SISBID Data Wrangling

2024-08-14

# R Basics

## Explaining output on slides

In slides, a command (we’ll also call them code or a code chunk) will look like this

head(mtcars)

mpg cyl disp hp drat wt qsec vs am gear carb  
Mazda RX4 21.0 6 160 110 3.90 2.620 16.46 0 1 4 4  
Mazda RX4 Wag 21.0 6 160 110 3.90 2.875 17.02 0 1 4 4  
Datsun 710 22.8 4 108 93 3.85 2.320 18.61 1 1 4 1  
Hornet 4 Drive 21.4 6 258 110 3.08 3.215 19.44 1 0 3 1  
Hornet Sportabout 18.7 8 360 175 3.15 3.440 17.02 0 0 3 2  
Valiant 18.1 6 225 105 2.76 3.460 20.22 1 0 3 1

And then directly after it, will be the output of the code.

These slides were made in R using knitr and R Markdown (covered later today when we discuss reproducible research)

## R variables

A few reminders: \* You can create variables from within the R environment and from files on your computer \* Use “<-” to assign values to a variable name \* Variable names are case-sensitive, i.e. X and x are different

x <- 2  
x

[1] 2

x \* 4

[1] 8

x + 2

[1] 4

## Help

For any function, you can write ?FUNCTION\_NAME, or help("FUNCTION\_NAME") to look at the help file:

?dir  
help("dir")

## Packages

Not all packages are available by default.

install.packages("tidyverse")  
library(tidyverse)

## Commenting in Scripts

Commenting in code is super important. You should be able to go back to your code years after writing it and figure out exactly what the script is doing. Commenting helps you do this. Also handy for notes!

## Commenting in Scripts

# Data Input

## Outline

* Part 0: A little bit of set up!
* Part 1: reading in manually (point and click)
* Part 2: reading in directly & working directories
* Part 3: checking data & multiple file formats

# Part 0: Setup - R Project

## New R Project

Let’s make an R Project so we can stay organized in the next steps.

Click the new R Project button at the top left of RStudio:

## New R Project

In the New Project Wizard, click “New Directory”:

## New R Project

Click “New Project”:

## New R Project

Type in a name for your new folder.

Store it somewhere easy to find, such as your Desktop:

## New R Project

You now have a new R Project folder on your Desktop!

Make sure you add any scripts or data files to this folder as we go through today’s lesson. This will make sure R is able to “find” your files.

# Part 1: Getting data into R (manual/point and click)

## Data Input

* ‘Reading in’ data is the first step of any real project/analysis
* R can read almost any file format, especially via add-on packages
* We are going to focus on simple delimited files first
  + comma separated (e.g. ‘.csv’)
  + tab delimited (e.g. ‘.txt’)
  + Microsoft Excel (e.g. ‘.xlsx’)

## Data Input

Youth Tobacco Survey (YTS) dataset:

“The YTS was developed to provide states with comprehensive data on both middle school and high school students regarding tobacco use, exposure to environmental tobacco smoke, smoking cessation, school curriculum, minors’ ability to purchase or otherwise obtain tobacco products, knowledge and attitudes about tobacco, and familiarity with pro-tobacco and anti-tobacco media messages.”

* Check out the data at: <https://catalog.data.gov/dataset/youth-tobacco-survey-yts-data>

## Data Input: Dataset Location

Dataset is located at <https://sisbid.github.io/Data-Wrangling/data/Youth_Tobacco_Survey_YTS_Data.csv>

* Download data by clicking the above link
  + Safari - if a file loads in your browser, choose File –> Save As, select, Format “Page Source” and save

## Import Dataset

* > File
* > Import Dataset
* > From Text (readr)
* > paste the url (<https://sisbid.github.io/Data-Wrangling/data/Youth_Tobacco_Survey_YTS_Data.csv>)
* > click “Update” and “Import”

## What Just Happened?

* You see a preview of the data on the top left pane.
* You see a new object called Youth\_Tobacco\_Survey\_YTS\_Data in your environment pane (top right). The table button opens the data for you to view.
* R ran some code in the console (bottom left).

## Import Dataset (recap)

## Browsing for Data on Your Machine

## Example 2: Delimiters

* > File
* > Import Dataset
* > From Text (readr)
* > paste the url (<https://sisbid.github.io/Data-Wrangling/data/dropouts.txt>)
* > select delimiter
* > click “Update” and “Import”

## Example 3: Excel

library(readxl)

* > File
* > Import Dataset
* > From Excel
* > paste the url (<https://sisbid.github.io/Data-Wrangling/data/asthma.xlsx>)
* > click “Update” and “Import”

## Manual Import: Pros and Cons

Pros: easy!!

Cons: obscures some of what’s happening, others will have difficulty running your code

## Summary & Lab

Review the process: <https://youtu.be/LEkNfJgpunQ>

* > File
* > Import Dataset
* > From Text (readr) / From Excel
* > paste the url / browse
* > click “Update” and “Import”

<https://sisbid.github.io/Data-Wrangling/labs/data-io-lab-part1.Rmd>

# Data Input

## Outline

* Part 0: A little bit of set up!
* Part 1: reading in manually (point and click)
* Part 2: reading in directly & working directories
* Part 3: checking data & multiple file formats

## Data Input: readr

read\_delim() and read\_csv() from the readr package

# example for character delimited:  
read\_delim(file = "file.txt", delim = "\t")

# comma delimited:  
read\_csv("file.csv")

## Data Input

* The filename is the path to your file, in quotes
* The function will look in your “working directory” if no absolute file path is given
* Note that the filename can also be a path to a file on a website (e.g. ‘www.someurl.com/table1.txt’)

## Example

<https://sisbid.github.io/Data-Wrangling/data/ufo/ufo_data_complete.csv>

# From URL  
ufo <- read\_csv(  
 "https://sisbid.github.io/Data-Wrangling/data/ufo/ufo\_data\_complete.csv"  
)  
  
# From your 'data-wrangling' directory  
ufo <- read\_csv("ufo\_data\_complete.csv")

(Warning message: One or more parsing issues, call 'problems()' – more on this later)

## Data Input

The read\_delim() and related functions return a “tibble” is a data.frame with special printing, which is the primary data format for most data cleaning and analyses.

class(ufo)

[1] "spec\_tbl\_df" "tbl\_df" "tbl" "data.frame"

Check to make sure you see the new object in the Environment pane.

## Data Input

There are also data importing functions provided in base R (rather than the readr package), like read.delim and read.csv.

These functions have slightly different syntax for reading in data, like header and as.is.

However, while many online resources use the base R tools, recent versions of RStudio switched to use these new readr data import tools, so we will use them here. They are also up to two times faster for reading in large datasets, and have a progress bar which is nice.

## Data Input: readr

read\_table() from the readr package, allows any number of whitespace characters between columns, and the lines can be of different lengths.

# example for whitespace delimited :  
read\_table(file = "file.txt")

## Clean the data while you read it in!

The argument trim\_ws removes trailing and leading spaces around your data.

# example:  
read\_csv(file = "file.txt", trim\_ws = TRUE)

## Data Input - working directories

What if your file is in the “Home” directory?

## Data Input

Backtrack using the relative path with ../ like:

ufo <- read\_csv("../ufo\_data\_complete.csv.gz")

## Data Input

Or, read in from a subfolder:

ufo <- read\_csv("data/ufo/ufo\_data\_complete.csv")

Warning: One or more parsing issues, call `problems()` on your data frame for details,  
e.g.:  
 dat <- vroom(...)  
 problems(dat)

Rows: 88875 Columns: 11  
── Column specification ────────────────────────────────────────────────────────  
Delimiter: ","  
chr (10): datetime, city, state, country, shape, duration (hours/min), comme...  
dbl (1): duration (seconds)  
  
ℹ Use `spec()` to retrieve the full column specification for this data.  
ℹ Specify the column types or set `show\_col\_types = FALSE` to quiet this message.

# Check the data + other formats

## Check the data out

* Some functions to look at a data frame:
  + head() shows first few rows
  + tail() shows the last few rows
  + View() shows the data as a spreadsheet
  + spec() gives specification of column types
  + str() gives the column types and specs
  + glimpse() similar to str (dplyr package)

## What did I just read in?

* nrow() displays the number of rows of a data frame
* ncol() displays the number of columns
* dim() displays a vector of length 2: # rows, # columns

nrow(ufo)

[1] 88875

ncol(ufo)

[1] 11

dim(ufo)

[1] 88875 11

## All Column Names

* colnames() displays the column names

colnames(ufo)

[1] "datetime" "city" "state"   
 [4] "country" "shape" "duration (seconds)"   
 [7] "duration (hours/min)" "comments" "date posted"   
[10] "latitude" "longitude"

## Column names and classes using glimpse()

glimpse(ufo)

Rows: 88,875  
Columns: 11  
$ datetime <chr> "10/10/1949 20:30", "10/10/1949 21:00", "10/10/…  
$ city <chr> "san marcos", "lackland afb", "chester (uk/engl…  
$ state <chr> "tx", "tx", NA, "tx", "hi", "tn", NA, "ct", "al…  
$ country <chr> "us", NA, "gb", "us", "us", "us", "gb", "us", "…  
$ shape <chr> "cylinder", "light", "circle", "circle", "light…  
$ `duration (seconds)` <dbl> 2700, 7200, 20, 20, 900, 300, 180, 1200, 180, 1…  
$ `duration (hours/min)` <chr> "45 minutes", "1-2 hrs", "20 seconds", "1/2 hou…  
$ comments <chr> "This event took place in early fall around 194…  
$ `date posted` <chr> "4/27/2004", "12/16/2005", "1/21/2008", "1/17/2…  
$ latitude <chr> "29.8830556", "29.38421", "53.2", "28.9783333",…  
$ longitude <chr> "-97.9411111", "-98.581082", "-2.916667", "-96.…

## Data Input

* Sometimes you get weird messages when reading in data.
* The problems()` function shows you any issues with the data read-in.

head(problems(ufo))

# A tibble: 6 × 5  
 row col expected actual file   
 <int> <int> <chr> <chr> <chr>   
1 878 12 11 columns 12 columns /Users/carriewright/Documents/GitHub/Teachi…  
2 1713 12 11 columns 12 columns /Users/carriewright/Documents/GitHub/Teachi…  
3 1815 12 11 columns 12 columns /Users/carriewright/Documents/GitHub/Teachi…  
4 2858 12 11 columns 12 columns /Users/carriewright/Documents/GitHub/Teachi…  
5 3734 12 11 columns 12 columns /Users/carriewright/Documents/GitHub/Teachi…  
6 4756 12 11 columns 12 columns /Users/carriewright/Documents/GitHub/Teachi…

dim(problems(ufo))

[1] 199 5

## Data input: other file types

* For reading Excel files, you can do one of:
  + use read\_excel() function from readxl package
  + use other packages: xlsx, openxlsx
* haven package has functions to read SAS, SPSS, Stata formats

## Selecting Excel sheets

Use the sheet argument to indicate which sheet to pull from. It can refer to the sheet’s index or name.

# example:  
read\_excel(path = "file.xlsx", sheet = 2)  
read\_excel(path = "file.xlsx", sheet = "data")

# After hours of cleaning… output!

## Data Output

While its nice to be able to read in a variety of data formats, it’s equally important to be able to output data somewhere.

write\_delim(): Write a data frame to a delimited file write\_csv(): Write a data frame to a comma-delimited file

**This is about twice as fast as write.csv(), and never writes row names.**

## Data Output

For example, we can write back out just the first 100 lines of the ufo dataset:

first\_100 <- ufo[1:100,]  
write\_delim(first\_100, file = "ufo\_first100.csv", delim = ",")  
write\_csv(first\_100, file = "ufo\_first100.csv")

## More ways to save: write\_rds

If you want to save **one** object, you can use readr::write\_rds to save to a compressed rds file:

write\_rds(ufo, file = "ufo\_dataset.rds", compress = "xz")

Read it back in:

ufo\_new <- read\_rds(file = "ufo\_dataset.rds")

## More ways to save: save

The save command can save a set of R objects into an “R data file”, with the extension .rda or .RData.

x = 5  
save(ufo, x, file = "ufo\_data.rda")

The opposite of save is load.

load(file = "ufo\_data.rda")

## Summary & Lab

* Use read\_delim(), read\_csv(), read\_table() for common data types
* These have helpful trim\_ws and na arguments!
* read\_excel() has the sheet argument for reading from different sheets of the Excel file
* Many functions like str(), View(), and glimpse() can help you understand your data better
* Save your data with write\_delim() and write\_csv()

<https://sisbid.github.io/Data-Wrangling/labs/data-io-lab-part2.Rmd>

## Overview

We showed different ways to read data into R using:

readr::read\_csv()  
readr::read\_delim()  
readxl::read\_excel()

In this module, we will show you how select rows and columns of datasets.

## Setup

We will be using the $\color{red}{\text{dplyr}}$ package in the tidyverse.

Here are several resources on how to use dplyr:

* <https://dplyr.tidyverse.org/>
* <https://r4ds.had.co.nz/>
* <https://cran.rstudio.com/web/packages/dplyr/vignettes/dplyr.html>
* <https://stat545.com/dplyr-intro.html>

The dplyr package also interfaces well with tibbles.

## Dataset

We will be using the diamonds dataset in the ggplot2 package as an example (so make sure you initiate the ggplot2 package if you are following along on your own).

head(diamonds)

# A tibble: 6 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
2 0.21 Premium E SI1 59.8 61 326 3.89 3.84 2.31  
3 0.23 Good E VS1 56.9 65 327 4.05 4.07 2.31  
4 0.29 Premium I VS2 62.4 58 334 4.2 4.23 2.63  
5 0.31 Good J SI2 63.3 58 335 4.34 4.35 2.75  
6 0.24 Very Good J VVS2 62.8 57 336 3.94 3.96 2.48

## Selecting a single column of a data.frame:

To grab just the values from a single column, you would use the pull function. The output will be a vector (and not a tibble).

Since this is a long vector we will just show the first 6 values using the head function around the output of the pull function.

head(pull(diamonds,carat))

[1] 0.23 0.21 0.23 0.29 0.31 0.24

## Using the pipe (comes with dplyr):

That was a lot of typing and nested functions, which can be confusing. Recently, the pipe %>% makes things such as this much more readable. It reads left side “pipes” into right side. RStudio CMD/Ctrl + Shift + M shortcut.

## Using the pipe (comes with dplyr):

Pipe diamonds into select, then pipe that into pull, and then show the head:

diamonds %>% pull(carat) %>% head()

[1] 0.23 0.21 0.23 0.29 0.31 0.24

## Selecting a single column of a data.frame:

The pull function is equivalent to using the $ method (in base R).

Note that base R and tidyverse don’t always play nice together.

head(pull(diamonds, carat))

[1] 0.23 0.21 0.23 0.29 0.31 0.24

head(diamonds$carat)

[1] 0.23 0.21 0.23 0.29 0.31 0.24

Note this does *not* return a tibble (or data.frame) but rather a vector.

## Selecting a single column of a data.frame:

The select function extracts one or more columns from a tibble or data.frame and returns a tibble (not a vector).

select(diamonds, carat)

# A tibble: 53,940 × 1  
 carat  
 <dbl>  
 1 0.23  
 2 0.21  
 3 0.23  
 4 0.29  
 5 0.31  
 6 0.24  
 7 0.24  
 8 0.26  
 9 0.22  
10 0.23  
# ℹ 53,930 more rows

## Selecting multiple columns of a data.frame:

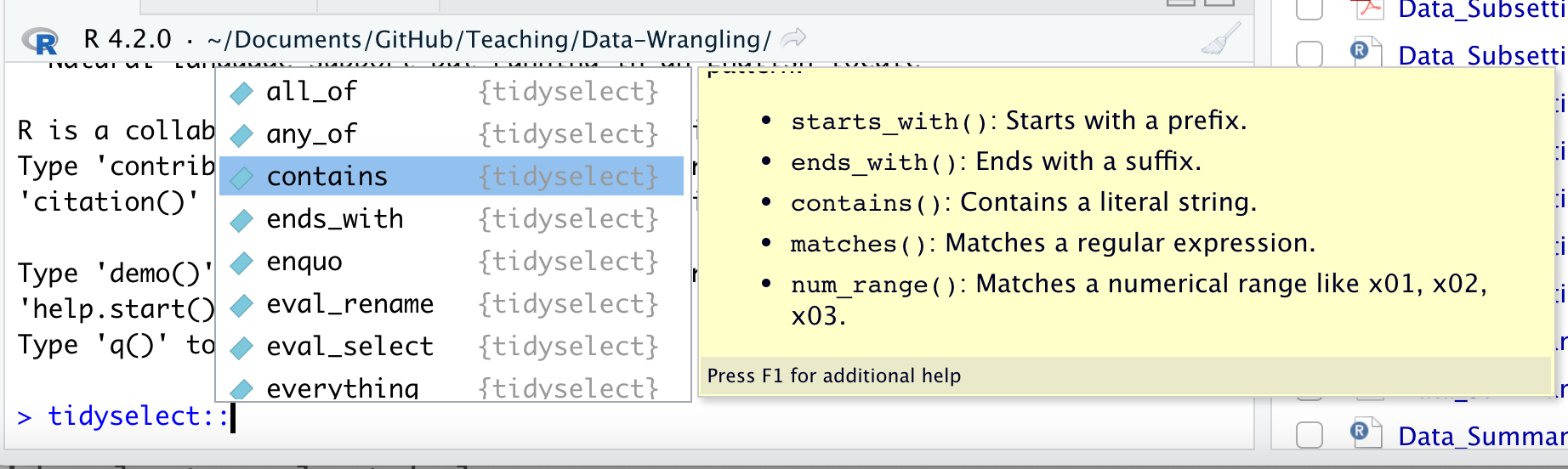
The select command from dplyr is very flexible. You just need to list all columns you want to extract separated by commas. You can use this as a way to just keep the columns you want for example.

select(diamonds, carat, depth)

# A tibble: 53,940 × 2  
 carat depth  
 <dbl> <dbl>  
 1 0.23 61.5  
 2 0.21 59.8  
 3 0.23 56.9  
 4 0.29 62.4  
 5 0.31 63.3  
 6 0.24 62.8  
 7 0.24 62.3  
 8 0.26 61.9  
 9 0.22 65.1  
10 0.23 59.4  
# ℹ 53,930 more rows

## See the Select “helpers”

Type tidyselect:: to see functions available.



