Ingesting Data

Modern Plain Text Social Science
Week 07

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Reading in data with readr and haven

Load the packages, as always

```r
library(here)      # manage file paths
library(socviz)    # data and some useful functions
library(tidyverse) # your friend and mine
library(haven)     # for Stata, SAS, and SPSS files
```

We’ve put a lot of pieces in place at this point

Including several things we haven’t fully exploited yet

Data we want to get into R

Reading in CSV files

Where's the data? Using here()

If we're loading a file, it's coming from *somewhere*.

If it's on our local disk somewhere, we will need to interact with the file system. We should try to do this in a way that avoids *absolute* file paths.

```
# This is not portable
df <- read_csv("/Users/kjhealy/Documents/data/misc/project/data/mydata.csv")
```

Where's the data? Using here()

If we're loading a file, it's coming from *somewhere*.

If it's on our local disk somewhere, we will need to interact with the file system. We should try to do this in a way that avoids *absolute* file paths.

```
# This is not portable
df <- read_csv("/Users/kjhealy/Documents/data/misc/project/data/mydata.csv")
```

We should also do it in a way that is *platform independent*.

This makes it easier to share your work, move it around, etc. Projects should be self-contained.

Where's the data? Using here()

The `here` package, and `here()` function builds paths relative to the top level of your R project.

```
here() # this path will be different for you
```

```
[1] "/Users/kjhealy/Documents/courses/mptc"
```

Where's the data? Using here()

This seminar's files all live in an RStudio project. It looks like this:

```
/Users/kjhealy/Documents/courses/mptc
├── 00_dummy_files
├── R
├── README.md
├── README.qmd
├── _extensions
├── _freeze
├── _motivation.qmd
├── _quarto.yml
├── _site
├── _targets
├── _targets.R
├── _variables.yml
├── _weekly-schedule.qmd
├── about
├── assets
├── assignment
├── avhrr
├── content
```

I want to load files from the `files/examples/` folder, but I also want *you* to be able to load them. I'm writing this from somewhere deep in the `slides` folder, but you won't be there. Also, I'm on a Mac, but you may not be.

Where's the data? Using here()

So:

```r
## Load the file relative to the path from the top of the project, without separators, etc
organs <- read_csv(file = here("files", "examples", "organdonation.csv"))
```

```r
organs
```

```
# A tibble: 238 × 21
   country  year donors   pop pop.dens   gdp gdp.lag health health.lag pubhealth
   <chr>   <dbl>  <dbl> <dbl>    <dbl> <dbl>   <dbl>  <dbl>      <dbl>     <dbl>
 1 Austra…    NA  NA    17065    0.220 16774   16591   1300       1224       4.8
 2 Austra…  1991  12.1  17284    0.223 17171   16774   1379       1300       5.4
 3 Austra…  1992  12.4  17495    0.226 17914   17171   1455       1379       5.4
 4 Austra…  1993  12.5  17667    0.228 18883   17914   1540       1455       5.4
 5 Austra…  1994  10.2  17855    0.231 19849   18883   1626       1540       5.4
 6 Austra…  1995  10.2  18072    0.233 21079   19849   1737       1626       5.5
 7 Austra…  1996  10.6  18311    0.237 21923   21079   1846       1737       5.6
 8 Austra…  1997  10.3  18518    0.239 22961   21923   1948       1846       5.7
 9 Austra…  1998  10.5  18711    0.242 24148   22961   2077       1948       5.9
10 Austra…  1999   8.67 18926    0.244 25445   24148   2231       2077       6.1
# ℹ 228 more rows
# ℹ 11 more variables: roads <dbl>, cerebvas <dbl>, assault <dbl>,
#   external <dbl>, txp.pop <dbl>, world <chr>, opt <chr>, consent.law <chr>,
#   consent.practice <chr>, consistent <chr>, ccode <chr>
```

`read_csv()` comes in different varieties

`read_csv()` Field separator is a comma: `,`

```
organs <- read_csv(file = here("files", "examples", "organdonation.csv"))
```

`read_csv2()` Field separator is a semicolon: `;`

```
# Example only
my_data <- read_csv2(file = here("files", "examples", "my_euro_file.csv))
```

Both are special cases of `read_delim()`

Other species are also catered to

`read_tsv()` Tab separated.

`read_fwf()` Fixed-width files.

`read_log()` Log files (i.e. computer log files).

`read_lines()` Just read in lines, without trying to parse them.

`read_table()` Data that's separated by one (or more) columns of space.

You can read files remotely, too

You can give all of these functions local files, or they can point to URLs.

Compressed files will be automatically uncompressed.

(Be careful what you download from remote locations!)

```r
organ_remote <- read_csv("http://kjhealy.co/organdonation.csv")

organ_remote
```

```
# A tibble: 238 × 21
   country  year donors   pop pop.dens   gdp gdp.lag health health.lag pubhealth
   <chr>   <dbl>  <dbl> <dbl>    <dbl> <dbl>   <dbl>  <dbl>      <dbl>     <dbl>
 1 Austra…    NA  NA    17065    0.220 16774   16591   1300       1224       4.8
 2 Austra…  1991  12.1  17284    0.223 17171   16774   1379       1300       5.4
 3 Austra…  1992  12.4  17495    0.226 17914   17171   1455       1379       5.4
 4 Austra…  1993  12.5  17667    0.228 18883   17914   1540       1455       5.4
 5 Austra…  1994  10.2  17855    0.231 19849   18883   1626       1540       5.4
 6 Austra…  1995  10.2  18072    0.233 21079   19849   1737       1626       5.5
 7 Austra…  1996  10.6  18311    0.237 21923   21079   1846       1737       5.6
 8 Austra…  1997  10.3  18518    0.239 22961   21923   1948       1846       5.7
 9 Austra…  1998  10.5  18711    0.242 24148   22961   2077       1948       5.9
10 Austra…  1999   8.67 18926    0.244 25445   24148   2231       2077       6.1
# ℹ 228 more rows
# ℹ 11 more variables: roads <dbl>, cerebvas <dbl>, assault <dbl>,
#   external <dbl>, txp.pop <dbl>, world <chr>, opt <chr>, consent.law <chr>,
#   consent.practice <chr>, consistent <chr>, ccode <chr>
```

An example: `read_table()`

```
England and Wales, Total Population, Death rates (period 1x1),  Last modified: 02 Apr
2018;  Methods Protocol: v6 (2017)

  Year          Age             Female          Male          Total
  1841            0             0.136067        0.169189        0.152777
  1841            1             0.059577        0.063208        0.061386
  1841            2             0.036406        0.036976        0.036689
  1841            3             0.024913        0.026055        0.025480
  1841            4             0.018457        0.019089        0.018772
  1841            5             0.013967        0.014279        0.014123
  1841            6             0.010870        0.011210        0.011040
  1841            7             0.008591        0.008985        0.008788
  1841            8             0.006860        0.007246        0.007053
  1841            9             0.005772        0.006050        0.005911
  1841           10             0.005303        0.005382        0.005343
  1841           11             0.005114        0.005002        0.005057
  1841           12             0.005145        0.004856        0.004999
  1841           13             0.005455        0.004955        0.005202
```

```
  1841          106             0.677711        6.000000        0.795287
  1841          107             0.900000               .        0.900000
  1841          108             1.388430               .        1.388430
  1841          109                    .               .               .
  1841          110+                   .               .               .
  1842            0             0.148491        0.184007        0.166481
  1842            1             0.063038        0.066596        0.064818
  1842            2             0.035203        0.035854        0.035527
```

An example: `read_table()`

```
England and Wales, Total Population, Death rates (period 1x1),  Last modified: 02 Apr
2018;  Methods Protocol: v6 (2017)

  Year          Age             Female          Male            Total
  1841            0             0.136067        0.169189        0.152777
  1841            1             0.059577        0.063208        0.061386
  1841            2             0.036406        0.036976        0.036689
  1841            3             0.024913        0.026055        0.025480
  1841            4             0.018457        0.019089        0.018772
  1841            5             0.013967        0.014279        0.014123
  1841            6             0.010870        0.011210        0.011040
  1841            7             0.008591        0.008985        0.008788
  1841            8             0.006860        0.007246        0.007053
  1841            9             0.005772        0.006050        0.005911
  1841           10             0.005303        0.005382        0.005343
  1841           11             0.005114        0.005002        0.005057
  1841           12             0.005145        0.004856        0.004999
  1841           13             0.005455        0.004955        0.005202
```

```
  1841          105             0.576967        1.727848        0.700373
  1841          106             0.677711        6.000000        0.795287
  1841          107             0.900000               .        0.900000
  1841          108             1.388430               .        1.388430
  1841          109                    .               .               .
  1841          110+                   .               .               .
  1842            0             0.148491        0.184007        0.166481
  1842            1             0.063038        0.066596        0.064818
  1842            2             0.035203        0.035854        0.035527
```

```r
engmort <- read_table(here("files", "examples", "mortality.txt"),
                      skip = 2, na = ".")

engmort
```

```
# A tibble: 222 × 5
    Year Age   Female    Male   Total
   <dbl> <chr>  <dbl>   <dbl>   <dbl>
 1  1841 0    0.136   0.169   0.153  
 2  1841 1    0.0596  0.0632  0.0614 
 3  1841 2    0.0364  0.0370  0.0367 
 4  1841 3    0.0249  0.0261  0.0255 
 5  1841 4    0.0185  0.0191  0.0188 
 6  1841 5    0.0140  0.0143  0.0141 
 7  1841 6    0.0109  0.0112  0.0110 
 8  1841 7    0.00859 0.00898 0.00879
 9  1841 8    0.00686 0.00725 0.00705
10  1841 9    0.00577 0.00605 0.00591
# ℹ 212 more rows
```

Attend to the column specification

```r
engmort <- read_table(here("files", "examples", "mortality.txt"),
                      skip = 2, na = ".")
```

```
── Column specification ────────────────────────────────────────────────────────
cols(
  Year = col_double(),
  Age = col_character(),
  Female = col_double(),
  Male = col_double(),
  Total = col_double()
)
```

Attend to the column specification

Absent you giving them a column specification, the `read_` functions try to *guess* what the type of each column is. They do this by looking at the first thousand rows of each column. They may guess incorrectly!

For plain-text delimited formats like CSV, TSV, and the like, their `read_` functions guess because they *have* to. Why? Because CSV is not really a format, and because CSV files do not carry metadata inside them about what their detailed structure is.

Normalizing names and recoding

```r
read_table(here("files", "examples", "mortality.txt"),
           skip = 2, na = ".")
```

```
# A tibble: 222 × 5
    Year Age    Female    Male   Total
   <dbl> <chr>   <dbl>   <dbl>   <dbl>
 1  1841 0     0.136   0.169   0.153
 2  1841 1     0.0596  0.0632  0.0614
 3  1841 2     0.0364  0.0370  0.0367
 4  1841 3     0.0249  0.0261  0.0255
 5  1841 4     0.0185  0.0191  0.0188
 6  1841 5     0.0140  0.0143  0.0141
 7  1841 6     0.0109  0.0112  0.0110
 8  1841 7     0.00859 0.00898 0.00879
 9  1841 8     0.00686 0.00725 0.00705
10  1841 9     0.00577 0.00605 0.00591
# ℹ 212 more rows
```

Normalizing names and recoding

```r
read_table(here("files", "examples", "mortality.txt"),
           skip = 2, na = ".") |>
  janitor::clean_names()
```

```
# A tibble: 222 × 5
    year age    female    male   total
   <dbl> <chr>   <dbl>   <dbl>   <dbl>
 1  1841 0     0.136   0.169   0.153
 2  1841 1     0.0596  0.0632  0.0614
 3  1841 2     0.0364  0.0370  0.0367
 4  1841 3     0.0249  0.0261  0.0255
 5  1841 4     0.0185  0.0191  0.0188
 6  1841 5     0.0140  0.0143  0.0141
 7  1841 6     0.0109  0.0112  0.0110
 8  1841 7     0.00859 0.00898 0.00879
 9  1841 8     0.00686 0.00725 0.00705
10  1841 9     0.00577 0.00605 0.00591
# ℹ 212 more rows
```

Normalizing names and recoding

```r
read_table(here("files", "examples", "mortality.txt"),
           skip = 2, na = ".") |>
  janitor::clean_names() |>
  mutate(age = as.integer(recode(age, "110+" = "110")))
```

```
# A tibble: 222 × 5
    year   age  female    male   total
   <dbl> <int>   <dbl>   <dbl>   <dbl>
 1  1841     0 0.136   0.169   0.153
 2  1841     1 0.0596  0.0632  0.0614
 3  1841     2 0.0364  0.0370  0.0367
 4  1841     3 0.0249  0.0261  0.0255
 5  1841     4 0.0185  0.0191  0.0188
 6  1841     5 0.0140  0.0143  0.0141
 7  1841     6 0.0109  0.0112  0.0110
 8  1841     7 0.00859 0.00898 0.00879
 9  1841     8 0.00686 0.00725 0.00705
10  1841     9 0.00577 0.00605 0.00591
# ℹ 212 more rows
```

Janitor

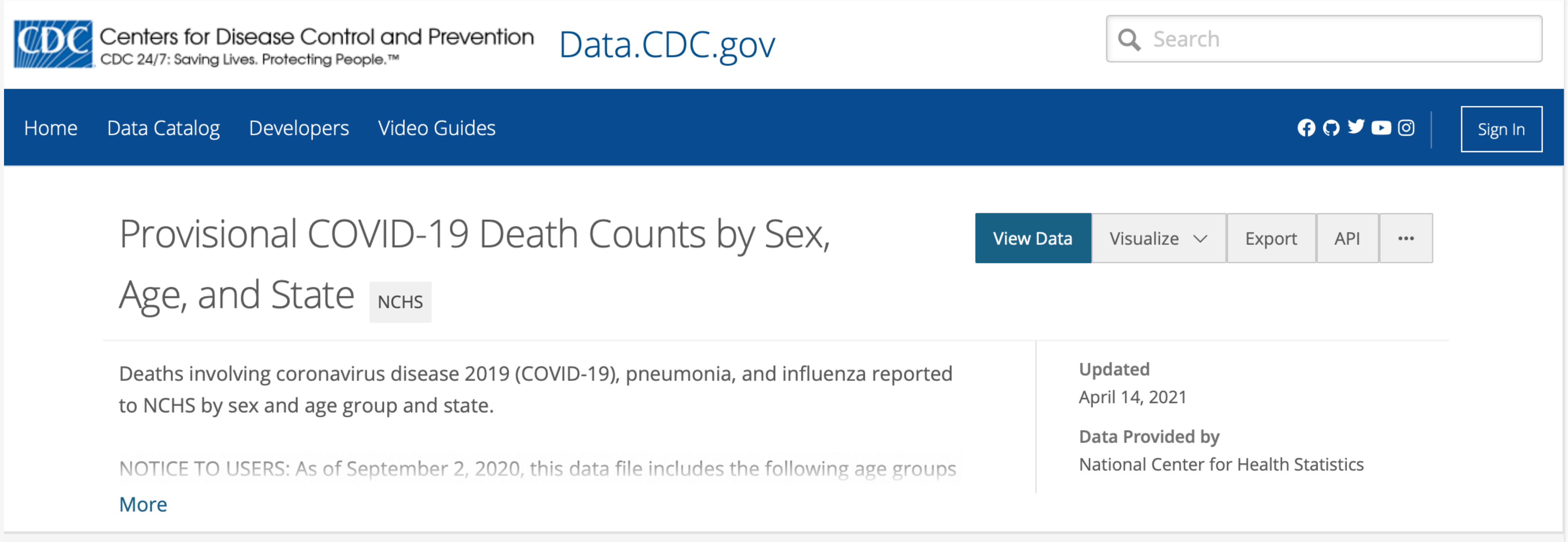
The `janitor` package is very handy!

The main cost of normalizing names comes with, e.g., data where there is a codebook you need to consult. But in general it's worth it.

Example: Colspecs

More on column specifications

CDC/NCHS data: Provisional COVID-19 Death Counts by Sex, Age, and State



More on column specifications

What's in this Dataset?

