A Walk on the R Side

Online edition!

an introduction to R for data analysis

GW Libraries Workshop
October 1, 2020

go.gwu.edu/rworkshop

Logistics

- Schedule:

  3-5 R, with 1 ☕ break

  5-6 Dinner break

  6-8 R, with 1 ☕ break
- Kiri can provide individual help
- Webex
  - We'll be using these ✋ ✓ ✗ and, if needed, breakout rooms
- Collaborative Notes document: bit.ly/r_oct1

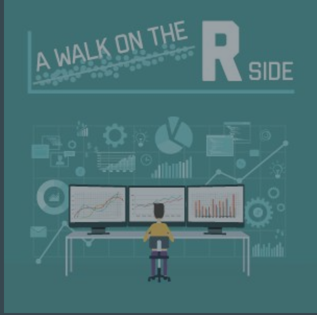
Goals

Learning Objectives

[Hopefully] You will learn how to do some of the following:

- Set up your laptop with R & RStudio (done!)
- Write and run an R program in RStudio
- Use variables of different types in R
- Use vectors and data frames in R to represent data
- Import & export data files
- "Wrangle" data in R
- Explore data in R with basic statistics and data visualizations
- Learn how to look for help to overcome obstacles

Agenda



- About R and RStudio
- Along the way: How to get help
- Hands-on:
  - variables
  - logical expressions
  - values, vectors, and data frames
  - R Studio projects
  - reading in data
  - exploring data
  - data wrangling: cleaning and reshaping
  - data visualization
  - data analysis
  - functions
  - R Markdown / reports
- Resources for further learning

Acknowledgments

software carpentry

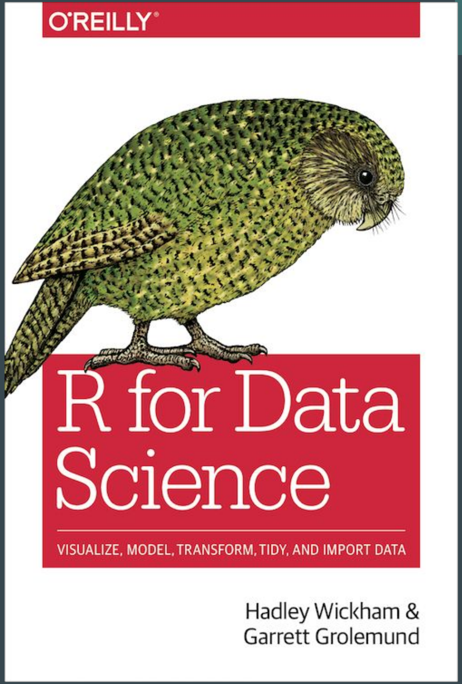
Teaching basic lab skills for research computing

DATA CARPENTRY

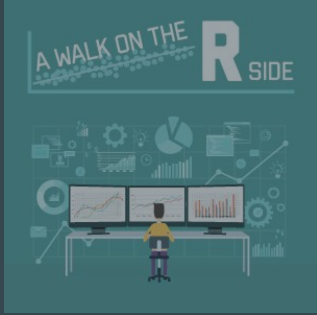
BUILDING COMMUNITIES TEACHING UNIVERSAL DATA LITERACY

R Tutorial

An R Introduction to Statistics



Workshop Housekeeping

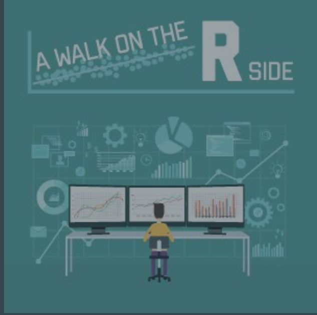


Mute unless you want to speak

Ask questions! Either via voice or chat

Use chat to help each other out

If something is confusing in the workshop, let us know.