Here are a few:

last\_col()  
ends\_with()  
starts\_with()  
contains() # search for a pattern  
everything()

## Tidyselect helpers

For example, we can take all columns that start with a “c”:

diamonds %>% select(starts\_with("c"))

# A tibble: 53,940 × 4  
 carat cut color clarity  
 <dbl> <ord> <ord> <ord>   
 1 0.23 Ideal E SI2   
 2 0.21 Premium E SI1   
 3 0.23 Good E VS1   
 4 0.29 Premium I VS2   
 5 0.31 Good J SI2   
 6 0.24 Very Good J VVS2   
 7 0.24 Very Good I VVS1   
 8 0.26 Very Good H SI1   
 9 0.22 Fair E VS2   
10 0.23 Very Good H VS1   
# ℹ 53,930 more rows

## Tidyselect helpers

Or we can take all columns that end with an “e”:

diamonds %>% select(ends\_with("e"))

# A tibble: 53,940 × 2  
 table price  
 <dbl> <int>  
 1 55 326  
 2 61 326  
 3 65 327  
 4 58 334  
 5 58 335  
 6 57 336  
 7 57 336  
 8 55 337  
 9 61 337  
10 61 338  
# ℹ 53,930 more rows

## Tidyselect helpers

We are going to cover “fancier” ways of matching column names (and strings more generally) in the data cleaning lecture.

## Subset rows of a data.frame:

The command in dplyr for subsetting rows is filter. Try ?filter.

The easiest way to filter is by testing whether numeric observations are greater than or less than some cutoff:

filter(diamonds, depth > 60)

# A tibble: 48,315 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
 1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
 2 0.29 Premium I VS2 62.4 58 334 4.2 4.23 2.63  
 3 0.31 Good J SI2 63.3 58 335 4.34 4.35 2.75  
 4 0.24 Very Good J VVS2 62.8 57 336 3.94 3.96 2.48  
 5 0.24 Very Good I VVS1 62.3 57 336 3.95 3.98 2.47  
 6 0.26 Very Good H SI1 61.9 55 337 4.07 4.11 2.53  
 7 0.22 Fair E VS2 65.1 61 337 3.87 3.78 2.49  
 8 0.3 Good J SI1 64 55 339 4.25 4.28 2.73  
 9 0.23 Ideal J VS1 62.8 56 340 3.93 3.9 2.46  
10 0.22 Premium F SI1 60.4 61 342 3.88 3.84 2.33  
# ℹ 48,305 more rows

Note, no subsetting is necessary. R “knows” depth refers to a column of diamonds.

## Subset rows of a data.frame:

You can also using piping here:

diamonds %>% filter(depth > 60)

# A tibble: 48,315 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
 1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
 2 0.29 Premium I VS2 62.4 58 334 4.2 4.23 2.63  
 3 0.31 Good J SI2 63.3 58 335 4.34 4.35 2.75  
 4 0.24 Very Good J VVS2 62.8 57 336 3.94 3.96 2.48  
 5 0.24 Very Good I VVS1 62.3 57 336 3.95 3.98 2.47  
 6 0.26 Very Good H SI1 61.9 55 337 4.07 4.11 2.53  
 7 0.22 Fair E VS2 65.1 61 337 3.87 3.78 2.49  
 8 0.3 Good J SI1 64 55 339 4.25 4.28 2.73  
 9 0.23 Ideal J VS1 62.8 56 340 3.93 3.9 2.46  
10 0.22 Premium F SI1 60.4 61 342 3.88 3.84 2.33  
# ℹ 48,305 more rows

## Subset rows of a data.frame:

You can combine filtering on multiple columns by separating the filter arguments with commas:

diamonds %>% filter(depth > 60, table > 60, price > 2775)

# A tibble: 1,704 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
 1 0.72 Premium F SI1 61.8 61 2777 5.82 5.71 3.56  
 2 0.72 Very Good H VS1 60.6 63 2782 5.83 5.76 3.51  
 3 0.81 Good G SI2 61 61 2789 5.94 5.99 3.64  
 4 0.71 Premium F VS1 60.1 62 2790 5.77 5.74 3.46  
 5 0.71 Premium G VS1 62.4 61 2803 5.7 5.65 3.54  
 6 0.74 Fair F VS2 61.1 68 2805 5.82 5.75 3.53  
 7 0.7 Good F VS1 62.8 61 2810 5.57 5.61 3.51  
 8 0.7 Very Good F VS2 60.9 61 2812 5.66 5.71 3.46  
 9 0.71 Good E SI1 62.8 64 2817 5.6 5.54 3.5   
10 0.7 Premium E VS2 62.4 61 2818 5.66 5.63 3.52  
# ℹ 1,694 more rows

## Subset rows of a data.frame:

You can also filter character strings by a single value or category. Here we need quotes around character strings.

diamonds %>% filter(color == "I",   
 clarity == "SI2", cut == "Premium")

# A tibble: 312 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
 1 0.42 Premium I SI2 61.5 59 552 4.78 4.84 2.96  
 2 1 Premium I SI2 58.2 60 2795 6.61 6.55 3.83  
 3 0.9 Premium I SI2 62.2 59 2826 6.11 6.07 3.79  
 4 1.05 Premium I SI2 58.3 57 2911 6.72 6.67 3.9   
 5 0.91 Premium I SI2 62 59 2913 6.18 6.23 3.85  
 6 0.9 Premium I SI2 62.5 58 2948 6.15 6.1 3.83  
 7 0.9 Premium I SI2 60.6 60 2948 6.28 6.23 3.79  
 8 1.06 Premium I SI2 61.5 57 2968 6.57 6.49 4.02  
 9 0.91 Premium I SI2 60.2 59 2981 6.29 6.24 3.77  
10 0.9 Premium I SI2 60.6 60 3001 6.23 6.28 3.79  
# ℹ 302 more rows

## Subset rows of a data.frame:

Sometimes you want to be able to filter on matching several values or categories. The %in% operator is useful here:

diamonds %>% filter(clarity %in% c("SI1", "SI2"))

# A tibble: 22,259 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
 1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
 2 0.21 Premium E SI1 59.8 61 326 3.89 3.84 2.31  
 3 0.31 Good J SI2 63.3 58 335 4.34 4.35 2.75  
 4 0.26 Very Good H SI1 61.9 55 337 4.07 4.11 2.53  
 5 0.3 Good J SI1 64 55 339 4.25 4.28 2.73  
 6 0.22 Premium F SI1 60.4 61 342 3.88 3.84 2.33  
 7 0.31 Ideal J SI2 62.2 54 344 4.35 4.37 2.71  
 8 0.2 Premium E SI2 60.2 62 345 3.79 3.75 2.27  
 9 0.3 Ideal I SI2 62 54 348 4.31 4.34 2.68  
10 0.3 Good J SI1 63.4 54 351 4.23 4.29 2.7   
# ℹ 22,249 more rows

## Subset rows of a data.frame:

You can mix and match filtering on numeric and categorical/character columns in the same filter() command:

diamonds %>% filter(clarity %in% c("SI1", "SI2"),  
 cut == "Premium", price > 3000)

# A tibble: 3,976 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
 1 0.9 Premium I SI2 60.6 60 3001 6.23 6.28 3.79  
 2 0.81 Premium F SI1 61.9 58 3004 5.99 5.96 3.7   
 3 0.92 Premium D SI2 60.2 61 3004 6.32 6.27 3.79  
 4 0.9 Premium D SI1 62.2 60 3013 6.08 6.05 3.77  
 5 0.96 Premium E SI2 62.8 60 3016 6.3 6.24 3.94  
 6 0.93 Premium G SI2 61.4 56 3019 6.27 6.23 3.84  
 7 0.78 Premium D SI1 60.4 57 3019 6.02 5.97 3.62  
 8 0.75 Premium E SI1 61.7 60 3024 5.84 5.8 3.59  
 9 0.75 Premium D SI1 59.2 58 3024 5.96 5.93 3.52  
10 1.02 Premium G SI2 61.7 58 3027 6.46 6.41 3.97  
# ℹ 3,966 more rows

## Note about quotes and numbers

R will interpret quotes around numbers as the characters themselves and not their numeric meaning. Thus it’s generally best to avoid quotes around numeric unless it is not being treated as a numeric value - for example levels or grades.

diamonds %>% filter(price > 3001) #This works  
diamonds %>% filter(price > "3001") # This does not  
  
diamonds %>% filter(price == 3001) # This works  
diamonds %>% filter(price == "3001") # this works

## Subset rows of a data.frame:

Other useful logical tests:

& : AND

| : OR

<= : less than or equals

>= : greater than or equals

!= : not equals

## Subset rows of a data.frame:

The AND operator (&) is the what is being performed “behind the scenes” when chaining together filter statements with commas:

diamonds %>% filter(depth > 60 & table > 60 & price > 2775)

# A tibble: 1,704 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
 1 0.72 Premium F SI1 61.8 61 2777 5.82 5.71 3.56  
 2 0.72 Very Good H VS1 60.6 63 2782 5.83 5.76 3.51  
 3 0.81 Good G SI2 61 61 2789 5.94 5.99 3.64  
 4 0.71 Premium F VS1 60.1 62 2790 5.77 5.74 3.46  
 5 0.71 Premium G VS1 62.4 61 2803 5.7 5.65 3.54  
 6 0.74 Fair F VS2 61.1 68 2805 5.82 5.75 3.53  
 7 0.7 Good F VS1 62.8 61 2810 5.57 5.61 3.51  
 8 0.7 Very Good F VS2 60.9 61 2812 5.66 5.71 3.46  
 9 0.71 Good E SI1 62.8 64 2817 5.6 5.54 3.5   
10 0.7 Premium E VS2 62.4 61 2818 5.66 5.63 3.52  
# ℹ 1,694 more rows

You can use either syntax.

## Subset rows of a data.frame:

The OR operator (|) is more permissive than the AND operator:

diamonds %>% filter(depth > 60 | table > 60 | price > 2775)

# A tibble: 52,198 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
 1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
 2 0.21 Premium E SI1 59.8 61 326 3.89 3.84 2.31  
 3 0.23 Good E VS1 56.9 65 327 4.05 4.07 2.31  
 4 0.29 Premium I VS2 62.4 58 334 4.2 4.23 2.63  
 5 0.31 Good J SI2 63.3 58 335 4.34 4.35 2.75  
 6 0.24 Very Good J VVS2 62.8 57 336 3.94 3.96 2.48  
 7 0.24 Very Good I VVS1 62.3 57 336 3.95 3.98 2.47  
 8 0.26 Very Good H SI1 61.9 55 337 4.07 4.11 2.53  
 9 0.22 Fair E VS2 65.1 61 337 3.87 3.78 2.49  
10 0.23 Very Good H VS1 59.4 61 338 4 4.05 2.39  
# ℹ 52,188 more rows

## Subset rows of a data.frame:

The OR operator (|) can be a substitute for %in% (although it might take more typing):

diamonds %>% filter(clarity =="SI1" | clarity == "SI2") %>% head(2)

# A tibble: 2 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
2 0.21 Premium E SI1 59.8 61 326 3.89 3.84 2.31

diamonds %>% filter(clarity %in% c("SI1", "SI2")) %>% head(2)

# A tibble: 2 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
2 0.21 Premium E SI1 59.8 61 326 3.89 3.84 2.31

## Combining filter and select:

You can combine filter and select to subset the rows and columns, respectively, of a data.frame:

diamonds %>%   
 filter(clarity == "SI2") %>%   
 select(starts\_with("c"))

# A tibble: 9,194 × 4  
 carat cut color clarity  
 <dbl> <ord> <ord> <ord>   
 1 0.23 Ideal E SI2   
 2 0.31 Good J SI2   
 3 0.31 Ideal J SI2   
 4 0.2 Premium E SI2   
 5 0.3 Ideal I SI2   
 6 0.3 Good I SI2   
 7 0.33 Ideal I SI2   
 8 0.33 Ideal I SI2   
 9 0.32 Good H SI2   
10 0.32 Very Good H SI2   
# ℹ 9,184 more rows

## Combining filter and select:

The order of these functions matters though, since you can remove columns that you might want to filter on.

diamonds %>%   
 select(starts\_with("c")) %>%  
 filter(table > 60))

This will result in an error because the table column is now gone after the select() function!

# Fancier filtering

## Combining tidyselect helpers with regular selection

head(diamonds, 2)

# A tibble: 2 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
2 0.21 Premium E SI1 59.8 61 326 3.89 3.84 2.31

diamonds %>% select(price, starts\_with("c"))

# A tibble: 53,940 × 5  
 price carat cut color clarity  
 <int> <dbl> <ord> <ord> <ord>   
 1 326 0.23 Ideal E SI2   
 2 326 0.21 Premium E SI1   
 3 327 0.23 Good E VS1   
 4 334 0.29 Premium I VS2   
 5 335 0.31 Good J SI2   
 6 336 0.24 Very Good J VVS2   
 7 336 0.24 Very Good I VVS1   
 8 337 0.26 Very Good H SI1   
 9 337 0.22 Fair E VS2   
10 338 0.23 Very Good H VS1   
# ℹ 53,930 more rows

## Multiple tidyselect functions

Follows OR logic.

diamonds %>% select(starts\_with("c"), ends\_with("e"))

# A tibble: 53,940 × 6  
 carat cut color clarity table price  
 <dbl> <ord> <ord> <ord> <dbl> <int>  
 1 0.23 Ideal E SI2 55 326  
 2 0.21 Premium E SI1 61 326  
 3 0.23 Good E VS1 65 327  
 4 0.29 Premium I VS2 58 334  
 5 0.31 Good J SI2 58 335  
 6 0.24 Very Good J VVS2 57 336  
 7 0.24 Very Good I VVS1 57 336  
 8 0.26 Very Good H SI1 55 337  
 9 0.22 Fair E VS2 61 337  
10 0.23 Very Good H VS1 61 338  
# ℹ 53,930 more rows

## Multiple patterns with tidyselect

Need to combine the patterns with the c() function.

diamonds %>% select(starts\_with(c("c", "p")))

# A tibble: 53,940 × 5  
 carat cut color clarity price  
 <dbl> <ord> <ord> <ord> <int>  
 1 0.23 Ideal E SI2 326  
 2 0.21 Premium E SI1 326  
 3 0.23 Good E VS1 327  
 4 0.29 Premium I VS2 334  
 5 0.31 Good J SI2 335  
 6 0.24 Very Good J VVS2 336  
 7 0.24 Very Good I VVS1 336  
 8 0.26 Very Good H SI1 337  
 9 0.22 Fair E VS2 337  
10 0.23 Very Good H VS1 338  
# ℹ 53,930 more rows

## Common error for filter or select

If you try to filter or select for a column that does not exist it will not work:

* misspelled column name
* column that was already removed

## Always good to check each step!

Did the filter work the way you expected? Did the dimensions change?

 Source: <https://media.giphy.com/media/5b5OU7aUekfdSAER5I/giphy.gif>

## Summary

* pull() can help us see a vector version of our variables - we can “pull” out the data from a dataframe
* The pipe (%>%) can help us to do sequential steps
* select() makes a smaller table of just selected variables
* tidyselect functions can help us select specific columns: contains(), ends\_with(), starts\_with()
* filter can remove rows based on conditions
* == is needed to filter for rows that are “exactly equal” to a value
* != does the opposite
* %in% enables us to do multiple == conditions such as %in% c(1,2,3)
* | is for or logic and & is for and logic when combining filter conditions together
* Always check that you filtered for what you think you did!

## Lab

[Link to Lab](http://sisbid.github.io/Data-Wrangling/labs/data-subsetting-lab-part1.Rmd)

# Subsetting part 2

## Data

Let’s continue to work with the Diamond dataset from the ggplot2 package of the tidyverse.

We will often use the glimpse() function of the dplyr package of the tidyverse to look at a rotated view of the data.

library(tidyverse)  
head(diamonds)

# A tibble: 6 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
2 0.21 Premium E SI1 59.8 61 326 3.89 3.84 2.31  
3 0.23 Good E VS1 56.9 65 327 4.05 4.07 2.31  
4 0.29 Premium I VS2 62.4 58 334 4.2 4.23 2.63  
5 0.31 Good J SI2 63.3 58 335 4.34 4.35 2.75  
6 0.24 Very Good J VVS2 62.8 57 336 3.94 3.96 2.48

## Let’s learn more about this data

We can use ?diamonds to get more informatin in the Help pane.

We might decide to rename some columns,

* x to be length
* y to be width
* z to be depth
* but first changing depth to be depth\_percentage

## Renaming Columns of a data frame or tibble

To rename columns in dplyr, you can use the rename function.

Notice the new name is listed **first**!

# general format! not code!  
{data you are creating or changing} <- {data you are using} %>%  
 rename({New Name} = {Old name})

diamonds\_2 <- diamonds %>%  
 rename(depth\_percentage = depth)  
head(diamonds\_2, n = 3)

# A tibble: 3 × 10  
 carat cut color clarity depth\_percentage table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
2 0.21 Premium E SI1 59.8 61 326 3.89 3.84 2.31  
3 0.23 Good E VS1 56.9 65 327 4.05 4.07 2.31

## More Renaming

diamonds\_2<- diamonds\_2 %>%  
 rename(length = x,  
 width = y,  
 depth = z)  
glimpse(diamonds\_2)

Rows: 53,940  
Columns: 10  
$ carat <dbl> 0.23, 0.21, 0.23, 0.29, 0.31, 0.24, 0.24, 0.26, 0.22,…  
$ cut <ord> Ideal, Premium, Good, Premium, Good, Very Good, Very …  
$ color <ord> E, E, E, I, J, J, I, H, E, H, J, J, F, J, E, E, I, J,…  
$ clarity <ord> SI2, SI1, VS1, VS2, SI2, VVS2, VVS1, SI1, VS2, VS1, S…  
$ depth\_percentage <dbl> 61.5, 59.8, 56.9, 62.4, 63.3, 62.8, 62.3, 61.9, 65.1,…  
$ table <dbl> 55, 61, 65, 58, 58, 57, 57, 55, 61, 61, 55, 56, 61, 5…  
$ price <int> 326, 326, 327, 334, 335, 336, 336, 337, 337, 338, 339…  
$ length <dbl> 3.95, 3.89, 4.05, 4.20, 4.34, 3.94, 3.95, 4.07, 3.87,…  
$ width <dbl> 3.98, 3.84, 4.07, 4.23, 4.35, 3.96, 3.98, 4.11, 3.78,…  
$ depth <dbl> 2.43, 2.31, 2.31, 2.63, 2.75, 2.48, 2.47, 2.53, 2.49,…

## Take Care with Column Names

When you can, avoid spaces, special punctuation, or numbers in column names, as these require special treatment to refer to them.

See <https://jhudatascience.org/intro_to_r/quotes_vs_backticks.html> for more guidance.

diamonds %>% rename(depth percentage = depth)# this will cause an error

diamonds %>% rename(depth\_percentage = depth) # this will work

diamonds %>% rename(`depth percentage` = depth) # not recommended

## Unusual Column Names

It’s best to avoid unusual column names where possible, as things get tricky later.

