Data Visualization - 7.

Make Maps (1)

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Code Horizons

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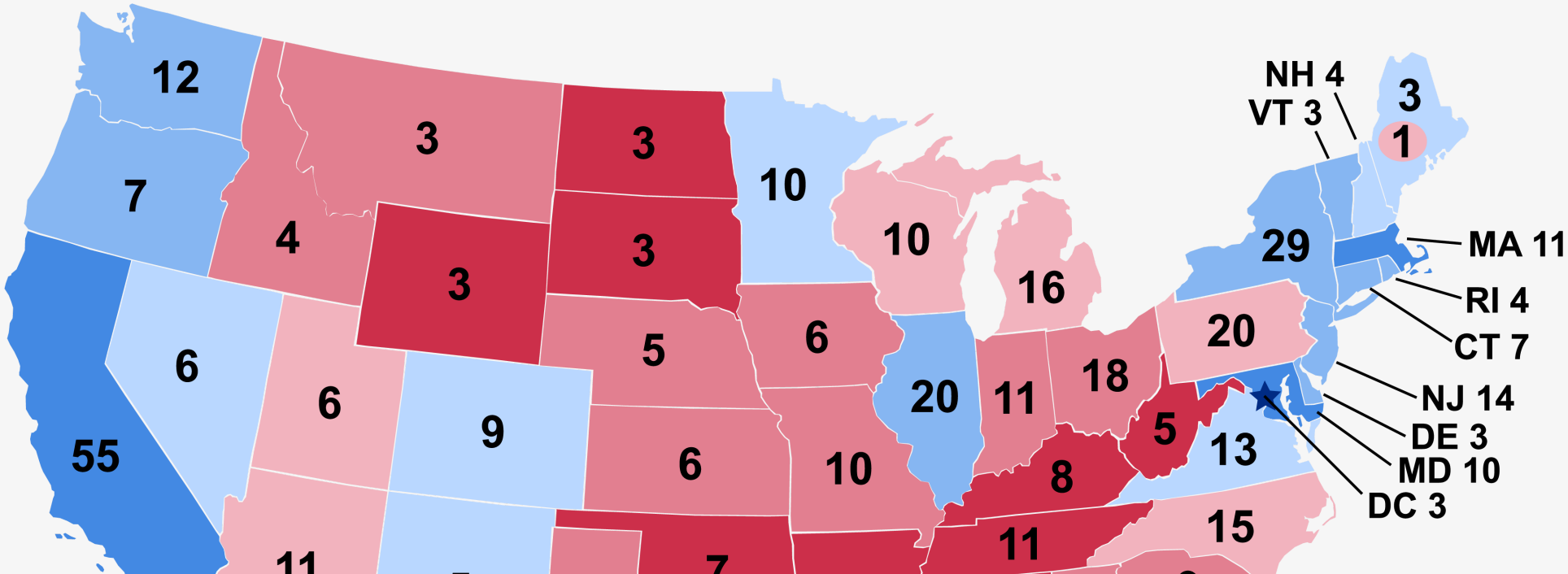
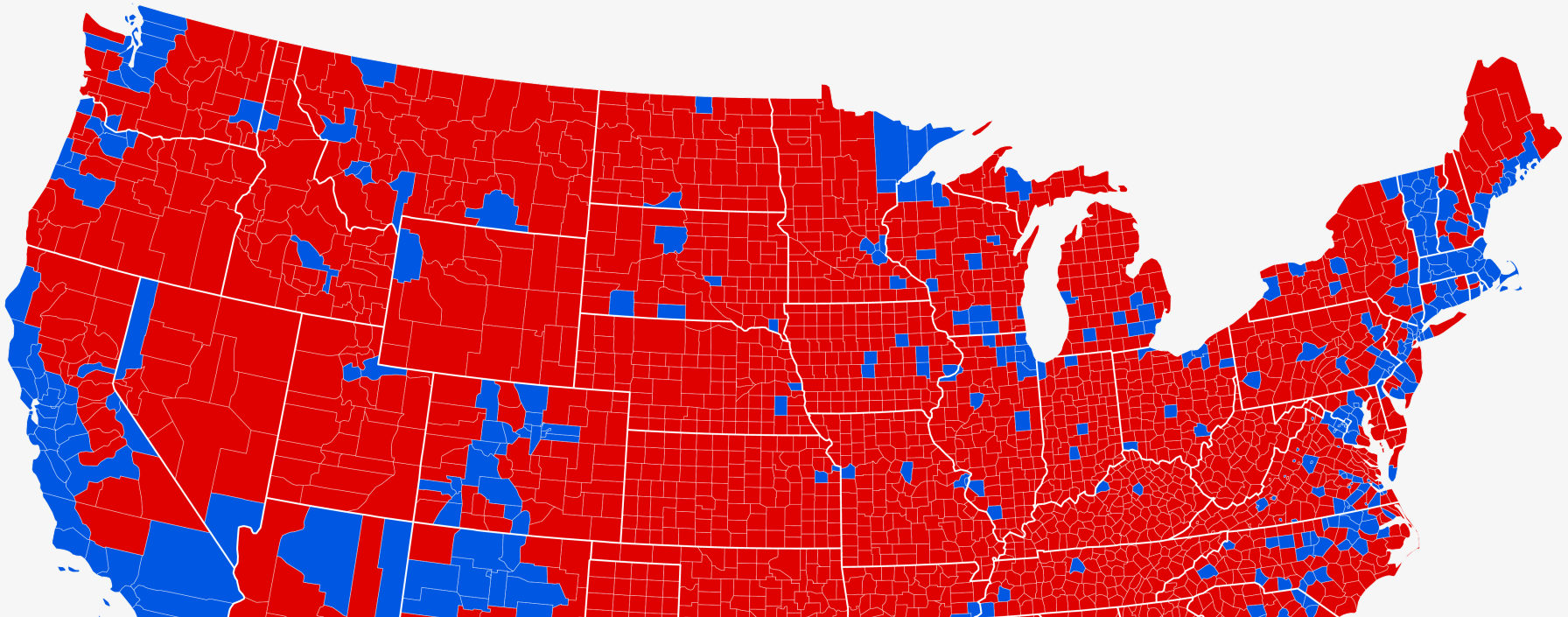
Making Maps

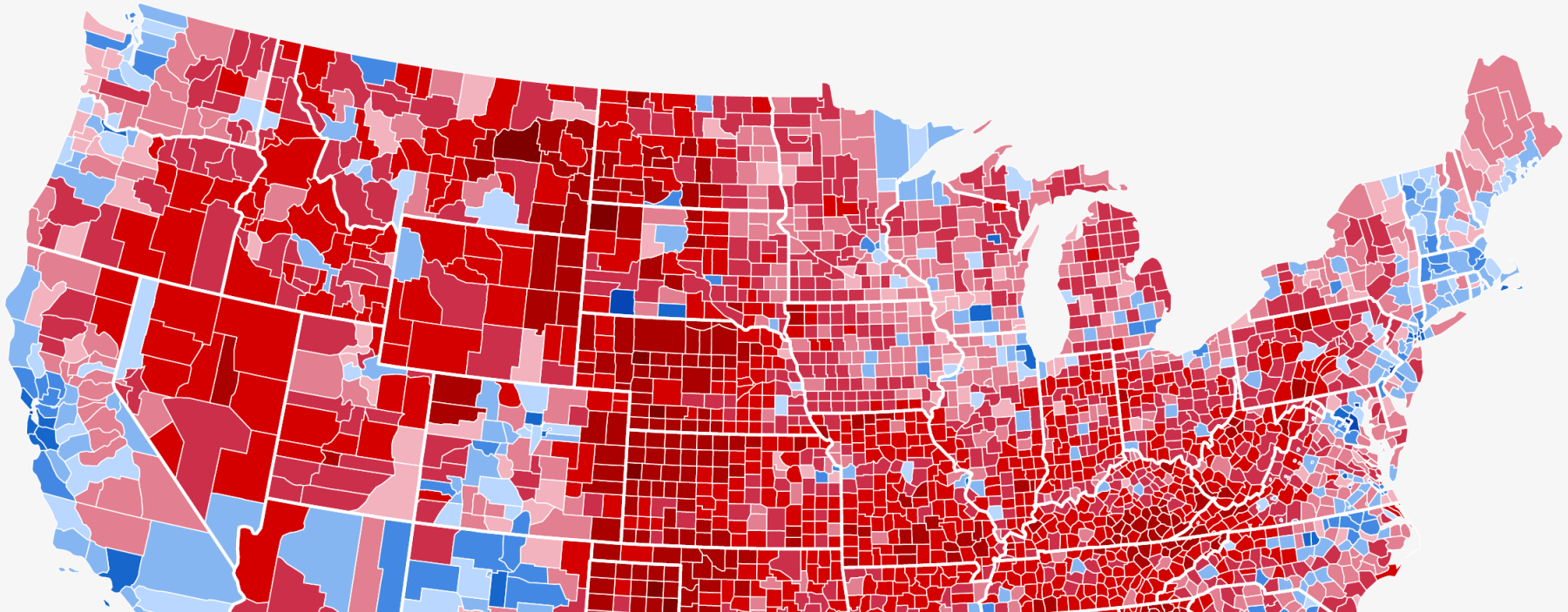
Load our packages

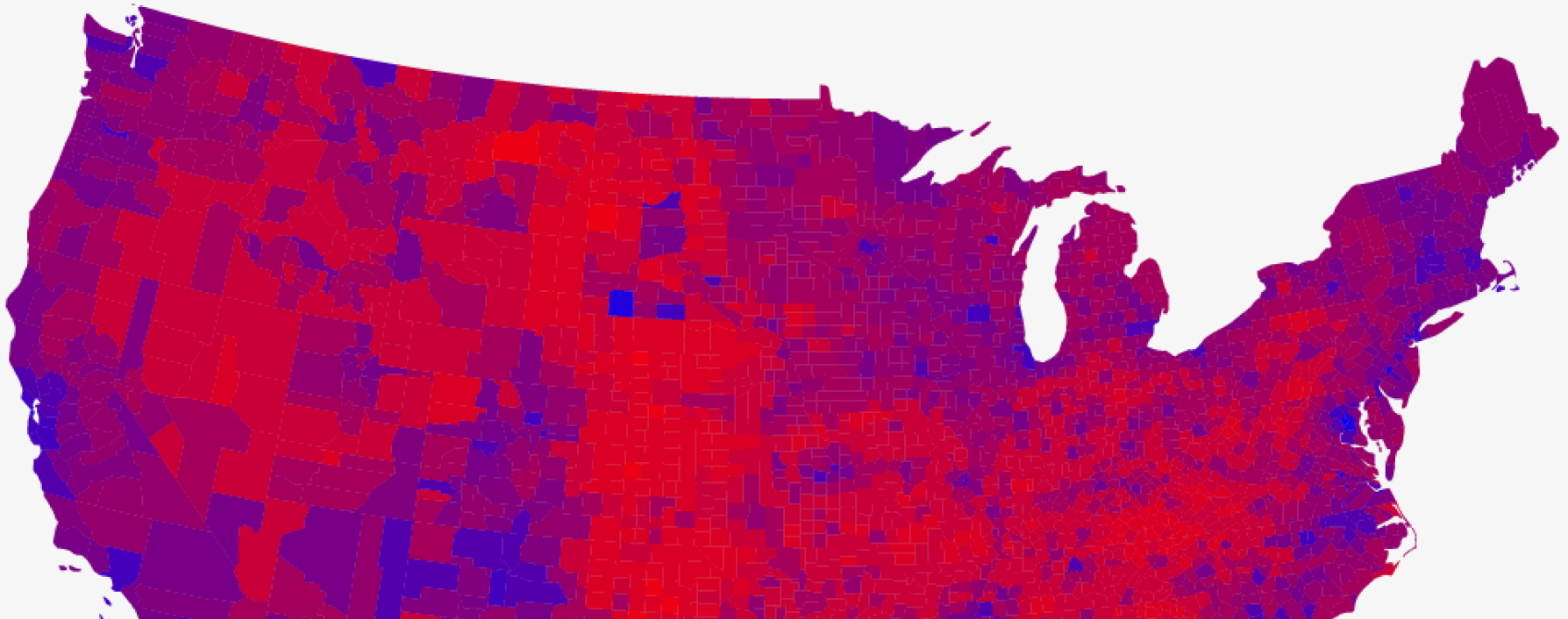
```
library(here)      # manage file paths
library(socviz)    # data and some useful functions
library(tidyverse) # your friend and mine
library(maps)      # Some basic maps
library(sf)        # Simple Features Geometries and geom_sf()
library(ggforce)   # Useful enhancements to ggplot
```

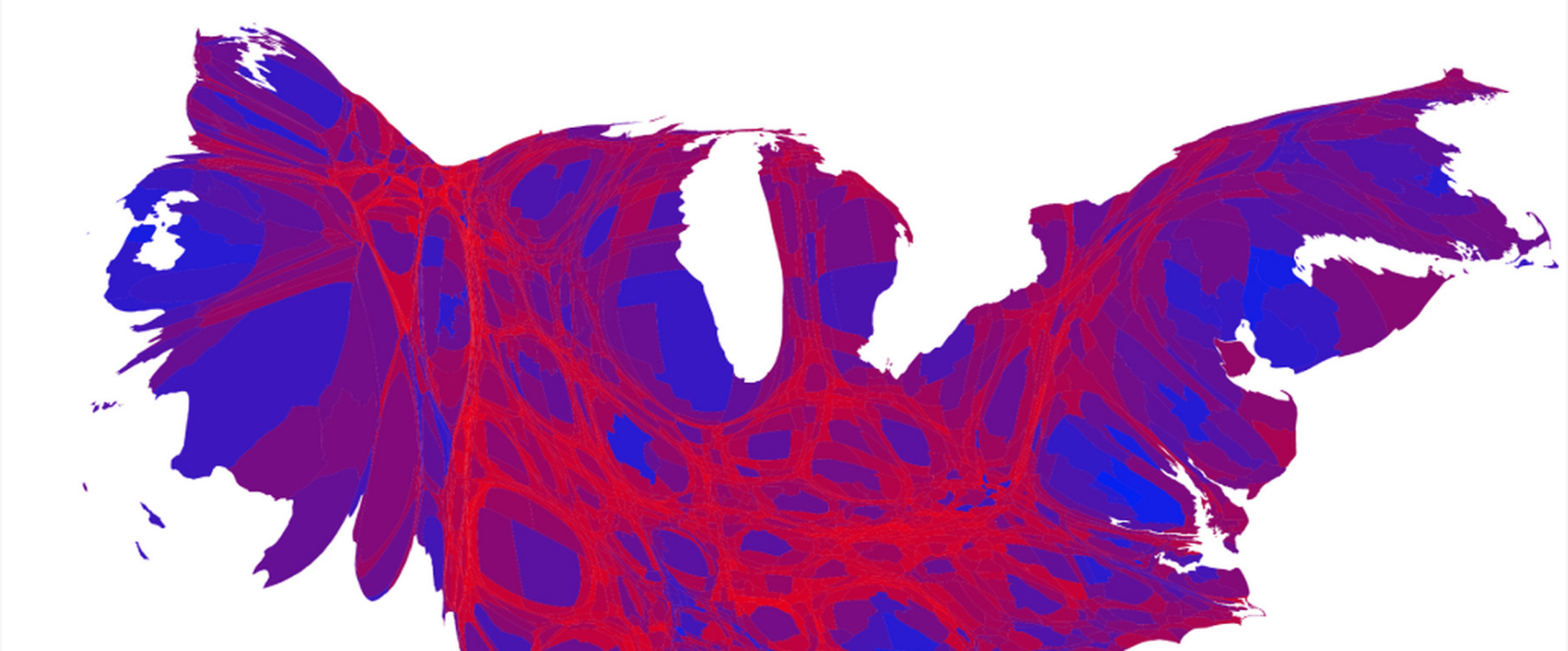
Choropleths

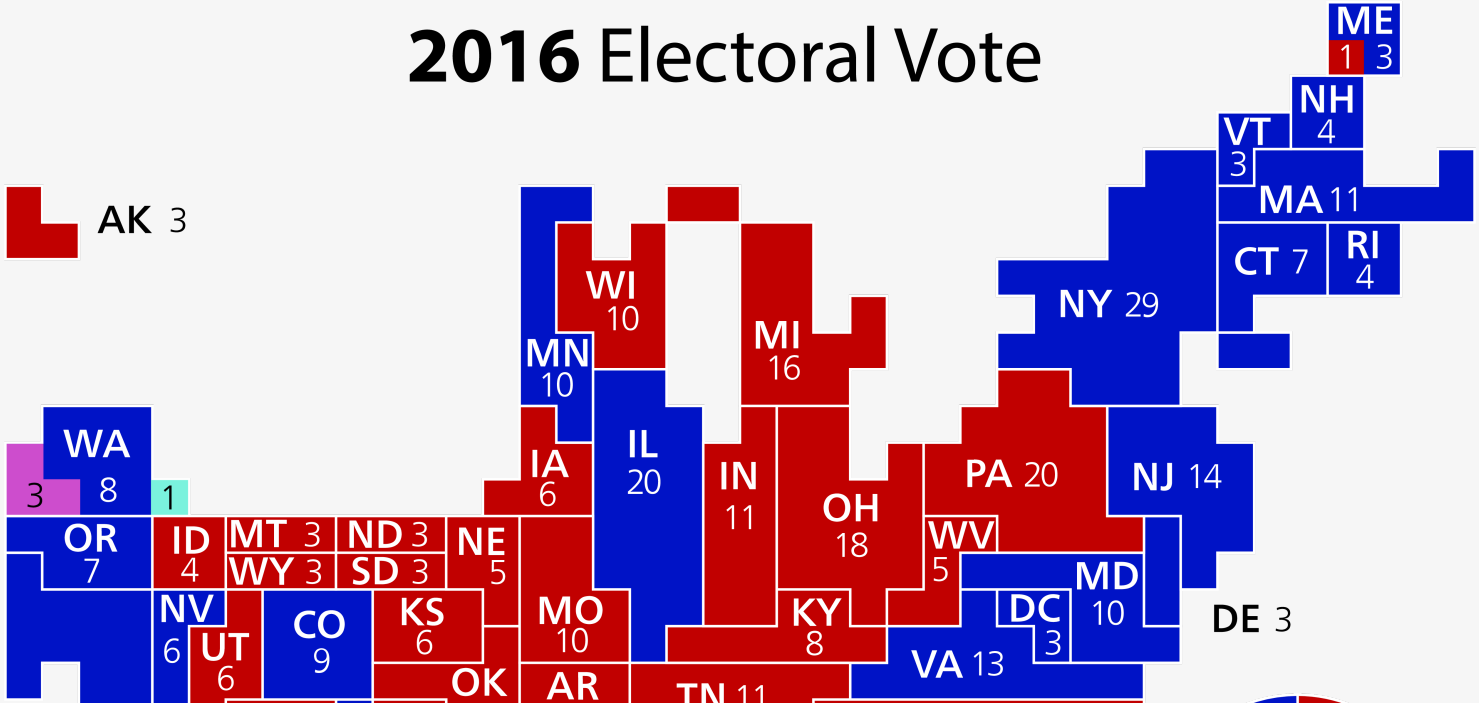

12
7
3
4
3
3
3
10
10
16
6
5
6
20
11
18
5
8
20
NH 4
VT 3
3
1
29
MA 11
RI 4
CT 7
NJ 14
DE 3
MD 10
DC 3
13
15
11
55
6
6
9
11
7
6
10