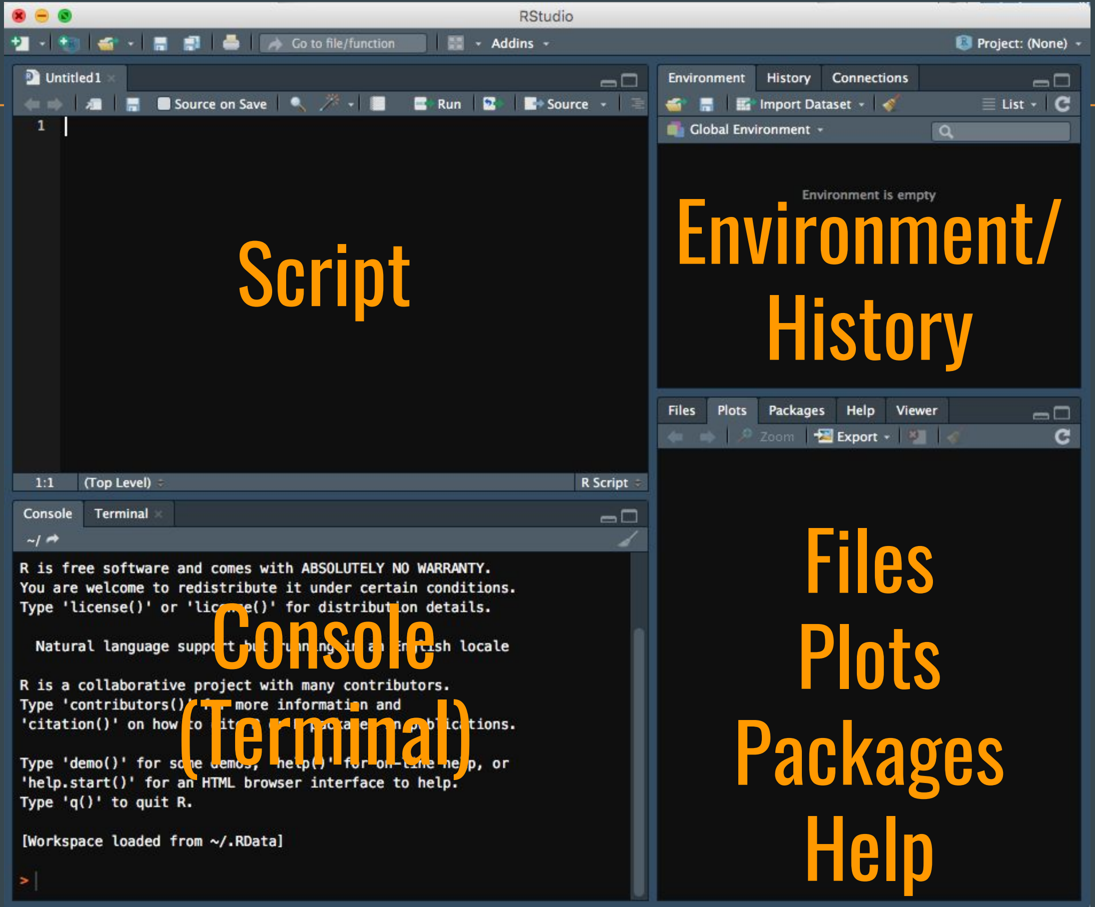
About R

- Free/Open source
- Cross-platform (Mac, Windows, Linux)
- For statistical computing (and data visualization)
- CRAN - r-project.org
  - R packages
  - R journal

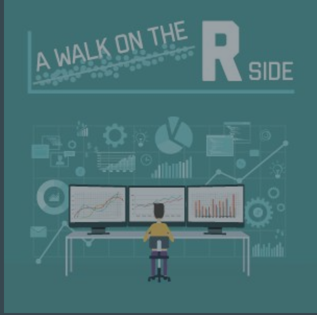
Reasons ReseaRcheRs pRefeR R

- Scripted language (vs. point/click)
- Features built around working with data
- Reproducibility
- Interdisciplinary
- Extensible
- Beautiful data visualization
- Community - RStudio Community, Stack Overflow

R Studio



```
R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

  Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[Workspace loaded from ~/.RData]

>
```



Variables/Objects

"Binding" data to a named object/variable allows you to store data in memory and access it later.

```
x <- 5

y <- c("Washington", "Chicago", "Washington", "Boston")

z <- data.frame(pt_id = c("A001", "B204"), bpm = c(60, 72))
```

Variables

- Try using R as a "calculator" in the Console
  - Try some mathematical functions, too
- Create some variables
  - variable naming
  - `<-` for assigning values to variables (Option - on Mac, Alt - on Win)
  - numeric, character, logical
  - Watch the Environment pane!
  - `typeof()`
  - Coercion w/ `as.integer, as.character, as.logical, as...`

Logical Expressions

- Operators include:
  ==, <, >, ! (not), & (and), | (or), etc.

