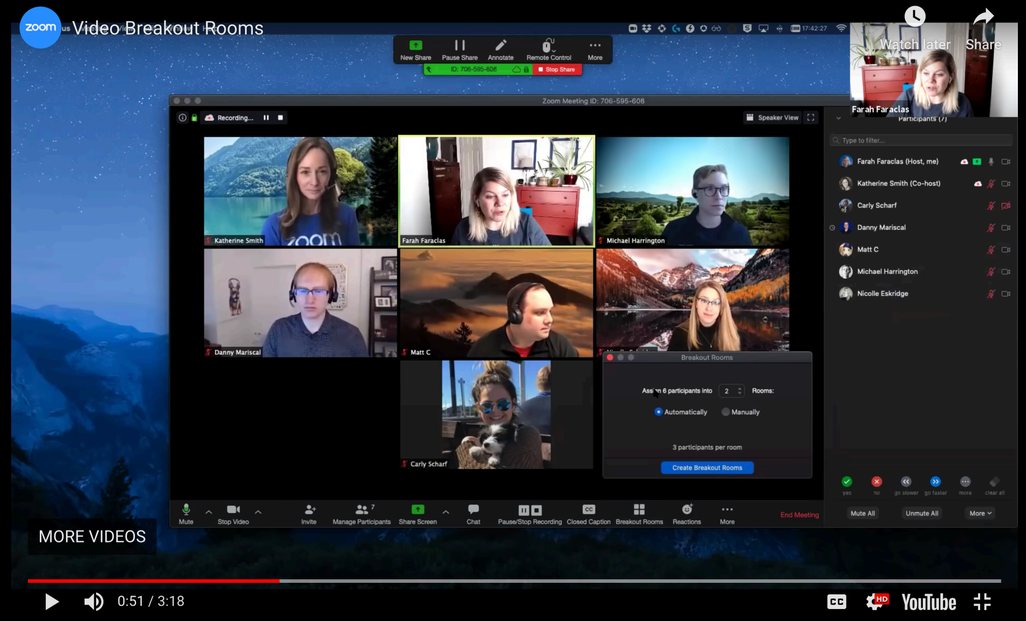
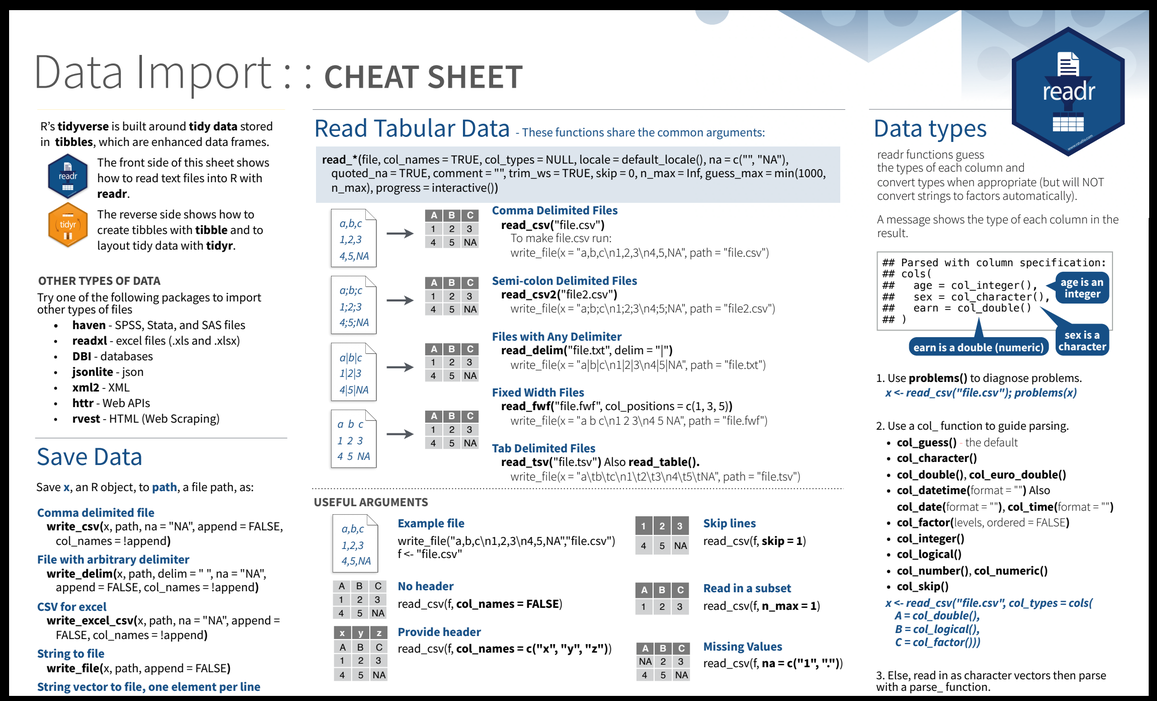
# Import Data with

# Exercise: What do you remember?

- Type into the chat window
  - *What package / function is for reading in SAS files?*
  - *What package / function is for reading in CSV files?*

