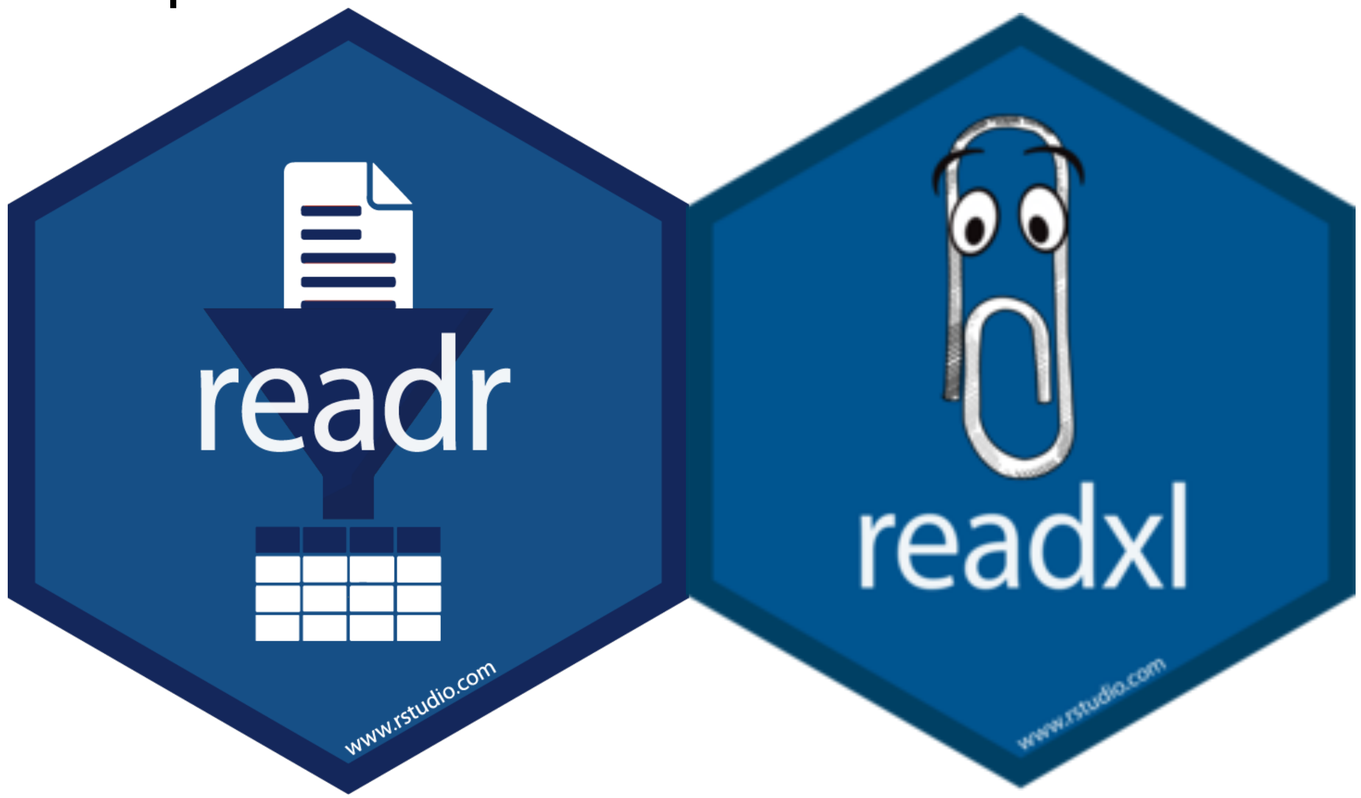
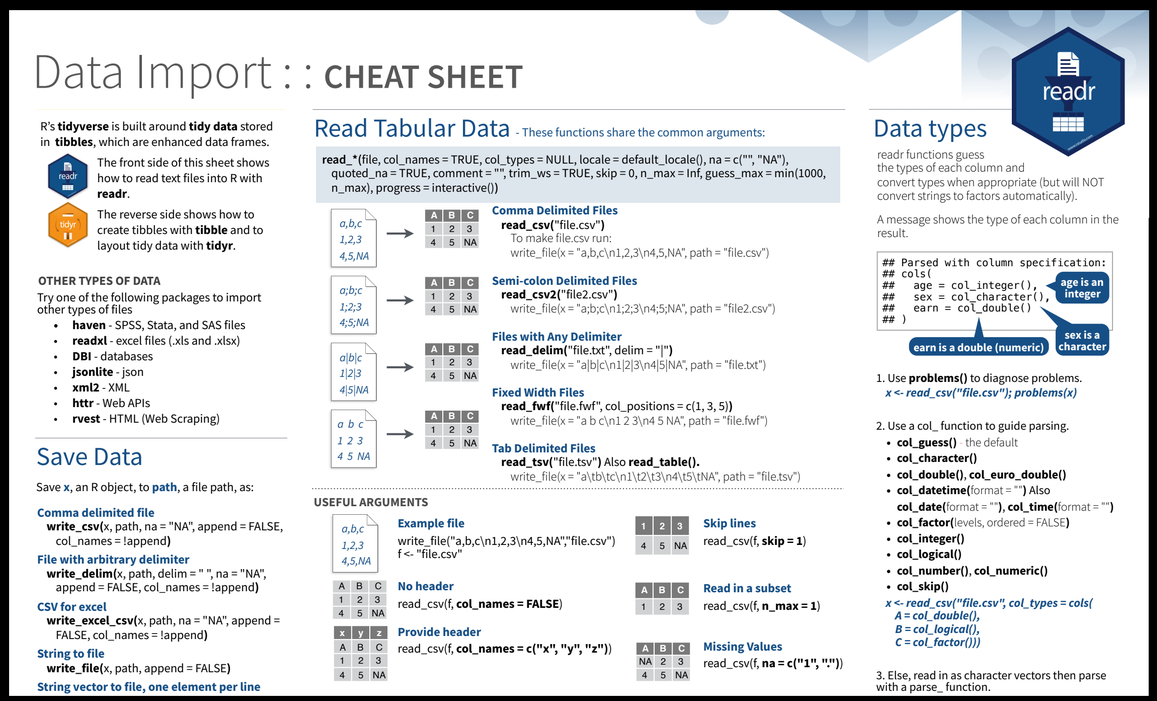
Import Data with



Exercise: Importing Data

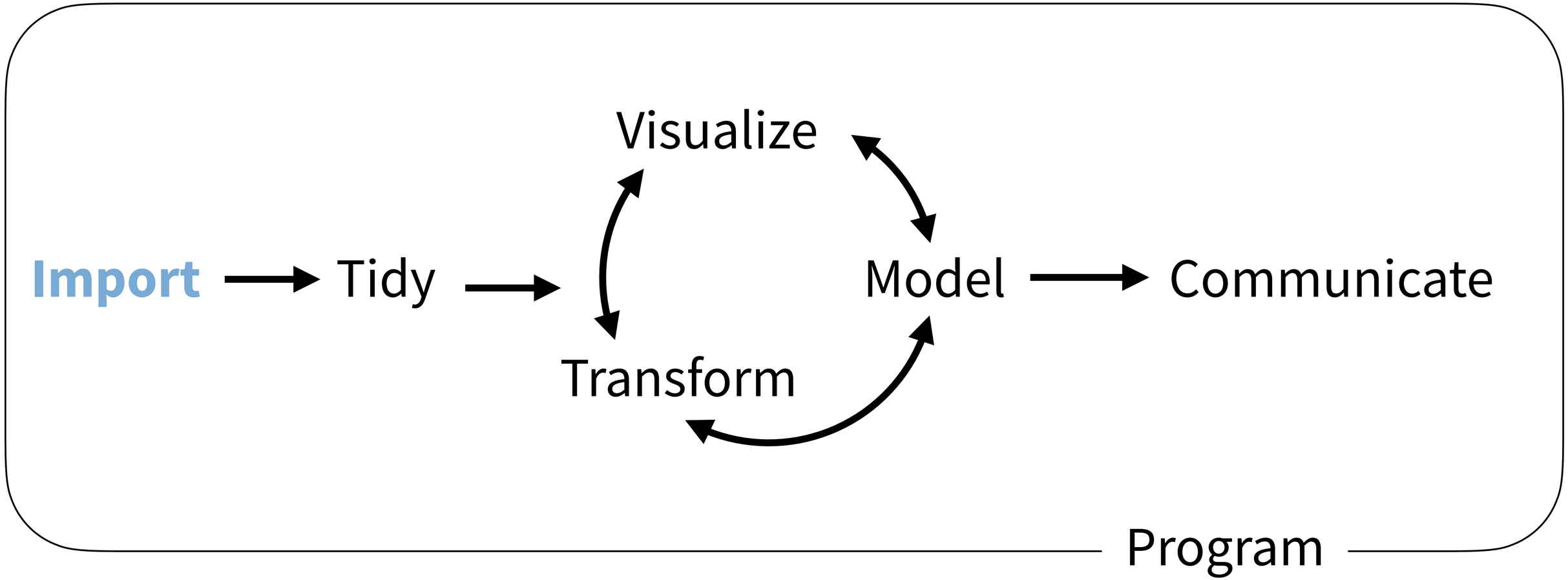
- Split into groups and ask your partner:
  - *Where is the data that your want to analyze?*
  - *How do you currently access it?*



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 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,.