Basic Data Structures

Atomic Vector

10.2

Vector

1	10.2
2	11.3
3	11.5
4	12.0

Data Frame

	time	temp	boiling
1	51	10.2	FALSE
2	58	11.3	FALSE
3	63	11.5	FALSE
4	70	12.0	TRUE

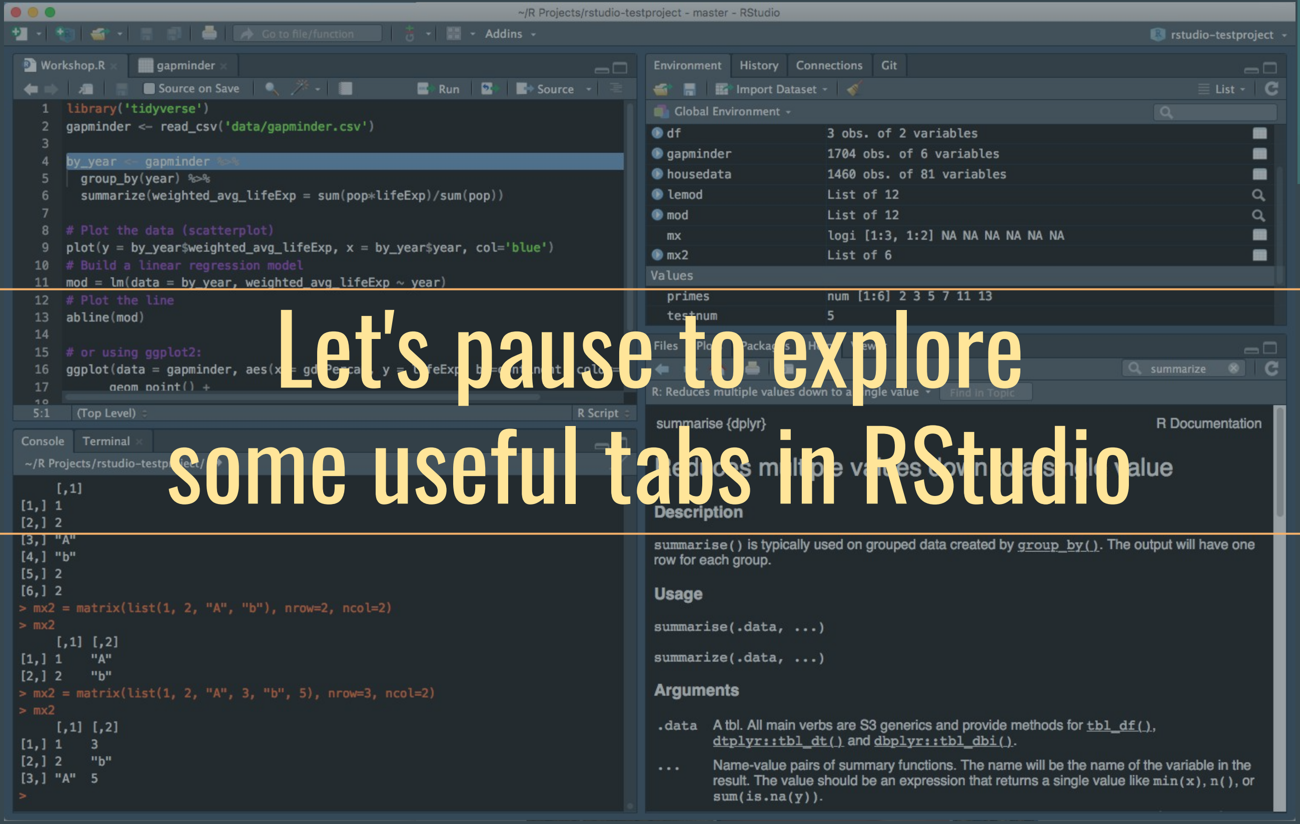
Vectors

Vectors

- A vector is
  - A sequence of data elements (components) all of the same type.
- Create vectors with `c()` (short for "combine")

