Import Data

Jake Thompson
wjakethompson.com
@wjakethompson

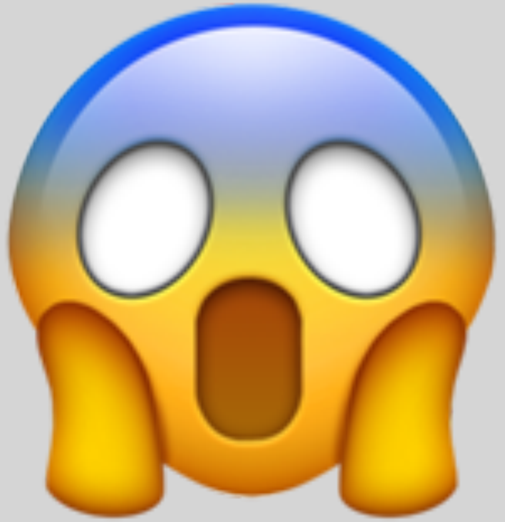
ATLAS
Accessible Teaching, Learning, and Assessment Systems

Incredibly boring, or...

absolutely infuriating.

Your Turn 0

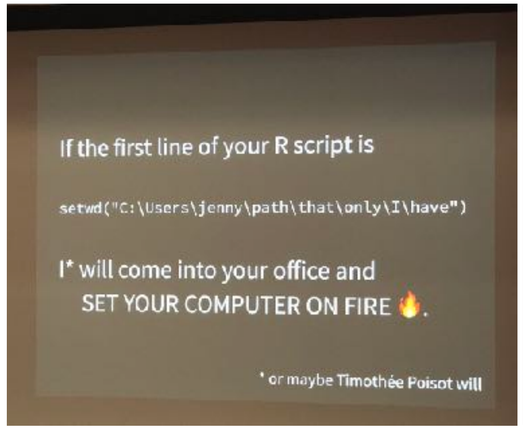
- Open **04-Import.Rmd**
- Run the setup chunk

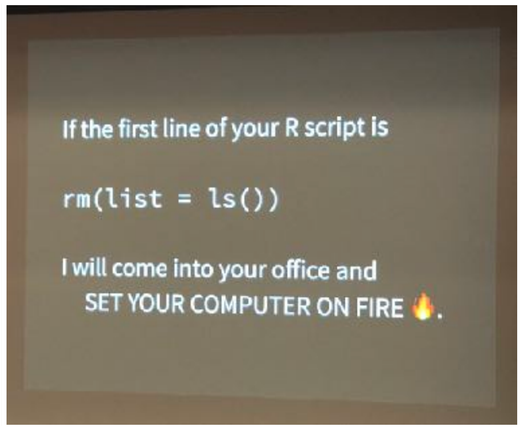


01 : 00

Hadley Wickham
@hadleywickham

The only two things that make @JennyBryan 😤😠🤯. Instead use projects + here::here() #rstats