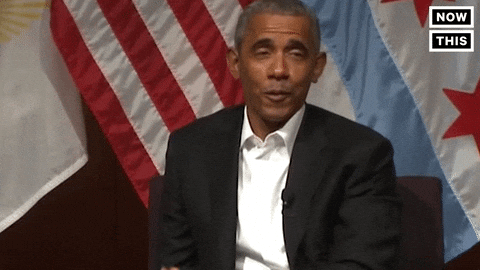
We just showed the use of ` backticks` . You may see people use quotes as well.

Other atypical column names are those with:

* spaces
* number without characters
* number starting the name
* other punctuation marks (besides “\_” or “.” and not at the beginning)

## A solution!

Rename tricky column names so that you don’t have to deal with them later!



## Example

glimpse(diamonds\_bad\_names)

Rows: 53,940  
Columns: 10  
$ carat <dbl> 0.23, 0.21, 0.23, 0.29, 0.31, 0.24, 0.24, 0.26,…  
$ cut <ord> Ideal, Premium, Good, Premium, Good, Very Good,…  
$ color <ord> E, E, E, I, J, J, I, H, E, H, J, J, F, J, E, E,…  
$ clarity <ord> SI2, SI1, VS1, VS2, SI2, VVS2, VVS1, SI1, VS2, …  
$ depth <dbl> 61.5, 59.8, 56.9, 62.4, 63.3, 62.8, 62.3, 61.9,…  
$ table <dbl> 55, 61, 65, 58, 58, 57, 57, 55, 61, 61, 55, 56,…  
$ `Price(in US dollars)` <int> 326, 326, 327, 334, 335, 336, 336, 337, 337, 33…  
$ `Length (in mm)` <dbl> 3.95, 3.89, 4.05, 4.20, 4.34, 3.94, 3.95, 4.07,…  
$ `Width in mm` <dbl> 3.98, 3.84, 4.07, 4.23, 4.35, 3.96, 3.98, 4.11,…  
$ `Depth percentage` <dbl> 2.43, 2.31, 2.31, 2.63, 2.75, 2.48, 2.47, 2.53,…

diamonds\_bad\_names %>%  
 rename(price = `Price(in US dollars)`)

# A tibble: 53,940 × 10  
 carat cut color clarity depth table price `Length (in mm)` `Width in mm`  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl>  
 1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98  
 2 0.21 Premium E SI1 59.8 61 326 3.89 3.84  
 3 0.23 Good E VS1 56.9 65 327 4.05 4.07  
 4 0.29 Premium I VS2 62.4 58 334 4.2 4.23  
 5 0.31 Good J SI2 63.3 58 335 4.34 4.35  
 6 0.24 Very Go… J VVS2 62.8 57 336 3.94 3.96  
 7 0.24 Very Go… I VVS1 62.3 57 336 3.95 3.98  
 8 0.26 Very Go… H SI1 61.9 55 337 4.07 4.11  
 9 0.22 Fair E VS2 65.1 61 337 3.87 3.78  
10 0.23 Very Go… H VS1 59.4 61 338 4 4.05  
# ℹ 53,930 more rows  
# ℹ 1 more variable: `Depth percentage` <dbl>

## Renaming all columns of a data frame: dplyr

To rename all columns you use the rename\_with(). In this case we will use toupper() to make all letters upper case. Could also use tolower() function.

diamonds\_upper <- diamonds %>% rename\_with(toupper)  
head(diamonds\_upper, 2)

# A tibble: 2 × 10  
 CARAT CUT COLOR CLARITY DEPTH TABLE PRICE X Y Z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
2 0.21 Premium E SI1 59.8 61 326 3.89 3.84 2.31

diamonds\_upper %>% rename\_with(tolower) %>% head(n = 2)

# A tibble: 2 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
2 0.21 Premium E SI1 59.8 61 326 3.89 3.84 2.31

## Janitor package

#install.packages("janitor")  
library(janitor)  
clean\_names(diamonds\_bad\_names) %>% glimpse()

Rows: 53,940  
Columns: 10  
$ carat <dbl> 0.23, 0.21, 0.23, 0.29, 0.31, 0.24, 0.24, 0.26, 0.…  
$ cut <ord> Ideal, Premium, Good, Premium, Good, Very Good, Ve…  
$ color <ord> E, E, E, I, J, J, I, H, E, H, J, J, F, J, E, E, I,…  
$ clarity <ord> SI2, SI1, VS1, VS2, SI2, VVS2, VVS1, SI1, VS2, VS1…  
$ depth <dbl> 61.5, 59.8, 56.9, 62.4, 63.3, 62.8, 62.3, 61.9, 65…  
$ table <dbl> 55, 61, 65, 58, 58, 57, 57, 55, 61, 61, 55, 56, 61…  
$ price\_in\_us\_dollars <int> 326, 326, 327, 334, 335, 336, 336, 337, 337, 338, …  
$ length\_in\_mm <dbl> 3.95, 3.89, 4.05, 4.20, 4.34, 3.94, 3.95, 4.07, 3.…  
$ width\_in\_mm <dbl> 3.98, 3.84, 4.07, 4.23, 4.35, 3.96, 3.98, 4.11, 3.…  
$ depth\_percentage <dbl> 2.43, 2.31, 2.31, 2.63, 2.75, 2.48, 2.47, 2.53, 2.…

# Subset based on a class

## The where() function can help select columns of a specific class

is.character() and is.numeric() are often the most helpful

head(diamonds, 2)

# A tibble: 2 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
2 0.21 Premium E SI1 59.8 61 326 3.89 3.84 2.31

diamonds %>% select(where(is.numeric)) %>% head(n = 2)

# A tibble: 2 × 7  
 carat depth table price x y z  
 <dbl> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
1 0.23 61.5 55 326 3.95 3.98 2.43  
2 0.21 59.8 61 326 3.89 3.84 2.31

## distinct() function

To filter for distinct values from a variable, multiple variables, or an entire tibble you can use the distinct() function from the dplyr package. Similar to count, but without the number of times the value shows up.

distinct(diamonds, cut)

# A tibble: 5 × 1  
 cut   
 <ord>   
1 Ideal   
2 Premium   
3 Good   
4 Very Good  
5 Fair

# Adding/Removing Columns

## Adding columns to a data frame: dplyr (tidyverse way)

The mutate function in dplyr allows you to add or modify columns of a data frame.

# General format - Not the code!  
{data object to update} <- {data to use} %>%   
 mutate({new variable name} = {new variable source})

1 US dollar = 1.37 Canadian dollars

diamonds %>%   
 mutate(price\_canadian = price \* 1.37) %>% glimpse()

Rows: 53,940  
Columns: 11  
$ carat <dbl> 0.23, 0.21, 0.23, 0.29, 0.31, 0.24, 0.24, 0.26, 0.22, 0…  
$ cut <ord> Ideal, Premium, Good, Premium, Good, Very Good, Very Go…  
$ color <ord> E, E, E, I, J, J, I, H, E, H, J, J, F, J, E, E, I, J, J…  
$ clarity <ord> SI2, SI1, VS1, VS2, SI2, VVS2, VVS1, SI1, VS2, VS1, SI1…  
$ depth <dbl> 61.5, 59.8, 56.9, 62.4, 63.3, 62.8, 62.3, 61.9, 65.1, 5…  
$ table <dbl> 55, 61, 65, 58, 58, 57, 57, 55, 61, 61, 55, 56, 61, 54,…  
$ price <int> 326, 326, 327, 334, 335, 336, 336, 337, 337, 338, 339, …  
$ x <dbl> 3.95, 3.89, 4.05, 4.20, 4.34, 3.94, 3.95, 4.07, 3.87, 4…  
$ y <dbl> 3.98, 3.84, 4.07, 4.23, 4.35, 3.96, 3.98, 4.11, 3.78, 4…  
$ z <dbl> 2.43, 2.31, 2.31, 2.63, 2.75, 2.48, 2.47, 2.53, 2.49, 2…  
$ price\_canadian <dbl> 446.62, 446.62, 447.99, 457.58, 458.95, 460.32, 460.32,…

## Use mutate to modify existing columns

The mutate function in dplyr allows you to add or modify columns of a data frame.

# General format - Not the code!  
{data object to update} <- {data to use} %>%  
 mutate({variable name to change} = {variable modification})

mutate(diamonds, price = price \* 1.32) %>% glimpse()

Rows: 53,940  
Columns: 10  
$ carat <dbl> 0.23, 0.21, 0.23, 0.29, 0.31, 0.24, 0.24, 0.26, 0.22, 0.23, 0.…  
$ cut <ord> Ideal, Premium, Good, Premium, Good, Very Good, Very Good, Ver…  
$ color <ord> E, E, E, I, J, J, I, H, E, H, J, J, F, J, E, E, I, J, J, J, I,…  
$ clarity <ord> SI2, SI1, VS1, VS2, SI2, VVS2, VVS1, SI1, VS2, VS1, SI1, VS1, …  
$ depth <dbl> 61.5, 59.8, 56.9, 62.4, 63.3, 62.8, 62.3, 61.9, 65.1, 59.4, 64…  
$ table <dbl> 55, 61, 65, 58, 58, 57, 57, 55, 61, 61, 55, 56, 61, 54, 62, 58…  
$ price <dbl> 430.32, 430.32, 431.64, 440.88, 442.20, 443.52, 443.52, 444.84…  
$ x <dbl> 3.95, 3.89, 4.05, 4.20, 4.34, 3.94, 3.95, 4.07, 3.87, 4.00, 4.…  
$ y <dbl> 3.98, 3.84, 4.07, 4.23, 4.35, 3.96, 3.98, 4.11, 3.78, 4.05, 4.…  
$ z <dbl> 2.43, 2.31, 2.31, 2.63, 2.75, 2.48, 2.47, 2.53, 2.49, 2.39, 2.…

## remember to save your data

If you want to actually make the change you need to reassign the data object.

diamonds <- diamonds %>% mutate(price = price \* 1.32) %>% glimpse()

## Removing columns of a data frame: dplyr

The select function can remove a column with minus (-)

select(diamonds, - price) %>% glimpse()

Rows: 53,940  
Columns: 9  
$ carat <dbl> 0.23, 0.21, 0.23, 0.29, 0.31, 0.24, 0.24, 0.26, 0.22, 0.23, 0.…  
$ cut <ord> Ideal, Premium, Good, Premium, Good, Very Good, Very Good, Ver…  
$ color <ord> E, E, E, I, J, J, I, H, E, H, J, J, F, J, E, E, I, J, J, J, I,…  
$ clarity <ord> SI2, SI1, VS1, VS2, SI2, VVS2, VVS1, SI1, VS2, VS1, SI1, VS1, …  
$ depth <dbl> 61.5, 59.8, 56.9, 62.4, 63.3, 62.8, 62.3, 61.9, 65.1, 59.4, 64…  
$ table <dbl> 55, 61, 65, 58, 58, 57, 57, 55, 61, 61, 55, 56, 61, 54, 62, 58…  
$ x <dbl> 3.95, 3.89, 4.05, 4.20, 4.34, 3.94, 3.95, 4.07, 3.87, 4.00, 4.…  
$ y <dbl> 3.98, 3.84, 4.07, 4.23, 4.35, 3.96, 3.98, 4.11, 3.78, 4.05, 4.…  
$ z <dbl> 2.43, 2.31, 2.31, 2.63, 2.75, 2.48, 2.47, 2.53, 2.49, 2.39, 2.…

**Or, you can simply select the columns you want to keep, ignoring the ones you want to remove.**

## Removing columns in a data frame: dplyr

You can use c() to list the columns to remove.

Remove newcol and drat:

select(diamonds, -c("x", "y", "z")) %>% glimpse()

Rows: 53,940  
Columns: 7  
$ carat <dbl> 0.23, 0.21, 0.23, 0.29, 0.31, 0.24, 0.24, 0.26, 0.22, 0.23, 0.…  
$ cut <ord> Ideal, Premium, Good, Premium, Good, Very Good, Very Good, Ver…  
$ color <ord> E, E, E, I, J, J, I, H, E, H, J, J, F, J, E, E, I, J, J, J, I,…  
$ clarity <ord> SI2, SI1, VS1, VS2, SI2, VVS2, VVS1, SI1, VS2, VS1, SI1, VS1, …  
$ depth <dbl> 61.5, 59.8, 56.9, 62.4, 63.3, 62.8, 62.3, 61.9, 65.1, 59.4, 64…  
$ table <dbl> 55, 61, 65, 58, 58, 57, 57, 55, 61, 61, 55, 56, 61, 54, 62, 58…  
$ price <int> 326, 326, 327, 334, 335, 336, 336, 337, 337, 338, 339, 340, 34…

# Ordering columns

## Ordering the columns of a data frame: dplyr

The select function can reorder columns.

head(diamonds, n = 2)

# A tibble: 2 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
2 0.21 Premium E SI1 59.8 61 326 3.89 3.84 2.31

diamonds %>% select(price, depth, carat, cut, color) %>% head(n = 2)

# A tibble: 2 × 5  
 price depth carat cut color  
 <int> <dbl> <dbl> <ord> <ord>  
1 326 61.5 0.23 Ideal E   
2 326 59.8 0.21 Premium E

## Ordering the columns of a data frame: dplyr

The select function can reorder columns. Put price first, then select the rest of columns:

head(diamonds, n = 2)

# A tibble: 2 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
2 0.21 Premium E SI1 59.8 61 326 3.89 3.84 2.31

diamonds %>% select(price, everything()) %>% head(n = 2)

# A tibble: 2 × 10  
 price carat cut color clarity depth table x y z  
 <int> <dbl> <ord> <ord> <ord> <dbl> <dbl> <dbl> <dbl> <dbl>  
1 326 0.23 Ideal E SI2 61.5 55 3.95 3.98 2.43  
2 326 0.21 Premium E SI1 59.8 61 3.89 3.84 2.31

## Ordering the columns of a data frame: dplyr

Put price at the end (“remove, everything, then add back in”):

head(diamonds, n = 2)

# A tibble: 2 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
2 0.21 Premium E SI1 59.8 61 326 3.89 3.84 2.31

diamonds %>% select(-price, everything(), price) %>% head(n = 2)

# A tibble: 2 × 10  
 carat cut color clarity depth table x y z price  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <dbl> <dbl> <dbl> <int>  
1 0.23 Ideal E SI2 61.5 55 3.95 3.98 2.43 326  
2 0.21 Premium E SI1 59.8 61 3.89 3.84 2.31 326

## Ordering the columns of a data frame: dplyr

In addition to select we can also use the relocate() function of dplyr to rearrange the columns for more complicated moves.

For example, let say we just wanted price to be before carat.

head(diamonds, n = 2)

# A tibble: 2 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
1 0.23 Ideal E SI2 61.5 55 326 3.95 3.98 2.43  
2 0.21 Premium E SI1 59.8 61 326 3.89 3.84 2.31

diamonds %>% relocate( price, .before = cut) %>% head(n = 2)

# A tibble: 2 × 10  
 carat price cut color clarity depth table x y z  
 <dbl> <int> <ord> <ord> <ord> <dbl> <dbl> <dbl> <dbl> <dbl>  
1 0.23 326 Ideal E SI2 61.5 55 3.95 3.98 2.43  
2 0.21 326 Premium E SI1 59.8 61 3.89 3.84 2.31

## Ordering the column names of a data frame: alphabetically

Using the base R order() function.

order(colnames(diamonds))

[1] 1 4 3 2 5 7 6 8 9 10

diamonds %>% select(order(colnames(diamonds)))

# A tibble: 53,940 × 10  
 carat clarity color cut depth price table x y z  
 <dbl> <ord> <ord> <ord> <dbl> <int> <dbl> <dbl> <dbl> <dbl>  
 1 0.23 SI2 E Ideal 61.5 326 55 3.95 3.98 2.43  
 2 0.21 SI1 E Premium 59.8 326 61 3.89 3.84 2.31  
 3 0.23 VS1 E Good 56.9 327 65 4.05 4.07 2.31  
 4 0.29 VS2 I Premium 62.4 334 58 4.2 4.23 2.63  
 5 0.31 SI2 J Good 63.3 335 58 4.34 4.35 2.75  
 6 0.24 VVS2 J Very Good 62.8 336 57 3.94 3.96 2.48  
 7 0.24 VVS1 I Very Good 62.3 336 57 3.95 3.98 2.47  
 8 0.26 SI1 H Very Good 61.9 337 55 4.07 4.11 2.53  
 9 0.22 VS2 E Fair 65.1 337 61 3.87 3.78 2.49  
10 0.23 VS1 H Very Good 59.4 338 61 4 4.05 2.39  
# ℹ 53,930 more rows

# Ordering rows

## Ordering the rows of a data frame: dplyr

The arrange function can reorder rows By default, arrange orders in increasing order:

diamonds %>% arrange(cut)

# A tibble: 53,940 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
 1 0.22 Fair E VS2 65.1 61 337 3.87 3.78 2.49  
 2 0.86 Fair E SI2 55.1 69 2757 6.45 6.33 3.52  
 3 0.96 Fair F SI2 66.3 62 2759 6.27 5.95 4.07  
 4 0.7 Fair F VS2 64.5 57 2762 5.57 5.53 3.58  
 5 0.7 Fair F VS2 65.3 55 2762 5.63 5.58 3.66  
 6 0.91 Fair H SI2 64.4 57 2763 6.11 6.09 3.93  
 7 0.91 Fair H SI2 65.7 60 2763 6.03 5.99 3.95  
 8 0.98 Fair H SI2 67.9 60 2777 6.05 5.97 4.08  
 9 0.84 Fair G SI1 55.1 67 2782 6.39 6.2 3.47  
10 1.01 Fair E I1 64.5 58 2788 6.29 6.21 4.03  
# ℹ 53,930 more rows

## Ordering the rows of a data frame: dplyr

Use the desc to arrange the rows in descending order:

diamonds %>% arrange(depth)

# A tibble: 53,940 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
 1 1 Fair G SI1 43 59 3634 6.32 6.27 3.97  
 2 1.09 Ideal J VS2 43 54 4778 6.53 6.55 4.12  
 3 1 Fair G VS2 44 53 4032 6.31 6.24 4.12  
 4 1.43 Fair I VS1 50.8 60 6727 7.73 7.25 3.93  
 5 0.3 Fair E VVS2 51 67 945 4.67 4.62 2.37  
 6 0.7 Fair D SI1 52.2 65 1895 6.04 5.99 3.14  
 7 0.37 Fair F IF 52.3 61 1166 4.96 4.91 2.58  
 8 0.56 Fair H VS2 52.7 70 1293 5.71 5.57 2.97  
 9 1.02 Fair I SI1 53 63 2856 6.84 6.77 3.66  
10 0.96 Fair E SI2 53.1 63 2815 6.73 6.65 3.55  
# ℹ 53,930 more rows

## Ordering the rows of a data frame: dplyr

Use the desc to arrange the rows in descending order:

diamonds %>% arrange(desc(price))