A WALK ON THE R SIDE

Let's pause to explore some useful tabs in RStudio



```r
library('tidyverse')
gapminder <- read_csv('data/gapminder.csv')

by_year <- gapminder %>%
  group_by(year) %>%
  summarize(weighted_avg_lifeExp = sum(pop*lifeExp)/sum(pop))

# Plot the data (scatterplot)
plot(y = by_year$weighted_avg_lifeExp, x = by_year$year, col='blue')
# Build a linear regression model
mod = lm(data = by_year, weighted_avg_lifeExp ~ year)
# Plot the line
abline(mod)

# or using ggplot2:
ggplot(data = gapminder, aes(x = gdpPercap, y = lifeExp, by=continent, color=
      geom_point() +
```

df	3 obs. of 2 variables
gapminder	1704 obs. of 6 variables
housedata	1460 obs. of 81 variables
lemod	List of 12
mod	List of 12
mx	logi [1:3, 1:2] NA NA NA NA NA NA
mx2	List of 6
Values	
primes	num [1:6] 2 3 5 7 11 13
testnum	5

```
     [,1]
[1,] 1
[2,] 2
[3,] "A"
[4,] "b"
[5,] 2
[6,] 2
> mx2 = matrix(list(1, 2, "A", "b"), nrow=2, ncol=2)
> mx2
     [,1] [,2]
[1,] 1    "A"
[2,] 2    "b"
> mx2 = matrix(list(1, 2, "A", 3, "b", 5), nrow=3, ncol=2)
> mx2
     [,1] [,2]
[1,] 1    3
[2,] 2    "b"
[3,] "A"  5
>
```

summarise {dplyr} R Documentation

Reduces multiple values down to a single value

Description

`summarise()` is typically used on grouped data created by `group_by()`. The output will have one row for each group.

Usage

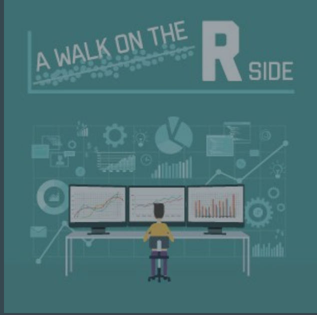
```
summarise(.data, ...)

summarize(.data, ...)
```

Arguments

`.data` A tbl. All main verbs are S3 generics and provide methods for `tbl_df()`, `dtplyr::tbl_dt()` and `dbplyr::tbl_dbi()`.

`...` Name-value pairs of summary functions. The name will be the name of the variable in the result. The value should be an expression that returns a single value like `min(x)`, `n()`, or `sum(is.na(y))`.

Data Frames



Data Frames

- A `data.frame` stores a data table
- Comprised of vectors of equal length. Vectors become columns.
- Columns and rows can have names.
- `tibble` (from the tibble package) has some advantages over `data.frame`

A brief word on `list` and `matrix`

Projects in RStudio

Projects in RStudio

Recommendations:

- Use [Github for] **version control**!
- Create folders to keep things organized

It's time to import some data!

Data Importing

- Prepare data as "tidy"
  - rectangular
  - one table per file
  - rows are observations, columns are variables

- Formats: CSV, TSV, Excel, Fixed-Width, JSON... and with the right packages: Stata, SPSS, SAS... (using **`rio`** or **`haven`**)

- A word about "big data" (consider **`data.table`**)

R Packages

flickr.com/photos/philocrites/405250216

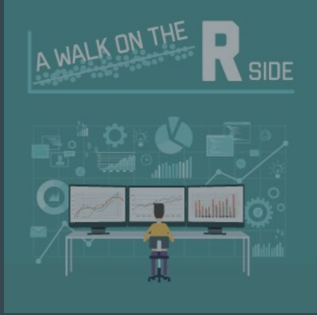
Installing and loading R packages

- `install.packages('mypackage')`
- `library(mypackage)`

Tidyverse Core Packages

tidyverse.org

- ggplot2 - graphics
- dplyr - data manipulation
- tidyr - tidying data
- readr - reading in data
- tibble - modern data frame
- purrr - functional programming



Other often-used R packages

Loading in various data file types	↔	haven, readxl
Mapping	↔	rgdal, tmap, leaflet
Analyzing 2D and 3D shapes	↔	geomorph
Genomic data	↔	bioconductor
Cluster analyses	↔	cluster
Time series data	↔	forecast
Text mining	↔	qdap, sentimentr, tidytext
graph/network analysis	↔	igraph, sna
Interactive web visualizations	↔	shiny
Web scraping	↔	rvest

Exploring Data

- head, tail
- subsetting
- slicing and dicing

Data Wrangling

flickr.com/photos/thewomensmuseum/3607075017

Data Transformation using the dplyr package

- filter()
- arrange()
- select()

- mutate()
- summarize()
- group_by()
- ...

You will want to use a "pipe": %>%

(shortcut: control-shift-M)

flickr.com/photos/jonasb/3151160389

Data Tidying with dplyr

- gather()
- spread()
- separate()
- unite()

Joining with dplyr

"Merges" tables together

- left_join()
- right_join()
- ...