Rows	Columns
52.3K	16

Columns in this Dataset

Column Name	Description	Type
Data As Of	Date of analysis	Date & Time
Start Date	First date of data period	Date & Time
End Date	Last date of data period	Date & Time
Group	Indicator of whether data measured by Month, by Year, or ...	Plain Text
Year	Year in which death occurred	Number
Month	Month in which death occurred	Number
State	Jurisdiction of occurrence	Plain Text
Sex	Sex	Plain Text
Age Group	Age group	Plain Text
COVID-19 Deaths	Deaths involving COVID-19 (ICD-code U07.1)	Number
Total Deaths	Deaths from all causes of death	Number
Pneumonia Deaths	Pneumonia Deaths (ICD-10 codes J12.0-J18.9)	Number
Pneumonia and COVID-19 Deaths	Deaths with Pneumonia and COVID-19 (ICD-10 codes J12.0-...	Number
Influenza Deaths	Influenza Deaths (ICD-10 codes J09-J11)	Number
Pneumonia, Influenza, or COVID-19 Deaths	Deaths with Pneumonia, Influenza, or COVID-19 (ICD-10 co...	Number
Footnote	Suppressed counts (1-9)	Plain Text

Show Less

Let's try to load it

```r
nchs <- with_edition(1, read_csv(here("files", "examples", "SAS_on_2021-04-13.csv")))
```

```
── Column specification ────────────────────────────────────────────────────────
cols(
  `Data As Of` = col_character(),
  `Start Date` = col_character(),
  `End Date` = col_character(),
  Group = col_character(),
  Year = col_logical(),
  Month = col_logical(),
  State = col_character(),
  Sex = col_character(),
  `Age Group` = col_character(),
  `COVID-19 Deaths` = col_double(),
  `Total Deaths` = col_double(),
  `Pneumonia Deaths` = col_double(),
  `Pneumonia and COVID-19 Deaths` = col_double(),
  `Influenza Deaths` = col_double(),
  `Pneumonia, Influenza, or COVID-19 Deaths` = col_double(),
  Footnote = col_character()
```

```
Warning: 88128 parsing failures.
 row  col           expected actual                                                                 file
2755 Year 1/0/T/F/TRUE/FALSE   2020 '/Users/kjhealy/Documents/courses/mptc/files/examples/SAS_on_2021-04-13.csv'
2756 Year 1/0/T/F/TRUE/FALSE   2020 '/Users/kjhealy/Documents/courses/mptc/files/examples/SAS_on_2021-04-13.csv'
2757 Year 1/0/T/F/TRUE/FALSE   2020 '/Users/kjhealy/Documents/courses/mptc/files/examples/SAS_on_2021-04-13.csv'
2758 Year 1/0/T/F/TRUE/FALSE   2020 '/Users/kjhealy/Documents/courses/mptc/files/examples/SAS_on_2021-04-13.csv'
2759 Year 1/0/T/F/TRUE/FALSE   2020 '/Users/kjhealy/Documents/courses/mptc/files/examples/SAS_on_2021-04-13.csv'
.... .... .................. ...... ..........................................................................
```

Let’s try to load it

```r
problems(nchs)
```

```
# A tibble: 88,128 × 5
     row col   expected           actual file
   <int> <chr> <chr>              <chr>  <chr>
 1  2755 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
 2  2756 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
 3  2757 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
 4  2758 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
 5  2759 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
 6  2760 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
 7  2761 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
 8  2762 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
 9  2763 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
10  2764 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
# ℹ 88,118 more rows
```

Let’s try to load it

```r
problems(nchs)
```

```
# A tibble: 88,128 × 5
     row col   expected           actual file
   <int> <chr> <chr>              <chr>  <chr>
 1  2755 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
 2  2756 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
 3  2757 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
 4  2758 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
 5  2759 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
 6  2760 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
 7  2761 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
 8  2762 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
 9  2763 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
10  2764 Year  1/0/T/F/TRUE/FALSE 2020   '/Users/kjhealy/Documents/courses/mptc…
# ℹ 88,118 more rows
```

Problems are stored as an attribute of the `nchs` object, so we can revisit them.

Parsing failures tend to cascade. Our data only has 56k rows but we got 88k failures.

Take a look with `head()`

```r
head(nchs)
```

```
# A tibble: 6 × 16
  `Data As Of` `Start Date` `End Date` Group Year  Month State Sex   `Age Group`
  <chr>        <chr>        <chr>      <chr> <lgl> <lgl> <chr> <chr> <chr>
1 04/07/2021   01/01/2020   04/03/2021 By T… NA    NA    Unit… All … All Ages
2 04/07/2021   01/01/2020   04/03/2021 By T… NA    NA    Unit… All … Under 1 ye…
3 04/07/2021   01/01/2020   04/03/2021 By T… NA    NA    Unit… All … 0-17 years
4 04/07/2021   01/01/2020   04/03/2021 By T… NA    NA    Unit… All … 1-4 years
5 04/07/2021   01/01/2020   04/03/2021 By T… NA    NA    Unit… All … 5-14 years
6 04/07/2021   01/01/2020   04/03/2021 By T… NA    NA    Unit… All … 15-24 years
# ℹ 7 more variables: `COVID-19 Deaths` <dbl>, `Total Deaths` <dbl>,
#   `Pneumonia Deaths` <dbl>, `Pneumonia and COVID-19 Deaths` <dbl>,
#   `Influenza Deaths` <dbl>, `Pneumonia, Influenza, or COVID-19 Deaths` <dbl>,
#   Footnote <chr>
```

Take a look with `tail()`

```r
tail(nchs)
```

```
# A tibble: 6 × 16
  `Data As Of` `Start Date` `End Date` Group Year  Month State Sex   `Age Group`
  <chr>        <chr>        <chr>      <chr> <lgl> <lgl> <chr> <chr> <chr>
1 04/07/2021   04/01/2021   04/03/2021 By M… NA    NA    Puer… Fema… 45-54 years
2 04/07/2021   04/01/2021   04/03/2021 By M… NA    NA    Puer… Fema… 50-64 years
3 04/07/2021   04/01/2021   04/03/2021 By M… NA    NA    Puer… Fema… 55-64 years
4 04/07/2021   04/01/2021   04/03/2021 By M… NA    NA    Puer… Fema… 65-74 years
5 04/07/2021   04/01/2021   04/03/2021 By M… NA    NA    Puer… Fema… 75-84 years
6 04/07/2021   04/01/2021   04/03/2021 By M… NA    NA    Puer… Fema… 85 years a…
# ℹ 7 more variables: `COVID-19 Deaths` <dbl>, `Total Deaths` <dbl>,
#   `Pneumonia Deaths` <dbl>, `Pneumonia and COVID-19 Deaths` <dbl>,
#   `Influenza Deaths` <dbl>, `Pneumonia, Influenza, or COVID-19 Deaths` <dbl>,
#   Footnote <chr>
```

Take a look with `slice_sample()`

```r
nchs |>
  slice_sample(n = 10)
```

```
# A tibble: 10 × 16
   `Data As Of` `Start Date` `End Date` Group    Year  Month State          Sex
   <chr>        <chr>        <chr>      <chr>    <lgl> <lgl> <chr>          <chr>
 1 04/07/2021   07/01/2020   07/31/2020 By Month NA    NA    West Virginia  Fema…
 2 04/07/2021   07/01/2020   07/31/2020 By Month NA    NA    Florida        Fema…
 3 04/07/2021   12/01/2020   12/31/2020 By Month NA    NA    Tennessee      All …
 4 04/07/2021   01/01/2020   01/31/2020 By Month NA    TRUE  West Virginia  All …
 5 04/07/2021   10/01/2020   10/31/2020 By Month NA    NA    Wyoming        All …
 6 04/07/2021   03/01/2021   03/31/2021 By Month NA    NA    South Caroli…  All …
 7 04/07/2021   06/01/2020   06/30/2020 By Month NA    NA    Louisiana      Fema…
 8 04/07/2021   11/01/2020   11/30/2020 By Month NA    NA    District of …  Male
 9 04/07/2021   02/01/2020   02/29/2020 By Month NA    NA    Washington     Male
10 04/07/2021   07/01/2020   07/31/2020 By Month NA    NA    South Dakota   All …
# ℹ 8 more variables: `Age Group` <chr>, `COVID-19 Deaths` <dbl>,
#   `Total Deaths` <dbl>, `Pneumonia Deaths` <dbl>,
#   `Pneumonia and COVID-19 Deaths` <dbl>, `Influenza Deaths` <dbl>,
#   `Pneumonia, Influenza, or COVID-19 Deaths` <dbl>, Footnote <chr>
```

Aside: one that happened earlier …

```r
nchs %>%
  slice_sample(n = 10)
```

```
## # A tibble: 10 x 16
##    `Data As Of` `Start Date` `End Date` Group   Year  Month State        Sex
##    <chr>        <chr>        <chr>      <chr>   <lgl> <lgl> <chr>        <chr>
##  1 04/07/2021   01/01/2020   04/03/2021 By Tot… NA    NA    Minnesota    Male
##  2 04/07/2021   02/01/2020   02/29/2020 By Mon… NA    NA    Georgia      Male
##  3 04/07/2021   02/01/2021   02/28/2021 By Mon… NA    NA    Maine        Male
##  4 04/07/2021   11/01/2020   11/30/2020 By Mon… NA    NA    New Jersey   Female
##  5 04/07/2021   01/01/2020   12/31/2020 By Year NA    NA    Rhode Island All Se…
##  6 04/07/2021   01/01/2020   01/31/2020 By Mon… NA    TRUE  New York     All Se…
##  7 04/07/2021   05/01/2020   05/31/2020 By Mon… NA    NA    District of… Male
##  8 04/07/2021   04/01/2021   04/03/2021 By Mon… NA    NA    North Carol… Female
##  9 04/07/2021   03/01/2021   03/31/2021 By Mon… NA    NA    Kentucky     Male
## 10 04/07/2021   04/01/2021   04/03/2021 By Mon… NA    NA    New Mexico   Female
## # … with 8 more variables: Age Group <chr>, COVID-19 Deaths <dbl>,
## #   Total Deaths <dbl>, Pneumonia Deaths <dbl>,
## #   Pneumonia and COVID-19 Deaths <dbl>, Influenza Deaths <dbl>,
## #   Pneumonia, Influenza, or COVID-19 Deaths <dbl>, Footnote <chr>
```

Take a look with `slice()`

Let's look at the rows `read_csv()` complained about.

```r
nchs |>
  slice(2750:2760)
```

```
# A tibble: 11 × 16
   `Data As Of` `Start Date` `End Date` Group    Year  Month State         Sex
   <chr>        <chr>        <chr>      <chr>    <lgl> <lgl> <chr>         <chr>
 1 04/07/2021   01/01/2020   04/03/2021 By Total NA    NA    Puerto Rico   Fema…
 2 04/07/2021   01/01/2020   04/03/2021 By Total NA    NA    Puerto Rico   Fema…
 3 04/07/2021   01/01/2020   04/03/2021 By Total NA    NA    Puerto Rico   Fema…
 4 04/07/2021   01/01/2020   04/03/2021 By Total NA    NA    Puerto Rico   Fema…
 5 04/07/2021   01/01/2020   04/03/2021 By Total NA    NA    Puerto Rico   Fema…
 6 04/07/2021   01/01/2020   12/31/2020 By Year  NA    NA    United States All …
 7 04/07/2021   01/01/2020   12/31/2020 By Year  NA    NA    United States All …
 8 04/07/2021   01/01/2020   12/31/2020 By Year  NA    NA    United States All …
 9 04/07/2021   01/01/2020   12/31/2020 By Year  NA    NA    United States All …
10 04/07/2021   01/01/2020   12/31/2020 By Year  NA    NA    United States All …
11 04/07/2021   01/01/2020   12/31/2020 By Year  NA    NA    United States All …
# ℹ 8 more variables: `Age Group` <chr>, `COVID-19 Deaths` <dbl>,
#   `Total Deaths` <dbl>, `Pneumonia Deaths` <dbl>,
#   `Pneumonia and COVID-19 Deaths` <dbl>, `Influenza Deaths` <dbl>,
#   `Pneumonia, Influenza, or COVID-19 Deaths` <dbl>, Footnote <chr>
```

Take a look with `slice()`

```
nchs |>
  slice(2750:2760) |>
  select(Year, Month, State)
```

```
# A tibble: 11 × 3
   Year  Month State
   <lgl> <lgl> <chr>
 1 NA    NA    Puerto Rico
 2 NA    NA    Puerto Rico
 3 NA    NA    Puerto Rico
 4 NA    NA    Puerto Rico
 5 NA    NA    Puerto Rico
 6 NA    NA    United States
 7 NA    NA    United States
 8 NA    NA    United States
 9 NA    NA    United States
10 NA    NA    United States
11 NA    NA    United States
```

Hm, something to do with the transition to national numbers maybe?

Take a look with `select()` & `filter()`

```r
nchs |>
  select(Year, Month, State) |>
  filter(State == "New York")
```

```
# A tibble: 969 × 3
   Year  Month State
   <lgl> <lgl> <chr>
 1 NA    NA    New York
 2 NA    NA    New York
 3 NA    NA    New York
 4 NA    NA    New York
 5 NA    NA    New York
 6 NA    NA    New York
 7 NA    NA    New York
 8 NA    NA    New York
 9 NA    NA    New York
10 NA    NA    New York
# ℹ 959 more rows
```

Take a look with `is.na()`

```
nchs ▷
  select(Year, Month, State) ▷
  filter(!is.na(Year))
```

```
# A tibble: 0 × 3
# ℹ 3 variables: Year <lgl>, Month <lgl>, State <chr>
```

It really has been read in as a completely empty column.

That doesn’t seem like it can be right.

Take a look with `distinct()`

```
nchs |>
  select(Year) |>
  distinct(Year)
```

```
# A tibble: 1 × 1
  Year
  <lgl>
1 NA
```

Again, it's been read in as a completely empty column.

Take a look with `read_lines()`

Time to reach for a different kitchen knife.

```r
read_lines(here("files", "examples", "SAS_on_2021-04-13.csv"), n_max = 10)
```

```
 [1] "Data As Of,Start Date,End Date,Group,Year,Month,State,Sex,Age Group,COVID-19 Deaths,Total Deaths,Pneumonia
Deaths,Pneumonia and COVID-19 Deaths,Influenza Deaths,\"Pneumonia, Influenza, or COVID-19 Deaths\",Footnote"
 [2] "04/07/2021,01/01/2020,04/03/2021,By Total,,,United States,All Sexes,All
Ages,539723,4161167,466437,263147,9037,750804,"
 [3] "04/07/2021,01/01/2020,04/03/2021,By Total,,,United States,All Sexes,Under 1 year,59,22626,246,10,21,316,"
 [4] "04/07/2021,01/01/2020,04/03/2021,By Total,,,United States,All Sexes,0-17 years,251,39620,667,46,179,1051,"
 [5] "04/07/2021,01/01/2020,04/03/2021,By Total,,,United States,All Sexes,1-4 years,31,4069,137,5,61,224,"
 [6] "04/07/2021,01/01/2020,04/03/2021,By Total,,,United States,All Sexes,5-14 years,89,6578,195,19,76,341,"
 [7] "04/07/2021,01/01/2020,04/03/2021,By Total,,,United States,All Sexes,15-24 years,804,42596,930,317,81,1493,"
 [8] "04/07/2021,01/01/2020,04/03/2021,By Total,,,United States,All Sexes,18-29
years,1996,75339,2184,884,150,3434,"
 [9] "04/07/2021,01/01/2020,04/03/2021,By Total,,,United States,All Sexes,25-34
years,3543,88196,3493,1617,237,5638,"
[10] "04/07/2021,01/01/2020,04/03/2021,By Total,,,United States,All Sexes,30-39
years,5792,107348,5276,2658,318,8706,"
```

We can get the whole thing this way

```
raw_file <- read_lines(here("files", "examples", "SAS_on_2021-04-13.csv"))
```

This imports the data as a long, long character vector, with each element being a line.

```
# reminder: indexing 1D vectors
letters[5:6]
```

```
[1] "e" "f"
```

Now we're just looking at lines in a file

```r
# This is not a tibble; it's a vector. We have to index it the basic way, like letters[1:5]
raw_file[2753:2758]
```

```
[1] "04/07/2021,01/01/2020,04/03/2021,By Total,,,Puerto Rico,Female,65-74 years,203,2650,410,151,,466,One or more data cells have counts between 1-9 and have been suppressed in accordance with NCHS confidentiality standards."
[2] "04/07/2021,01/01/2020,04/03/2021,By Total,,,Puerto Rico,Female,75-84 years,234,4274,656,154,16,751,"
[3] "04/07/2021,01/01/2020,04/03/2021,By Total,,,Puerto Rico,Female,85 years and over,222,6164,795,136,29,909,"
[4] "04/07/2021,01/01/2020,12/31/2020,By Year,2020,,United States,All Sexes,All Ages,380949,3372967,349667,178222,8779,560025,"
[5] "04/07/2021,01/01/2020,12/31/2020,By Year,2020,,United States,All Sexes,Under 1 year,48,19356,224,9,21,284,"
[6] "04/07/2021,01/01/2020,12/31/2020,By Year,2020,,United States,All Sexes,0-17 years,189,33808,598,35,178,930,"
```

OK, let’s go back to the colspec!

```r
nchs <- with_edition(1, read_csv(here("files", "examples", "SAS_on_2021-04-13.csv")))
```

```
── Column specification ────────────────────────────────────────────────────────
cols(
  `Data As Of` = col_character(),
  `Start Date` = col_character(),
  `End Date` = col_character(),
  Group = col_character(),
  Year = col_logical(),
  Month = col_logical(),
  State = col_character(),
  Sex = col_character(),
  `Age Group` = col_character(),
  `COVID-19 Deaths` = col_double(),
  `Total Deaths` = col_double(),
  `Pneumonia Deaths` = col_double(),
  `Pneumonia and COVID-19 Deaths` = col_double(),
  `Influenza Deaths` = col_double(),
  `Pneumonia, Influenza, or COVID-19 Deaths` = col_double(),
  Footnote = col_character()
```

We can just copy it from the console output! It’s valid code.

