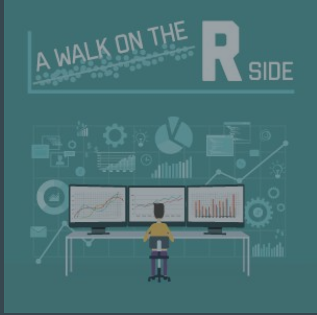
A Walk on the R Side

an introduction to R for data analysis

GW Libraries Workshop
September 2022

go.gwu.edu/rworkshop

FAQ



Q: Will this workshop be recorded?

A: Yes, but it will not be posted publicly. Email me for the link!

Q: Will you sign my form for Professional Enhancement hours?

A: Yes, email me!

Q: Can I get a copy of your R code?

A: Yes, email me

Logistics

- Schedule

  12:45 - 5:00

  ~ 3 ☕ breaks

Upcoming R workshops

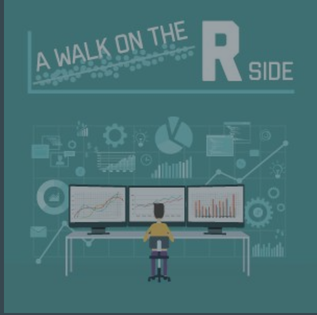
- Oct. 7, 14, 28 (Fridays 10a-12p) - Statistical Inference with R
- Nov. 4 (Friday 10a-12p) - Interactive Data Viz w/RShiny