```

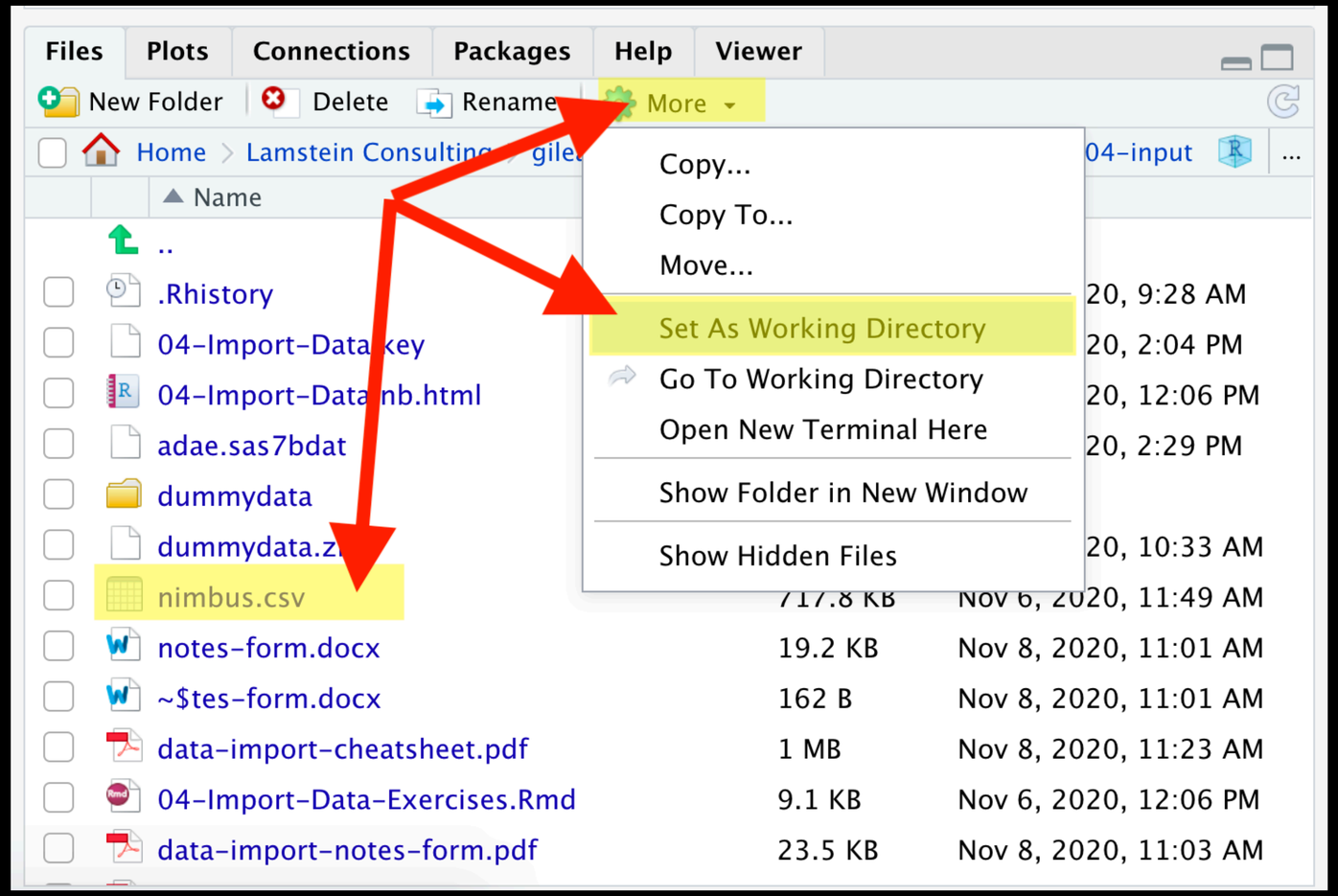
read_csv()

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

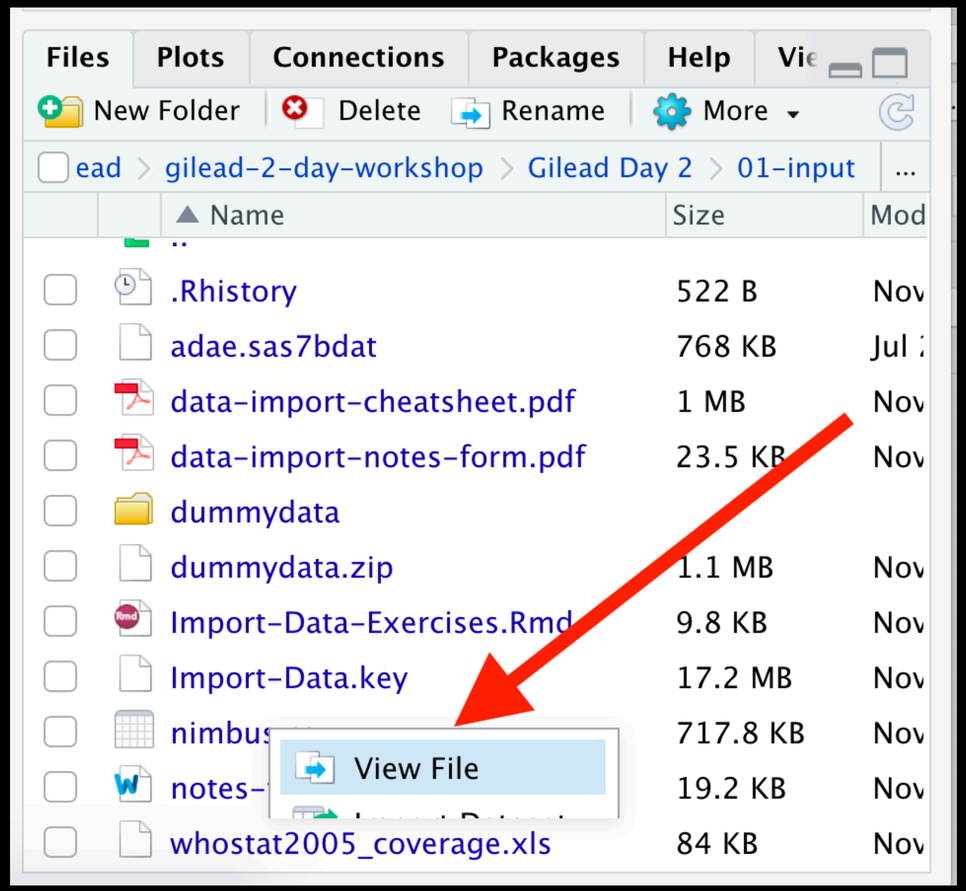
Find **nimbus.csv** (in your working directory). Then read it into an object. Then view the results.