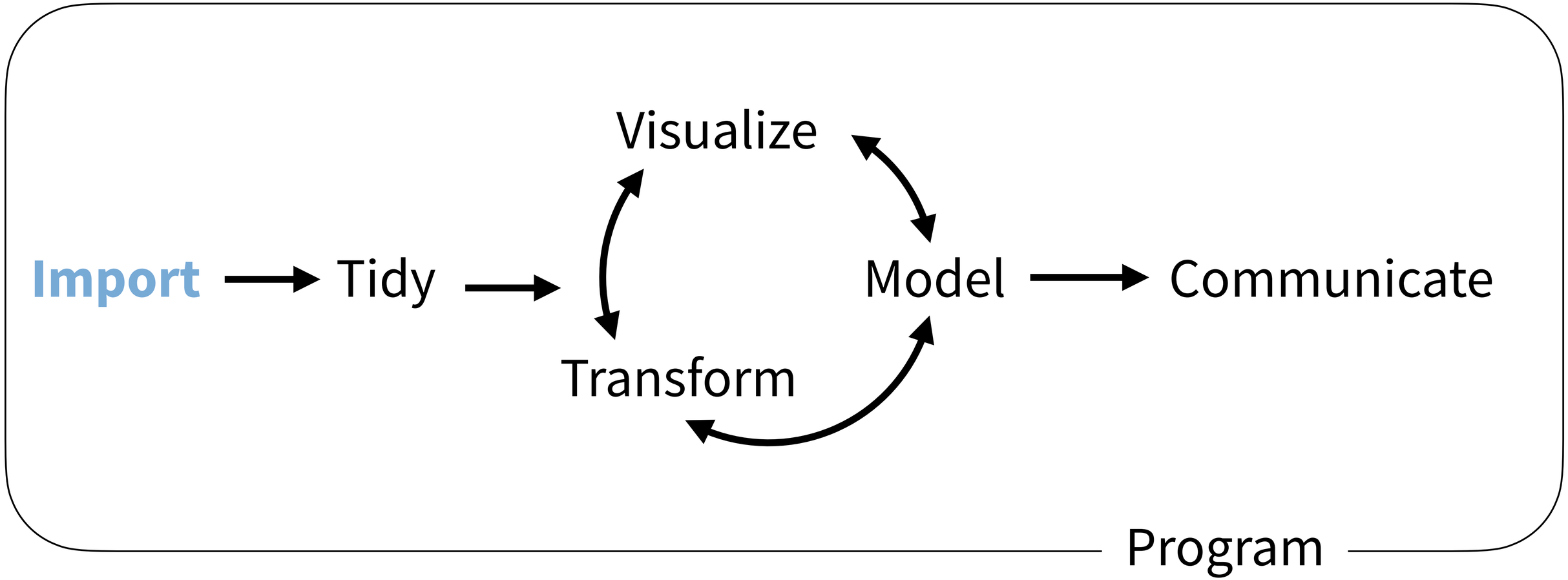



# Notes form & Cheat Sheet

Please take out

# (Applied) **Data Science**



# Data Import in the Tidyverse
# A package for each storage type!

| package | accesses |
|---|---|
| readr | csv, tsv, etc. |
| haven | SPSS, Stata, and SAS files |
| readxl | excel files (.xls, .xlsx) |
| jsonlite | json |
| xml2 | xml |
| httr | web API's |
| rvest | web pages (web scraping) |
| DBI | databases |
| sparklyr | data loaded into spark |

# Reading SAS files

# haven


functions for reading in SAS, SPSS and Stata files

```
# install.packages("tidyverse")
library(haven)
```

# read_sas()

haven functions share a common syntax

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

**object to save output into**

**path from working directory to file**

```
library(haven)
df = read_sas("adae.sas7bdat")
df
```

A tibble: 38 x 95

| | STUDYID | SUBJID | SITEID | AGE | SEX | RACE | SAFFL | ARM | ARMCD | ACTARM |
|---|---|---|---|---|---|---|---|---|---|---|
| | <chr> | <chr> | <dbl> | <dbl> | <chr> | <chr> | <chr> | <chr> | <chr> | <chr> |
| 1 | GS-US-… | 1001 | 1000 | 20 | F | WHITE | Y | [Pla… | P | [Plac… |
| 2 | GS-US-… | 1001 | 1000 | 20 | F | WHITE | Y | [Pla… | P | [Plac… |
| 3 | GS-US-… | 1001 | 1000 | 20 | F | WHITE | Y | [Pla… | P | [Plac… |
| 4 | GS-US-… | 1001 | 1000 | 20 | F | WHITE | Y | [Pla… | P | [Plac… |
| 5 | GS-US-… | 1001 | 1000 | 20 | F | WHITE | Y | [Pla… | P | [Plac… |
| 6 | GS-US-… | 1001 | 1000 | 20 | F | WHITE | Y | [Pla… | P | [Plac… |
| 7 | GS-US-… | 1001 | 1000 | 20 | F | WHITE | Y | [Pla… | P | [Plac… |
| 8 | GS-US-… | 1001 | 1000 | 20 | F | WHITE | Y | [Pla… | P | [Plac… |
| 9 | GS-US-… | 1002 | 1000 | 21 | M | OTHER | Y | [20 … | 1 | [20 m… |
| 0 | GS-US-… | 1002 | 1000 | 21 | M | OTHER | Y | [20 … | 1 | [20 m… |

… with 28 more rows, and 85 more variables: ACTARMCD <chr>, COHORT <chr>, COHORTN <dbl>, TRT01P <chr>, TRT01PN <dbl>,

04-Import-Data-Exercises.Rmd | df

Filter | Cols: « ‹ 1 – 50 › »

| | STUDYID<br>Study Identifier | SUBJID<br>Subject Identifier | SITEID<br>Study Site Identifier | AGE<br>Age | SEX<br>Sex | RACE<br>Race | SAFFL<br>Safety Population Flag |
|---|---|---|---|---|---|---|---|
| 1 | GS-US-xxx-xxxx | 1001 | 1000 | 20 | F | WHITE | Y |
| 2 | GS-US-xxx-xxxx | 1001 | 1000 | 20 | F | WHITE | Y |
| 3 | GS-US-xxx-xxxx | 1001 | 1000 | 20 | F | WHITE | Y |
| 4 | GS-US-xxx-xxxx | 1001 | 1000 | 20 | F | WHITE | Y |
| 5 | GS-US-xxx-xxxx | 1001 | 1000 | 20 | F | WHITE | Y |
| 6 | GS-US-xxx-xxxx | 1001 | 1000 | 20 | F | WHITE | Y |
| 7 | GS-US-xxx-xxxx | 1001 | 1000 | 20 | F | WHITE | Y |
| 8 | GS-US-xxx-xxxx | 1001 | 1000 | 20 | F | WHITE | Y |
| 9 | GS-US-xxx-xxxx | 1002 | 1000 | 21 | M | OTHER | Y |
| 10 | GS-US-xxx-xxxx | 1002 | 1000 | 21 | M | OTHER | Y |
| 11 | GS-US-xxx-xxxx | 1002 | 1000 | 21 | M | OTHER | Y |
| 12 | GS-US-xxx-xxxx | 1003 | 1000 | 20 | M | WHITE | Y |
| 13 | GS-US-xxx-xxxx | 1003 | 1000 | 20 | M | WHITE | Y |
| 14 | GS-US-xxx-xxxx | 1003 | 1000 | 20 | M | WHITE | Y |
| 15 | GS-US-xxx-xxxx | 1003 | 1000 | 20 | M | WHITE | Y |