# A tibble: 53,940 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
 1 2.29 Premium I VS2 60.8 60 18823 8.5 8.47 5.16  
 2 2 Very Good G SI1 63.5 56 18818 7.9 7.97 5.04  
 3 1.51 Ideal G IF 61.7 55 18806 7.37 7.41 4.56  
 4 2.07 Ideal G SI2 62.5 55 18804 8.2 8.13 5.11  
 5 2 Very Good H SI1 62.8 57 18803 7.95 8 5.01  
 6 2.29 Premium I SI1 61.8 59 18797 8.52 8.45 5.24  
 7 2.04 Premium H SI1 58.1 60 18795 8.37 8.28 4.84  
 8 2 Premium I VS1 60.8 59 18795 8.13 8.02 4.91  
 9 1.71 Premium F VS2 62.3 59 18791 7.57 7.53 4.7   
10 2.15 Ideal G SI2 62.6 54 18791 8.29 8.35 5.21  
# ℹ 53,930 more rows

## Ordering the rows of a data frame: dplyr

You can combine increasing and decreasing orderings. The first listed gets priority.

arrange(diamonds, desc(carat), table)

# A tibble: 53,940 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
 1 5.01 Fair J I1 65.5 59 18018 10.7 10.5 6.98  
 2 4.5 Fair J I1 65.8 58 18531 10.2 10.2 6.72  
 3 4.13 Fair H I1 64.8 61 17329 10 9.85 6.43  
 4 4.01 Premium I I1 61 61 15223 10.1 10.1 6.17  
 5 4.01 Premium J I1 62.5 62 15223 10.0 9.94 6.24  
 6 4 Very Good I I1 63.3 58 15984 10.0 9.94 6.31  
 7 3.67 Premium I I1 62.4 56 16193 9.86 9.81 6.13  
 8 3.65 Fair H I1 67.1 53 11668 9.53 9.48 6.38  
 9 3.51 Premium J VS2 62.5 59 18701 9.66 9.63 6.03  
10 3.5 Ideal H I1 62.8 57 12587 9.65 9.59 6.03  
# ℹ 53,930 more rows

## Ordering the rows of a data frame: dplyr

You can combine increasing and decreasing orderings. The first listed gets priority. Here table is prioritized.

arrange(diamonds, table, desc(carat))

# A tibble: 53,940 × 10  
 carat cut color clarity depth table price x y z  
 <dbl> <ord> <ord> <ord> <dbl> <dbl> <int> <dbl> <dbl> <dbl>  
 1 1.04 Ideal I VS1 62.9 43 4997 6.45 6.41 4.04  
 2 0.29 Very Good E VS1 62.8 44 474 4.2 4.24 2.65  
 3 1 Fair I VS1 64 49 3951 6.43 6.39 4.1   
 4 0.3 Fair E SI1 64.5 49 630 4.28 4.25 2.75  
 5 2 Fair H SI1 61.2 50 13764 8.17 8.08 4.97  
 6 1.02 Fair F SI1 61.8 50 4227 6.59 6.51 4.05  
 7 0.94 Fair H SI2 66 50.1 3353 6.13 6.17 4.06  
 8 2.01 Good H SI2 64 51 15888 8.08 8.01 5.15  
 9 1 Premium H SI1 62.2 51 3511 6.47 6.4 4   
10 1 Fair E VS2 66.4 51 4480 6.31 6.22 4.16  
# ℹ 53,930 more rows

## Summary

* rename can change a name - new name = old name
* clean\_names of the janitor package can change many names
* select() and relocate() can be used to reorder columns
* can remove a column in a few ways:
  + using select() with negative sign in front of column name(s)
  + jut not selecting it
* mutate() can be used to modify an existing variable or make a new variable
* arrange() can be used to reorder rows
* can arrange in descending order with desc()

## Lab

[Link to Lab](http://sisbid.github.io/Data-Wrangling/labs/data-subsetting-lab-part2.Rmd)

## Data Summarization

* Basic statistical summarization
  + mean(x): takes the mean of x
  + sd(x): takes the standard deviation of x
  + median(x): takes the median of x
  + quantile(x): displays sample quantiles of x. Default is min, IQR, max
  + range(x): displays the range. Same as c(min(x), max(x))
  + sum(x): sum of x
  + max(x): maximum value in x
  + min(x): minimum value in x
* **all have the**  na.rm = **argument for missing data**

## Statistical summarization

These functions work on **vectors**:

x <- c(1, 5, 7, 4, 2, 8)  
mean(x)

[1] 4.5

Summarization on a data.frame/tibble:

mtcars %>% pull(hp) %>% mean()

[1] 146.6875

## Youth Tobacco Survey

Let’s use the Youth Tobacco Survey data again:

yts <-   
 read\_csv("https://sisbid.github.io/Data-Wrangling/data/Youth\_Tobacco\_Survey\_YTS\_Data.csv")  
head(yts)

# A tibble: 6 × 31  
 YEAR LocationAbbr LocationDesc TopicType TopicDesc MeasureDesc DataSource  
 <dbl> <chr> <chr> <chr> <chr> <chr> <chr>   
1 2015 AZ Arizona Tobacco Use … Cessatio… Percent of… YTS   
2 2015 AZ Arizona Tobacco Use … Cessatio… Percent of… YTS   
3 2015 AZ Arizona Tobacco Use … Cessatio… Percent of… YTS   
4 2015 AZ Arizona Tobacco Use … Cessatio… Quit Attem… YTS   
5 2015 AZ Arizona Tobacco Use … Cessatio… Quit Attem… YTS   
6 2015 AZ Arizona Tobacco Use … Cessatio… Quit Attem… YTS   
# ℹ 24 more variables: Response <chr>, Data\_Value\_Unit <chr>,  
# Data\_Value\_Type <chr>, Data\_Value <dbl>, Data\_Value\_Footnote\_Symbol <chr>,  
# Data\_Value\_Footnote <chr>, Data\_Value\_Std\_Err <dbl>,  
# Low\_Confidence\_Limit <dbl>, High\_Confidence\_Limit <dbl>, Sample\_Size <dbl>,  
# Gender <chr>, Race <chr>, Age <chr>, Education <chr>, GeoLocation <chr>,  
# TopicTypeId <chr>, TopicId <chr>, MeasureId <chr>, StratificationID1 <chr>,  
# StratificationID2 <chr>, StratificationID3 <chr>, …

## Column to vector

Let’s work with one column as a vector using pull().

locations <- yts %>% pull(LocationDesc)  
locations

[1] "Arizona" "Arizona"   
 [3] "Arizona" "Arizona"   
 [5] "Arizona" "Arizona"   
 [7] "Arizona" "Arizona"   
 [9] "Arizona" "Arizona"   
 [11] "Arizona" "Arizona"   
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## Check for NAs

use sum(is.na()):

sum(is.na(locations))

[1] 0

## dplyr: count

Use count directly on a data.frame and column: count the number of rows in each group. The nrow of the dataset tells you the number of unique groups.

yts %>% count(LocationDesc)

# A tibble: 50 × 2  
 LocationDesc n  
 <chr> <int>  
 1 Alabama 378  
 2 Arizona 240  
 3 Arkansas 210  
 4 California 96  
 5 Colorado 48  
 6 Connecticut 384  
 7 Delaware 312  
 8 District of Columbia 48  
 9 Florida 96  
10 Georgia 282  
# ℹ 40 more rows

## dplyr: count

Multiple columns listed further subdivides the count.

yts %>% count(LocationDesc, TopicDesc)

# A tibble: 146 × 3  
 LocationDesc TopicDesc n  
 <chr> <chr> <int>  
 1 Alabama Cessation (Youth) 90  
 2 Alabama Cigarette Use (Youth) 144  
 3 Alabama Smokeless Tobacco Use (Youth) 144  
 4 Arizona Cessation (Youth) 60  
 5 Arizona Cigarette Use (Youth) 99  
 6 Arizona Smokeless Tobacco Use (Youth) 81  
 7 Arkansas Cessation (Youth) 42  
 8 Arkansas Cigarette Use (Youth) 78  
 9 Arkansas Smokeless Tobacco Use (Youth) 90  
10 California Cessation (Youth) 24  
# ℹ 136 more rows

## dplyr: count

Option to sort the results with sort = TRUE

yts %>% count(LocationDesc, sort = TRUE)

# A tibble: 50 × 2  
 LocationDesc n  
 <chr> <int>  
 1 Mississippi 567  
 2 New Jersey 387  
 3 Connecticut 384  
 4 Alabama 378  
 5 North Carolina 366  
 6 Wisconsin 360  
 7 West Virginia 336  
 8 North Dakota 330  
 9 Pennsylvania 330  
10 Oklahoma 318  
# ℹ 40 more rows

## dplyr: count

Instead of counting the number of rows in each group, wt computes sum(wt) for each group.

# Add up "Data\_Value" for each LocationDesc category  
yts %>% count(LocationDesc, wt = Data\_Value)

# A tibble: 50 × 2  
 LocationDesc n  
 <chr> <dbl>  
 1 Alabama 9220.  
 2 Arizona 3937.  
 3 Arkansas 5443.  
 4 California 2059.  
 5 Colorado 1136.  
 6 Connecticut 5838.  
 7 Delaware 5886   
 8 District of Columbia 853.  
 9 Florida 2786.  
10 Georgia 5625.  
# ℹ 40 more rows

# Grouping

## Perform Operations By Groups: dplyr

group\_by allows you group the data set by variables/columns you specify:

# Regular data  
yts

# A tibble: 9,794 × 31  
 YEAR LocationAbbr LocationDesc TopicType TopicDesc MeasureDesc DataSource  
 <dbl> <chr> <chr> <chr> <chr> <chr> <chr>   
 1 2015 AZ Arizona Tobacco Use… Cessatio… Percent of… YTS   
 2 2015 AZ Arizona Tobacco Use… Cessatio… Percent of… YTS   
 3 2015 AZ Arizona Tobacco Use… Cessatio… Percent of… YTS   
 4 2015 AZ Arizona Tobacco Use… Cessatio… Quit Attem… YTS   
 5 2015 AZ Arizona Tobacco Use… Cessatio… Quit Attem… YTS   
 6 2015 AZ Arizona Tobacco Use… Cessatio… Quit Attem… YTS   
 7 2015 AZ Arizona Tobacco Use… Cigarett… Smoking St… YTS   
 8 2015 AZ Arizona Tobacco Use… Cigarett… Smoking St… YTS   
 9 2015 AZ Arizona Tobacco Use… Cigarett… Smoking St… YTS   
10 2015 AZ Arizona Tobacco Use… Cigarett… Smoking St… YTS   
# ℹ 9,784 more rows  
# ℹ 24 more variables: Response <chr>, Data\_Value\_Unit <chr>,  
# Data\_Value\_Type <chr>, Data\_Value <dbl>, Data\_Value\_Footnote\_Symbol <chr>,  
# Data\_Value\_Footnote <chr>, Data\_Value\_Std\_Err <dbl>,  
# Low\_Confidence\_Limit <dbl>, High\_Confidence\_Limit <dbl>, Sample\_Size <dbl>,  
# Gender <chr>, Race <chr>, Age <chr>, Education <chr>, GeoLocation <chr>,  
# TopicTypeId <chr>, TopicId <chr>, MeasureId <chr>, …

## Perform Operations By Groups: dplyr

group\_by allows you group the data set by variables/columns you specify:

yts\_grouped <- yts %>% group\_by(Response)  
yts\_grouped

# A tibble: 9,794 × 31  
# Groups: Response [4]  
 YEAR LocationAbbr LocationDesc TopicType TopicDesc MeasureDesc DataSource  
 <dbl> <chr> <chr> <chr> <chr> <chr> <chr>   
 1 2015 AZ Arizona Tobacco Use… Cessatio… Percent of… YTS   
 2 2015 AZ Arizona Tobacco Use… Cessatio… Percent of… YTS   
 3 2015 AZ Arizona Tobacco Use… Cessatio… Percent of… YTS   
 4 2015 AZ Arizona Tobacco Use… Cessatio… Quit Attem… YTS   
 5 2015 AZ Arizona Tobacco Use… Cessatio… Quit Attem… YTS   
 6 2015 AZ Arizona Tobacco Use… Cessatio… Quit Attem… YTS   
 7 2015 AZ Arizona Tobacco Use… Cigarett… Smoking St… YTS   
 8 2015 AZ Arizona Tobacco Use… Cigarett… Smoking St… YTS   
 9 2015 AZ Arizona Tobacco Use… Cigarett… Smoking St… YTS   
10 2015 AZ Arizona Tobacco Use… Cigarett… Smoking St… YTS   
# ℹ 9,784 more rows  
# ℹ 24 more variables: Response <chr>, Data\_Value\_Unit <chr>,  
# Data\_Value\_Type <chr>, Data\_Value <dbl>, Data\_Value\_Footnote\_Symbol <chr>,  
# Data\_Value\_Footnote <chr>, Data\_Value\_Std\_Err <dbl>,  
# Low\_Confidence\_Limit <dbl>, High\_Confidence\_Limit <dbl>, Sample\_Size <dbl>,  
# Gender <chr>, Race <chr>, Age <chr>, Education <chr>, GeoLocation <chr>,  
# TopicTypeId <chr>, TopicId <chr>, MeasureId <chr>, …

## Summarize the data: dplyr summarize() function

summarize is a helpful function to use after group\_by(). It creates a summary table of a column you’re interested in.

yts %>%   
 summarize(mean\_value = mean(Data\_Value, na.rm = TRUE))

# A tibble: 1 × 1  
 mean\_value  
 <dbl>  
1 21.0

## Summarize the grouped data

It’s grouped! Grouping doesn’t change the data in any way, but how **functions operate on it**. Now we can summarize Data\_Value (percent of respondents) by group:

yts\_grouped %>%   
 summarize(mean\_value = mean(Data\_Value, na.rm = TRUE))

# A tibble: 4 × 2  
 Response mean\_value  
 <chr> <dbl>  
1 Current 9.68  
2 Ever 26.1   
3 Frequent 3.48  
4 <NA> 53.5

## Use the pipe to string these together!

Pipe yts into group\_by, then pipe that into summarize:

yts %>%  
 group\_by(Response) %>%  
 summarize(mean\_value = mean(Data\_Value, na.rm = TRUE),  
 max\_value = max(Data\_Value, na.rm = TRUE))

# A tibble: 4 × 3  
 Response mean\_value max\_value  
 <chr> <dbl> <dbl>  
1 Current 9.68 40.6  
2 Ever 26.1 98   
3 Frequent 3.48 23.9  
4 <NA> 53.5 81.9

## group\_by with mutate - Useful for comparisons

Use group\_by to calculate the mean value for each year. We can use mutate to add it as a column.

yts\_year <- yts %>%  
 group\_by(YEAR) %>%  
 mutate(year\_avg = mean(Data\_Value, na.rm = TRUE)) %>%  
 select(LocationDesc, Data\_Value, year\_avg)

## group\_by with mutate - Useful for comparisons

Create a “difference” variable:

yts\_year %>% mutate(Diff = Data\_Value - year\_avg)

# A tibble: 9,794 × 5  
# Groups: YEAR [17]  
 YEAR LocationDesc Data\_Value year\_avg Diff  
 <dbl> <chr> <dbl> <dbl> <dbl>  
 1 2015 Arizona NA 15.2 NA   
 2 2015 Arizona NA 15.2 NA   
 3 2015 Arizona NA 15.2 NA   
 4 2015 Arizona NA 15.2 NA   
 5 2015 Arizona NA 15.2 NA   
 6 2015 Arizona NA 15.2 NA   
 7 2015 Arizona 3.2 15.2 -12.0   
 8 2015 Arizona 3.2 15.2 -12.0   
 9 2015 Arizona 3.1 15.2 -12.1   
10 2015 Arizona 12.5 15.2 -2.66  
# ℹ 9,784 more rows

## Use n() for sample size by group

There are other functions, such as n() count the number of observations.

yts %>%  
 group\_by(YEAR) %>%  
 summarize(n = n(),  
 mean = mean(Data\_Value, na.rm = TRUE))

# A tibble: 17 × 3  
 YEAR n mean  
 <dbl> <int> <dbl>  
 1 1999 372 26.1  
 2 2000 1224 26.7  
 3 2001 426 23.4  
 4 2002 1016 25.2  
 5 2003 498 21.3  
 6 2004 611 20.7  
 7 2005 636 21.8  
 8 2006 518 21.8  
 9 2007 516 20.0  
10 2008 483 18.2  
11 2009 686 18.3  
12 2010 447 17.8  
13 2011 521 17.8  
14 2012 244 15.5  
15 2013 685 16.7  
16 2014 334 15.7  
17 2015 577 15.2

# Iterative summaries

## Iterative summaries: dplyr summarize() and across() functions

Use the [across](https://dplyr.tidyverse.org/reference/across.html) function with summarize() to summarize across multiple columns of your data.

yts %>%  
 group\_by(YEAR) %>%  
 summarize(across(   
 c(Data\_Value, Data\_Value\_Std\_Err, Sample\_Size),   
 ~ mean(.x, na.rm = TRUE)  
 ))

# A tibble: 17 × 4  
 YEAR Data\_Value Data\_Value\_Std\_Err Sample\_Size  
 <dbl> <dbl> <dbl> <dbl>  
 1 1999 26.1 1.98 1591.  
 2 2000 26.7 2.03 1743.  
 3 2001 23.4 1.79 2060.  
 4 2002 25.2 1.81 2653.  
 5 2003 21.3 1.92 2325.  
 6 2004 20.7 1.84 1246.  
 7 2005 21.8 2.17 1017.  
 8 2006 21.8 2.15 1191.  
 9 2007 20.0 1.96 1093.  
10 2008 18.2 1.73 1203.  
11 2009 18.3 1.90 1033.  
12 2010 17.8 1.71 1202.  
13 2011 17.8 1.84 1274.  
14 2012 15.5 1.58 1053.  
15 2013 16.7 1.75 1158.  
16 2014 15.7 1.61 1139.  
17 2015 15.2 1.61 1187.

## Select different columns based on the data class

select helpers (??tidyr\_tidy\_select) are great. We could also use:

* is.numeric
* is.character
* is.factor

to look for data.

