Data Wrangling

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Agenda

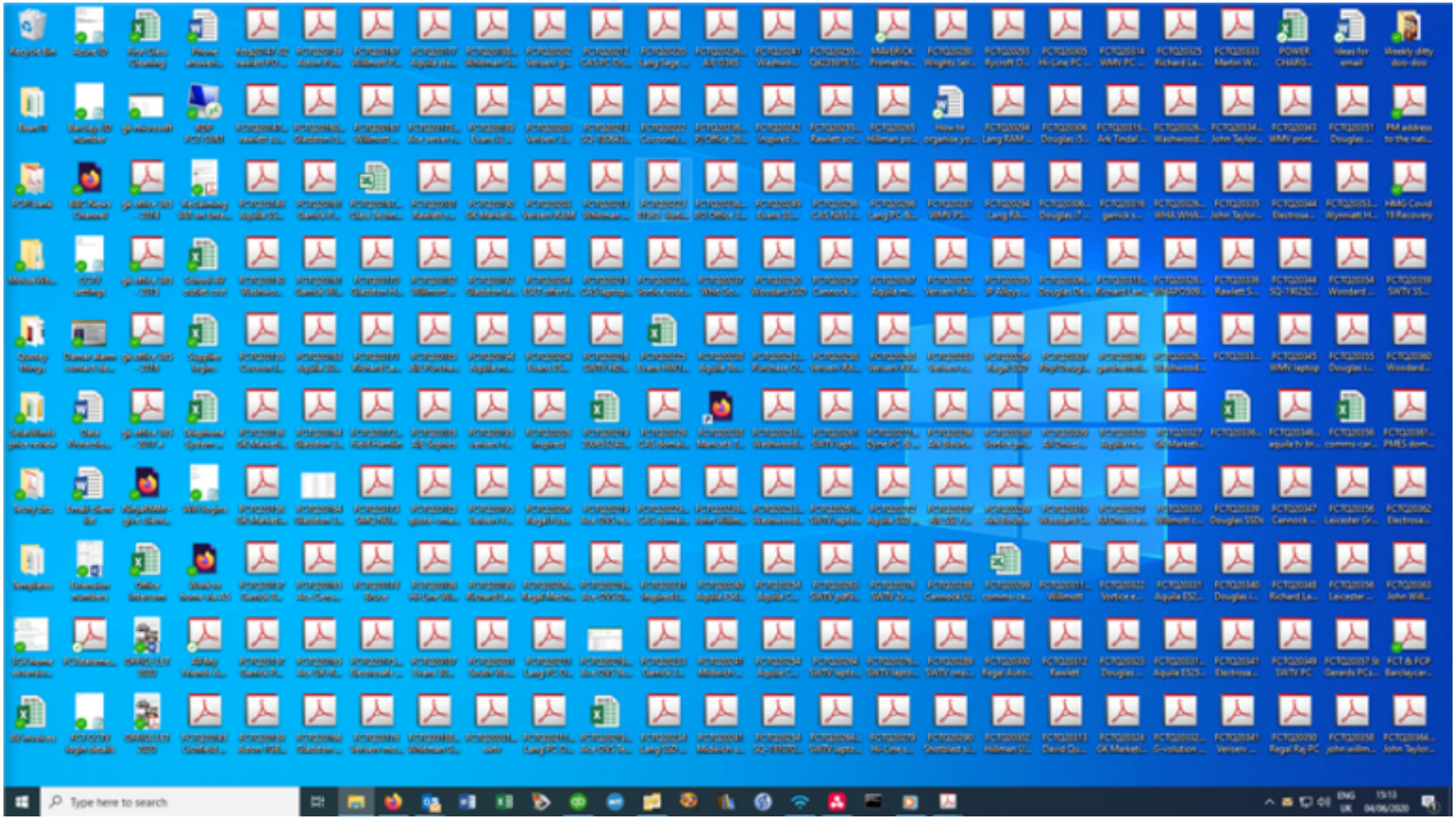
1. Review
2. Data wrangling
3. Operating on rows
4. Operating on columns
5. Operating on groups
6. Creating a bar plot!

1. Review

- Ways to look at data saved in data frames
  - glimse()
- A statistical graphic is a **mapping** of **data** variables to **aes**thetic attributes of **geom**etric objects.
- Visualizing data using ggplot2 with a geom layer(s)
  - `geom_point` (scatterplot)
  - `geom_line` (linegraphs)
  - `geom_boxplot` (boxplots)
  - `geom_histogram` (histogram)
  - `geom_bar` (barplots)

2. Data wrangling

Let's talk about the **best** practices



Certainly we don't want this..

Organize your folder first!

Create a project folder and name sub-folders

e.g.

```
\TPDstat
  \Data
  \Figure
  \Assignment
  \Table
  \Figure
  \TPD_is_the_Best
```

Two options in R

1. setwd()

1.1 Set your working directory as TPDstat (in the preivious example)
1.2. load data from the subfolder, save figures and tables in the subfolders, and then generate the output using Rmarkdown!

2. A (much) better way: create a R project in the folder and link it to git!

2.1. Click file -> New project -> designate a folder (e.g., TPDstat) -> save the Rproject
2.2. Open the saved Rproject, begin using R (with a new R script(s), etc.)!
2.3. (optional) create a repository in Github and push/pull git (together with git, this is the best practice)!

R can certainly load almost all types of data; fwf (fixed width format), dcf, DIF, html, SPSS, SAS, Stata, Systat, XML, javascript, Excel, Minitab, etc.

An illustrated example: CSV

CSV is a form of a fixed width format; comma-separated values.
The CSV file would look like this:

```
Title,Author,ISBN13,Pages
1984,George Orwell,978-0451524935,268
Animal Farm,George Orwell,978-0451526342,144
Brave New World,Aldous Huxley,978-0060929879,288
Fahrenheit 451,Ray Bradbury,978-0345342966,208
Jane Eyre,Charlotte Brontë,978-0142437209,532
Wuthering Heights,Emily Brontë,978-0141439556,416
Agnes Grey,Anne Brontë,978-1593083236,256
Walden,Henry David Thoreau,978-1420922615,156
Walden Two,B. F. Skinner,978-0872207783,301
"Eats, Shoots & Leaves",Lynne Truss,978-1592400874,209
```

An illustrated example: CSV (cont)

To load the CSV file, we can use the `readr` package, which is pre-installed in the `tidyverse` package! Let's load then the `tidyverse` into our library to use `readr`. Let's load data on labor mobility in policing from Florida

```
library(tidyverse)
labor_mobil <- read.csv("data/FL_police_mobility.csv")
as_tibble(labor_mobil)
```

```
## # A tibble: 88,446 x 13
##    Employ~1 payroll agency  ptbid sepre~2 start~3 sep_d~4 Y_start Y_stop sex
##       <int>   <int> <chr>   <int> <chr>   <chr>   <chr>     <int>  <int> <ch
##  1       22   96534 alach~  65073 "VS-IA~ 12jul1~ "11apr~    1990   2002 M
##  2      238 1424094 alach~  85046 "Vol"   10dec1~ "11sep~    1990   1996 M
##  3       97  533430 altam~ 233716 "Vol"   27mar2~ "01apr~    2006   2016 M
##  4        1    4088 altha~  88095 "TWA"   01jun2~ "09oct~    2003   2003 M
##  5        7   30345 apala~ 243033 "Vol"   04jan2~ "18oct~    2005   2005 M
##  6       98  536256 apopk~ 172716 ""      30sep2~ ""         2002     NA M
##  7       16   61232 arcad~ 281303 ""      01dec2~ ""         2008   2011 M
##  8        6   22440 astat~ 110808 ""      01apr2~ ""         2016     NA M
##  9       25  139954 atlan~ 230648 ""      18jul2~ ""         2011     NA M
## 10       12   67465 atlan~ 113978 ""      16feb2~ ""         2000     NA M
## # ... with 88,436 more rows, 3 more variables: race_code <chr>,
## #   birth_year <int>, education_level <chr>, and abbreviated variable names
## #   1: EmployeesNumber, 2: sepreason, 3: start_date, 4: sep_date, 5: sex_cod
```

You can use SQL in R using dplyr and/or sqldf packages!

```
library(dplyr)
# install.packages("sqldf")
library(sqldf)
```

Creating a data.frame

Let's create a data.frame using built in iris data.

```
iris <- iris
```

Using dplyr:

```
iris |>
  select(Sepal.Width) |>
  filter(Sepal.Width>=4.0)
```

```
##   Sepal.Width
## 1         4.0
## 2         4.4
## 3         4.1
## 4         4.2
```

Using sqldf:

```
sqldf("select [Sepal.Width] from iris
      where
        [Sepal.Width]  >= 4.0")
```

```
##   Sepal.Width
## 1         4.0
## 2         4.4
## 3         4.1
## 4         4.2
```

Why data wrangling?

- The standard R object for dataset is the `data.frame`
  - Each column is a vector of the same length
  - Columns can be different types
- Access columns with `$`: e.g., `mydata$myvariable`

```
options(width = 70)
mtcars$mpg
```

```
##  [1] 21.0 21.0 22.8 21.4 18.7 18.1 14.3 24.4 22.8 19.2 17.8 16.4 17.3
## [14] 15.2 10.4 10.4 14.7 32.4 30.4 33.9 21.5 15.5 15.2 13.3 19.2 27.3
## [27] 26.0 30.4 15.8 19.7 15.0 21.4
```

