

A Walk on the Side

an introduction to R for data analysis

...

GW Libraries Workshop
Spring 2019

go.gwu.edu/rworkshop



Goals



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



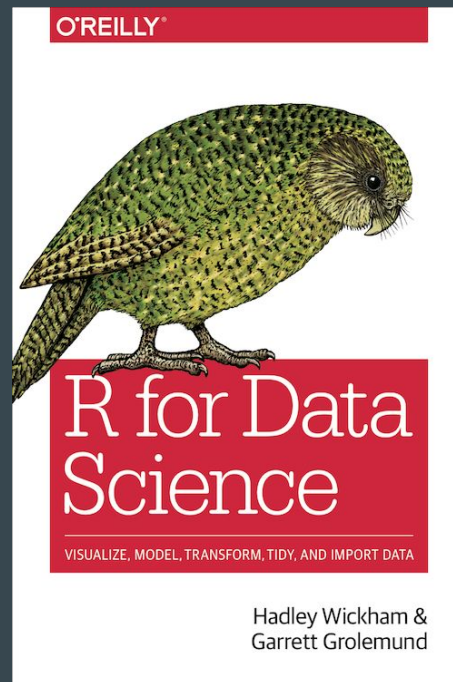
Teaching basic lab skills
for research computing

DATA CARPENTRY

BUILDING COMMUNITIES TEACHING UNIVERSAL DATA LITERACY

R Tutorial

An R Introduction to Statistics



Workshop Housekeeping

Ask questions!

Respect every question and person asking the question

Help each other out!

If something is confusing in the workshop,
it probably needs improvement; let us know.

Stay as long as you like

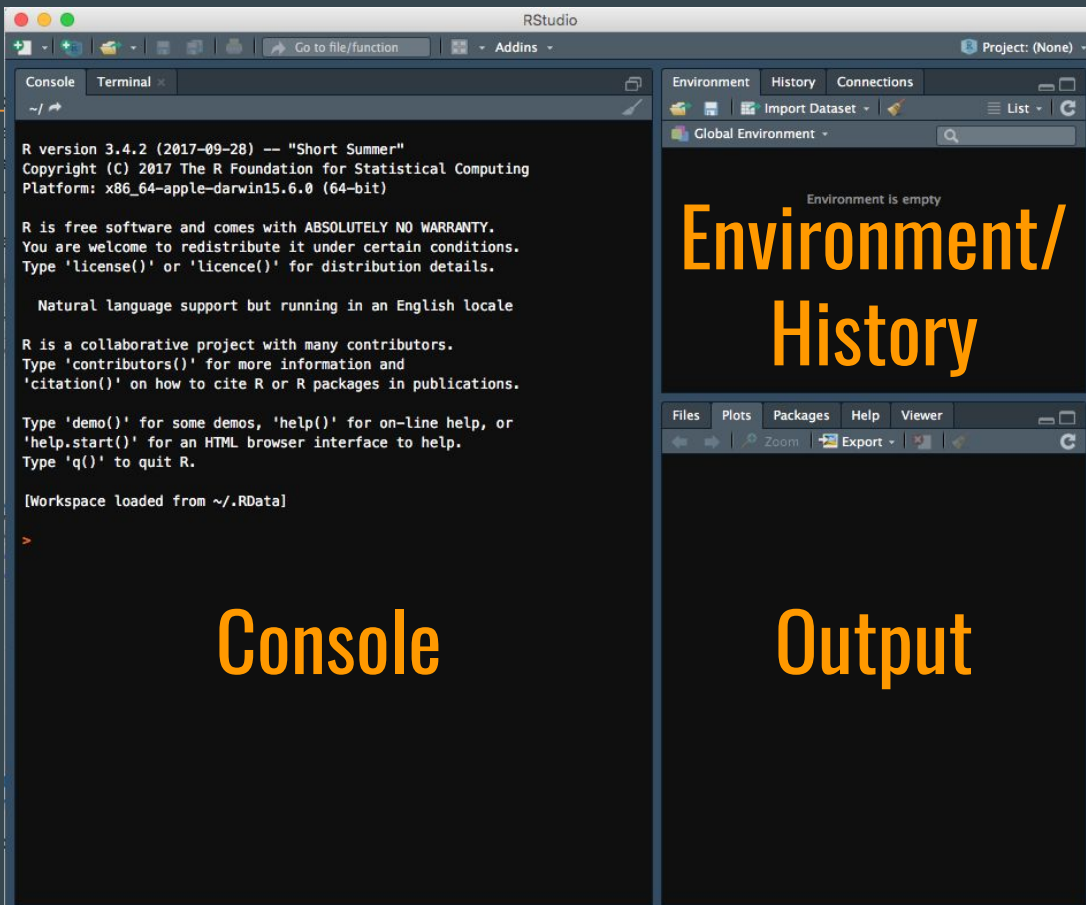


About R

- Free/Open source
- For statistical computing (and data visualization)
- CRAN - r-project.org
 - [R packages](#)
 - [R journal](#)
 - ...