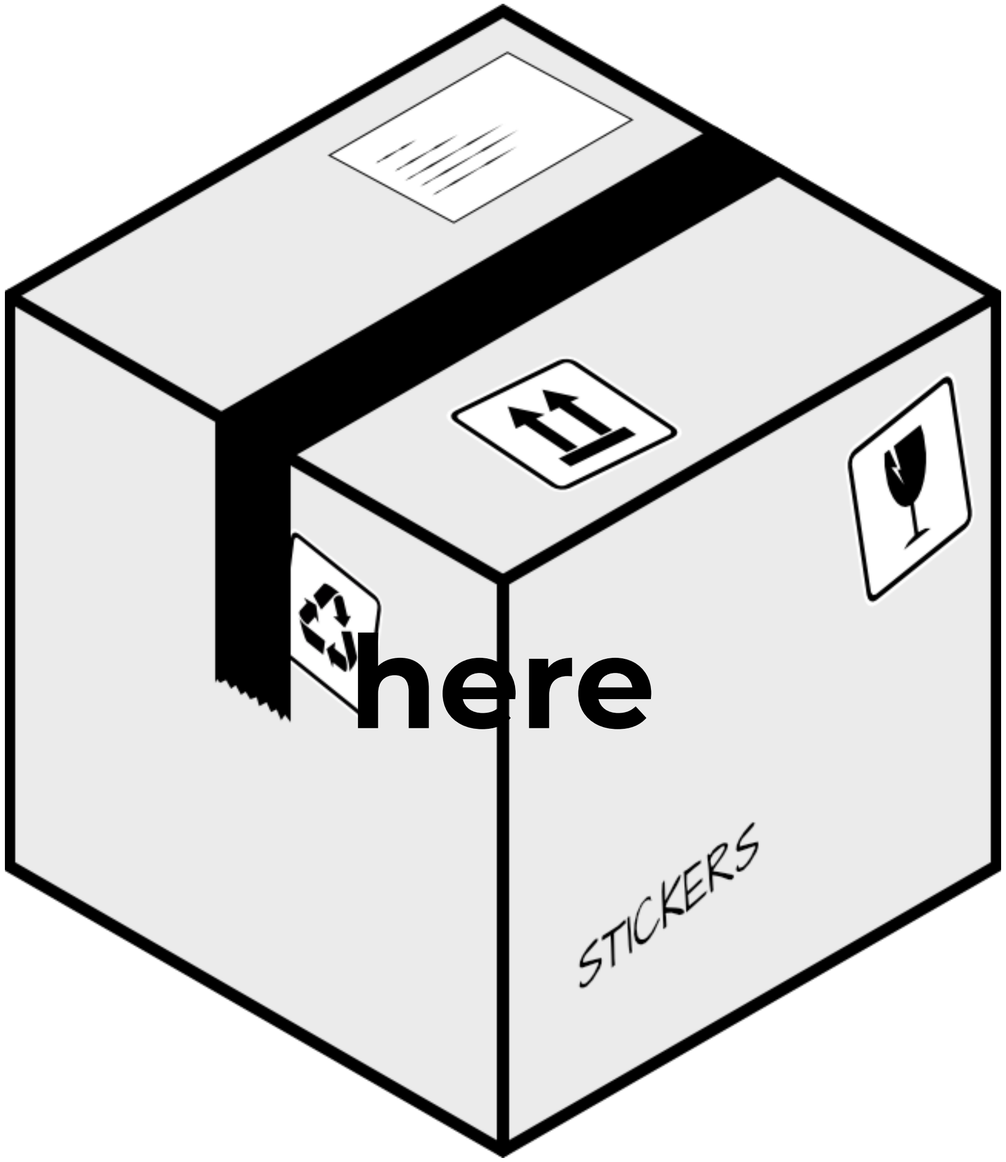
6:50 pm - 10 Dec 2017

Be kind to your collaborators

- Workflow
  - Editor
  - Home directory
  - R code you ran before break
- Product
  - Raw data
  - R code someone else needs to run to replicate results
- **Workflows should not be hardwired into the products**

Projects

- Each analysis as a *project*
  - Folder on computer with all relevant files
- R scripts written with assumption of:
  1. Clean session
  2. Working directory = project directory
- Creates everything it needs, touches nothing it didn't create



In R4DS

Workflow: Projects

here()

Find the project directory and build file paths

```
library(here)
# here() starts at /Users/w449t405/Documents/GIT/courses/tidyds-2019

here()
# [1] "/Users/w449t405/Documents/GIT/courses/tidyds-2019"

here("data", "nimbus.csv")
# [1] "/Users/w449t405/Documents/GIT/courses/tidyds-2019/data/nimbus.csv"
```

here()

Where does **here()** start?

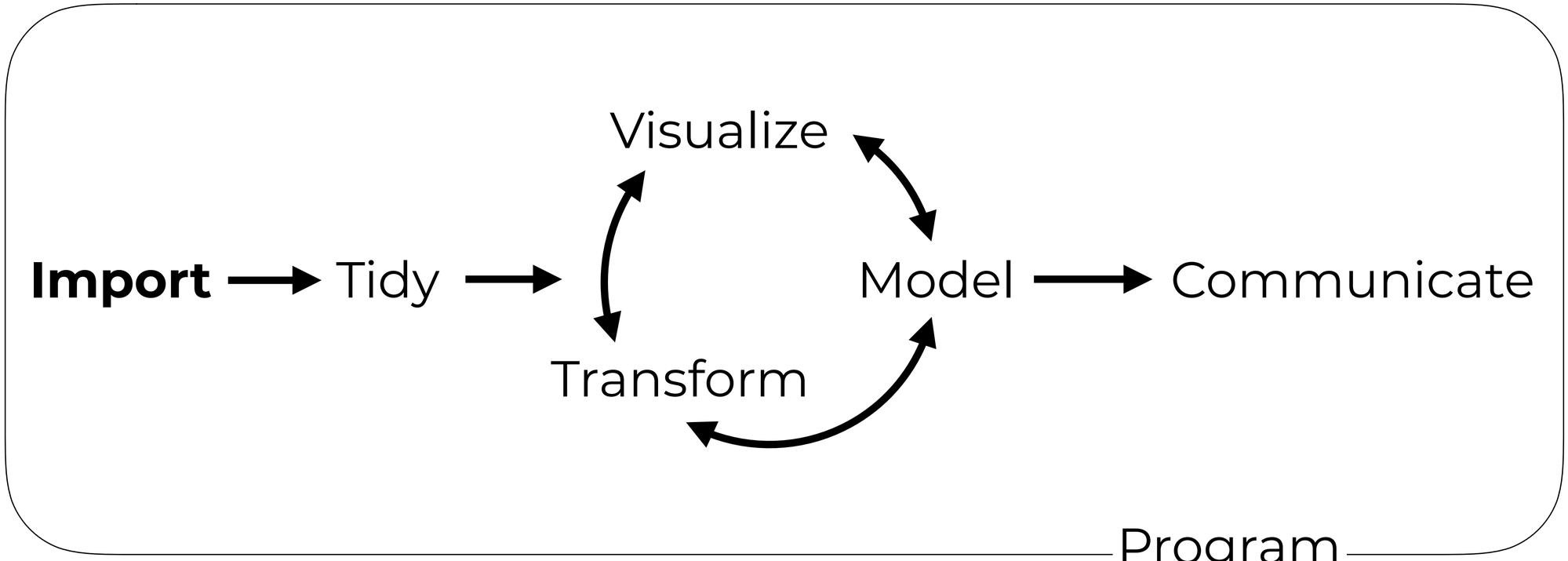
- Is a file named `.here` present?
- Is there a `.Rproj` file (i.e., `tidyds-2019.Rproj`)
- Is there a `.git` or `.svn` directory?

```
dr_here()
# here() starts at /Users/w449t405/Documents/GIT/courses/tidyds-2019,
# because it contains a file matching `[.]Rproj$` with contents matching
# `^Version: ` in the first line
```