# Reading in CSV Files

# readr


Simple, consistent functions for working with strings / csv data.

```
# install.packages("tidyverse")
library(readr)
```

Open **Import-Data-Exercises.Rmd**

# readr functions

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

# nimbus.csv

```
date,longitude,latitude,ozone
1985-10-01T00:00:00Z,-179.375,-87.5,.
1985-10-01T00:00:00Z,-178.125,-87.5,.
1985-10-01T00:00:00Z,-176.875,-87.5,.
1985-10-01T00:00:00Z,-175.625,-87.5,.
1985-10-01T00:00:00Z,-174.375,-87.5,.
1985-10-01T00:00:00Z,-173.125,-87.5,.
1985-10-01T00:00:00Z,-171.875,-87.5,.
1985-10-01T00:00:00Z,-170.625,-87.5,.
1985-10-01T00:00:00Z,-169.375,-87.5,.
```

# nimbus.csv

```
date,longitude,latitude,ozone
1985-10-01T00:00:00Z,-179.375,-87.5,.
1985-10-01T00:00:00Z,-178.125,-87.5,.
1985-10-01T00:00:00Z,-176.875,-87.5,.
1985-10-01T00:00:00Z,-175.625,-87.5,.
1985-10-01T00:00:00Z,-174.375,-87.5,.
1985-10-01T00:00:00Z,-173.125,-87.5,.
1985-10-01T00:00:00Z,-171.875,-87.5,.
1985-10-01T00:00:00Z,-170.625,-87.5,.
1985-10-01T00:00:00Z,-169.375,-87.5,.
```

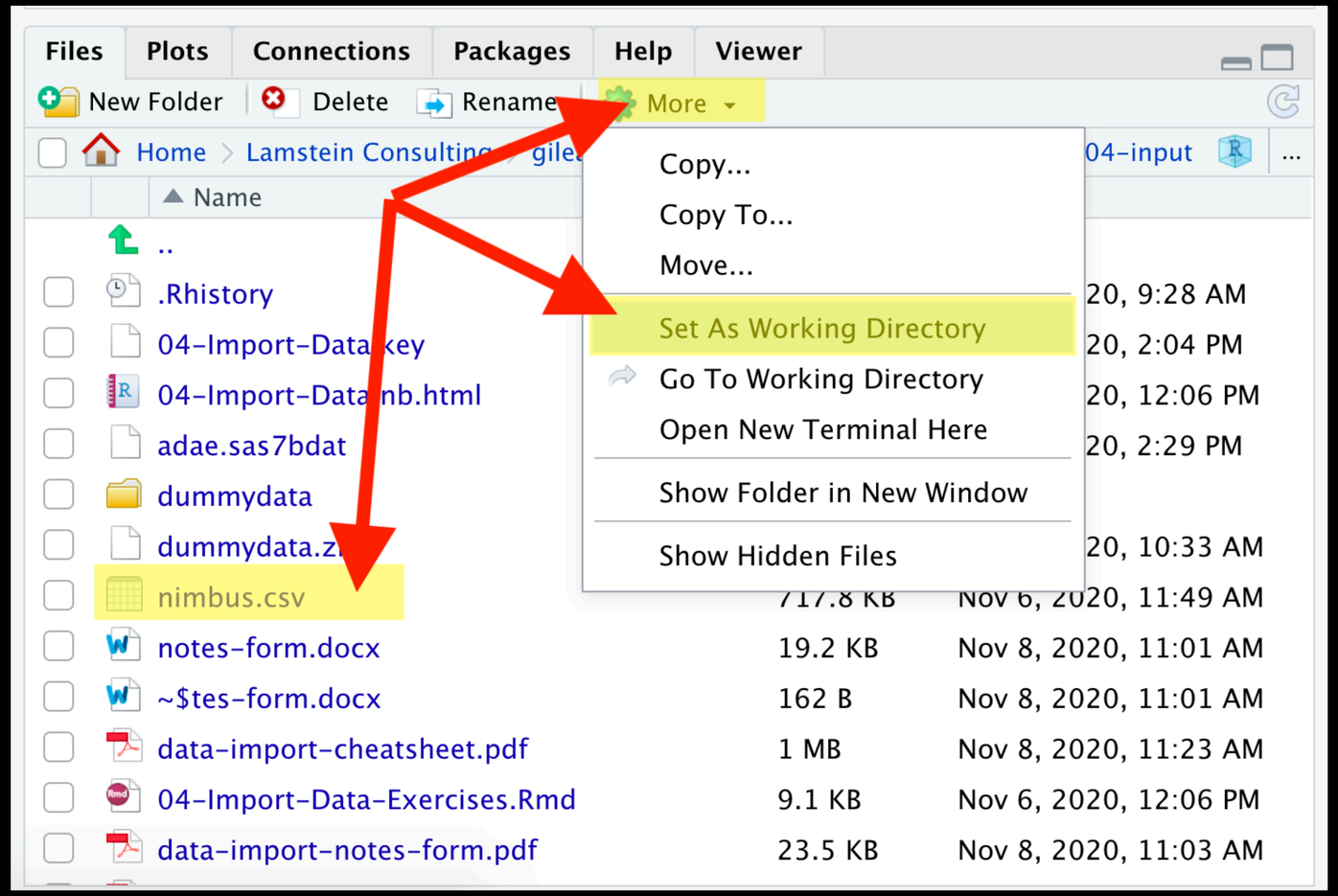
# read_csv()

