

A Walk on the Side

an introduction to R for data analysis

...

GW Libraries/STEMWorks Workshop
Spring 2018

go.gwu.edu/gwlibrworkshop

Agenda

- About R and RStudio
- 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
 - reports
- Resources for further learning



Acknowledgments



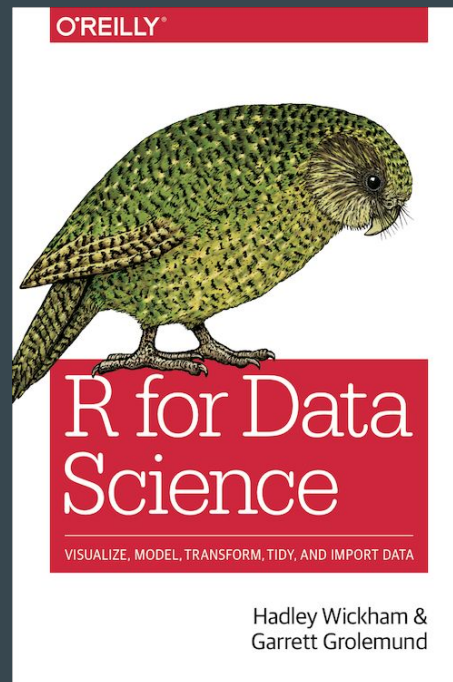
Teaching basic lab skills
for research computing

