Intro to the **Tidyverse** and importing/cleaning tables

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Outline for today:

- 1. Intro to the Tidyverse
- 2. Importing table data into R (excel, tsv, csv, etc.)
- 3. Cleaning data

1. The Tidyverse

The Tidyverse

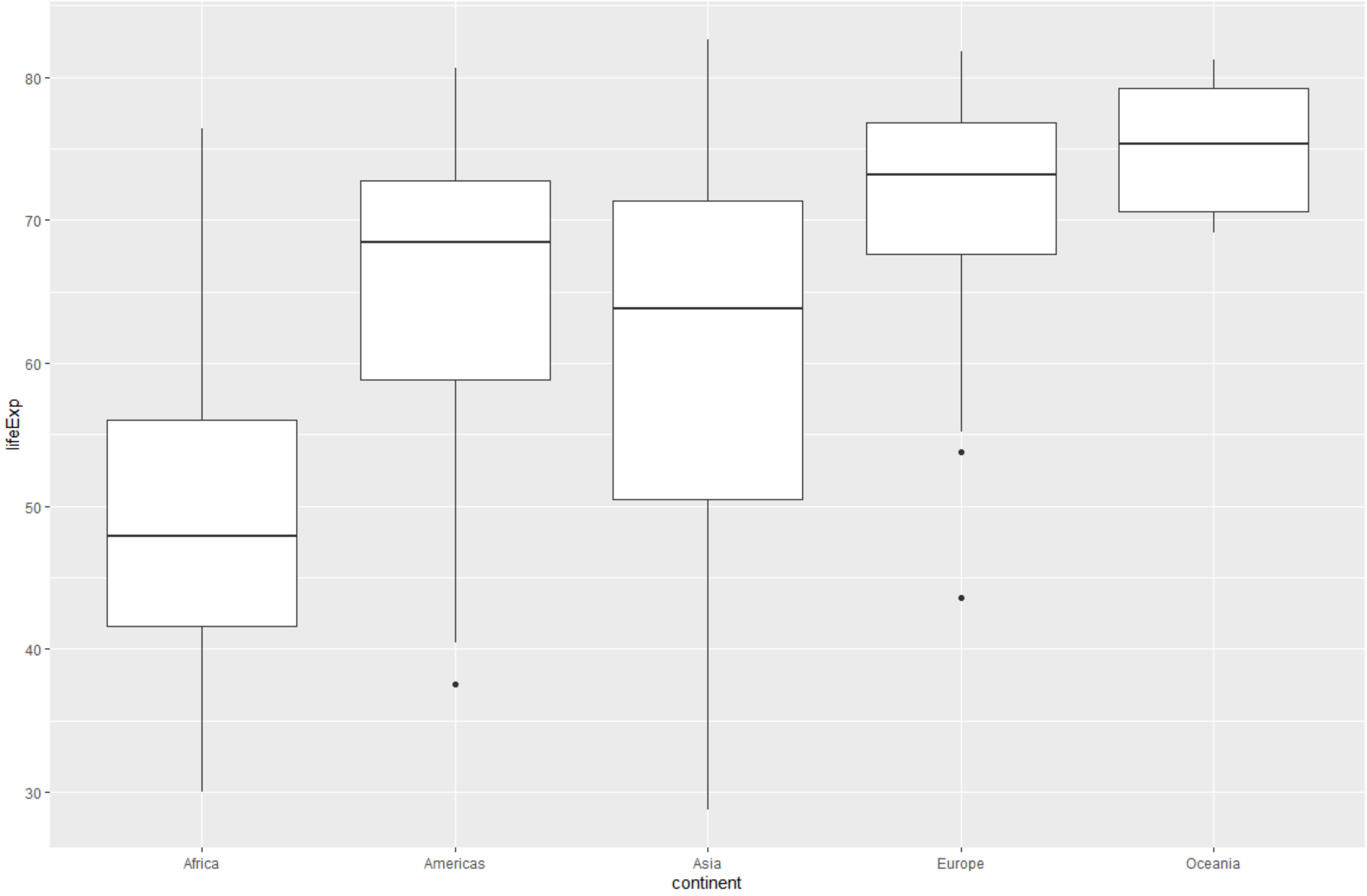
- Group of R packages designed for data science