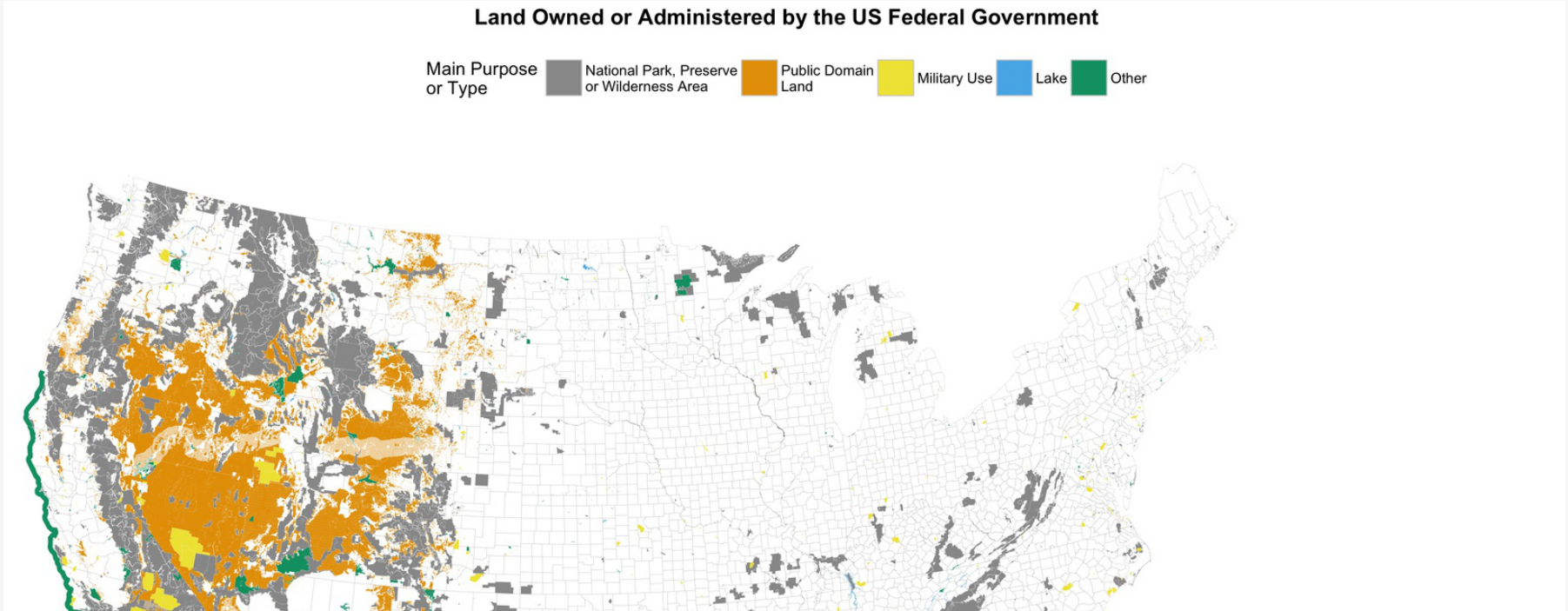


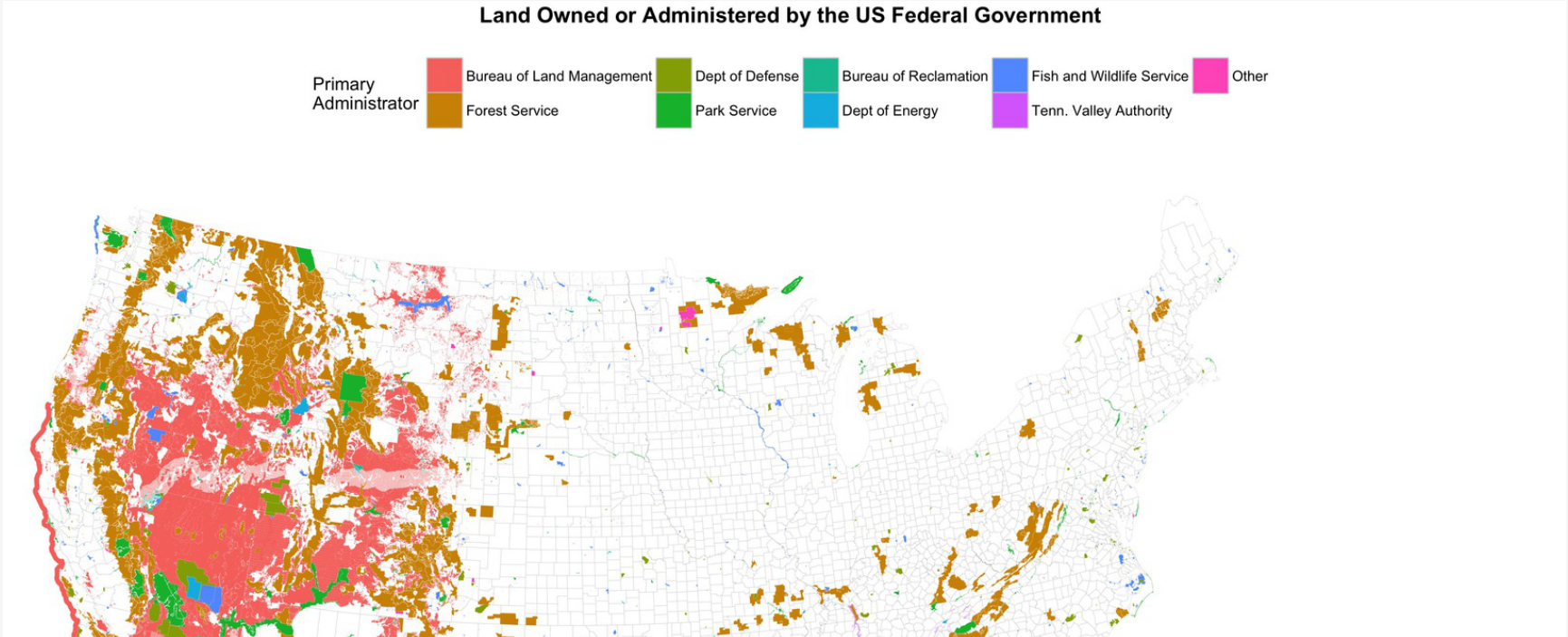




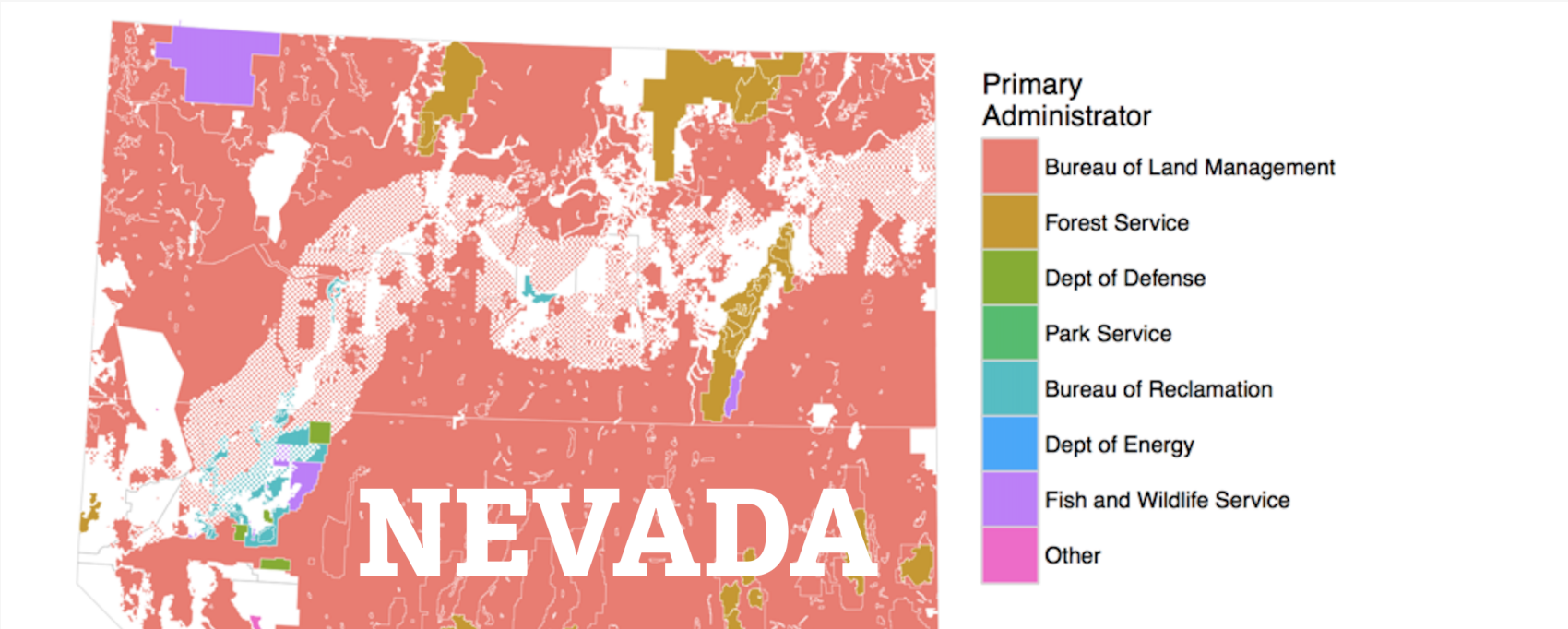



2016 Electoral Vote
AK 3
WA 8
3
1
OR 7
CA 55
ID 4
NV 6
UT 6
AZ 11
CO 9
MT 3
WY 3
ND 3
SD 3
NE 5
KS 6
OK 7
TX 38
MN 10
IA 6
MO 10
AR 6
LA 8
WI 10
IL 20
MS 6
AL 9
TN 11
MI 16
IN 11
KY 8
OH 18
WV 5
GA 16
SC 9
NC 15
FL 29
PA 20
VA 13
ME 1 3
NH 4
VT 3
MA 11
CT 7
RI 4
NY 29
NJ 14
MD 10
DC 3
DE 3


Land Owned or Administered by the US Federal Government
Main Purpose or Type
National Park, Preserve or Wilderness Area
Public Domain Land
Military Use
Lake
Other

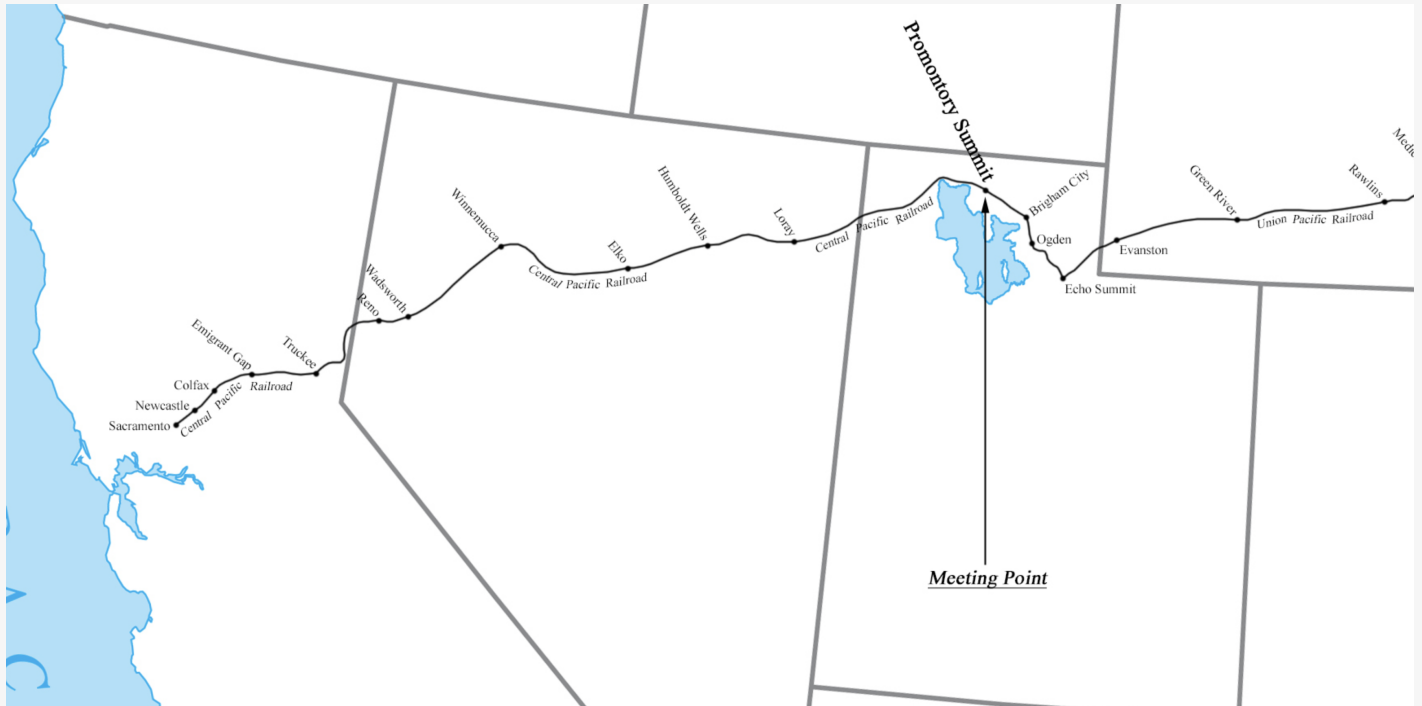

Land Owned or Administered by the US Federal Government
Primary Administrator
Bureau of Land Management
Forest Service
Dept of Defense
Park Service
Bureau of Reclamation
Dept of Energy
Fish and Wildlife Service
Tenn. Valley Authority
Other

Aside: What the hell's that?

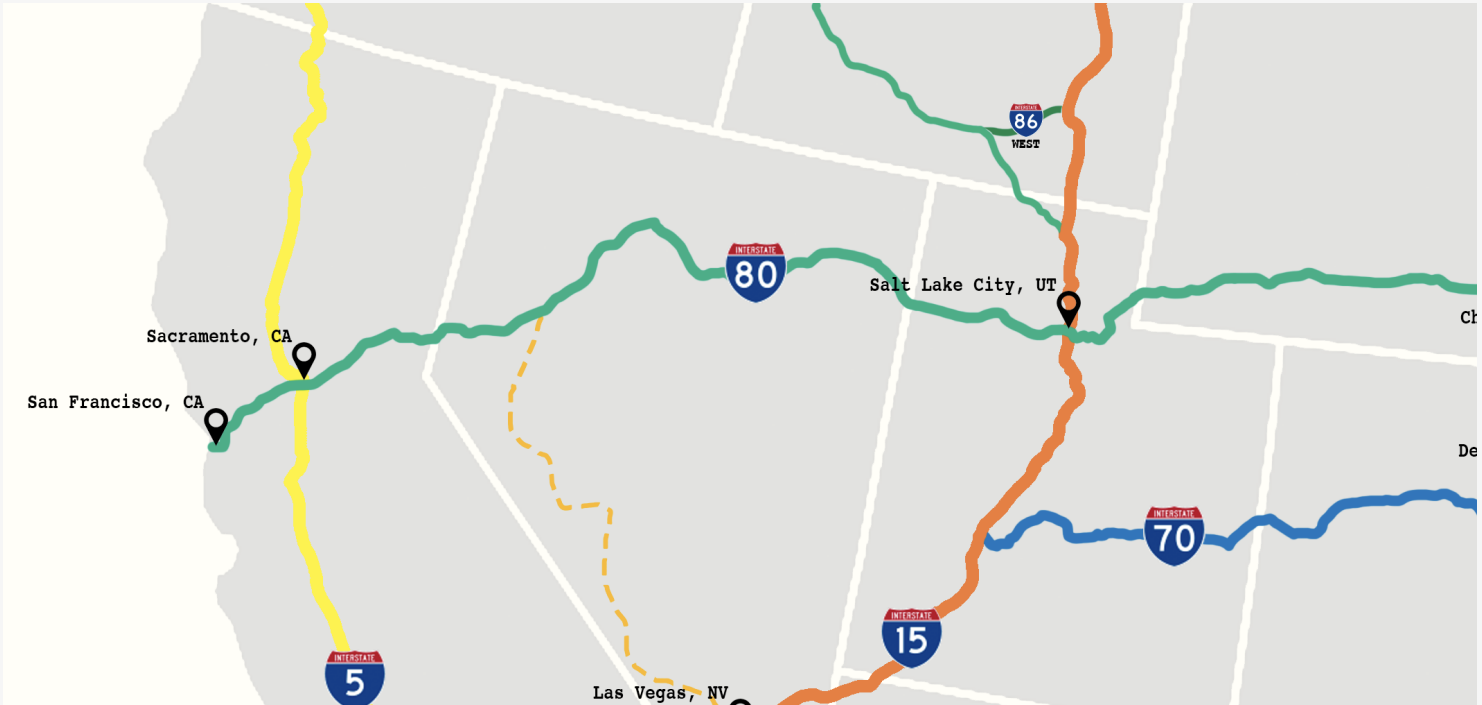


Zoom and Enhance

It’s the Transcontinental Railroad



Still with us, too



Maps as polygons

Packages

```
library(here)       # manage file paths
library(socviz)     # data and some useful functions
library(tidyverse)  # your friend and mine
library(maps)       # Some basic maps
library(ggforce)    # ggplot extensions
```

Take a look at this data

```
## This is from the map library
# library(maps)

us_states ← map_data("state")

dim(us_states)
```

```
[1] 15537     6
```

```
## Making it a tibble prevents crashes
## in the slide rendering later on
us_states ← as_tibble(us_states)

us_states
```

```
# A tibble: 15,537 × 6
    long   lat group order region  subregion
   <dbl> <dbl> <dbl> <int> <chr>   <chr>
 1 -87.5  30.4     1     1 alabama <NA>
 2 -87.5  30.4     1     2 alabama <NA>
 3 -87.5  30.4     1     3 alabama <NA>
 4 -87.5  30.3     1     4 alabama <NA>
 5 -87.6  30.3     1     5 alabama <NA>
 6 -87.6  30.3     1     6 alabama <NA>
 7 -87.6  30.3     1     7 alabama <NA>
 8 -87.6  30.3     1     8 alabama <NA>
```

What is this, at root?

```
us_states
```

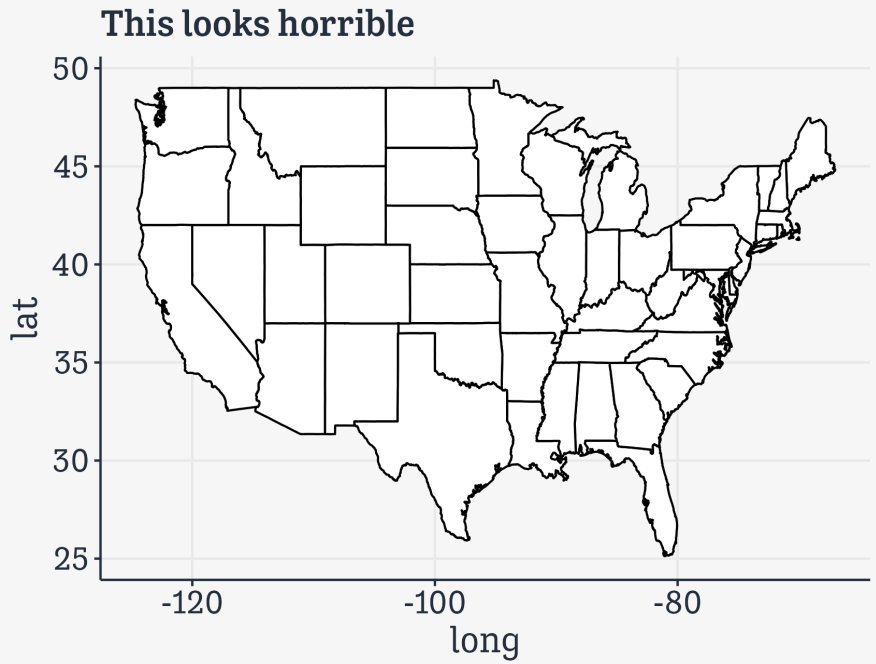
```
# A tibble: 15,537 × 6
    long   lat group order region  subregion
   <dbl> <dbl> <dbl> <int> <chr>   <chr>
 1 -87.5  30.4     1     1 alabama <NA>
 2 -87.5  30.4     1     2 alabama <NA>
 3 -87.5  30.4     1     3 alabama <NA>
 4 -87.5  30.3     1     4 alabama <NA>
 5 -87.6  30.3     1     5 alabama <NA>
 6 -87.6  30.3     1     6 alabama <NA>
 7 -87.6  30.3     1     7 alabama <NA>
 8 -87.6  30.3     1     8 alabama <NA>
 9 -87.7  30.3     1     9 alabama <NA>
10 -87.8  30.3     1    10 alabama <NA>
# ℹ 15,527 more rows
```

It's a series of rows defining `x` and `y` coordinatates on a plane.

If we join those points up as lines while respecting their `group` (i.e. so `ggplot` knows when to "lift the pen", as with the `gapminder` line plot), we will get an outline map of states in the U.S.