In R4DS

Data Import

ATLAS



readr vs. base R

Compared to **read.table()** and friends:

- ~ 10 times faster
- Returns tibbles
- Intuitive defaults (e.g., no strings as factors)

readr functions

function	reads
`read_csv()`	Comma separated values
`read_csv2()`	Semi-colon separate values
`read_delim()`	General delimited files
`read_fwf()`	Fixed width files
`read_log()`	Apache log files
`read_table()`	Space separated files
`read_tsv()`	Tab delimited values

readr functions

function	reads
`read_csv()`	**Comma separated values**
`read_csv2()`	Semi-colon separate values
`read_delim()`	General delimited files
`read_fwf()`	Fixed width files
`read_log()`	Apache log files
`read_table()`	Space separated files
`read_tsv()`	Tab delimited values

nimbus.csv

```
date,longitude,latitude,ozone
1985-10-01T00:00:00Z,-179.375,-73.5,302
1985-10-01T00:00:00Z,-178.125,-73.5,302
1985-10-01T00:00:00Z,-176.875,-73.5,302
1985-10-01T00:00:00Z,-175.625,-73.5,302
1985-10-01T00:00:00Z,-174.375,-73.5,304
1985-10-01T00:00:00Z,-173.125,-73.5,304
1985-10-01T00:00:00Z,-171.875,-73.5,304
1985-10-01T00:00:00Z,-170.625,-73.5,304
1985-10-01T00:00:00Z,-164.375,-73.5,287
1985-10-01T00:00:00Z,-163.125,-73.5,287
1985-10-01T00:00:00Z,-161.875,-73.5,287
1985-10-01T00:00:00Z,-160.625,-73.5,287
```

nimbus.csv

```
date,longitude,latitude,ozone
1985-10-01T00:00:00Z,-179.375,-73.5,302
1985-10-01T00:00:00Z,-178.125,-73.5,302
1985-10-01T00:00:00Z,-176.875,-73.5,302
1985-10-01T00:00:00Z,-175.625,-73.5,302
1985-10-01T00:00:00Z,-174.375,-73.5,304
1985-10-01T00:00:00Z,-173.125,-73.5,304
1985-10-01T00:00:00Z,-171.875,-73.5,304
1985-10-01T00:00:00Z,-170.625,-73.5,304
1985-10-01T00:00:00Z,-164.375,-73.5,287
1985-10-01T00:00:00Z,-163.125,-73.5,287
1985-10-01T00:00:00Z,-161.875,-73.5,287
1985-10-01T00:00:00Z,-160.625,-73.5,287
```

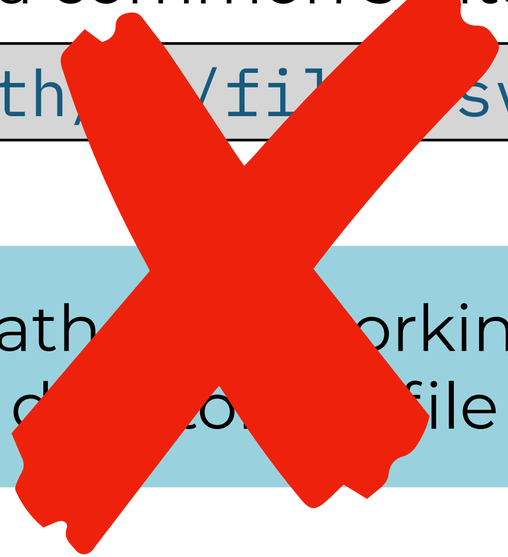
read_csv()

readr functions share a common syntax

```
df <- read_csv("path/to/file.csv", ...)
```

object to save output into

path to working directory to file



read_csv()

readr functions share a common syntax

```
df <- read_csv(here("path", "to", "file.csv"), ...)
```