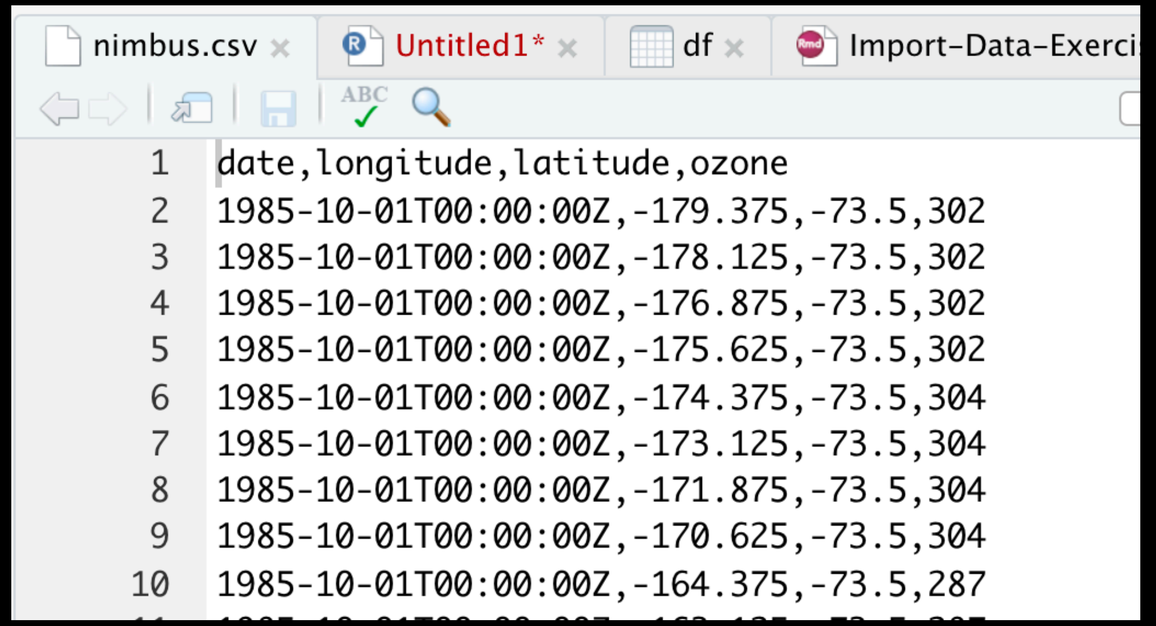
Your Turn 1

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

Your Turn

Reread in **nimbus.csv**. But this time convert the "."'s to NA's. How many NA's are in the ozone column?