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

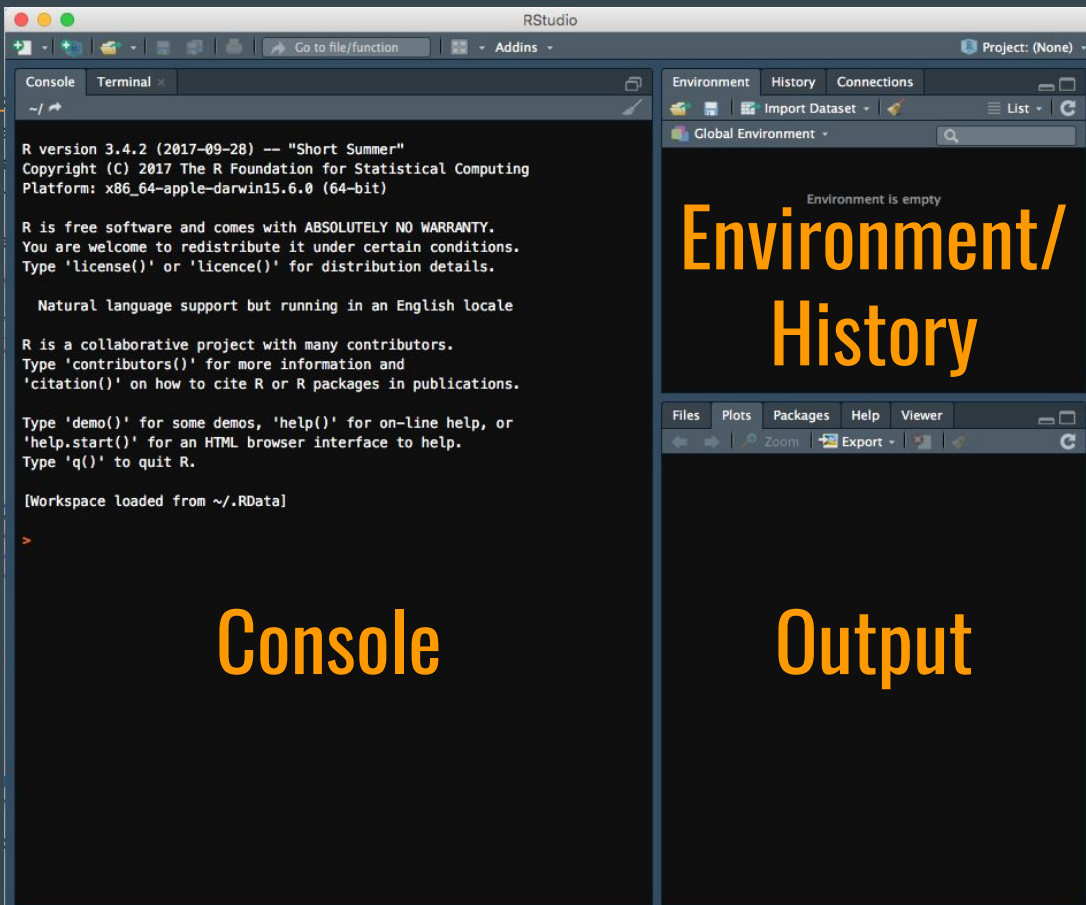


About R

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



R Studio

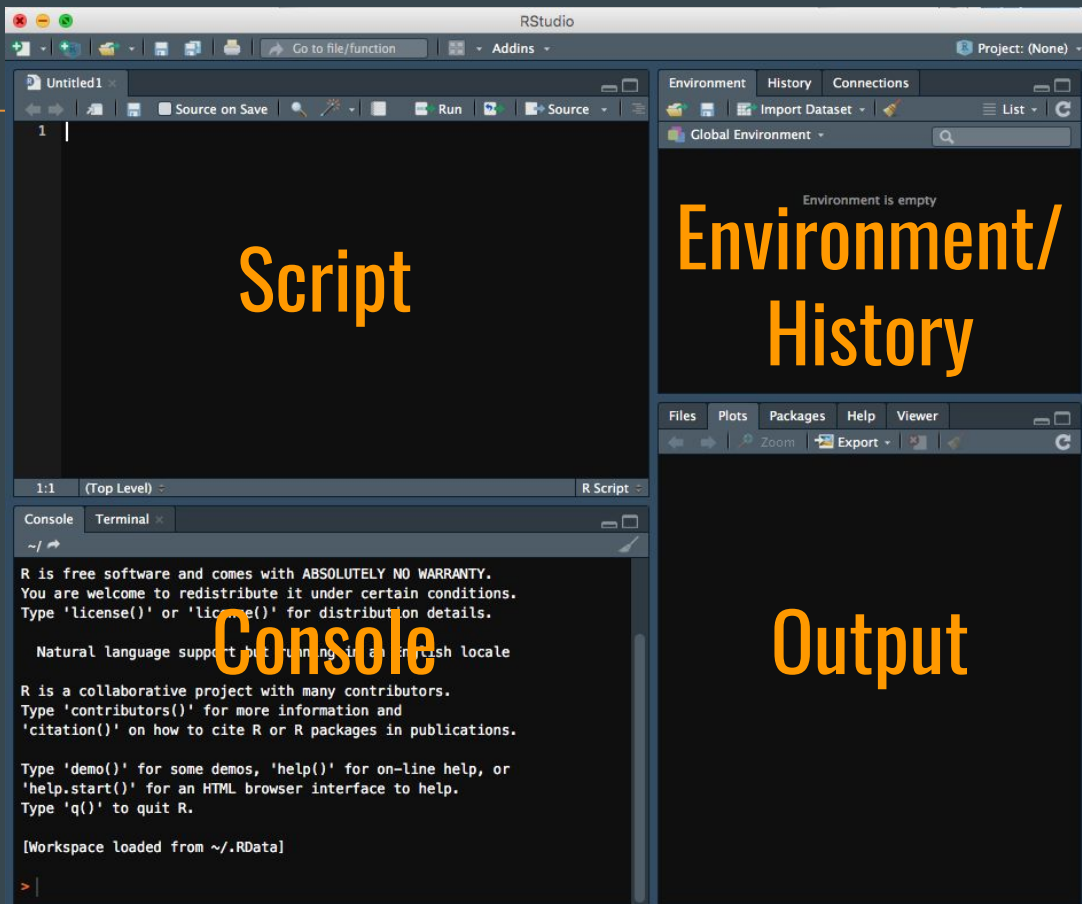


Console

Output

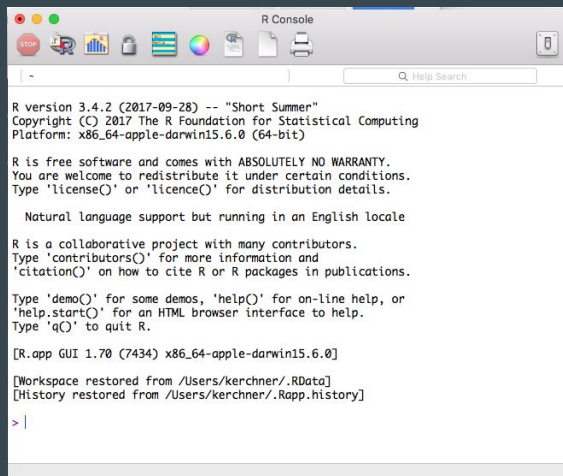


R Studio



Other Ways To Use R

Plain R console



The screenshot shows the 'R Console' window. At the top, it displays the R version (3.4.2) and copyright information. Below this, it states that R is free software with absolutely no warranty. The console also shows the natural language support running in an English locale. It mentions that R is a collaborative project with many contributors and provides instructions on how to cite R or R packages in publications. The console also shows the type 'demo()' for some demos, 'help()' for on-line help, or 'help.start()' for an HTML browser interface to help. The console also shows the type 'q()' to quit R. At the bottom, it shows the R.app GUI version (1.70) and the platform (x86_64-apple-darwin15.6.0). The console also shows the workspace restored from /Users/kerchner/.RData and the history restored from /Users/kerchner/.Rapp.history. The prompt is '> |'.

```
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.

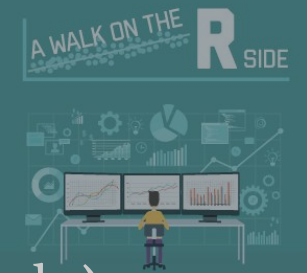
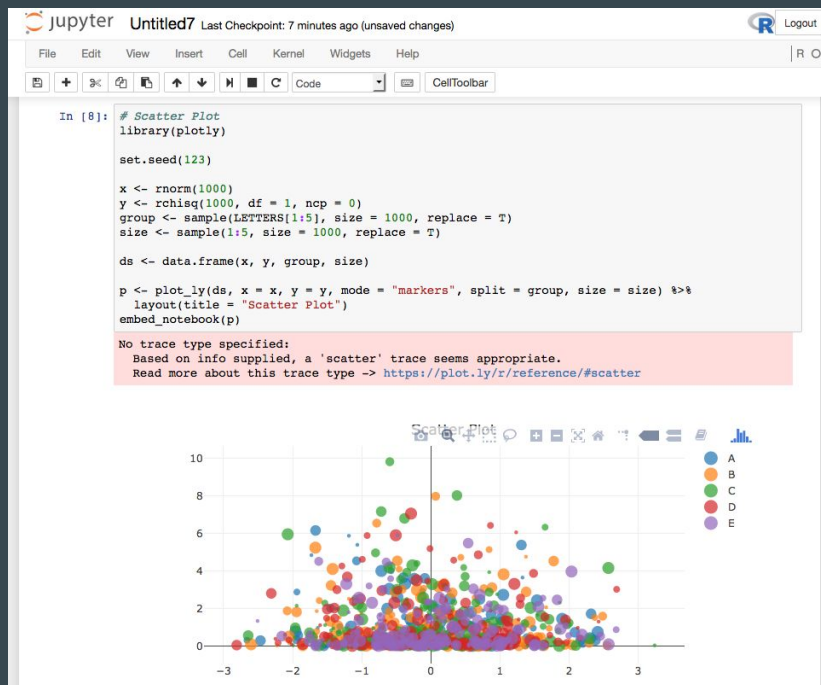
Natural language support but running in an English locale

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.

[R.app GUI 1.70 (7434) x86_64-apple-darwin15.6.0]
[Workspace restored from /Users/kerchner/.RData]
[History restored from /Users/kerchner/.Rapp.history]
> |
```

Jupyter Notebook (e.g. in Anaconda)