## Iterative summaries: dplyr summarize() and across() functions

Select only numeric columns.

is.numeric(1)

[1] TRUE

yts %>%   
 summarize(across( where(is.numeric), ~ mean(.x, na.rm = TRUE)))

# A tibble: 1 × 7  
 YEAR Data\_Value Data\_Value\_Std\_Err Low\_Confidence\_Limit High\_Confidence\_Limit  
 <dbl> <dbl> <dbl> <dbl> <dbl>  
1 2006. 21.0 1.87 17.3 24.6  
# ℹ 2 more variables: Sample\_Size <dbl>, DisplayOrder <dbl>

## Changing the order of character data - factors

yts %>% count(Education)

# A tibble: 2 × 2  
 Education n  
 <chr> <int>  
1 High School 4588  
2 Middle School 5206

yts %>%  
 mutate(Education = factor(  
 Education,   
 levels = c("Middle School", "High School")  
 )) %>%   
 count(Education)

# A tibble: 2 × 2  
 Education n  
 <fct> <int>  
1 Middle School 5206  
2 High School 4588

## summary() Function

Using summary() can give you rough snapshots of each numeric column (character columns are skipped):

summary(yts)

YEAR LocationAbbr LocationDesc TopicType   
 Min. :1999 Length:9794 Length:9794 Length:9794   
 1st Qu.:2002 Class :character Class :character Class :character   
 Median :2006 Mode :character Mode :character Mode :character   
 Mean :2006   
 3rd Qu.:2010   
 Max. :2015   
   
 TopicDesc MeasureDesc DataSource Response   
 Length:9794 Length:9794 Length:9794 Length:9794   
 Class :character Class :character Class :character Class :character   
 Mode :character Mode :character Mode :character Mode :character   
   
   
   
   
 Data\_Value\_Unit Data\_Value\_Type Data\_Value   
 Length:9794 Length:9794 Min. : 0.00   
 Class :character Class :character 1st Qu.: 3.20   
 Mode :character Mode :character Median :11.30   
 Mean :20.97   
 3rd Qu.:39.10   
 Max. :98.00   
 NA's :425   
 Data\_Value\_Footnote\_Symbol Data\_Value\_Footnote Data\_Value\_Std\_Err  
 Length:9794 Length:9794 Min. : 0.000   
 Class :character Class :character 1st Qu.: 0.600   
 Mode :character Mode :character Median : 1.300   
 Mean : 1.874   
 3rd Qu.: 2.500   
 Max. :16.100   
 NA's :425   
 Low\_Confidence\_Limit High\_Confidence\_Limit Sample\_Size Gender   
 Min. : 0.00 Min. : 0.00 Min. : 50 Length:9794   
 1st Qu.: 1.90 1st Qu.: 4.60 1st Qu.: 668 Class :character   
 Median : 8.50 Median :14.10 Median : 994 Mode :character   
 Mean :17.31 Mean :24.64 Mean : 1505   
 3rd Qu.:31.60 3rd Qu.:45.60 3rd Qu.: 1648   
 Max. :97.60 Max. :98.40 Max. :36910   
 NA's :425 NA's :425 NA's :425   
 Race Age Education GeoLocation   
 Length:9794 Length:9794 Length:9794 Length:9794   
 Class :character Class :character Class :character Class :character   
 Mode :character Mode :character Mode :character Mode :character   
   
   
   
   
 TopicTypeId TopicId MeasureId StratificationID1   
 Length:9794 Length:9794 Length:9794 Length:9794   
 Class :character Class :character Class :character Class :character   
 Mode :character Mode :character Mode :character Mode :character   
   
   
   
   
 StratificationID2 StratificationID3 StratificationID4 SubMeasureID   
 Length:9794 Length:9794 Length:9794 Length:9794   
 Class :character Class :character Class :character Class :character   
 Mode :character Mode :character Mode :character Mode :character   
   
   
   
   
 DisplayOrder   
 Min. : 1.000   
 1st Qu.: 7.000   
 Median : 9.000   
 Mean : 8.094   
 3rd Qu.:11.000   
 Max. :12.000

## Summary

* summary stats (mean()) work with pull()
* count(x): what unique values do you have?
* group\_by(): changes all subsequent functions
  + combine with summarize() to get statistics per group
  + combine with across() to programmatically select columns
* summary(x): quantile information

<https://sisbid.github.io/Data-Wrangling/labs/data-summarization-lab.Rmd>

## Data Cleaning

In general, data cleaning is a process of investigating your data for inaccuracies, or recoding it in a way that makes it more manageable.

MOST IMPORTANT RULE - LOOK AT YOUR DATA!

## Read in the UFO dataset

Read in data or download from: <http://sisbid.github.io/Data-Wrangling/data/ufo/ufo_data_complete.csv.gz>

ufo <- read\_delim(  
 "https://sisbid.github.io/Data-Wrangling/data/ufo/ufo\_data\_complete.csv",   
 delim = ",")

Warning: One or more parsing issues, call `problems()` on your data frame for details,  
e.g.:  
 dat <- vroom(...)  
 problems(dat)

## The “problems”

You saw warning messages when reading in this dataset. We can see these with the problems() function from readr.

If we scroll through we can see some interesting notes.

p <-problems(ufo)  
p %>% glimpse()

Rows: 200  
Columns: 5  
$ row <int> 878, 1713, 1815, 2858, 3734, 4756, 5389, 5423, 5614, 5849, 60…  
$ col <int> 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 1…  
$ expected <chr> "11 columns", "11 columns", "11 columns", "11 columns", "11 c…  
$ actual <chr> "12 columns", "12 columns", "12 columns", "12 columns", "12 c…  
$ file <chr> "", "", "", "", "", "", "", "", "", "", "", "", "", "", "", "…

## Any unique problems?

count(p, expected, actual, col)

# A tibble: 5 × 4  
 expected actual col n  
 <chr> <chr> <int> <int>  
1 11 columns "12 columns" 12 196  
2 a double "0.5`" 6 1  
3 a double "2631600 " 6 1  
4 a double "2`" 6 1  
5 a double "8`" 6 1

## The “problems”

colnames(ufo)

[1] "datetime" "city" "state"   
 [4] "country" "shape" "duration (seconds)"   
 [7] "duration (hours/min)" "comments" "date posted"   
[10] "latitude" "longitude"

glimpse(ufo)

Rows: 88,875  
Columns: 11  
$ datetime <chr> "10/10/1949 20:30", "10/10/1949 21:00", "10/10/…  
$ city <chr> "san marcos", "lackland afb", "chester (uk/engl…  
$ state <chr> "tx", "tx", NA, "tx", "hi", "tn", NA, "ct", "al…  
$ country <chr> "us", NA, "gb", "us", "us", "us", "gb", "us", "…  
$ shape <chr> "cylinder", "light", "circle", "circle", "light…  
$ `duration (seconds)` <dbl> 2700, 7200, 20, 20, 900, 300, 180, 1200, 180, 1…  
$ `duration (hours/min)` <chr> "45 minutes", "1-2 hrs", "20 seconds", "1/2 hou…  
$ comments <chr> "This event took place in early fall around 194…  
$ `date posted` <chr> "4/27/2004", "12/16/2005", "1/21/2008", "1/17/2…  
$ latitude <chr> "29.8830556", "29.38421", "53.2", "28.9783333",…  
$ longitude <chr> "-97.9411111", "-98.581082", "-2.916667", "-96.…

## Taking a deeper look

The slice function can show us particular row numbers

p %>% filter(col != 12)

# A tibble: 4 × 5  
 row col expected actual file   
 <int> <int> <chr> <chr> <chr>  
1 30894 6 a double "2`" ""   
2 39616 6 a double "8`" ""   
3 45691 6 a double "2631600 " ""   
4 65125 6 a double "0.5`" ""

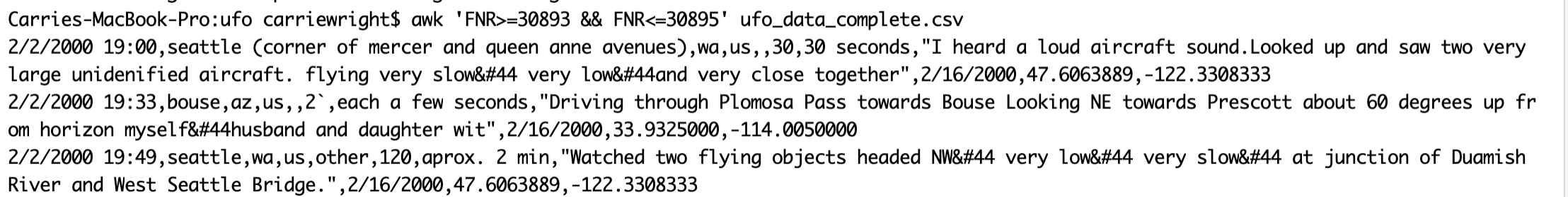
## Taking a deeper look

The slice function can show us particular row numbers

slice(ufo, 30894 -1) %>% glimpse()

Rows: 1  
Columns: 11  
$ datetime <chr> "2/2/2000 19:33"  
$ city <chr> "bouse"  
$ state <chr> "az"  
$ country <chr> "us"  
$ shape <chr> NA  
$ `duration (seconds)` <dbl> NA  
$ `duration (hours/min)` <chr> "each a few seconds"  
$ comments <chr> "Driving through Plomosa Pass towards Bouse Loo…  
$ `date posted` <chr> "2/16/2000"  
$ latitude <chr> "33.9325000"  
$ longitude <chr> "-114.0050000"

knitr::include\_graphics(here::here("images", "raw\_ufo\_col6.png"))



## Reading in again

Now we have a chance to keep but clean these values! We will read in duration (seconds) now as a character type. Use ?read\_csv to see documentation about special ways of reading in data.

url <-   
 "https://sisbid.github.io/Data-Wrangling/data/ufo/ufo\_data\_complete.csv"  
ufo <-read\_csv(url, col\_types = cols(`duration (seconds)` = "c"))

Warning: One or more parsing issues, call `problems()` on your data frame for details,  
e.g.:  
 dat <- vroom(...)  
 problems(dat)

## Look at the problems again

Looks like an extra column for these rows.

p <- problems(ufo)  
count(p, expected, actual, col)

# A tibble: 1 × 4  
 expected actual col n  
 <chr> <chr> <int> <int>  
1 11 columns 12 columns 12 196

Our previous problematic rows have values instead of NAs

slice(ufo, 30894 -1) %>% glimpse()

Rows: 1  
Columns: 11  
$ datetime <chr> "2/2/2000 19:33"  
$ city <chr> "bouse"  
$ state <chr> "az"  
$ country <chr> "us"  
$ shape <chr> NA  
$ `duration (seconds)` <chr> "2`"  
$ `duration (hours/min)` <chr> "each a few seconds"  
$ comments <chr> "Driving through Plomosa Pass towards Bouse Loo…  
$ `date posted` <chr> "2/16/2000"  
$ latitude <chr> "33.9325000"  
$ longitude <chr> "-114.0050000"

## Drop the remaining shifted problematic rows for now

Multiply by negative one to drop the rows. Use the slice function to “select” those rows based on the index. Need to offset for -1 because problems() gives us the index row based on the raw data, not the read in data (which has a header). We will multiple by negative one to select out those rows as well.

head(p, n = 2)

# A tibble: 2 × 5  
 row col expected actual file   
 <int> <int> <chr> <chr> <chr>  
1 878 12 11 columns 12 columns ""   
2 1713 12 11 columns 12 columns ""

(pull(p, row) -1) %>% head()

[1] 877 1712 1814 2857 3733 4755

((pull(p, row) -1) \*-1) %>% head()

[1] -877 -1712 -1814 -2857 -3733 -4755

ufo\_clean <- ufo %>% slice((pull(p, row)-1)\*-1)

## Checking

nrow(ufo) - nrow(ufo\_clean)

[1] 196

count(p, expected, actual)

# A tibble: 1 × 3  
 expected actual n  
 <chr> <chr> <int>  
1 11 columns 12 columns 196

## Clean names with the clean\_names() function from the janitor package

colnames(ufo\_clean)

[1] "datetime" "city" "state"   
 [4] "country" "shape" "duration (seconds)"   
 [7] "duration (hours/min)" "comments" "date posted"   
[10] "latitude" "longitude"

ufo\_clean <- clean\_names(ufo\_clean)  
colnames(ufo\_clean)

[1] "datetime" "city" "state"   
 [4] "country" "shape" "duration\_seconds"   
 [7] "duration\_hours\_min" "comments" "date\_posted"   
[10] "latitude" "longitude"

# Recoding Variables

## Exact Swaps - recode function

within mutate...  
recode(variable, value\_old = value\_new,  
 other\_value\_old = other\_value\_new)

ufo\_clean %>%   
 mutate(country =   
 recode(country, gb = "Great Britain")) %>%   
 glimpse()

Rows: 88,679  
Columns: 11  
$ datetime <chr> "10/10/1949 20:30", "10/10/1949 21:00", "10/10/1955…  
$ city <chr> "san marcos", "lackland afb", "chester (uk/england)…  
$ state <chr> "tx", "tx", NA, "tx", "hi", "tn", NA, "ct", "al", "…  
$ country <chr> "us", NA, "Great Britain", "us", "us", "us", "Great…  
$ shape <chr> "cylinder", "light", "circle", "circle", "light", "…  
$ duration\_seconds <chr> "2700", "7200", "20", "20", "900", "300", "180", "1…  
$ duration\_hours\_min <chr> "45 minutes", "1-2 hrs", "20 seconds", "1/2 hour", …  
$ comments <chr> "This event took place in early fall around 1949-50…  
$ date\_posted <chr> "4/27/2004", "12/16/2005", "1/21/2008", "1/17/2004"…  
$ latitude <chr> "29.8830556", "29.38421", "53.2", "28.9783333", "21…  
$ longitude <chr> "-97.9411111", "-98.581082", "-2.916667", "-96.6458…

## Exact Swaps - recode function

ufo\_clean %>% mutate(country =   
 recode(country,   
 gb = "Great Britain",  
 us = "United States")) %>%   
 glimpse()

Rows: 88,679  
Columns: 11  
$ datetime <chr> "10/10/1949 20:30", "10/10/1949 21:00", "10/10/1955…  
$ city <chr> "san marcos", "lackland afb", "chester (uk/england)…  
$ state <chr> "tx", "tx", NA, "tx", "hi", "tn", NA, "ct", "al", "…  
$ country <chr> "United States", NA, "Great Britain", "United State…  
$ shape <chr> "cylinder", "light", "circle", "circle", "light", "…  
$ duration\_seconds <chr> "2700", "7200", "20", "20", "900", "300", "180", "1…  
$ duration\_hours\_min <chr> "45 minutes", "1-2 hrs", "20 seconds", "1/2 hour", …  
$ comments <chr> "This event took place in early fall around 1949-50…  
$ date\_posted <chr> "4/27/2004", "12/16/2005", "1/21/2008", "1/17/2004"…  
$ latitude <chr> "29.8830556", "29.38421", "53.2", "28.9783333", "21…  
$ longitude <chr> "-97.9411111", "-98.581082", "-2.916667", "-96.6458…

## How many countries?

ufo\_clean %>% count(country)

# A tibble: 6 × 2  
 country n  
 <chr> <int>  
1 au 593  
2 ca 3266  
3 de 112  
4 gb 2050  
5 us 70293  
6 <NA> 12365

## case\_when() regions to create a new variable based on conditions of other variables

case\_when(test ~ value if test is true,  
 test2 ~ vlue if test2 is true,  
 TRUE ~ value if all above tests are not true) # defaults to NA

ufo\_clean <- ufo\_clean %>% mutate(   
 region = case\_when(  
 country %in% c("us", "ca") ~ "North America",  
 country %in% c("de") ~ "Europe",  
 country %in% "gb" ~ "Great Britain",  
 TRUE ~ "Other"  
 ))  
ufo\_clean %>% select(country, region) %>% head()

# A tibble: 6 × 2  
 country region   
 <chr> <chr>   
1 us North America  
2 <NA> Other   
3 gb Great Britain  
4 us North America  
5 us North America  
6 us North America

## case\_when - another example

The TRUE value can also just be the original values.

ufo\_clean %>% mutate(country = case\_when(  
 country == "gb" ~ "Great Britain",  
 country == "us" ~"United States",  
 country == "au" ~ "Australia",  
 country == "DE" ~ "Germany",  
 TRUE ~ country))%>%  
 glimpse()

Rows: 88,679  
Columns: 12  
$ datetime <chr> "10/10/1949 20:30", "10/10/1949 21:00", "10/10/1955…  
$ city <chr> "san marcos", "lackland afb", "chester (uk/england)…  
$ state <chr> "tx", "tx", NA, "tx", "hi", "tn", NA, "ct", "al", "…  
$ country <chr> "United States", NA, "Great Britain", "United State…  
$ shape <chr> "cylinder", "light", "circle", "circle", "light", "…  
$ duration\_seconds <chr> "2700", "7200", "20", "20", "900", "300", "180", "1…  
$ duration\_hours\_min <chr> "45 minutes", "1-2 hrs", "20 seconds", "1/2 hour", …  
$ comments <chr> "This event took place in early fall around 1949-50…  
$ date\_posted <chr> "4/27/2004", "12/16/2005", "1/21/2008", "1/17/2004"…  
$ latitude <chr> "29.8830556", "29.38421", "53.2", "28.9783333", "21…  
$ longitude <chr> "-97.9411111", "-98.581082", "-2.916667", "-96.6458…  
$ region <chr> "North America", "Other", "Great Britain", "North A…

## Summary

* recode makes exact swaps
* case\_when can use conditionals, need to specify what value for if no conditions are met (can be the original value of a variable if we use the variable name).