readr functions share a common syntax

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

**object to save output into**

**path from working directory to file**




# Set Your Working Directory

# Your Turn 1

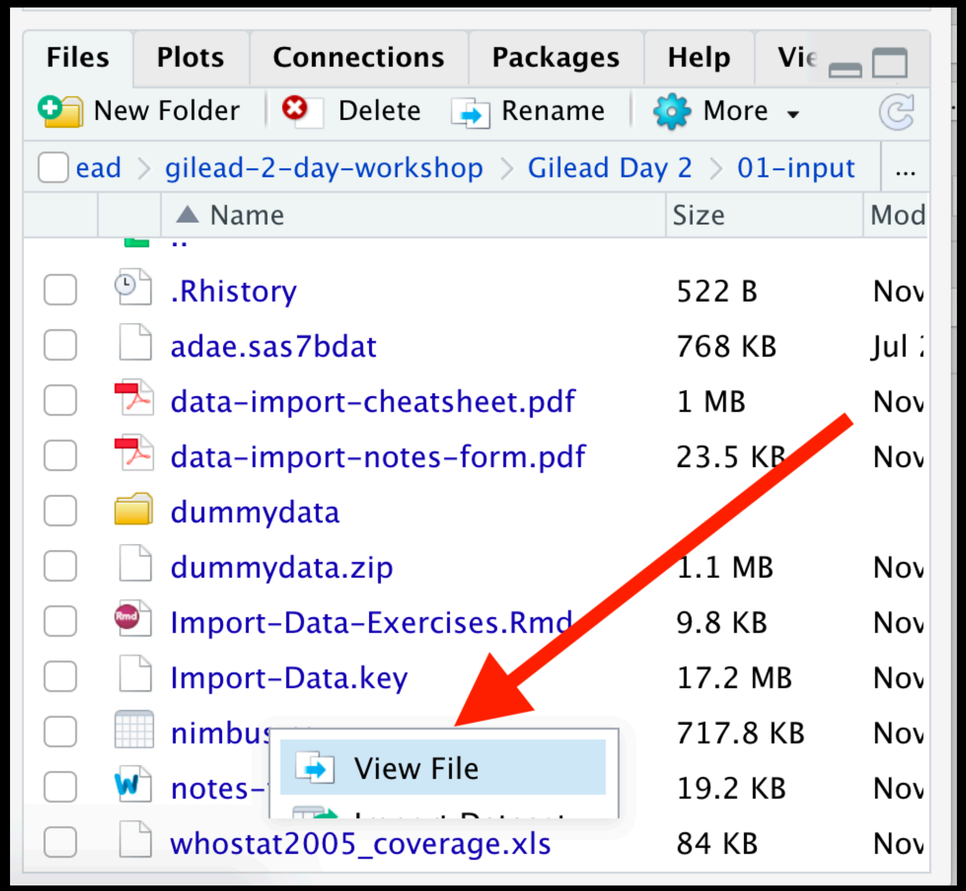
Find **nimbus.csv** (in your working directory). Then read it into an object. Then view the results.

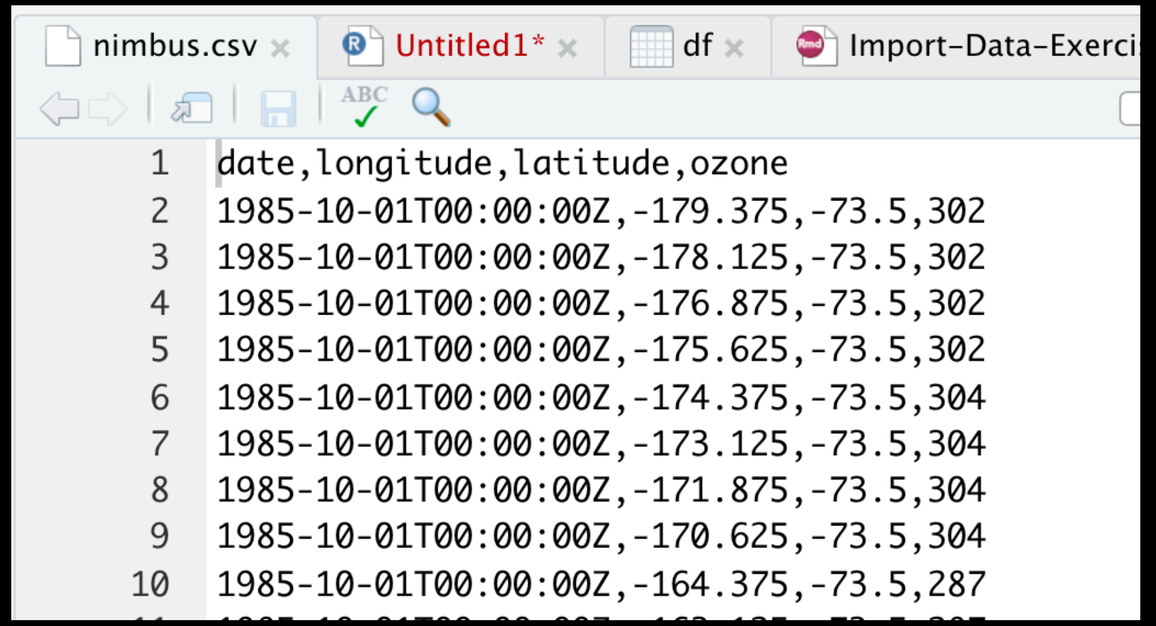
# Your Turn 1

Find **nimbus.csv** (in your working directory). Then read it into an object. Then view the results.

```
nimbus <- read_csv("nimbus.csv")
```

```
nimbus
```