Your Turn

Reread in **nimbus.csv**. But this time convert the "."'s to NA's. How many NA's are in the ozone column?

```
nimbus <- read_csv("nimbus.csv", na = ".")
View(nimbus)
nimbus %>%
  summarize(nas = sum(is.na(ozone)), n = n())
## # A tibble: 1 × 2
##     nas     n
##   <int> <int>
## 1   155 18963
```

Quiz

What "type" of column is ozone?

```
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 = ".")
```

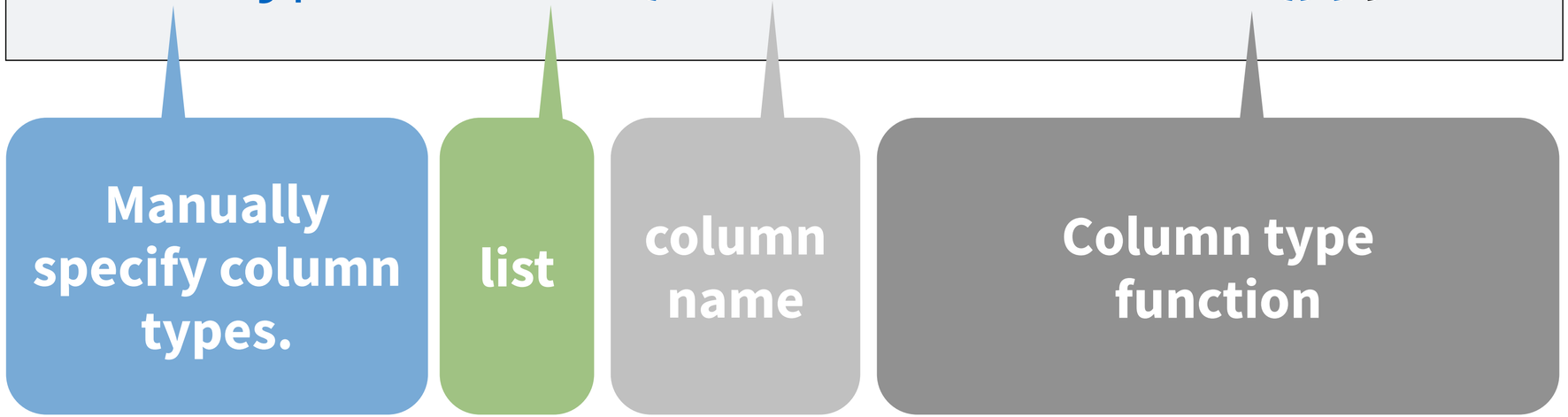
date <S3: POSIXct>	longitude <dbl>	latitude <dbl>	ozone <chr>