We use it with col_types

```
nchs <- with_edition(1, read_csv(here("files", "examples", "SAS_on_2021-04-13.csv"),
           col_types = cols(
  `Data As Of` = col_character(),
  `Start Date` = col_character(),
  `End Date` = col_character(),
  Group = col_character(),
  Year = col_logical(),
  Month = col_logical(),
  State = col_character(),
  Sex = col_character(),
  `Age Group` = col_character(),
  `COVID-19 Deaths` = col_double(),
  `Total Deaths` = col_double(),
  `Pneumonia Deaths` = col_double(),
  `Pneumonia and COVID-19 Deaths` = col_double(),
  `Influenza Deaths` = col_double(),
  `Pneumonia, Influenza, or COVID-19 Deaths` = col_double(),
  Footnote = col_character()
)))
```

But we know we need to make some adjustments.

Fixes

```r
# Date format
us_style <-  "%m/%d/%Y"

nchs <- with_edition(1, read_csv(
  here("files", "examples", "SAS_on_2021-04-13.csv"),
  col_types = cols(
    `Data As Of` = col_date(format = us_style),
    `Start Date` = col_date(format = us_style),
    `End Date` = col_date(format = us_style),
    Group = col_character(),
    Year = col_character(),
    Month = col_character(),
    State = col_character(),
    Sex = col_character(),
    `Age Group` = col_character(),
    `COVID-19 Deaths` = col_integer(),
    `Total Deaths` = col_integer(),
    `Pneumonia Deaths` = col_integer(),
    `Pneumonia and COVID-19 Deaths` = col_integer(),
    `Influenza Deaths` = col_integer(),
    `Pneumonia, Influenza, or COVID-19 Deaths` = col_integer(),
    Footnote = col_character()
  )) |>
  janitor::clean_names() |>
  select(-footnote) |>
  mutate(age_group = str_to_sentence(age_group)) |>
  filter(!str_detect(state, "Total"))
)
```

Now let's look again

```r
dim(nchs)
```

```
[1] 52326    15
```

```r
nchs ▷
  select(year, month, state) ▷
  filter(!is.na(year))
```

```
# A tibble: 49,572 × 3
   year  month state
   <chr> <chr> <chr>
 1 2020  <NA>  United States
 2 2020  <NA>  United States
 3 2020  <NA>  United States
 4 2020  <NA>  United States
 5 2020  <NA>  United States
 6 2020  <NA>  United States
 7 2020  <NA>  United States
 8 2020  <NA>  United States
 9 2020  <NA>  United States
10 2020  <NA>  United States
# ℹ 49,562 more rows
```

Now let’s look again

```
nchs ▷
  distinct(year)
```

```
# A tibble: 3 × 1
  year
  <chr>
1 <NA>
2 2020
3 2021
```

Lessons learned

If we wanted to …

```r
library(stringr)  # it's back!
```

If we wanted to …

```r
library(stringr)  # it's back!

nchs
```

```
# A tibble: 52,326 × 15
   data_as_of start_date end_date   group    year  month state   sex   age_group
   <date>     <date>     <date>     <chr>    <chr> <chr> <chr>   <chr> <chr>
 1 2021-04-07 2020-01-01 2021-04-03 By Total <NA>  <NA>  United… All … All ages
 2 2021-04-07 2020-01-01 2021-04-03 By Total <NA>  <NA>  United… All … Under 1 …
 3 2021-04-07 2020-01-01 2021-04-03 By Total <NA>  <NA>  United… All … 0-17 yea…
 4 2021-04-07 2020-01-01 2021-04-03 By Total <NA>  <NA>  United… All … 1-4 years
 5 2021-04-07 2020-01-01 2021-04-03 By Total <NA>  <NA>  United… All … 5-14 yea…
 6 2021-04-07 2020-01-01 2021-04-03 By Total <NA>  <NA>  United… All … 15-24 ye…
 7 2021-04-07 2020-01-01 2021-04-03 By Total <NA>  <NA>  United… All … 18-29 ye…
 8 2021-04-07 2020-01-01 2021-04-03 By Total <NA>  <NA>  United… All … 25-34 ye…
 9 2021-04-07 2020-01-01 2021-04-03 By Total <NA>  <NA>  United… All … 30-39 ye…
10 2021-04-07 2020-01-01 2021-04-03 By Total <NA>  <NA>  United… All … 35-44 ye…
# ℹ 52,316 more rows
# ℹ 6 more variables: covid_19_deaths <int>, total_deaths <int>,
#   pneumonia_deaths <int>, pneumonia_and_covid_19_deaths <int>,
#   influenza_deaths <int>, pneumonia_influenza_or_covid_19_deaths <int>
```

If we wanted to …

```r
library(stringr)  # it's back!

nchs ▷
  select(!(c(data_as_of:end_date, year, month)))
```

```
# A tibble: 52,326 × 10
   group    state  sex   age_group covid_19_deaths total_deaths pneumonia_deaths
   <chr>    <chr>  <chr> <chr>               <int>        <int>            <int>
 1 By Total Unite… All … All ages           539723      4161167           466437
 2 By Total Unite… All … Under 1 …              59        22626              246
 3 By Total Unite… All … 0-17 yea…             251        39620              667
 4 By Total Unite… All … 1-4 years              31         4069              137
 5 By Total Unite… All … 5-14 yea…              89         6578              195
 6 By Total Unite… All … 15-24 ye…             804        42596              930
 7 By Total Unite… All … 18-29 ye…            1996        75339             2184
 8 By Total Unite… All … 25-34 ye…            3543        88196             3493
 9 By Total Unite… All … 30-39 ye…            5792       107348             5276
10 By Total Unite… All … 35-44 ye…            9259       126848             8203
# ℹ 52,316 more rows
# ℹ 3 more variables: pneumonia_and_covid_19_deaths <int>,
#   influenza_deaths <int>, pneumonia_influenza_or_covid_19_deaths <int>
```

If we wanted to …

```r
library(stringr)  # it's back!

nchs ▷
  select(!(c(data_as_of:end_date, year, month))) ▷
  pivot_longer(
    covid_19_deaths:pneumonia_influenza_or_covid_19_death
    names_to = "outcome",
    values_to = "n")
```

```
# A tibble: 313,956 × 6
   group    state         sex       age_group    outcome                      n
   <chr>    <chr>         <chr>     <chr>        <chr>                    <int>
 1 By Total United States All Sexes All ages     covid_19_deaths         5.40e5
 2 By Total United States All Sexes All ages     total_deaths            4.16e6
 3 By Total United States All Sexes All ages     pneumonia_deaths        4.66e5
 4 By Total United States All Sexes All ages     pneumonia_and_covid_19_… 2.63e5
 5 By Total United States All Sexes All ages     influenza_deaths        9.04e3
 6 By Total United States All Sexes All ages     pneumonia_influenza_or_… 7.51e5
 7 By Total United States All Sexes Under 1 year covid_19_deaths         5.9 e1
 8 By Total United States All Sexes Under 1 year total_deaths            2.26e4
 9 By Total United States All Sexes Under 1 year pneumonia_deaths        2.46e2
10 By Total United States All Sexes Under 1 year pneumonia_and_covid_19_… 1   e1
# ℹ 313,946 more rows
```

If we wanted to ...

```
library(stringr)  # it's back!

nchs ▷
  select(!(c(data_as_of:end_date, year, month))) ▷
  pivot_longer(
    covid_19_deaths:pneumonia_influenza_or_covid_19_death
    names_to = "outcome",
    values_to = "n") ▷
  mutate(
    outcome = str_to_sentence(outcome),
    outcome = str_replace_all(outcome, "_", " "),
    outcome = str_replace(outcome, "(C|c)ovid 19", "COVID
```

```
# A tibble: 313,956 × 6
   group    state         sex        age_group    outcome                      n
   <chr>    <chr>         <chr>      <chr>        <chr>                    <int>
 1 By Total United States All Sexes All ages     COVID-19 deaths          5.40e5
 2 By Total United States All Sexes All ages     Total deaths             4.16e6
 3 By Total United States All Sexes All ages     Pneumonia deaths         4.66e5
 4 By Total United States All Sexes All ages     Pneumonia and COVID-19 … 2.63e5
 5 By Total United States All Sexes All ages     Influenza deaths         9.04e3
 6 By Total United States All Sexes All ages     Pneumonia influenza or … 7.51e5
 7 By Total United States All Sexes Under 1 year COVID-19 deaths          5.9 e1
 8 By Total United States All Sexes Under 1 year Total deaths             2.26e4
 9 By Total United States All Sexes Under 1 year Pneumonia deaths         2.46e2
10 By Total United States All Sexes Under 1 year Pneumonia and COVID-19 … 1   e1
# ℹ 313,946 more rows
```

If we wanted to …

Put this in an object called `nchs_fmt`

… we could make a table or graph

```r
nchs_fmt ▷
  select(state, age_group, outcome, n)
```

```
# A tibble: 313,956 × 4
   state         age_group    outcome                                  n
   <chr>         <chr>        <chr>                                <int>
 1 United States All ages     COVID-19 deaths                     539723
 2 United States All ages     Total deaths                       4161167
 3 United States All ages     Pneumonia deaths                    466437
 4 United States All ages     Pneumonia and COVID-19 deaths       263147
 5 United States All ages     Influenza deaths                      9037
 6 United States All ages     Pneumonia influenza or COVID-19 deaths  750804
 7 United States Under 1 year COVID-19 deaths                         59
 8 United States Under 1 year Total deaths                         22626
 9 United States Under 1 year Pneumonia deaths                       246
10 United States Under 1 year Pneumonia and COVID-19 deaths           10
# ℹ 313,946 more rows
```

Cleaned up (but not tidy)

```r
nchs_fmt |>
  distinct(group)
```

```
# A tibble: 3 × 1
  group
  <chr>
1 By Total
2 By Year
3 By Month
```

Cleaned up (but not tidy)

```
nchs_fmt ▷
  distinct(group)
```

```
# A tibble: 3 × 1
  group
  <chr>
1 By Total
2 By Year
3 By Month
```

```
nchs_fmt ▷
  distinct(age_group)
```

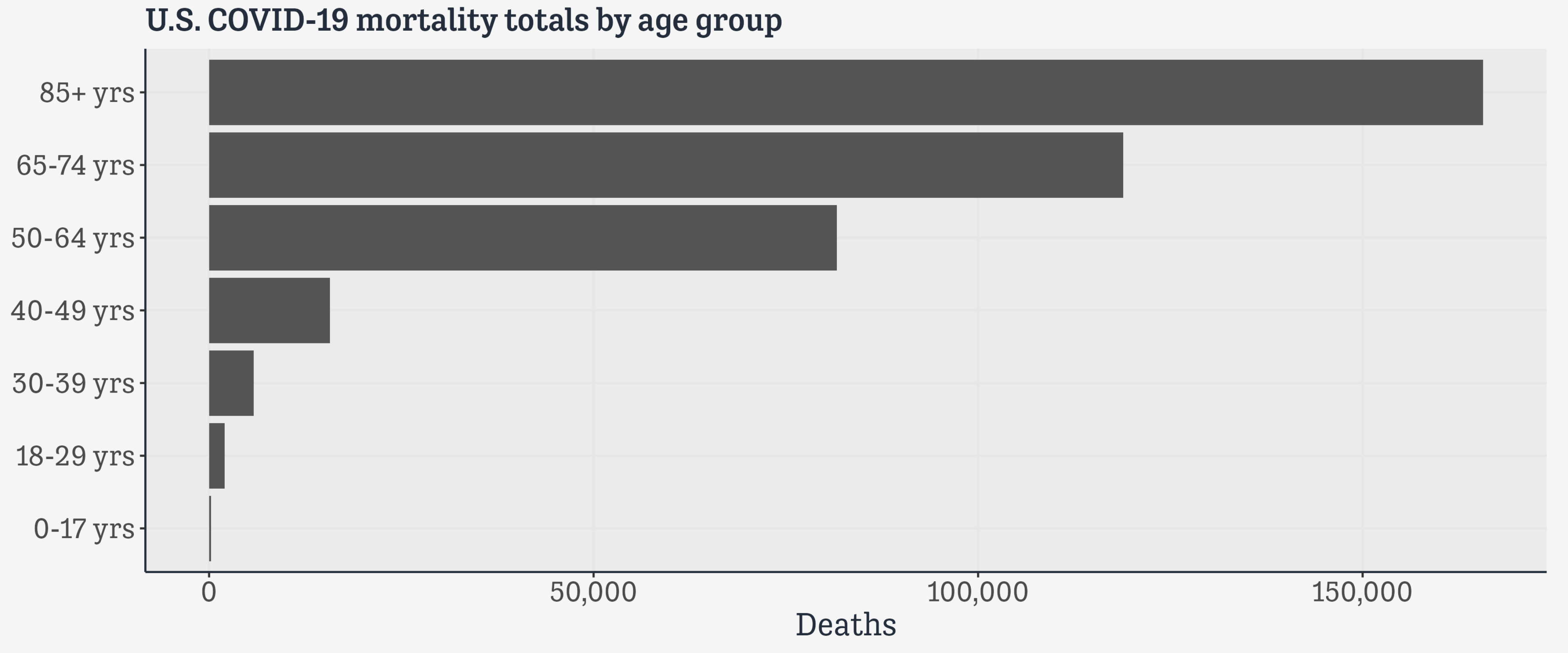
```
# A tibble: 17 × 1
   age_group
   <chr>
 1 All ages
 2 Under 1 year
 3 0-17 years
 4 1-4 years
 5 5-14 years
 6 15-24 years
 7 18-29 years
 8 25-34 years
 9 30-39 years
10 35-44 years
11 40-49 years
12 45-54 years
13 50-64 years
14 55-64 years
15 65-74 years
16 75-84 years
```

Make our plot

```
p_out <- nchs_fmt |>
  filter(group %in% "By Total",
         sex %in% "All Sexes",
         state %in% "United States",
         age_group %in% c("0-17 years",
                          "18-29 years",
                          "30-39 years",
                          "40-49 years",
                          "50-64 years",
                          "65-74 years",
                          "85 years and over"),
         outcome %in% "COVID-19 deaths") |>
  mutate(age_group = str_replace(age_group, "years", "yrs"),
         age_group = str_replace(age_group, " and over", ""),
         age_group = str_replace(age_group, "85", "85+")) |>
  ggplot(mapping = aes(x = n, y = age_group)) +
  geom_col() + scale_x_continuous(labels = scales::comma) +
  labs(x = "Deaths", y = NULL, title = "U.S. COVID-19 mortality totals by age group")
```

Result

```
p_out
```


U.S. COVID-19 mortality totals by age group
85+ yrs
65-74 yrs
50-64 yrs
40-49 yrs
30-39 yrs
18-29 yrs
0-17 yrs
0
50,000
100,000
150,000
Deaths

Every dataset is different

Dropping missings

Dropping missing values

```r
df <- tribble(
  ~a, ~b, ~c,
  1, NA, 2,
  NA, NA, NA,
  2, 2, 2
)

df
```

```
# A tibble: 3 × 3
      a     b     c
  <dbl> <dbl> <dbl>
1     1    NA     2
2    NA    NA    NA
3     2     2     2
```

Dropping **missing values**

```
# 2 Convenience function
df |>
  drop_na()
```

```
# A tibble: 1 × 3
      a     b     c
  <dbl> <dbl> <dbl>
1     2     2     2
```

Drops all rows with *any* missing cases.