- Common design/grammar structures

- More user friendly than base R

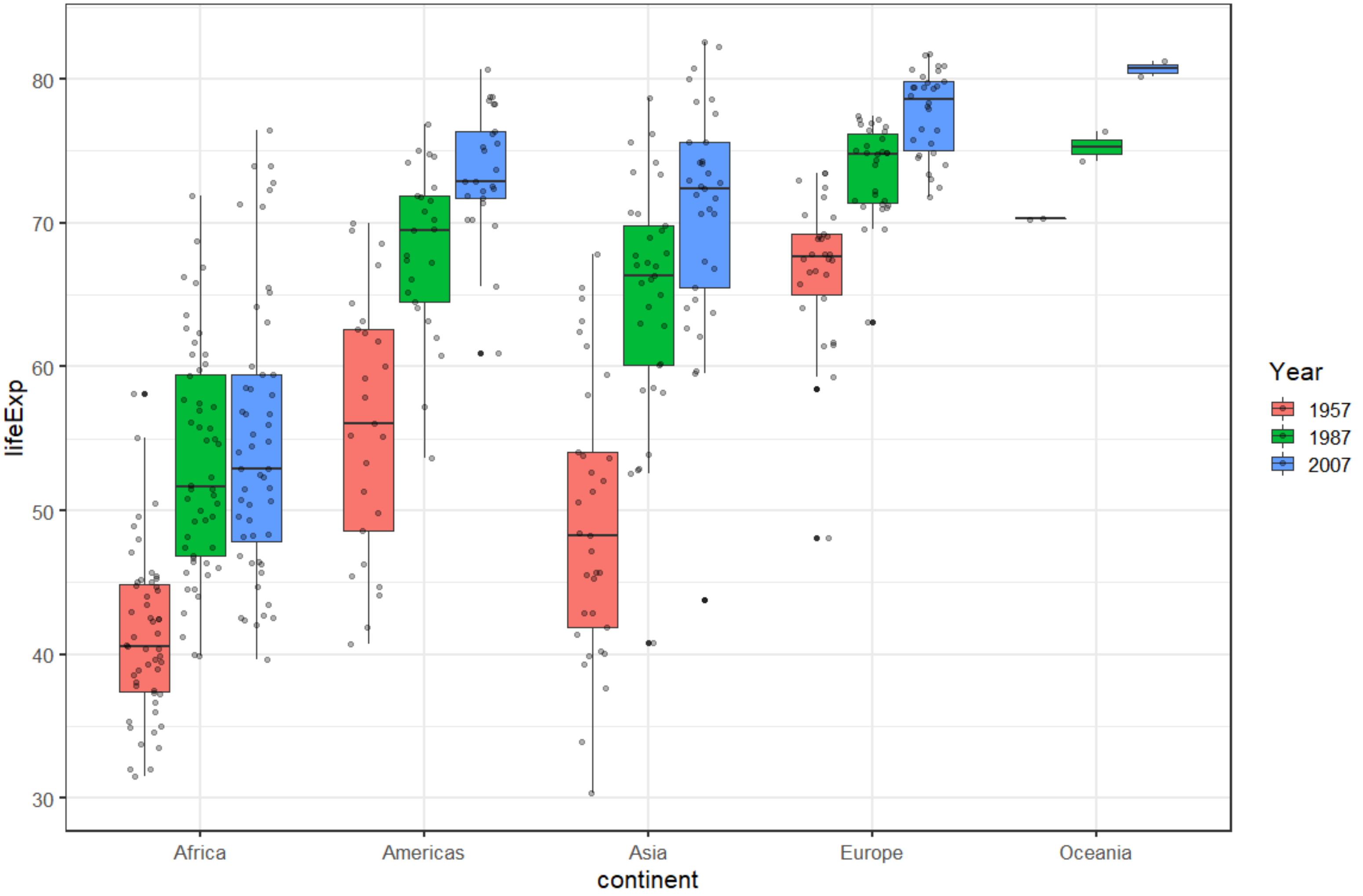
Wickham et al., (2019). Welcome to the Tidyverse. *Journal of Open Source Software*, 4(43), 1686, https://doi.org/10.21105/joss.01686

ggplot2



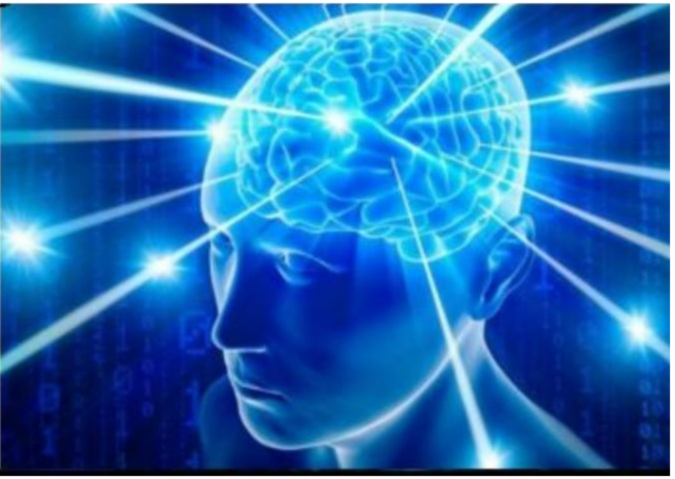
lifeExp
80
70
60
50
40
30
Africa
Americas
Asia
Europe
Oceania
continent