## Lab

<https://sisbid.github.io/Data-Wrangling/labs/data-cleaning-lab.Rmd>

## Extra slides

## Strange country values

Sometimes country is NA even though state is known. A conditional more flexible recoding would be helpful…

head(ufo\_clean)

# A tibble: 6 × 12  
 datetime city state country shape duration\_seconds duration\_hours\_min  
 <chr> <chr> <chr> <chr> <chr> <chr> <chr>   
1 10/10/1949 20:30 san … tx us cyli… 2700 45 minutes   
2 10/10/1949 21:00 lack… tx <NA> light 7200 1-2 hrs   
3 10/10/1955 17:00 ches… <NA> gb circ… 20 20 seconds   
4 10/10/1956 21:00 edna tx us circ… 20 1/2 hour   
5 10/10/1960 20:00 kane… hi us light 900 15 minutes   
6 10/10/1961 19:00 bris… tn us sphe… 300 5 minutes   
# ℹ 5 more variables: comments <chr>, date\_posted <chr>, latitude <chr>,  
# longitude <chr>, region <chr>

## Deeper look

Looking at city… it seems like many of these are in fact in the US.

ufo\_clean %>% filter(state == "tx") %>% count(country, state)

# A tibble: 2 × 3  
 country state n  
 <chr> <chr> <int>  
1 us tx 3742  
2 <NA> tx 299

ufo\_clean %>% filter(state == "tx" & is.na(country)) %>% select(city)

# A tibble: 299 × 1  
 city   
 <chr>   
 1 lackland afb   
 2 mercedies   
 3 texas city/galveston   
 4 houston/tomball   
 5 bettendorf   
 6 dallas/ft. worth (mansfield)  
 7 halletsville   
 8 gulf of mexico   
 9 haltom   
10 aubrey/frisco   
# ℹ 289 more rows

## Checkin Utah as well

ufo\_clean %>% filter(state == "ut") %>% count(country, state)

# A tibble: 2 × 3  
 country state n  
 <chr> <chr> <int>  
1 us ut 659  
2 <NA> ut 138

ufo\_clean %>% filter(state == "ut" & is.na(country)) %>% select(city)

# A tibble: 138 × 1  
 city   
 <chr>   
 1 canyonlands np   
 2 ogden/clinton   
 3 sandy   
 4 salt lake valley  
 5 sandy   
 6 duchenne   
 7 west valley   
 8 salt flats   
 9 west valley   
10 west valley   
# ℹ 128 more rows

## Get US States

ufo\_clean %>% filter(country == "us") %>%  
 count(state) %>%  
 pull(state)

[1] "ak" "al" "ar" "az" "ca" "co" "ct" "dc" "de" "fl" "ga" "hi" "ia" "id" "il"  
[16] "in" "ks" "ky" "la" "ma" "md" "me" "mi" "mn" "mo" "ms" "mt" "nc" "nd" "ne"  
[31] "nh" "nj" "nm" "nv" "ny" "oh" "ok" "or" "pa" "pr" "ri" "sc" "sd" "tn" "tx"  
[46] "ut" "va" "vt" "wa" "wi" "wv" "wy"

US\_states <- ufo\_clean %>%  
 filter(country == "us") %>%  
 count(state) %>%  
 pull(state)

## Get Canada States

ufo\_clean %>% filter(country == "ca") %>%  
 count(state) %>%  
 pull(state)

[1] "ab" "bc" "mb" "nb" "nf" "ns" "nt" "on" "pe" "pq" "qc" "sa" "sk" "yk" "yt"  
[16] NA

CA\_states <- ufo\_clean %>%  
 filter(country == "ca") %>%  
 count(state) %>%  
 pull(state)

## Get Great Britan states

ufo\_clean %>% filter(country == "gb") %>%  
 count(state) %>%  
 pull(state)

[1] "bc" "la" "ms" "nc" "ns" "nt" "ri" "sk" "tn" "wv" "yt" NA

GB\_states <- ufo\_clean %>%  
 filter(country == "gb") %>%  
 count(state) %>%  
 pull(state)

A small overlap with US states.

## Get DE states

ufo\_clean %>% filter(country == "de") %>%  
 count(state) %>%  
 pull(state)

[1] NA

## Get AU states

ufo\_clean %>% filter(country == "au") %>%  
 count(state) %>%  
 pull(state)

[1] "al" "dc" "nt" "oh" "sa" "wa" "yt" NA

AU\_states <- ufo\_clean %>%  
 filter(country == "au") %>%  
 count(state) %>%  
 pull(state)

Some overlap with US states.

## Get just unique

The setdiff() function can show us what is unique or different for the first of 2 listed sets.

numbers <-c(1,2,3)  
letters <-c("a", "b", 3)  
  
setdiff(numbers, letters)

[1] 1 2

setdiff(letters, numbers)

[1] "a" "b"

## Get just unique

US\_states

[1] "ak" "al" "ar" "az" "ca" "co" "ct" "dc" "de" "fl" "ga" "hi" "ia" "id" "il"  
[16] "in" "ks" "ky" "la" "ma" "md" "me" "mi" "mn" "mo" "ms" "mt" "nc" "nd" "ne"  
[31] "nh" "nj" "nm" "nv" "ny" "oh" "ok" "or" "pa" "pr" "ri" "sc" "sd" "tn" "tx"  
[46] "ut" "va" "vt" "wa" "wi" "wv" "wy"

c(AU\_states, GB\_states, CA\_states)

[1] "al" "dc" "nt" "oh" "sa" "wa" "yt" NA "bc" "la" "ms" "nc" "ns" "nt" "ri"  
[16] "sk" "tn" "wv" "yt" NA "ab" "bc" "mb" "nb" "nf" "ns" "nt" "on" "pe" "pq"  
[31] "qc" "sa" "sk" "yk" "yt" NA

US\_states <- setdiff(US\_states, c(AU\_states, GB\_states, CA\_states))  
US\_states

[1] "ak" "ar" "az" "ca" "co" "ct" "de" "fl" "ga" "hi" "ia" "id" "il" "in" "ks"  
[16] "ky" "ma" "md" "me" "mi" "mn" "mo" "mt" "nd" "ne" "nh" "nj" "nm" "nv" "ny"  
[31] "ok" "or" "pa" "pr" "sc" "sd" "tx" "ut" "va" "vt" "wi" "wy"

## Continued

AU\_states <- setdiff(AU\_states, c(US\_states, GB\_states, CA\_states))  
  
CA\_states <- setdiff(CA\_states, c(US\_states, GB\_states, AU\_states))  
  
GB\_states <- setdiff(GB\_states, c(US\_states, AU\_states, CA\_states))

## How often do rows have a value for country but not a value of “us”?

ufo\_clean %>%  
 filter(country != "us" & !is.na(country)) %>%  
 count(country)

# A tibble: 4 × 2  
 country n  
 <chr> <int>  
1 au 593  
2 ca 3266  
3 de 112  
4 gb 2050

## more complicated case\_when

Let’s make an assumption that if the state value is within the data as a state for a specific country, than it comes from that country for the sake of illustration.

ufo\_clean <- ufo\_clean %>% mutate(prob\_country =  
 case\_when((is.na(country) & state %in% c(US\_states)) ~ "United States",  
 (is.na(country) & state %in% c(CA\_states)) ~ "Canada",  
 (is.na(country) & state %in% c(AU\_states)) ~ "Australia",  
 (is.na(country) & state %in% c(GB\_states)) ~ "Great Britain",  
 TRUE ~ country))

## results

count(ufo\_clean, prob\_country)

# A tibble: 10 × 2  
 prob\_country n  
 <chr> <int>  
 1 Australia 694  
 2 Canada 536  
 3 Great Britain 5296  
 4 United States 5838  
 5 au 593  
 6 ca 3266  
 7 de 112  
 8 gb 2050  
 9 us 70293  
10 <NA> 1

## results

Take a look at those NAs.

ufo\_clean %>% filter(is.na(prob\_country))

# A tibble: 1 × 13  
 datetime city state country shape duration\_seconds duration\_hours\_min  
 <chr> <chr> <chr> <chr> <chr> <chr> <chr>   
1 10/25/1997 22:00 st. … vi <NA> light 8 5-8 secds   
# ℹ 6 more variables: comments <chr>, date\_posted <chr>, latitude <chr>,  
# longitude <chr>, region <chr>, prob\_country <chr>

## We could confirm with city info and latitude and longitude

ufo\_clean %>% filter(country == "de") %>%  
 pull(city)

[1] "berlin (germany)"   
 [2] "berlin (germany)"   
 [3] "obernheim (germany)"   
 [4] "ottersberg (germany)"   
 [5] "urbach (germany)"   
 [6] "bremen (30 km south of) (germany)"   
 [7] "sembach (germany)"   
 [8] "magdeburg (germany)"   
 [9] "neuruppin (germany)"   
 [10] "lampertheim (germany)"   
 [11] "ramstein (germany)"   
 [12] "bremen (germany)"   
 [13] "nurenburg (germany)"   
 [14] "senftenberg (germany)"   
 [15] "schwalmtal (germany)"   
 [16] "neuss (germany)"   
 [17] "babenhausen (germany)"   
 [18] "berlin (germany)"   
 [19] "mittenwald (germany)"   
 [20] "ransbach-baumbach (germany)"   
 [21] "ansbach (germany)"   
 [22] "miesau (germany)"   
 [23] "bensheim (germany)"   
 [24] "muenster (germany)"   
 [25] "chemnitz (germany)"   
 [26] "kirchzell (germany)"   
 [27] "bremen (germany)"   
 [28] "wildflecken (germany)"   
 [29] "munich (germany)"   
 [30] "baumholder (germany)"   
 [31] "zirndorf (west germany)"   
 [32] "hamburg (germany)"   
 [33] "langenleiten (germany)"   
 [34] "baumholder (germany)"   
 [35] "zehdenick (germany)"   
 [36] "hanau (germany)"   
 [37] "berlin (germany)"   
 [38] "aachen (near cologne) (germany)"   
 [39] "munich (oberschliessheim army airfield) (germany)"  
 [40] "munich (near) (germany)"   
 [41] "bremen (germany)"   
 [42] "berlin (germany)"   
 [43] "bad pyrmont (germany)"   
 [44] "freiburg (germany)"   
 [45] "frankfurt am main (germany)"   
 [46] "siegen (germany)"   
 [47] "erlangen (germany)"   
 [48] "koblenz (westerwald mountains near) (germany)"   
 [49] "osnabruck (germany)"   
 [50] "kelsterbach (germany)"   
 [51] "trier (germany)"   
 [52] "thulba (germany)"   
 [53] "elbingen (germany)"   
 [54] "bocholt (germany)"   
 [55] "emmelshausen (germany)"   
 [56] "darmstadt (germany)"   
 [57] "stuttgart (germany)"   
 [58] "berlin (germany)"   
 [59] "ansbach (germany)"   
 [60] "frankfurt (germany)"   
 [61] "dresden (germany)"   
 [62] "mainz (germany)"   
 [63] "werder (havel) (germany)"   
 [64] "schweinfurt (west germany)"   
 [65] "emlichheim (germany)"   
 [66] "staufen (germany)"   
 [67] "neuseddin (potsdam)(germany)"   
 [68] "mannheim (west germany)"   
 [69] "schafhausen (germany)"   
 [70] "berlin (germany)"   
 [71] "erfurt (thuringia&#44 germany)"   
 [72] "munich (germany)"   
 [73] "waldorf (west germany)"   
 [74] "bamberg (germany/bavaria)"   
 [75] "fulda (near) (germany)"   
 [76] "hamburg (germany)"   
 [77] "ansbach (germany)"   
 [78] "dresden (germany)"   
 [79] "bierenbachtal (germany)"   
 [80] "kassel (germany) (on highway)"   
 [81] "bamberg (germany)"   
 [82] "maugenhard (germany)"   
 [83] "aschersleben (germany)"   
 [84] "regensburg (germany)"   
 [85] "berlin (germany)"   
 [86] "berlin (germany)"   
 [87] "ramstein (germany)"   
 [88] "bochum (germany)"   
 [89] "mainz (germany)"   
 [90] "berlin (germany)"   
 [91] "neumarkt (germany)"   
 [92] "munich (germany)"   
 [93] "biesenthal (germany)"   
 [94] "haus (germany)"   
 [95] "freiburg (germany)"   
 [96] "obernheim (germany)"   
 [97] "weissenburg (germany)"   
 [98] "bitburg (germany)"   
 [99] "berlin (germany)"   
[100] "heidelberg (germany)"   
[101] "hannover (germany)"   
[102] "schwetzingen (germany)"   
[103] "buchholz (germany)"   
[104] "cologne (germany)"   
[105] "weiden (ne bavaria) (germany)"   
[106] "grafenhausen (germany)"   
[107] "heilbronn (germany)"   
[108] "gelsenkirchen (germany)"   
[109] "neckarsulm (germany)"   
[110] "kelsterbach (germany)"   
[111] "mannheim (germany)"   
[112] "kaiserlautern (germany)"

## Even more specific

ufo\_clean <- ufo\_clean %>% mutate(prob\_country =  
 case\_when(  
 (is.na(country) & state %in% c(US\_states)) |  
 country == "us" ~ "United States",  
 (is.na(country) & state %in% c(CA\_states)) |  
 country == "ca" ~ "Canada",  
 (is.na(country) & state %in% c(AU\_states)) |  
 country == "au" ~ "Australia",  
 (is.na(country) & state %in% c(GB\_states)) |  
 country == "gb" ~ "Great Britain",  
 country == "de" ~ "Germany",  
 TRUE ~ country))

We would want to confirm what we recoded with the cities and latitude and longitude, especially to deal with the overlaps in the state lists.

## Check counts

ufo\_clean %>%  
 count(country, prob\_country)

# A tibble: 10 × 3  
 country prob\_country n  
 <chr> <chr> <int>  
 1 au Australia 593  
 2 ca Canada 3266  
 3 de Germany 112  
 4 gb Great Britain 2050  
 5 us United States 70293  
 6 <NA> Australia 694  
 7 <NA> Canada 536  
 8 <NA> Great Britain 5296  
 9 <NA> United States 5838  
10 <NA> <NA> 1

# Data Cleaning Part 2

## Example of Cleaning: more complicated

For example, let’s say we have a variable about treatment or control conditions coded as treatment, T, treat, Treat, C, Cont, cont, cOnt, Control, and control. Using Excel to find all of these would be a matter of filtering and changing all by hand or using if statements.

Sometimes though, it’s not so simple. That’s where functions that find patterns come to be very useful.

## Take a look at the data

count(data\_gen, status)

# A tibble: 11 × 2  
 status n  
 <chr> <int>  
 1 C 81  
 2 Cont 90  
 3 Control 91  
 4 T 91  
 5 Traet 105  
 6 Treat 100  
 7 cOnt 79  
 8 cont 83  
 9 control 98  
10 treat 86  
11 treatment 96

## Example of Cleaning: more complicated

In R, you could use case\_when():

#case\_when way:  
data\_gen <-data\_gen %>% mutate(status =   
 case\_when(status   
 %in% c("C", "cont", "cOnt", "Cont", "control", "Control")  
 ~ "Control",  
 TRUE ~ status))   
count(data\_gen, status)

# A tibble: 6 × 2  
 status n  
 <chr> <int>  
1 Control 522  
2 T 91  
3 Traet 105  
4 Treat 100  
5 treat 86  
6 treatment 96

Oh dear! This only fixes some values! It is difficult to notice values like "Traet".

# String functions

## The stringr package

Like dplyr, the stringr package:

* Makes some things more intuitive
* Is different than base R
* Is used on forums for answers
* Has a standard format for most functions: str\_
  + the first argument is a string like first argument is a data.frame in dplyr

## Useful String Functions

Useful String functions from base R and stringr

* toupper(), tolower() - uppercase or lowercase your data
* str\_sentence() - uppercase just the first character (in the stringr package)
* paste() - paste strings together with a space
* paste0 - paste strings together with no space as default
* str\_trim() (in the stringr package) or trimws in base
  + will trim whitespace
* nchar - get the number of characters in a string

## recoding with str\_to\_sentence()

#case\_when way:  
data\_gen <-data\_gen %>%  
 mutate(status = str\_to\_sentence(status))  
count(data\_gen, status)

# A tibble: 5 × 2  
 status n  
 <chr> <int>  
1 Control 522  
2 T 91  
3 Traet 105  
4 Treat 186  
5 Treatment 96

## recoding with str\_to\_sentence()

#case\_when way:  
data\_gen <-data\_gen %>%  
 mutate(status = str\_to\_sentence(status)) %>%  
 mutate(status =   
 case\_when(status %in%   
 c("Treatment", "T", "Treat", "Traet", "Treat")  
 ~ "Treatment",  
 TRUE ~ status))   
count(data\_gen, status)

# A tibble: 2 × 2  
 status n  
 <chr> <int>  
1 Control 522  
2 Treatment 478

OK, now we are getting somewhere!

## Reading in again

Now we have a chance to keep but clean these values!

ufo <-read\_csv(  
 "https://sisbid.github.io/Data-Wrangling/data/ufo/ufo\_data\_complete.csv",   
 col\_types = cols(`duration (seconds)` = "c"))

Warning: One or more parsing issues, call `problems()` on your data frame for details,  
e.g.:  
 dat <- vroom(...)  
 problems(dat)

## Clean names with the clean\_names() function from the janitor package

colnames(ufo)

[1] "datetime" "city" "state"   
 [4] "country" "shape" "duration (seconds)"   
 [7] "duration (hours/min)" "comments" "date posted"   
[10] "latitude" "longitude"

ufo\_clean <- clean\_names(ufo)  
colnames(ufo\_clean)

[1] "datetime" "city" "state"   
 [4] "country" "shape" "duration\_seconds"   
 [7] "duration\_hours\_min" "comments" "date\_posted"   
[10] "latitude" "longitude"

## str\_detect and filter

Now let’s fix our ufo data and remove those pesky backticks in the duration\_seconds variable. First let’s find them with str\_detect.

ufo\_clean %>%   
 filter(str\_detect(   
 string = duration\_seconds,   
 pattern = "`"))

# A tibble: 3 × 11  
 datetime city state country shape duration\_seconds duration\_hours\_min  
 <chr> <chr> <chr> <chr> <chr> <chr> <chr>   
1 2/2/2000 19:33 bouse az us <NA> 2` each a few seconds  
2 4/10/2005 22:52 santa… ca us <NA> 8` eight seconds   
3 7/21/2006 13:00 ibagu… <NA> <NA> circ… 0.5` 1/2 segundo   
# ℹ 4 more variables: comments <chr>, date\_posted <chr>, latitude <chr>,  
# longitude <chr>

## str\_remove

ufo\_clean <- ufo\_clean %>%   
 mutate(duration\_seconds =   
 str\_remove(string = duration\_seconds,  
 pattern = "`"))

## Lets also mutate to be as.numeric again

ufo\_clean <- ufo\_clean %>%   
 mutate(duration\_seconds = as.numeric(duration\_seconds))  
  
glimpse(ufo\_clean)

Rows: 88,875  
Columns: 11  
$ datetime <chr> "10/10/1949 20:30", "10/10/1949 21:00", "10/10/1955…  
$ city <chr> "san marcos", "lackland afb", "chester (uk/england)…  
$ state <chr> "tx", "tx", NA, "tx", "hi", "tn", NA, "ct", "al", "…  
$ country <chr> "us", NA, "gb", "us", "us", "us", "gb", "us", "us",…  
$ shape <chr> "cylinder", "light", "circle", "circle", "light", "…  
$ duration\_seconds <dbl> 2700, 7200, 20, 20, 900, 300, 180, 1200, 180, 120, …  
$ duration\_hours\_min <chr> "45 minutes", "1-2 hrs", "20 seconds", "1/2 hour", …  
$ comments <chr> "This event took place in early fall around 1949-50…  
$ date\_posted <chr> "4/27/2004", "12/16/2005", "1/21/2008", "1/17/2004"…  
$ latitude <chr> "29.8830556", "29.38421", "53.2", "28.9783333", "21…  
$ longitude <chr> "-97.9411111", "-98.581082", "-2.916667", "-96.6458…

## Substringing

stringr

* str\_sub(x, start, end) - substrings from position start to position end

## Substringing

Examples:

str\_sub("I like friesian horses", 8,12)

[1] "fries"

#123456789101112  
#I like fries  
str\_sub(c("Site A", "Site B", "Site C"), 6,6)

[1] "A" "B" "C"

## Splitting/Find/Replace and Regular Expressions

* R can do much more than find exact matches for a whole string
* Like Perl and other languages, it can use regular expressions.
* What are regular expressions?
  + Ways to search for specific strings
  + Can be very complicated or simple
  + Highly Useful - think “Find” on steroids

## A bit on Regular Expressions

* <http://www.regular-expressions.info/reference.html>
* They can use to match a large number of strings in one statement
* . matches any single character
* \* means repeat as many (even if 0) more times the last character
* ? makes a pattern optional (i.e. it matches 0 or 1 times)
* ^ matches start of vector ^a - starts with “a”
* $ matches end of vector b$ - ends with “b”

## ‘Find’ functions: stringr

str\_detect, str\_subset, str\_replace, and str\_replace\_all search for matches to argument pattern within each element of a character vector: they differ in the format of and amount of detail in the results.