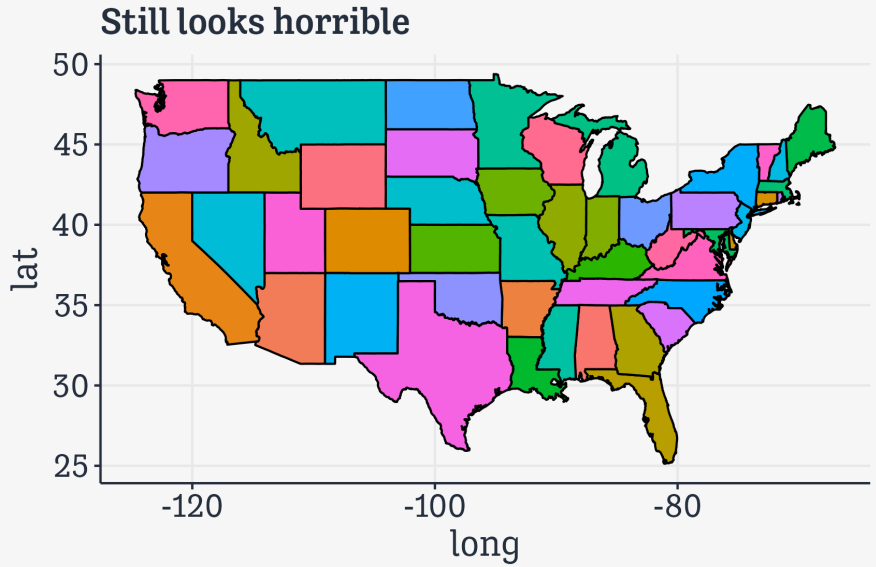
Like this, with geom_polygon()

```
us_states ▷
  ggplot(mapping = aes(x = long,
                       y = lat,
                       group = group)) +
  geom_polygon(fill = "white",
               color = "black") +
  labs(title = "This looks horrible")
```



We can show a `fill`, too, like any geom

```
us_states ▷
  ggplot(mapping = aes(x = long,
                       y = lat,
                       fill = region,#<<
                       group = group)) +
  geom_polygon(color = "black") +
  guides(fill = "none") + #<<
  labs(title = "Still looks horrible",
       caption = "Set fill = none

         to stop ggplot from
         producing a key
         with 50 entries")
```



We need to do two things

1: Fix the map projection

2: Add some data to fill with.

For now, we'll do it the direct way

To make explicit what's happening, and to emphasize how *it's all just points and lines made from tables* we'll first do it at the level of the `ggplot` grammar with a geom that just draws shapes, `geom_polygon()`. After that, we'll introduce a new package, `sf` and a new geom, `geom_sf()` that will handle this for us, and more.

Fix the projection

```
1  us_states ← as_tibble(map_data("state"))
```

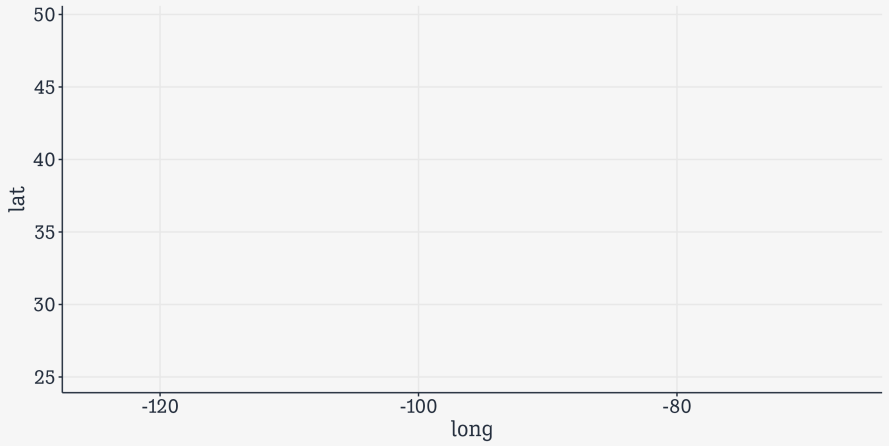
Fix the projection

```
1  us_states ← as_tibble(map_data("state"))
2
3  us_states
```

```
# A tibble: 15,537 × 6
    long   lat group order region  subregion
   <dbl> <dbl> <dbl> <int> <chr>   <chr>
 1 -87.5  30.4     1     1 alabama <NA>
 2 -87.5  30.4     1     2 alabama <NA>
 3 -87.5  30.4     1     3 alabama <NA>
 4 -87.5  30.3     1     4 alabama <NA>
 5 -87.6  30.3     1     5 alabama <NA>
 6 -87.6  30.3     1     6 alabama <NA>
 7 -87.6  30.3     1     7 alabama <NA>
 8 -87.6  30.3     1     8 alabama <NA>
 9 -87.7  30.3     1     9 alabama <NA>
10 -87.8  30.3     1    10 alabama <NA>
# ℹ 15,527 more rows
```

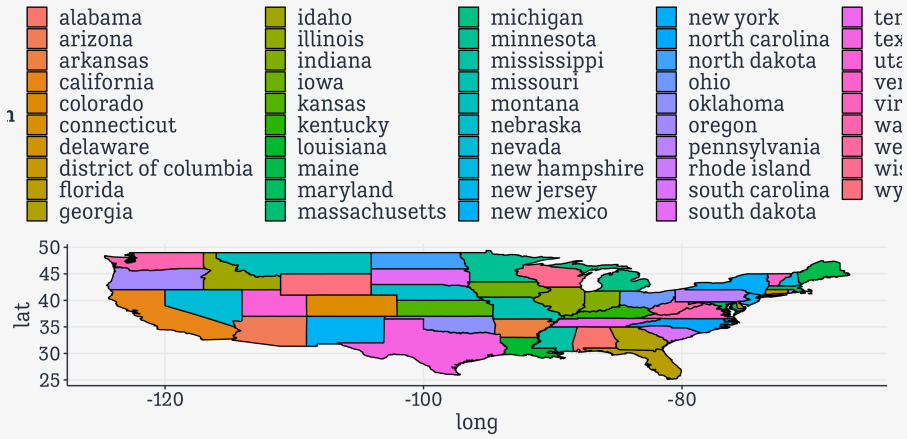
Fix the projection

```
us_states ← as_tibble(map_data("state"))

us_states ▷
  ggplot(mapping = aes(x = long,
                       y = lat,
                       fill = region,
                       group = group))
```



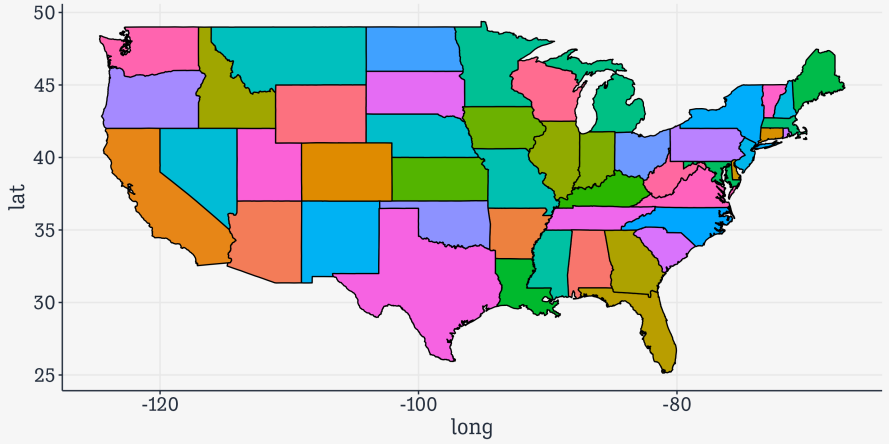
Fix the projection

```
1  us_states ← as_tibble(map_data("state"))
2
3  us_states ▷
4    ggplot(mapping = aes(x = long,
5                         y = lat,
6                         fill = region,
7                         group = group)) +
8    geom_polygon(color = "black")
```



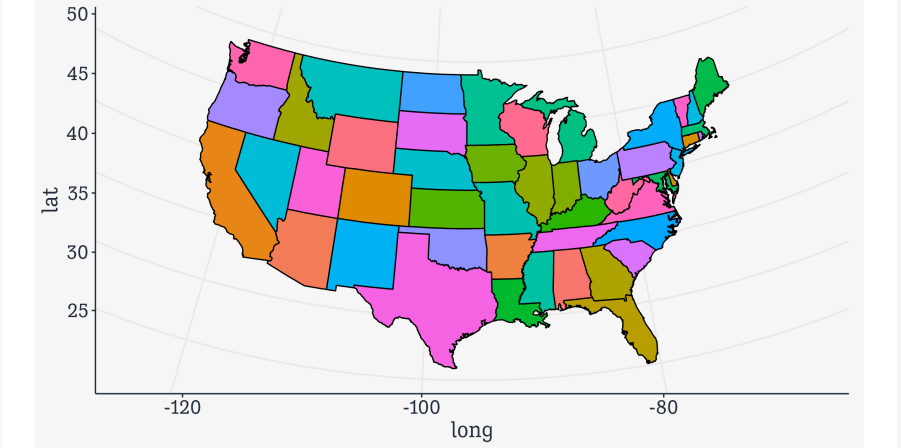
Fix the projection

```
us_states ← as_tibble(map_data("state"))

us_states ▷
  ggplot(mapping = aes(x = long,
                       y = lat,
                       fill = region,
                       group = group)) +
  geom_polygon(color = "black") +
  guides(fill = "none")
```

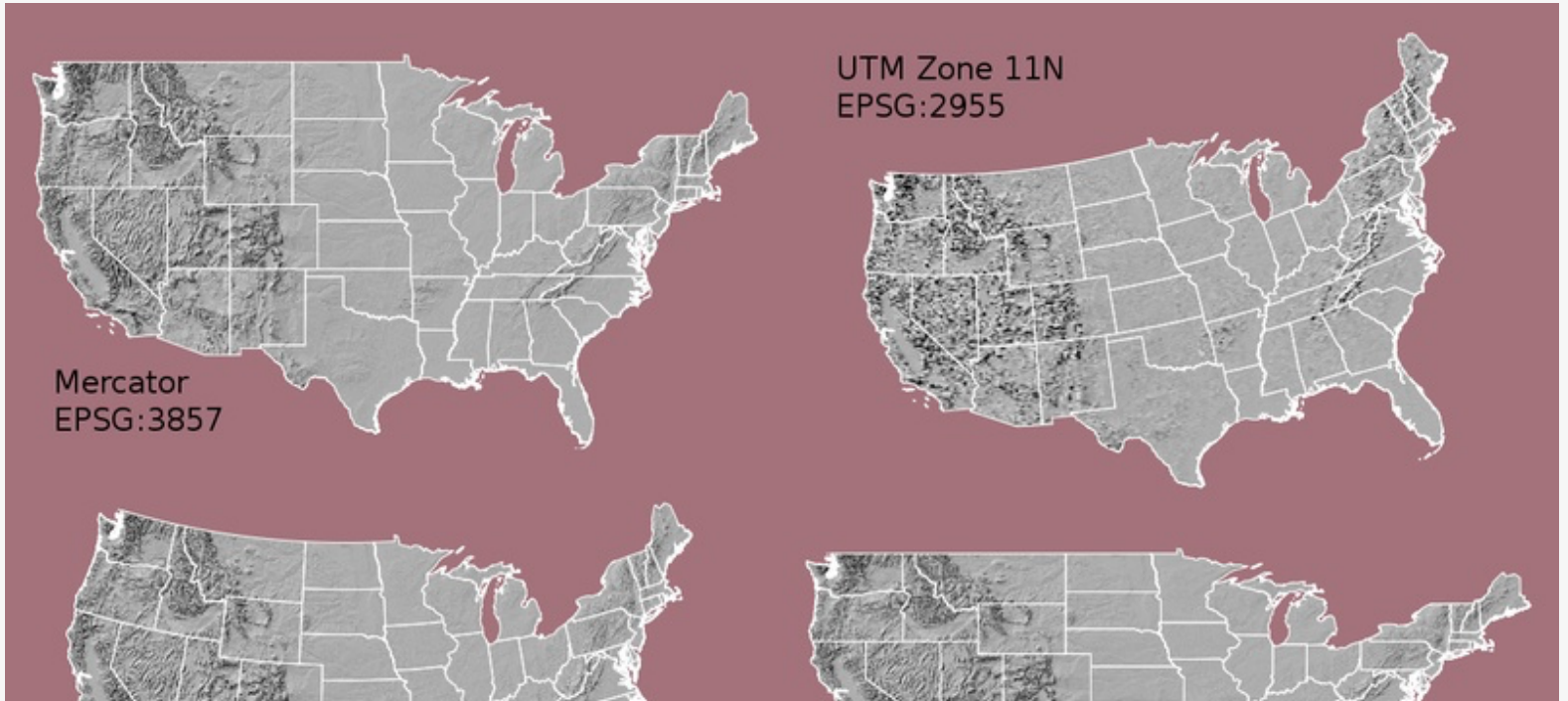


Fix the projection

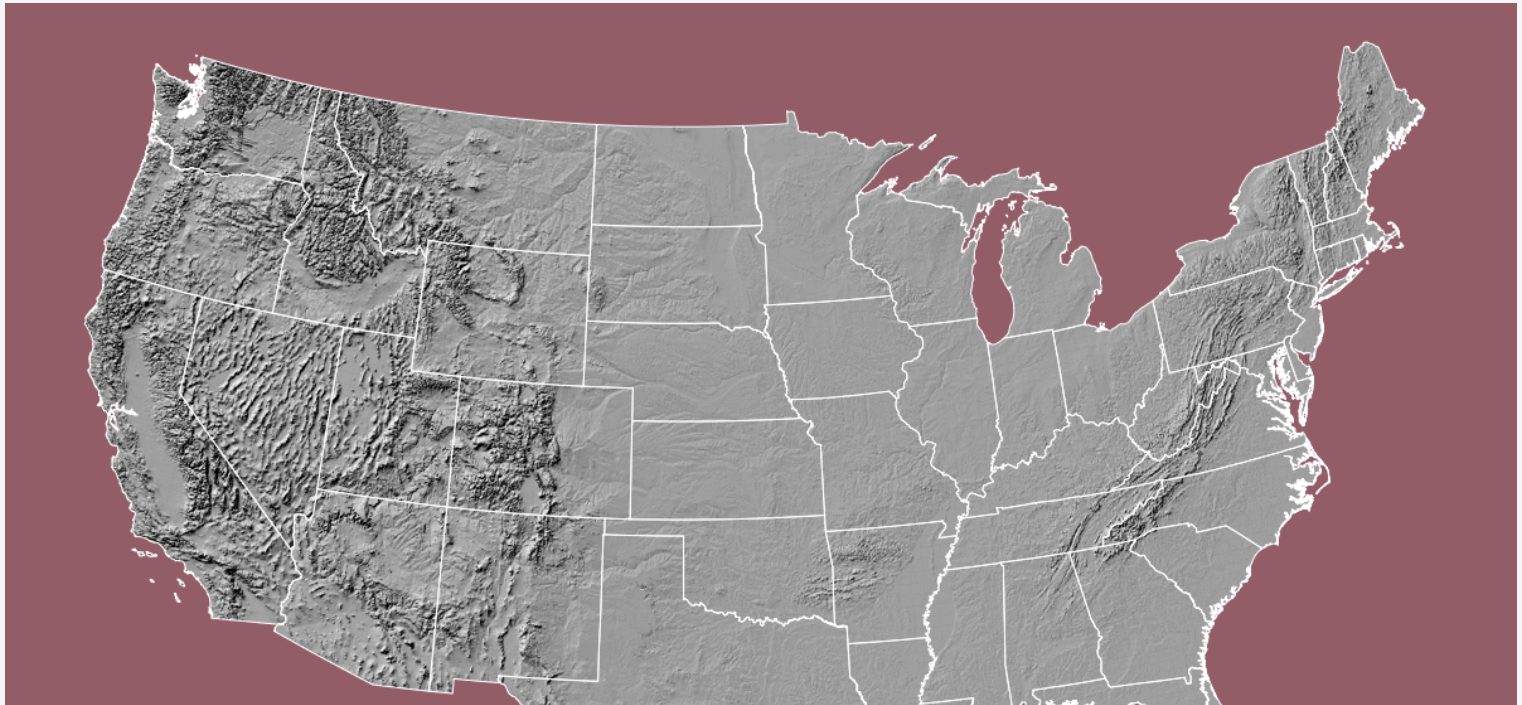
```
us_states ← as_tibble(map_data("state"))

us_states ▷
  ggplot(mapping = aes(x = long,
                       y = lat,
                       fill = region,
                       group = group)) +
  geom_polygon(color = "black") +
  guides(fill = "none") +
  coord_map(projection = "albers",
            lat0 = 39,
            lat1 = 45)
```

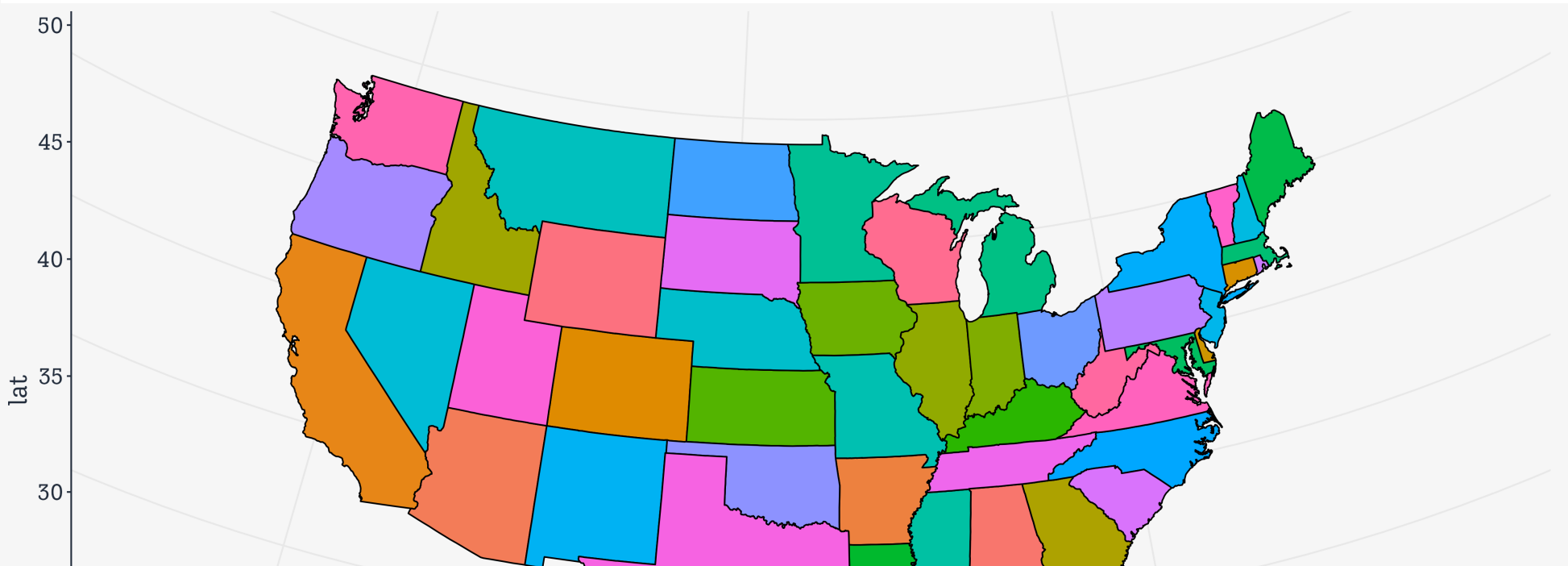


U.S. Map Projections



U.S. Map Projections




50
45
40
35
30
lat

Next, some data

We can merge our state-level `election` data with the `us_states` table, but we need to do a little work.

us_states

```
# A tibble: 15,537 × 6
    long   lat group order region  subregion
   <dbl> <dbl> <dbl> <int> <chr>   <chr>
 1 -87.5  30.4     1     1 alabama <NA>
 2 -87.5  30.4     1     2 alabama <NA>
 3 -87.5  30.4     1     3 alabama <NA>
 4 -87.5  30.3     1     4 alabama <NA>
 5 -87.6  30.3     1     5 alabama <NA>
 6 -87.6  30.3     1     6 alabama <NA>
 7 -87.6  30.3     1     7 alabama <NA>
 8 -87.6  30.3     1     8 alabama <NA>
 9 -87.7  30.3     1     9 alabama <NA>
10 -87.8  30.3     1    10 alabama <NA>
# ℹ 15,527 more rows
```

election

```
# A tibble: 51 × 22
   state     st     fips total_vote vote_margin
winner party pct_margin r_points
   <chr>     <chr> <dbl>      <dbl>       <dbl>
<chr>  <chr>      <dbl>    <dbl>
 1 Alabama   AL        1    2123372      588708
Trump  Repu…     0.277     27.7
 2 Alaska    AK        2     318608       46933
Trump  Repu…     0.147     14.7
 3 Arizona   AZ        4    2604657       91234
Trump  Repu…     0.035      3.5
 4 Arkansas  AR        5    1130635      304378
Trump  Repu…     0.269     26.9
 5 Californ… CA        6   14237893     4269978
Clint… Demo…     0.300    -30.0
 6 Colorado  CO        8    2780247      136386
```