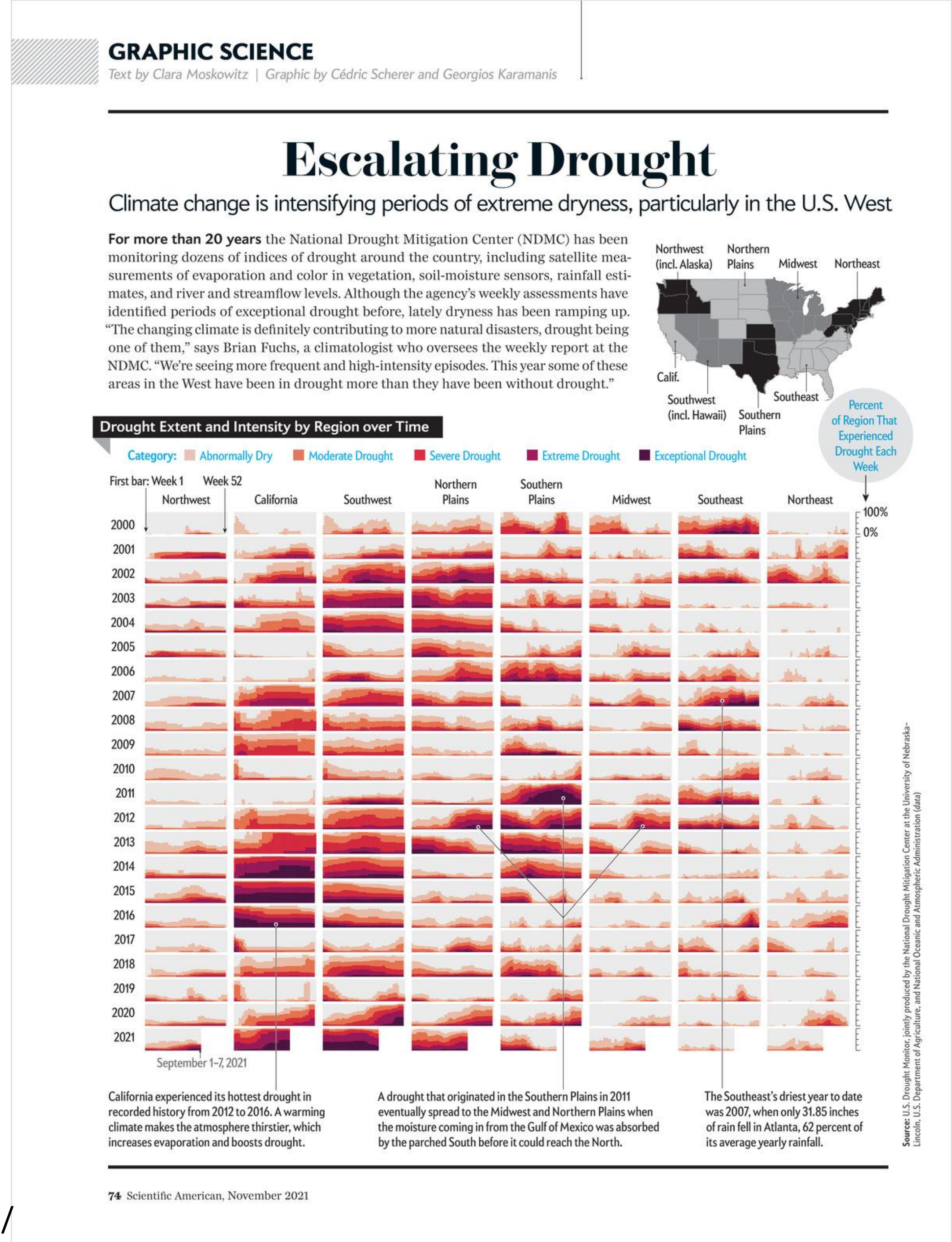
ggplot2



lifeExp
80
70
60
50
40
30
Africa
Americas
Asia
Europe
Oceania
continent
Year
1957
1987
2007

ggplot2





GRAPHIC SCIENCE

Text by Clara Moskowitz | Graphic by Cédric Scherer and Georgios Karamanis

Escalating Drought

Climate change is intensifying periods of extreme dryness, particularly in the U.S. West

For more than 20 years the National Drought Mitigation Center (NDMC) has been monitoring dozens of indices of drought around the country, including satellite measurements of evaporation and color in vegetation, soil-moisture sensors, rainfall estimates, and river and streamflow levels. Although the agency's weekly assessments have identified periods of exceptional drought before, lately dryness has been ramping up. "The changing climate is definitely contributing to more natural disasters, drought being one of them," says Brian Fuchs, a climatologist who oversees the weekly report at the NDMC. "We're seeing more frequent and high-intensity episodes. This year some of these areas in the West have been in drought more than they have been without drought."

Drought Extent and Intensity by Region over Time

California experienced its hottest drought in recorded history from 2012 to 2016. A warming climate makes the atmosphere thirstier, which increases evaporation and boosts drought.

A drought that originated in the Southern Plains in 2011 eventually spread to the Midwest and Northern Plains when the moisture coming in from the Gulf of Mexico was absorbed by the parched South before it could reach the North.

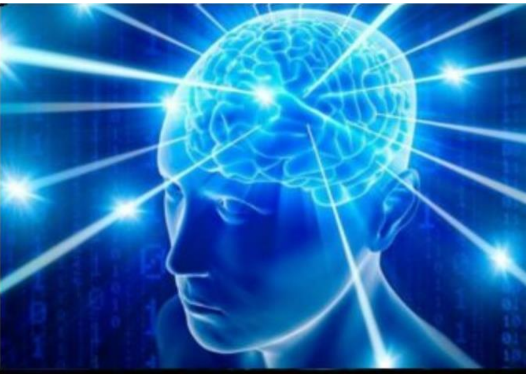
The Southeast's driest year to date was 2007, when only 31.85 inches of rain fell in Atlanta, 62 percent of its average yearly rainfall.