1985-10-01	-179.375	-87.5	*NA*
1985-10-01	-178.125	-87.5	*NA*
1985-10-01	-176.875	-87.5	*NA*
1985-10-01	-175.625	-87.5	*NA*
1985-10-01	-174.375	-87.5	*NA*
1985-10-01	-173.125	-87.5	*NA*
1985-10-01	-171.875	-87.5	*NA*
1985-10-01	-170.625	-87.5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

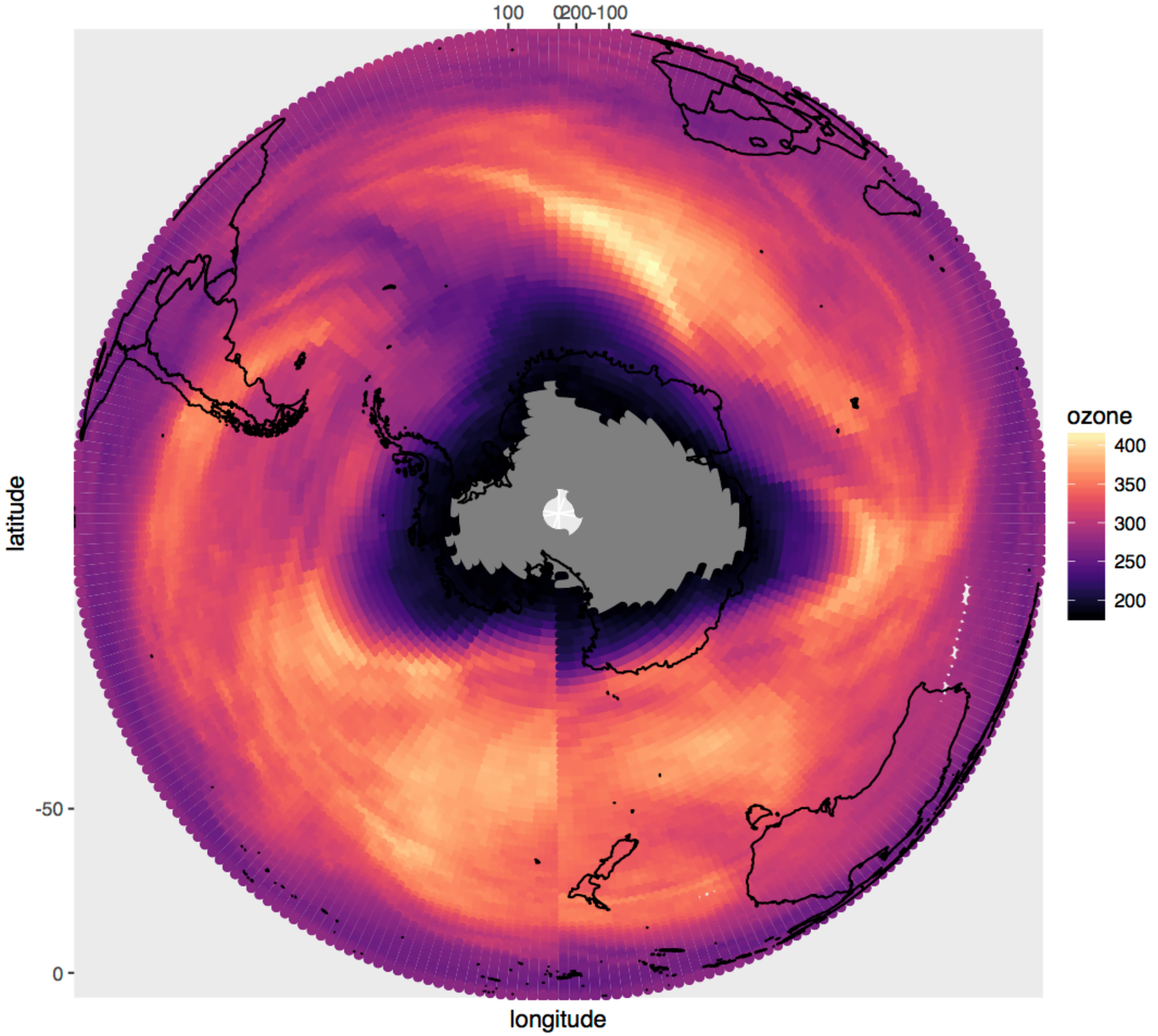
Your Turn

Read in **nimbus.csv**. accounting for NA's and setting the col_type of ozone to a double. Then make this plot. What do you see?