Dropping **missing values**

What if we only want to drop all rows with *all* missing cases?

```r
# 3
df |>
  # Anonymous function \(x)
  filter(!if_all(everything(), \(x) is.na(x)))
```

```
# A tibble: 2 × 3
      a     b     c
  <dbl> <dbl> <dbl>
1     1    NA     2
2     2     2     2
```

```r
# 4 Convenience function from janitor
df |>
  janitor::remove_empty("rows")
```

```
# A tibble: 2 × 3
      a     b     c
  <dbl> <dbl> <dbl>
1     1    NA     2
2     2     2     2
```

Revisit: Using `across()` and `where()`

Do more than one thing

The other week we saw this:

```
gss_sm ▷
  group_by(race, sex, degree) ▷
  summarize(n = n(),
            mean_age = mean(age, na.rm = TRUE),
            mean_kids = mean(childs, na.rm = TRUE))
```

```
# A tibble: 34 × 6
# Groups:   race, sex [6]
   race  sex    degree             n mean_age mean_kids
   <fct> <fct>  <fct>          <int>    <dbl>     <dbl>
 1 White Male   Lt High School    96     52.9      2.45
 2 White Male   High School      470     48.8      1.61
 3 White Male   Junior College    65     47.1      1.54
 4 White Male   Bachelor         208     48.6      1.35
 5 White Male   Graduate         112     56.0      1.71
 6 White Female Lt High School   101     55.4      2.81
 7 White Female High School      587     51.9      1.98
 8 White Female Junior College   101     48.2      1.91
 9 White Female Bachelor         218     49.2      1.44
10 White Female Graduate         138     53.6      1.38
# ℹ 24 more rows
```

Do more than one thing

Similarly for `organdata` we might want to do:

```
organdata |>
  group_by(consent_law, country) |>
  summarize(donors_mean = mean(donors, na.rm = TRUE),
            donors_sd = sd(donors, na.rm = TRUE),
            gdp_mean = mean(gdp, na.rm = TRUE),
            health_mean = mean(health, na.rm = TRUE),
            roads_mean = mean(roads, na.rm = TRUE))
```

```
# A tibble: 17 × 7
# Groups:   consent_law [2]
   consent_law country      donors_mean donors_sd gdp_mean health_mean roads_mean
   <chr>       <chr>              <dbl>     <dbl>    <dbl>       <dbl>      <dbl>
 1 Informed    Australia           10.6     1.14    22179.       1958.      105. 
 2 Informed    Canada              14.0     0.751   23711.       2272.      109. 
 3 Informed    Denmark             13.1     1.47    23722.       2054.      102. 
 4 Informed    Germany             13.0     0.611   22163.       2349.      113. 
 5 Informed    Ireland             19.8     2.48    20824.       1480.      118. 
 6 Informed    Netherlands         13.7     1.55    23013.       1993.       76.1
 7 Informed    United Kin…         13.5     0.775   21359.       1561.       67.9
 8 Informed    United Sta…         20.0     1.33    29212.       3988.      155. 
 9 Presumed    Austria             23.5     2.42    23876.       1875.      150. 
10 Presumed    Belgium             21.9     1.94    22500.       1958.      155. 
11 Presumed    Finland             18.4     1.53    21019.       1615.       93.6
12 Presumed    France              16.8     1.60    22603.       2160.      156. 
13 Presumed    Italy               11.1     4.28    21554.       1757       122. 
14 Presumed    Norway              15.4     1.11    26448.       2217.       70.0
15 Presumed    Spain               28.1     4.96    16933        1289.      161. 
```

Use across()

And we also saw this we could use `across()` to apply a function to more than one column.

```r
my_vars <- c("gdp", "donors", "roads")

## nested parens again, but it's worth it
organdata |>
  group_by(consent_law, country) |>
  summarize(across(all_of(my_vars),
                 list(avg = \(x) mean(x, na.rm = TRUE))
                )
           )
```

```
# A tibble: 17 × 5
# Groups:   consent_law [2]
   consent_law country        gdp_avg donors_avg roads_avg
   <chr>       <chr>            <dbl>      <dbl>     <dbl>
 1 Informed    Australia       22179.       10.6     105.
 2 Informed    Canada          23711.       14.0     109.
 3 Informed    Denmark         23722.       13.1     102.
 4 Informed    Germany         22163.       13.0     113.
 5 Informed    Ireland         20824.       19.8     118.
 6 Informed    Netherlands     23013.       13.7      76.1
 7 Informed    United Kingdom  21359.       13.5      67.9
 8 Informed    United States   29212.       20.0     155.
 9 Presumed    Austria         23876.       23.5     150.
10 Presumed    Belgium         22500.       21.9     155.
11 Presumed    Finland         21019.       18.4      93.6
12 Presumed    France          22603.       16.8     156.
13 Presumed    Italy           21554.       11.1     122.
```

Let’s look at that again

```r
my_vars <- c("gdp", "donors", "roads")
```

Let’s look at that again

```r
my_vars <- c("gdp", "donors", "roads")

## nested parens again, but it's worth it
organdata
```

```
# A tibble: 238 × 21
   country   year       donors   pop pop_dens   gdp gdp_lag health health_lag
   <chr>     <date>      <dbl> <int>    <dbl> <int>   <int>  <dbl>      <dbl>
 1 Australia NA          NA    17065    0.220 16774   16591   1300       1224
 2 Australia 1991-01-01  12.1  17284    0.223 17171   16774   1379       1300
 3 Australia 1992-01-01  12.4  17495    0.226 17914   17171   1455       1379
 4 Australia 1993-01-01  12.5  17667    0.228 18883   17914   1540       1455
 5 Australia 1994-01-01  10.2  17855    0.231 19849   18883   1626       1540
 6 Australia 1995-01-01  10.2  18072    0.233 21079   19849   1737       1626
 7 Australia 1996-01-01  10.6  18311    0.237 21923   21079   1846       1737
 8 Australia 1997-01-01  10.3  18518    0.239 22961   21923   1948       1846
 9 Australia 1998-01-01  10.5  18711    0.242 24148   22961   2077       1948
10 Australia 1999-01-01   8.67 18926    0.244 25445   24148   2231       2077
# ℹ 228 more rows
# ℹ 12 more variables: pubhealth <dbl>, roads <dbl>, cerebvas <int>,
#   assault <int>, external <int>, txp_pop <dbl>, world <chr>, opt <chr>,
#   consent_law <chr>, consent_practice <chr>, consistent <chr>, ccode <chr>
```

Let’s look at that again

```r
my_vars <- c("gdp", "donors", "roads")

## nested parens again, but it's worth it
organdata |>
  group_by(consent_law, country)
```

```
# A tibble: 238 × 21
# Groups:   consent_law, country [17]
   country   year       donors   pop pop_dens   gdp gdp_lag health health_lag
   <chr>     <date>      <dbl> <int>    <dbl> <int>   <int>  <dbl>      <dbl>
 1 Australia NA          NA    17065    0.220 16774   16591   1300       1224
 2 Australia 1991-01-01  12.1  17284    0.223 17171   16774   1379       1300
 3 Australia 1992-01-01  12.4  17495    0.226 17914   17171   1455       1379
 4 Australia 1993-01-01  12.5  17667    0.228 18883   17914   1540       1455
 5 Australia 1994-01-01  10.2  17855    0.231 19849   18883   1626       1540
 6 Australia 1995-01-01  10.2  18072    0.233 21079   19849   1737       1626
 7 Australia 1996-01-01  10.6  18311    0.237 21923   21079   1846       1737
 8 Australia 1997-01-01  10.3  18518    0.239 22961   21923   1948       1846
 9 Australia 1998-01-01  10.5  18711    0.242 24148   22961   2077       1948
10 Australia 1999-01-01   8.67 18926    0.244 25445   24148   2231       2077
# ℹ 228 more rows
# ℹ 12 more variables: pubhealth <dbl>, roads <dbl>, cerebvas <int>,
#   assault <int>, external <int>, txp_pop <dbl>, world <chr>, opt <chr>,
#   consent_law <chr>, consent_practice <chr>, consistent <chr>, ccode <chr>
```

Let's look at that again

```r
my_vars <- c("gdp", "donors", "roads")

## nested parens again, but it's worth it
organdata |>
  group_by(consent_law, country) |>
  summarize(across(all_of(my_vars),
                   list(avg = \(x) mean(x, na.rm = TRUE))
                  )
           )
```

```
# A tibble: 17 × 5
# Groups:   consent_law [2]
   consent_law country        gdp_avg donors_avg roads_avg
   <chr>       <chr>            <dbl>      <dbl>     <dbl>
 1 Informed    Australia       22179.       10.6     105.
 2 Informed    Canada          23711.       14.0     109.
 3 Informed    Denmark         23722.       13.1     102.
 4 Informed    Germany         22163.       13.0     113.
 5 Informed    Ireland         20824.       19.8     118.
 6 Informed    Netherlands     23013.       13.7      76.1
 7 Informed    United Kingdom  21359.       13.5      67.9
 8 Informed    United States   29212.       20.0     155.
 9 Presumed    Austria         23876.       23.5     150.
10 Presumed    Belgium         22500.       21.9     155.
11 Presumed    Finland         21019.       18.4      93.6
12 Presumed    France          22603.       16.8     156.
13 Presumed    Italy           21554.       11.1     122.
14 Presumed    Norway          26448.       15.4      70.0
15 Presumed    Spain           16933        28.1     161.
16 Presumed    Sweden          22415.       13.1      72.3
17 Presumed    Switzerland     27233        14.2      96.4
```

Let’s look at that again

```r
my_vars <- c("gdp", "donors", "roads")

organdata |>
  group_by(consent_law, country) |>
  summarize(across(all_of(my_vars),
                   list(avg = \(x) mean(x, na.rm = TRUE))
                  )
            )
```

We can calculate more than one thing

```r
my_vars <- c("gdp", "donors", "roads")

organdata |>
  group_by(consent_law, country) |>
  summarize(across(all_of(my_vars),
                   list(avg = \(x) mean(x, na.rm = TRUE),
                        sdev = \(x) sd(x, na.rm = TRUE),
                        md = \(x) median(x, na.rm = TRUE))
                   )
            )
```

```
# A tibble: 17 × 11
# Groups:   consent_law [2]
   consent_law country   gdp_avg gdp_sdev gdp_md donors_avg donors_sdev donors_md
   <chr>       <chr>       <dbl>    <dbl>  <int>      <dbl>       <dbl>     <dbl>
 1 Informed    Austral…   22179.    3959.  21923       10.6       1.14       10.4
 2 Informed    Canada     23711.    3966.  22764       14.0       0.751      14.0
 3 Informed    Denmark    23722.    3896.  23548       13.1       1.47       12.9
 4 Informed    Germany    22163.    2501.  22164       13.0       0.611      13  
 5 Informed    Ireland    20824.    6670.  19245       19.8       2.48       19.2
 6 Informed    Netherl…   23013.    3770.  22541       13.7       1.55       13.8
 7 Informed    United …   21359.    3929.  20839       13.5       0.775      13.5
 8 Informed    United …   29212.    4571.  28772       20.0       1.33       20.1
 9 Presumed    Austria    23876.    3343.  23798       23.5       2.42       23.8
10 Presumed    Belgium    22500.    3171.  22152       21.9       1.94       21.4
11 Presumed    Finland    21019.    3668.  19842       18.4       1.53       19.4
12 Presumed    France     22603.    3260.  21990       16.8       1.60       16.6
13 Presumed    Italy      21554.    2781.  21396       11.1       4.28       11.3
14 Presumed    Norway     26448.    6492.  26218       15.4       1.11       15.4
15 Presumed    Spain      16933     2888.  16416       28.1       4.96       28  
```

It's OK to use the function names

```r
my_vars <- c("gdp", "donors", "roads")

organdata |>
  group_by(consent_law, country) |>
  summarize(across(all_of(my_vars),
                   list(mean = \(x) mean(x, na.rm = TRUE),
                        sd = \(x) sd(x, na.rm = TRUE),
                        median = \(x) median(x, na.rm = TRUE))
                   )
            )
```

```
# A tibble: 17 × 11
# Groups:   consent_law [2]
   consent_law country        gdp_mean gdp_sd gdp_median donors_mean donors_sd
   <chr>       <chr>             <dbl>  <dbl>      <int>       <dbl>     <dbl>
 1 Informed    Australia        22179.  3959.      21923        10.6     1.14
 2 Informed    Canada           23711.  3966.      22764        14.0     0.751
 3 Informed    Denmark          23722.  3896.      23548        13.1     1.47
 4 Informed    Germany          22163.  2501.      22164        13.0     0.611
 5 Informed    Ireland          20824.  6670.      19245        19.8     2.48
 6 Informed    Netherlands      23013.  3770.      22541        13.7     1.55
 7 Informed    United Kingdom   21359.  3929.      20839        13.5     0.775
 8 Informed    United States    29212.  4571.      28772        20.0     1.33
 9 Presumed    Austria          23876.  3343.      23798        23.5     2.42
10 Presumed    Belgium          22500.  3171.      22152        21.9     1.94
11 Presumed    Finland          21019.  3668.      19842        18.4     1.53
12 Presumed    France           22603.  3260.      21990        16.8     1.60
13 Presumed    Italy            21554.  2781.      21396        11.1     4.28
14 Presumed    Norway           26448.  6492.      26218        15.4     1.11
15 Presumed    Spain            16933   2888.      16416        28.1     4.96
```

Selection with `across(where())`

```r
organdata |>
  group_by(consent_law, country) |>
  summarize(across(where(is.numeric),
                   list(mean = \(x) mean(x, na.rm = TRUE),
                        sd = \(x) sd(x, na.rm = TRUE),
                        median = \(x) median(x, na.rm = TRUE))
                  )
            ) |>
    print(n = 3) # just to save slide space
```

```
# A tibble: 17 × 41
# Groups:   consent_law [2]
  consent_law country   donors_mean donors_sd donors_median pop_mean pop_sd
  <chr>       <chr>           <dbl>     <dbl>         <dbl>    <dbl>  <dbl>
1 Informed    Australia        10.6     1.14           10.4   18318.   831.
2 Informed    Canada           14.0     0.751          14.0   29608.  1193.
3 Informed    Denmark          13.1     1.47           12.9    5257.   80.6
# ℹ 14 more rows
# ℹ 34 more variables: pop_median <int>, pop_dens_mean <dbl>,
#   pop_dens_sd <dbl>, pop_dens_median <dbl>, gdp_mean <dbl>, gdp_sd <dbl>,
#   gdp_median <int>, gdp_lag_mean <dbl>, gdp_lag_sd <dbl>,
#   gdp_lag_median <dbl>, health_mean <dbl>, health_sd <dbl>,
#   health_median <dbl>, health_lag_mean <dbl>, health_lag_sd <dbl>,
#   health_lag_median <dbl>, pubhealth_mean <dbl>, pubhealth_sd <dbl>, …
```

Name new columns with `.names`

```r
organdata ▷
  group_by(consent_law, country) ▷
  summarize(across(where(is.numeric),
                  list(mean = \(x) mean(x, na.rm = TRUE),
                       sd = \(x) sd(x, na.rm = TRUE),
                       median = \(x) median(x, na.rm = TRUE)),
                  .names = "{fn}_{col}"
                  )
            ) ▷
  print(n = 3)
```

```
# A tibble: 17 × 41
# Groups:   consent_law [2]
  consent_law country   mean_donors sd_donors median_donors mean_pop sd_pop
  <chr>       <chr>           <dbl>     <dbl>         <dbl>    <dbl>  <dbl>
1 Informed    Australia        10.6     1.14           10.4   18318.   831.
2 Informed    Canada           14.0     0.751          14.0   29608. 1193.
3 Informed    Denmark          13.1     1.47           12.9    5257.   80.6
# ℹ 14 more rows
# ℹ 34 more variables: median_pop <int>, mean_pop_dens <dbl>,
#   sd_pop_dens <dbl>, median_pop_dens <dbl>, mean_gdp <dbl>, sd_gdp <dbl>,
#   median_gdp <int>, mean_gdp_lag <dbl>, sd_gdp_lag <dbl>,
#   median_gdp_lag <dbl>, mean_health <dbl>, sd_health <dbl>,
#   median_health <dbl>, mean_health_lag <dbl>, sd_health_lag <dbl>,
#   median_health_lag <dbl>, mean_pubhealth <dbl>, sd_pubhealth <dbl>, …
```

Name new columns with `.names`

In tidyverse functions, arguments that begin with a “`.`” generally have it in order to avoid confusion with existing items, or are “pronouns” referring to e.g. “the name of the thing we’re currently talking about as we evaluate this function”.