Let's tRy it!



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!
 - `class()`
 - 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 Go to file/function Run Addins rstudio-testproject

```
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 = continent, 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**

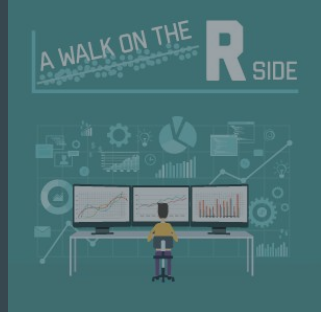


Projects in RStudio

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

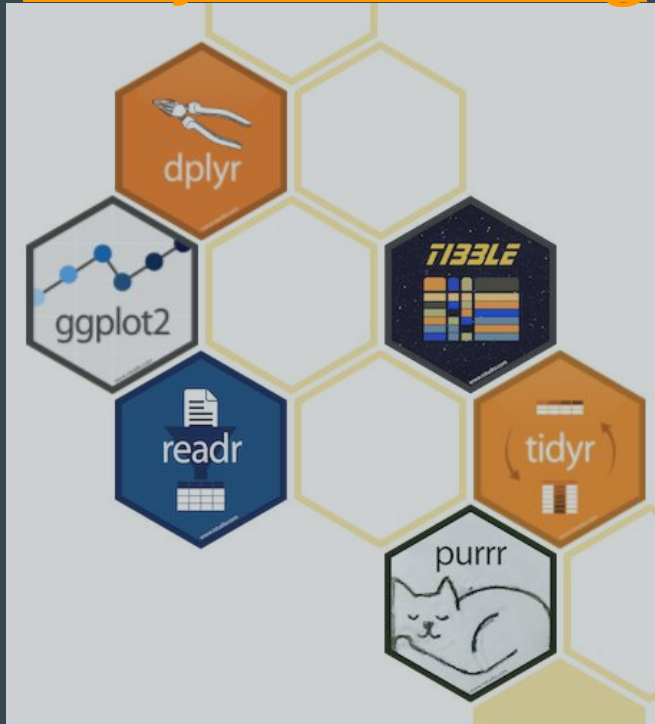
- `install.packages('mypackage')` - or press the Install button on the Packages tab in RStudio
- `library('mypackage')` -- or check the box on the Packages tab in RStudio



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

Basic stats functions, like ANOVA ▶ MASS

Mapping ▶ tmap, tmaptools, 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 Shiny



Some Handy R Links

Tutorials



- 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
- R for Data Science <http://r4ds.had.co.nz>

Classes at GW that teach or use R



Aside from the Data Science and Business Analytics programs:

- PSC 2102 - Fall 2018 (and possibly Summer II, 2018)
Visualizing and Modeling Politics
Prof. Eric Lawrence
- PPPA 6085 - Data Visualization
- TBD - Public Health, Prof. Helmchen - Fall 2018

Reference Links

- r-project.org
- R search engine: rseek.org
- rstudio.com
 - Cheat Sheets
- stackoverflow.com



Thanks!

- Dan Kerchner kerchner@gwu.edu
- Dr. Kes Schroer schroerk@gwu.edu
- Vishwesh Haldevanekar vishwesh_s_h@gwu.edu

These slides: go.gwu.edu/gwlibrworkshop

R or Statistics Appointments with Vishwesh:
calendly.com/vishwesh_s_h