```
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")
```

```
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

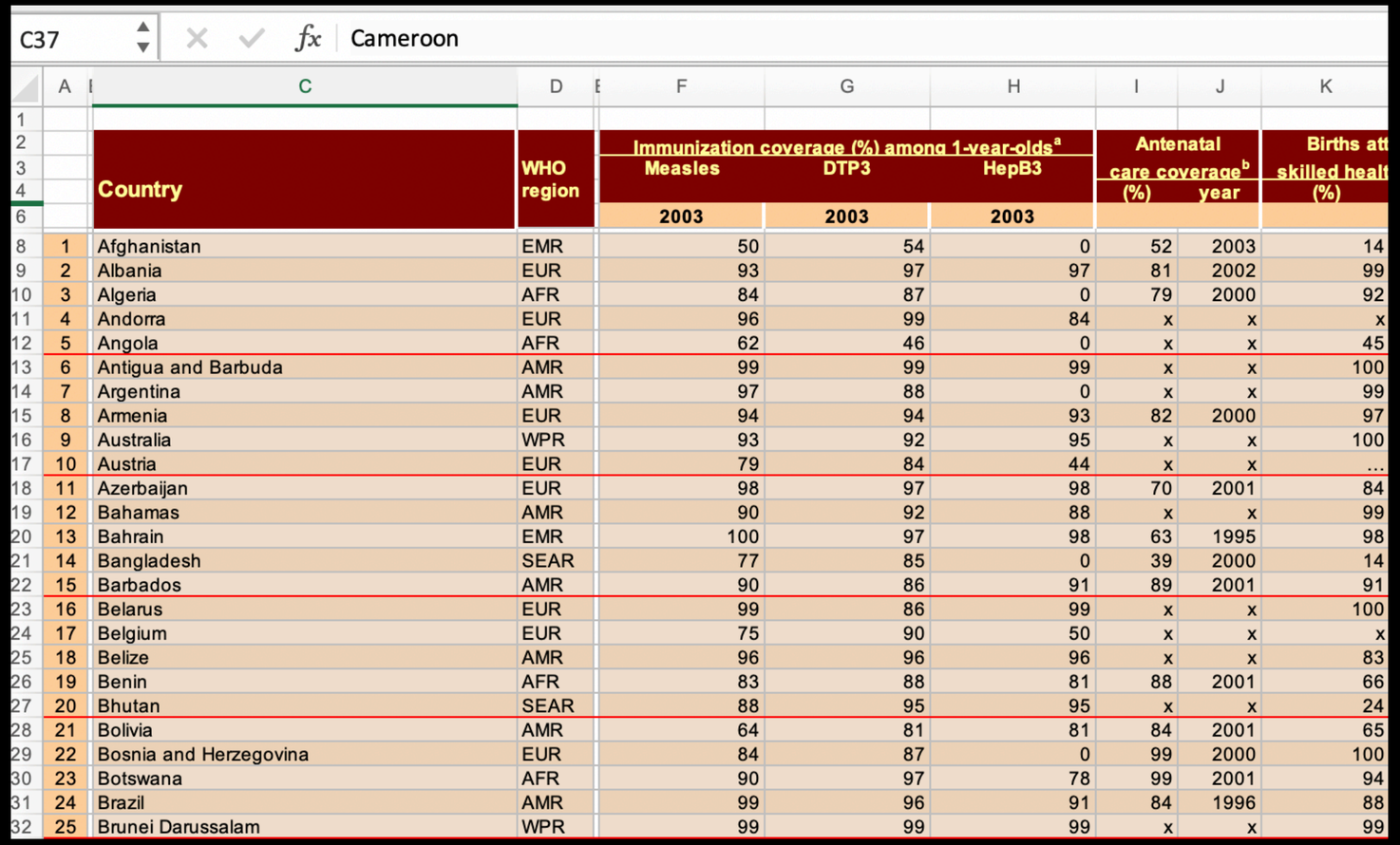
file
path to save at

Reading in Excel Files

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?

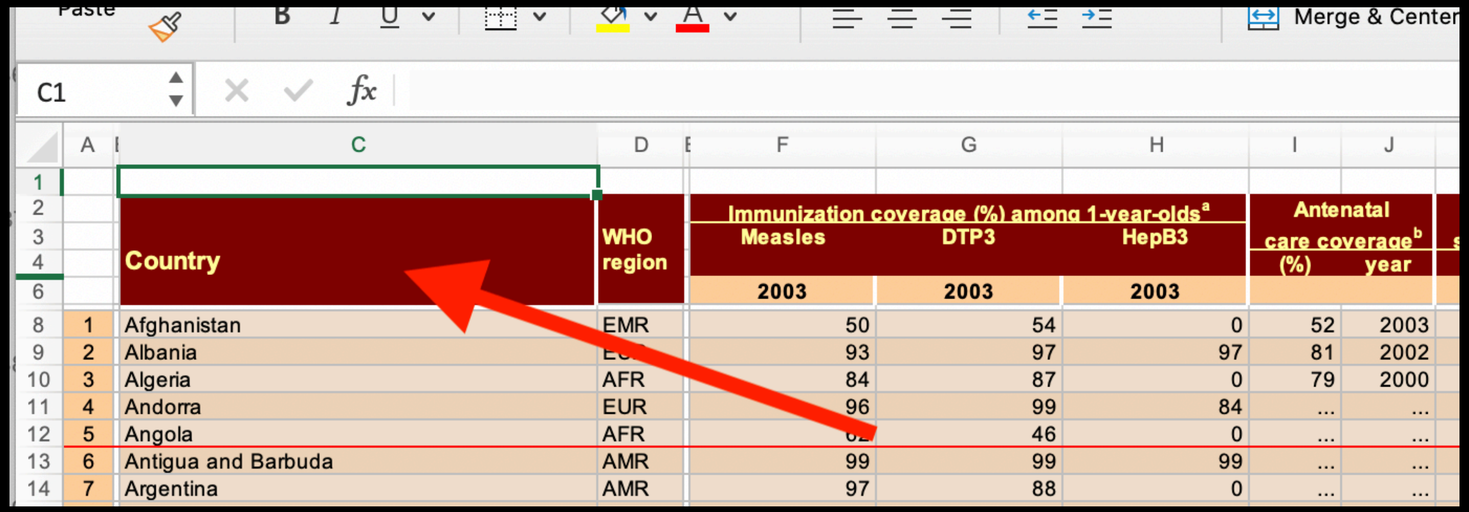
(Hint: Is this data "tidy"?)