R Studio



The screenshot displays the RStudio application window. The top toolbar includes icons for file operations and a menu bar with 'Go to file/function' and 'Addins'. The main interface is divided into four panes. The left pane is the 'Console', which contains the R startup message and workspace information. The right pane is the 'Environment/History' pane, which shows the 'Global Environment' and a message that the environment is empty. The bottom pane is the 'Output' pane, which is currently empty. The top-right pane is the 'Files' pane, which shows the file explorer.

Console

```
R version 3.4.2 (2017-09-28) -- "Short Summer"
Copyright (C) 2017 The R Foundation for Statistical Computing
Platform: x86_64-apple-darwin15.6.0 (64-bit)

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]
```

Environment/History

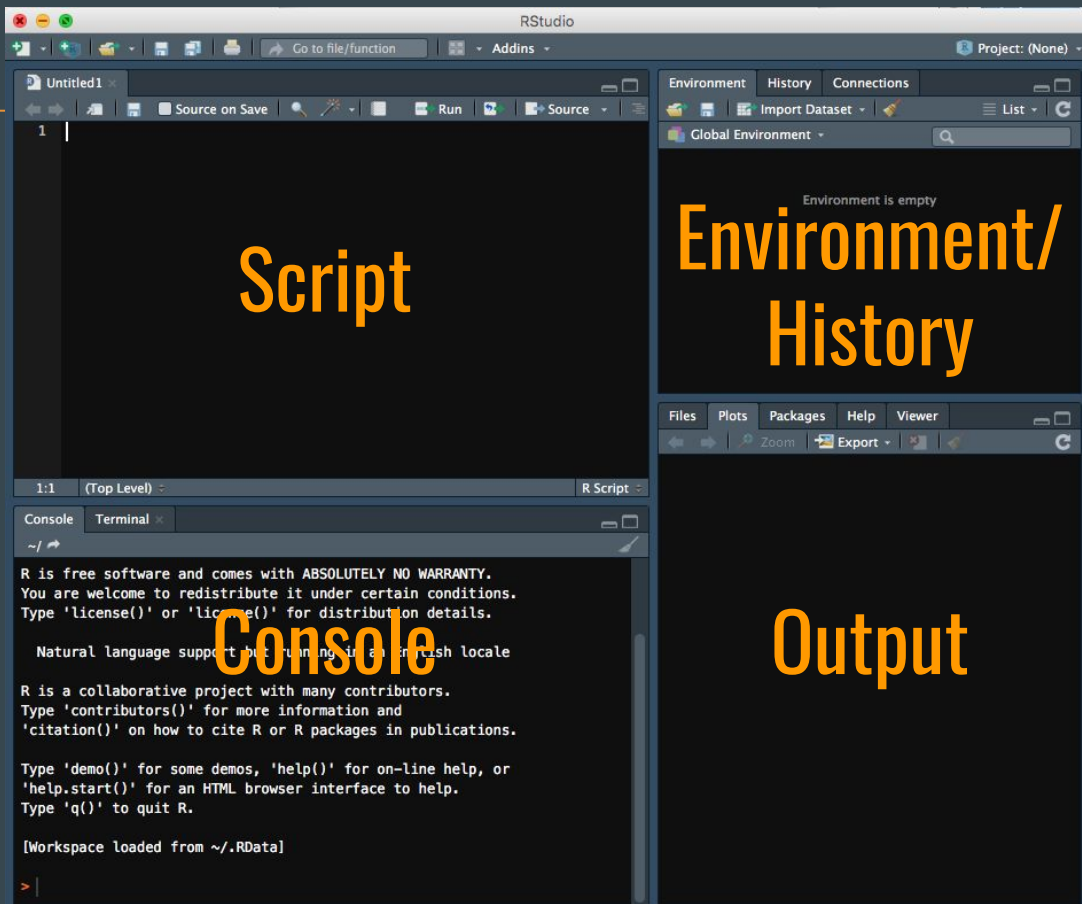
Environment is empty

Output

A WALK ON THE R SIDE



R Studio



A WALK ON THE R SIDE





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.