This all works with `mutate()`, too

```r
organdata |>
  mutate(across(where(is.character), toupper)) |>
  select(where(is.character))
```

```
# A tibble: 238 × 7
   country   world   opt   consent_law consent_practice consistent ccode
   <chr>     <chr>   <chr> <chr>       <chr>            <chr>      <chr>
 1 AUSTRALIA LIBERAL IN    INFORMED    INFORMED         YES        OZ
 2 AUSTRALIA LIBERAL IN    INFORMED    INFORMED         YES        OZ
 3 AUSTRALIA LIBERAL IN    INFORMED    INFORMED         YES        OZ
 4 AUSTRALIA LIBERAL IN    INFORMED    INFORMED         YES        OZ
 5 AUSTRALIA LIBERAL IN    INFORMED    INFORMED         YES        OZ
 6 AUSTRALIA LIBERAL IN    INFORMED    INFORMED         YES        OZ
 7 AUSTRALIA LIBERAL IN    INFORMED    INFORMED         YES        OZ
 8 AUSTRALIA LIBERAL IN    INFORMED    INFORMED         YES        OZ
 9 AUSTRALIA LIBERAL IN    INFORMED    INFORMED         YES        OZ
10 AUSTRALIA LIBERAL IN    INFORMED    INFORMED         YES        OZ
# ℹ 228 more rows
```

Example: cleaning a table

Cleaning a table

With that in mind … Some marketing data

SEGMENT	DESCRIPTION	R	F	M
Champions	Bought recently, buy often and spend the most	4– 5	4– 5	4– 5
Loyal Customers	Spend good money. Responsive to promotions	2– 5	3– 5	3– 5
Potential Loyalist	Recent customers, spent good amount, bought more than once	3– 5	1– 3	1– 3
New Customers	Bought more recently, but not often	4– 5	<= 1	<= 1
Promising	Recent shoppers, but haven’t spent much	3– 4	<= 1	<= 1
Need Attention	Above average recency, frequency & monetary values	2– 3	2– 3	2– 3
About To Sleep	Below average recency, frequency & monetary values	2– 3	<= 2	<= 2
At Risk	Spent big money, purchased often but long time ago	<= 2	2– 5	2– 5
Can’t Lose Them	Made big purchases and often, but long time ago	<= 1	4– 5	4– 5
Hibernating	Low spenders, low frequency, purchased long time ago	1– 2	1– 2	1– 2
Lost	Lowest recency, frequency & monetary scores	<= 2	<= 2	<= 2

Cleaning a table

```
read_csv(here("files", "examples", "rfm_table.csv"))
```

```
# A tibble: 23 × 5
   SEGMENT            DESCRIPTION                               R     F     M
   <chr>              <chr>                                     <chr> <chr> <chr>
 1 <NA>               <NA>                                      <NA>  <NA>  <NA>
 2 Champions          Bought recently, buy often and spend th… 4- 5  4- 5  4- 5
 3 <NA>               <NA>                                      <NA>  <NA>  <NA>
 4 Loyal Customers    Spend good money. Responsive to promoti… 2- 5  3- 5  3- 5
 5 <NA>               <NA>                                      <NA>  <NA>  <NA>
 6 Potential Loyalist Recent customers, spent good amount, bo… 3- 5  1- 3  1- 3
 7 <NA>               <NA>                                      <NA>  <NA>  <NA>
 8 New Customers      Bought more recently, but not often       4- 5  ≤ 1   ≤ 1
 9 <NA>               <NA>                                      <NA>  <NA>  <NA>
10 Promising          Recent shoppers, but haven't spent much   3- 4  ≤ 1   ≤ 1
# ℹ 13 more rows
```

Cleaning a table

```r
read_csv(here("files", "examples", "rfm_table.csv")) |>
  janitor::clean_names()
```

```
# A tibble: 23 × 5
   segment           description                                  r     f     m    
   <chr>             <chr>                                        <chr> <chr> <chr>
 1 <NA>              <NA>                                         <NA>  <NA>  <NA> 
 2 Champions         Bought recently, buy often and spend th…     4- 5  4- 5  4- 5 
 3 <NA>              <NA>                                         <NA>  <NA>  <NA> 
 4 Loyal Customers   Spend good money. Responsive to promoti…     2- 5  3- 5  3- 5 
 5 <NA>              <NA>                                         <NA>  <NA>  <NA> 
 6 Potential Loyalist Recent customers, spent good amount, bo…    3- 5  1- 3  1- 3 
 7 <NA>              <NA>                                         <NA>  <NA>  <NA> 
 8 New Customers     Bought more recently, but not often          4- 5  ≤ 1   ≤ 1  
 9 <NA>              <NA>                                         <NA>  <NA>  <NA> 
10 Promising         Recent shoppers, but haven't spent much      3- 4  ≤ 1   ≤ 1  
# ℹ 13 more rows
```

Cleaning a table

```
read_csv(here("files", "examples", "rfm_table.csv")) |>
  janitor::clean_names() |>
  janitor::remove_empty("rows")
```

```
# A tibble: 11 × 5
   segment            description                                r     f     m
   <chr>              <chr>                                      <chr> <chr> <chr>
 1 Champions          Bought recently, buy often and spend th… 4- 5  4- 5  4- 5
 2 Loyal Customers    Spend good money. Responsive to promoti… 2- 5  3- 5  3- 5
 3 Potential Loyalist Recent customers, spent good amount, bo… 3- 5  1- 3  1- 3
 4 New Customers      Bought more recently, but not often      4- 5  ≤ 1   ≤ 1
 5 Promising          Recent shoppers, but haven't spent much  3- 4  ≤ 1   ≤ 1
 6 Need Attention     Above average recency, frequency & mone… 2- 3  2- 3  2- 3
 7 About To Sleep     Below average recency, frequency & mone… 2- 3  ≤ 2   ≤ 2
 8 At Risk            Spent big money, purchased often but lo… ≤ 2   2- 5  2- 5
 9 Can't Lose Them    Made big purchases and often, but long … ≤ 1   4- 5  4- 5
10 Hibernating        Low spenders, low frequency, purchased … 1- 2  1- 2  1- 2
11 Lost               Lowest recency, frequency & monetary sc… ≤ 2   ≤ 2   ≤ 2
```

Cleaning a table

```r
read_csv(here("files", "examples", "rfm_table.csv")) |>
  janitor::clean_names() |>
  janitor::remove_empty("rows") |>
  pivot_longer(cols = r:m)
```

```
# A tibble: 33 × 4
   segment            description                                     name  value
   <chr>              <chr>                                           <chr> <chr>
 1 Champions          Bought recently, buy often and spend the most   r     4- 5
 2 Champions          Bought recently, buy often and spend the most   f     4- 5
 3 Champions          Bought recently, buy often and spend the most   m     4- 5
 4 Loyal Customers    Spend good money. Responsive to promotions      r     2- 5
 5 Loyal Customers    Spend good money. Responsive to promotions      f     3- 5
 6 Loyal Customers    Spend good money. Responsive to promotions      m     3- 5
 7 Potential Loyalist Recent customers, spent good amount, bought m… r     3- 5
 8 Potential Loyalist Recent customers, spent good amount, bought m… f     1- 3
 9 Potential Loyalist Recent customers, spent good amount, bought m… m     1- 3
10 New Customers      Bought more recently, but not often             r     4- 5
# ℹ 23 more rows
```

Cleaning a table

```r
read_csv(here("files", "examples", "rfm_table.csv")) |>
  janitor::clean_names() |>
  janitor::remove_empty("rows") |>
  pivot_longer(cols = r:m) |>
  separate(col = value, into = c("lo", "hi"),
           remove = FALSE, convert = TRUE,
           fill = "left")
```

```
# A tibble: 33 × 6
   segment           description                          name  value    lo    hi
   <chr>             <chr>                                <chr> <chr> <int> <int>
 1 Champions         Bought recently, buy often and sp… r     4- 5      4     5
 2 Champions         Bought recently, buy often and sp… f     4- 5      4     5
 3 Champions         Bought recently, buy often and sp… m     4- 5      4     5
 4 Loyal Customers   Spend good money. Responsive to p… r     2- 5      2     5
 5 Loyal Customers   Spend good money. Responsive to p… f     3- 5      3     5
 6 Loyal Customers   Spend good money. Responsive to p… m     3- 5      3     5
 7 Potential Loyalist Recent customers, spent good amou… r     3- 5      3     5
 8 Potential Loyalist Recent customers, spent good amou… f     1- 3      1     3
 9 Potential Loyalist Recent customers, spent good amou… m     1- 3      1     3
10 New Customers     Bought more recently, but not oft… r     4- 5      4     5
# ℹ 23 more rows
```

Cleaning a table

```
read_csv(here("files", "examples", "rfm_table.csv")) |>
  janitor::clean_names() |>
  janitor::remove_empty("rows") |>
  pivot_longer(cols = r:m) |>
  separate(col = value, into = c("lo", "hi"),
           remove = FALSE, convert = TRUE,
           fill = "left") |>
  select(-value)
```

```
# A tibble: 33 × 5
   segment             description                                name     lo    hi
   <chr>               <chr>                                      <chr> <int> <int>
 1 Champions           Bought recently, buy often and spend th… r         4     5
 2 Champions           Bought recently, buy often and spend th… f         4     5
 3 Champions           Bought recently, buy often and spend th… m         4     5
 4 Loyal Customers     Spend good money. Responsive to promoti… r         2     5
 5 Loyal Customers     Spend good money. Responsive to promoti… f         3     5
 6 Loyal Customers     Spend good money. Responsive to promoti… m         3     5
 7 Potential Loyalist Recent customers, spent good amount, bo… r         3     5
 8 Potential Loyalist Recent customers, spent good amount, bo… f         1     3
 9 Potential Loyalist Recent customers, spent good amount, bo… m         1     3
10 New Customers       Bought more recently, but not often        r         4     5
# ℹ 23 more rows
```

Cleaning a table

```r
read_csv(here("files", "examples", "rfm_table.csv")) |>
  janitor::clean_names() |>
  janitor::remove_empty("rows") |>
  pivot_longer(cols = r:m) |>
  separate(col = value, into = c("lo", "hi"),
           remove = FALSE, convert = TRUE,
           fill = "left") |>
  select(-value) |>
  pivot_wider(names_from = name,
              values_from = lo:hi)
```

```
# A tibble: 11 × 8
   segment            description                lo_r  lo_f  lo_m  hi_r  hi_f  hi_m
   <chr>              <chr>                     <int> <int> <int> <int> <int> <int>
 1 Champions          Bought recently, buy …        4     4     4     5     5     5
 2 Loyal Customers    Spend good money. Res…        2     3     3     5     5     5
 3 Potential Loyalist Recent customers, spe…        3     1     1     5     3     3
 4 New Customers      Bought more recently,…        4    NA    NA     5     1     1
 5 Promising          Recent shoppers, but …        3    NA    NA     4     1     1
 6 Need Attention     Above average recency…        2     2     2     3     3     3
 7 About To Sleep     Below average recency…        2    NA    NA     3     2     2
 8 At Risk            Spent big money, purc…       NA     2     2     2     5     5
 9 Can't Lose Them    Made big purchases an…       NA     4     4     1     5     5
10 Hibernating        Low spenders, low fre…        1     1     1     2     2     2
11 Lost               Lowest recency, frequ…       NA    NA    NA     2     2     2
```

Cleaning a table

```r
read_csv(here("files", "examples", "rfm_table.csv")) |>
  janitor::clean_names() |>
  janitor::remove_empty("rows") |>
  pivot_longer(cols = r:m) |>
  separate(col = value, into = c("lo", "hi"),
           remove = FALSE, convert = TRUE,
           fill = "left") |>
  select(-value) |>
  pivot_wider(names_from = name,
              values_from = lo:hi) |>
  mutate(across(where(is.integer), replace_na, 0))
```

```
# A tibble: 11 × 8
   segment            description               lo_r  lo_f  lo_m  hi_r  hi_f  hi_m
   <chr>              <chr>                    <int> <int> <int> <int> <int> <int>
 1 Champions          Bought recently, buy …       4     4     4     5     5     5
 2 Loyal Customers    Spend good money. Res…       2     3     3     5     5     5
 3 Potential Loyalist Recent customers, spe…       3     1     1     5     3     3
 4 New Customers      Bought more recently,…       4     0     0     5     1     1
 5 Promising          Recent shoppers, but …       3     0     0     4     1     1
 6 Need Attention     Above average recency…       2     2     2     3     3     3
 7 About To Sleep     Below average recency…       2     0     0     3     2     2
 8 At Risk            Spent big money, purc…       0     2     2     2     5     5
 9 Can't Lose Them    Made big purchases an…       0     4     4     1     5     5
10 Hibernating        Low spenders, low fre…       1     1     1     2     2     2
11 Lost               Lowest recency, frequ…       0     0     0     2     2     2
```

Cleaning a table

```r
read_csv(here("files", "examples", "rfm_table.csv")) |>
  janitor::clean_names() |>
  janitor::remove_empty("rows") |>
  pivot_longer(cols = r:m) |>
  separate(col = value, into = c("lo", "hi"),
           remove = FALSE, convert = TRUE,
           fill = "left") |>
  select(-value) |>
  pivot_wider(names_from = name,
              values_from = lo:hi) |>
  mutate(across(where(is.integer), replace_na, 0)) |>
  select(segment,
         lo_r, hi_r,
         lo_f, hi_f,
         lo_m, hi_m,
         description)
```

```
# A tibble: 11 × 8
   segment             lo_r  hi_r  lo_f  hi_f  lo_m  hi_m description
   <chr>              <int> <int> <int> <int> <int> <int> <chr>
 1 Champions              4     5     4     5     4     5 Bought recently, buy …
 2 Loyal Customers        2     5     3     5     3     5 Spend good money. Res…
 3 Potential Loyalist     3     5     1     3     1     3 Recent customers, spe…
 4 New Customers          4     5     0     1     0     1 Bought more recently,…
 5 Promising              3     4     0     1     0     1 Recent shoppers, but …
 6 Need Attention         2     3     2     3     2     3 Above average recency…
 7 About To Sleep         2     3     0     2     0     2 Below average recency…
 8 At Risk                0     2     2     5     2     5 Spent big money, purc…
 9 Can't Lose Them        0     1     4     5     4     5 Made big purchases an…
10 Hibernating            1     2     1     2     1     2 Low spenders, low fre…
11 Lost                   0     2     0     2     0     2 Lowest recency, frequ…
```

A candidate for `rowwise()`?

```r
rfm_table
```

```
# A tibble: 11 × 8
   segment             lo_r  hi_r  lo_f  hi_f  lo_m  hi_m description
   <chr>              <int> <int> <int> <int> <int> <int> <chr>
 1 Champions              4     5     4     5     4     5 Bought recently, buy …
 2 Loyal Customers        2     5     3     5     3     5 Spend good money. Res…
 3 Potential Loyalist     3     5     1     3     1     3 Recent customers, spe…
 4 New Customers          4     5     0     1     0     1 Bought more recently,…
 5 Promising              3     4     0     1     0     1 Recent shoppers, but …
 6 Need Attention         2     3     2     3     2     3 Above average recency…
 7 About To Sleep         2     3     0     2     0     2 Below average recency…
 8 At Risk                0     2     2     5     2     5 Spent big money, purc…
 9 Can't Lose Them        0     1     4     5     4     5 Made big purchases an…
10 Hibernating            1     2     1     2     1     2 Low spenders, low fre…
11 Lost                   0     2     0     2     0     2 Lowest recency, frequ…
```

A candidate for `rowwise()`?