Problems with data frames

```
mtcars
```

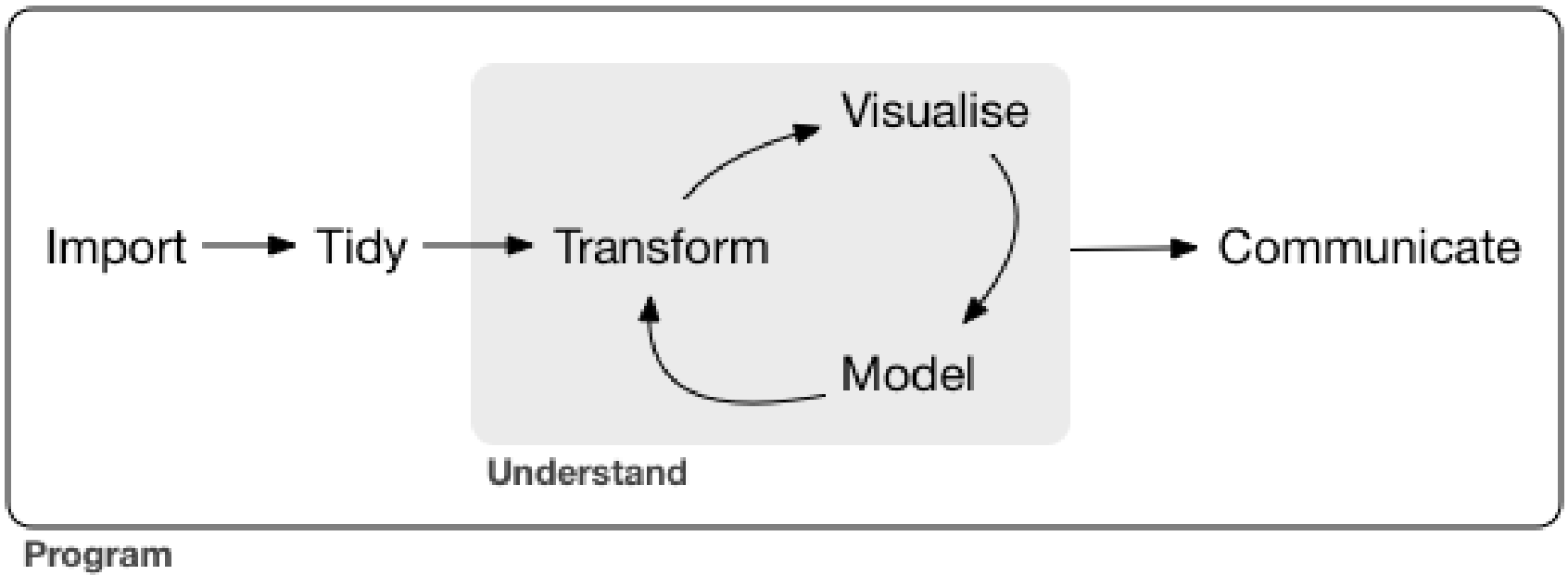
```
##                    mpg cyl  disp  hp drat    wt  qsec vs am gear
## Mazda RX4         21.0   6 160.0 110 3.90 2.620 16.46  0  1    4
## Mazda RX4 Wag     21.0   6 160.0 110 3.90 2.875 17.02  0  1    4
## Datsun 710        22.8   4 108.0  93 3.85 2.320 18.61  1  1    4
## Hornet 4 Drive    21.4   6 258.0 110 3.08 3.215 19.44  1  0    3
## Hornet Sportabout 18.7   8 360.0 175 3.15 3.440 17.02  0  0    3
## Valiant           18.1   6 225.0 105 2.76 3.460 20.22  1  0    3
## Duster 360        14.3   8 360.0 245 3.21 3.570 15.84  0  0    3
## Merc 240D         24.4   4 146.7  62 3.69 3.190 20.00  1  0    4
## Merc 230          22.8   4 140.8  95 3.92 3.150 22.90  1  0    4
## Merc 280          19.2   6 167.6 123 3.92 3.440 18.30  1  0    4
## Merc 280C         17.8   6 167.6 123 3.92 3.440 18.90  1  0    4
## Merc 450SE        16.4   8 275.8 180 3.07 4.070 17.40  0  0    3
## Merc 450SL        17.3   8 275.8 180 3.07 3.730 17.60  0  0    3
## Merc 450SLC       15.2   8 275.8 180 3.07 3.780 18.00  0  0    3
## Cadillac Fleetwood  10.4   8 472.0 205 2.93 5.250 17.98  0  0    3
## Lincoln Continental 10.4   8 460.0 215 3.00 5.424 17.82  0  0    3
## Chrysler Imperial   14.7   8 440.0 230 3.23 5.345 17.42  0  0    3
## Fiat 128          32.4   4  78.7  66 4.08 2.200 19.47  1  1    4
## Honda Civic       30.4   4  75.7  52 4.93 1.615 18.52  1  1    4
## Toyota Corolla    33.9   4  71.1  65 4.22 1.835 19.90  1  1    4
## Toyota Corona     21.5   4 120.1  97 3.70 2.465 20.01  1  0    3
## Dodge Challenger  15.5   8 318.0 150 2.76 3.520 16.87  0  0    3
## AMC Javelin       15.2   8 304.0 150 3.15 3.435 17.30  0  0    3
```

tibbles: a tidyverse alternative

```
library(ggplot2)
midwest
```

```
## # A tibble: 437 x 28
##      PID county    state  area popto~1 popde~2 p~pwh~3 popbl~4 popam~5
##    <int> <chr>     <chr> <dbl>   <int>   <dbl>   <int>   <int>   <int>
##  1   561 ADAMS     IL    0.052   66090   1271.   63917    1702      98
##  2   562 ALEXANDER IL    0.014   10626    759     7054    3496      19
##  3   563 BOND      IL    0.022   14991    681.   14477     429      35
##  4   564 BOONE     IL    0.017   30806   1812.   29344     127      46
##  5   565 BROWN     IL    0.018    5836    324.    5264     547      14
##  6   566 BUREAU    IL    0.05    35688    714.   35157      50      65
##  7   567 CALHOUN   IL    0.017    5322    313.    5298       1       8
##  8   568 CARROLL   IL    0.027   16805    622.   16519     111      30
##  9   569 CASS      IL    0.024   13437    560.   13384      16       8
## 10   570 CHAMPAIGN IL    0.058  173025   2983.  146506   16559     331
## # ... with 427 more rows, 19 more variables: popasian <int>,
## #   popother <int>, percwhite <dbl>, percblack <dbl>,
## #   percamerindan <dbl>, percasian <dbl>, percother <dbl>,
## #   popadults <int>, perchsd <dbl>, percollege <dbl>, percprof <dbl>,
## #   poppovertyknown <int>, percpovertyknown <dbl>,
## #   percbelowpoverty <dbl>, percchildbelowpovert <dbl>,
## #   percadultpoverty <dbl>, percelderlypoverty <dbl>, ...
```

Transform-Visualize-Model cycle



dplyr: a package for data transformation

- All `dplyer` functions:
  - Take a dataset as their first argument
  - Manipulate the dataset in some way
  - Returns the manipulated dataset

Nested calls can be difficult to read (have to read inside out):

```
f(g(h(r(x))))
```

The pipe |> allows us to move output between functions (|> "and then"):

```
x |>
  r() |>
  h() |>
  g() |>
  h()
```

The piped output goes to the first argument by default

Local news data

Application: Local news data

We will be using the `dplyr` package with local news data

Martin and McCrain (2019) use data on local news at TV stations before and after a large acquisition by a conglomerate

Q: How does station ownership affect local news coverage?

Local news data codebook

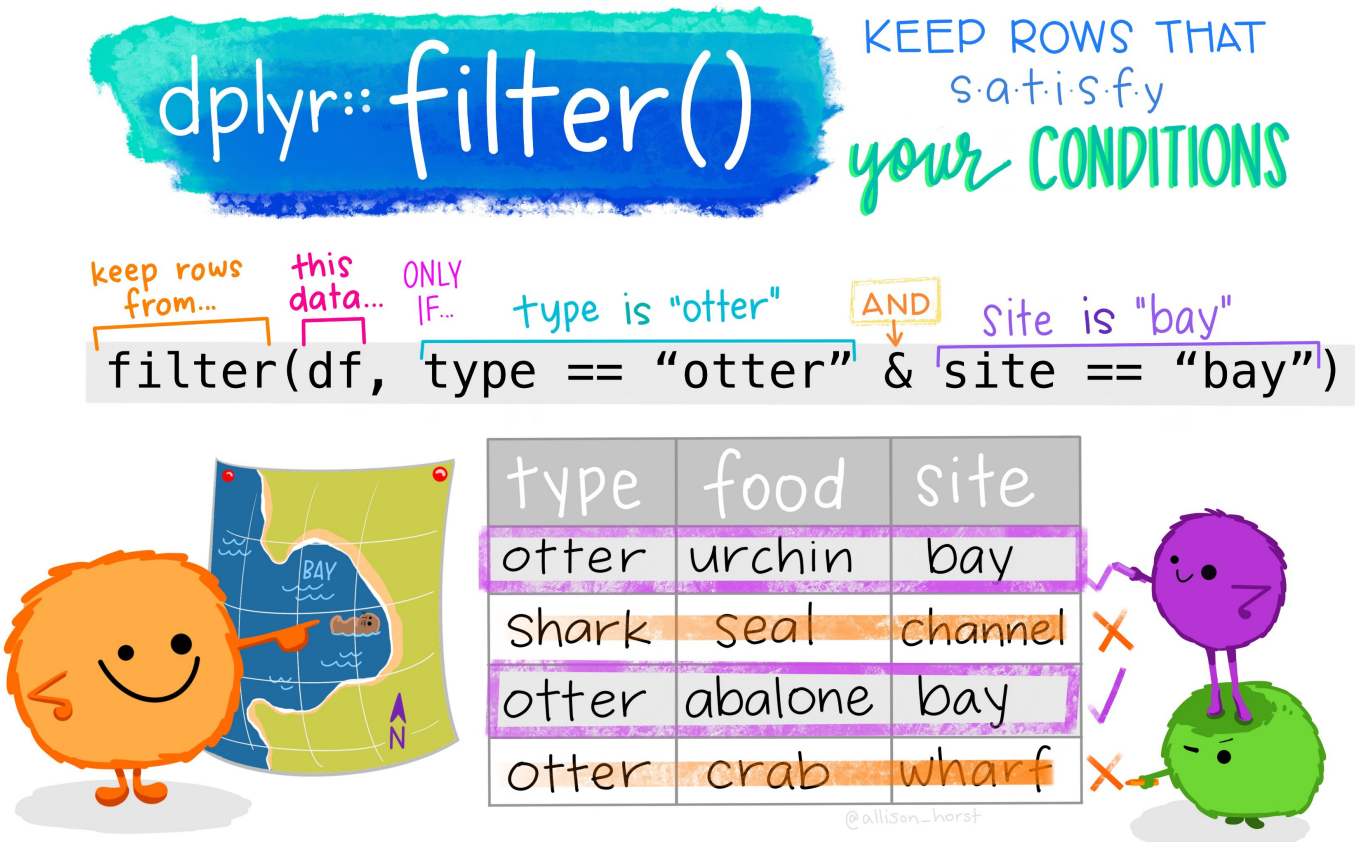
Variable	Description
`callsign`	Callsign of the station
`affiliation`	Network affiliation of the station
`date`	Airdate of news
`weekday`	Day of the week of airdate
`ideology`	Measure of news slant (bigger is more conservative)
`national_politics`	Avg. proportion of segments on national politics
`local_politics`	Avg. proportion of segments on local politics
`sinclair2017`	Station acquired by Sinclaire group in Sept 2017
`post`	Date is before/after acquisition (0/1)
`month`	Month of the airdate

```r
# to load the TPDdata library, you should install it first using the codes
# that I uploaded in the Teams chat
library(TPDdata)
data(news)
news
```

```
## # A tibble: 3,137 x 10
##    callsign affil~1 date       weekday ideol~2 natio~3 local~4 sincl~5
##    <chr>    <chr>   <date>     <ord>     <dbl>   <dbl>   <dbl>   <dbl>
##  1 KRBC     NBC     2017-06-05 Mon      NA      0.0286  0.0190       0
##  2 KTAB     CBS     2017-06-05 Mon      NA      0.0286  0.0190       0
##  3 KXVA     FOX     2017-06-05 Mon      NA      0.0393  0.0262       0
##  4 KPAX     CBS     2017-06-06 Tue      NA      0.00357 0.194        0
##  5 KTAB     CBS     2017-06-06 Tue      NA      0.0945  0.109        0
##  6 KECI     NBC     2017-06-07 Wed       0.0655 0.225   0.148        1
##  7 KPAX     CBS     2017-06-07 Wed       0.0853 0.283   0.123        0
##  8 KRBC     NBC     2017-06-07 Wed       0.0183 0.130   0.189        0
##  9 KTAB     CBS     2017-06-07 Wed       0.0850 0.0901  0.138        0
## 10 KTMF     ABC     2017-06-07 Wed       0.0842 0.152   0.129        0
## # ... with 3,127 more rows, 2 more variables: post <dbl>,
## #   month <ord>, and abbreviated variable names 1: affiliation,
## #   2: ideology, 3: national_politics, 4: local_politics,
## #   5: sinclair2017
```