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

~ / R Projects / rstudio-testproject - master - RStudio

Workshop.R x gapminder x

Source on Save Run Addins

```
1 library('tidyverse')
2 gapminder <- read_csv('data/gapminder.csv')
3
4 by_year <- gapminder %>%
5   group_by(year) %>%
6   summarize(weighted_avg_lifeExp = sum(pop*lifeExp)/sum(pop))
7
8 # Plot the data (scatterplot)
9 plot(y = by_year$weighted_avg_lifeExp, x = by_year$year, col='blue')
10 # Build a linear regression model
11 mod = lm(data = by_year, weighted_avg_lifeExp ~ year)
12 # Plot the line
13 abline(mod)
14
15 # or using ggplot2:
16 ggplot(data = gapminder, aes(x=year, y=lifeExp, base_indent=1, color=continent))
17   geom_point() +
18   # ...
19
20 5:1 (Top Level) R Script
```

Environment History Connections Git

Global Environment

- 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
- mx2 List of 6

Values

primes num [1:6] 2 3 5 7 11 13

testnum 5

Files Packages Help

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))`.

Console Terminal

```
~/R Projects / rstudio-testproject - master - RStudio
```

```
[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
>
```



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**

To summarize...



Value

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



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



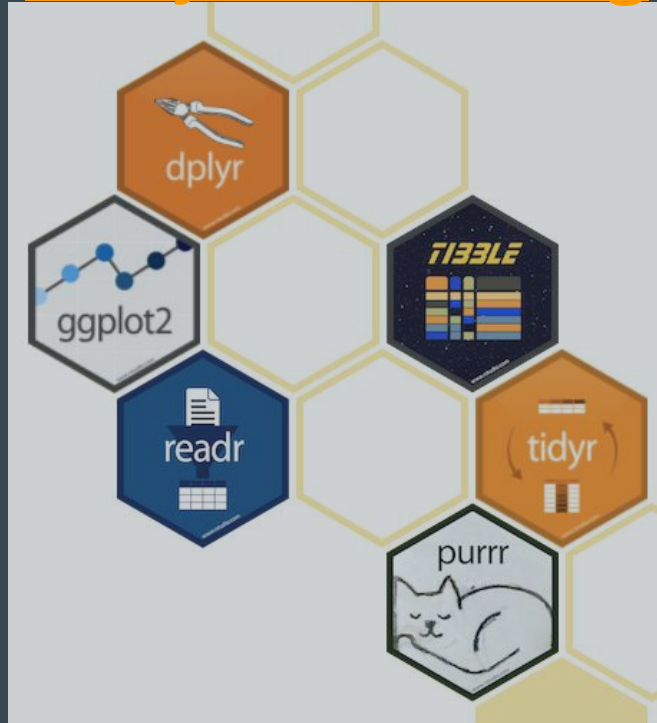
Installing and loading R packages

- `install.packages('mypackage')` - or press the Install button on the Packages tab in RStudio
- `library('mypackage')` -- or check the box on the Packages tab in RStudio

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

Exploring Data

- head, tail
- subsetting
- slicing and dicing





Data Wrangling

[flickr.com/photos/thewomensmuseum/3687975017/](https://www.flickr.com/photos/thewomensmuseum/3687975017/)

Data Transformation using the dplyr package

- filter()
- arrange()
- select()
- mutate()
- summarize()
- group_by()
- ...

You will want to use a "pipe": `%>%`
(shortcut: **control-shift-M**)



Data Tidying with dplyr

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



Joining with dplyr

"Merges" tables together

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





Data Visualization

Data Visualization

3 main packages:

- "base R"
- lattice
- ggplot2





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 links:
 - www.rstudio.com/online-learning/#r-programming
- Software Carpentry:
 - <http://swcarpentry.github.io/r-novice-inflammation>
 - <http://swcarpentry.github.io/r-novice-gapminder>
- Data Carpentry:
 - <http://datacarpentry.github.io/R-ecology-lesson/>
 - <http://www.datacarpentry.org/R-genomics/>
- Lynda.com lynda.it.gwu.edu - 3 video courses (~12 hours)
- r-tutor.com/r-introduction & r-tutor.com/elementary-statistics



Books you can access for free

- Free books online - Hadley Wickham:
 - R for Data Science 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)

Classes at GW that teach or use R



Aside from the Data Science and Business Analytics programs:

- PSC 2102 - Fall 2018
Visualizing and Modeling Politics
Prof. Eric Lawrence
- PPPA 6085 - Data Visualization
- HSML 6268 - Health Economics & Quantitative Methods

Reference Links

- 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

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