This does what we expect:

```r
rfm_table |>
  mutate(sum_lo = lo_r + lo_f + lo_m,
         sum_hi = hi_r + hi_f + hi_m) |>
  select(segment, sum_lo, sum_hi, everything())
```

```
# A tibble: 11 × 10
   segment          sum_lo sum_hi  lo_r  hi_r  lo_f  hi_f  lo_m  hi_m description
   <chr>             <int>  <int> <int> <int> <int> <int> <int> <int> <chr>
 1 Champions            12     15     4     5     4     5     4     5 Bought rec…
 2 Loyal Customers       8     15     2     5     3     5     3     5 Spend good…
 3 Potential Loya…       5     11     3     5     1     3     1     3 Recent cus…
 4 New Customers         4      7     4     5     0     1     0     1 Bought mor…
 5 Promising             3      6     3     4     0     1     0     1 Recent sho…
 6 Need Attention        6      9     2     3     2     3     2     3 Above aver…
 7 About To Sleep        2      7     2     3     0     2     0     2 Below aver…
 8 At Risk               4     12     0     2     2     5     2     5 Spent big …
 9 Can't Lose Them       8     11     0     1     4     5     4     5 Made big p…
10 Hibernating           3      6     1     2     1     2     1     2 Low spende…
11 Lost                  0      6     0     2     0     2     0     2 Lowest rec…
```

A candidate for `rowwise()`?

But this does not:

```
rfm_table |>
  mutate(sum_lo = sum(lo_r, lo_f, lo_m),
         sum_hi = sum(hi_r, hi_f, hi_m)) |>
  select(segment, sum_lo, sum_hi, everything())
```

```
# A tibble: 11 × 10
   segment          sum_lo sum_hi  lo_r  hi_r  lo_f  hi_f  lo_m  hi_m description
   <chr>             <int>  <int> <int> <int> <int> <int> <int> <int> <chr>
 1 Champions            55    105     4     5     4     5     4     5 Bought rec…
 2 Loyal Customers      55    105     2     5     3     5     3     5 Spend good…
 3 Potential Loya…      55    105     3     5     1     3     1     3 Recent cus…
 4 New Customers        55    105     4     5     0     1     0     1 Bought mor…
 5 Promising            55    105     3     4     0     1     0     1 Recent sho…
 6 Need Attention       55    105     2     3     2     3     2     3 Above aver…
 7 About To Sleep       55    105     2     3     0     2     0     2 Below aver…
 8 At Risk              55    105     0     2     2     5     2     5 Spent big …
 9 Can't Lose Them      55    105     0     1     4     5     4     5 Made big p…
10 Hibernating          55    105     1     2     1     2     1     2 Low spende…
11 Lost                 55    105     0     2     0     2     0     2 Lowest rec…
```

Sum is taking all the columns, adding them up (into a single number), and putting that result in each row.

A candidate for `rowwise()`?

Similarly, this will not give the answer we probably expect:

```r
rfm_table |>
  mutate(mean_lo = mean(c(lo_r, lo_f, lo_m)),
         mean_hi = mean(c(hi_r, hi_f, hi_m))) |>
  select(segment, mean_lo, mean_hi, everything())
```

```
# A tibble: 11 × 10
   segment       mean_lo mean_hi  lo_r  hi_r  lo_f  hi_f  lo_m  hi_m description
   <chr>           <dbl>   <dbl> <int> <int> <int> <int> <int> <int> <chr>
 1 Champions        1.67    3.18     4     5     4     5     4     5 Bought rec…
 2 Loyal Custom…    1.67    3.18     2     5     3     5     3     5 Spend good…
 3 Potential Lo…    1.67    3.18     3     5     1     3     1     3 Recent cus…
 4 New Customers    1.67    3.18     4     5     0     1     0     1 Bought mor…
 5 Promising        1.67    3.18     3     4     0     1     0     1 Recent sho…
 6 Need Attenti…    1.67    3.18     2     3     2     3     2     3 Above aver…
 7 About To Sle…    1.67    3.18     2     3     0     2     0     2 Below aver…
 8 At Risk          1.67    3.18     0     2     2     5     2     5 Spent big …
 9 Can't Lose T…    1.67    3.18     0     1     4     5     4     5 Made big p…
10 Hibernating      1.67    3.18     1     2     1     2     1     2 Low spende…
11 Lost             1.67    3.18     0     2     0     2     0     2 Lowest rec…
```

A candidate for `rowwise()`?

But this will:

```r
rfm_table |>
  rowwise() |>
  mutate(mean_lo = mean(c(lo_r, lo_f, lo_m)),
         mean_hi = mean(c(hi_r, hi_f, hi_m))) |>
  select(segment, mean_lo, mean_hi, everything())
```

```
# A tibble: 11 × 10
# Rowwise:
   segment        mean_lo mean_hi  lo_r  hi_r  lo_f  hi_f  lo_m  hi_m description
   <chr>            <dbl>   <dbl> <int> <int> <int> <int> <int> <int> <chr>
 1 Champions        4        5        4     5     4     5     4     5 Bought rec…
 2 Loyal Custom…    2.67     5        2     5     3     5     3     5 Spend good…
 3 Potential Lo…    1.67     3.67     3     5     1     3     1     3 Recent cus…
 4 New Customers    1.33     2.33     4     5     0     1     0     1 Bought mor…
 5 Promising        1        2        3     4     0     1     0     1 Recent sho…
 6 Need Attenti…    2        3        2     3     2     3     2     3 Above aver…
 7 About To Sle…    0.667    2.33     2     3     0     2     0     2 Below aver…
 8 At Risk          1.33     4        0     2     2     5     2     5 Spent big …
 9 Can't Lose T…    2.67     3.67     0     1     4     5     4     5 Made big p…
10 Hibernating      1        2        1     2     1     2     1     2 Low spende…
11 Lost             0        2        0     2     0     2     0     2 Lowest rec…
```

Rowwise isn’t very efficient

You may want `group_by()` instead

```r
rfm_table |>
  group_by(segment) |>
  mutate(mean_lo = mean(c(lo_r, lo_f, lo_m)),
         mean_hi = mean(c(hi_r, hi_f, hi_m))) |>
  select(segment, mean_lo, mean_hi, everything())
```

```
# A tibble: 11 × 10
# Groups:   segment [11]
   segment       mean_lo mean_hi  lo_r  hi_r  lo_f  hi_f  lo_m  hi_m description
   <chr>           <dbl>   <dbl> <int> <int> <int> <int> <int> <int> <chr>
 1 Champions       4        5        4     5     4     5     4     5 Bought rec…
 2 Loyal Custom…   2.67     5        2     5     3     5     3     5 Spend good…
 3 Potential Lo…   1.67     3.67     3     5     1     3     1     3 Recent cus…
 4 New Customers   1.33     2.33     4     5     0     1     0     1 Bought mor…
 5 Promising       1        2        3     4     0     1     0     1 Recent sho…
 6 Need Attenti…   2        3        2     3     2     3     2     3 Above aver…
 7 About To Sle…   0.667    2.33     2     3     0     2     0     2 Below aver…
 8 At Risk         1.33     4        0     2     2     5     2     5 Spent big …
 9 Can't Lose T…   2.67     3.67     0     1     4     5     4     5 Made big p…
10 Hibernating     1        2        1     2     1     2     1     2 Low spende…
11 Lost            0        2        0     2     0     2     0     2 Lowest rec…
```

You may want `group_by()` instead

```
rfm_table ▷
  group_by(segment) ▷
  mutate(sum_lo = sum(lo_r, lo_f, lo_m),
         sum_hi = sum(hi_r, hi_f, hi_m)) ▷
  select(segment, sum_lo, sum_hi, everything())
```

```
# A tibble: 11 × 10
# Groups:   segment [11]
   segment          sum_lo sum_hi  lo_r  hi_r  lo_f  hi_f  lo_m  hi_m description
   <chr>             <int>  <int> <int> <int> <int> <int> <int> <int> <chr>
 1 Champions            12     15     4     5     4     5     4     5 Bought rec…
 2 Loyal Customers       8     15     2     5     3     5     3     5 Spend good…
 3 Potential Loya…       5     11     3     5     1     3     1     3 Recent cus…
 4 New Customers         4      7     4     5     0     1     0     1 Bought mor…
 5 Promising             3      6     3     4     0     1     0     1 Recent sho…
 6 Need Attention        6      9     2     3     2     3     2     3 Above aver…
 7 About To Sleep        2      7     2     3     0     2     0     2 Below aver…
 8 At Risk               4     12     0     2     2     5     2     5 Spent big …
 9 Can't Lose Them       8     11     0     1     4     5     4     5 Made big p…
10 Hibernating           3      6     1     2     1     2     1     2 Low spende…
11 Lost                  0      6     0     2     0     2     0     2 Lowest rec…
```

Foreign formats

What about Stata?

Using haven

Haven is the Tidyverse's package for reading and managing files from Stata, SPSS, and SAS. You should prefer it to the older Base R package `foreign`, which has similar functionality.

We're going to import a General Social Survey dataset that's in Stata's `.dta` format.

```r
library(haven)

# This will take a moment
gss_panel <- read_stata(here("files", "examples", "gss_panel_long.dta"))
```

The GSS panel

The data:

```
gss_panel
```

```
# A tibble: 14,610 × 2,757
   firstyear firstid    year    id vpsu   vstrat adults ballot  dateintv famgen
       <dbl> <dbl+lbl> <dbl> <dbl> <dbl+> <dbl+> <dbl+> <dbl+l> <dbl+lb> <dbl+l>
 1      2006  9         2006     9     2  1957        1  3 [BAL… 709      1 [1 G…
 2      2006  9         2008  3001    NA    NA        2  3 [BAL… 503      1 [1 G…
 3      2006  9         2010  6001 NA(i)    NA        2  3 [BAL… 508      1 [1 G…
 4      2006 10         2010  6002 NA(i)    NA        1  1 [BAL… 408      1 [1 G…
 5      2006 10         2006    10     2  1957        2  1 [BAL… 630      2 [2 G…
 6      2006 10         2008  3002    NA    NA        2  1 [BAL… 426      2 [2 G…
 7      2006 11         2008  3003    NA    NA        2  3 [BAL… 718      4 [2 G…
 8      2006 11         2010  6003 NA(i)    NA   NA(n)  3 [BAL… 518      2 [2 G…
 9      2006 11         2006    11     2  1957        2  3 [BAL… 630      4 [2 G…
10      2006 12         2010  6004 NA(i)    NA        4  1 [BAL… 324      2 [2 G…
# ℹ 14,600 more rows
# ℹ 2,747 more variables: form <dbl+lbl>, formwt <dbl>, gender1 <dbl+lbl>,
#   hompop <dbl+lbl>, intage <dbl+lbl>, intid <dbl+lbl>, intyrs <dbl+lbl>,
#   mode <dbl+lbl>, oversamp <dbl>, phase <dbl+lbl>, race <dbl+lbl>,
#   reg16 <dbl+lbl>, region <dbl+lbl>, relate1 <dbl+lbl>, relhh1 <dbl+lbl>,
#   relhhd1 <dbl+lbl>, respnum <dbl+lbl>, rvisitor <dbl+lbl>,
```

The GSS panel

The GSS panel

You can see the labeling system at work:

```
gss_panel |>
  select(degree) |>
  group_by(degree) |>
  tally()
```

```
# A tibble: 6 × 2
  degree                      n
  <dbl+lbl>               <int>
1     0 [LT HIGH SCHOOL]   1850
2     1 [HIGH SCHOOL]      7274
3     2 [JUNIOR COLLEGE]   1161
4     3 [bachelor]         2767
5     4 [graduate]         1556
6 NA(d)                       2
```

The GSS panel

Values get pivoted, not labels, though.

```
gss_panel |>
  select(sex, degree) |>
  group_by(sex, degree) |>
  tally() |>
  pivot_wider(names_from = sex, values_from = n)
```

```
# A tibble: 6 × 3
  degree                      `1`   `2`
  <dbl+lbl>                 <int> <int>
1     0 [LT HIGH SCHOOL]      814  1036
2     1 [HIGH SCHOOL]        3131  4143
3     2 [JUNIOR COLLEGE]      440   721
4     3 [bachelor]           1293  1474
5     4 [graduate]            696   860
6 NA(d)                        NA     2
```

The GSS panel

Option 1: Just drop all the labels.

```
gss_panel |>
  zap_missing() |>
  zap_labels()
```

```
# A tibble: 14,610 × 2,757
   firstyear firstid  year    id  vpsu vstrat adults ballot dateintv famgen
       <dbl>   <dbl> <dbl> <dbl> <dbl>  <dbl>  <dbl>  <dbl>    <dbl>  <dbl>
 1      2006       9  2006     9     2   1957      1      3      709      1
 2      2006       9  2008  3001    NA     NA      2      3      503      1
 3      2006       9  2010  6001    NA     NA      2      3      508      1
 4      2006      10  2010  6002    NA     NA      1      1      408      1
 5      2006      10  2006    10     2   1957      2      1      630      2
 6      2006      10  2008  3002    NA     NA      2      1      426      2
 7      2006      11  2008  3003    NA     NA      2      3      718      4
 8      2006      11  2010  6003    NA     NA     NA      3      518      2
 9      2006      11  2006    11     2   1957      2      3      630      4
10      2006      12  2010  6004    NA     NA      4      1      324      2
# ℹ 14,600 more rows
# ℹ 2,747 more variables: form <dbl>, formwt <dbl>, gender1 <dbl>,
#   hompop <dbl>, intage <dbl>, intid <dbl>, intyrs <dbl>, mode <dbl>,
#   oversamp <dbl>, phase <dbl>, race <dbl>, reg16 <dbl>, region <dbl>,
#   relate1 <dbl>, relhh1 <dbl>, relhhd1 <dbl>, respnum <dbl>, rvisitor <dbl>,
#   sampcode <dbl>, sample <dbl>, sex <dbl>, size <dbl>, spaneng <dbl>,
```

The GSS panel

Option 2: Convert the labels

Let's focus on a few measures of interest, and do some recoding.

```r
## Categorical vars
cat_vars <- c("race", "sex", "degree", "relig", "income", "polviews", "fefam")

## Integer vars
int_vars <- c("year", "id", "ballot", "age", "tvhours")


## Survey design
wt_vars <- c("vpsu",
             "vstrat",
             "oversamp",
             "formwt",              # weight to deal with experimental randomization
             "wtssall",             # weight variable
             "sampcode",            # sampling error code
             "sample")              # sampling frame and method


my_gss_vars <- c(int_vars, cat_vars, wt_vars)
```

Cut down the dataset

```
gss_sub <- gss_panel |>
  select(all_of(my_gss_vars))

gss_sub
```

```
# A tibble: 14,610 × 19
    year    id ballot        age       tvhours     race    sex     degree  relig
   <dbl> <dbl> <dbl+lbl>     <dbl+lb> <dbl+lbl>    <dbl+l> <dbl+l> <dbl+l> <dbl+l>
 1  2006     9 3 [BALLOT C] 23       NA(a) [iap] 2 [bla… 2 [fem… 3 [bac… 4 [non…
 2  2008  3001 3 [BALLOT C] 25       NA(i)       3 [oth… 2 [fem… 3 [bac… 4 [non…
 3  2010  6001 3 [BALLOT C] 27       NA(i)       2 [bla… 2 [fem… 3 [bac… 4 [non…
 4  2010  6002 1 [BALLOT A] 36          3        1 [whi… 2 [fem… 4 [gra… 4 [non…
 5  2006    10 1 [BALLOT A] 32          3        3 [oth… 2 [fem… 4 [gra… 4 [non…
 6  2008  3002 1 [BALLOT A] 34          3        3 [oth… 2 [fem… 4 [gra… 4 [non…
 7  2008  3003 3 [BALLOT C] 83       NA(i)       2 [bla… 2 [fem… 0 [LT … 1 [pro…
 8  2010  6003 3 [BALLOT C] 85       NA(i)       2 [bla… 2 [fem… 0 [LT … 1 [pro…
 9  2006    11 3 [BALLOT C] 81       NA(a) [iap] 2 [bla… 2 [fem… 0 [LT … 1 [pro…
10  2010  6004 1 [BALLOT A] 51         10        3 [oth… 1 [mal… 1 [HIG… 2 [cat…
# ℹ 14,600 more rows
# ℹ 10 more variables: income <dbl+lbl>, polviews <dbl+lbl>, fefam <dbl+lbl>,
#   vpsu <dbl+lbl>, vstrat <dbl+lbl>, oversamp <dbl>, formwt <dbl>,
#   wtssall <dbl+lbl>, sampcode <dbl+lbl>, sample <dbl+lbl>
```