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

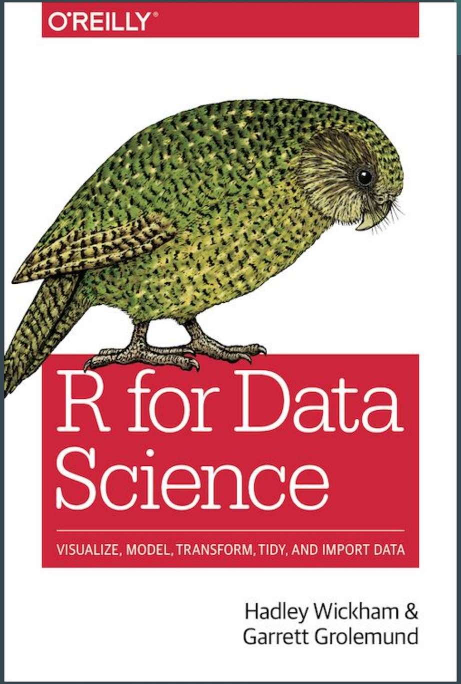
DATA CARPENTRY

BUILDING COMMUNITIES TEACHING UNIVERSAL DATA LITERACY

R Tutorial

An R Introduction to Statistics

r-tutor.com



O'REILLY

R for Data Science

VISUALIZE, MODEL, TRANSFORM, TIDY, AND IMPORT DATA

Hadley Wickham & Garrett Grolemund

r4ds.had.co.nz

Workshop Housekeeping

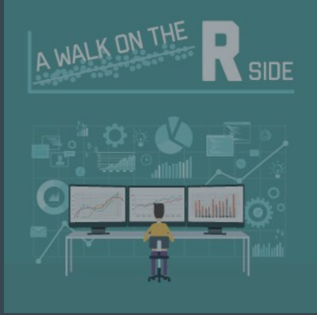
Ask questions! Either via voice or chat

Use chat to help each other out

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

About R

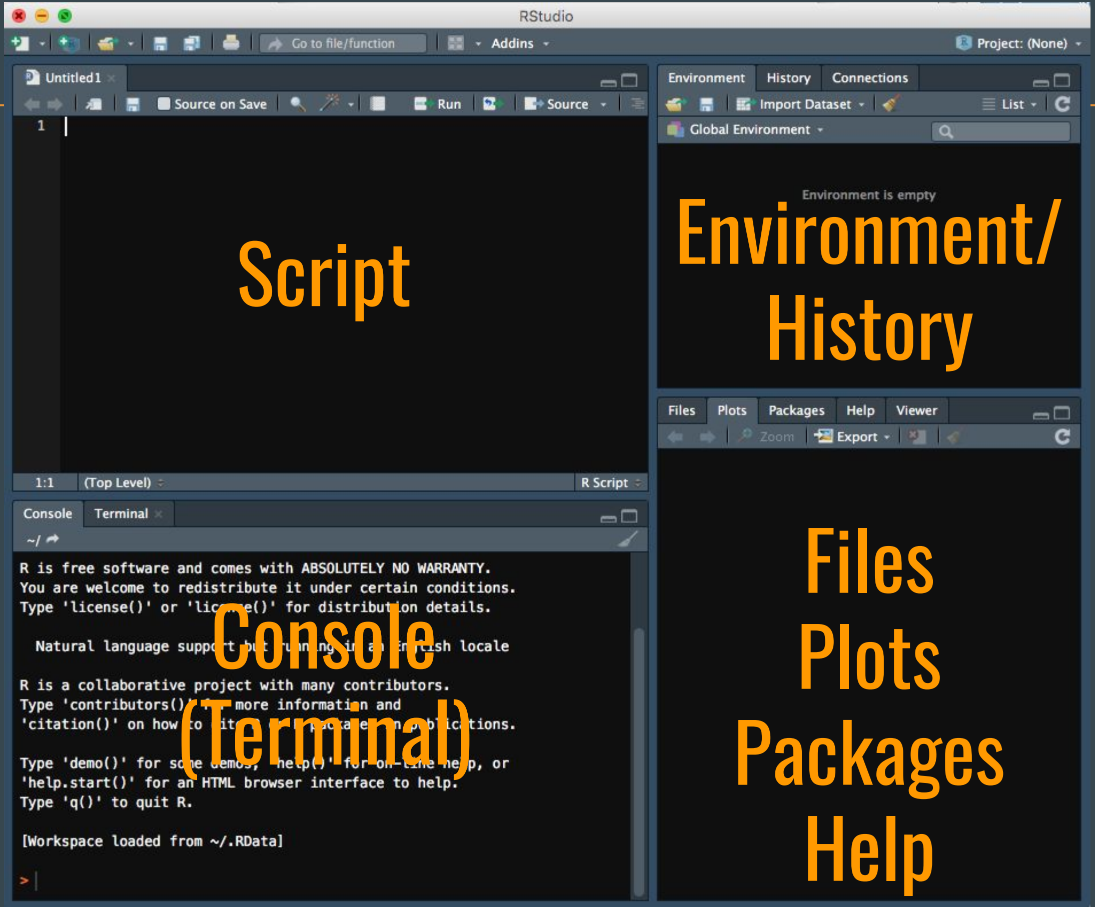
- Free/Open source
- Cross-platform (Mac, Windows, Linux)
- For statistical computing (and data visualization)
- CRAN - r-project.org
    - R packages
    - R journal



Reasons researchers prefer R

- Scripted language (vs. point/click)
- Features built around working with data
- Reproducibility
- Interdisciplinary
- Extensible
- Beautiful data visualization
- RStudio is a well-liked R development app
- 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]

>
```

Script

Environment/
History

Console
(Terminal)

Files
Plots
Packages
Help

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))
```