Recode to make a key

```
election ← election ▷
  mutate(region = tolower(state)) ▷
  relocate(region)

election
```

```
# A tibble: 51 × 23
   region       state st     fips total_vote vote_margin winner party pct_margin
   <chr>        <chr> <chr> <dbl>      <dbl>       <dbl> <chr>  <chr>      <dbl>
 1 alabama      Alab… AL        1    2123372      588708 Trump  Repu…     0.277
 2 alaska       Alas… AK        2     318608       46933 Trump  Repu…     0.147
 3 arizona      Ariz… AZ        4    2604657       91234 Trump  Repu…     0.035
 4 arkansas     Arka… AR        5    1130635      304378 Trump  Repu…     0.269
 5 california   Cali… CA        6   14237893     4269978 Clint… Demo…     0.300
 6 colorado     Colo… CO        8    2780247      136386 Clint… Demo…     0.0491
 7 connecticut  Conn… CT        9    1644920      224357 Clint… Demo…     0.136
 8 delaware     Dela… DE       10     443814       50476 Clint… Demo…     0.114
 9 district of… Dist… DC       11     311268      270107 Clint… Demo…     0.868
10 florida      Flor… FL       12    9502747      112911 Trump  Repu…     0.0119
# ℹ 41 more rows
# ℹ 14 more variables: r_points <dbl>, d_points <dbl>, pct_clinton <dbl>,
#   pct_trump <dbl>, pct_johnson <dbl>, pct_other <dbl>, clinton_vote <dbl>,
#   trump_vote <dbl>, johnson_vote <dbl>, other_vote <dbl>, ev_dem <dbl>,
#   ev_rep <dbl>, ev_oth <dbl>, census <chr>
```

Now we can join them

us_states

```
# A tibble: 15,537 × 6
    long   lat group order region  subregion
   <dbl> <dbl> <dbl> <int> <chr>   <chr>
 1 -87.5  30.4     1     1 alabama <NA>
 2 -87.5  30.4     1     2 alabama <NA>
 3 -87.5  30.4     1     3 alabama <NA>
 4 -87.5  30.3     1     4 alabama <NA>
 5 -87.6  30.3     1     5 alabama <NA>
 6 -87.6  30.3     1     6 alabama <NA>
 7 -87.6  30.3     1     7 alabama <NA>
 8 -87.6  30.3     1     8 alabama <NA>
 9 -87.7  30.3     1     9 alabama <NA>
10 -87.8  30.3     1    10 alabama <NA>
# ℹ 15,527 more rows
```

election

```
# A tibble: 51 × 23
   region       state st     fips total_vote
vote_margin winner party pct_margin
   <chr>        <chr> <chr> <dbl>      <dbl>
<dbl> <chr>  <chr>      <dbl>
 1 alabama      Alab… AL        1    2123372
588708 Trump  Repu…     0.277
 2 alaska       Alas… AK        2     318608
46933 Trump  Repu…     0.147
 3 arizona      Ariz… AZ        4    2604657
91234 Trump  Repu…     0.035
 4 arkansas     Arka… AR        5    1130635
304378 Trump  Repu…     0.269
 5 california   Cali… CA        6   14237893
4269978 Clint… Demo…     0.300
 6 colorado     Colo… CO        8    2780247
```

This is a *left join*

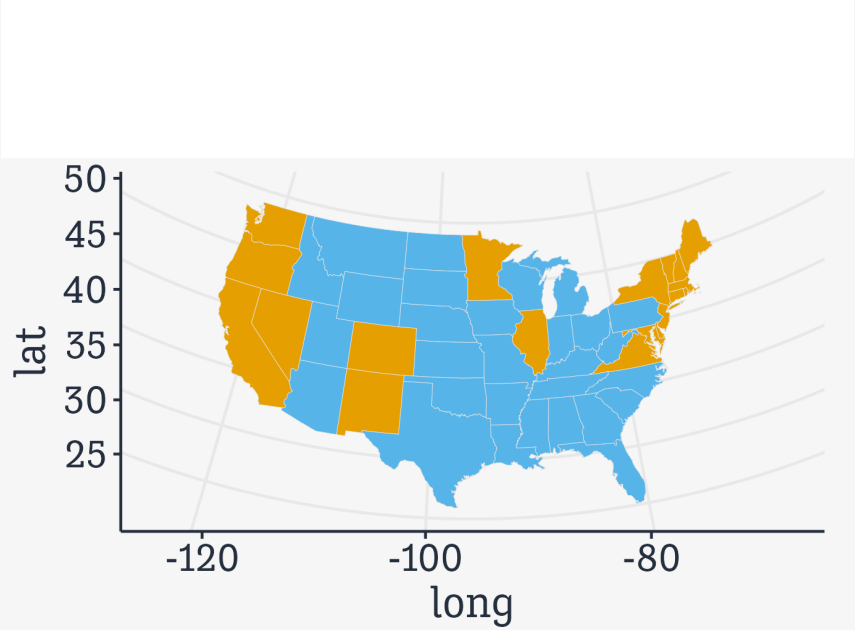
```
us_states_elec ← left_join(us_states, election, by = "region")

us_states_elec
```

```
# A tibble: 15,537 × 28
    long   lat group order region  subregion state   st     fips total_vote
   <dbl> <dbl> <dbl> <int> <chr>   <chr>     <chr>   <chr> <dbl>      <dbl>
 1 -87.5  30.4     1     1 alabama <NA>      Alabama AL        1    2123372
 2 -87.5  30.4     1     2 alabama <NA>      Alabama AL        1    2123372
 3 -87.5  30.4     1     3 alabama <NA>      Alabama AL        1    2123372
 4 -87.5  30.3     1     4 alabama <NA>      Alabama AL        1    2123372
 5 -87.6  30.3     1     5 alabama <NA>      Alabama AL        1    2123372
 6 -87.6  30.3     1     6 alabama <NA>      Alabama AL        1    2123372
 7 -87.6  30.3     1     7 alabama <NA>      Alabama AL        1    2123372
 8 -87.6  30.3     1     8 alabama <NA>      Alabama AL        1    2123372
 9 -87.7  30.3     1     9 alabama <NA>      Alabama AL        1    2123372
10 -87.8  30.3     1    10 alabama <NA>      Alabama AL        1    2123372
# ℹ 15,527 more rows
# ℹ 18 more variables: vote_margin <dbl>, winner <chr>, party <chr>,
#   pct_margin <dbl>, r_points <dbl>, d_points <dbl>, pct_clinton <dbl>,
#   pct_trump <dbl>, pct_johnson <dbl>, pct_other <dbl>, clinton_vote <dbl>,
#   trump_vote <dbl>, johnson_vote <dbl>, other_vote <dbl>, ev_dem <dbl>,
#   ev_rep <dbl>, ev_oth <dbl>, census <chr>
```

Now our `us_states_elec` table has both the line-drawing information and (very redundantly) the election data merged in, with rows repeated as

Choropleths

```
us_states_elec ▷
  ggplot(mapping = aes(x = long,
                       y = lat,
                       fill = party,#<<
                       group = group)) +
  geom_polygon(color = "gray90",
               size = 0.1) +
  coord_map(projection = "albers",


            lat0 = 39, lat1 = 45) +
  guides(fill = "none")
```



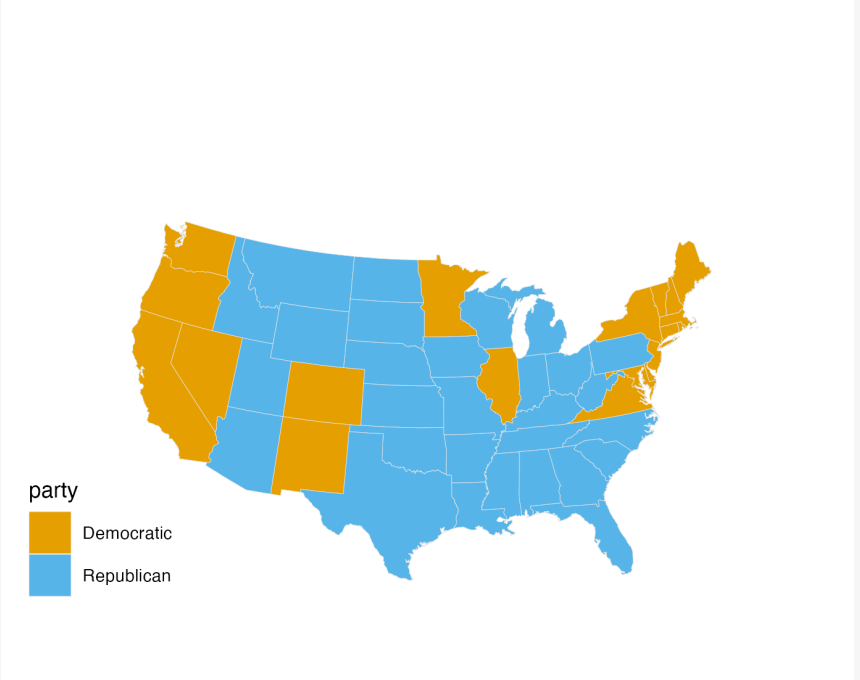
Let's turn off the gridlines

This is a *theme function*.

```
theme_map ← function(base_size=9, base_family="") {
    require(grid)
    theme_bw(base_size=base_size, base_family=base_family) %+replace%
        theme(axis.line=element_blank(),
              axis.text=element_blank(),
              axis.ticks=element_blank(),
              axis.title=element_blank(),
              panel.background=element_blank(),
              panel.border=element_blank(),
              panel.grid=element_blank(),
              panel.spacing=unit(0, "lines"),
              plot.background=element_blank(),
              legend.justification = c(0,0),
              legend.position = c(0,0)
              )
}
```

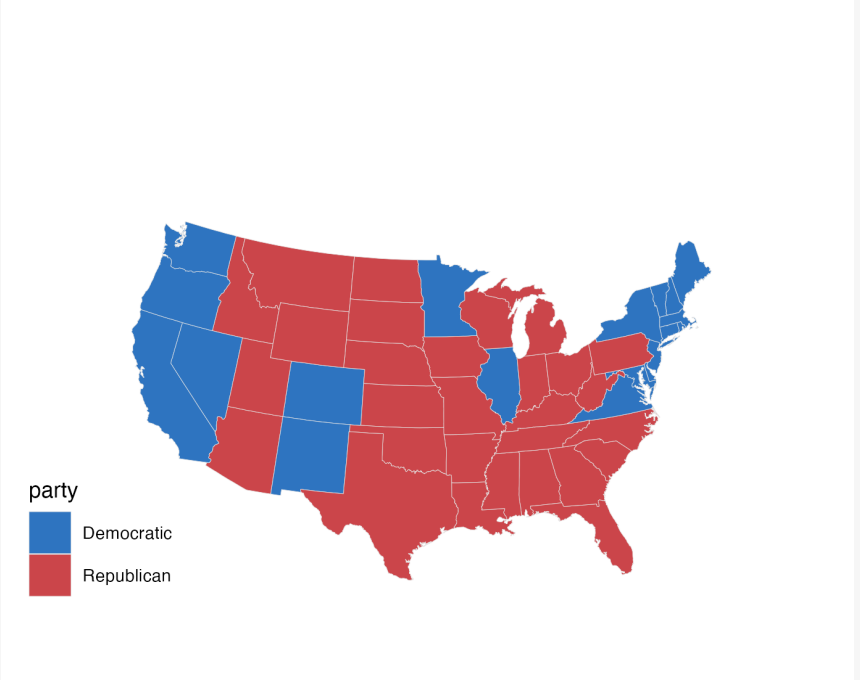
Add the theme function at the end

```
us_states_elec ▷
  ggplot(mapping = aes(x = long,
                       y = lat,
                       fill = party,#<<
                       group = group)) +
  geom_polygon(color = "gray90",
               size = 0.1) +
  coord_map(projection = "albers",


            lat0 = 39, lat1 = 45) +
  theme_map()
```



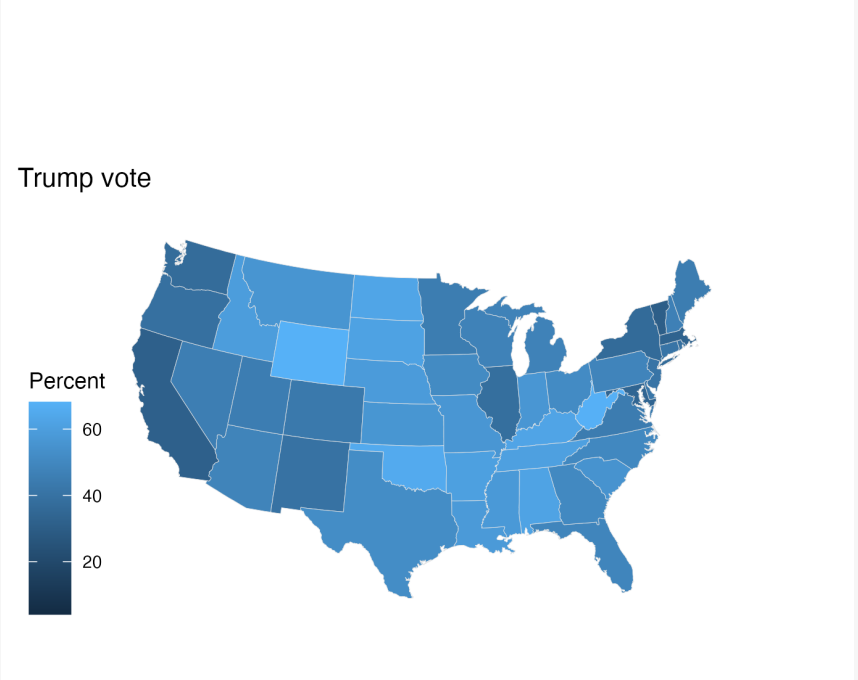
Fix the Party Colors

```
## Hex color codes for Democratic Blue and Repu
party_colors ← c("#2E74C0", "#CB454A")


us_states_elec ▷
  ggplot(mapping = aes(x = long,
                       y = lat,
                       fill = party,#<<
                       group = group)) +

  geom_polygon(color = "gray90",
               size = 0.1) +
  scale_fill_manual(values = party_colors) +
  coord_map(projection = "albers",
            lat0 = 39, lat1 = 45) +
  theme_map()
```



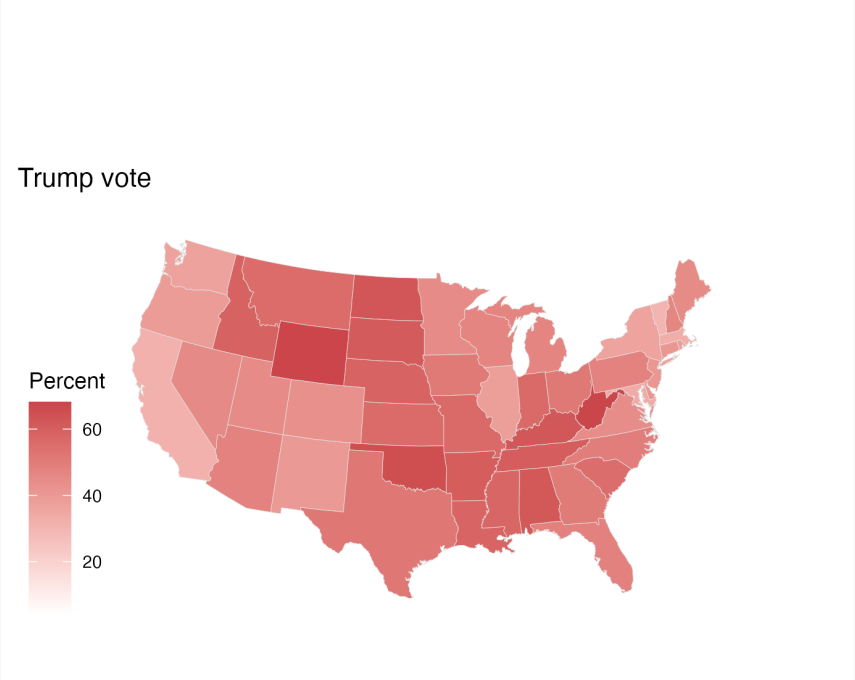
Continuous measures are *gradients*

```
us_states_elec ▷
  ggplot(mapping = aes(x = long,
                       y = lat,
                       fill = pct_trump,#<<
                       group = group)) +
  geom_polygon(color = "gray90",
               size = 0.1) +
  coord_map(projection = "albers",
            lat0 = 39, lat1 = 45) +

  labs(title = "Trump vote",
       fill = "Percent") +
  theme_map()
```



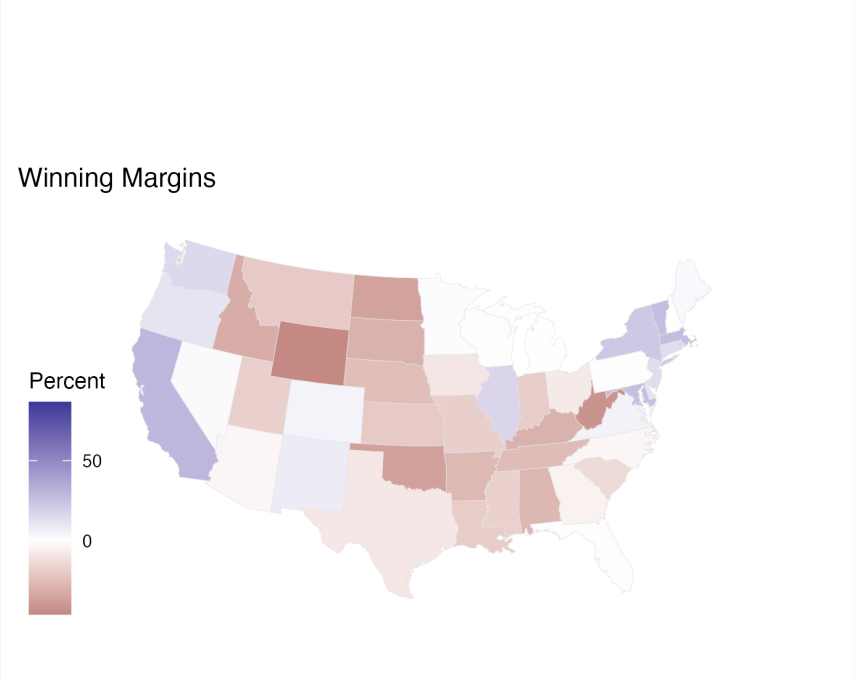
Fix the gradient with a scale function

```
us_states_elec ▷
  ggplot(mapping = aes(x = long,
                       y = lat,
                       fill = pct_trump,
                       group = group)) +
  geom_polygon(color = "gray90",
               size = 0.1) +
  scale_fill_gradient(low = "white",  #<<
                      high = "#CB454A") + #<<

        labs(title = "Trump vote") +
  coord_map(projection = "albers",
            lat0 = 39, lat1 = 45) +
  labs(title = "Trump vote",
       fill = "Percent") +
  theme_map()
```