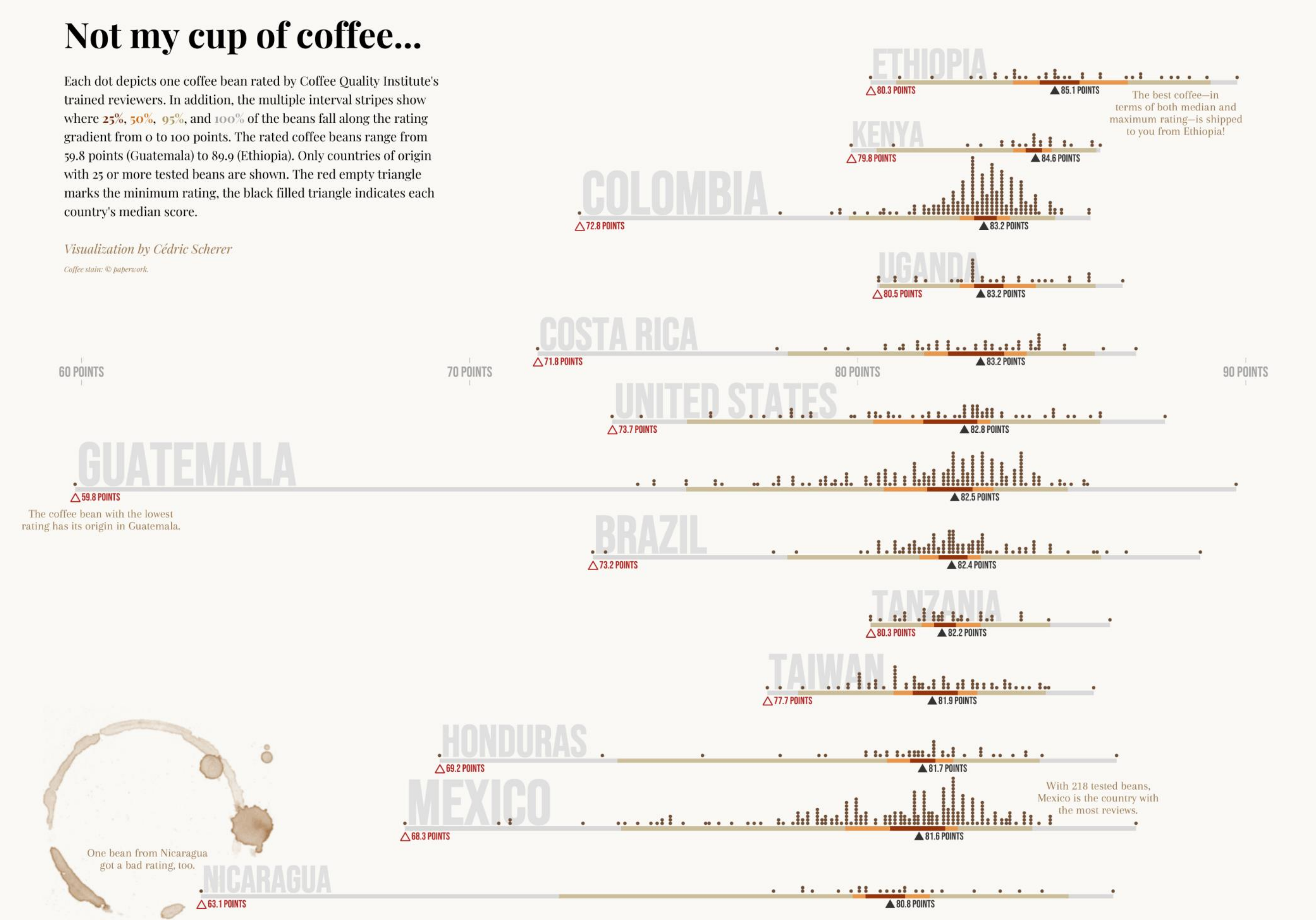
Source: U.S. Drought Monitor, jointly produced by the National Drought Mitigation Center at the University of Nebraska–Lincoln, U.S. Department of Agriculture, and National Oceanic and Atmospheric Administration (data)

74 Scientific American, November 2021

https://www.cedricscherer.com/top/dataviz/

ggplot2





Not my cup of coffee...

Each dot depicts one coffee bean rated by Coffee Quality Institute's trained reviewers. In addition, the multiple interval stripes show where 25%, 50%, 95%, and 100% of the beans fall along the rating gradient from 0 to 100 points. The rated coffee beans range from 59.8 points (Guatemala) to 89.9 (Ethiopia). Only countries of origin with 25 or more tested beans are shown. The red empty triangle marks the minimum rating, the black filled triangle indicates each country's median score.

Visualization by Cédric Scherer

Coffee stain: © paperwork.

The best coffee—in terms of both median and maximum rating—is shipped to you from Ethiopia!

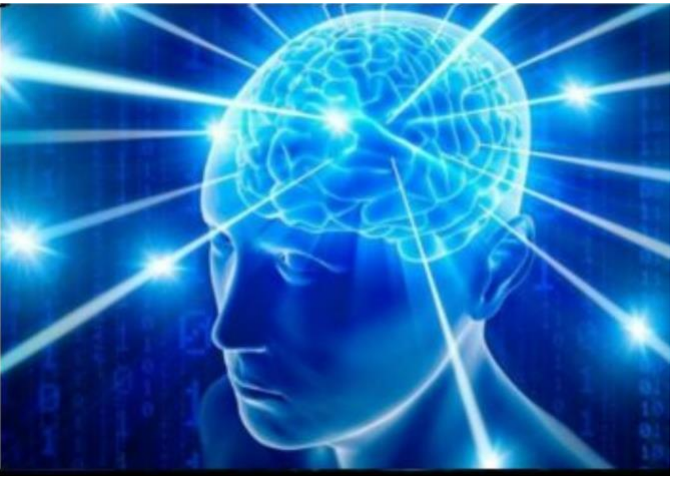
The coffee bean with the lowest rating has its origin in Guatemala.

