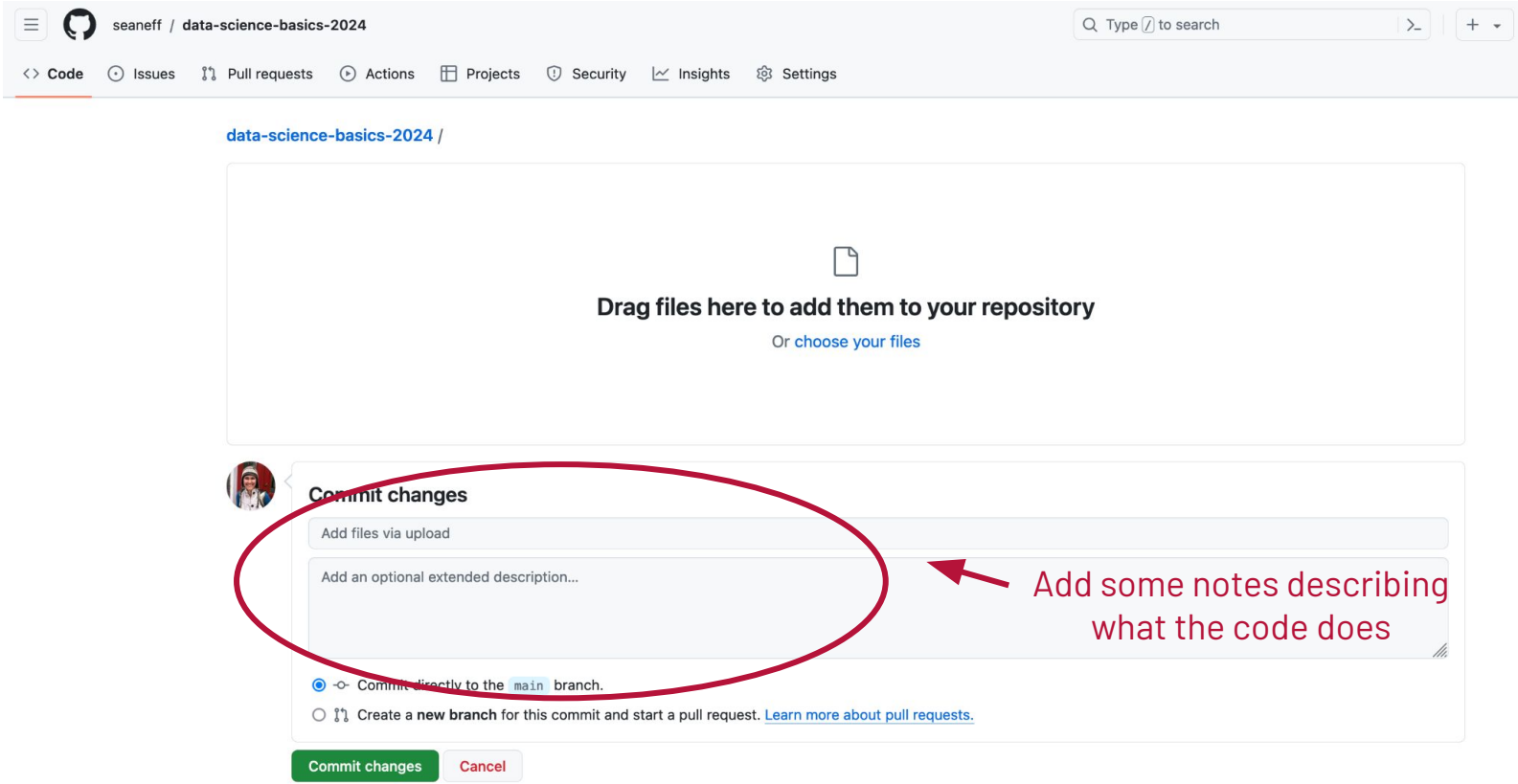
Upload your code to GitHub



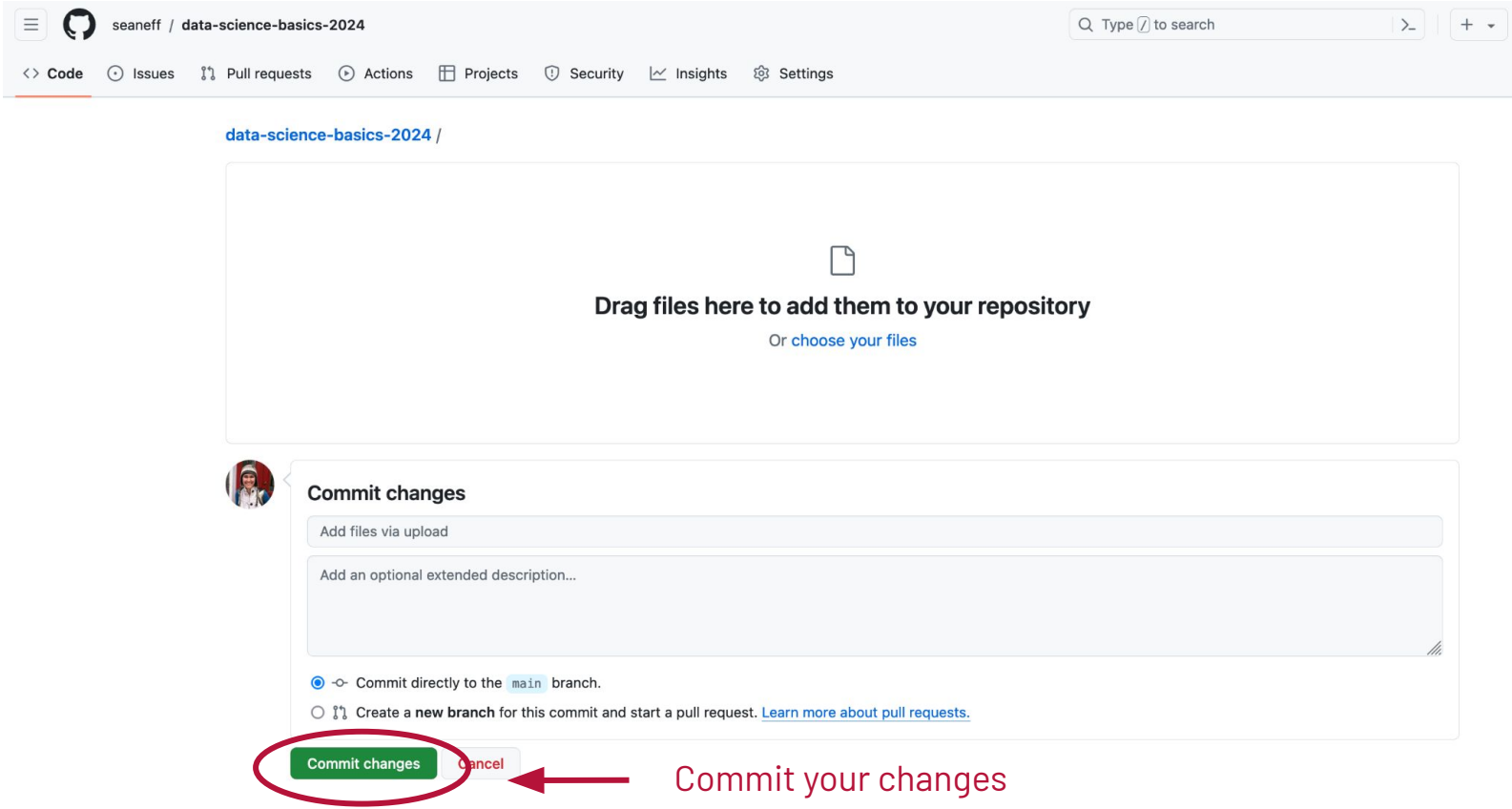
Upload your code to GitHub



Upload your code to GitHub



Upload your code to GitHub



OPTIONAL homework

explore some repositories on github

- Lots of people put code on github for lots of different types of projects
- Spend some time exploring open-source projects on github.
  - What did you find? What types of projects?
  - How were the repositories organized?
  - What surprised you?

OPTIONAL homework

explore some repositories on github

- Some examples of repositories on github to explore
  - Plague data analysis – Dr. Colin Carlson
  - A color palette for R – Dr. Karthik Ram
  - Ebola data – Dr. Caitlin Rivers
  - Amazing data visualizations – Dr. Cara Thompson

Recap from today

Data management and version control

- Understand the foundations of data management
- Learn best practices for documentation
- Load and clean your first dataset in R
  - learn about data structures
  - filter data to excluding missing values
  - explore a new dataset with summary statistics and plots
- Upload your code to GitHub

Plan for tomorrow

Exploratory data analysis

- What is exploratory data analysis (EDA)?
- Calculate basic descriptive statistics in R
- Explore different strategies for data visualization
- Make a repository on github
- Build your first data visualizations in R

Thank you!

See you tomorrow.

Please come with a fully charged laptop.