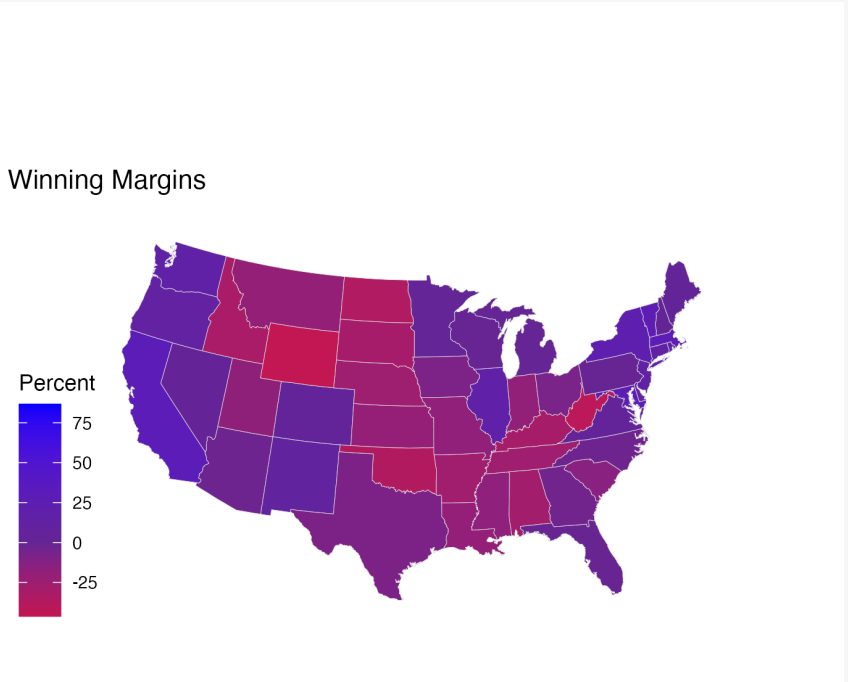
Some gradients are *diverging*

```
us_states_elec ▷
  ggplot(mapping = aes(x = long,
                       y = lat,
                       fill = d_points,#<<
                       group = group)) +
  geom_polygon(color = "gray90",
               size = 0.1) +
  scale_fill_gradient2() + #<<
  coord_map(projection = "albers",
            lat0 = 39, lat1 = 45) +
  labs(title = "Winning Margins",
       fill = "Percent") +
  theme_map()
```

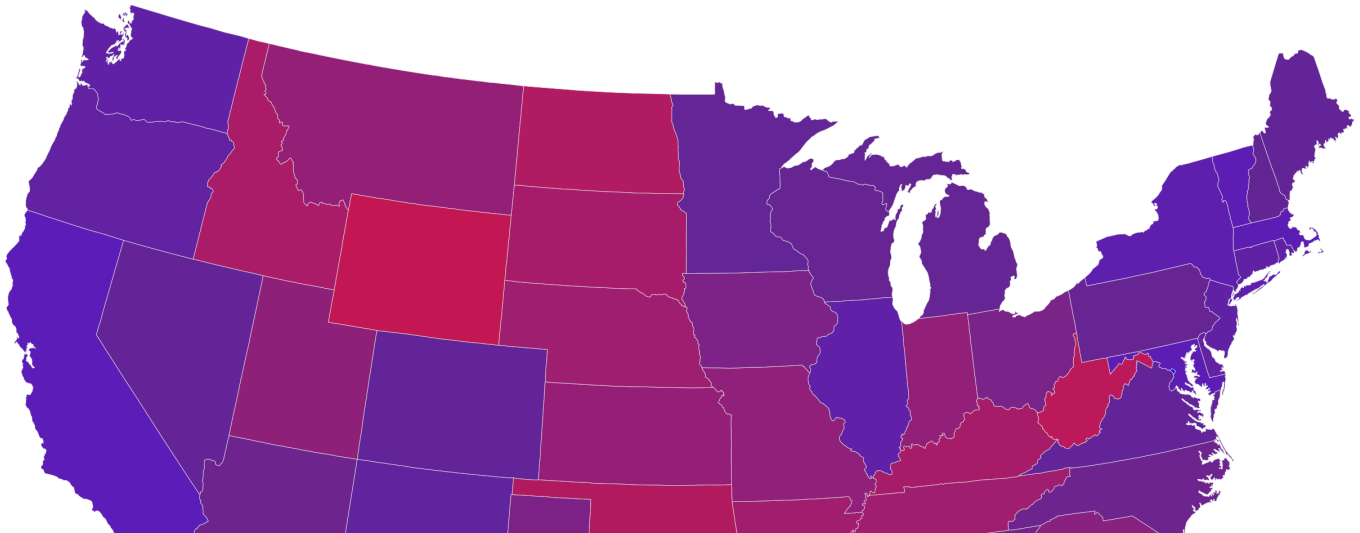


Purple America Map

```
us_states_elec ▷
  ggplot(mapping = aes(x = long,
                       y = lat,
                       fill = d_points,#<<
                       group = group)) +
  geom_polygon(color = "gray90",
               size = 0.1) +
  scale_fill_gradient2(low = "red",#<<
                mid = scales::muted("purple"),#
                high = "blue",#<<
                breaks = c(-25, 0, 25, #<<
                           50, 75)) + #<<
  coord_map(projection = "albers",
            lat0 = 39, lat1 = 45) +
  labs(title = "Winning Margins",
       fill = "Percent") +
  theme_map()
```

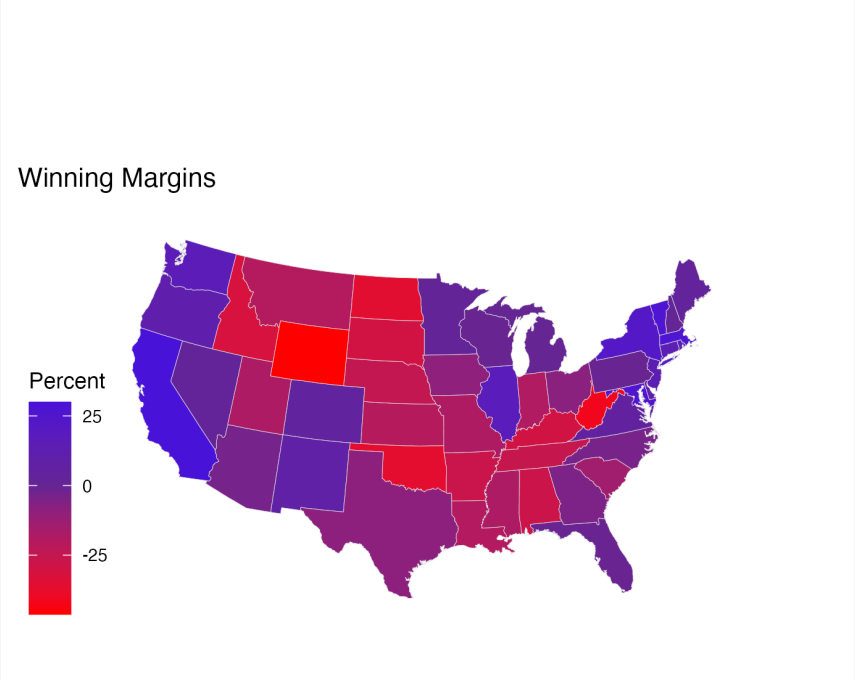


Winning Margins

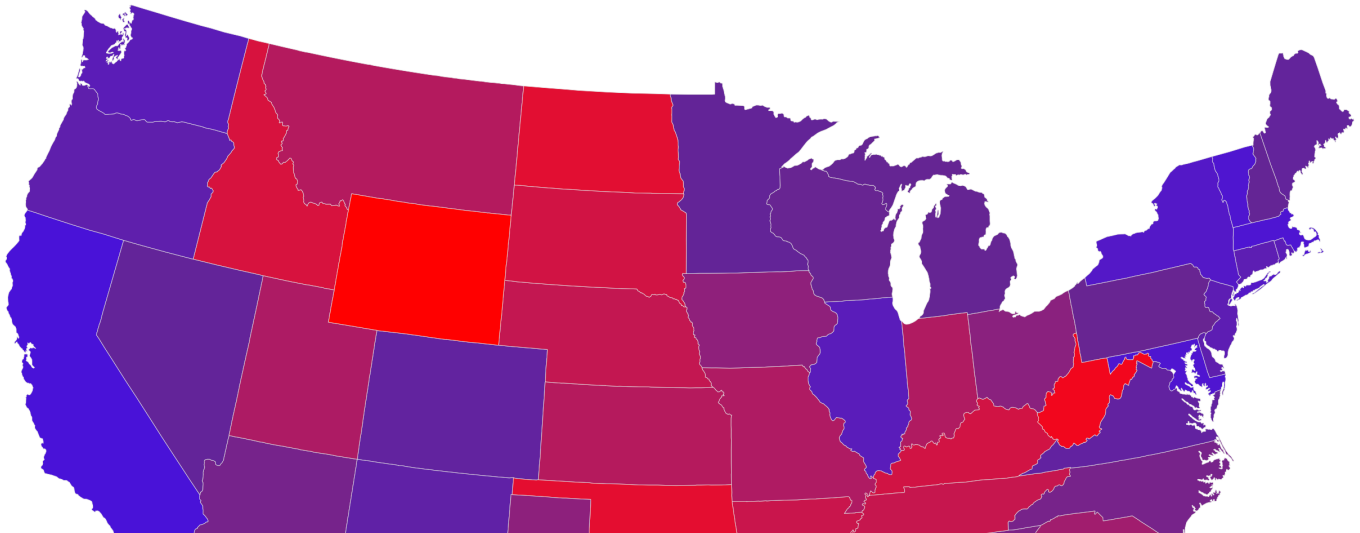


Purple America Map, without DC

```
us_states_elec ▷
  filter(region %nin% "district of columbia") ▷
  ggplot(mapping = aes(x = long,
                       y = lat,
                       fill = d_points,
                       group = group)) +
  geom_polygon(color = "gray90",
               size = 0.1) +
  scale_fill_gradient2(low = "red",
                       mid = scales::muted("purple"),
                       high = "blue") +
  coord_map(projection = "albers",
            lat0 = 39, lat1 = 45) +
  labs(title = "Winning Margins",
       fill = "Percent") +
  theme_map()
```



Winning Margins



America's Ur-Choropleths

County-level choropleths

Conceptually identical to state ones. The tables are just bigger, because there are way more lines to draw.

```
county_map ← as_tibble(county_map)
county_map
```

```
# A tibble: 191,382 × 7
       long       lat order hole  piece group            id
      <dbl>     <dbl> <int> <lgl> <fct> <fct>            <chr>
 1 1225889. -1275020.     1 FALSE 1     0500000US01001.1 01001

 2 1235324. -1274008.     2 FALSE 1     0500000US01001.1 01001
 3 1244873. -1272331.     3 FALSE 1     0500000US01001.1 01001
 4 1244129. -1267515.     4 FALSE 1     0500000US01001.1 01001
 5 1272010. -1262889.     5 FALSE 1     0500000US01001.1 01001
 6 1276797. -1295514.     6 FALSE 1     0500000US01001.1 01001
 7 1273832. -1297124.     7 FALSE 1     0500000US01001.1 01001
 8 1272727. -1296631.     8 FALSE 1     0500000US01001.1 01001
 9 1272513. -1299771.     9 FALSE 1     0500000US01001.1 01001
10 1269950. -1302038.    10 FALSE 1     0500000US01001.1 01001
# ℹ 191,372 more rows
```

191,000 or so rows

`id` here is the county FIPS code.

County-level choropleths

```
county_data ← as_tibble(county_data)
county_data
```

```
# A tibble: 3,195 × 32
   id    name  state census_region pop_dens pop_dens4 pop_dens6 pct_black    pop
   <chr> <chr> <fct> <fct>         <fct>    <fct>     <fct>     <fct>      <int>
 1 0     <NA>  <NA>  <NA>          [   50,… [ 45,  1… [ 82,  2… [10.0,15… 3.19e8
 2 01000 1     AL    South         [   50,… [ 45,  1… [ 82,  2… [25.0,50… 4.85e6
 3 01001 Auta… AL    South         [   50,… [ 45,  1… [ 82,  2… [15.0,25… 5.54e4
 4 01003 Bald… AL    South         [  100,… [118,716… [ 82,  2… [ 5.0,10… 2.00e5
 5 01005 Barb… AL    South         [   10,… [ 17,   … [ 25,   … [25.0,50… 2.69e4
 6 01007 Bibb… AL    South         [   10,… [ 17,   … [ 25,   … [15.0,25… 2.25e4
 7 01009 Blou… AL    South         [   50,… [ 45,  1… [ 82,  2… [ 0.0, 2… 5.77e4
 8 01011 Bull… AL    South         [   10,… [ 17,   … [  9,   … [50.0,85… 1.08e4
 9 01013 Butl… AL    South         [   10,… [ 17,   … [ 25,   … [25.0,50… 2.03e4
10 01015 Calh… AL    South         [  100,… [118,716… [ 82,  2… [15.0,25… 1.16e5
# ℹ 3,185 more rows
# ℹ 23 more variables: female <dbl>, white <dbl>, black <dbl>,
#   travel_time <dbl>, land_area <dbl>, hh_income <int>, su_gun4 <fct>,
#   su_gun6 <fct>, fips <dbl>, votes_dem_2016 <int>, votes_gop_2016 <int>,
#   total_votes_2016 <int>, per_dem_2016 <dbl>, per_gop_2016 <dbl>,
#   diff_2016 <int>, per_dem_2012 <dbl>, per_gop_2012 <dbl>, diff_2012 <int>,
```

County-level choropleths

3,195 entities, including states (FIPS `id` ends in four zeros)

And the US as a whole (FIPS `id` of `0`)

Sample a few rows, with specific columns:

```
county_data  ▷
    select(id, name, state, pop_dens, pct_black) ▷
    sample_n(10)
```

```
# A tibble: 10 × 5
   id    name                state pop_dens      pct_black
   <chr> <chr>               <fct> <fct>         <fct>
 1 01083 Limestone County    AL    [  100,  500) [10.0,15.0)
 2 39145 Scioto County       OH    [  100,  500) [ 2.0, 5.0)
 3 48073 Cherokee County     TX    [   10,   50) [10.0,15.0)
 4 29005 Atchison County     MO    [    0,   10) [ 0.0, 2.0)
 5 13211 Morgan County       GA    [   50,  100) [15.0,25.0)
 6 47001 Anderson County     TN    [  100,  500) [ 2.0, 5.0)
 7 37193 Wilkes County       NC    [   50,  100) [ 2.0, 5.0)
 8 21177 Muhlenberg County   KY    [   50,  100) [ 5.0,10.0)
 9 51099 King George County  VA    [  100,  500) [15.0,25.0)
10 21053 Clinton County      KY    [   50,  100) [ 0.0, 2.0)
```

Joined table

```
county_full ← as_tibble(left_join(county_map, county_data, by = "id"))

county_full
```

```
# A tibble: 191,382 × 38
       long       lat order hole  piece group    id    name  state census_region
      <dbl>     <dbl> <int> <lgl> <fct> <fct>    <chr> <chr> <fct> <fct>
 1 1225889. -1275020.     1 FALSE 1     0500000… 01001 Auta… AL    South
 2 1235324. -1274008.     2 FALSE 1     0500000… 01001 Auta… AL    South
 3 1244873. -1272331.     3 FALSE 1     0500000… 01001 Auta… AL    South
 4 1244129. -1267515.     4 FALSE 1     0500000… 01001 Auta… AL    South
 5 1272010. -1262889.     5 FALSE 1     0500000… 01001 Auta… AL    South
 6 1276797. -1295514.     6 FALSE 1     0500000… 01001 Auta… AL    South
 7 1273832. -1297124.     7 FALSE 1     0500000… 01001 Auta… AL    South
 8 1272727. -1296631.     8 FALSE 1     0500000… 01001 Auta… AL    South
 9 1272513. -1299771.     9 FALSE 1     0500000… 01001 Auta… AL    South
10 1269950. -1302038.    10 FALSE 1     0500000… 01001 Auta… AL    South
# ℹ 191,372 more rows
# ℹ 28 more variables: pop_dens <fct>, pop_dens4 <fct>, pop_dens6 <fct>,
#   pct_black <fct>, pop <int>, female <dbl>, white <dbl>, black <dbl>,
#   travel_time <dbl>, land_area <dbl>, hh_income <int>, su_gun4 <fct>,
#   su_gun6 <fct>, fips <dbl>, votes_dem_2016 <int>, votes_gop_2016 <int>,
#   total_votes_2016 <int>, per_dem_2016 <dbl>, per_gop_2016 <dbl>,
```

County Population Density

```
county_full ← as_tibble(left_join(county_map, county_data, by
```

County Population Density

```
county_full <- as_tibble(left_join(county_map, county_data, by
```

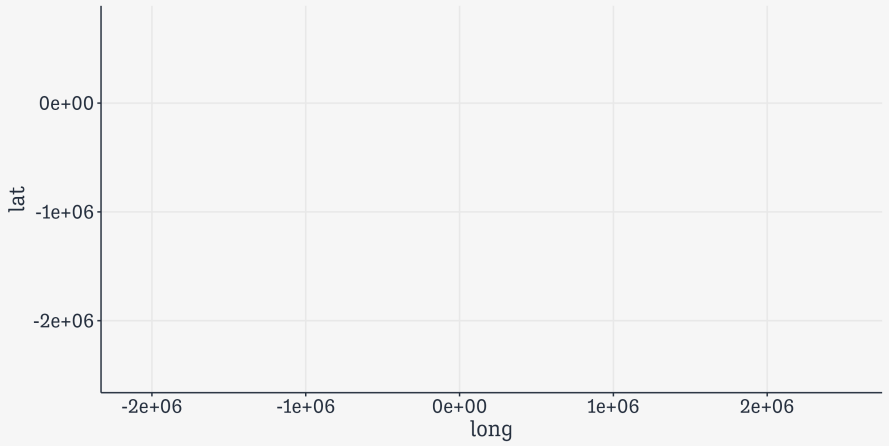
```

county_full
```

```
# A tibble: 191,382 × 38
       long       lat order hole  piece group    id    name  state
census_region
      <dbl>     <dbl> <int> <lgl> <fct> <fct>    <chr> <chr> <fct>
<fct>
 1 1225889. -1275020.     1 FALSE 1     0500000… 01001 Auta… AL
South
 2 1235324. -1274008.     2 FALSE 1     0500000… 01001 Auta… AL
South
 3 1244873. -1272331.     3 FALSE 1     0500000… 01001 Auta… AL
South
 4 1244129. -1267515.     4 FALSE 1     0500000… 01001 Auta… AL
South
 5 1272010. -1262889.     5 FALSE 1     0500000… 01001 Auta… AL
South
 6 1276797. -1295514.     6 FALSE 1     0500000… 01001 Auta… AL
South
 7 1273832. -1297124.     7 FALSE 1     0500000… 01001 Auta… AL
South
 8 1272727. -1296631.     8 FALSE 1     0500000… 01001 Auta… AL
South
 9 1272513. -1299771.     9 FALSE 1     0500000… 01001 Auta… AL
South
10 1269950. -1302038.    10 FALSE 1     0500000… 01001 Auta… AL
South
```

County Population Density

```
county_full ← as_tibble(left_join(county_map, county_data, by
```

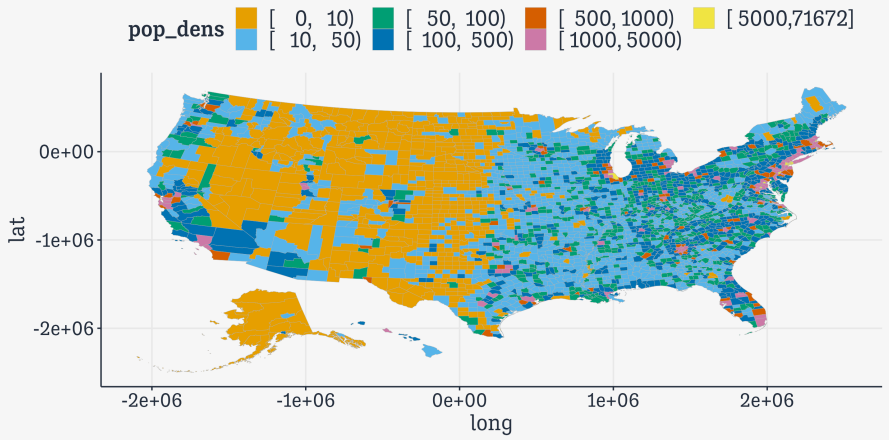
```
county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pop_dens,
                       group = group))
```