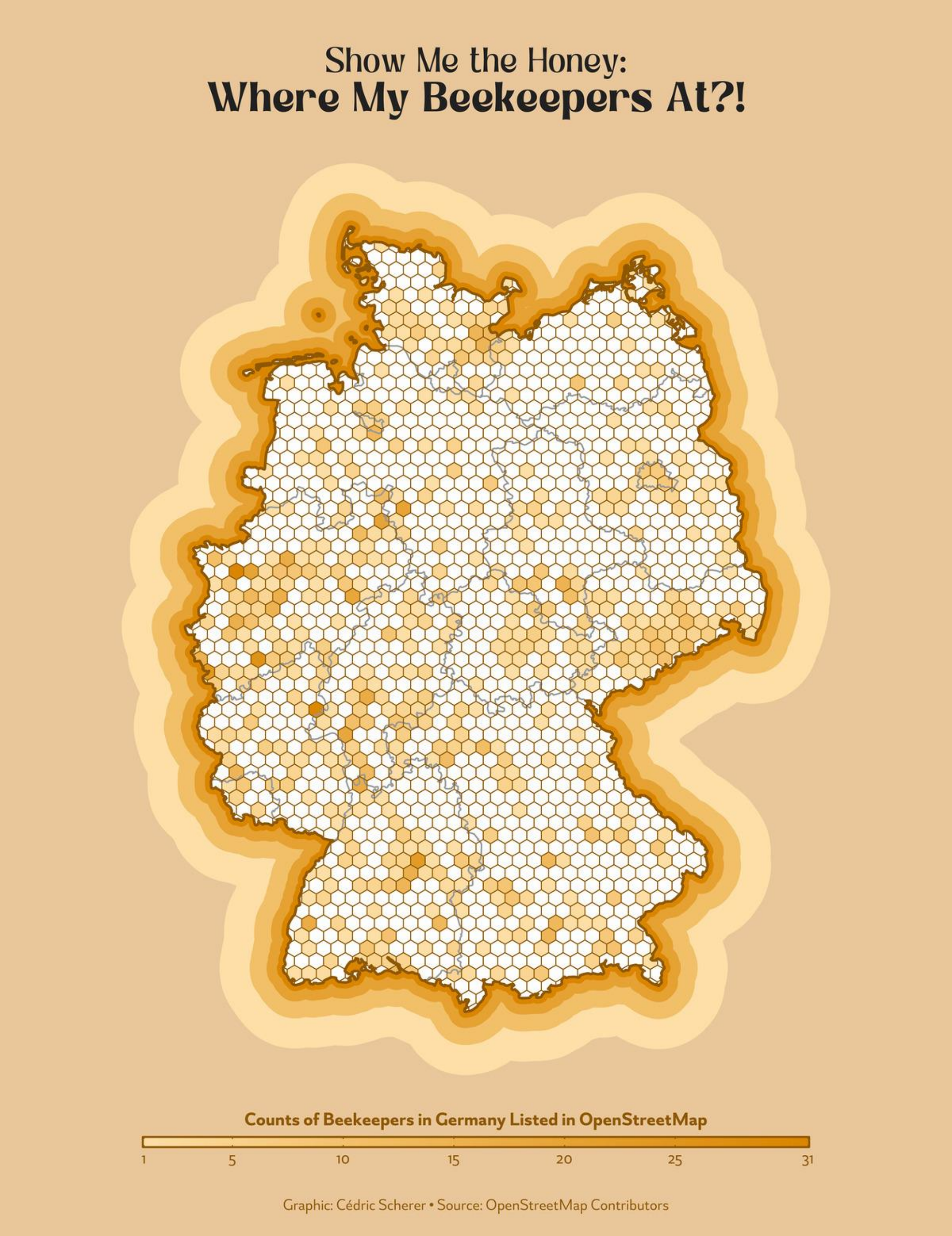
With 218 tested beans, Mexico is the country with the most reviews.

One bean from Nicaragua got a bad rating, too.

https://www.cedricscherer.com/top/dataviz/

ggplot2




Show Me the Honey:
Where My Beekeepers At?!
Counts of Beekeepers in Germany Listed in OpenStreetMap
1
5
10
15
20
25
31
Graphic: Cédric Scherer • Source: OpenStreetMap Contributors

https://www.cedricscherer.com/top/dataviz/

Pipes! %>%

- Sends the output of one function to the input of another

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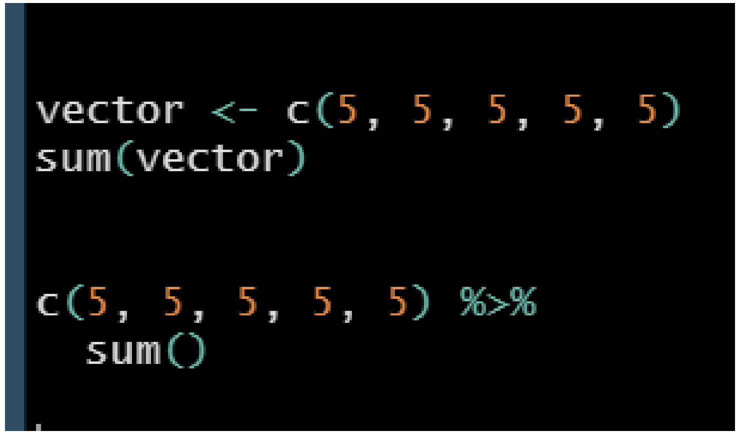

```
vector <- c(5, 5, 5, 5, 5)
sum(vector)


c(5, 5, 5, 5, 5) %>%
  sum()
```