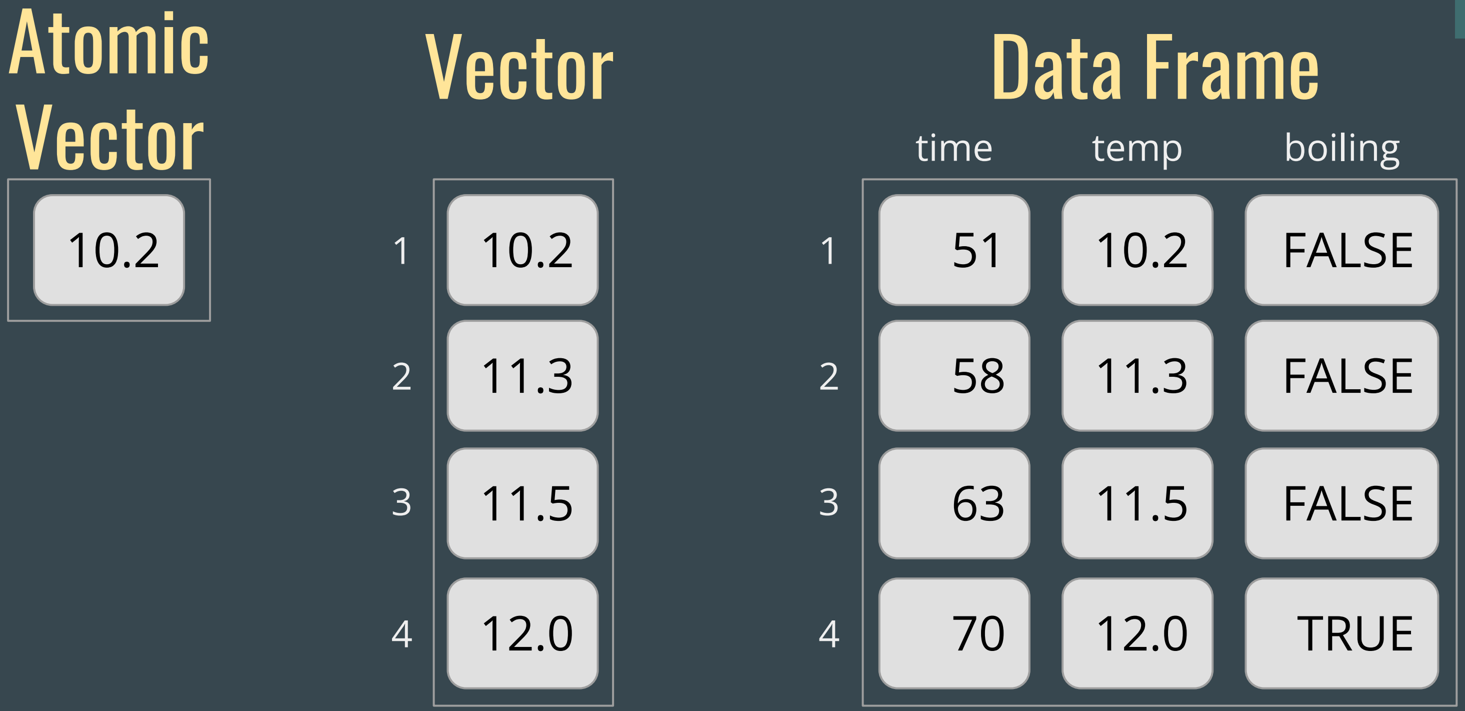
Variables

- 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

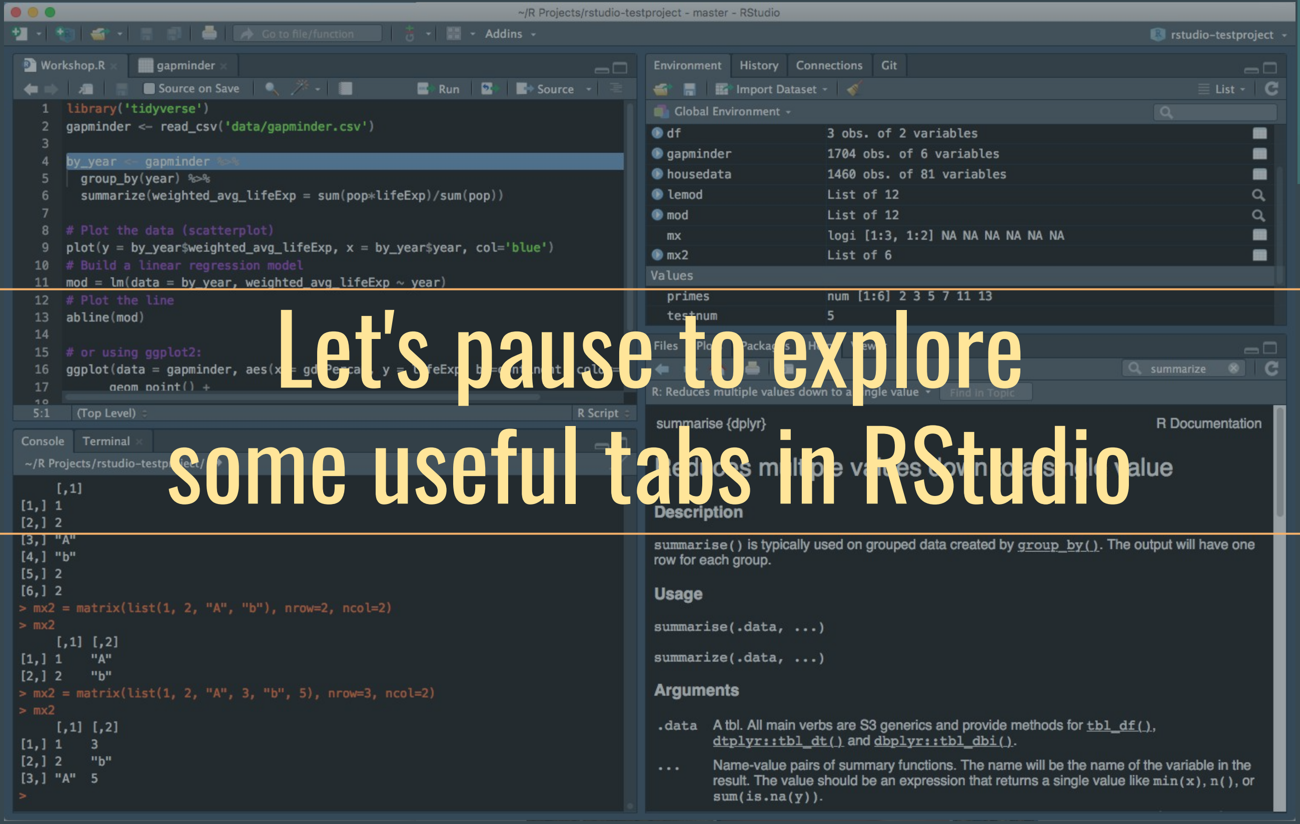
	time	temp	boiling
1	51	10.2	FALSE
2	58	11.3	FALSE
3	63	11.5	FALSE
4	70	12.0	TRUE