# Viewing CSV files in RStudio

# Parsing

# Quiz

What class is ozone?

```
nimbus %>% pluck("ozone") %>% class()
```

```
nimbus %>% pluck("ozone") %>% class()
```

```
[1] "character"
```

```
nimbus %>% pluck("ozone") %>% unique()
```

```
  [1] "302" "304" "287" "274" "264" "242" "211" "195" "197" "196" "198" "193" "187"
 [14] "190" "199" "194" "213" "218" "221" "229" "209" "186" "188" "191" "189" "184"
 [27] "180" "183" "215" "312" "319" "320" "311" "300" "290" "267" "226" "210" "200"
 [40] "203" "201" "192" "204" "206" "208" "205" "223" "232" "238" "243" "220" "202"
 [53] "185" "219" "222" "216" "324" "336" "333" "323" "308" "295" "244" "212" "237"
 [66] "248" "239" "241" "250" "249" "252" "234" "318" "313" "326" "335" "337" "316"
 [79] "266" "207" "227" "251" "253" "257" "261" "214" "228" "273" "285" "288" "291"
 [92] "270" "254" "317" "325" "332" "340" "344" "338" "297" "247" "217" "225" "231"
[105] "235" "236" "262" "260" "265" "272" "278" "280" "279" "255" "245" "224" "181"
[118] "240" "269" "296" "307" "315" "321" "306" "299" "298" "283" "327" "322" "328"
[131] "331" "310" "275" "233" "258" "276" "281" "289" "330" "346" "305" "334" "359"
[144] "347" "314" "301" "256" "263" "277" "284" "282" "271" "246" "183" "182" "230"
[157] "349" "351" "350" "342" "329" "355" "371" "309" "303" "292" "259" "268" "341"
[170] "343" "348" "345" "354" "361" "372" "382" "376" "356" "293" "286" "353" "355"
[183] "358" "360" "363" "370" "384" "380" "294" "339" "362" "352" "368" "373" "377"
```


# . = NA

```
nimbus
```

| date <S3: POSIXct> | longitude <dbl> | latitude <dbl> | ozone <chr> |
|---|---|---|---|
| 1985-10-01 | -179.375 | -87.5 | . |
| 1985-10-01 | -178.125 | -87.5 | . |
| 1985-10-01 | -176.875 | -87.5 | . |
| 1985-10-01 | -175.625 | -87.5 | . |
| 1985-10-01 | -174.375 | -87.5 | . |
| 1985-10-01 | -173.125 | -87.5 | . |
| 1985-10-01 | -171.875 | -87.5 | . |
| 1985-10-01 | -170.625 | -87.5 | . |
| 1985-10-01 | -169.375 | -87.5 | . |

# read_csv()

readr functions share a common syntax

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

**object to save output into**

**path from working directory to file**

**Value(s) to convert to NA**

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

| | 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 | 3 |
| 4 | 1985-10-01 00:00:00 | -176. | -73.5 | 3 |
| 5 | 1985-10-01 00:00:00 | -174. | -73.5 | 3 |
| 6 | 1985-10-01 00:00:00 | -173. | -73.5 | 3 |
| 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> stands for "double"**

suppose

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

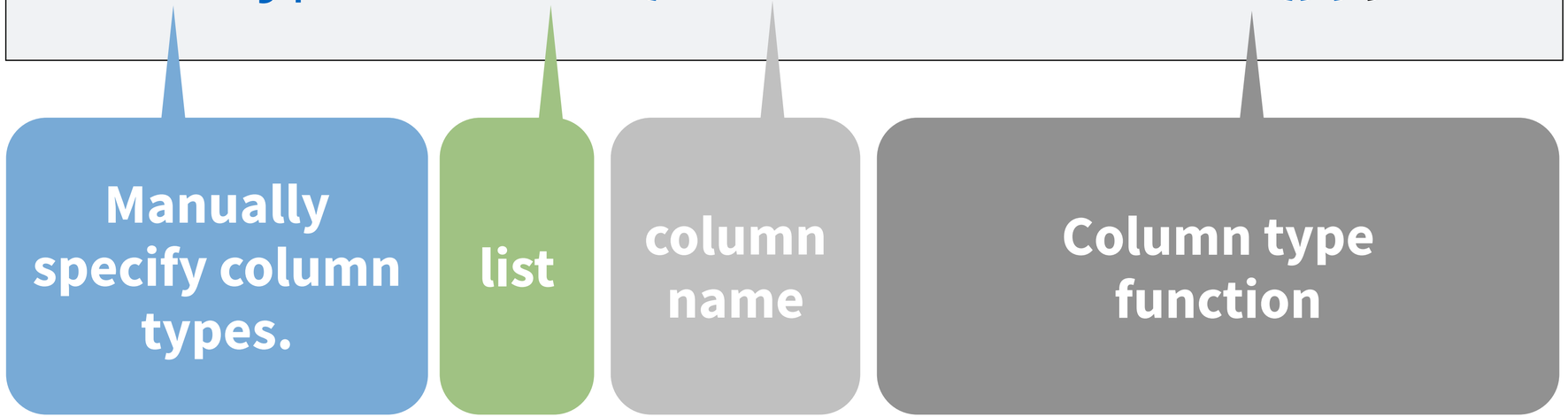
| date <S3: POSIXct> | longitude <dbl> | latitude <dbl> | ozone <chr> |
|---|---|---|---|
| 1985-10-01 | -179.375 | -87.5 | *NA* |
| 1985-10-01 | -178.125 | -87.5 | *NA* |
| 1985-10-01 | -176.875 | -87.5 | *NA* |
| 1985-10-01 | -175.625 | -87.5 | *NA* |
| 1985-10-01 | -174.375 | -87.5 | *NA* |
| 1985-10-01 | -173.125 | -87.5 | *NA* |
| 1985-10-01 | -171.875 | -87.5 | *NA* |
| 1985-10-01 | -170.625 | -87.5 | *NA* |
| 1985-10-01 | -169.375 | -87.5 | *NA* |
| 1985-10-01 | -168.125 | -87.5 | *NA* |

**<chr> stands for character string** (not a number)

# read_csv()

readr functions share a common syntax

```
nimbus <- read_csv("nimbus.csv", na = ".",
  col_types = list(ozone = col_double()))
```