Pipes! %>%

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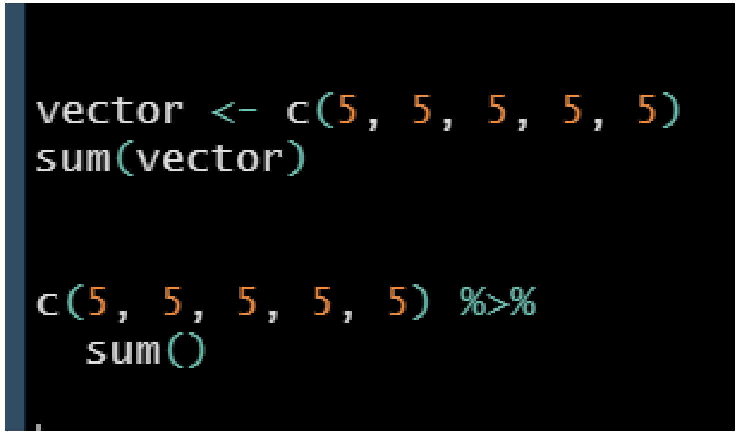

```
vector <- c(5, 5, 5, 5, 5)
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```
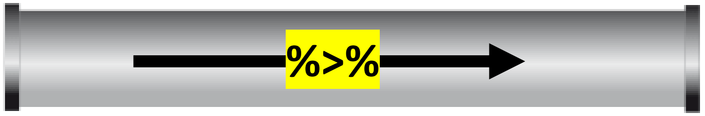
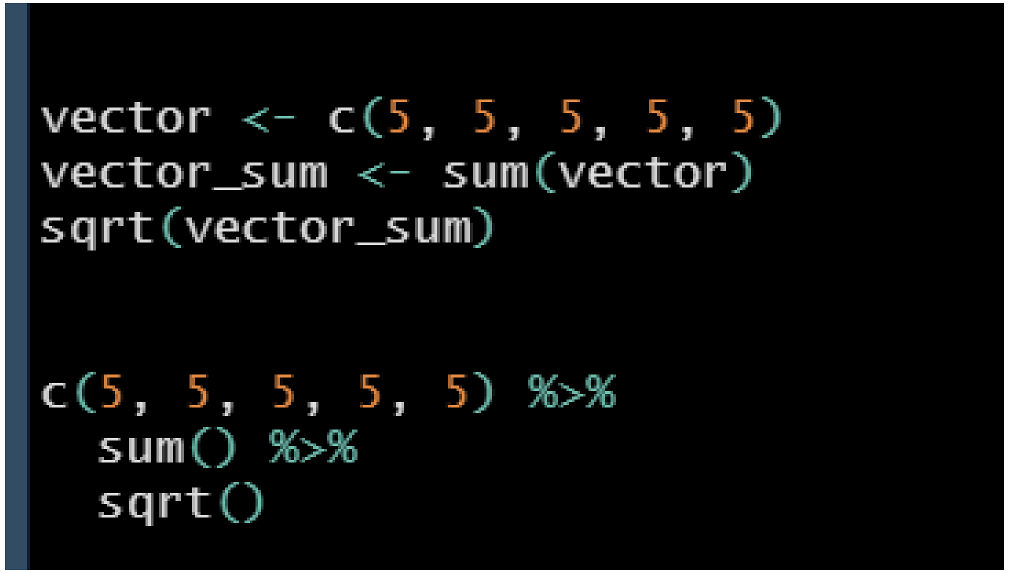

- Create vector



- Sum()

Pipes! %>%

- Can simplify code and make it more intuitive/readable



```
vector <- c(5, 5, 5, 5, 5)
vector_sum <- sum(vector)
sqrt(vector_sum)


c(5, 5, 5, 5, 5) %>%
  sum() %>%
  sqrt()
```

2. Importing table data into R

Data frames

- A list of equal length vectors

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    - You can easily extract any column as a vector (dataframe$colname)

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  - You can easily extract any column as a vector (dataframe$colname)

- Very commonly used in data analysis (rows = samples, columns = variables)

- **as.data.frame (base R)**

tibble

- **tibble()**
  - Tidyverse functions automatically import tabular data to tibbles
  - Provides a more succinct overview of your data!
  - Automatically prints the types of data for each column (e.g. chr, dbl)

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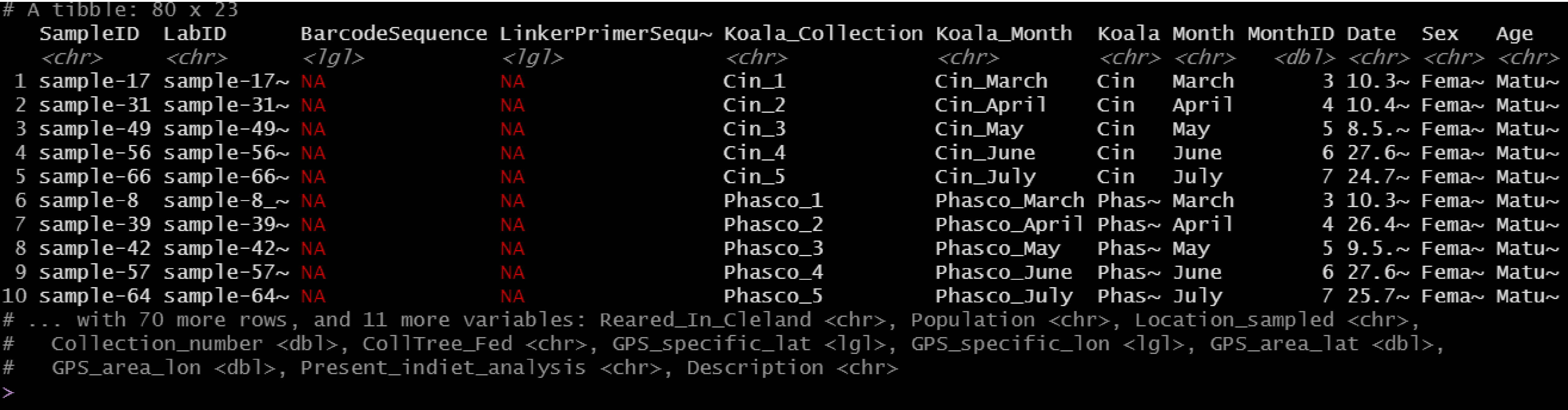