Vectors

Vectors

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

Let's pause to explore some useful tabs in RStudio



```
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, b = continent, col =
      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
>
```

R: Reduces multiple values down to a single value

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

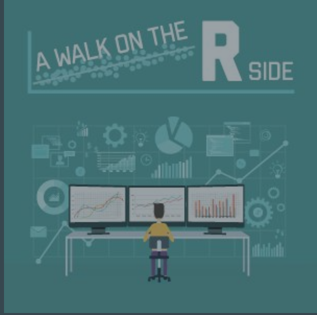
```
summarise(.data, ...)

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)`

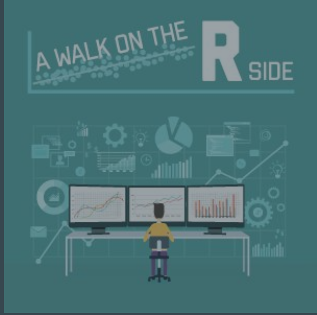
Tidyverse Core Packages

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

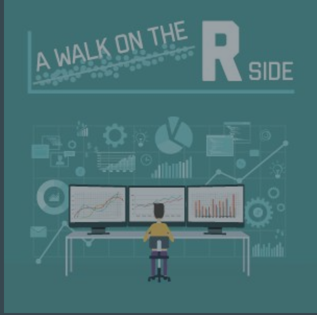
Data Tidying with dplyr

- 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

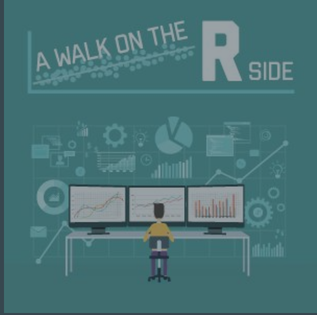
Parting thoughts

Recommended practices

- Use Projects in RStudio
    - Set up folders
- Use tidyverse packages (dplyr, tidyr, etc.) to wrangle your data
- Leave raw data raw
- 🧹 Empty out your variables, then make sure your script runs from the top
- Learn by finding and using working examples

Some Handy R Links

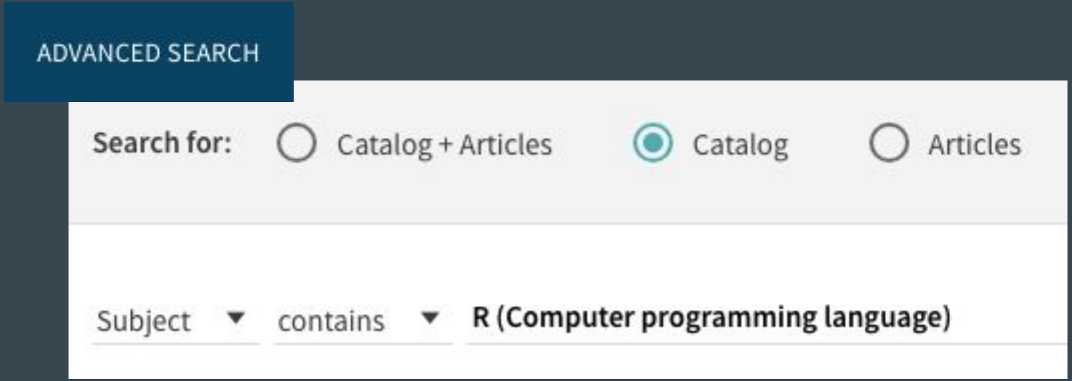
Tutorials



- 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:



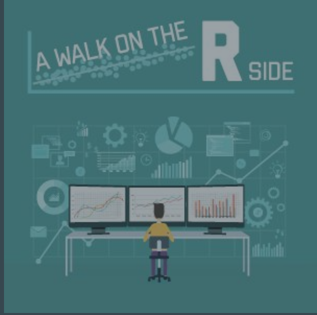
ADVANCED SEARCH

Search for: ○ Catalog + Articles ● Catalog ○ Articles

Subject ▾ contains ▾ R (Computer programming language)

Reference Links

- R language (CRAN): r-project.org
- Other R packages (not on CRAN): r-universe.dev
- 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: academiccommons.gwu.edu/data-consulting

Appointments with me: calendly.com/kerchner

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