3. Operating on rows

`filter()` selects rows that satisfy the argument you pass it:



Let's filter the local news data by observations aired on Tuesday (`Tue`) only; the variable name is `weekday`

How can we write the code?

```
# don't forget to call the library first (to use filter)
library(dplyr)
news |>
  filter(weekday == "Tue")
```

```
news |>
  filter(weekday == "Tue")
```

```
## # A tibble: 626 x 10
##    calls~1 affil~2 date       weekday ideology natio~3 local~4 sincl~5
##    <chr>   <chr>   <date>     <ord>      <dbl>   <dbl>   <dbl>   <dbl>
##  1 KPAX    CBS     2017-06-06 Tue     NA       0.00357  0.194        0
##  2 KTAB    CBS     2017-06-06 Tue     NA       0.0945   0.109        0
##  3 KAEF    ABC     2017-06-13 Tue      0.0242  0.180    0.234        1
##  4 KBVU    FOX     2017-06-13 Tue      0.00894 0.186    0.245        1
##  5 KBZK    CBS     2017-06-13 Tue      0.129   0.306    0.0763       0
##  6 KCVU    FOX     2017-06-13 Tue      0.114   0.124    0.178        1
##  7 KECI    NBC     2017-06-13 Tue      0.115   0.283    0.0926       1
##  8 KHSL    CBS     2017-06-13 Tue      0.0821  0.274    0.248        0
##  9 KNVN    NBC     2017-06-13 Tue      0.120   0.261    0.253        0
## 10 KPAX    CBS     2017-06-13 Tue      0.0984  0.208    0.171        0
## # ... with 616 more rows, 2 more variables: post <dbl>, month <ord>,
## #   and abbreviated variable names 1: callsign, 2: affiliation,
## #   3: national_politics, 4: local_politics, 5: sinclair2017
```

Multiple conditions mean "and"

```
news |>
  filter(weekday == "Tue",
         affiliation == "FOX")
```

```
## # A tibble: 130 x 10
##    calls~1 affil~2 date       weekday ideology natio~3 local~4 sincl~5
##    <chr>   <chr>   <date>     <ord>      <dbl>   <dbl>   <dbl>   <dbl>
##  1 KBVU    FOX     2017-06-13 Tue      0.00894  0.186   0.245       1
##  2 KCVU    FOX     2017-06-13 Tue      0.114    0.124   0.178       1
##  3 WEMT    FOX     2017-06-13 Tue      0.235    0.149   0.155       1
##  4 WYDO    FOX     2017-06-13 Tue      0.0949   0.182   0.180       1
##  5 KBVU    FOX     2017-06-20 Tue     NA        0.0229  0.268       1
##  6 KCVU    FOX     2017-06-20 Tue     NA        0.0170  0.261       1
##  7 KXVA    FOX     2017-06-20 Tue     NA        0.0203  0.0939      0
##  8 WEMT    FOX     2017-06-20 Tue      0.268    0.134   0.151       1
##  9 WYDO    FOX     2017-06-20 Tue      0.0590   0.155   0.0943      1
## 10 KBVU    FOX     2017-06-27 Tue     NA        0.0601  0.279       1
## # ... with 120 more rows, 2 more variables: post <dbl>, month <ord>,
## #   and abbreviated variable names 1: callsign, 2: affiliation,
## #   3: national_politics, 4: local_politics, 5: sinclair2017
```

Multiple conditions mean "and"

Then how about the codes below? Would we get the same results?

```
news |>
  filter(weekday == "Tue",
         affiliation == "Fox")
```

```
## # A tibble: 0 x 10
## # ... with 10 variables: callsign <chr>, affiliation <chr>,
## #   date <date>, weekday <ord>, ideology <dbl>,
## #   national_politics <dbl>, local_politics <dbl>,
## #   sinclair2017 <dbl>, post <dbl>, month <ord>
```

Wait... What..? What happened?

- Comparing two values/vectors:
  - > greater than
  - >= greater than or equal to
  - < less than
  - <= less than or equal to
  - == equal to
  - != not equal to
- Combining multiple logical statements:
  - & and
  - | or

A common mistake

Would this work?

```
news |>
  filter(weekday = "Tue")
```

```
## Error in `filter()`:
## ! We detected a named input.
## i This usually means that you've used `=` instead of `==`.
## i Did you mean `weekday == "Tue"`?
```

Let's try a couple more filters!

```
news |>
  filter(affiliation == "FOX" | affiliation =="ABC")
```

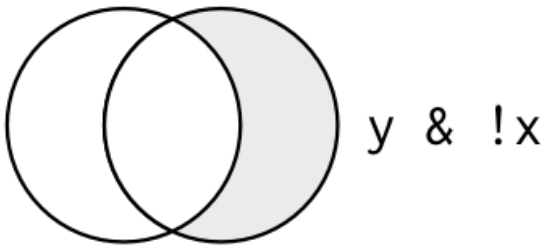
```
## # A tibble: 1,525 x 10
##    calls~1 affil~2 date       weekday ideology natio~3 local~4 sincl~5
##    <chr>   <chr>   <date>     <ord>      <dbl>   <dbl>   <dbl>   <dbl>
##  1 KXVA    FOX     2017-06-05 Mon     NA       0.0393  0.0262        0
##  2 KTMF    ABC     2017-06-07 Wed      8.42e-2 0.152   0.129         0
##  3 KTXS    ABC     2017-06-07 Wed     -4.88e-4 0.0925  0.0791        1
##  4 KXVA    FOX     2017-06-07 Wed     NA       0.00718 0.00479       0
##  5 KAEF    ABC     2017-06-08 Thu      4.26e-2 0.213   0.228         1
##  6 KBVU    FOX     2017-06-08 Thu     -8.60e-2 0.169   0.247         1
##  7 KTMF    ABC     2017-06-08 Thu      4.33e-2 0.179   0.139         0
##  8 KTXS    ABC     2017-06-08 Thu      6.27e-2 0.158   0.115         1
##  9 KXVA    FOX     2017-06-08 Thu     NA       0.0124  0.0873        0
## 10 WCTI    ABC     2017-06-08 Thu      1.39e-1 0.225   0.0759        1
## # ... with 1,515 more rows, 2 more variables: post <dbl>,
## #   month <ord>, and abbreviated variable names 1: callsign,
## #   2: affiliation, 3: national_politics, 4: local_politics,
## #   5: sinclair2017
```

When combining | and ==, useful to use %in%:

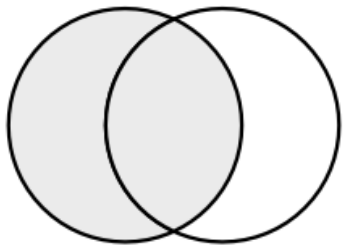
```
news |>
  filter(weekday %in% c("Mon", "Fri"))
```

```
## # A tibble: 1,253 x 10
##    callsign affil~1 date       weekday ideol~2 natio~3 local~4 sincl~5
##    <chr>    <chr>   <date>     <ord>     <dbl>   <dbl>   <dbl>   <dbl>
##  1 KRBC     NBC     2017-06-05 Mon      NA       0.0286  0.0190       0
##  2 KTAB     CBS     2017-06-05 Mon      NA       0.0286  0.0190       0
##  3 KXVA     FOX     2017-06-05 Mon      NA       0.0393  0.0262       0
##  4 KAEF     ABC     2017-06-09 Fri       0.0870  0.153   0.269        1
##  5 KBVU     FOX     2017-06-09 Fri      NA       0.0553  0.384        1
##  6 KECI     NBC     2017-06-09 Fri       0.115   0.216   0.108        1
##  7 KPAX     CBS     2017-06-09 Fri       0.0882  0.315   0.128        0
##  8 KRBC     NBC     2017-06-09 Fri       0.0929  0.152   0.147        0
##  9 KTAB     CBS     2017-06-09 Fri       0.0588  0.0711  0.176        0
## 10 KTMF     ABC     2017-06-09 Fri      NA       0.0495  0.0999       0
## # ... with 1,243 more rows, 2 more variables: post <dbl>,
## #   month <ord>, and abbreviated variable names 1: affiliation,
## #   2: ideology, 3: national_politics, 4: local_politics,
## #   5: sinclair2017
```

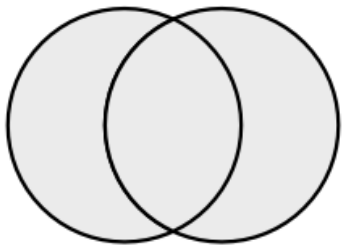
Complicated logicals



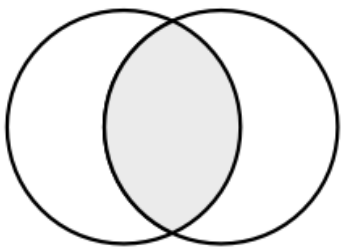
`y & !x`



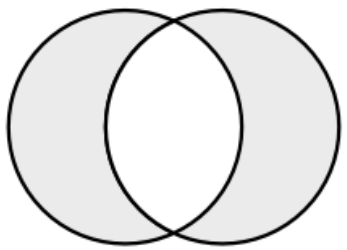
`x`



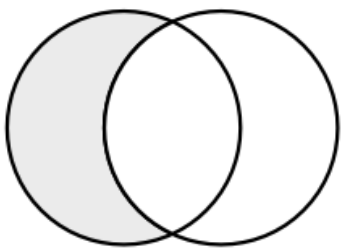
`x | y`



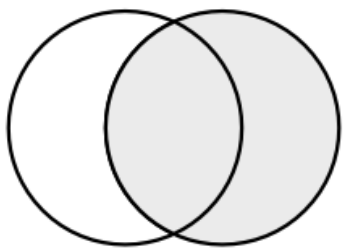
`x & y`



`xor(x, y)`



`x & !y`



`y`

`arrange()` will reorder the rows based on the values of the columns (the default option is ascending)

With multiple arguments, sort by first argument, then second, then third...

arrange by callsign then date

```
news |>
  arrange(callsign, date)
```

```
## # A tibble: 3,137 x 10
##    callsign affil~1 date       weekday ideol~2 natio~3 local~4 sincl~5
##    <chr>    <chr>   <date>     <ord>     <dbl>   <dbl>   <dbl>   <dbl>
##  1 KAEF     ABC     2017-06-08 Thu      0.0426  0.213   0.228       1
##  2 KAEF     ABC     2017-06-09 Fri      0.0870  0.153   0.269       1
##  3 KAEF     ABC     2017-06-12 Mon      0.0135  0.149   0.188       1
##  4 KAEF     ABC     2017-06-13 Tue      0.0242  0.180   0.234       1
##  5 KAEF     ABC     2017-06-14 Wed      0.123   0.182   0.0968      1
##  6 KAEF     ABC     2017-06-15 Thu      0.0778  0.114   0.203       1
##  7 KAEF     ABC     2017-06-16 Fri     NA       0.109   0.176       1
##  8 KAEF     ABC     2017-06-19 Mon      0.778   0.0823  0.179       1
##  9 KAEF     ABC     2017-06-20 Tue      0.115   0.131   0.163       1
## 10 KAEF     ABC     2017-06-21 Wed     -0.315   0.130   0.192       1
## # ... with 3,127 more rows, 2 more variables: post <dbl>,
## #   month <ord>, and abbreviated variable names 1: affiliation,
## #   2: ideology, 3: national_politics, 4: local_politics,
## #   5: sinclair2017
```