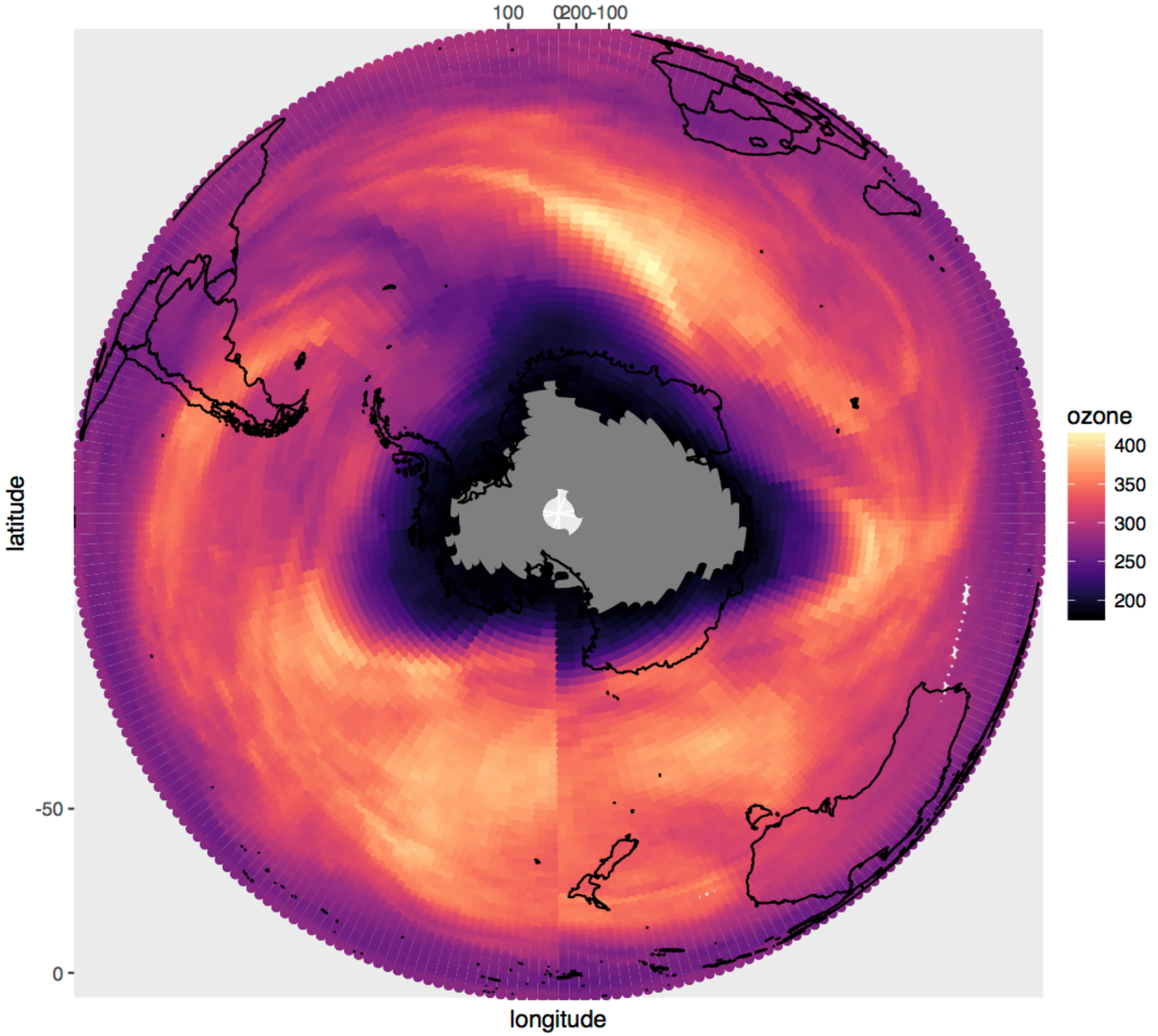


| type function | data type |
|---|---|
| col_character() | character |
| col_date() | Date |
| col_datetime() | POSIXct (date-time) |
| col_double() | double (numeric) |
| col_factor() | factor |
| col_guess() | let readr guess (default) |
| col_integer() | integer |
| col_logical() | logical |
| col_number()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

| 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 |

```
nimbus <- read_csv("nimbus.csv", na = ".",
  col_types = list(ozone = col_double()))

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


100
0
200
-100
latitude
-50
0
longitude
ozone
400
350
300
250
200

# Writing

# readr functions

| function | writes |
|---|---|
| write_csv() | Comma separated values |
| write_excel_csv() | CSV intended for opening in Excel |
| write_delim() | General delimited files |
| write_file() | Single string, written as is |
| write_lines() | Vector of strings, one element per line |
| write_tsv() | Tab delimited values |

# write_csv()

Saves data set as a csv on your computer.