* str\_detect - returns TRUE if pattern is found
* str\_subset - returns only the strings where the pattern were detected
* str\_extract - returns only the pattern that was detected
* str\_replace - replaces pattern with replacement the first time
* str\_replace\_all - replaces pattern with replacement as many times matched

## ‘Find’ functions: Finding Indices

These are the indices where the pattern match occurs:

ufo\_clean %>%   
 filter(str\_detect(comments, "two aliens")) %>%   
 head()

# A tibble: 2 × 11  
 datetime city state country shape duration\_seconds duration\_hours\_min  
 <chr> <chr> <chr> <chr> <chr> <dbl> <chr>   
1 10/14/2006 02:00 yuma va us form… 300 5 minutes   
2 7/1/2007 23:00 nort… ct <NA> unkn… 60 1 minute   
# ℹ 4 more variables: comments <chr>, date\_posted <chr>, latitude <chr>,  
# longitude <chr>

## To Take a look at comments… need to select it first

ufo\_clean %>%  
 filter(str\_detect(comments, "two aliens")) %>%   
 select(comments)

# A tibble: 2 × 1  
 comments   
 <chr>   
1 ((HOAX??)) two aliens appeared from a bright light to peacefully investigate…  
2 Witnessed two aliens walking along baseball field fence.

## ‘Find’ functions: str\_subset() is easier

str\_subset() gives the values that match the pattern:

ufo\_clean %>% pull(comments) %>%  
 str\_subset( "two aliens")

[1] "((HOAX??)) two aliens appeared from a bright light to peacefully investigate the surroundings in the woods"  
[2] "Witnessed two aliens walking along baseball field fence."

## Showing difference in str\_extract

str\_extract extracts just the matched string

ufo\_clean %>%   
 mutate(aliens = str\_extract(comments, "two aliens")) %>%  
 count(aliens)

# A tibble: 2 × 2  
 aliens n  
 <chr> <int>  
1 two aliens 2  
2 <NA> 88873

* Look for any comment that starts with “aliens”

ufo\_clean %>% pull(comments) %>%str\_subset( "^aliens")

[1] "aliens speak german???" "aliens exist" "aliens in srilanka"

## Using Regular Expressions

That contains space then ship maybe with stuff in between

ufo\_clean %>% pull(comments) %>%  
 str\_subset("space.?ship") %>% head(4) # gets "spaceship" or "space ship" or...

[1] "I saw the cylinder shaped looked like a spaceship hovring above the east side of the Air Force base. Saw it for about 30 seconds and ra"   
[2] "description of a spaceship spotted over Birmingham Alabama in 1967."   
[3] "A space ship was descending to the ground"   
[4] "On Monday october 3&#44 2005&#44 I spotted two spaceships in the sky. The first spotted ship was what seemed to be a bright star&#44 when it st"

ufo\_clean %>% pull(comments) %>%   
 str\_subset("space.ship") %>% head(4) # no "spaceship" must have character in between

[1] "A space ship was descending to the ground"   
[2] "I saw a Silver space ship rising into the early morning sky over Houston&#44 Texas."   
[3] "Saw a space ship hanging over the southern (Manzano) portion of the Sandia Mountains on evening. It was brightly lit&#44 but not entirely."  
[4] "saw space ship for 5 min&#33 Got scared crapless&#33&#33&#33&#33&#33&#33&#33&#33&#33&#33&#33&#33&#33&#33&#33&#33 happened in arizona"

## time information

pull(ufo\_clean, duration\_hours\_min) %>% head(n = 20)

[1] "45 minutes" "1-2 hrs" "20 seconds" "1/2 hour"   
 [5] "15 minutes" "5 minutes" "about 3 mins" "20 minutes"   
 [9] "3 minutes" "several minutes" "5 min." "3 minutes"   
[13] "30 min." "3 minutes" "30 seconds" "20minutes"   
[17] "2 minutes" "20-30 min" "20 sec." "2 min"

## str\_replace()

Let’s say we wanted to make the time information more consistent. Using case\_when() could be very tedious and error-prone!

We can use str\_replace() to do so.

ufo\_clean %>% mutate(duration\_hours\_min =   
 str\_replace(string = duration\_hours\_min,   
 pattern = "minutes",   
 replacement ="mins")) %>%  
 pull(duration\_hours\_min) %>%  
 head(8)

[1] "45 mins" "1-2 hrs" "20 seconds" "1/2 hour" "15 mins"   
[6] "5 mins" "about 3 mins" "20 mins"

## Separating columns

Better yet, you might notice that this data isn’t tidy- there are more than two entries for each value - amount of time and unit. We could separate this using separate() from the tidyr package.

ufo\_clean %>% separate(duration\_hours\_min,  
 into = c("duration\_amount", "duration\_unit"),  
 sep = " ") %>%  
 select(duration\_amount, duration\_unit) %>% head()

# A tibble: 6 × 2  
 duration\_amount duration\_unit  
 <chr> <chr>   
1 45 minutes   
2 1-2 hrs   
3 20 seconds   
4 1/2 hour   
5 15 minutes   
6 5 minutes

As you can see there is still plenty of cleaning to do!

## more seperating

ufo\_clean <- ufo\_clean %>% separate(datetime,  
 into = c("date", "time"),  
 sep = " ")  
ufo\_clean %>% select(date, time) %>% head()

# A tibble: 6 × 2  
 date time   
 <chr> <chr>  
1 10/10/1949 20:30  
2 10/10/1949 21:00  
3 10/10/1955 17:00  
4 10/10/1956 21:00  
5 10/10/1960 20:00  
6 10/10/1961 19:00

## Dates and times

The [lubridate](<https://lubridate.tidyverse.org/>) package is amazing for dates. Most important functions are those that look like ymd or mdy etc. They specify how a date should be interpreted.

library(lubridate)#need to load this one!  
  
ufo\_clean <- ufo\_clean %>% mutate(date = mdy(date))  
head(ufo\_clean)

# A tibble: 6 × 12  
 date time city state country shape duration\_seconds duration\_hours\_min  
 <date> <chr> <chr> <chr> <chr> <chr> <dbl> <chr>   
1 1949-10-10 20:30 san … tx us cyli… 2700 45 minutes   
2 1949-10-10 21:00 lack… tx <NA> light 7200 1-2 hrs   
3 1955-10-10 17:00 ches… <NA> gb circ… 20 20 seconds   
4 1956-10-10 21:00 edna tx us circ… 20 1/2 hour   
5 1960-10-10 20:00 kane… hi us light 900 15 minutes   
6 1961-10-10 19:00 bris… tn us sphe… 300 5 minutes   
# ℹ 4 more variables: comments <chr>, date\_posted <chr>, latitude <chr>,  
# longitude <chr>

## str\_\*functions

str\_detect(string = c("abcdd", "two"), pattern = "dd")

[1] TRUE FALSE

str\_subset(string = c("abcdd", "two"), pattern = "dd")

[1] "abcdd"

str\_extract(string = c("abcdd", "two"), pattern = "dd")

[1] "dd" NA

str\_sub(string = c("abcdd", "two"), start = 1, end = 3)

[1] "abc" "two"

## Summary

* stringr package has lots of helpful functions that work on vectors or variables in a data frame
* str\_detect helps find patterns
* str\_detect and filter can help you filter data based on patterns within value
* str\_extract helps extract a pattern
* str\_sub extracts pieces of strings based on the position of the the characters
* str\_subset gives the values that match a pattern
* separate can separate columns into two
* ^ indicates the start of a string
* $ indicates the end of a string
* the lubridate package is useful for dates and times

## Lab

<https://sisbid.github.io/Data-Wrangling/labs/data-cleaning-lab-part2.Rmd>

## Reshaping: wide vs. long data

<https://github.com/gadenbuie/tidyexplain/blob/main/images/tidyr-pivoting.gif>

## What is wide/long data?

Data is stored *differently* in the tibble.

Wide: has many columns

# A tibble: 1 × 4  
 State June\_vacc\_rate May\_vacc\_rate April\_vacc\_rate  
 <chr> <dbl> <dbl> <dbl>  
1 Alabama 0.516 0.514 0.511

Long: column names become data

# A tibble: 3 × 3  
 State name value  
 <chr> <chr> <dbl>  
1 Alabama June\_vacc\_rate 0.516  
2 Alabama May\_vacc\_rate 0.514  
3 Alabama April\_vacc\_rate 0.511

## What is wide/long data?

Wide: multiple columns per individual, values spread across multiple columns

# A tibble: 2 × 4  
 State June\_vacc\_rate May\_vacc\_rate April\_vacc\_rate  
 <chr> <dbl> <dbl> <dbl>  
1 Alabama 0.516 0.514 0.511  
2 Alaska 0.627 0.626 0.623

Long: multiple rows per observation, a single column contains the values

# A tibble: 6 × 3  
 State name value  
 <chr> <chr> <dbl>  
1 Alabama June\_vacc\_rate 0.516  
2 Alabama May\_vacc\_rate 0.514  
3 Alabama April\_vacc\_rate 0.511  
4 Alaska June\_vacc\_rate 0.627  
5 Alaska May\_vacc\_rate 0.626  
6 Alaska April\_vacc\_rate 0.623

## What is wide/long data?

Data is wide or long **with respect** to certain variables.

## Why do we need to switch between wide/long data?

Wide: **Easier for humans to read**

# A tibble: 2 × 4  
 State June\_vacc\_rate May\_vacc\_rate April\_vacc\_rate  
 <chr> <dbl> <dbl> <dbl>  
1 Alabama 0.516 0.514 0.511  
2 Alaska 0.627 0.626 0.623

Long: **Easier for R to make plots & do analysis**

# A tibble: 6 × 3  
 State name value  
 <chr> <chr> <dbl>  
1 Alabama June\_vacc\_rate 0.516  
2 Alabama May\_vacc\_rate 0.514  
3 Alabama April\_vacc\_rate 0.511  
4 Alaska June\_vacc\_rate 0.627  
5 Alaska May\_vacc\_rate 0.626  
6 Alaska April\_vacc\_rate 0.623

## Pivoting using tidyr package

tidyr allows you to “tidy” your data. We will be talking about:

* pivot\_longer - make multiple columns into variables, (wide to long)
* pivot\_wider - make a variable into multiple columns, (long to wide)
* separate - string into multiple columns

The reshape command exists. Its arguments are considered more confusing, so we don’t recommend it.

You might see old functions gather and spread when googling. These are older iterations of pivot\_longer and pivot\_wider, respectively.

# pivot\_longer…

## Reshaping data from wide to long

pivot\_longer() - puts column data into rows (tidyr package)

* First describe which columns we want to “pivot\_longer”

{long\_data} <- {wide\_data} %>% pivot\_longer(cols = {columns to pivot})

## Reshaping data from wide to long

wide\_data

# A tibble: 1 × 3  
 June\_vacc\_rate May\_vacc\_rate April\_vacc\_rate  
 <dbl> <dbl> <dbl>  
1 0.516 0.514 0.511

long\_data <- wide\_data %>% pivot\_longer(cols = everything())  
long\_data

# A tibble: 3 × 2  
 name value  
 <chr> <dbl>  
1 June\_vacc\_rate 0.516  
2 May\_vacc\_rate 0.514  
3 April\_vacc\_rate 0.511

## Reshaping data from wide to long

pivot\_longer() - puts column data into rows (tidyr package)

* First describe which columns we want to “pivot\_longer”
* names\_to = gives a new name to the pivoted columns
* values\_to = gives a new name to the values that used to be in those columns

{long\_data} <- {wide\_data} %>% pivot\_longer(cols = {columns to pivot},  
 names\_to = {New column name: contains old column names},  
 values\_to = {New column name: contains cell values})

## Reshaping data from wide to long

wide\_data

# A tibble: 1 × 3  
 June\_vacc\_rate May\_vacc\_rate April\_vacc\_rate  
 <dbl> <dbl> <dbl>  
1 0.516 0.514 0.511

long\_data <- wide\_data %>% pivot\_longer(cols = everything(),  
 names\_to = "Month",  
 values\_to = "Rate")  
long\_data

# A tibble: 3 × 2  
 Month Rate  
 <chr> <dbl>  
1 June\_vacc\_rate 0.516  
2 May\_vacc\_rate 0.514  
3 April\_vacc\_rate 0.511

Newly created column names are enclosed in quotation marks.

## Data used: Charm City Circulator

<https://sisbid.github.io/Data-Wrangling/data/Charm_City_Circulator_Ridership.csv>

circ <-   
 read\_csv("https://sisbid.github.io/Data-Wrangling/data/Charm\_City\_Circulator\_Ridership.csv")  
head(circ, 5)

# A tibble: 5 × 15  
 day date orangeBoardings orangeAlightings orangeAverage purpleBoardings  
 <chr> <chr> <dbl> <dbl> <dbl> <dbl>  
1 Monday 01/1… 877 1027 952 NA  
2 Tuesday 01/1… 777 815 796 NA  
3 Wednesday 01/1… 1203 1220 1212. NA  
4 Thursday 01/1… 1194 1233 1214. NA  
5 Friday 01/1… 1645 1643 1644 NA  
# ℹ 9 more variables: purpleAlightings <dbl>, purpleAverage <dbl>,  
# greenBoardings <dbl>, greenAlightings <dbl>, greenAverage <dbl>,  
# bannerBoardings <dbl>, bannerAlightings <dbl>, bannerAverage <dbl>,  
# daily <dbl>

## Reshaping data from wide to long

long <- circ %>%   
 pivot\_longer(starts\_with(c("orange","purple","green","banner")))  
long

# A tibble: 13,752 × 5  
 day date daily name value  
 <chr> <chr> <dbl> <chr> <dbl>  
 1 Monday 01/11/2010 952 orangeBoardings 877  
 2 Monday 01/11/2010 952 orangeAlightings 1027  
 3 Monday 01/11/2010 952 orangeAverage 952  
 4 Monday 01/11/2010 952 purpleBoardings NA  
 5 Monday 01/11/2010 952 purpleAlightings NA  
 6 Monday 01/11/2010 952 purpleAverage NA  
 7 Monday 01/11/2010 952 greenBoardings NA  
 8 Monday 01/11/2010 952 greenAlightings NA  
 9 Monday 01/11/2010 952 greenAverage NA  
10 Monday 01/11/2010 952 bannerBoardings NA  
# ℹ 13,742 more rows

## Reshaping data from wide to long

There are many ways to select the columns we want. Use ?tidyr\_tidy\_select to look at more column selection options.

long <- circ %>%   
 pivot\_longer( !c(day, date, daily))  
long

# A tibble: 13,752 × 5  
 day date daily name value  
 <chr> <chr> <dbl> <chr> <dbl>  
 1 Monday 01/11/2010 952 orangeBoardings 877  
 2 Monday 01/11/2010 952 orangeAlightings 1027  
 3 Monday 01/11/2010 952 orangeAverage 952  
 4 Monday 01/11/2010 952 purpleBoardings NA  
 5 Monday 01/11/2010 952 purpleAlightings NA  
 6 Monday 01/11/2010 952 purpleAverage NA  
 7 Monday 01/11/2010 952 greenBoardings NA  
 8 Monday 01/11/2010 952 greenAlightings NA  
 9 Monday 01/11/2010 952 greenAverage NA  
10 Monday 01/11/2010 952 bannerBoardings NA  
# ℹ 13,742 more rows

## Cleaning up long data

We will use str\_replace from the stringr package to put \_ in the names

long <- long %>% mutate(  
 name = str\_replace(name, "Board", "\_Board"),  
 name = str\_replace(name, "Alight", "\_Alight"),  
 name = str\_replace(name, "Average", "\_Average")   
)  
long

# A tibble: 13,752 × 5  
 day date daily name value  
 <chr> <chr> <dbl> <chr> <dbl>  
 1 Monday 01/11/2010 952 orange\_Boardings 877  
 2 Monday 01/11/2010 952 orange\_Alightings 1027  
 3 Monday 01/11/2010 952 orange\_Average 952  
 4 Monday 01/11/2010 952 purple\_Boardings NA  
 5 Monday 01/11/2010 952 purple\_Alightings NA  
 6 Monday 01/11/2010 952 purple\_Average NA  
 7 Monday 01/11/2010 952 green\_Boardings NA  
 8 Monday 01/11/2010 952 green\_Alightings NA  
 9 Monday 01/11/2010 952 green\_Average NA  
10 Monday 01/11/2010 952 banner\_Boardings NA  
# ℹ 13,742 more rows

## Cleaning up long data

Now each var is Boardings, Averages, or Alightings. We use “into =” to name the new columns and “sep =” to show where the separation should happen.

long <- long %>%   
 separate(name, into = c("line", "type"), sep = "\_")  
long

# A tibble: 13,752 × 6  
 day date daily line type value  
 <chr> <chr> <dbl> <chr> <chr> <dbl>  
 1 Monday 01/11/2010 952 orange Boardings 877  
 2 Monday 01/11/2010 952 orange Alightings 1027  
 3 Monday 01/11/2010 952 orange Average 952  
 4 Monday 01/11/2010 952 purple Boardings NA  
 5 Monday 01/11/2010 952 purple Alightings NA  
 6 Monday 01/11/2010 952 purple Average NA  
 7 Monday 01/11/2010 952 green Boardings NA  
 8 Monday 01/11/2010 952 green Alightings NA  
 9 Monday 01/11/2010 952 green Average NA  
10 Monday 01/11/2010 952 banner Boardings NA  
# ℹ 13,742 more rows

# pivot\_wider…

## Reshaping data from long to wide

pivot\_wider() - spreads row data into columns (tidyr package)

* names\_from = the old column whose contents will be spread into multiple new column names.
* values\_from = the old column whose contents will fill in the values of those new columns.