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()

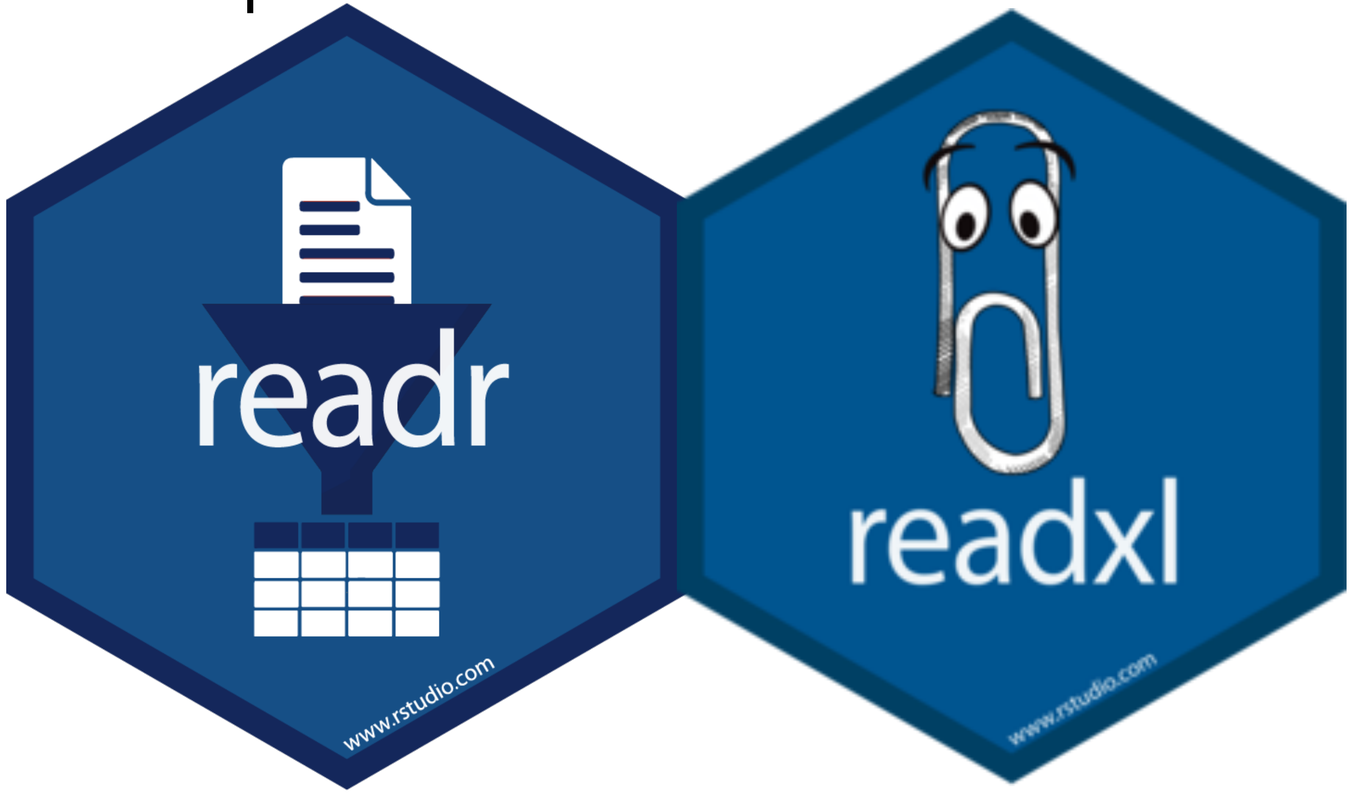
List sheets in an Excel file

```
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