Which station-dates were the most liberal?

```
news |>
  arrange(ideology)
```

```
## # A tibble: 3,137 x 10
##    callsign affil~1 date       weekday ideol~2 natio~3 local~4 sincl~5
##    <chr>    <chr>   <date>     <ord>     <dbl>   <dbl>   <dbl>   <dbl>
##  1 KRBC     NBC     2017-10-19 Thu      -0.674  0.0731   0.161       0
##  2 WJHL     CBS     2017-12-08 Fri      -0.673  0.0364   0.206       0
##  3 KRBC     NBC     2017-10-18 Wed      -0.586  0.0470   0.135       0
##  4 KCVU     FOX     2017-06-22 Thu      -0.414  0.158    0.172       1
##  5 KRBC     NBC     2017-12-11 Mon      -0.365  0.0674   0.163       0
##  6 KAEF     ABC     2017-06-21 Wed      -0.315  0.130    0.192       1
##  7 KTMF     ABC     2017-12-01 Fri      -0.303  0.179    0.150       0
##  8 KWYB     ABC     2017-12-01 Fri      -0.303  0.160    0.161       0
##  9 KTVM     NBC     2017-09-01 Fri      -0.302  0.0507   0.106       1
## 10 KNVN     NBC     2017-12-08 Fri      -0.299  0.121    0.211       0
## # ... with 3,127 more rows, 2 more variables: post <dbl>,
## #   month <ord>, and abbreviated variable names 1: affiliation,
## #   2: ideology, 3: national_politics, 4: local_politics,
## #   5: sinclair2017
```

Which station-dates were the most conservative?

```
news |>
  arrange(desc(ideology))
```

```
## # A tibble: 3,137 x 10
##    callsign affil~1 date       weekday ideol~2 natio~3 local~4 sincl~5
##    <chr>    <chr>   <date>     <ord>     <dbl>   <dbl>   <dbl>   <dbl>
##  1 KAEF     ABC     2017-06-19 Mon       0.778  0.0823   0.179       1
##  2 WYDO     FOX     2017-07-19 Wed       0.580  0.126    0.121       1
##  3 KRCR     ABC     2017-10-03 Tue       0.566  0.123    0.192       1
##  4 KAEF     ABC     2017-10-18 Wed       0.496  0.0892   0.217       1
##  5 KBVU     FOX     2017-11-16 Thu       0.491  0.159    0.184       1
##  6 KTMF     ABC     2017-11-06 Mon       0.455  0.138    0.154       0
##  7 KAEF     ABC     2017-06-29 Thu       0.447  0.126    0.220       1
##  8 KPAX     CBS     2017-11-23 Thu       0.437  0.125    0.128       0
##  9 KTAB     CBS     2017-11-16 Thu       0.427  0.0631   0.104       0
## 10 KCVU     FOX     2017-07-06 Thu       0.406  0.154    0.148       1
## # ... with 3,127 more rows, 2 more variables: post <dbl>,
## #   month <ord>, and abbreviated variable names 1: affiliation,
## #   2: ideology, 3: national_politics, 4: local_politics,
## #   5: sinclair2017
```

`slice()` can give you a specific set of rows:

Let's look at the first and fifth observations

```
## first and third row
news |>
  slice(1, 5)
```

```
## # A tibble: 2 x 10
##   callsign affili~1 date       weekday ideol~2 natio~3 local~4 sincl~5
##   <chr>    <chr>    <date>     <ord>     <dbl>   <dbl>   <dbl>   <dbl>
## 1 KRBC     NBC      2017-06-05 Mon          NA  0.0286  0.0190       0
## 2 KTAB     CBS      2017-06-06 Tue          NA  0.0945  0.109        0
## # ... with 2 more variables: post <dbl>, month <ord>, and abbreviated
## #   variable names 1: affiliation, 2: ideology, 3: national_politics,
## #   4: local_politics, 5: sinclair2017
```

You can ask for a range of rows with `start:stop` syntax:

```
## first five rows
news |>
  slice(1:5)
```

```
## # A tibble: 5 x 10
##   callsign affili~1 date       weekday ideol~2 natio~3 local~4 sincl~5
##   <chr>    <chr>    <date>     <ord>     <dbl>   <dbl>   <dbl>   <dbl>
## 1 KRBC     NBC      2017-06-05 Mon          NA 0.0286   0.0190       0
## 2 KTAB     CBS      2017-06-05 Mon          NA 0.0286   0.0190       0
## 3 KXVA     FOX      2017-06-05 Mon          NA 0.0393   0.0262       0
## 4 KPAX     CBS      2017-06-06 Tue          NA 0.00357  0.194        0
## 5 KTAB     CBS      2017-06-06 Tue          NA 0.0945   0.109        0
## # ... with 2 more variables: post <dbl>, month <ord>, and abbreviated
## #   variable names 1: affiliation, 2: ideology, 3: national_politics,
## #   4: local_politics, 5: sinclair2017
```

`slice_max(var, n = 5)` will return the top 5 observations on column `var`

```
news |>
  slice_max(ideology, n = 5)
```

```
## # A tibble: 5 x 10
##   callsign affili~1 date       weekday ideol~2 natio~3 local~4 sincl~5
##   <chr>    <chr>    <date>     <ord>     <dbl>   <dbl>   <dbl>   <dbl>
## 1 KAEF     ABC      2017-06-19 Mon       0.778  0.0823   0.179       1
## 2 WYDO     FOX      2017-07-19 Wed       0.580  0.126    0.121       1
## 3 KRCR     ABC      2017-10-03 Tue       0.566  0.123    0.192       1
## 4 KAEF     ABC      2017-10-18 Wed       0.496  0.0892   0.217       1
## 5 KBVU     FOX      2017-11-16 Thu       0.491  0.159    0.184       1
## # ... with 2 more variables: post <dbl>, month <ord>, and abbreviated
## #   variable names 1: affiliation, 2: ideology, 3: national_politics,
## #   4: local_politics, 5: sinclair2017
```

`slice_min(var, n = 5)` will return the bottom 5 observations on column `var`

```
news |>
  slice_min(ideology, n = 5)
```

```
## # A tibble: 5 x 10
##   callsign affili~1 date       weekday ideol~2 natio~3 local~4 sincl~5
##   <chr>    <chr>    <date>     <ord>     <dbl>   <dbl>   <dbl>   <dbl>
## 1 KRBC     NBC      2017-10-19 Thu      -0.674  0.0731   0.161       0
## 2 WJHL     CBS      2017-12-08 Fri      -0.673  0.0364   0.206       0
## 3 KRBC     NBC      2017-10-18 Wed      -0.586  0.0470   0.135       0
## 4 KCVU     FOX      2017-06-22 Thu      -0.414  0.158    0.172       1
## 5 KRBC     NBC      2017-12-11 Mon      -0.365  0.0674   0.163       0
## # ... with 2 more variables: post <dbl>, month <ord>, and abbreviated
## #   variable names 1: affiliation, 2: ideology, 3: national_politics,
## #   4: local_politics, 5: sinclair2017
```

4. Operating on columns

`select()` selects columns via their names

```
news |>
  select(callsign, date, ideology)
```

```
## # A tibble: 3,137 x 3
##    callsign date       ideology
##    <chr>    <date>        <dbl>
##  1 KRBC     2017-06-05   NA
##  2 KTAB     2017-06-05   NA
##  3 KXVA     2017-06-05   NA
##  4 KPAX     2017-06-06   NA
##  5 KTAB     2017-06-06   NA
##  6 KECI     2017-06-07    0.0655
##  7 KPAX     2017-06-07    0.0853
##  8 KRBC     2017-06-07    0.0183
##  9 KTAB     2017-06-07    0.0850
## 10 KTMF     2017-06-07    0.0842
## # ... with 3,127 more rows
```

Selecting based on a range of variables

```
news |>
  select(callsign:ideology)
```

```
## # A tibble: 3,137 x 5
##    callsign affiliation date       weekday ideology
##    <chr>    <chr>       <date>     <ord>      <dbl>
##  1 KRBC     NBC         2017-06-05 Mon       NA
##  2 KTAB     CBS         2017-06-05 Mon       NA
##  3 KXVA     FOX         2017-06-05 Mon       NA
##  4 KPAX     CBS         2017-06-06 Tue       NA
##  5 KTAB     CBS         2017-06-06 Tue       NA
##  6 KECI     NBC         2017-06-07 Wed        0.0655
##  7 KPAX     CBS         2017-06-07 Wed        0.0853
##  8 KRBC     NBC         2017-06-07 Wed        0.0183
##  9 KTAB     CBS         2017-06-07 Wed        0.0850
## 10 KTMF     ABC         2017-06-07 Wed        0.0842
## # ... with 3,127 more rows
```

What would this code do?

```
news |>
  select(!callsign:ideology)
```

Selecting all not in a range

```
## # A tibble: 3,137 x 5
##    national_politics local_politics sinclair2017  post month
##                <dbl>          <dbl>        <dbl> <dbl> <ord>
##  1            0.0286         0.0190            0     0 Jun
##  2            0.0286         0.0190            0     0 Jun
##  3            0.0393         0.0262            0     0 Jun
##  4           0.00357         0.194             0     0 Jun
##  5            0.0945         0.109             0     0 Jun
##  6             0.225         0.148             1     0 Jun
##  7             0.283         0.123             0     0 Jun
##  8             0.130         0.189             0     0 Jun
##  9            0.0901         0.138             0     0 Jun
## 10             0.152         0.129             0     0 Jun
## # ... with 3,127 more rows
```

Selecting all numeric columns

```
news |>
  select(where(is.numeric))
```

```
## # A tibble: 3,137 x 5
##    ideology national_politics local_politics sinclair2017  post
##       <dbl>             <dbl>          <dbl>        <dbl> <dbl>
##  1  NA                0.0286         0.0190            0     0
##  2  NA                0.0286         0.0190            0     0
##  3  NA                0.0393         0.0262            0     0
##  4  NA                0.00357        0.194             0     0
##  5  NA                0.0945         0.109             0     0
##  6   0.0655           0.225          0.148             1     0
##  7   0.0853           0.283          0.123             0     0
##  8   0.0183           0.130          0.189             0     0
##  9   0.0850           0.0901         0.138             0     0
## 10   0.0842           0.152          0.129             0     0
## # ... with 3,127 more rows
```

Combining multiple selections

```
news |>
  select(callsign:weekday, ends_with("politics"))
```

```
## # A tibble: 3,137 x 6
##    callsign affiliation date       weekday national_politics local_p~1
##    <chr>    <chr>       <date>     <ord>                <dbl>     <dbl>
##  1 KRBC     NBC         2017-06-05 Mon                 0.0286    0.0190
##  2 KTAB     CBS         2017-06-05 Mon                 0.0286    0.0190
##  3 KXVA     FOX         2017-06-05 Mon                 0.0393    0.0262
##  4 KPAX     CBS         2017-06-06 Tue                 0.00357   0.194
##  5 KTAB     CBS         2017-06-06 Tue                 0.0945    0.109
##  6 KECI     NBC         2017-06-07 Wed                 0.225     0.148
##  7 KPAX     CBS         2017-06-07 Wed                 0.283     0.123
##  8 KRBC     NBC         2017-06-07 Wed                 0.130     0.189
##  9 KTAB     CBS         2017-06-07 Wed                 0.0901    0.138
## 10 KTMF     ABC         2017-06-07 Wed                 0.152     0.129
## # ... with 3,127 more rows, and abbreviated variable name
## #   1: local_politics
```