County Population Density

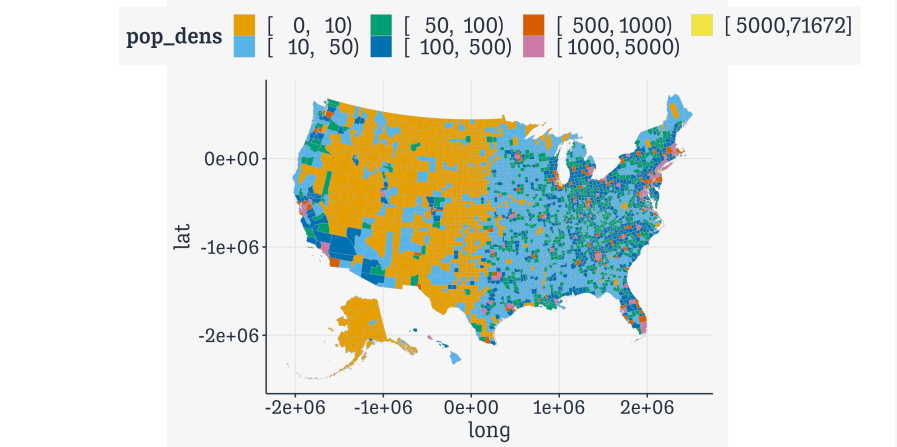
```
county_full ← as_tibble(left_join(county_map, county_data, by
```

```
county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pop_dens,
                       group = group)) +
  geom_polygon(color = "gray70",
               size = 0.1)
```



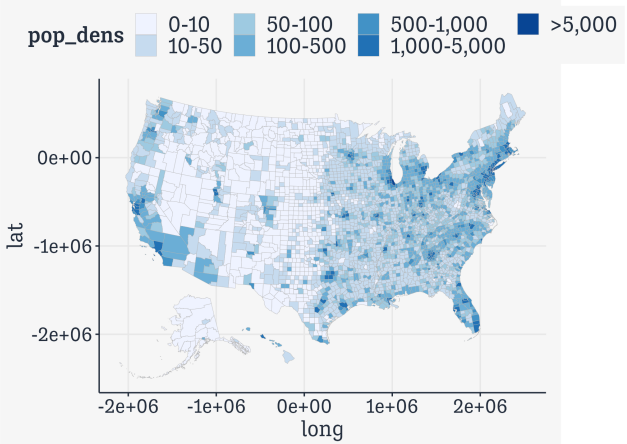
County Population Density

```
county_full ← as_tibble(left_join(county_map, county_data, by
 
 
county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pop_dens,
                       group = group)) +
  geom_polygon(color = "gray70",
               size = 0.1) +
  coord_fixed()
```



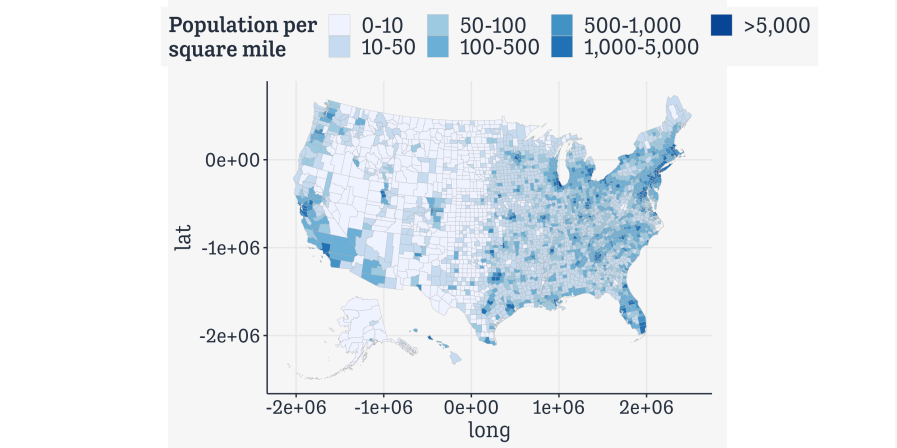
County Population Density

```
county_full <- as_tibble(left_join(county_map, county_data, by

county_full %>%
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pop_dens,
                       group = group)) +
  geom_polygon(color = "gray70",
               size = 0.1) +
  coord_fixed() +
  scale_fill_brewer(palette="Blues",
                    labels = c("0-10", "10-50", "50-100",
                     "100-500", "500-1,000",
                      "1,000-5,000", ">5,000"))
```



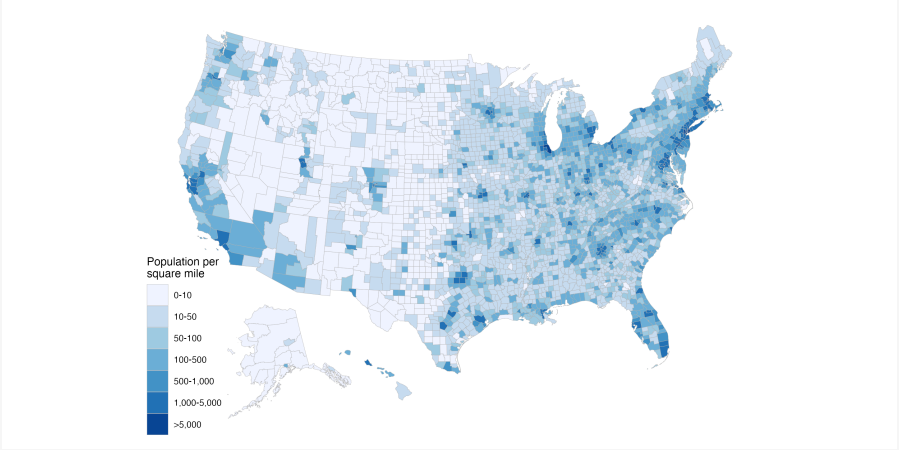
County Population Density

```
county_full ← as_tibble(left_join(county_map, county_data, by
 
 
county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pop_dens,
                       group = group)) +
  geom_polygon(color = "gray70",
               size = 0.1) +
  coord_fixed() +
  scale_fill_brewer(palette="Blues",
                    labels = c("0-10", "10-50", "50-100",
                     "100-500", "500-1,000",
                      "1,000-5,000", ">5,000")) +
  labs(fill = "Population per\nsquare mile")
```



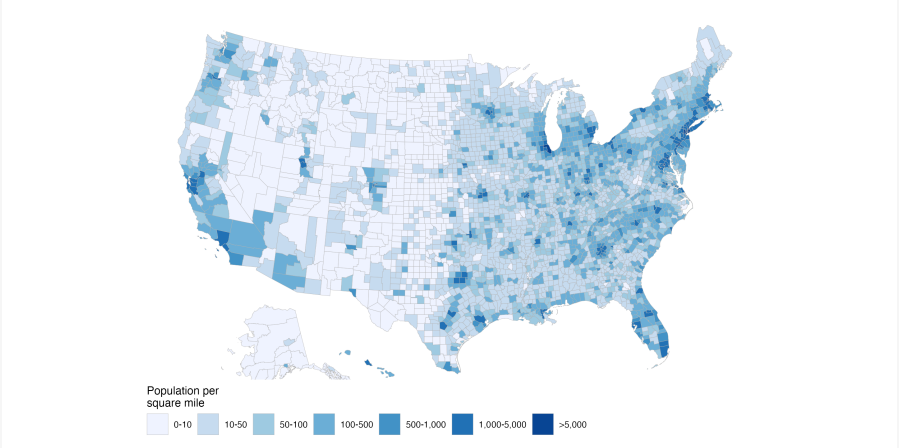
County Population Density

```
county_full ← as_tibble(left_join(county_map, county_data, by
county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pop_dens,
                       group = group)) +
  geom_polygon(color = "gray70",
               size = 0.1) +
  coord_fixed() +
  scale_fill_brewer(palette="Blues",
                    labels = c("0-10", "10-50", "50-100",
                     "100-500", "500-1,000",
                      "1,000-5,000", ">5,000")) +
  labs(fill = "Population per\nsquare mile") +
  kjhslides::kjh_theme_map()
```



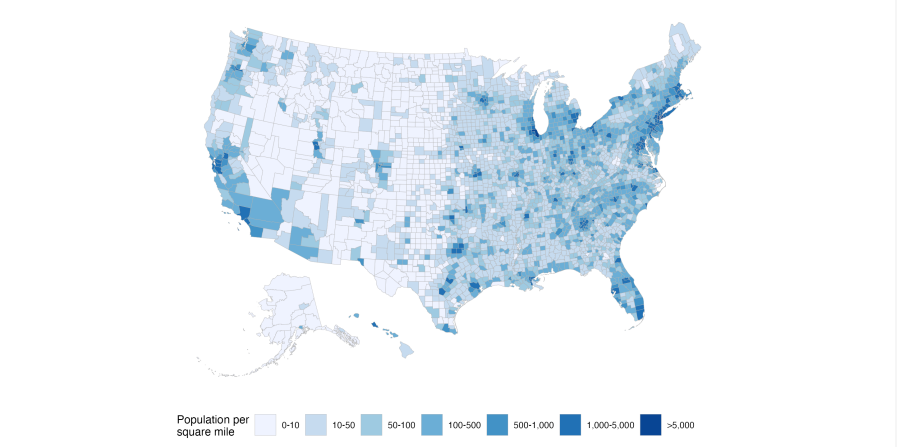
County Population Density

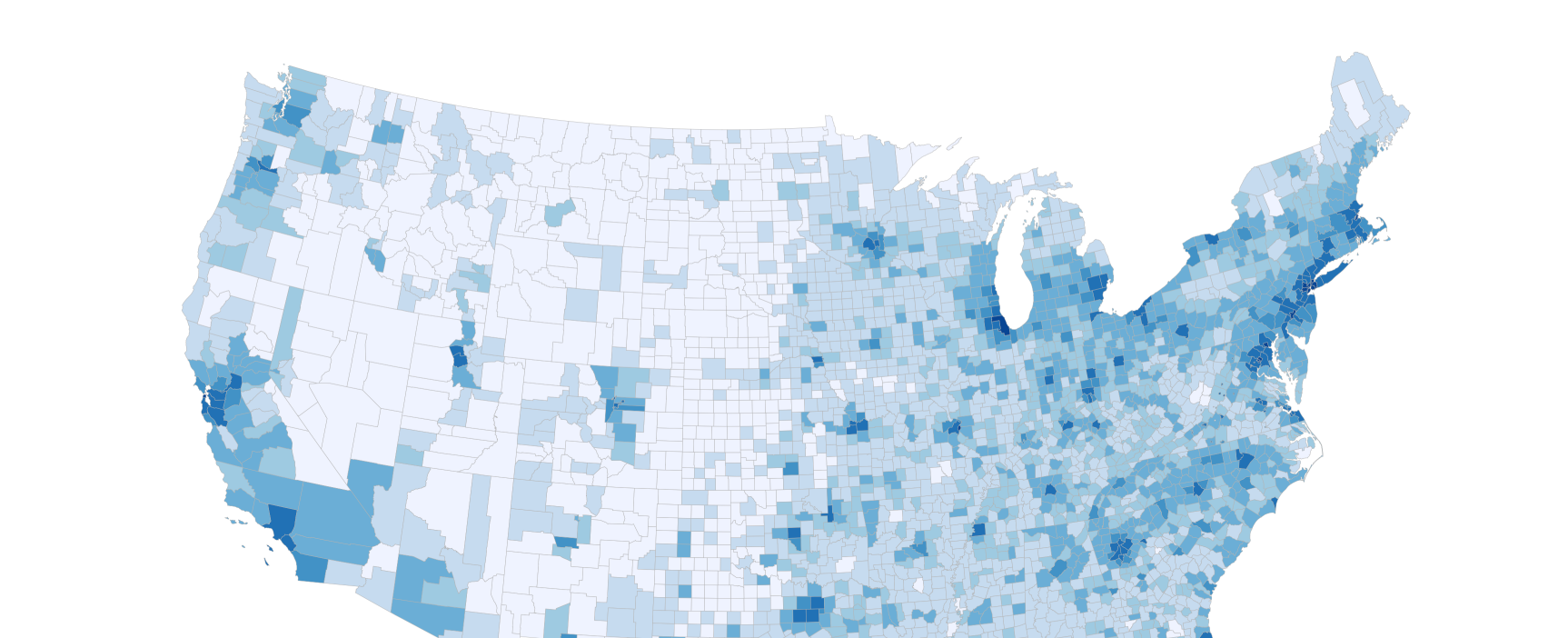
```
county_full ← as_tibble(left_join(county_map, county_data, by

county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pop_dens,
                       group = group)) +
  geom_polygon(color = "gray70",
               size = 0.1) +
  coord_fixed() +
  scale_fill_brewer(palette="Blues",
                    labels = c("0-10", "10-50", "50-100",
                     "100-500", "500-1,000",
                      "1,000-5,000", ">5,000")) +
  labs(fill = "Population per\nsquare mile") +
  kjhslides::kjh_theme_map() +
  guides(fill = guide_legend(nrow = 1))
```



County Population Density

```
county_full ← as_tibble(left_join(county_map, county_data, by

county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pop_dens,
                       group = group)) +
  geom_polygon(color = "gray70",
               size = 0.1) +
  coord_fixed() +
  scale_fill_brewer(palette="Blues",
                    labels = c("0-10", "10-50", "50-100",
                     "100-500", "500-1,000",
                      "1,000-5,000", ">5,000")) +
  labs(fill = "Population per\nsquare mile") +
  kjhslides::kjh_theme_map() +
  guides(fill = guide_legend(nrow = 1)) +
  theme(legend.position = "bottom")
```





Same again for Percent Black

```
1  county_full ← as_tibble(left_join(county_map, county_data, by
```

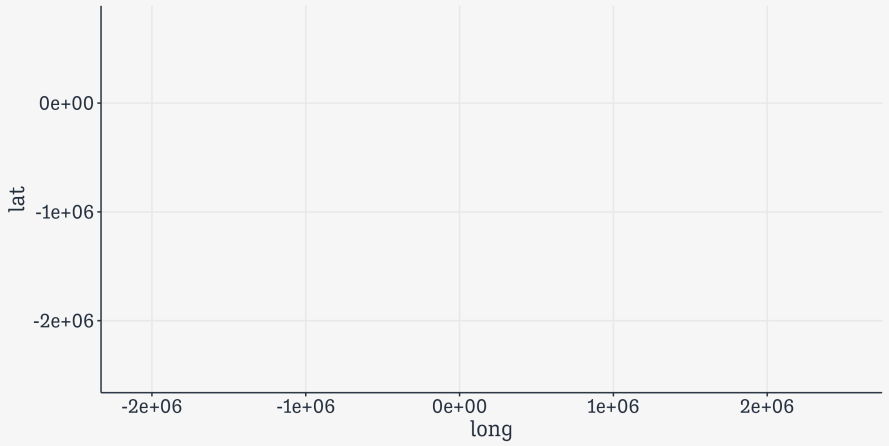
Same again for Percent Black

```
county_full ← as_tibble(left_join(county_map, county_data, by
county_full
```

```
# A tibble: 191,382 × 38
       long       lat order hole  piece group    id    name  state
census_region
      <dbl>     <dbl> <int> <lgl> <fct> <fct>    <chr> <chr> <fct>
<fct>
 1 1225889. -1275020.     1 FALSE 1     0500000… 01001 Auta… AL
South
 2 1235324. -1274008.     2 FALSE 1     0500000… 01001 Auta… AL
South
 3 1244873. -1272331.     3 FALSE 1     0500000… 01001 Auta… AL
South
 4 1244129. -1267515.     4 FALSE 1     0500000… 01001 Auta… AL
South
 5 1272010. -1262889.     5 FALSE 1     0500000… 01001 Auta… AL
South
 6 1276797. -1295514.     6 FALSE 1     0500000… 01001 Auta… AL
South
 7 1273832. -1297124.     7 FALSE 1     0500000… 01001 Auta… AL
South
 8 1272727. -1296631.     8 FALSE 1     0500000… 01001 Auta… AL
South
 9 1272513. -1299771.     9 FALSE 1     0500000… 01001 Auta… AL
South
10 1269950. -1302038.    10 FALSE 1     0500000… 01001 Auta… AL
South
```

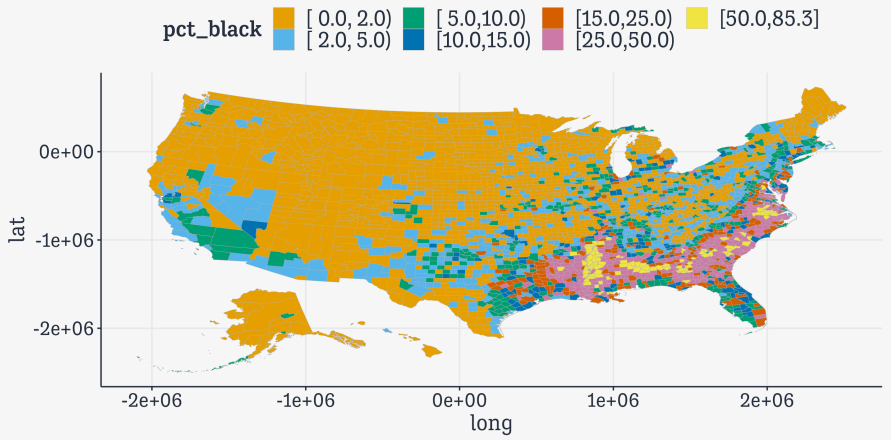
Same again for Percent Black

```
county_full ← as_tibble(left_join(county_map, county_data, by
county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pct_black,
                       group = group))
```



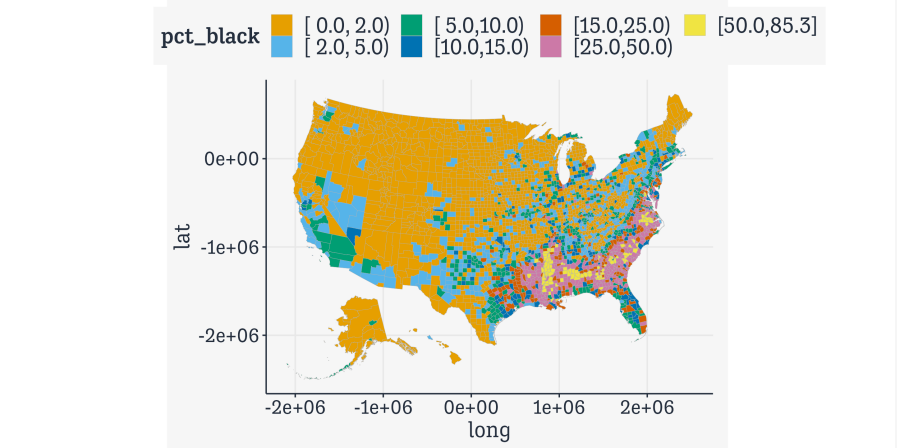
Same again for Percent Black

```
county_full ← as_tibble(left_join(county_map, county_data, by
county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pct_black,
                       group = group)) +
  geom_polygon(color = "gray70",
               size = 0.1)
```



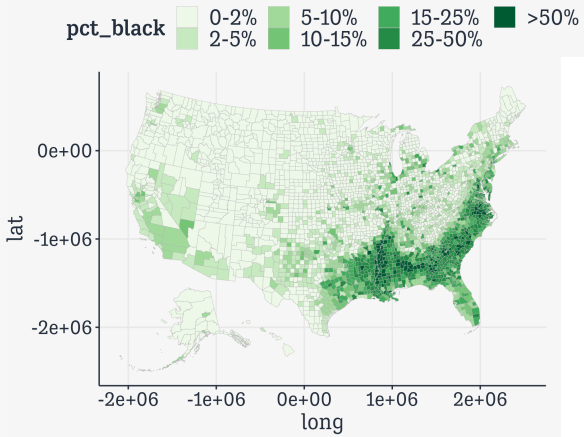
Same again for Percent Black

```
county_full ← as_tibble(left_join(county_map, county_data, by
county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pct_black,
                       group = group)) +
  geom_polygon(color = "gray70",
               size = 0.1) +
  coord_fixed()
```



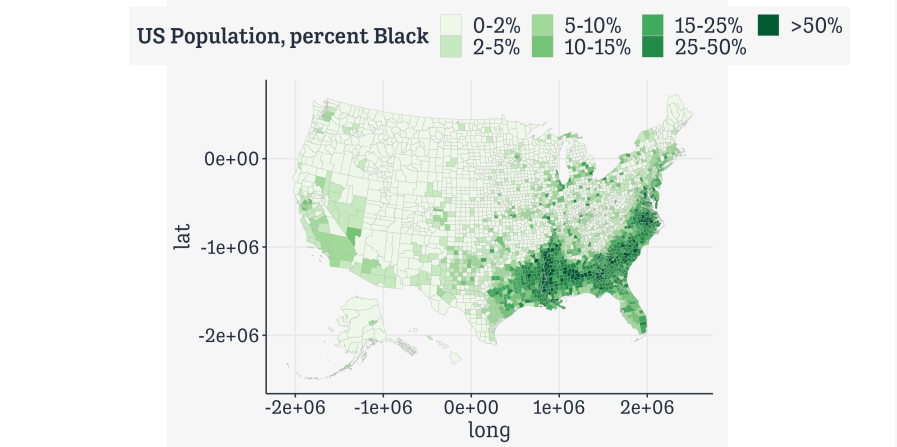
Same again for Percent Black

```
county_full ← as_tibble(left_join(county_map, county_data, by
county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pct_black,
                       group = group)) +
  geom_polygon(color = "gray70",
               size = 0.1) +
  coord_fixed() +
  scale_fill_brewer(palette="Greens",
                    labels = c("0-2%", "2-5%", "5-10%",
                               "10-15%", "15-25%",
                               "25-50%", ">50%"))
```