Data Visualization
with "base R" and ggplot

Data Analysis

Functions

R Markdown

R Markdown

- A format for writing reproducible, dynamic reports with R (as HTML, PDF, MS Word, and more)
- rmarkdown.rstudio.com
- # Header 1
  ## Header 2
  Italic **bold**
- Insert R code directly into your document

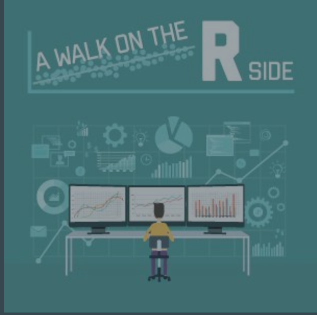
~~~
```{r setup}
# your R code goes here
```
~~~

- Include LaTeX code with $ or $$

R Shiny

Some Handy R Links

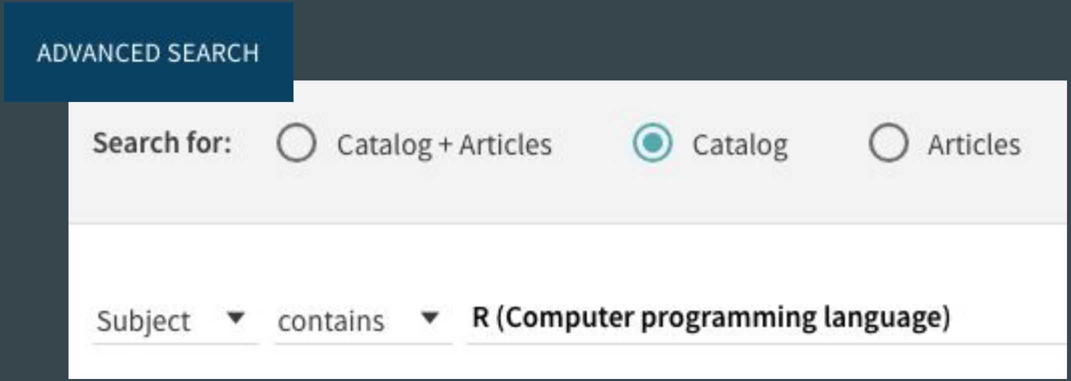
Tutorials



- RStudio R paths: education.rstudio.com/learn/
- Data Carpentry & Software Carpentry:
  - datacarpentry.org/R-ecology-lesson/
  - datacarpentry.org/r-socialsci/
  - swcarpentry.github.io/r-novice-inflammation
  - swcarpentry.github.io/r-novice-gapminder
- Linkedin Learning @ GW: go.gwu.edu/linkedinlearning
- r-tutor.com/r-introduction & r-tutor.com/elementary-statistics
- R Graph Gallery (w/code): r-graph-gallery.com

Books you can access for free

- Free books online - Hadley Wickham:
  - R for Data Science [r4ds.had.co.nz](r4ds.had.co.nz)
  - Advanced R adv-r.hadley.nz/
- Through your GW library privileges:

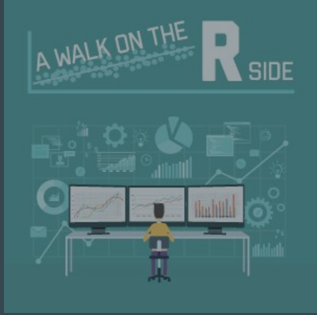


ADVANCED SEARCH

Search for: ○ Catalog + Articles ● Catalog ○ Articles

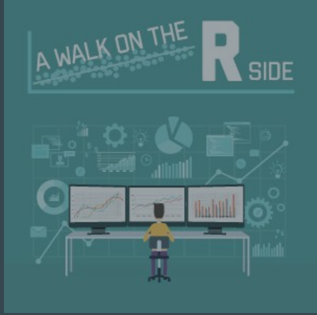
Subject ▾ contains ▾ R (Computer programming language)

Reference Links



- R language (CRAN): r-project.org
- R search engine: rseek.org
- rstudio.com
  - Cheat Sheets! rstudio.com/resources/cheatsheets
- stackoverflow.com

Thanks!



Dan Kerchner kerchner@gwu.edu

These slides: go.gwu.edu/rworkshop

R or Statistics Appointments: calendly.com/statistical-consulting-gw

Appointments with me: calendly.com/kerchner

Coding consultations (Python, git, etc.): calendly.com/gwul-coding/