```
write_csv(nimbus, file = "nimbus2.csv")
```

**Table to save**

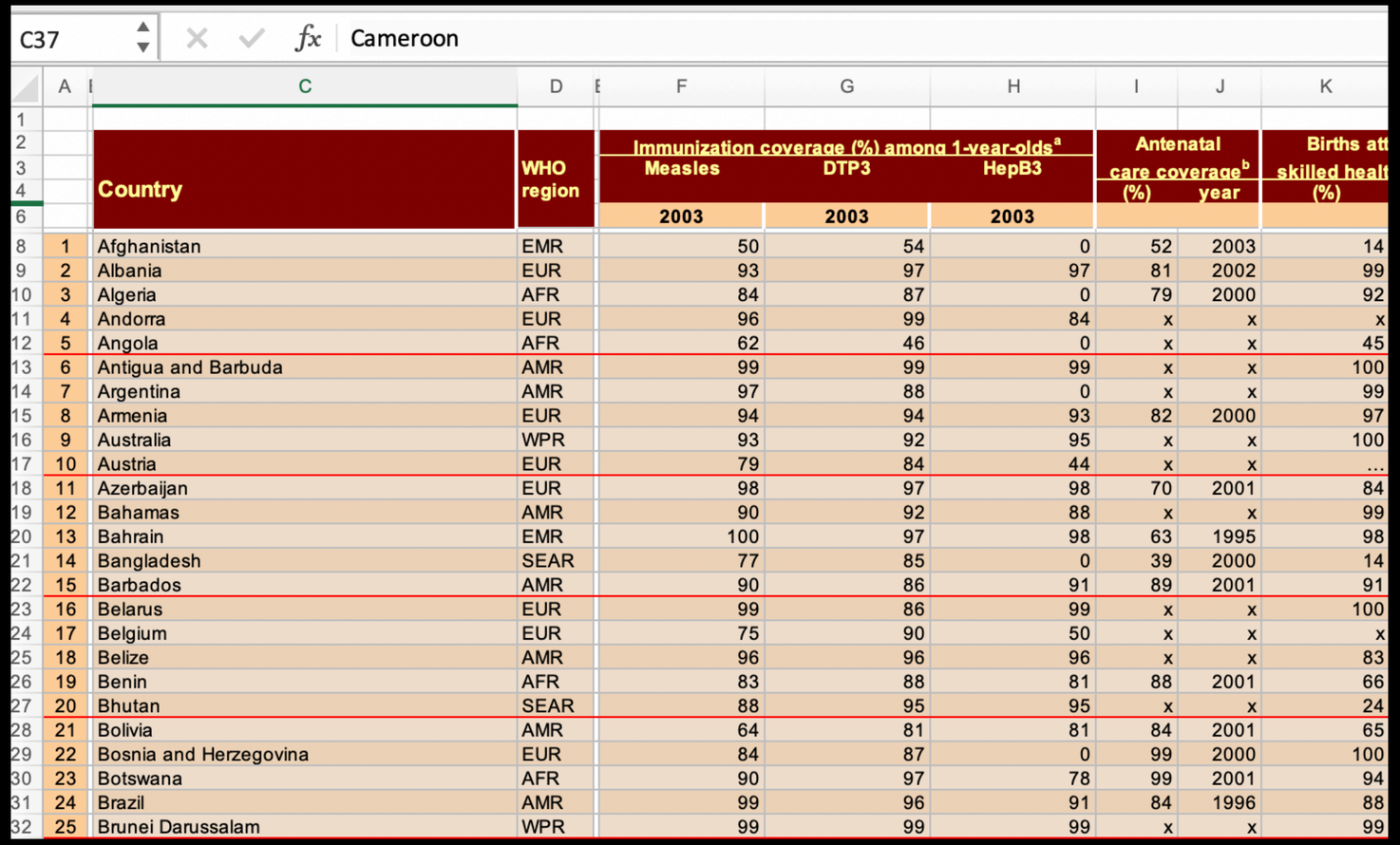
**file**
**path to save at**

# Reading in Excel

# readxl


Reading in Excel Files