object to save output into

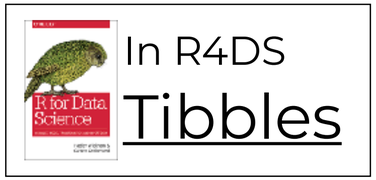
build path to file using **here()**

Your Turn 1

- Find **nimbus.csv** in your project directory
- Read it into an object
- View the results

```
nimbus <- read_csv(here("data", "nimbus.csv"))
nimbus
# A tibble: 18,963 x 4
   date                longitude latitude ozone
   <dttm>                  <dbl>    <dbl> <chr>
 1 1985-10-01 00:00:00     -179.    -73.5 302
 2 1985-10-01 00:00:00     -178.    -73.5 302
 3 1985-10-01 00:00:00     -177.    -73.5 302
 4 1985-10-01 00:00:00     -176.    -73.5 302
 5 1985-10-01 00:00:00     -174.    -73.5 304
 6 1985-10-01 00:00:00     -173.    -73.5 304
 7 1985-10-01 00:00:00     -172.    -73.5 304
 8 1985-10-01 00:00:00     -171.    -73.5 304
 9 1985-10-01 00:00:00     -164.    -73.5 287
10 1985-10-01 00:00:00     -163.    -73.5 287
# … with 18,953 more rows
```

tibbles



In R4DS

Tibbles

ATLAS

read.csv() vs. read_csv()

Console | Terminal | Jobs

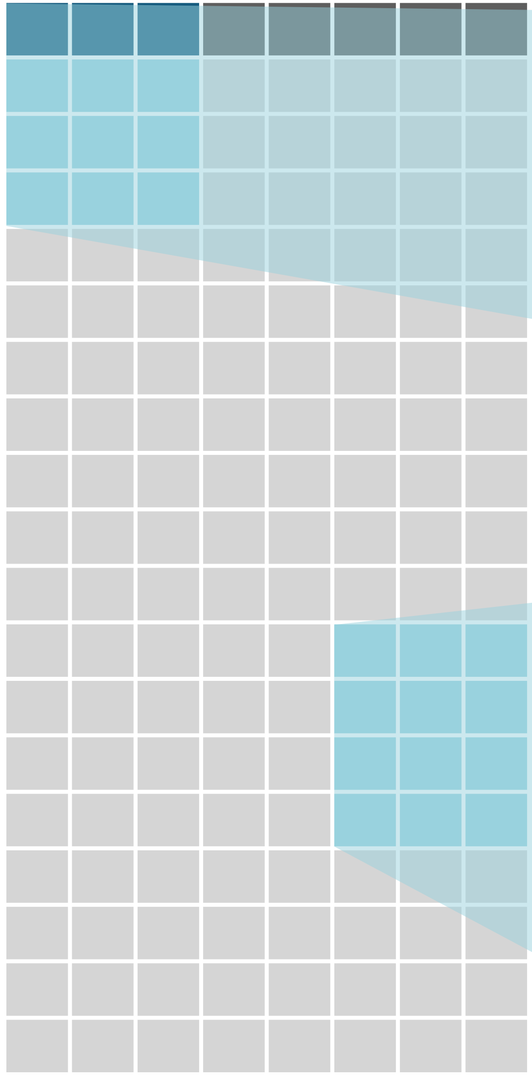
~/Documents/GIT/courses/tidyds-2019/

```
210 1985-10-01T00:00:00Z   -93.125    -72.5   204
211 1985-10-01T00:00:00Z   -91.875    -72.5   204
212 1985-10-01T00:00:00Z   -90.625    -72.5   204
213 1985-10-01T00:00:00Z   -89.375    -72.5   209
214 1985-10-01T00:00:00Z   -88.125    -72.5   209
215 1985-10-01T00:00:00Z   -86.875    -72.5   209
216 1985-10-01T00:00:00Z   -85.625    -72.5   209
217 1985-10-01T00:00:00Z   -84.375    -72.5   206
218 1985-10-01T00:00:00Z   -83.125    -72.5   206
219 1985-10-01T00:00:00Z   -81.875    -72.5   206
220 1985-10-01T00:00:00Z   -80.625    -72.5   206
221 1985-10-01T00:00:00Z   -79.375    -72.5   208
222 1985-10-01T00:00:00Z   -78.125    -72.5   208
223 1985-10-01T00:00:00Z   -76.875    -72.5   208
224 1985-10-01T00:00:00Z   -75.625    -72.5   208
225 1985-10-01T00:00:00Z   -74.375    -72.5   205
226 1985-10-01T00:00:00Z   -73.125    -72.5   205
227 1985-10-01T00:00:00Z   -71.875    -72.5   205
228 1985-10-01T00:00:00Z   -70.625    -72.5   205
229 1985-10-01T00:00:00Z   -69.375    -72.5   203
230 1985-10-01T00:00:00Z   -68.125    -72.5   203
231 1985-10-01T00:00:00Z   -66.875    -72.5   208
232 1985-10-01T00:00:00Z   -65.625    -72.5   208
233 1985-10-01T00:00:00Z   -64.375    -72.5   223
234 1985-10-01T00:00:00Z   -63.125    -72.5   223
235 1985-10-01T00:00:00Z   -61.875    -72.5   223
236 1985-10-01T00:00:00Z   -60.625    -72.5   223
237 1985-10-01T00:00:00Z   -59.375    -72.5   232
238 1985-10-01T00:00:00Z   -58.125    -72.5   232
239 1985-10-01T00:00:00Z   -56.875    -72.5   232
240 1985-10-01T00:00:00Z   -55.625    -72.5   232
241 1985-10-01T00:00:00Z   -54.375    -72.5   238
242 1985-10-01T00:00:00Z   -53.125    -72.5   238
243 1985-10-01T00:00:00Z   -51.875    -72.5   238
244 1985-10-01T00:00:00Z   -50.625    -72.5   238
245 1985-10-01T00:00:00Z   -49.375    -72.5   243
246 1985-10-01T00:00:00Z   -48.125    -72.5   243
247 1985-10-01T00:00:00Z   -46.875    -72.5   243
248 1985-10-01T00:00:00Z   -45.625    -72.5   243
249 1985-10-01T00:00:00Z   -44.375    -72.5   232
250 1985-10-01T00:00:00Z   -43.125    -72.5   232
 [ reached 'max' / getOption("max.print") -- omitted 18713 rows ]
>
```