The GSS Panel: Recoding

```r
gss_sub |>
  mutate(across(everything(), zap_missing)) |>
  mutate(across(all_of(wt_vars), as.numeric)) |>
  mutate(across(all_of(int_vars), as.integer)) |>
  mutate(across(all_of(cat_vars), as_factor)) |>
  mutate(across(all_of(cat_vars), fct_relabel, tolower)) |>
  mutate(across(all_of(cat_vars), fct_relabel, tools::toTitleCase)) |>
  mutate(income = str_replace(income, " - ", "-"))
```

```
# A tibble: 14,610 × 19
    year    id ballot   age tvhours race  sex    degree    relig income polviews
   <int> <int>  <int> <int>   <int> <fct> <fct>  <fct>     <fct> <chr>  <fct>
 1  2006     9      3    23      NA Black Female Bachelor  None  $2500… Conserv…
 2  2008  3001      3    25      NA Other Female Bachelor  None  $2500… Extreme…
 3  2010  6001      3    27      NA Black Female Bachelor  None  $2500… Extreme…
 4  2010  6002      1    36       3 White Female Graduate  None  $2500… Liberal
 5  2006    10      1    32       3 Other Female Graduate  None  <NA>   Slightl…
 6  2008  3002      1    34       3 Other Female Graduate  None  $2500… Moderate
 7  2008  3003      3    83      NA Black Female Lt High … Prot… $2000… Liberal
 8  2010  6003      3    85      NA Black Female Lt High … Prot… <NA>   Moderate
 9  2006    11      3    81      NA Black Female Lt High … Prot… <NA>   Moderate
10  2010  6004      1    51      10 Other Male   High Sch… Cath… Lt $1… Liberal
# ℹ 14,600 more rows
# ℹ 8 more variables: fefam <fct>, vpsu <dbl>, vstrat <dbl>, oversamp <dbl>,
#   formwt <dbl>, wtssall <dbl>, sampcode <dbl>, sample <dbl>
```

How we'd actually write this

```r
gss_sub <- gss_sub |>
  mutate(across(everything(), zap_missing),
         across(all_of(wt_vars), as.numeric),
         across(all_of(int_vars), as.integer),
         across(all_of(cat_vars), as_factor),
         across(all_of(cat_vars), fct_relabel, tolower),
         across(all_of(cat_vars), fct_relabel, tools::toTitleCase),
         income = str_replace(income, " - ", "-"))
```

The GSS panel: more recoding

Age quintiles: find the cutpoints

```
# seq can make all kinds of sequences
seq(from = 0, to = 1, by = 0.2)
```

```
[1] 0.0 0.2 0.4 0.6 0.8 1.0
```

```
age_quintiles <- quantile(as.numeric(gss_panel$age),
                          probs = seq(0, 1, 0.2),
                          na.rm = TRUE)

## These are the quintile cutpoints
age_quintiles
```

```
  0%  20%  40%  60%  80% 100%
  18   33   43   53   65   89
```

The GSS panel: more recoding

Age quintiles: create the quintile variable

```
## Apply the cut
gss_sub |>
  mutate(agequint = cut(x = age,
                        breaks = unique(age_quintiles),
                        include.lowest = TRUE)) |>
  pull(agequint) |> # grab a column and make it an ordinary vector
  table()
```

```
[18,33] (33,43] (43,53] (53,65] (65,89]
   3157    2680    2851    3057    2720
```

We'll need to clean up those labels.

The GSS panel: more recoding

I told you that regexp stuff would pay off.

```r
convert_agegrp <- function(x){
    x <- stringr::str_remove(x, "\\(")  # Remove open paren
    x <- stringr::str_remove(x, "\\[")  # Remove open bracket
    x <- stringr::str_remove(x, "\\]")  # Remove close bracket
    x <- stringr::str_replace(x, ",", "-") # Replace comma with dash
    x <- stringr::str_replace(x, "-89", "+") # Replace -89 with +
    regex <- "^(.*$)" # Matches everything in string to end of line
    x <- stringr::str_replace(x, regex, "Age \\1") # Preface string with "Age"
    x
}
```

The GSS panel: more recoding

```r
gss_sub
```

```
# A tibble: 14,610 × 19
    year    id ballot   age tvhours race  sex    degree    relig income
polviews
   <int> <int>  <int> <int>   <int> <fct> <fct>  <fct>     <fct> <chr>  <fct>
 1  2006     9      3    23      NA Black Female Bachelor  None  $2500…
Conserv…
 2  2008  3001      3    25      NA Other Female Bachelor  None  $2500…
Extreme…
 3  2010  6001      3    27      NA Black Female Bachelor  None  $2500…
Extreme…
 4  2010  6002      1    36       3 White Female Graduate  None  $2500… Liberal
 5  2006    10      1    32       3 Other Female Graduate  None  <NA>
Slightl…
 6  2008  3002      1    34       3 Other Female Graduate  None  $2500…
Moderate
 7  2008  3003      3    83      NA Black Female Lt High … Prot… $2000… Liberal
 8  2010  6003      3    85      NA Black Female Lt High … Prot… <NA>
Moderate
 9  2006    11      3    81      NA Black Female Lt High … Prot… <NA>
Moderate
10  2010  6004      1    51      10 Other Male   High Sch… Cath… Lt $1… Liberal
# ℹ 14,600 more rows
# ℹ 8 more variables: fefam <fct>, vpsu <dbl>, vstrat <dbl>, oversamp <dbl>,
#   formwt <dbl>, wtssall <dbl>, sampcode <dbl>, sample <dbl>
```

The GSS panel: more recoding

```r
gss_sub |>
# `select` is here just so you can see
#  what's happening to the columns
  select(age, year, degree, fefam)
```

```
# A tibble: 14,610 × 4
     age  year degree         fefam
   <int> <int> <fct>          <fct>
 1    23  2006 Bachelor       <NA>
 2    25  2008 Bachelor       <NA>
 3    27  2010 Bachelor       <NA>
 4    36  2010 Graduate       Disagree
 5    32  2006 Graduate       Agree
 6    34  2008 Graduate       Disagree
 7    83  2008 Lt High School <NA>
 8    85  2010 Lt High School <NA>
 9    81  2006 Lt High School <NA>
10    51  2010 High School    Disagree
# ℹ 14,600 more rows
```

The GSS panel: more recoding

```r
gss_sub ▷
#  `select` is here just so you can see
#   what's happening to the columns
  select(age, year, degree, fefam) ▷
  mutate(agequint = cut(x = age,
                        breaks = unique(age_quintiles),
                        include.lowest = TRUE))
```

```
# A tibble: 14,610 × 5
     age  year degree         fefam    agequint
   <int> <int> <fct>          <fct>    <fct>
 1    23  2006 Bachelor       <NA>     [18,33]
 2    25  2008 Bachelor       <NA>     [18,33]
 3    27  2010 Bachelor       <NA>     [18,33]
 4    36  2010 Graduate       Disagree (33,43]
 5    32  2006 Graduate       Agree    [18,33]
 6    34  2008 Graduate       Disagree (33,43]
 7    83  2008 Lt High School <NA>     (65,89]
 8    85  2010 Lt High School <NA>     (65,89]
 9    81  2006 Lt High School <NA>     (65,89]
10    51  2010 High School    Disagree (43,53]
# ℹ 14,600 more rows
```

The GSS panel: more recoding

```
gss_sub ▷
#  `select` is here just so you can see
#   what's happening to the columns
  select(age, year, degree, fefam) ▷
  mutate(agequint = cut(x = age,
                        breaks = unique(age_quintiles),
                        include.lowest = TRUE)) ▷
  mutate(agequint = fct_relabel(agequint, convert_agegrp))
```

```
# A tibble: 14,610 × 5
     age  year degree         fefam    agequint
   <int> <int> <fct>          <fct>    <fct>
 1    23  2006 Bachelor       <NA>     Age 18-33
 2    25  2008 Bachelor       <NA>     Age 18-33
 3    27  2010 Bachelor       <NA>     Age 18-33
 4    36  2010 Graduate       Disagree Age 33-43
 5    32  2006 Graduate       Agree    Age 18-33
 6    34  2008 Graduate       Disagree Age 33-43
 7    83  2008 Lt High School <NA>     Age 65+
 8    85  2010 Lt High School <NA>     Age 65+
 9    81  2006 Lt High School <NA>     Age 65+
10    51  2010 High School    Disagree Age 43-53
# ℹ 14,600 more rows
```

The GSS panel: more recoding

```
gss_sub |>
# `select` is here just so you can see
#  what's happening to the columns
  select(age, year, degree, fefam) |>
  mutate(agequint = cut(x = age,
                        breaks = unique(age_quintiles),
                        include.lowest = TRUE)) |>
  mutate(agequint = fct_relabel(agequint, convert_agegrp)) |>
  mutate(year_f = droplevels(factor(year)))
```

```
# A tibble: 14,610 × 6
     age  year degree         fefam    agequint  year_f
   <int> <int> <fct>          <fct>    <fct>     <fct>
 1    23  2006 Bachelor       <NA>     Age 18-33 2006
 2    25  2008 Bachelor       <NA>     Age 18-33 2008
 3    27  2010 Bachelor       <NA>     Age 18-33 2010
 4    36  2010 Graduate       Disagree Age 33-43 2010
 5    32  2006 Graduate       Agree    Age 18-33 2006
 6    34  2008 Graduate       Disagree Age 33-43 2008
 7    83  2008 Lt High School <NA>     Age 65+   2008
 8    85  2010 Lt High School <NA>     Age 65+   2010
 9    81  2006 Lt High School <NA>     Age 65+   2006
10    51  2010 High School    Disagree Age 43-53 2010
# ℹ 14,600 more rows
```

The GSS panel: more recoding

```r
gss_sub |>
# `select` is here just so you can see
#  what's happening to the columns
  select(age, year, degree, fefam) |>
  mutate(agequint = cut(x = age,
                        breaks = unique(age_quintiles),
                        include.lowest = TRUE)) |>
  mutate(agequint = fct_relabel(agequint, convert_agegrp)) |>
  mutate(year_f = droplevels(factor(year))) |>
  mutate(young = ifelse(age < 26, "Yes", "No"))
```

```
# A tibble: 14,610 × 7
     age  year degree         fefam    agequint  year_f young
   <int> <int> <fct>          <fct>    <fct>     <fct>  <chr>
 1    23  2006 Bachelor       <NA>     Age 18-33 2006   Yes
 2    25  2008 Bachelor       <NA>     Age 18-33 2008   Yes
 3    27  2010 Bachelor       <NA>     Age 18-33 2010   No
 4    36  2010 Graduate       Disagree Age 33-43 2010   No
 5    32  2006 Graduate       Agree    Age 18-33 2006   No
 6    34  2008 Graduate       Disagree Age 33-43 2008   No
 7    83  2008 Lt High School <NA>     Age 65+   2008   No
 8    85  2010 Lt High School <NA>     Age 65+   2010   No
 9    81  2006 Lt High School <NA>     Age 65+   2006   No
10    51  2010 High School    Disagree Age 43-53 2010   No
# ℹ 14,600 more rows
```

The GSS panel: more recoding

```r
gss_sub |>
# `select` is here just so you can see
#  what's happening to the columns
  select(age, year, degree, fefam) |>
  mutate(agequint = cut(x = age,
                        breaks = unique(age_quintiles),
                        include.lowest = TRUE)) |>
  mutate(agequint = fct_relabel(agequint, convert_agegrp)) |>
  mutate(year_f = droplevels(factor(year))) |>
  mutate(young = ifelse(age < 26, "Yes", "No")) |>
  mutate(fefam_d = fct_recode(fefam,
                              Agree = "Strongly Agree",
                              Disagree = "Strongly Disagree"))
```

```
# A tibble: 14,610 × 8
     age  year degree         fefam    agequint  year_f young fefam_d
   <int> <int> <fct>          <fct>    <fct>     <fct>  <chr> <fct>
 1    23  2006 Bachelor       <NA>     Age 18-33 2006   Yes   <NA>
 2    25  2008 Bachelor       <NA>     Age 18-33 2008   Yes   <NA>
 3    27  2010 Bachelor       <NA>     Age 18-33 2010   No    <NA>
 4    36  2010 Graduate       Disagree Age 33-43 2010   No    Disagree
 5    32  2006 Graduate       Agree    Age 18-33 2006   No    Agree
 6    34  2008 Graduate       Disagree Age 33-43 2008   No    Disagree
 7    83  2008 Lt High School <NA>     Age 65+   2008   No    <NA>
 8    85  2010 Lt High School <NA>     Age 65+   2010   No    <NA>
 9    81  2006 Lt High School <NA>     Age 65+   2006   No    <NA>
10    51  2010 High School    Disagree Age 43-53 2010   No    Disagree
# ℹ 14,600 more rows
```

The GSS panel: more recoding

```r
gss_sub ▷
# `select` is here just so you can see
#  what's happening to the columns
  select(age, year, degree, fefam) ▷
  mutate(agequint = cut(x = age,
                      breaks = unique(age_quintiles),
                      include.lowest = TRUE)) ▷
  mutate(agequint = fct_relabel(agequint, convert_agegrp)) ▷
  mutate(year_f = droplevels(factor(year))) ▷
  mutate(young = ifelse(age < 26, "Yes", "No")) ▷
  mutate(fefam_d = fct_recode(fefam,
                            Agree = "Strongly Agree",
                            Disagree = "Strongly Disagree")) ▷
  mutate(degree = factor(degree,
                        levels = levels(gss_sub$degree),
                        ordered = TRUE))
```

```
# A tibble: 14,610 × 8
     age  year degree         fefam    agequint  year_f young fefam_d
   <int> <int> <ord>          <fct>    <fct>     <fct>  <chr> <fct>
 1    23  2006 Bachelor       <NA>     Age 18-33 2006   Yes   <NA>
 2    25  2008 Bachelor       <NA>     Age 18-33 2008   Yes   <NA>
 3    27  2010 Bachelor       <NA>     Age 18-33 2010   No    <NA>
 4    36  2010 Graduate       Disagree Age 33-43 2010   No    Disagree
 5    32  2006 Graduate       Agree    Age 18-33 2006   No    Agree
 6    34  2008 Graduate       Disagree Age 33-43 2008   No    Disagree
 7    83  2008 Lt High School <NA>     Age 65+   2008   No    <NA>
 8    85  2010 Lt High School <NA>     Age 65+   2010   No    <NA>
 9    81  2006 Lt High School <NA>     Age 65+   2006   No    <NA>
10    51  2010 High School    Disagree Age 43-53 2010   No    Disagree
# ℹ 14,600 more rows
```

How we’d actually write this

```
gss_sub <- gss_sub |>
      mutate(agequint = cut(x = age,
                            breaks = unique(age_quintiles),
                            include.lowest = TRUE),
              agequint = fct_relabel(agequint, convert_agegrp),
              year_f = droplevels(factor(year)),
              young = ifelse(age < 26, "Yes", "No"),
              fefam_d = fct_recode(fefam,
                                   Agree = "Strongly Agree",
                                   Disagree = "Strongly Disagree"),
              degree = factor(degree,
                              levels = levels(gss_sub$degree),
                              ordered = TRUE))

gss_sub
```

```
# A tibble: 14,610 × 23
    year    id ballot   age tvhours race  sex    degree    relig income polviews
   <int> <int>  <int> <int>   <int> <fct> <fct>  <ord>     <fct> <chr>  <fct>
 1  2006     9      3    23      NA Black Female Bachelor  None  $2500… Conserv…
 2  2008  3001      3    25      NA Other Female Bachelor  None  $2500… Extreme…
 3  2010  6001      3    27      NA Black Female Bachelor  None  $2500… Extreme…
 4  2010  6002      1    36       3 White Female Graduate  None  $2500… Liberal
 5  2006    10      1    32       3 Other Female Graduate  None  <NA>   Slightl…
 6  2008  3002      1    34       3 Other Female Graduate  None  $2500… Moderate
 7  2008  3003      3    83      NA Black Female Lt High … Prot… $2000… Liberal
 8  2010  6003      3    85      NA Black Female Lt High … Prot… <NA>   Moderate
 9  2006    11      3    81      NA Black Female Lt High … Prot… <NA>   Moderate
10  2010  6004      1    51      10 Other Male   High Sch… Cath… Lt $1… Liberal
# ℹ 14,600 more rows
# ℹ 12 more variables: fefam <fct>, vpsu <dbl>, vstrat <dbl>, oversamp <dbl>,
#   formwt <dbl>, wtssall <dbl>, sampcode <dbl>, sample <dbl>, agequint <fct>,
#   year_f <fct>, young <chr>, fefam_d <fct>
```