`rename(new_name = old_name)` renames the `old_name` variable to `new_name`

`mutate(new_var = function(old_vars))` adds new columns that are functions of existing columns

```
news |>
  mutate(
    national_local_diff = national_politics - local_politics,
    national_politics_perc = national_politics * 100
  ) |>
  select(callsign, date, national_politics, local_politics,
         national_local_diff, national_politics_perc)
```

```
## # A tibble: 3,137 x 6
##    callsign date       national_politics local_poli~1 nation~2 natio~3
##    <chr>    <date>                 <dbl>        <dbl>    <dbl>   <dbl>
##  1 KRBC     2017-06-05           0.0286        0.0190  0.00952   2.86
##  2 KTAB     2017-06-05           0.0286        0.0190  0.00952   2.86
##  3 KXVA     2017-06-05           0.0393        0.0262  0.0131    3.93
##  4 KPAX     2017-06-06           0.00357       0.194  -0.191     0.357
##  5 KTAB     2017-06-06           0.0945        0.109  -0.0145    9.45
##  6 KECI     2017-06-07           0.225         0.148   0.0761   22.5
##  7 KPAX     2017-06-07           0.283         0.123   0.160    28.3
##  8 KRBC     2017-06-07           0.130         0.189  -0.0589   13.0
##  9 KTAB     2017-06-07           0.0901        0.138  -0.0476    9.01
## 10 KTMF     2017-06-07           0.152         0.129   0.0229   15.2
## # ... with 3,127 more rows, and abbreviated variable names
## #   1: local_politics, 2: national_local_diff,
## #   3: national_politics_perc
```

`if_else(test_condition, yes, no)` allows us to create a vector that depends on a logical

New vector gets yes expression when `test_condition` is `TRUE`, `no` otherwise

What would the codes below do?

```
news |>
  mutate(ownership = if_else(sinclair2017 == 1,
                             "Acquired by Sinclair",
                             "Not Acquired")) |>
  select(callsign, affiliation, date, ownership)
```

```
## # A tibble: 3,137 x 4
##    callsign affiliation date       ownership
##    <chr>    <chr>       <date>     <chr>
##  1 KRBC     NBC         2017-06-05 Not Acquired
##  2 KTAB     CBS         2017-06-05 Not Acquired
##  3 KXVA     FOX         2017-06-05 Not Acquired
##  4 KPAX     CBS         2017-06-06 Not Acquired
##  5 KTAB     CBS         2017-06-06 Not Acquired
##  6 KECI     NBC         2017-06-07 Acquired by Sinclair
##  7 KPAX     CBS         2017-06-07 Not Acquired
##  8 KRBC     NBC         2017-06-07 Not Acquired
##  9 KTAB     CBS         2017-06-07 Not Acquired
## 10 KTMF     ABC         2017-06-07 Not Acquired
## # ... with 3,127 more rows
```

5. Operating on groups

`group_by()`

`group_by(var)` divides the data into groups based on the `var` variable

Doesn't change data yet, but subsequent operations will by var

```
news |>
  group_by(month)
```

```
## # A tibble: 3,137 x 10
## # Groups:   month [7]
##    callsign affil~1 date       weekday ideol~2 natio~3 local~4 sincl~5
##    <chr>    <chr>   <date>     <ord>     <dbl>   <dbl>   <dbl>   <dbl>
##  1 KRBC     NBC     2017-06-05 Mon      NA      0.0286   0.0190       0
##  2 KTAB     CBS     2017-06-05 Mon      NA      0.0286   0.0190       0
##  3 KXVA     FOX     2017-06-05 Mon      NA      0.0393   0.0262       0
##  4 KPAX     CBS     2017-06-06 Tue      NA      0.00357  0.194        0
##  5 KTAB     CBS     2017-06-06 Tue      NA      0.0945   0.109        0
##  6 KECI     NBC     2017-06-07 Wed       0.0655 0.225    0.148        1
##  7 KPAX     CBS     2017-06-07 Wed       0.0853 0.283    0.123        0
##  8 KRBC     NBC     2017-06-07 Wed       0.0183 0.130    0.189        0
##  9 KTAB     CBS     2017-06-07 Wed       0.0850 0.0901   0.138        0
## 10 KTMF     ABC     2017-06-07 Wed       0.0842 0.152    0.129        0
## # ... with 3,127 more rows, 2 more variables: post <dbl>,
## #   month <ord>, and abbreviated variable names 1: affiliation,
## #   2: ideology, 3: national_politics, 4: local_politics,
## #   5: sinclair2017
```

`summarize(sum_var = fun(curr_var))` calculates summaries of variables by groups

ideological slant by month

```
news |>
  group_by(month) |>
  summarize(
    slant_mean = mean(ideology, na.rm = TRUE)
  )
```

```
## # A tibble: 7 x 2
##   month slant_mean
##   <ord>      <dbl>
## 1 Jun       0.0786
## 2 Jul       0.103
## 3 Aug       0.105
## 4 Sep       0.0751
## 5 Oct       0.0862
## 6 Nov       0.0972
## 7 Dec       0.0774
```

Summaries by ownership and pre/post

```
news |>
  group_by(sinclair2017, post) |>
  summarize(
    slant_mean = mean(ideology, na.rm=TRUE),
    national_mean = mean(national_politics, na.rm=TRUE)
  )
```

```
## `summarise()` has grouped output by 'sinclair2017'. You
## using the `.groups` argument.
```

```
## # A tibble: 4 x 4
## # Groups:   sinclair2017 [2]
##   sinclair2017  post slant_mean national_mean
##          <dbl> <dbl>      <dbl>         <dbl>
## 1            0     0     0.100          0.118
## 2            0     1     0.0768         0.107
## 3            1     0     0.0936         0.124
## 4            1     1     0.0938         0.144
```

Summarize across types of variables

across() will apply a summary function across many variables

```
news |>
  group_by(sinclair2017, post) |>
  summarize(
    across(where(is.numeric), mean, na.rm = TRUE)
  )
```

```
## Warning: There was 1 warning in `summarize()`.
## i In argument: `across(where(is.numeric), mean, na.rm = TRUE)`.
## i In group 1: `sinclair2017 = 0`, `post = 0`.
## Caused by warning:
## ! The `...` argument of `across()` is deprecated as of dplyr 1.1.0.
## Supply arguments directly to `.fns` through an anonymous function
## instead.
##
##   # Previously
##   across(a:b, mean, na.rm = TRUE)
##
##   # Now
##   across(a:b, \(x) mean(x, na.rm = TRUE))

## `summarise()` has grouped output by 'sinclair2017'. You can override
## using the `.groups` argument.

## # A tibble: 4 x 5
## # Groups:   sinclair2017 [2]
##   sinclair2017  post ideology national_politics local_politics
##          <dbl> <dbl>    <dbl>             <dbl>          <dbl>
## 1            0     0   0.100              0.118          0.158
## 2            0     1   0.0768             0.107          0.150
## 3            1     0   0.0936             0.124          0.170
## 4            1     1   0.0938             0.144          0.147
```

This also works!

```
news |>
  group_by(sinclair2017, post) %>%
  summarize(
    across(where(is.numeric),
                   \(x) mean(x, na.rm = TRUE)))
```

```
## `summarise()` has grouped output by 'sinclair2017'. You can override
## using the `.groups` argument.
```

```
## # A tibble: 4 x 5
## # Groups:   sinclair2017 [2]
##   sinclair2017  post ideology national_politics local_politics
##          <dbl> <dbl>    <dbl>             <dbl>          <dbl>
## 1            0     0   0.100              0.118          0.158
## 2            0     1   0.0768             0.107          0.150
## 3            1     0   0.0936             0.124          0.170
## 4            1     1   0.0938             0.144          0.147
```

This one as well!

```
news |>
  group_by(sinclair2017, post) %>%
  summarize(
    across(where(is.numeric),
                   ~ mean(.x, na.rm = TRUE)))
```

```
## `summarise()` has grouped output by 'sinclair2017'. You can override
## using the `.groups` argument.
```

```
## # A tibble: 4 x 5
## # Groups:   sinclair2017 [2]
##   sinclair2017  post ideology national_politics local_politics
##          <dbl> <dbl>    <dbl>             <dbl>          <dbl>
## 1            0     0   0.100              0.118          0.158
## 2            0     1   0.0768             0.107          0.150
## 3            1     0   0.0936             0.124          0.170
## 4            1     1   0.0938             0.144          0.147
```

kable() to produce nice tables :)

```
news |>
  group_by(month) |>
  summarize(
    slant_mean = mean(ideology, na.rm=TRUE)
  ) |>
  knitr::kable()
```

month	slant_mean
Jun	0.0785518
Jul	0.1032917
Aug	0.1049908
Sep	0.0751067
Oct	0.0861639
Nov	0.0971796
Dec	0.0773873

Nice table! But, column names?

Producing nicer column names

```
news |>
  group_by(month) |>
  summarize(
    slant_mean = mean(ideology, na.rm=TRUE)
  ) |>
  knitr::kable(col.names = c("Month", "Avg. Slant"))
```

Month	Avg. Slant
Jun	0.0785518
Jul	0.1032917
Aug	0.1049908
Sep	0.0751067
Oct	0.0861639
Nov	0.0971796
Dec	0.0773873

Producing a table of counts of a categorical variable

```
news |>
  group_by(affiliation) |>
  summarize(n = n())
```

```
## # A tibble: 4 x 2
##   affiliation     n
##   <chr>       <int>
## 1 ABC           863
## 2 CBS           807
## 3 FOX           662
## 4 NBC           805
```

Helper function `count()`

`count()` does the same thing:

```
news |>
  count(affiliation)
```

```
## # A tibble: 4 x 2
##   affiliation     n
##   <chr>       <int>
## 1 ABC           863
## 2 CBS           807
## 3 FOX           662
## 4 NBC           805
```