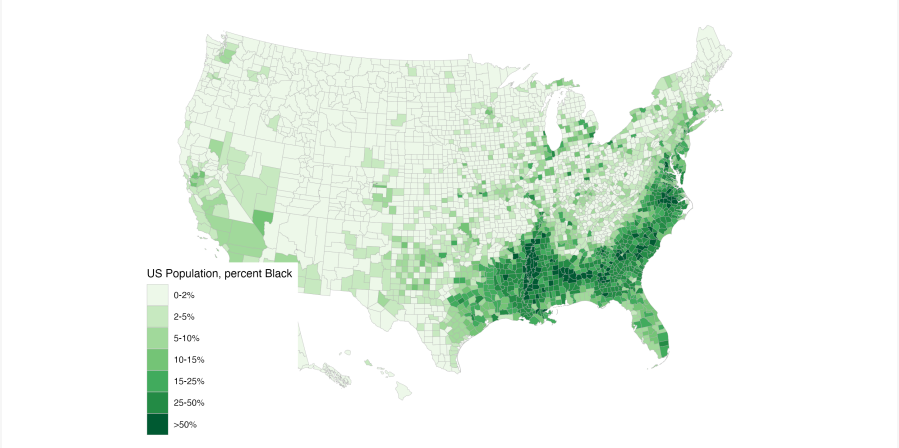
Same again for Percent Black

```
county_full ← as_tibble(left_join(county_map, county_data, by
county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pct_black,
                       group = group)) +
  geom_polygon(color = "gray70",
               size = 0.1) +
  coord_fixed() +
  scale_fill_brewer(palette="Greens",
                    labels = c("0-2%", "2-5%", "5-10%",
                               "10-15%", "15-25%",
                               "25-50%", ">50%")) +
  labs(fill = "US Population, percent Black")
```



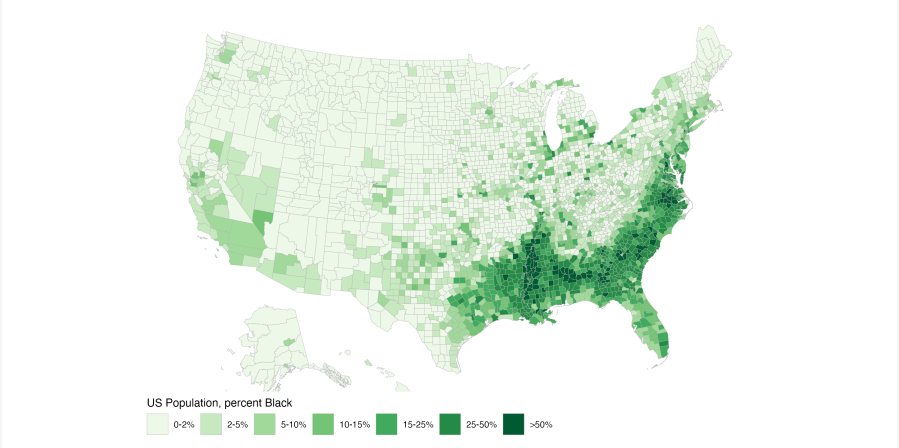
Same again for Percent Black

```
county_full ← as_tibble(left_join(county_map, county_data, by
county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pct_black,
                       group = group)) +
  geom_polygon(color = "gray70",
               size = 0.1) +
  coord_fixed() +
  scale_fill_brewer(palette="Greens",
                    labels = c("0-2%", "2-5%", "5-10%",
                               "10-15%", "15-25%",
                               "25-50%", ">50%")) +
  labs(fill = "US Population, percent Black") +
  kjhslides::kjh_theme_map()
```



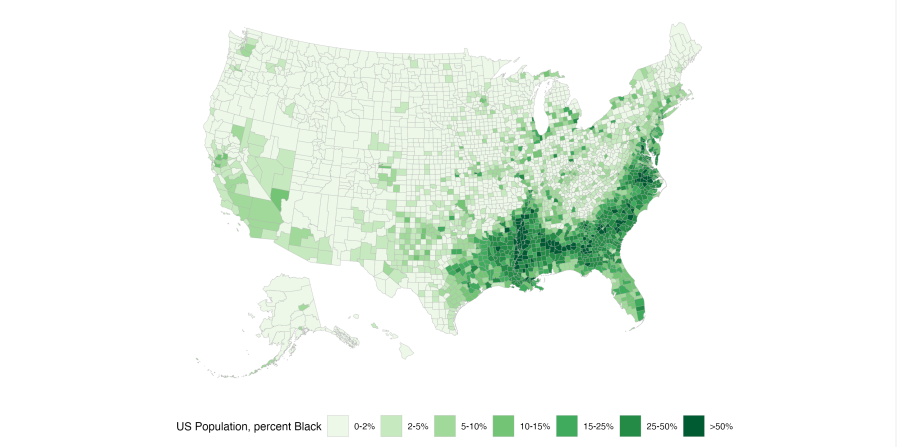
Same again for Percent Black

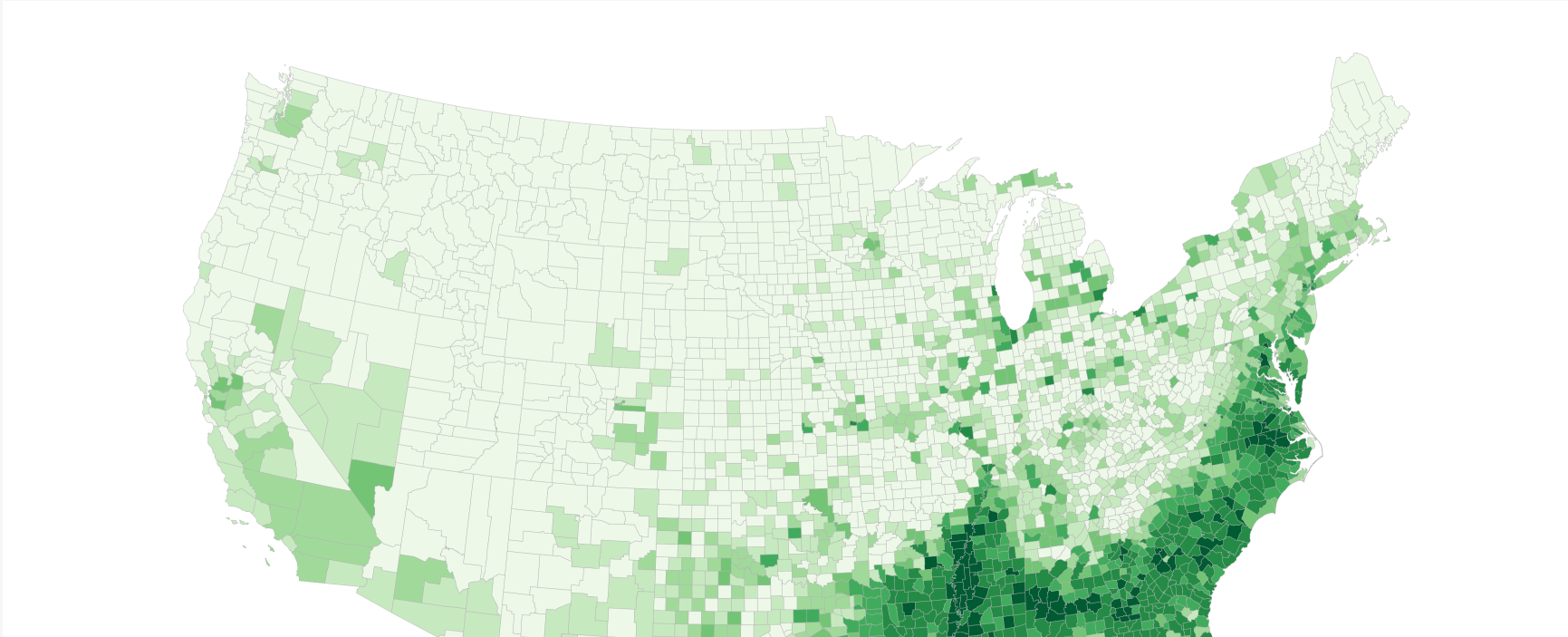
```
county_full ← as_tibble(left_join(county_map, county_data, by
county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pct_black,
                       group = group)) +
  geom_polygon(color = "gray70",
               size = 0.1) +
  coord_fixed() +
  scale_fill_brewer(palette="Greens",
                    labels = c("0-2%", "2-5%", "5-10%",
                               "10-15%", "15-25%",
                               "25-50%", ">50%")) +
  labs(fill = "US Population, percent Black") +
  kjhslides::kjh_theme_map() +
  guides(fill = guide_legend(nrow = 1))
```



Same again for Percent Black

```
county_full ← as_tibble(left_join(county_map, county_data, by
county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pct_black,
                       group = group)) +
  geom_polygon(color = "gray70",
               size = 0.1) +
  coord_fixed() +
  scale_fill_brewer(palette="Greens",
                    labels = c("0-2%", "2-5%", "5-10%",
                               "10-15%", "15-25%",
                               "25-50%", ">50%")) +
  labs(fill = "US Population, percent Black") +
  kjhslides::kjh_theme_map() +
  guides(fill = guide_legend(nrow = 1)) +
  theme(legend.position = "bottom")
```





Big counties, few people, rare events

Example: Reverse coding

Code | Reverse

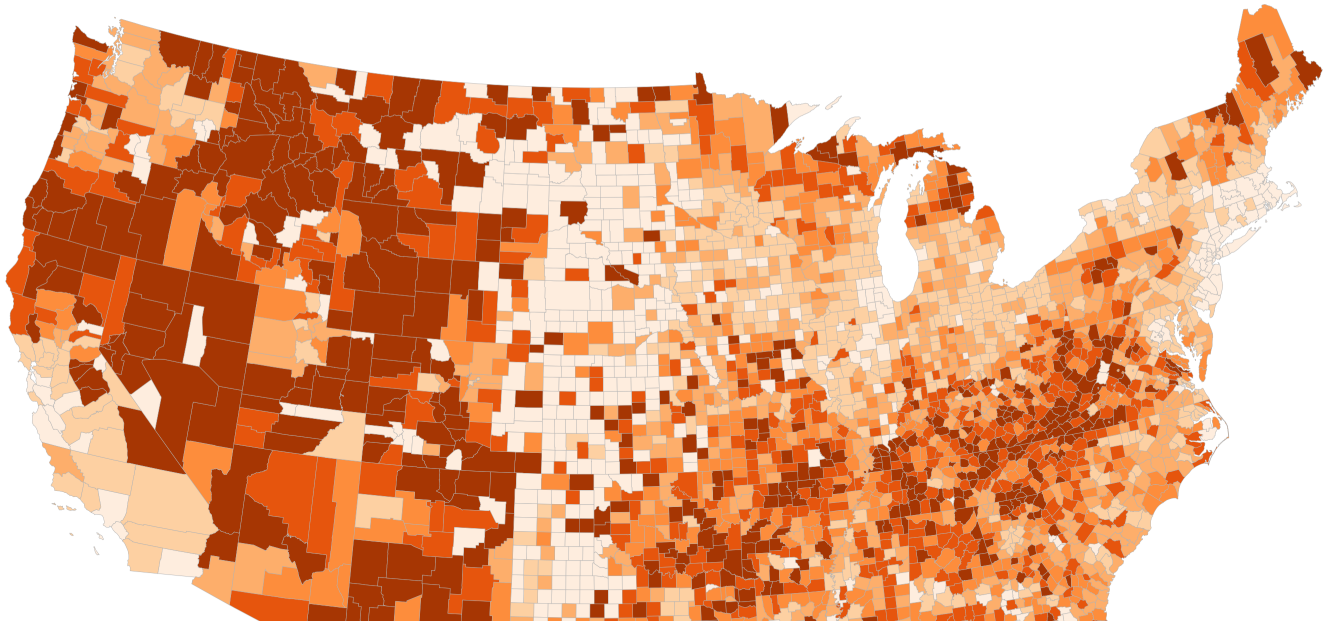
```
orange_pal ← RColorBrewer::brewer.pal(n = 6,
                                      name = "Oranges")
orange_pal
```

```
[1] "#FEEDDE" "#FDD0A2" "#FDAE6B" "#FD8D3C" "#E6550D" "#A63603"
```

Build a plot

```
p_g1 ← county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = su_gun6, #<<
                       group = group)) +
  geom_polygon(color = "gray70",
               size = 0.1) +
  coord_fixed() +
  scale_fill_manual(values = orange_pal) + #<<
  labs(title = "Gun-Related Suicides, 1999-2015",

       fill = "Rate per 100,000 pop.") +
  theme_map() +
  guides(fill = guide_legend(nrow = 1)) +
  theme(legend.position = "bottom")
```

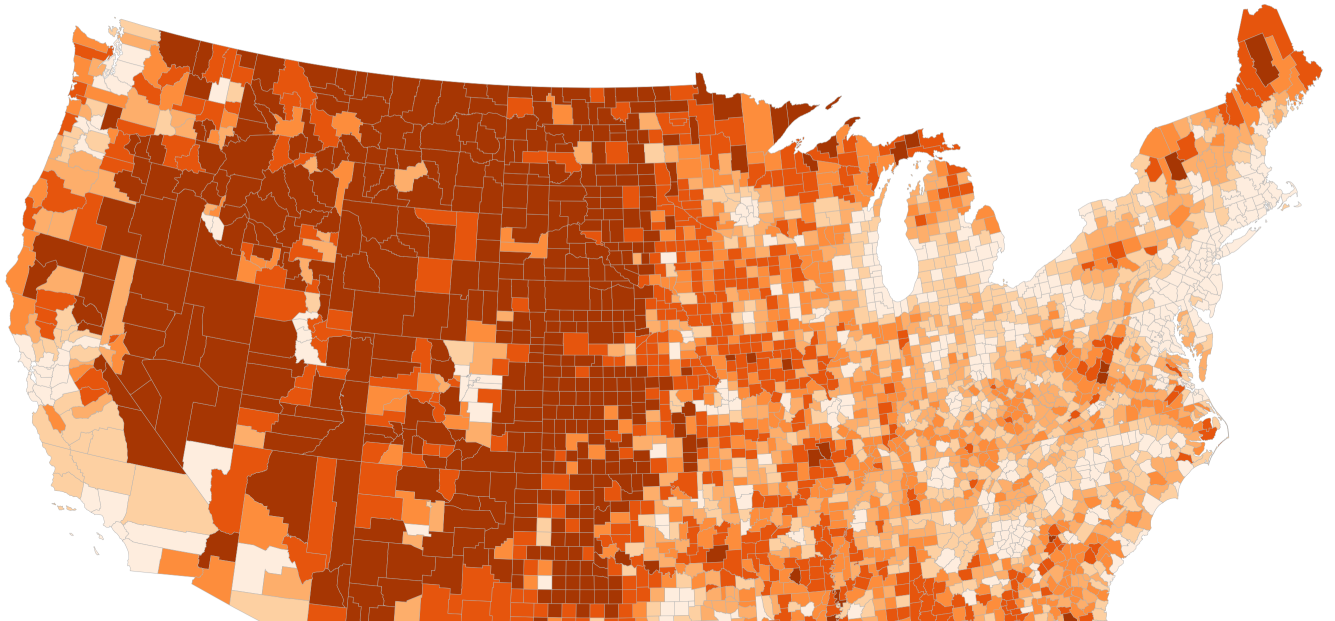
Gun-Related Suicides, 1999-2015



And another

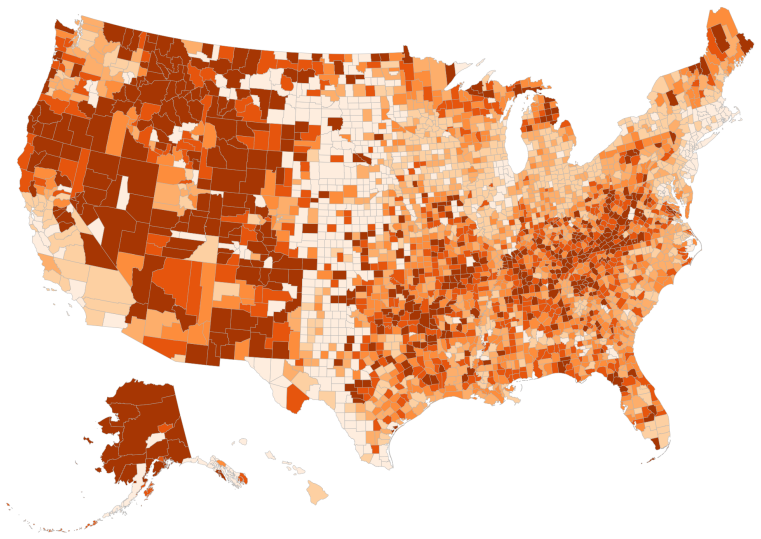
```
p_g2 ← county_full ▷
  ggplot(mapping = aes(x = long, y = lat,
                       fill = pop_dens6, #<<
                       group = group)) +
  geom_polygon(color = "gray70",
               size = 0.1) +
  coord_fixed() +
  scale_fill_manual(values = orange_rev) + #<<
  labs(title = "Reverse-coded Population Density",

       fill = "Persons per square mile") +
  theme_map() +
  guides(fill = guide_legend(nrow = 1)) +
  theme(legend.position = "bottom")
```