```
# A tibble: 80 x 23
   SampleID  LabID      BarcodeSequence LinkerPrimerSequ~ Koala_Collection Koala_Month  Koala Month MonthID Date  Sex   Age  
   <chr>     <chr>      <lgl>           <lgl>             <chr>            <chr>        <chr> <chr>   <dbl> <chr> <chr> <chr>
 1 sample-17 sample-17~ NA              NA                Cin_1            Cin_March    Cin   March       3 10.3~ Fema~ Matu~
 2 sample-31 sample-31~ NA              NA                Cin_2            Cin_April    Cin   April       4 10.4~ Fema~ Matu~
 3 sample-49 sample-49~ NA              NA                Cin_3            Cin_May      Cin   May         5 8.5.~ Fema~ Matu~
 4 sample-56 sample-56~ NA              NA                Cin_4            Cin_June     Cin   June        6 27.6~ Fema~ Matu~
 5 sample-66 sample-66~ NA              NA                Cin_5            Cin_July     Cin   July        7 24.7~ Fema~ Matu~
 6 sample-8  sample-8_~ NA              NA                Phasco_1         Phasco_March Phas~ March       3 10.3~ Fema~ Matu~
 7 sample-39 sample-39~ NA              NA                Phasco_2         Phasco_April Phas~ April       4 26.4~ Fema~ Matu~
 8 sample-42 sample-42~ NA              NA                Phasco_3         Phasco_May   Phas~ May         5 9.5.~ Fema~ Matu~
 9 sample-57 sample-57~ NA              NA                Phasco_4         Phasco_June  Phas~ June        6 27.6~ Fema~ Matu~
10 sample-64 sample-64~ NA              NA                Phasco_5         Phasco_July  Phas~ July        7 25.7~ Fema~ Matu~
# ... with 70 more rows, and 11 more variables: Reared_In_Cleland <chr>, Population <chr>, Location_sampled <chr>,
#   Collection_number <dbl>, CollTree_Fed <chr>, GPS_specific_lat <lgl>, GPS_specific_lon <lgl>, GPS_area_lat <dbl>,
#   GPS_area_lon <dbl>, Present_indiet_analysis <chr>, Description <chr>
>
```

Functions for importing table data

- **read_xlsx()**

- read_xlsx(**path** = “*path/to/your/table.xlsx*”, **sheet** = “*sheet1*”)

Readxl cheatsheet: https://raw.githubusercontent.com/rstudio/cheatsheets/main/data-import.pdf

Functions for importing table data

- **read_delim()**
- read_delim(**file** = “*path/to/your/file.*filetype”, **delim** = ‘*delimiter*’)

Readr cheatsheet: https://raw.githubusercontent.com/rstudio/cheatsheets/main/data-import.pdf

Functions for importing table data

- **read_delim()**

- read_delim(**file** = “*path/to/your/file.*filetype”, **delim** = ‘*delimiter*’)

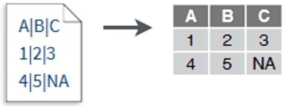
- Common delimiters:
  - comma separated (.csv) **delim** = ‘,’
  - tab separated (.tsv) **delim** = ‘\t’

Readr cheatsheet: https://raw.githubusercontent.com/rstudio/cheatsheets/main/data-import.pdf

Data import with the tidyverse : : CHEAT SHEET

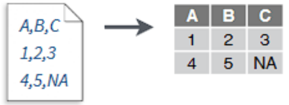
Read Tabular Data with readr

read_*(file, col_names = TRUE, col_types = NULL, col_select = NULL, id = NULL, locale, n_max = Inf, skip = 0, na = c("", "NA"), guess_max = min(1000, n_max), show_col_types = TRUE) See **?read_delim**



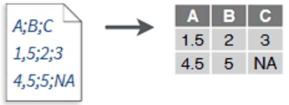
A	B	C
1	2	3
4	5	NA

read_delim("file.txt", delim = "|"**)** Read files with any delimiter. If no delimiter is specified, it will automatically guess.
To make file.txt, run: write_file("A|B|C\n1|2|3\n4|5|NA", file = "file.txt")



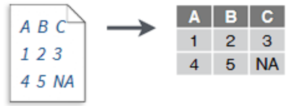
A	B	C
1	2	3
4	5	NA

read_csv("file.csv"**)** Read a comma delimited file with period decimal marks.
write_file("A,B,C\n1,2,3\n4,5,NA", file = "file.csv")



A	B	C
1.5	2	3
4.5	5	NA

read_csv2("file2.csv"**)** Read semicolon delimited files with comma decimal marks.
write_file("A;B;C\n1,5;2;3\n4,5;5;NA", file = "file2.csv")



A	B	C
1	2	3
4	5	NA

read_tsv("file.tsv"**)** Read a tab delimited file. Also **read_table()**.
read_fwf("file.tsv", fwf_widths(c(2, 2, NA))**)** Read a fixed width file.
write_file("A\tB\tC\n1\t2\t3\n4\t5\tNA\n", file = "file.tsv")

USEFUL READ ARGUMENTS

A	B	C
1	2	3
4	5	NA

No header
read_csv("file.csv", col_names = FALSE)

x	y	z
A	B	C
1	2	3
4	5	NA

Provide header
read_csv("file.csv",
col_names = c("x", "y", "z"))

Read multiple files into a single table
read_csv(c("f1.csv", "f2.csv", "f3.csv"),
id = "origin_file")

1	2	3
4	5	NA

Skip lines
read_csv("file.csv", skip = 1)

A	B	C
1	2	3

Read a subset of lines
read_csv("file.csv", n_max = 1)

A	B	C
NA	2	3
4	5	NA

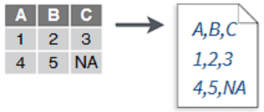
Read values as missing
read_csv("file.csv", na = c("1"))

A;B;C
1,5;2;3,0

Specify decimal marks
read_delim("file2.csv", locale =
locale(decimal_mark = ","))

Save Data with readr

write_*(x, file, na = "NA", append, col_names, quote, escape, eol, num_threads, progress)



A	B	C
1	2	3
4	5	NA

write_delim(x, file, delim = " "**)** Write files with any delimiter.

write_csv(x, file**)** Write a comma delimited file.

write_csv2(x, file**)** Write a semicolon delimited file.

One of the first steps of a project is to import outside data into R. Data is often stored in tabular formats, like csv files or spreadsheets.

The front page of this sheet shows how to import and save text files into R using **readr**.

The back page shows how to import spreadsheet data from Excel files using **readxl** or Google Sheets using **googlesheets4**.

OTHER TYPES OF DATA

Try one of the following packages to import other types of files:

- **haven** - SPSS, Stata, and SAS files
- **DBI** - databases
- **jsonlite** - json
- **xml2** - XML
- **httr** - Web APIs
- **rvest** - HTML (Web Scraping)
- **readr::read_lines()** - text data

Column Specification with readr

Column specifications define what data type each column of a file will be imported as. By default readr will generate a column spec when a file is read and output a summary.

spec(x**)** Extract the full column specification for the given imported data frame.