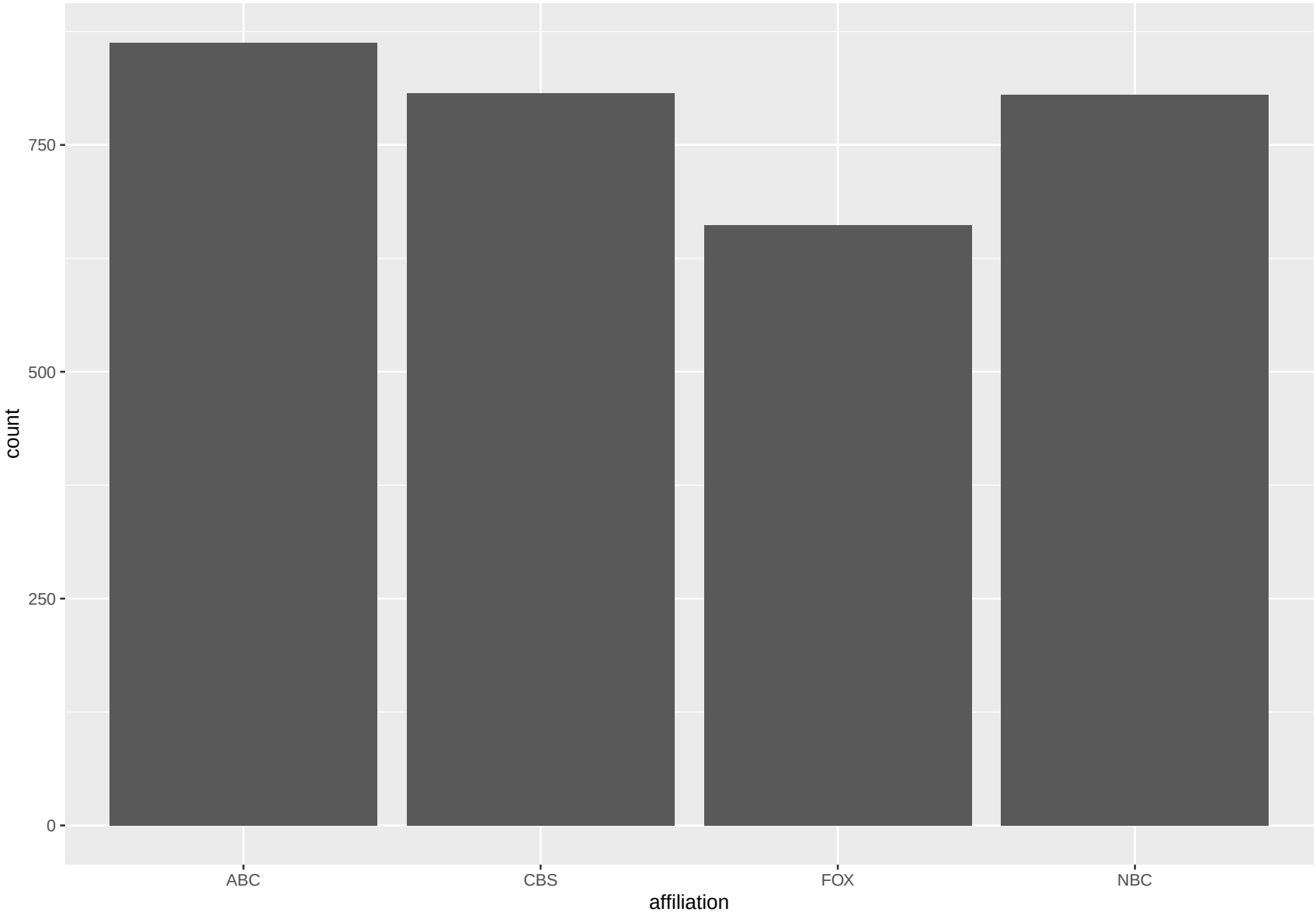
6. Creating barplots

Combining our skills

Let's combine out tools to produce a bar plot with `geom_bar()`

By default, bar plots take a single variable and show the number of observations in each category

```
ggplot(news, mapping = aes(x = affiliation)) +
  geom_bar()
```



Barplots of non-counts

Barplots can represent a lot beyond counts, including variables in our dataset or group summeries

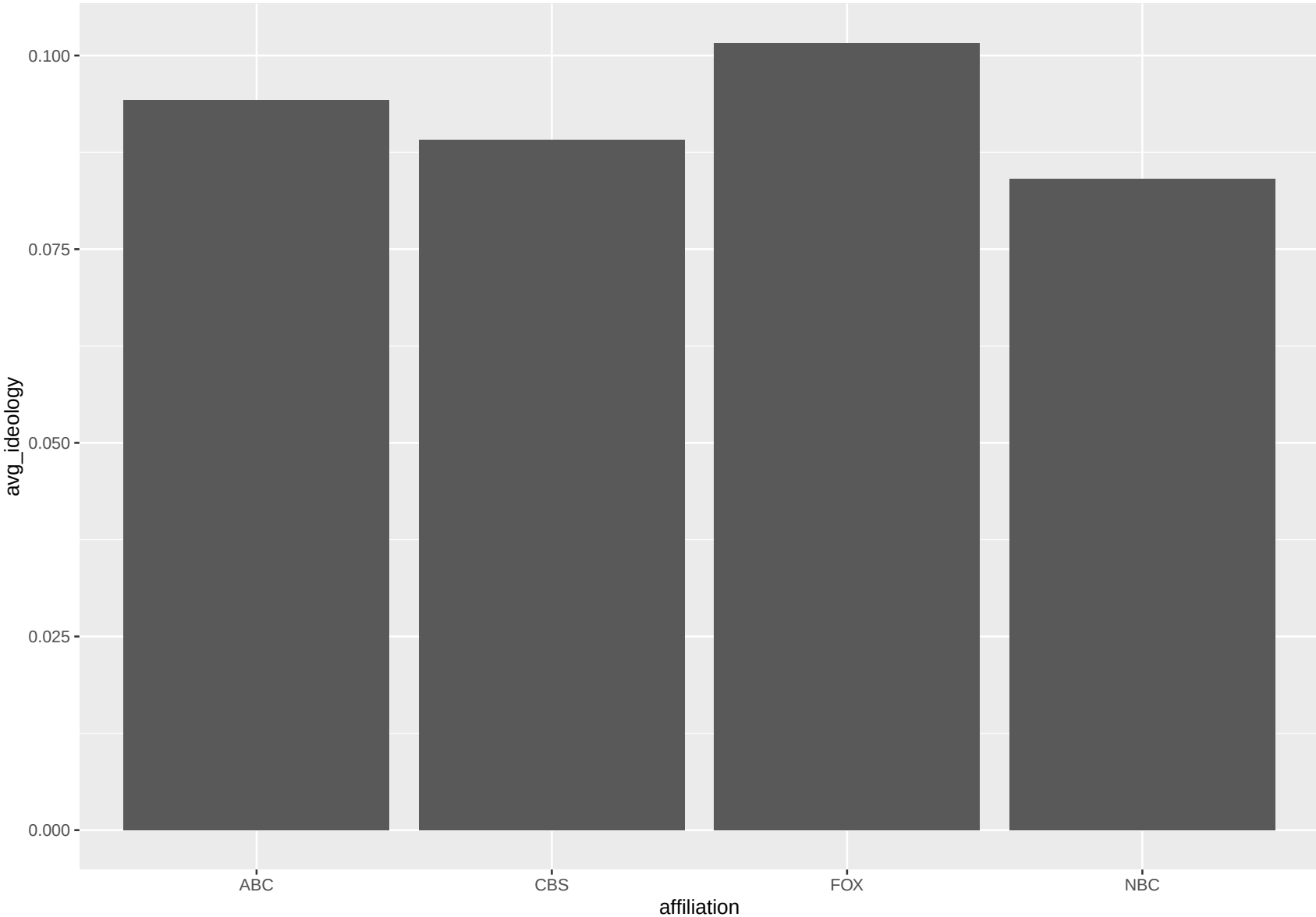
When the height of the bar is another variable in our data and not just a count, we set the `x` and `y` aesthetics and use `geom_col()` instead of `geom_bar()`

Let's create a group summary: the average ideology scores by affiliation

```
aff_ideology_means <- news |>
  group_by(affiliation) |>
  summarize(avg_ideology = mean(ideology, na.rm=TRUE))
aff_ideology_means
```

```
## # A tibble: 4 x 2
##   affiliation avg_ideology
##   <chr>              <dbl>
## 1 ABC               0.0943
## 2 CBS               0.0891
## 3 FOX               0.102
## 4 NBC               0.0841
```

```
ggplot(aff_ideology_means, aes(x = affiliation, y = avg_ideology)) +
  geom_col()
```


0.100
0.075
0.050
0.025
0.000
avg_ideology
ABC
CBS
FOX
NBC
affiliation

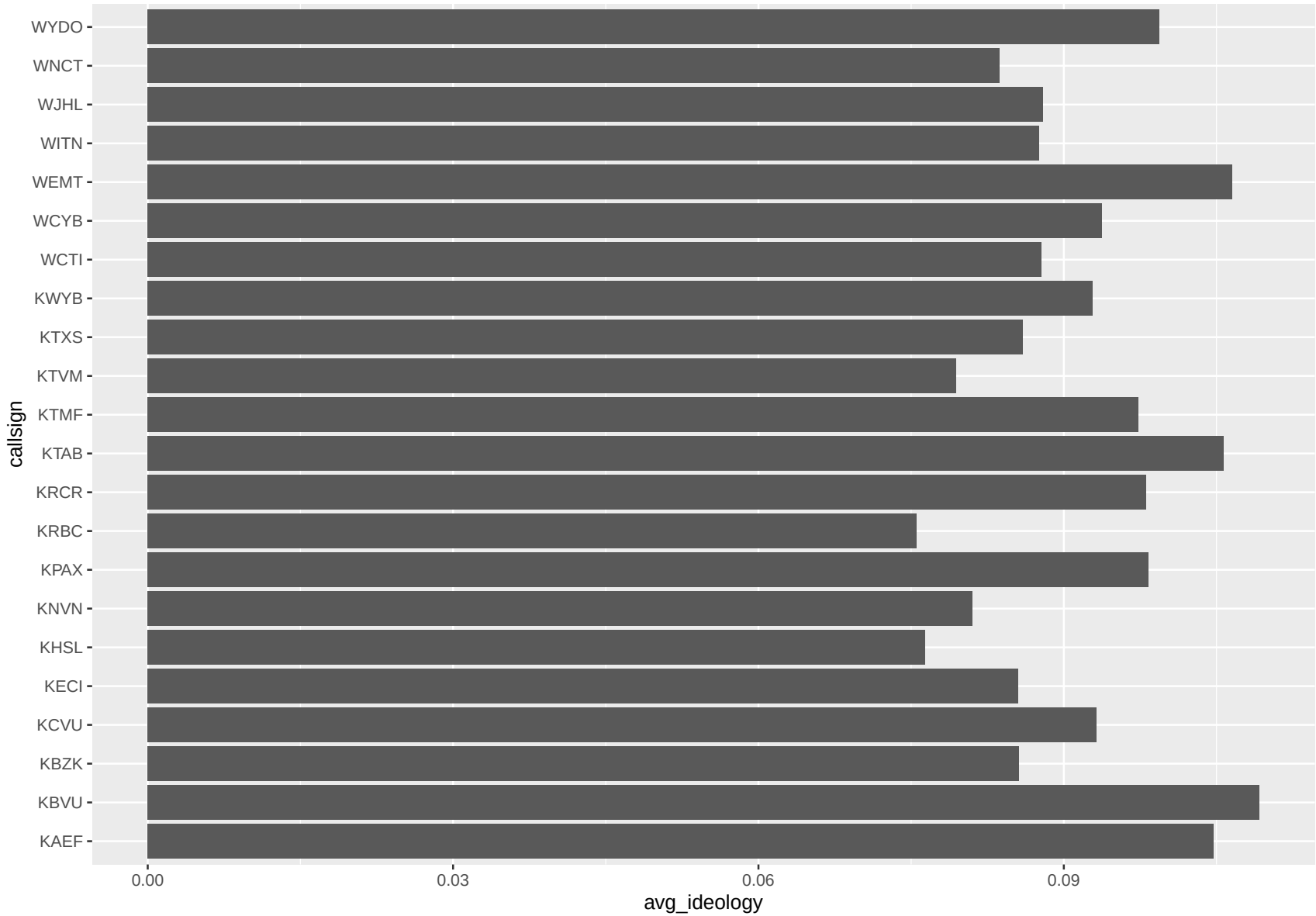
A more complicated example

Let's create a bar plot that shows the top 10 stations in terms of slant. First, let's get the data:

```
station_ideology <- news |>
  group_by(callsign, affiliation) |>
  summarize(avg_ideology = mean(ideology, na.rm = TRUE)) |>
  slice_max(avg_ideology, n = 20)
```

na.omit() helps removing NA

```
ggplot(na.omit(station_ideology), aes( x = avg_ideology, y = callsign)) +
  geom_col()
```