Console | Terminal | Jobs

~/Documents/GIT/courses/tidyds-2019/

```
> nimbus
# A tibble: 18,963 x 4
   date                longitude latitude ozone
   <dttm>                  <dbl>    <dbl> <chr>
 1 1985-10-01 00:00:00     -179.    -73.5 302
 2 1985-10-01 00:00:00     -178.    -73.5 302
 3 1985-10-01 00:00:00     -177.    -73.5 302
 4 1985-10-01 00:00:00     -176.    -73.5 302
 5 1985-10-01 00:00:00     -174.    -73.5 304
 6 1985-10-01 00:00:00     -173.    -73.5 304
 7 1985-10-01 00:00:00     -172.    -73.5 304
 8 1985-10-01 00:00:00     -171.    -73.5 304
 9 1985-10-01 00:00:00     -164.    -73.5 287
10 1985-10-01 00:00:00     -163.    -73.5 287
# … with 18,953 more rows
>
```



```
# A tibble: 87 x 13
   name  height  mass hair_color skin_color eye_color birth_year gender
   <chr>  <int> <dbl> <chr>      <chr>      <chr>           <dbl> <chr>
 1 Luke…    172    77 blond      fair       blue             19   male
 2 C-3PO    167    75 NA         gold       yellow          112   NA
 3 R2-D2     96    32 NA         white, bl… red              33   NA
 4 Dart…    202   136 none       white      yellow           41.9 male
 5 Leia…    150    49 brown      light      brown            19   female
 6 Owen…    178   120 brown, gr… light      blue             52   male
 7 Beru…    165    75 brown      light      blue             47   female
 8 R5-D4     97    32 NA         white, red red              NA   NA
 9 Bigg…    183    84 black      light      brown            24   male
10 Obi-…    182    77 auburn, w… fair       blue-gray        57   male
# … with 77 more rows, and 5 more variables: homeworld <chr>, species <chr>,
#   films <list>, vehicles <list>, starships <list>
```

tibble display

```
48
49
50
51
52
53
54
55                                                    Jedi starfighter
56
57                                                    Naboo fighter
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
 [ reached 'max' / getOption("max.print") -- omitted 11 rows ]
```

data frame display

tibbles

A type of data frame common throughout the tidyverse packages

Tibbles enhance data frames in three ways:

1. **Subsetting** - `[` always returns a new tibble, `[[` and `$` always return a new vector

2. **No partial matching** - You must use full column names when subsetting

3. **Display** - When you print a nibble, R provides a concise view of the data that fits on one screen

tibble helpers

function	does
`as_tibble()`	convert a data frame to a tibble
`as.data.frame()`	convert a tibble to a data frame
`tribble()`	make a tibble (transversed)

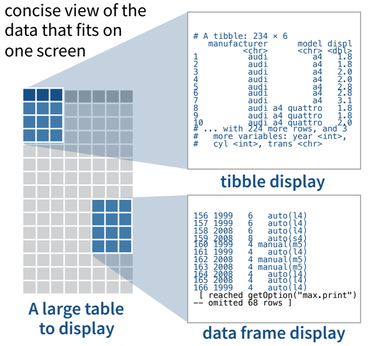
```
tribble(
  ~x,  ~y,
   1, "a",
   2, "b",
   3, "c")
```

x	y
1	a
2	b
3	c

Tibbles - an enhanced data frame

The **tibble** package provides a new S3 class for storing tabular data, the tibble. Tibbles inherit the data frame class, but improve three behaviors:

- **Subsetting** - [always returns a new tibble, [[and $ always return a vector.
- **No partial matching** - You must use full column names when subsetting
- **Display** - When you print a tibble, R provides a concise view of the data that fits on one screen



- Control the default appearance with options:
  options(tibble.print_max = n, tibble.print_min = m, tibble.width = Inf)
- View full data set with **View()** or **glimpse()**
- Revert to data frame with **as.data.frame()**

CONSTRUCT A TIBBLE IN TWO WAYS

tibble(…)
Construct by columns.
tibble(x = 1:3, y = c("a", "b", "c"))

Both make this tibble

tribble(…)
Construct by rows.
tribble(~x, ~y, 1, "a", 2, "b", 3, "c")

```
A tibble: 3 × 2
      x     y
  <int> <chr>
1     1     a
2     2     b
3     3     c
```

as_tibble(x, …) Convert data frame to tibble.

enframe(x, name = "name", value = "value")
Convert named vector to a tibble

is_tibble(x) Test whether x is a tibble.

Adapted from Master the Tidyverse, CC BY RStudio

Parsing

Quiz

- Look at the **nimbus** data
- What class (data type) is ozone?

```
nimbus %>%
  pull(ozone) %>%
  class()
```

```
nimbus %>%
  pull(ozone) %>%
  class()
# [1] "character"

nimbus %>%
  pull(ozone) %>%
  unique()
#  [1] "302" "304" "287" "274" "264" "242" "211" "195"
#  [9] "197" "196" "198" "193" "187" "190" "199" "194"
# [17] "213" "218" "221" "229" "209" "186" "188" "191"
# [25] "189" "184" "180" "."   "215" "312" "319" "320"
# [33] "311" "300" "290" "267" "226" "210" "200" "203"
# [41] "201" "192" "204" "206" "208" "205" "223" "232"
# [49] "238" "243" "220" "202" "185" "219" "222" "216"
```

NA values

```
nimbus %>%
  filter(ozone == ".")
# A tibble: 155 x 4
   date                longitude latitude ozone
   <dttm>                  <dbl>    <dbl> <chr>
 1 1985-10-01 00:00:00      70.6    -73.5 .
 2 1985-10-01 00:00:00      71.9    -73.5 .
 3 1985-10-01 00:00:00      73.1    -73.5 .
 4 1985-10-01 00:00:00      74.4    -73.5 .
 5 1985-10-01 00:00:00      75.6    -73.5 .
 6 1985-10-01 00:00:00      76.9    -73.5 .
 7 1985-10-01 00:00:00      78.1    -73.5 .
 8 1985-10-01 00:00:00      79.4    -73.5 .
 9 1985-10-01 00:00:00      65.6    -72.5 .
10 1985-10-01 00:00:00      66.9    -72.5 .
# … with 145 more rows
```

Define missing values

readr functions share a common syntax

```
df <- read_csv(here("data", "nimbus.csv"), na = ".")
```

object to save output into

build path to file using **here()**

Values to convert to **NA**

Your Turn 2

- Read in **nimbus.csv**
- Set values of `.` to **NA**

```
nimbus <- read_csv(here("data", "nimbus.csv"), na = ".")
nimbus
# A tibble: 18,963 x 4
   date                longitude latitude ozone
   <dttm>                  <dbl>    <dbl> <dbl>
 1 1985-10-01 00:00:00     -179.    -73.5   302
 2 1985-10-01 00:00:00     -178.    -73.5   302
 3 1985-10-01 00:00:00     -177.    -73.5   302
 4 1985-10-01 00:00:00     -176.    -73.5   302
 5 1985-10-01 00:00:00     -174.    -73.5   304
 6 1985-10-01 00:00:00     -173.    -73.5   304
 7 1985-10-01 00:00:00     -172.    -73.5   304
 8 1985-10-01 00:00:00     -171.    -73.5   304
 9 1985-10-01 00:00:00     -164.    -73.5   287
10 1985-10-01 00:00:00     -163.    -73.5   287
# … with 18,953 more rows
```

<dbl> stand for double
(decimal number)

```
nimbus <- read_csv(here("data", "nimbus.csv"))
nimbus
# A tibble: 18,963 x 4
   date                longitude latitude ozone
   <dttm>                  <dbl>    <dbl> <chr>
 1 1985-10-01 00:00:00     -179.    -73.5 302
 2 1985-10-01 00:00:00     -178.    -73.5 302
 3 1985-10-01 00:00:00     -177.    -73.5 302
 4 1985-10-01 00:00:00     -176.    -73.5 302
 5 1985-10-01 00:00:00     -174.    -73.5 304
 6 1985-10-01 00:00:00     -173.    -73.5 304
 7 1985-10-01 00:00:00     -172.    -73.5 304
 8 1985-10-01 00:00:00     -171.    -73.5 304
 9 1985-10-01 00:00:00     -164.    -73.5 287
10 1985-10-01 00:00:00     -163.    -73.5 287
# … with 18,953 more rows
```