```
# install.packages("tidyverse")
library(readxl)
```



C37 | Cameroon

| | A | C | D | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | |
| 2 | | Country | WHO region | Immunization coverage (%) among 1-year-olds[a] | | | Antenatal | | Births att |
| 3 | | | | Measles | DTP3 | HepB3 | care coverage[b] | | skilled healt |
| 4 | | | | | | | (%) | year | (%) |
| 6 | | | | 2003 | 2003 | 2003 | | | |
| 8 | 1 | Afghanistan | EMR | 50 | 54 | 0 | 52 | 2003 | 14 |
| 9 | 2 | Albania | EUR | 93 | 97 | 97 | 81 | 2002 | 99 |
| 10 | 3 | Algeria | AFR | 84 | 87 | 0 | 79 | 2000 | 92 |
| 11 | 4 | Andorra | EUR | 96 | 99 | 84 | x | x | x |
| 12 | 5 | Angola | AFR | 62 | 46 | 0 | x | x | 45 |
| 13 | 6 | Antigua and Barbuda | AMR | 99 | 99 | 99 | x | x | 100 |
| 14 | 7 | Argentina | AMR | 97 | 88 | 0 | x | x | 99 |
| 15 | 8 | Armenia | EUR | 94 | 94 | 93 | 82 | 2000 | 97 |
| 16 | 9 | Australia | WPR | 93 | 92 | 95 | x | x | 100 |
| 17 | 10 | Austria | EUR | 79 | 84 | 44 | x | x | ... |
| 18 | 11 | Azerbaijan | EUR | 98 | 97 | 98 | 70 | 2001 | 84 |
| 19 | 12 | Bahamas | AMR | 90 | 92 | 88 | x | x | 99 |
| 20 | 13 | Bahrain | EMR | 100 | 97 | 98 | 63 | 1995 | 98 |
| 21 | 14 | Bangladesh | SEAR | 77 | 85 | 0 | 39 | 2000 | 14 |
| 22 | 15 | Barbados | AMR | 90 | 86 | 91 | 89 | 2001 | 91 |
| 23 | 16 | Belarus | EUR | 99 | 86 | 99 | x | x | 100 |
| 24 | 17 | Belgium | EUR | 75 | 90 | 50 | x | x | x |
| 25 | 18 | Belize | AMR | 96 | 96 | 96 | x | x | 83 |
| 26 | 19 | Benin | AFR | 83 | 88 | 81 | 88 | 2001 | 66 |
| 27 | 20 | Bhutan | SEAR | 88 | 95 | 95 | x | x | 24 |
| 28 | 21 | Bolivia | AMR | 64 | 81 | 81 | 84 | 2001 | 65 |
| 29 | 22 | Bosnia and Herzegovina | EUR | 84 | 87 | 0 | 99 | 2000 | 100 |
| 30 | 23 | Botswana | AFR | 90 | 97 | 78 | 99 | 2001 | 94 |
| 31 | 24 | Brazil | AMR | 99 | 96 | 91 | 84 | 1996 | 88 |
| 32 | 25 | Brunei Darussalam | WPR | 99 | 99 | 99 | x | x | 99 |

# who.xls

Country-Level Immunization Stats from the World Health Organization

# Quiz

Open up **who.xls** in Excel.

What problems might you encounter reading this data into R?

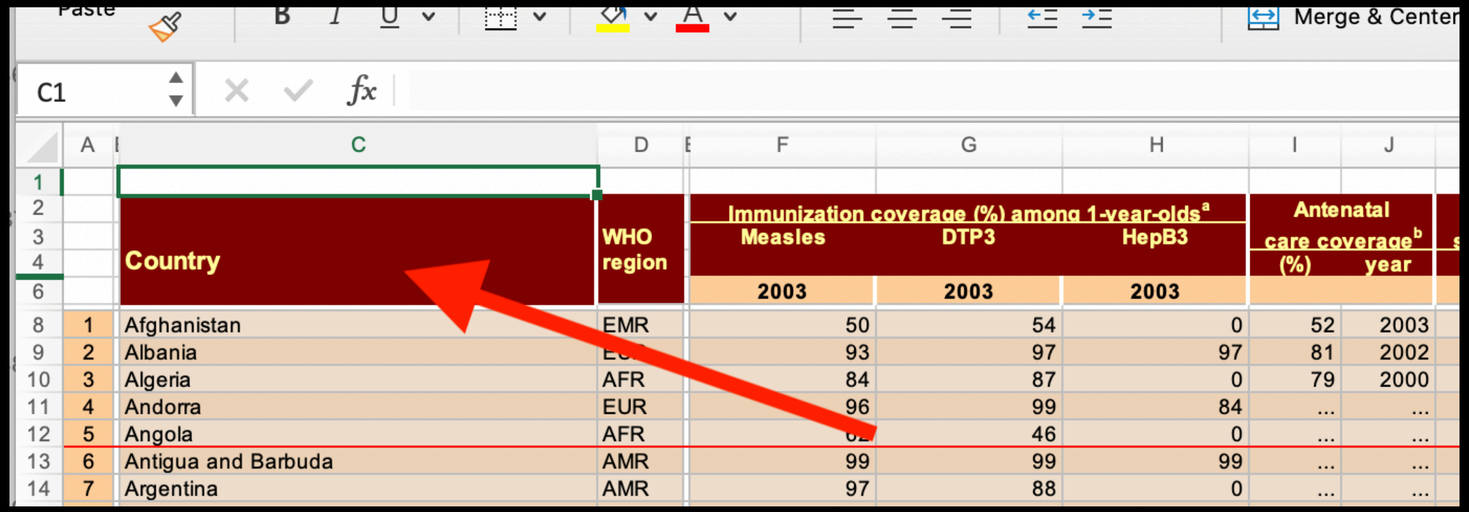
(Hint: Is this data "tidy"?)

| | | | | |
|---|---|---|---|---|
| Zambia | AFR | 84 | 80 | 0 |
| Zimbabwe | AFR | 80 | 80 | 80 |
| | | | | |
| | | | | |
| **Region** | | | | |
| African Region | AFR | 63 | 61 | 29 |
| Region of the Americas | AMR | 93 | 91 | 77 |
| South-East Asia Region | SEAR | 71 | 73 | 13 |
| European Region | EUR | 90 | 91 | 67 |
| Eastern Mediterranean Region | EMR | 75 | 77 | 44 |
| Western Pacific Region | WPR | 85 | 89 | 65 |
| | | | | |
| **Figures computed by WHO to improve comparability where appropriate; they are not necessarily the official st** | | | | |
| | | | | |
| … data not available or not applicable. | | | | |
| [a]World Health Organization, Department of Immunization Vaccines and Biologicals, Vaccine Assessment and Monitor | | | | |
| [b]The World Health Report 2005: make every mother and child count. Geneva, World Health Organization, 2005. (http | | | | |
| [c]The WHO Global Roll Back Malaria database. (http://www.who.int/globalatlas/autologin/malaria_login.asp) | | | | |
| [d]WHO report 2005. Global Tuberculosis Control; Surveillance, Planning, Financing. Geneva, World Health Organizatio | | | | |
| [e]The WHO Global Database on Child Growth and Malnutrition. (http://www.who.int/nutgrowthdb) | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

# Sheet != Table

| | |
|---|---|
| 2.7 | 50 |
| x | 50 |
| x | 45 |
| x | 23 |
| x | 28 |
| x | 50 |

# 2 NA values




# Multi-row columns

# read_excel()

Read in an Excel File

```
df <- read_excel("who.xls", na = c("x", ""))
```

**object to save output into**

**path from working directory to file**

**Value(s) to convert to NA**

# read_excel()

Read in an Excel File

```
df <- read_excel("who.xls", na = c("x", ""), range="A1:B2")
```

**Range of Cells to read**

# Exercise: Reading in the Small Table

Read in the small table in **who.xls.** Make it look like the image on the right

1. Set the **range** parameter set to read in just the second, smaller table.
2. Set the **NA** parameter appropriately.
3. Set **another option** ... so that the first row is not treated as a column name (see ?read_excel)

| | ...1 | ...2 | ...3 | ...4 |
|---|---|---|---|---|
| 1 | African Region | AFR | *NA* | |
| 2 | Region of the Americas | AMR | *NA* | |
| 3 | South-East Asia Region | SEAR | *NA* | |
| 4 | European Region | EUR | *NA* | |
| 5 | Eastern Mediterranean Region | EMR | *NA* | |
| 6 | Western Pacific Region | WPR | *NA* | |

# Exercise: Reading in the Small Table

```
read_excel("who.xls",
           na        = c("x", ""),
           range     = "C204:U209",
           col_names = FALSE)
```

| | ...1 | ...2 | ...3 | ...4 |
|---|---|---|---|---|
| 1 | African Region | AFR | *NA* | |
| 2 | Region of the Americas | AMR | *NA* | |
| 3 | South-East Asia Region | SEAR | *NA* | |
| 4 | European Region | EUR | *NA* | |
| 5 | Eastern Mediterranean Region | EMR | *NA* | |
| 6 | Western Pacific Region | WPR | *NA* | |

# excel_sheets()

List sheets in an Excel file

```
excel_sheets("who.xls")
[1] "2.Health service coverage"
```

# Data Import in the Tidyverse
# A package for each storage type!

| package | accesses |
|---|---|
| readr | csv, tsv, etc. |
| haven | SPSS, Stata, and SAS files |
| readxl | excel files (.xls, .xlsx) |
| jsonlite | json |
| xml2 | xml |
| httr | web API's |
| rvest | web pages (web scraping) |
| DBI | databases |
| sparklyr | data loaded into spark |

# Import Data with


# Notes form