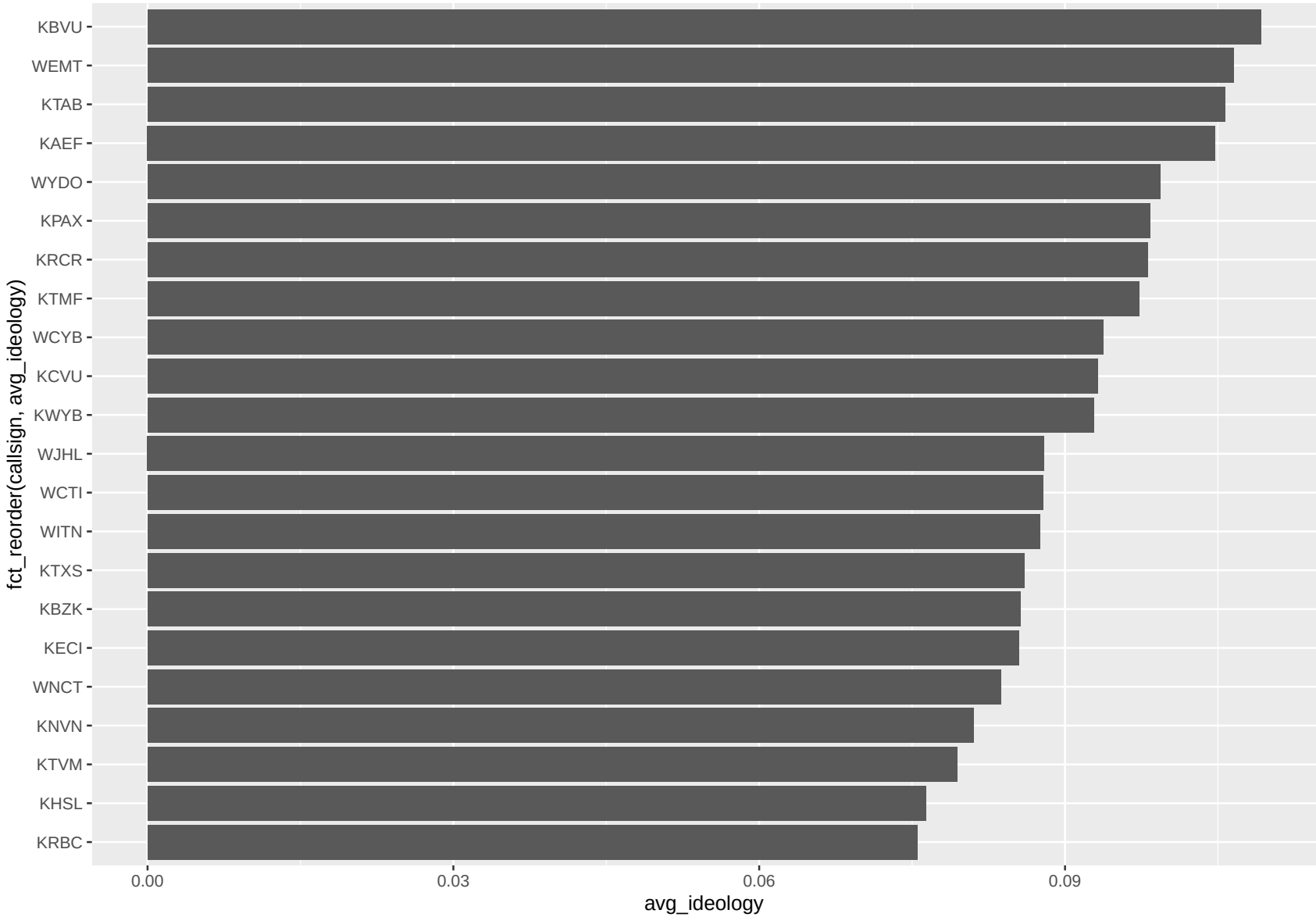


How do we reorder the stations?

We would like to order the stations by ideology

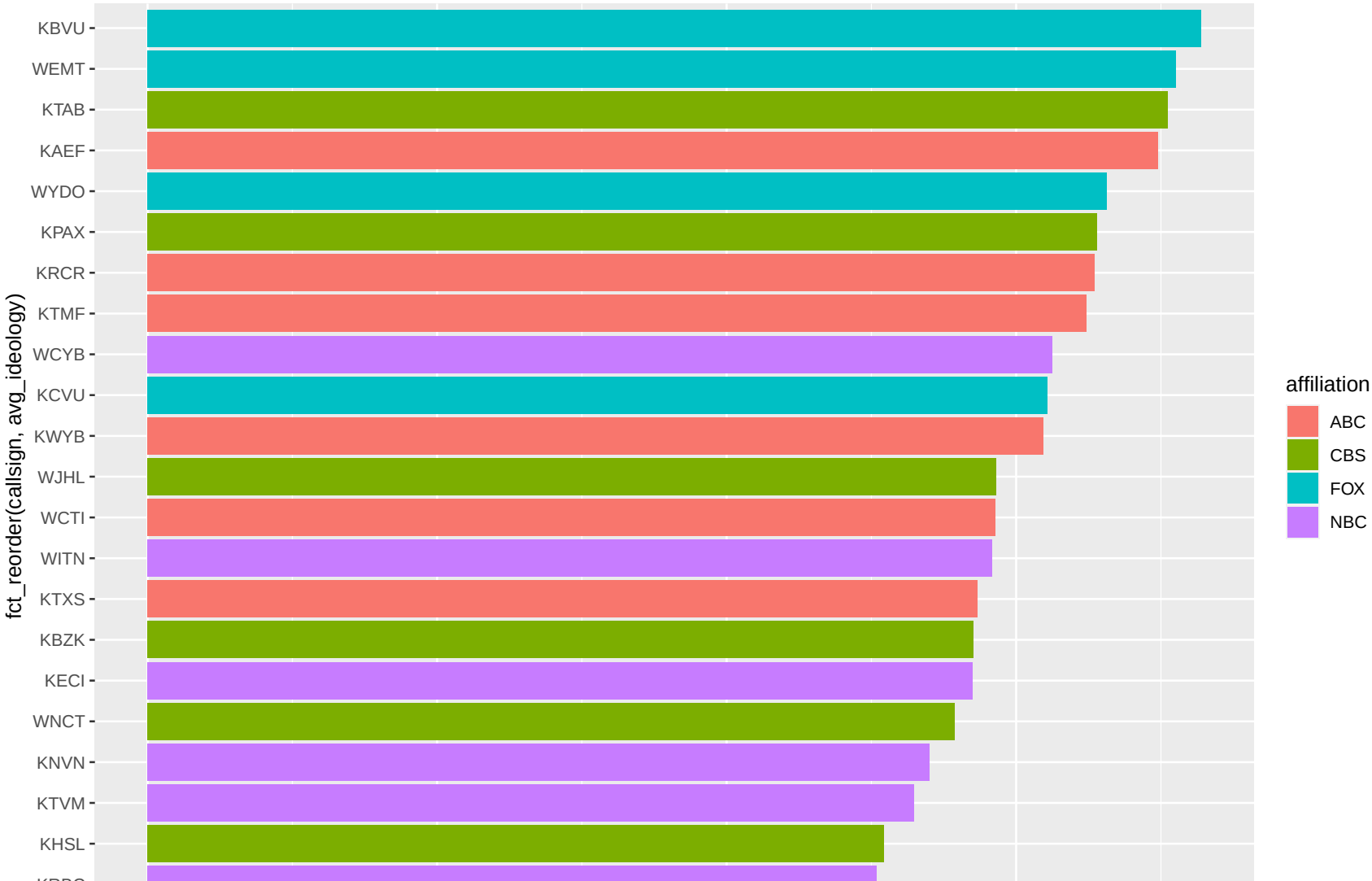
`fct_reorder(group, order_var)` function (loaded with `tidyverse`) will reorder the groups by the order bar (low to high). Easiest to put this in the mapping.

```
ggplot(na.omit(station_ideology),
       mapping = aes(x = avg_ideology,
                     y = fct_reorder(callsign, avg_ideology))) +
  geom_col()
```



Adding color by affiliation

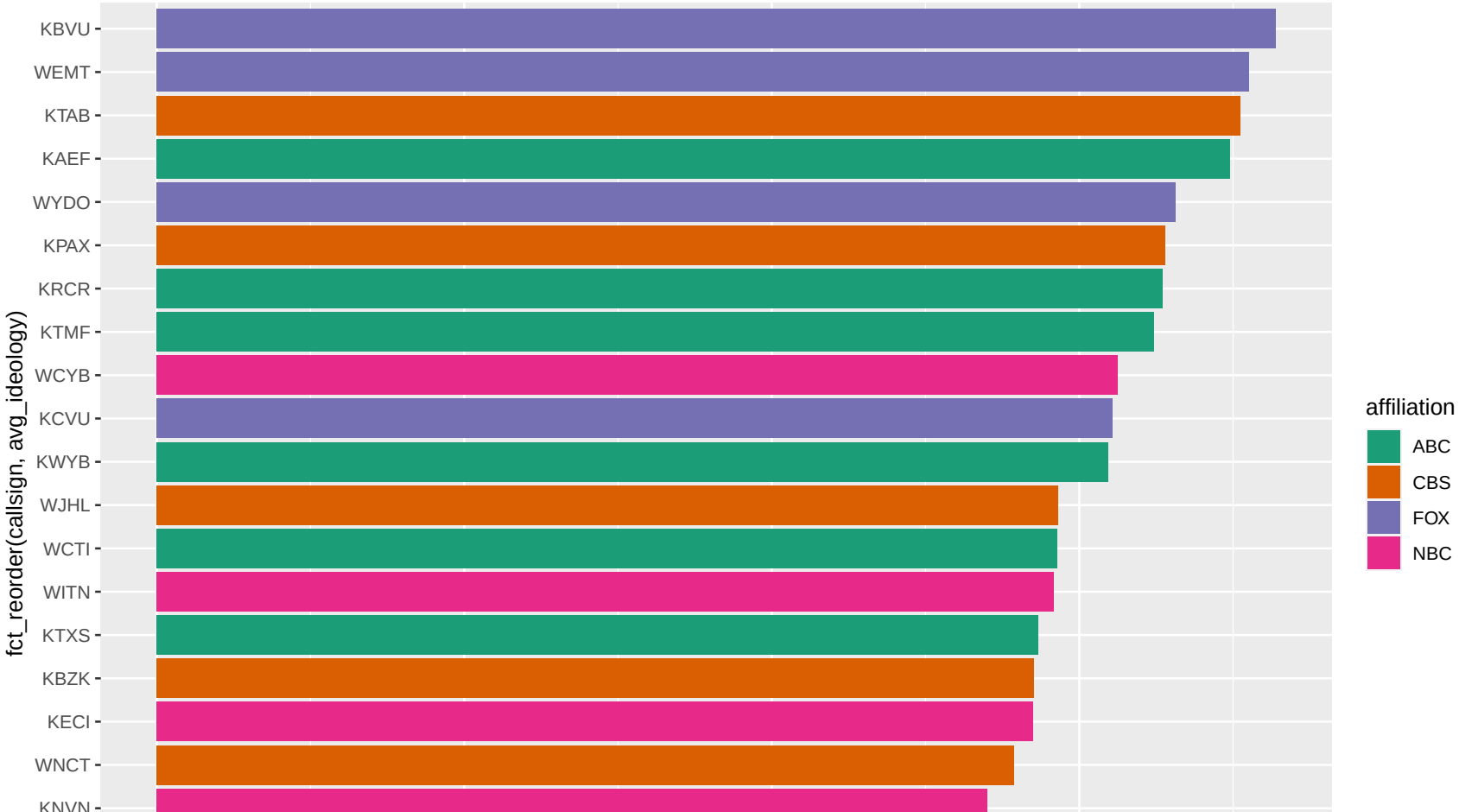
```
ggplot(na.omit(station_ideology),
       mapping = aes(x = avg_ideology,
                     y = fct_reorder(callsign, avg_ideology))) +
  geom_col(mapping = aes(fill = affiliation))
```