<chr> stand for character string (not a number)

Specify column types

readr functions share a common syntax

```
df <- read_csv(here("path", "to", "file.csv"), na = ".",
               col_types = cols(ozone = col_integer()))
```

Manually specify column types

cols()

Column name

Column type function

Column types

type function	data type
`col_character()`	character
`col_date()`	Date
`col_datetime()`	POSIXct (date-time)
`col_double()`	double (numeric)
`col_factor()`	factor
`col_guess()`	let readr guess (default)
`col_integer()`	integer
`col_logical()`	logical
`col_number()`	numbers mixed with non-number characters
`col_numeric()`	double or integer
`col_skip()`	do not read
`col_time()`	time

Your Turn 3

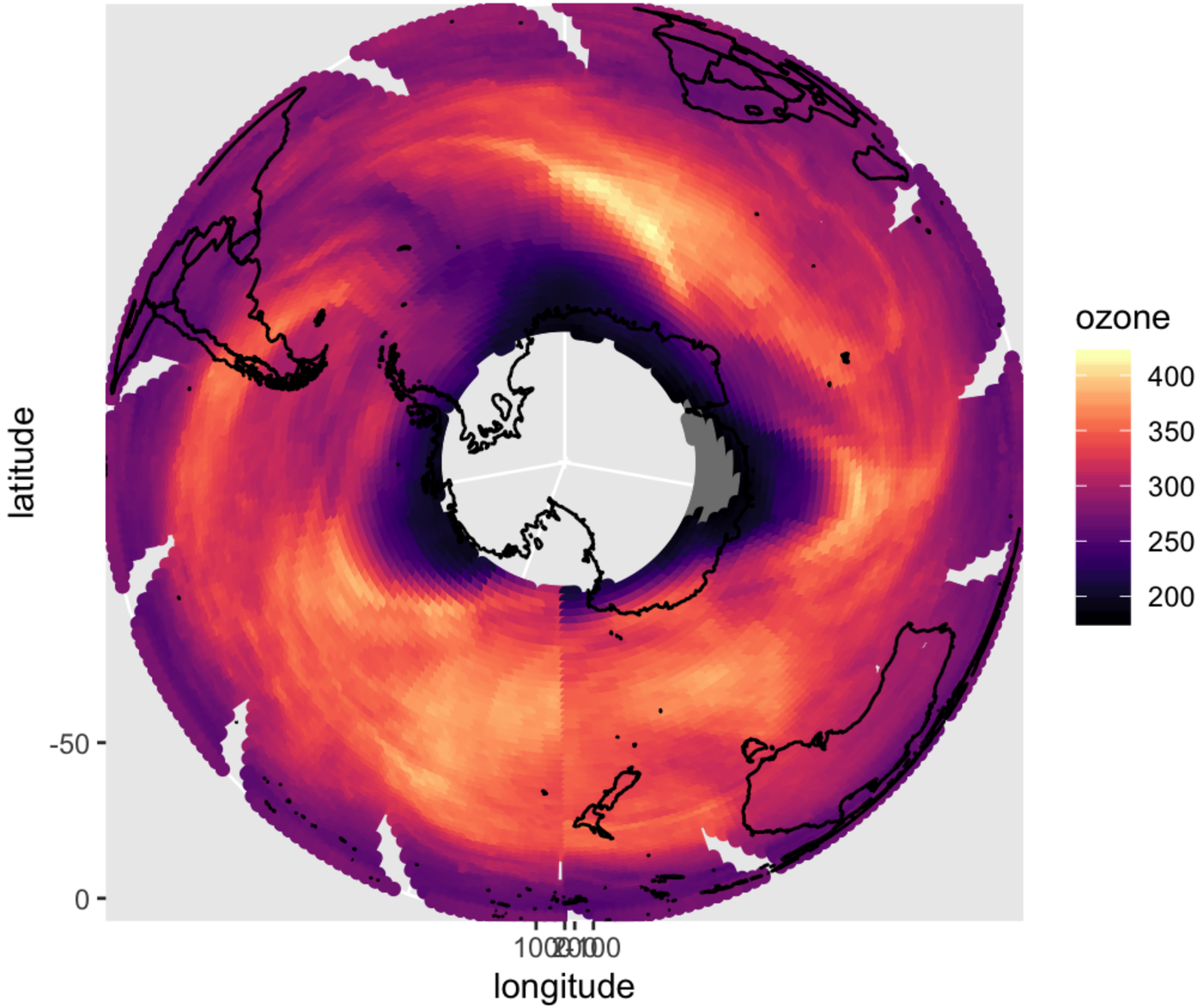
- Modify the code below
- Specify **ozone** as integer values

```
nimbus <- read_csv(here("data", "nimbus.csv"), na = ".")
```