How we’d actually write this

```r
gss_sub <- gss_sub |>
    mutate(agequint = cut(x = age,
                          breaks = unique(age_quintiles),
                          include.lowest = TRUE),
            agequint = fct_relabel(agequint, convert_agegrp),
            year_f = factor(year),
            young = ifelse(age < 26, "Yes", "No"),
            fefam_d = fct_recode(fefam,
                                Agree = "Strongly Agree",
                                Disagree = "Strongly Disagree"),
            degree = factor(degree,
                           levels = levels(gss_sub$degree),
                           ordered = TRUE))
```

How we'd actually write this

```r
gss_sub <- gss_sub |>
    mutate(agequint = cut(x = age,
                          breaks = unique(age_quintiles),
                          include.lowest = TRUE),
           agequint = fct_relabel(agequint, convert_agegrp),
           year_f = droplevels(factor(year)),
           young = ifelse(age < 26, "Yes", "No"),
           fefam_d = fct_recode(fefam,
                                Agree = "Strongly Agree",
                                Disagree = "Strongly Disagree"),
           degree = factor(degree,
                           levels = levels(gss_sub$degree),
                           ordered = TRUE))
```

GSS Panel

```r
gss_sub |>
  select(sex, year, year_f, age, young, fefam, fefam_d) |>
  sample_n(15)
```

```
# A tibble: 15 × 7
   sex     year year_f   age young fefam             fefam_d
   <fct>  <int> <fct>  <int> <chr> <fct>             <fct>
 1 Female  2008 2008      42 No    Strongly Disagree Disagree
 2 Male    2012 2012      63 No    Disagree          Disagree
 3 Male    2012 2012      30 No    Disagree          Disagree
 4 Male    2006 2006      32 No    Disagree          Disagree
 5 Female  2006 2006      25 Yes   Disagree          Disagree
 6 Male    2012 2012      35 No    Agree             Agree
 7 Male    2008 2008      45 No    <NA>              <NA>
 8 Male    2012 2012      54 No    Disagree          Disagree
 9 Male    2010 2010      45 No    Disagree          Disagree
10 Male    2012 2012      53 No    Disagree          Disagree
11 Male    2010 2010      89 No    <NA>              <NA>
12 Male    2010 2010      63 No    Agree             Agree
13 Female  2010 2010      62 No    <NA>              <NA>
14 Female  2008 2008      62 No    <NA>              <NA>
15 Female  2010 2010      35 No    Agree             Agree
```

GSS Panel

```r
gss_sub |>
  select(sex, degree) |>
  group_by(sex, degree) |>
  tally() |>
  pivot_wider(names_from = sex, values_from = n)
```

```
# A tibble: 6 × 3
  degree          Male Female
  <ord>          <int>  <int>
1 Lt High School   814   1036
2 High School     3131   4143
3 Junior College   440    721
4 Bachelor        1293   1474
5 Graduate         696    860
6 <NA>              NA      2
```

An extension: partial applications of functions

Can we get more concise?

We have this code:

```
organdata |>
  group_by(consent_law, country) |>
  summarize(across(where(is.numeric),
                   list(mean = \(x) mean(x, na.rm = TRUE),
                        sd = \(x) sd(x, na.rm = TRUE),
                        median = \(x) median(x, na.rm = TRUE))
                  )
            ) |>
    print(n = 3)
```

Let's say we want to do this a lot and we *always* want to use `na.rm = TRUE`.

Can we get more concise?

We could write a function to do this, like this, for `mean`:

```r
mean_na_rm <- \(x) mean(x, na.rm = TRUE) # lambda shorthand works here too

organdata |>
  group_by(consent_law, country) |>
  summarize(across(where(is.numeric),
                   list(mean = mean_na_rm,
                        sd = \(x) sd(x, na.rm = TRUE),
                        median = \(x) median(x, na.rm = TRUE)))) |>
    print(n = 3)
```

```
# A tibble: 17 × 41
# Groups:   consent_law [2]
  consent_law country   donors_mean donors_sd donors_median pop_mean pop_sd
  <chr>       <chr>           <dbl>     <dbl>         <dbl>    <dbl>  <dbl>
1 Informed    Australia        10.6     1.14           10.4   18318.   831.
2 Informed    Canada           14.0     0.751          14.0   29608.  1193.
3 Informed    Denmark          13.1     1.47           12.9    5257.   80.6
# ℹ 14 more rows
# ℹ 34 more variables: pop_median <int>, pop_dens_mean <dbl>,
#   pop_dens_sd <dbl>, pop_dens_median <dbl>, gdp_mean <dbl>, gdp_sd <dbl>,
#   gdp_median <int>, gdp_lag_mean <dbl>, gdp_lag_sd <dbl>,
#   gdp_lag_median <dbl>, health_mean <dbl>, health_sd <dbl>,
#   health_median <dbl>, health_lag_mean <dbl>, health_lag_sd <dbl>,
#   health_lag_median <dbl>, pubhealth_mean <dbl>, pubhealth_sd <dbl>, …
```

This works! There is a slightly more general way to do this, though.

Partial application of functions

The `purrr` package has a function called `partial()` that lets you do this in a more general way.

```
mean_na_rm <- partial(mean, na.rm = TRUE)
median_na_rm <- partial(median, na.rm = TRUE)
sd_na_rm <- partial(sd, na.rm = TRUE)
```

Partial application of functions

```
organdata |>
  group_by(consent_law, country) |>
  summarize(across(where(is.numeric),
                   list(mean = mean_na_rm,
                        sd = sd_na_rm,
                        median = median_na_rm))) |>
    print(n = 3)
```

```
# A tibble: 17 × 41
# Groups:   consent_law [2]
  consent_law country   donors_mean donors_sd donors_median pop_mean pop_sd
  <chr>       <chr>           <dbl>     <dbl>         <dbl>    <dbl>  <dbl>
1 Informed    Australia        10.6     1.14           10.4   18318.   831.
2 Informed    Canada           14.0     0.751          14.0   29608.  1193.
3 Informed    Denmark          13.1     1.47           12.9    5257.   80.6
# ℹ 14 more rows
# ℹ 34 more variables: pop_median <int>, pop_dens_mean <dbl>,
#   pop_dens_sd <dbl>, pop_dens_median <dbl>, gdp_mean <dbl>, gdp_sd <dbl>,
#   gdp_median <int>, gdp_lag_mean <dbl>, gdp_lag_sd <dbl>,
#   gdp_lag_median <dbl>, health_mean <dbl>, health_sd <dbl>,
#   health_median <dbl>, health_lag_mean <dbl>, health_lag_sd <dbl>,
#   health_lag_median <dbl>, pubhealth_mean <dbl>, pubhealth_sd <dbl>, …
```

This is called "partial application" and is quite handy. You can fix any number of function arguments. Usually the idea is just fix all of them except the first one, which is the one that will be supplied by `across()`. This sort of "purifies" the function a little.

Partial application of functions

A minute ago we saw this:

```
convert_agegrp ← function(x){
    x ← stringr::str_remove(x, "\\(")  # Remove open paren
    x ← stringr::str_remove(x, "\\[")  # Remove open bracket
    x ← stringr::str_remove(x, "\\]")  # Remove close bracket
    x ← stringr::str_replace(x, ",", "-") # Replace comma with dash
    x ← stringr::str_replace(x, "-89", "+") # Replace -89 with +
    regex ← "^(.*$)" # Matches everything in string to end of line
    x ← stringr::str_replace(x, regex, "Age \\1") # Preface string with "Age"
    x
}
```

Nothing wrong with that, but imagine we had a lot of variables that involved versions of these operations but they were often slightly different. And if our regexps got complex we'd always have to have the comment next to them to know for sure what they did. We could use `partial()` to address this.

Partial application of functions

```r
remove_open_paren <- partial(stringr::str_remove, pattern = "\\(")
remove_open_bracket <- partial(stringr::str_remove, pattern = "\\[")
remove_close_bracket <- partial(stringr::str_remove, pattern = "\\]")
replace_comma_with_dash <- partial(stringr::str_replace, pattern = ",", replacement = "-")
```

We do this once. In the simplest case we put these declarations at the top of our Quarto file or R script, but more usefully we put them in e.g. `R/data-cleaners.R` or, if we do a lot of this we make a package that has these functions in them, consistently named and tested so we know each one works.

Partial application of functions

So when we have, e.g.,

```
df
```

```
# A tibble: 10 × 2
      id agegrp
   <dbl> <chr>
 1     1 Interval (43,55]
 2     2 Interval (55,66]
 3     3 Interval (66,89]
 4     4 Interval (31,43]
 5     5 Interval (43,55]
 6     6 Interval (43,55]
 7     7 Interval (43,55]
 8     8 Interval [18,31]
 9     9 Interval (66,89]
10    10 Interval (55,66]
```

Partial application of functions

We could do …

```
df |>
 mutate(agegrp = remove_open_paren(agegrp),
        agegrp = remove_open_bracket(agegrp),
        agegrp = remove_close_bracket(agegrp),
        agegrp = replace_comma_with_dash(agegrp))
```

```
# A tibble: 10 × 2
      id agegrp
   <dbl> <chr>
 1     1 Interval 43-55
 2     2 Interval 55-66
 3     3 Interval 66-89
 4     4 Interval 31-43
 5     5 Interval 43-55
 6     6 Interval 43-55
 7     7 Interval 43-55
 8     8 Interval 18-31
 9     9 Interval 66-89
10    10 Interval 55-66
```

Partial application of functions

Or, bundle them into other functions that chain them together as needed:

```r
clean_agegrp <- function(x){
  x <- remove_open_paren(x)
  x <- remove_open_bracket(x)
  x <- remove_close_bracket(x)
  x <- replace_comma_with_dash(x)
  x
}

df |>
 mutate(agegrp = clean_agegrp(agegrp)) |>
 print(n = 3)
```

```
# A tibble: 10 × 2
     id agegrp
  <dbl> <chr>
1     1 Interval 43-55
2     2 Interval 55-66
3     3 Interval 66-89
# ℹ 7 more rows
```

Breaking down a complex function into smaller pieces can make it easier to understand, test, and maintain. You can also reuse the smaller pieces in other contexts, and assemble the pieces into specific functions.

Partial application of functions

Or even:

```
clean_agegrp <- function(x){
  remove_open_paren(x) |>
  remove_open_bracket() |>
  remove_close_bracket() |>
  replace_comma_with_dash()
}

df |>
 mutate(agegrp = clean_agegrp(agegrp)) |>
 print(n = 3)
```

```
# A tibble: 10 × 2
     id agegrp
  <dbl> <chr>
1     1 Interval 43-55
2     2 Interval 55-66
3     3 Interval 66-89
# ℹ 7 more rows
```

You can see how this code is easier to read.

More about factors

More on factors

We've already seen `fct_relabel()` and `fct_recode()` from forcats.

There are numerous other convenience functions for factors.

More on factors

```r
gss_sub |>
  count(degree)
```

```
# A tibble: 6 × 2
  degree             n
  <ord>          <int>
1 Lt High School  1850
2 High School     7274
3 Junior College  1161
4 Bachelor        2767
5 Graduate        1556
6 <NA>               2
```

```r
levels(gss_sub$degree)
```

```
[1] "Lt High School" "High School"    "Junior College" "Bachelor"
[5] "Graduate"
```

More on factors

Make the NA values an explicit level

```
gss_sub |>
  mutate(degree_na = fct_na_value_to_level(degree)) |>
  count(degree_na)
```

```
# A tibble: 6 × 2
  degree_na          n
  <ord>          <int>
1 Lt High School  1850
2 High School     7274
3 Junior College  1161
4 Bachelor        2767
5 Graduate        1556
6 <NA>               2
```

There's also `fct_na_level_to_value()` to go the other way.

More on factors

Relevel by frequency

```
gss_sub |>
  mutate(degree_freq = fct_infreq(degree)) |>
  count(degree_freq)
```

```
# A tibble: 6 × 2
  degree_freq        n
  <ord>          <int>
1 High School     7274
2 Bachelor        2767
3 Lt High School  1850
4 Graduate        1556
5 Junior College  1161
6 <NA>               2
```

More on factors

Relevel manually

```r
is.ordered(gss_sub$sex)
```

```
[1] FALSE
```

```r
levels(gss_sub$sex)
```

```
[1] "Male"   "Female"
```

More on factors

Relevel manually

```
summary(lm(age ~ sex, data = gss_sub))
```

```

Call:
lm(formula = age ~ sex, data = gss_sub)

Residuals:
    Min      1Q  Median      3Q     Max 
-31.431 -13.972  -0.431  12.569  40.028 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  48.9720     0.2149 227.846   <2e-16 ***
sexFemale     0.4594     0.2864   1.604    0.109    
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 17.08 on 14463 degrees of freedom
  (145 observations deleted due to missingness)
Multiple R-squared:  0.0001779,	Adjusted R-squared:  0.0001088 
F-statistic: 2.573 on 1 and 14463 DF,  p-value: 0.1087
```

More on factors

Relevel manually

```r
gss_sub <- gss_sub |>
  mutate(sex = fct_relevel(sex, "Female"))

levels(gss_sub$sex)
```

```
[1] "Female" "Male"
```

More on factors

Relevel manually

```r
summary(lm(age ~ sex, data = gss_sub))
```

```

Call:
lm(formula = age ~ sex, data = gss_sub)

Residuals:
    Min      1Q  Median      3Q     Max 
-31.431 -13.972  -0.431  12.569  40.028 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  49.4313     0.1892 261.233   <2e-16 ***
sexMale      -0.4594     0.2864  -1.604    0.109    
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 17.08 on 14463 degrees of freedom
  (145 observations deleted due to missingness)
Multiple R-squared:  0.0001779,	Adjusted R-squared:  0.0001088 
F-statistic: 2.573 on 1 and 14463 DF,  p-value: 0.1087
```

More on factors

Interact or cross factors

```r
gss_sub <- gss_sub |>
  mutate(degree_by_race = fct_cross(race, degree))

gss_sub |>
  count(degree_by_race)
```

```
# A tibble: 16 × 2
   degree_by_race            n
   <fct>                 <int>
 1 White:Lt High School   1188
 2 White:High School      5548
 3 White:Junior College    885
 4 White:Bachelor         2334
 5 White:Graduate         1293
 6 Black:Lt High School    379
 7 Black:High School      1180
 8 Black:Junior College    206
 9 Black:Bachelor          233
10 Black:Graduate          116
11 Other:Lt High School    283
12 Other:High School       546
13 Other:Junior College     70
14 Other:Bachelor          200
15 Other:Graduate          147
16 <NA>                      2
```

More on factors

Relevel manually by lumping … the least frequent n

```
gss_sub ▷
  mutate(degree_n = fct_lump_n(degree, n = 3)) ▷
  count(degree_n)
```

```
# A tibble: 5 × 2
  degree_n           n
  <ord>          <int>
1 Lt High School  1850
2 High School     7274
3 Bachelor        2767
4 Other           2717
5 <NA>               2
```

More on factors

Relevel manually by lumping ...to other, manually

```
gss_sub |>
  mutate(degree_o = fct_other(degree,
                              keep = c("Lt High School",
                                       "High School"))) |>
  count(degree_o)
```

```
# A tibble: 4 × 2
  degree_o           n
  <ord>          <int>
1 Lt High School  1850
2 High School     7274
3 Other           5484
4 <NA>               2
```