Setting the color palette

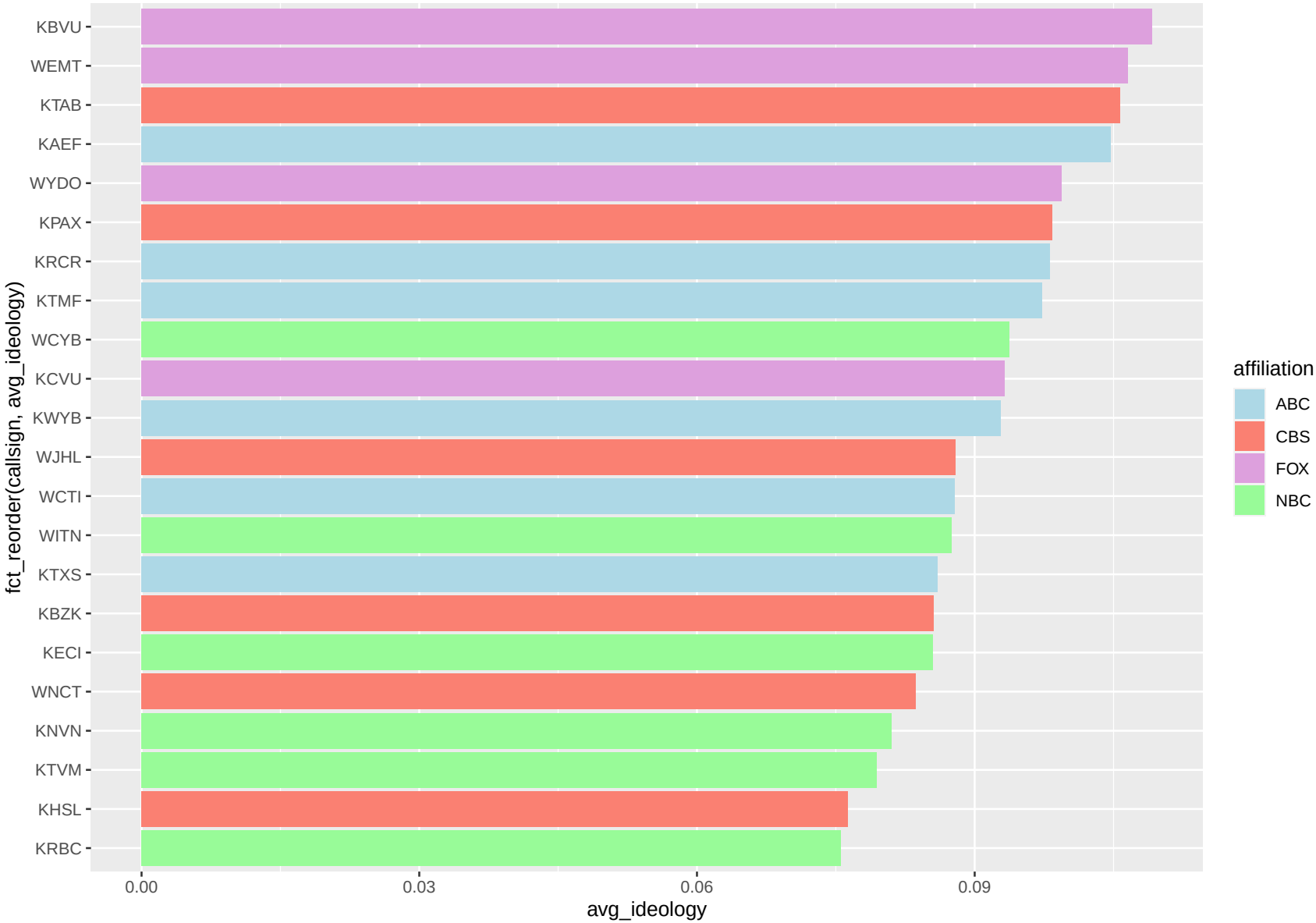
We can use color pallettes from a project called `ColorBrewer`

```
ggplot(na.omit(station_ideology),
       mapping = aes(x = avg_ideology,
                     y = fct_reorder(callsign, avg_ideology))) +
  geom_col(mapping = aes(fill = affiliation)) +
  scale_fill_brewer(palette = "Dark2")
```



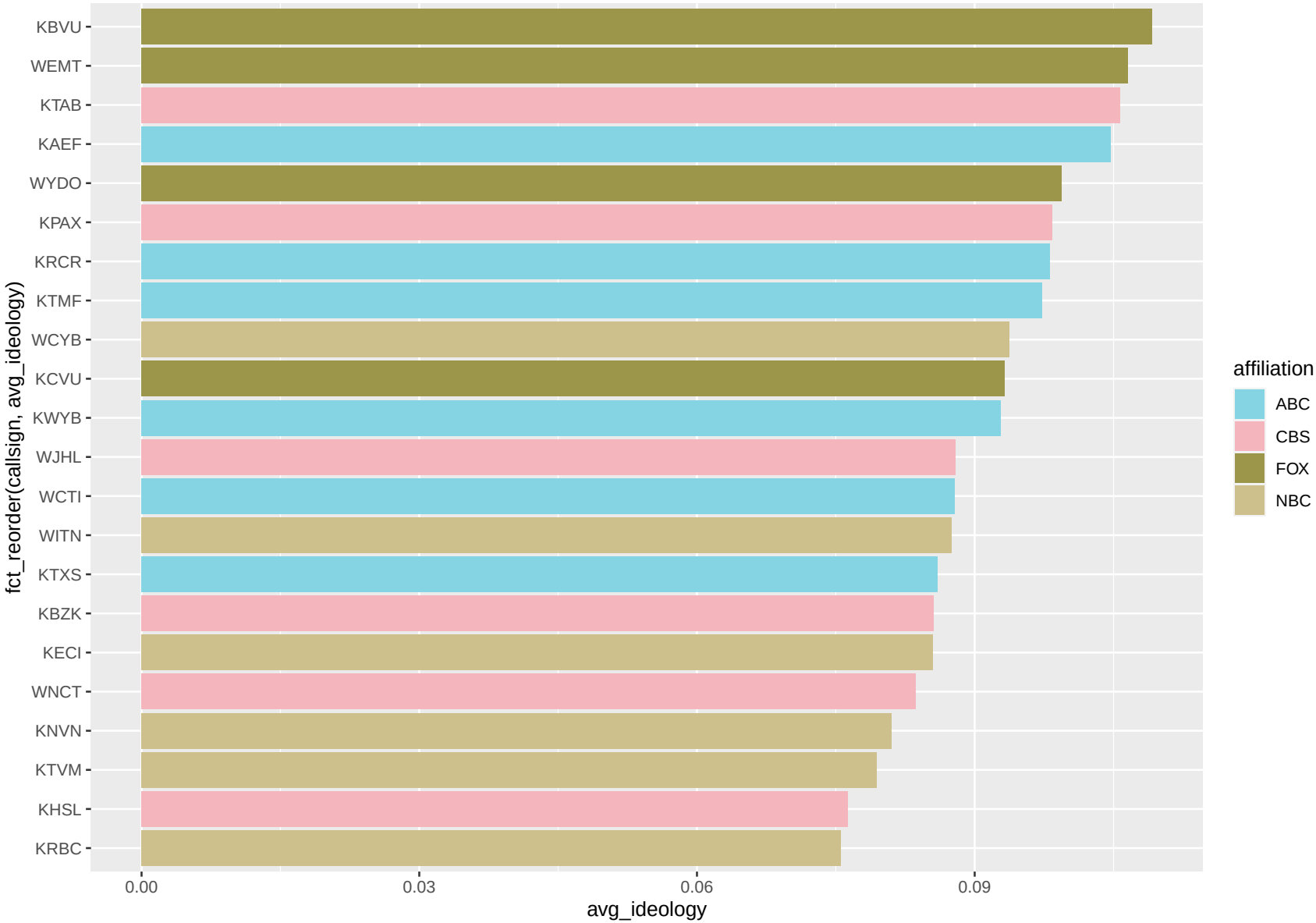
Manually setting the color palette

```
ggplot(na.omit(station_ideology),
       mapping = aes(x = avg_ideology,
                     y = fct_reorder(callsign, avg_ideology))) +
  geom_col(mapping = aes(fill = affiliation)) +
  scale_fill_manual(values =c(ABC = "lightblue",
                              CBS = "salmon",
                              FOX = "plum",
                              NBC = "palegreen"))
```


KBVU
WEMT
KTAB
KAEF
WYDO
KPAX
KRCR
KTMF
WCYB
KCVU
KWYB
WJHL
WCTI
WITN
KTXS
KBZK
KECI
WNCT
KNVN
KTVM
KHSL
KRBC
fct_reorder(callsign, avg_ideology)
0.00
0.03
0.06
0.09
avg_ideology
affiliation
ABC
CBS
FOX
NBC

Other packages provide more palettes:

```
library(wesanderson)
ggplot(na.omit(station_ideology),
       mapping = aes(x = avg_ideology,
                     y = fct_reorder(callsign, avg_ideology))) +
  geom_col(mapping = aes(fill = affiliation)) +
  scale_fill_manual(values = wes_palette("Moonrise3"))
```


KBVU
WEMT
KTAB
KAEF
WYDO
KPAX
KRCR
KTMF
WCYB
KCVU
KWYB
WJHL
WCTI
WITN
KTXS
KBZK
KECI
WNCT
KNVN
KTVM
KHSL
KRBC
fct_reorder(callsign, avg_ideology)
0.00
0.03
0.06
0.09
avg_ideology
affiliation
ABC
CBS
FOX
NBC