{wide\_data} <- {long\_data} %>%   
 pivot\_wider(names\_from = {Old column name: contains new column names},  
 values\_from = {Old column name: contains new cell values})

## Reshaping data from long to wide

long\_data

# A tibble: 3 × 2  
 Month Rate  
 <chr> <dbl>  
1 June\_vacc\_rate 0.516  
2 May\_vacc\_rate 0.514  
3 April\_vacc\_rate 0.511

wide\_data <- long\_data %>% pivot\_wider(names\_from = "Month",   
 values\_from = "Rate")   
wide\_data

# A tibble: 1 × 3  
 June\_vacc\_rate May\_vacc\_rate April\_vacc\_rate  
 <dbl> <dbl> <dbl>  
1 0.516 0.514 0.511

## Reshaping Charm City Circulator

long

# A tibble: 13,752 × 6  
 day date daily line type value  
 <chr> <chr> <dbl> <chr> <chr> <dbl>  
 1 Monday 01/11/2010 952 orange Boardings 877  
 2 Monday 01/11/2010 952 orange Alightings 1027  
 3 Monday 01/11/2010 952 orange Average 952  
 4 Monday 01/11/2010 952 purple Boardings NA  
 5 Monday 01/11/2010 952 purple Alightings NA  
 6 Monday 01/11/2010 952 purple Average NA  
 7 Monday 01/11/2010 952 green Boardings NA  
 8 Monday 01/11/2010 952 green Alightings NA  
 9 Monday 01/11/2010 952 green Average NA  
10 Monday 01/11/2010 952 banner Boardings NA  
# ℹ 13,742 more rows

## Reshaping Charm City Circulator

wide <- long %>% pivot\_wider(names\_from = "type",   
 values\_from = "value")   
wide

# A tibble: 4,584 × 7  
 day date daily line Boardings Alightings Average  
 <chr> <chr> <dbl> <chr> <dbl> <dbl> <dbl>  
 1 Monday 01/11/2010 952 orange 877 1027 952   
 2 Monday 01/11/2010 952 purple NA NA NA   
 3 Monday 01/11/2010 952 green NA NA NA   
 4 Monday 01/11/2010 952 banner NA NA NA   
 5 Tuesday 01/12/2010 796 orange 777 815 796   
 6 Tuesday 01/12/2010 796 purple NA NA NA   
 7 Tuesday 01/12/2010 796 green NA NA NA   
 8 Tuesday 01/12/2010 796 banner NA NA NA   
 9 Wednesday 01/13/2010 1212. orange 1203 1220 1212.  
10 Wednesday 01/13/2010 1212. purple NA NA NA   
# ℹ 4,574 more rows

# Adding prefixes

## Prefixes when pivoting

the datasets::airquality data shows various air quality metrics measured in New York in 1973.

air <- datasets::airquality %>% select(Temp, Month, Day)  
air

Temp Month Day  
1 67 5 1  
2 72 5 2  
3 74 5 3  
4 62 5 4  
5 56 5 5  
6 66 5 6  
7 65 5 7  
8 59 5 8  
9 61 5 9  
10 69 5 10  
11 74 5 11  
12 69 5 12  
13 66 5 13  
14 68 5 14  
15 58 5 15  
16 64 5 16  
17 66 5 17  
18 57 5 18  
19 68 5 19  
20 62 5 20  
21 59 5 21  
22 73 5 22  
23 61 5 23  
24 61 5 24  
25 57 5 25  
26 58 5 26  
27 57 5 27  
28 67 5 28  
29 81 5 29  
30 79 5 30  
31 76 5 31  
32 78 6 1  
33 74 6 2  
34 67 6 3  
35 84 6 4  
36 85 6 5  
37 79 6 6  
38 82 6 7  
39 87 6 8  
40 90 6 9  
41 87 6 10  
42 93 6 11  
43 92 6 12  
44 82 6 13  
45 80 6 14  
46 79 6 15  
47 77 6 16  
48 72 6 17  
49 65 6 18  
50 73 6 19  
51 76 6 20  
52 77 6 21  
53 76 6 22  
54 76 6 23  
55 76 6 24  
56 75 6 25  
57 78 6 26  
58 73 6 27  
59 80 6 28  
60 77 6 29  
61 83 6 30  
62 84 7 1  
63 85 7 2  
64 81 7 3  
65 84 7 4  
66 83 7 5  
67 83 7 6  
68 88 7 7  
69 92 7 8  
70 92 7 9  
71 89 7 10  
72 82 7 11  
73 73 7 12  
74 81 7 13  
75 91 7 14  
76 80 7 15  
77 81 7 16  
78 82 7 17  
79 84 7 18  
80 87 7 19  
81 85 7 20  
82 74 7 21  
83 81 7 22  
84 82 7 23  
85 86 7 24  
86 85 7 25  
87 82 7 26  
88 86 7 27  
89 88 7 28  
90 86 7 29  
91 83 7 30  
92 81 7 31  
93 81 8 1  
94 81 8 2  
95 82 8 3  
96 86 8 4  
97 85 8 5  
98 87 8 6  
99 89 8 7  
100 90 8 8  
101 90 8 9  
102 92 8 10  
103 86 8 11  
104 86 8 12  
105 82 8 13  
106 80 8 14  
107 79 8 15  
108 77 8 16  
109 79 8 17  
110 76 8 18  
111 78 8 19  
112 78 8 20  
113 77 8 21  
114 72 8 22  
115 75 8 23  
116 79 8 24  
117 81 8 25  
118 86 8 26  
119 88 8 27  
120 97 8 28  
121 94 8 29  
122 96 8 30  
123 94 8 31  
124 91 9 1  
125 92 9 2  
126 93 9 3  
127 93 9 4  
128 87 9 5  
129 84 9 6  
130 80 9 7  
131 78 9 8  
132 75 9 9  
133 73 9 10  
134 81 9 11  
135 76 9 12  
136 77 9 13  
137 71 9 14  
138 71 9 15  
139 78 9 16  
140 67 9 17  
141 76 9 18  
142 68 9 19  
143 82 9 20  
144 64 9 21  
145 71 9 22  
146 81 9 23  
147 69 9 24  
148 63 9 25  
149 70 9 26  
150 77 9 27  
151 75 9 28  
152 76 9 29  
153 68 9 30

## Prefixes when pivoting

Let’s pivot Month wider: but it might be helpful to add “Month” to the new column name so it isn’t just numbers.

air %>% pivot\_wider(names\_from = "Month",   
 values\_from = "Temp")

# A tibble: 31 × 6  
 Day `5` `6` `7` `8` `9`  
 <int> <int> <int> <int> <int> <int>  
 1 1 67 78 84 81 91  
 2 2 72 74 85 81 92  
 3 3 74 67 81 82 93  
 4 4 62 84 84 86 93  
 5 5 56 85 83 85 87  
 6 6 66 79 83 87 84  
 7 7 65 82 88 89 80  
 8 8 59 87 92 90 78  
 9 9 61 90 92 90 75  
10 10 69 87 89 92 73  
# ℹ 21 more rows

## Prefixes when pivoting

Much better!

air %>% pivot\_wider(names\_from = "Month",   
 values\_from = "Temp",  
 names\_prefix = "Month\_")

# A tibble: 31 × 6  
 Day Month\_5 Month\_6 Month\_7 Month\_8 Month\_9  
 <int> <int> <int> <int> <int> <int>  
 1 1 67 78 84 81 91  
 2 2 72 74 85 81 92  
 3 3 74 67 81 82 93  
 4 4 62 84 84 86 93  
 5 5 56 85 83 85 87  
 6 6 66 79 83 87 84  
 7 7 65 82 88 89 80  
 8 8 59 87 92 90 78  
 9 9 61 90 92 90 75  
10 10 69 87 89 92 73  
# ℹ 21 more rows

## Summary

* tidyr package helps us convert between wide and long data
* pivot\_longer() goes from wide -> long
  + Specify columns you want to pivot
  + Specify names\_to = and values\_to = for custom naming
* pivot\_wider() goes from long -> wide
  + Specify names\_from = and values\_from =

## Joining

“Combining datasets”

## Joining in dplyr

* Merging/joining data sets together - usually on key variables, usually “id”
* ?join - see different types of joining for dplyr
* inner\_join(x, y) - only rows that match for x and y are kept
* full\_join(x, y) - all rows of x and y are kept
* left\_join(x, y) - all rows of x are kept even if not merged with y
* right\_join(x, y) - all rows of y are kept even if not merged with x
* anti\_join(x, y) - all rows from x not in y keeping just columns from x.

## Merging: Simple Data

data\_As

# A tibble: 2 × 3  
 State June\_vacc\_rate May\_vacc\_rate  
 <chr> <dbl> <dbl>  
1 Alabama 0.516 0.514  
2 Alaska 0.627 0.626

data\_cold

# A tibble: 3 × 2  
 State April\_vacc\_rate  
 <chr> <dbl>  
1 Maine 0.795  
2 Alaska 0.623  
3 Vermont 0.82

## Inner Join

<https://github.com/gadenbuie/tidyexplain/blob/main/images/inner-join.gif>

## Inner Join

## Inner Join

lj <- inner\_join(data\_As, data\_cold)  
lj

# A tibble: 1 × 4  
 State June\_vacc\_rate May\_vacc\_rate April\_vacc\_rate  
 <chr> <dbl> <dbl> <dbl>  
1 Alaska 0.627 0.626 0.623

## Left Join

<https://raw.githubusercontent.com/gadenbuie/tidyexplain/main/images/left-join.gif>

## Left Join

## Left Join

lj <- left\_join(data\_As, data\_cold)  
lj

# A tibble: 2 × 4  
 State June\_vacc\_rate May\_vacc\_rate April\_vacc\_rate  
 <chr> <dbl> <dbl> <dbl>  
1 Alabama 0.516 0.514 NA   
2 Alaska 0.627 0.626 0.623

## Install tidylog package to log outputs

Numbers in parentheses indicate that these rows are not included in the result.

# install.packages("tidylog")  
library(tidylog)  
left\_join(data\_As, data\_cold)

# A tibble: 2 × 4  
 State June\_vacc\_rate May\_vacc\_rate April\_vacc\_rate  
 <chr> <dbl> <dbl> <dbl>  
1 Alabama 0.516 0.514 NA   
2 Alaska 0.627 0.626 0.623

## Right Join

<https://raw.githubusercontent.com/gadenbuie/tidyexplain/main/images/right-join.gif>

## Right Join

## Right Join

rj <- right\_join(data\_As, data\_cold)  
rj

# A tibble: 3 × 4  
 State June\_vacc\_rate May\_vacc\_rate April\_vacc\_rate  
 <chr> <dbl> <dbl> <dbl>  
1 Alaska 0.627 0.626 0.623  
2 Maine NA NA 0.795  
3 Vermont NA NA 0.82

## Left Join: Switching arguments

lj2 <- left\_join(data\_cold, data\_As)  
lj2

# A tibble: 3 × 4  
 State April\_vacc\_rate June\_vacc\_rate May\_vacc\_rate  
 <chr> <dbl> <dbl> <dbl>  
1 Maine 0.795 NA NA   
2 Alaska 0.623 0.627 0.626  
3 Vermont 0.82 NA NA

## Full Join

<https://raw.githubusercontent.com/gadenbuie/tidyexplain/main/images/full-join.gif>

## Full Join

## Full Join

fj <- full\_join(data\_As, data\_cold)  
fj

# A tibble: 4 × 4  
 State June\_vacc\_rate May\_vacc\_rate April\_vacc\_rate  
 <chr> <dbl> <dbl> <dbl>  
1 Alabama 0.516 0.514 NA   
2 Alaska 0.627 0.626 0.623  
3 Maine NA NA 0.795  
4 Vermont NA NA 0.82

## Watch out for “includes duplicates”

data\_As

# A tibble: 2 × 2  
 State state\_bird   
 <chr> <chr>   
1 Alabama wild turkey   
2 Alaska willow ptarmigan

data\_cold

# A tibble: 3 × 3  
 State vacc\_rate month  
 <chr> <dbl> <chr>  
1 Maine 0.795 April  
2 Alaska 0.623 April  
3 Alaska 0.626 May

## Watch out for “includes duplicates”

lj <- left\_join(data\_As, data\_cold)

## Watch out for “includes duplicates”

Data including the joining column (“State”) has been duplicated.

lj

# A tibble: 3 × 4  
 State state\_bird vacc\_rate month  
 <chr> <chr> <dbl> <chr>  
1 Alabama wild turkey NA <NA>   
2 Alaska willow ptarmigan 0.623 April  
3 Alaska willow ptarmigan 0.626 May

Note that “Alaska willow ptarmigan” appears twice.

## Watch out for “includes duplicates”

<https://github.com/gadenbuie/tidyexplain/blob/main/images/left-join-extra.gif>

## Regular left join

<https://raw.githubusercontent.com/gadenbuie/tidyexplain/main/images/left-join.gif>

## Stop tidylog

unloadNamespace("tidylog")

## Using the by argument

By default joins use the intersection of column names. If by is specified, it uses that.

full\_join(data\_As, data\_cold, by = "State")

# A tibble: 4 × 4  
 State state\_bird vacc\_rate month  
 <chr> <chr> <dbl> <chr>  
1 Alabama wild turkey NA <NA>   
2 Alaska willow ptarmigan 0.623 April  
3 Alaska willow ptarmigan 0.626 May   
4 Maine <NA> 0.795 April

## Using the by argument

You can join based on multiple columns by using something like by = c(col1, col2).

If the datasets have two different names for the same data, use:

full\_join(x, y, by = c("a" = "b"))

## Using “setdiff” (base)

We might want to determine what indexes ARE in the first dataset that AREN’T in the second:

data\_As

# A tibble: 2 × 2  
 State state\_bird   
 <chr> <chr>   
1 Alabama wild turkey   
2 Alaska willow ptarmigan

data\_cold

# A tibble: 3 × 3  
 State vacc\_rate month  
 <chr> <dbl> <chr>  
1 Maine 0.795 April  
2 Alaska 0.623 April  
3 Alaska 0.626 May

## Using “setdiff” (base)

Use setdiff to determine what indexes ARE in the first dataset that AREN’T in the second:

A\_states <- data\_As %>% pull(State)  
cold\_states <- data\_cold %>% pull(State)

setdiff(A\_states, cold\_states)

[1] "Alabama"

setdiff(cold\_states, A\_states)

[1] "Maine"

## Using bind\_rows() (dplyr)

Rows are stacked on top of each other. Works like rbind() from base R, but is “smarter” and looks for matching column names.

rbind(data\_As, data\_cold)

Error in rbind(deparse.level, ...): numbers of columns of arguments do not match

bind\_rows(data\_As, data\_cold)

# A tibble: 5 × 4  
 State state\_bird vacc\_rate month  
 <chr> <chr> <dbl> <chr>  
1 Alabama wild turkey NA <NA>   
2 Alaska willow ptarmigan NA <NA>   
3 Maine <NA> 0.795 April  
4 Alaska <NA> 0.623 April  
5 Alaska <NA> 0.626 May

## bind\_rows vs full join

full\_join(data\_As, data\_cold)

# A tibble: 4 × 4  
 State state\_bird vacc\_rate month  
 <chr> <chr> <dbl> <chr>  
1 Alabama wild turkey NA <NA>   
2 Alaska willow ptarmigan 0.623 April  
3 Alaska willow ptarmigan 0.626 May   
4 Maine <NA> 0.795 April

## Other stuff: anti\_join (dplyr)

[source](https://www.geeksforgeeks.org/anti-join-in-r/)

## anti\_join()

<https://raw.githubusercontent.com/gadenbuie/tidyexplain/main/images/anti-join.gif>

## Other stuff: anti\_join (dplyr)

anti\_join(data\_As, data\_cold)

# A tibble: 1 × 2  
 State state\_bird   
 <chr> <chr>   
1 Alabama wild turkey

## Other stuff: anti\_join (dplyr)

anti\_join(data\_cold, data\_As)

# A tibble: 1 × 3  
 State vacc\_rate month  
 <chr> <dbl> <chr>  
1 Maine 0.795 April

## Summary

* Merging/joining data sets together - assumes all column names that overlap
  + use the by = c("a" = "b") if they differ
* inner\_join(x, y) - only rows that match for x and y are kept
* full\_join(x, y) - all rows of x and y are kept
* left\_join(x, y) - all rows of x are kept even if not merged with y
* right\_join(x, y) - all rows of y are kept even if not merged with x
* Use the tidylog package for a detailed summary
* setdiff(x, y) shows what in x is missing from y
* bind\_rows(x, y) appends datasets

# Extra slides

## Other stuff: cross\_join (dplyr)

Cross joins match each row in x to every row in y, resulting in a data frame with nrow(x) \* nrow(y) rows.

cross\_join(data\_As, data\_cold)

# A tibble: 6 × 5  
 State.x state\_bird State.y vacc\_rate month  
 <chr> <chr> <chr> <dbl> <chr>  
1 Alabama wild turkey Maine 0.795 April  
2 Alabama wild turkey Alaska 0.623 April  
3 Alabama wild turkey Alaska 0.626 May   
4 Alaska willow ptarmigan Maine 0.795 April  
5 Alaska willow ptarmigan Alaska 0.623 April  
6 Alaska willow ptarmigan Alaska 0.626 May

## Other stuff: nest\_join (dplyr)

A nest join leaves x almost unchanged, except that it adds a new column for the y dataset. Matched values are stored inside the “cell” as a tibble.

nj <- nest\_join(data\_As, data\_cold)

nj

# A tibble: 2 × 3  
 State state\_bird data\_cold   
 <chr> <chr> <list>   
1 Alabama wild turkey <tibble [0 × 2]>  
2 Alaska willow ptarmigan <tibble [2 × 2]>

## Other stuff: nest\_join (dplyr)

nj %>% pull(data\_cold)

[[1]]  
# A tibble: 0 × 2  
# ℹ 2 variables: vacc\_rate <dbl>, month <chr>  
  
[[2]]  
# A tibble: 2 × 2  
 vacc\_rate month  
 <dbl> <chr>  
1 0.623 April  
2 0.626 May

## “Includes duplicates” with both datasets duplicated:

data\_As <- tibble(State = c("Alabama", "Alaska", "Alaska"),  
 state\_bird = c("wild turkey", "willow ptarmigan", "puffin"))  
data\_cold <- tibble(State = c("Maine", "Alaska", "Alaska"),  
 vacc\_rate = c("32.4%", "41.7%", "46.2%"),  
 month = c("April", "April", "May"))

## “Includes duplicates” with both datasets duplicated:

full\_join(data\_As, data\_cold)

Warning in full\_join(data\_As, data\_cold): Detected an unexpected many-to-many relationship between `x` and `y`.  
ℹ Row 2 of `x` matches multiple rows in `y`.  
ℹ Row 2 of `y` matches multiple rows in `x`.  
ℹ If a many-to-many relationship is expected, set `relationship =  
 "many-to-many"` to silence this warning.

# A tibble: 6 × 4  
 State state\_bird vacc\_rate month  
 <chr> <chr> <chr> <chr>  
1 Alabama wild turkey <NA> <NA>   
2 Alaska willow ptarmigan 41.7% April  
3 Alaska willow ptarmigan 46.2% May   
4 Alaska puffin 41.7% April  
5 Alaska puffin 46.2% May   
6 Maine <NA> 32.4% April