```
spec(x)
# cols(
#   age = col_integer(),
#   sex = col_character(),
#   earn = col_double()
# )
```

age is an integer

sex is a character

earn is a double (numeric)

USEFUL COLUMN ARGUMENTS

Hide col spec message
read_*(file, show_col_types = FALSE)

Select columns to import
Use names, position, or selection helpers.
read_*(file, col_select = c(age, earn))

Guess column types
To guess a column type, read_ *() looks at the first 1000 rows of data. Increase with **guess_max**.
read_*(file, guess_max = Inf)

COLUMN TYPES

Each column type has a function and corresponding string abbreviation.

- **col_logical()** - "l"
- **col_integer()** - "i"
- **col_double()** - "d"
- **col_number()** - "n"
- **col_character()** - "c"
- **col_factor(**levels, ordered = FALSE**)** - "f"
- **col_datetime(**format = ""**)** - "T"
- **col_date(**format = ""**)** - "D"
- **col_time(**format = ""**)** - "t"
- **col_skip()** - "-", "_"
- **col_guess()** - "?"

DEFINE COLUMN SPECIFICATION

Set a default type

```
read_csv(
  file,
  col_type = list(.default = col_double())
)
```

Use column type or string abbreviation

```
read_csv(
  file,
  col_type = list(x = col_double(), y = "l", z = "_")
)
```

Use a single string of abbreviations

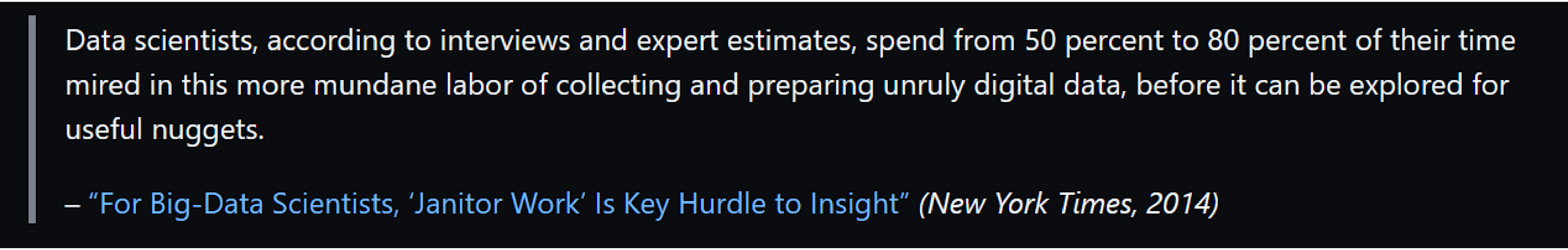
```
# col types: skip, guess, integer, logical, character
read_csv(
  file,
  col_type = "_?ilc"
```

googlesheets4
www.rstudio.com

3. Cleaning table data

Real world data
iris &
mtcars

Janitor



> Data scientists, according to interviews and expert estimates, spend from 50 percent to 80 percent of their time mired in this more mundane labor of collecting and preparing unruly digital data, before it can be explored for useful nuggets.
>
> – “For Big-Data Scientists, ‘Janitor Work’ Is Key Hurdle to Insight” *(New York Times, 2014)*

https://www.nytimes.com/2014/08/18/technology/for-big-data-scientists-hurdle-to-insights-is-janitor-work.html

Janitor

- **clean_names()**
  - As the name suggests! E.g. SaMpLe.NaMe% -> sample.name

Janitor

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- **remove_empty()**
  - Removes empty columns

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Janitor

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  - As the name suggests! E.g. SaMpLe.NaMe% -> sample.name
- **remove_empty()**
  - Removes empty columns
- **remove_constant()**
  - Removes useless columns
- **get_dupes()**
  - Finds duplicate entries (rows)

Dplyr

- **distinct()**
  - Prints only distinct rows in a data frame

Exercise time!

- See the exercises in “Exercises.R”

Summary

- The Tidyverse

- Importing data into R

readxl
readr

- Cleaning data

janitor
dplyr