02:00

```
nimbus <- read_csv(here("data", "nimbus.csv"), na = ".",
                   col_types = cols(ozone = col_integer()))

library(viridis)
world <- map_data(map = "world")
ggplot(data = nimbus) +
  geom_point(mapping = aes(x = longitude, y = latittude, color = ozone)) +
  geom_path(data = world, mapping = aes(x = long, y = lat, group = group)) +
  coord_map("ortho", orientation = c(-90, 0, 0)) +
  scale_color_viridis(option = "A")
```



Other Data Types

Excel Files (.xls and .xlsx)

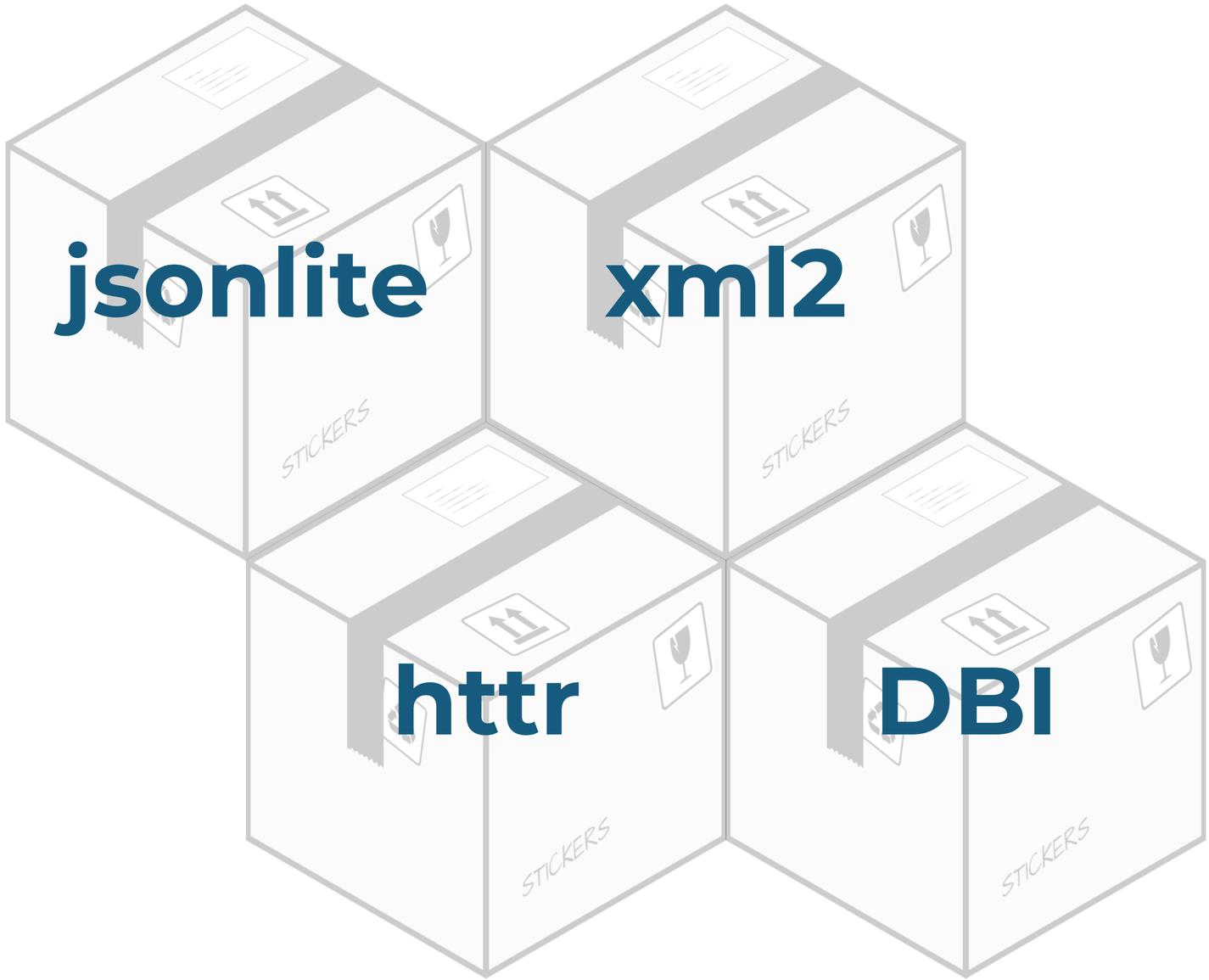
Data from other statistical software (SPSS, Stata, and SAS)

Google Sheets and other files in Google Drive

Efficient data sharing between R and Python

Web Pages (web scraping)

Data loaded into spark


jsonlite
xml2
httr
DBI
STICKERS
STICKERS
STICKERS
STICKERS

Import Data

ATLAS
Accessible Teaching, Learning, and Assessment Systems

wjakethompson.com wjakethompson@ku.edu @wjakethompson @wjakethompson