Reverse-coded Population Density

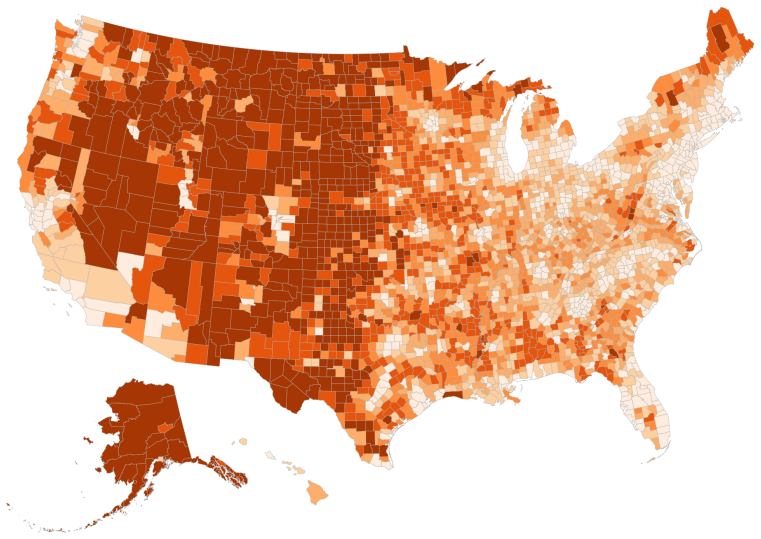


Comparison

Gun-Related Suicides, 1999-2015



Reverse-coded Population Density



Small multiples for maps

Opiate-related Mortality, 1999-2014

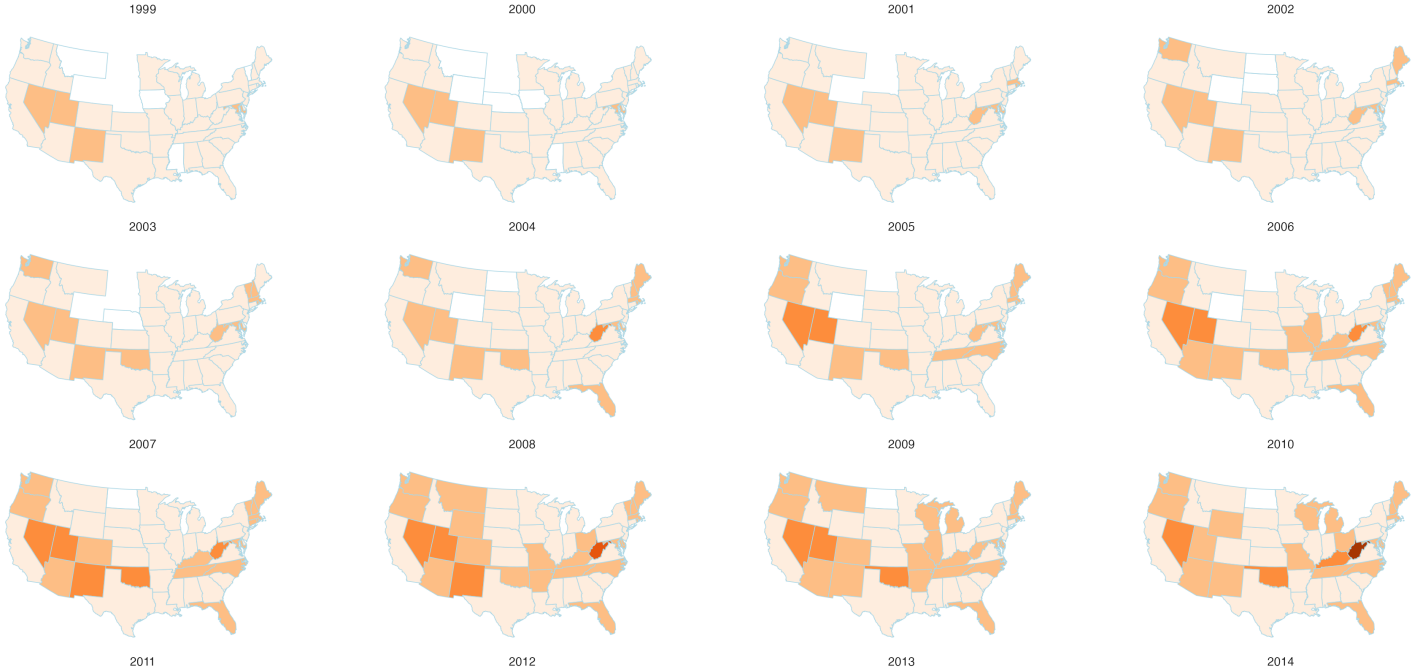
```
opiates
```

```
# A tibble: 800 × 11
    year state    fips deaths population crude adjusted adjusted_se region abbr
   <int> <chr>   <int>  <int>      <int> <dbl>    <dbl>       <dbl> <ord>  <chr>
 1  1999 Alabama     1     37    4430141   0.8      0.8         0.1 South  AL
 2  1999 Alaska      2     27     624779   4.3      4           0.8 West   AK
 3  1999 Arizona     4    229    5023823   4.6      4.7         0.3 West   AZ
 4  1999 Arkans…     5     28    2651860   1.1      1.1         0.2 South  AR
 5  1999 Califo…     6   1474   33499204   4.4      4.5         0.1 West   CA
 6  1999 Colora…     8    164    4226018   3.9      3.7         0.3 West   CO
 7  1999 Connec…     9    151    3386401   4.5      4.4         0.4 North… CT
 8  1999 Delawa…    10     32     774990   4.1      4.1         0.7 South  DE
 9  1999 Distri…    11     28     570213   4.9      4.9         0.9 South  DC
10  1999 Florida    12    402   15759421   2.6      2.6         0.1 South  FL
# ℹ 790 more rows
# ℹ 1 more variable: division_name <chr>
```

```
opiates$state ← tolower(opiates$state)
us_states$state ← us_states$region
opiates_map ← left_join(us_states, opiates, by = "state")
```

```r
p_out ← opiates_map ▷
  ggplot(mapping = aes(x = long, y = lat,
                       group = group,
                       fill = cut_interval(adjusted, n = 5))) +
  geom_polygon(color = "lightblue", size = 0.2) +
  coord_map(projection = "albers", lat0 = 39, lat1 = 45) +
  scale_fill_brewer(type = "seq", palette = "Oranges") +
  kjhslides::kjh_theme_map() +
  facet_wrap(~ year, ncol = 4) +
  guides(fill = guide_legend(nrow = 1)) +
  theme(legend.position = "bottom",
        strip.background = element_blank()) +
  labs(fill = "Death rate per 100,000 population",
       title = "Opiate-Related Deaths by State, 1999-2014")
```

Opiate-Related Deaths by State, 1999-2014



Is your data really spatial?

The two leading states in each region in 2014

```
## Put this in an object called `st_top`
opiates
```

```
# A tibble: 800 × 11
    year state    fips deaths population crude adjusted
adjusted_se region abbr
   <int> <chr>   <int>  <int>      <int> <dbl>    <dbl>
<dbl> <ord>  <chr>
 1  1999 alabama     1     37    4430141   0.8      0.8
0.1 South  AL
 2  1999 alaska      2     27     624779   4.3      4
0.8 West   AK
 3  1999 arizona     4    229    5023823   4.6      4.7
0.3 West   AZ
 4  1999 arkans…     5     28    2651860   1.1      1.1
0.2 South  AR
 5  1999 califo…     6   1474   33499204   4.4      4.5
0.1 West   CA
 6  1999 colora…     8    164    4226018   3.9      3.7
0.3 West   CO
 7  1999 connec…     9    151    3386401   4.5      4.4
0.4 North… CT
 8  1999 delawa…    10     32     774990   4.1      4.1
0.7 South  DE
 9  1999 distri…    11     28     570213   4.9      4.9
0.9 South  DC
10  1999 florida    12    402   15759421   2.6      2.6
0.1 South  FL
```

The two leading states in each region in 2014

```
## Put this in an object called `st_top`
opiates ▷
  filter(year == max(year),
         abbr ≠ "DC")
```

```
# A tibble: 50 × 11
    year state    fips deaths population crude adjusted
adjusted_se region abbr
   <int> <chr>   <int>  <int>      <int> <dbl>    <dbl>
<dbl> <ord>  <chr>
 1  2014 alabama     1    270    4849377   5.6      5.6
0.3 South  AL
 2  2014 alaska      2     76     736732  10.3     10.6
1.2 West   AK
 3  2014 arizona     4    589    6731484   8.7      8.8
0.4 West   AZ
 4  2014 arkans…     5    173    2966369   5.8      6.3
0.5 South  AR
 5  2014 califo…     6   2024   38802500   5.2      5
0.1 West   CA
 6  2014 colora…     8    517    5355866   9.7      9.4
0.4 West   CO
 7  2014 connec…     9    525    3596677  14.6     15.2
0.7 North… CT
 8  2014 delawa…    10    124     935614  13.3     13.9
1.3 South  DE
 9  2014 florida    12   1399   19893297   7        7.2
0.2 South  FL
10  2014 georgia    13    710   10097343   7        7
0.3 South  GA
```

The two leading states in each region in 2014

```
## Put this in an object called `st_top`
opiates ▷
  filter(year == max(year),
         abbr ≠ "DC") ▷
  group_by(region)
```

```
# A tibble: 50 × 11
# Groups:   region [4]
    year state    fips deaths population crude adjusted
adjusted_se region abbr
   <int> <chr>   <int>  <int>      <int> <dbl>    <dbl>
<dbl> <ord>  <chr>
 1  2014 alabama     1    270    4849377   5.6      5.6
0.3 South  AL
 2  2014 alaska      2     76     736732  10.3     10.6
1.2 West   AK
 3  2014 arizona     4    589    6731484   8.7      8.8
0.4 West   AZ
 4  2014 arkans…     5    173    2966369   5.8      6.3
0.5 South  AR
 5  2014 califo…     6   2024   38802500   5.2      5
0.1 West   CA
 6  2014 colora…     8    517    5355866   9.7      9.4
0.4 West   CO
 7  2014 connec…     9    525    3596677  14.6     15.2
0.7 North… CT
 8  2014 delawa…    10    124     935614  13.3     13.9
1.3 South  DE
 9  2014 florida    12   1399   19893297   7        7.2
0.2 South  FL
10  2014 georgia    13    710   10097343   7        7
```

The two leading states in each region in 2014

```
## Put this in an object called `st_top`
opiates ▷
  filter(year == max(year),
         abbr ≠ "DC") ▷
  group_by(region) ▷
  slice_max(order_by = adjusted,
            n = 2)
```

```
# A tibble: 8 × 11
# Groups:   region [4]
   year state     fips deaths population crude adjusted
adjusted_se region abbr
  <int> <chr>    <int>  <int>      <int> <dbl>    <dbl>
<dbl> <ord>  <chr>
1  2014 new ham…    33    297    1326813  22.4     23.4
1.4 North… NH
2  2014 rhode i…    44    205    1055173  19.4     19.8
1.4 North… RI
3  2014 ohio        39   2106   11594163  18.2     19.1
0.4 Midwe… OH
4  2014 missouri    29    696    6063589  11.5     12
0.5 Midwe… MO
5  2014 new mex…    35    402    2085572  19.3     20.2         1
West   NM
6  2014 utah        49    455    2942902  15.5     16.8
0.8 West   UT
7  2014 west vi…    54    554    1850326  29.9     31.6
1.4 South  WV
8  2014 kentucky    21    729    4413457  16.5     16.8
0.6 South  KY
# ℹ 1 more variable: division_name <chr>
```

The two leading states in each region in 2014

```
## Put this in an object called `st_top`
opiates ▷
  filter(year == max(year),
         abbr ≠ "DC") ▷
  group_by(region) ▷
  slice_max(order_by = adjusted,
            n = 2)
```

```
# A tibble: 8 × 11
# Groups:   region [4]
   year state     fips deaths population crude adjusted
adjusted_se region abbr
  <int> <chr>    <int>  <int>      <int> <dbl>    <dbl>
<dbl> <ord>  <chr>
1  2014 new ham…    33    297    1326813  22.4     23.4
1.4 North… NH
2  2014 rhode i…    44    205    1055173  19.4     19.8
1.4 North… RI
3  2014 ohio        39   2106   11594163  18.2     19.1
0.4 Midwe… OH
4  2014 missouri    29    696    6063589  11.5     12
0.5 Midwe… MO
5  2014 new mex…    35    402    2085572  19.3     20.2         1
West   NM
6  2014 utah        49    455    2942902  15.5     16.8
0.8 West   UT
7  2014 west vi…    54    554    1850326  29.9     31.6
1.4 South  WV
8  2014 kentucky    21    729    4413457  16.5     16.8
0.6 South  KY
# ℹ 1 more variable: division_name <chr>
```

Opiates Time Series plot

```
st_top ← opiates ▷  filter(year == max(year), abbr ≠ "DC")
```

Opiates Time Series plot

```
st_top ← opiates ▷  filter(year == max(year), abbr ≠ "DC")
  group_by(region)
```

Opiates Time Series plot

```
st_top ← opiates ▷  filter(year == max(year), abbr ≠ "DC") ▷
  group_by(region) ▷
  slice_max(order_by = adjusted, n = 2)
```

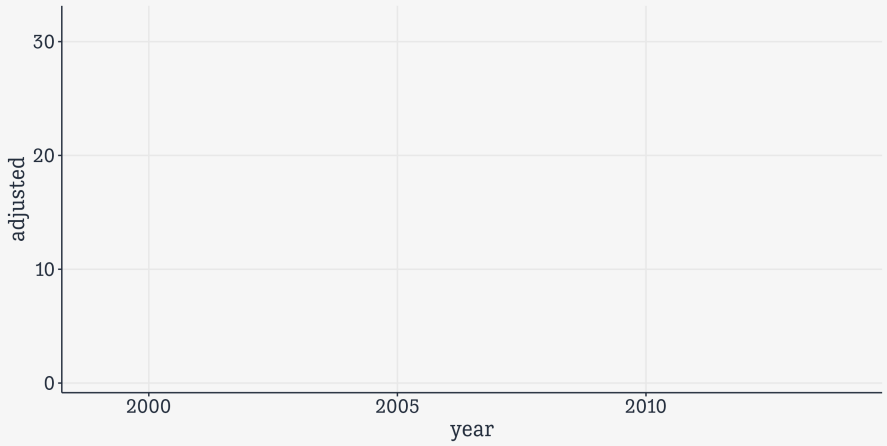
Opiates Time Series plot

```
st_top ← opiates ▷  filter(year == max(year), abbr ≠ "DC")
  group_by(region) ▷
  slice_max(order_by = adjusted, n = 2)

opiates
```

```
# A tibble: 800 × 11
    year state    fips deaths population crude adjusted
adjusted_se region abbr
   <int> <chr>   <int>  <int>      <int> <dbl>    <dbl>
<dbl> <ord>  <chr>
 1  1999 alabama     1     37    4430141   0.8      0.8
0.1 South  AL
 2  1999 alaska      2     27     624779   4.3      4
0.8 West   AK
 3  1999 arizona     4    229    5023823   4.6      4.7
0.3 West   AZ
 4  1999 arkans…     5     28    2651860   1.1      1.1
0.2 South  AR
 5  1999 califo…     6   1474   33499204   4.4      4.5
0.1 West   CA
 6  1999 colora…     8    164    4226018   3.9      3.7
0.3 West   CO
 7  1999 connec…     9    151    3386401   4.5      4.4
0.4 North… CT
 8  1999 delawa…    10     32     774990   4.1      4.1
0.7 South  DE
 9  1999 distri…    11     28     570213   4.9      4.9
0.9 South  DC
10  1999 florida    12    402   15759421   2.6      2.6
0.1 South  FL
```

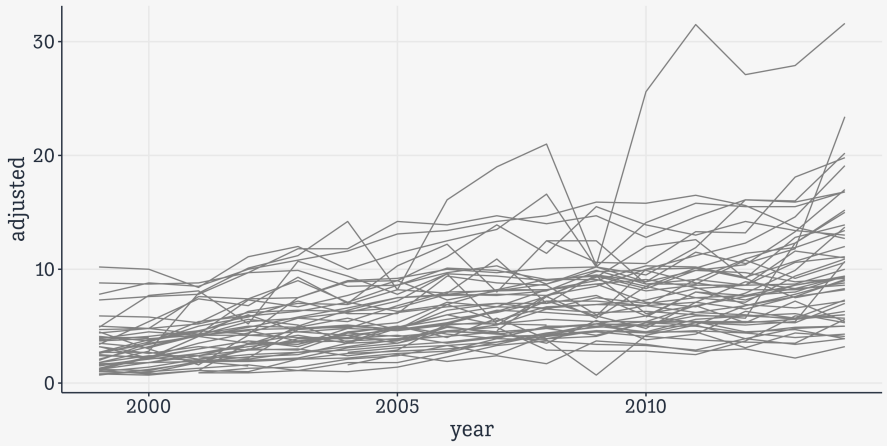
Opiates Time Series plot

```
st_top ← opiates ▷  filter(year == max(year), abr ≠ "DC")
  group_by(region) ▷
  slice_max(order_by = adjusted, n = 2)

opiates ▷
  ggplot(aes(x = year,
             y = adjusted))
```



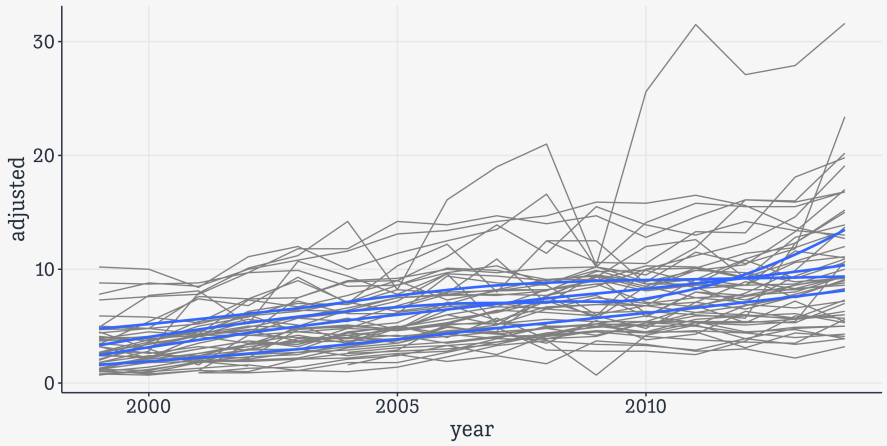
Opiates Time Series plot

```r
st_top ← opiates ▷  filter(year == max(year), abbr ≠ "DC")
  group_by(region) ▷
  slice_max(order_by = adjusted, n = 2)

opiates ▷
  ggplot(aes(x = year,
             y = adjusted)) +
  geom_line(aes(group = state),
            color = "gray50")
```



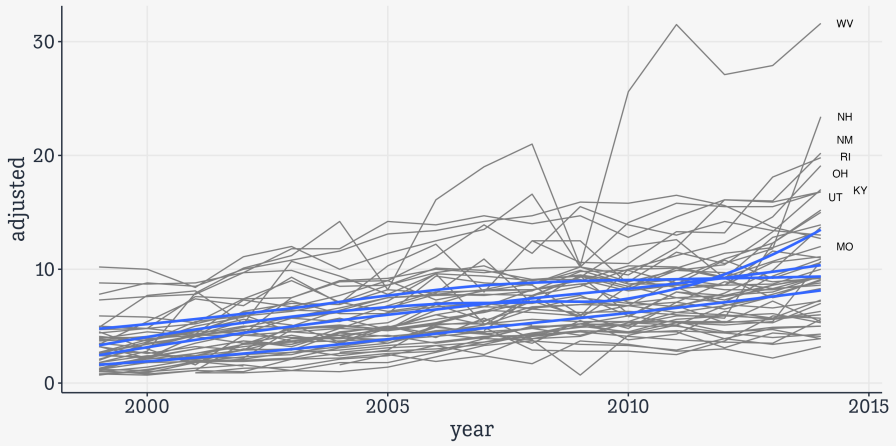
Opiates Time Series plot

```
st_top ← opiates ▷  filter(year == max(year), abr ≠ "DC")
  group_by(region) ▷
  slice_max(order_by = adjusted, n = 2)

opiates ▷
  ggplot(aes(x = year,
             y = adjusted)) +
  geom_line(aes(group = state),
            color = "gray50") +
  geom_smooth(aes(group = region),
              se = FALSE)
```



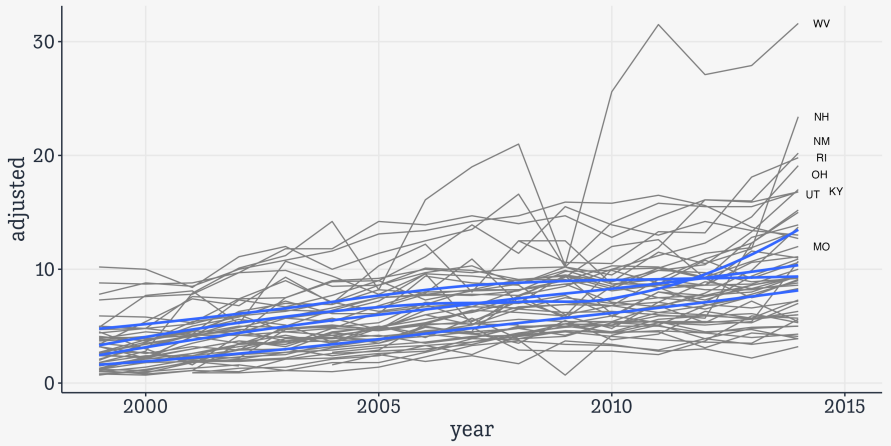
Opiates Time Series plot

```
st_top ← opiates ▷  filter(year == max(year), abbr ≠ "DC")
  group_by(region) ▷
  slice_max(order_by = adjusted, n = 2)

opiates ▷
  ggplot(aes(x = year,
             y = adjusted)) +
  geom_line(aes(group = state),
            color = "gray50") +
  geom_smooth(aes(group = region),
              se = FALSE) +
  ggrepel::geom_text_repel(
    data = st_top,
    mapping = aes(x = year,
                  y = adjusted,
                  label = abbr),
    size = 3,
    segment.color = NA,
    nudge_x = 0.5)
```



Opiates Time Series plot

```r
st_top <- opiates %>%  filter(year == max(year), abbr != "DC")
  group_by(region) %>%
  slice_max(order_by = adjusted, n = 2)

opiates %>%
  ggplot(aes(x = year,
             y = adjusted)) +
  geom_line(aes(group = state),
            color = "gray50") +
  geom_smooth(aes(group = region),
              se = FALSE) +
  ggrepel::geom_text_repel(
    data = st_top,
    mapping = aes(x = year,
                  y = adjusted,
                  label = abbr),
    size = 3,
    segment.color = NA,
    nudge_x = 0.5) +
  coord_cartesian(c(min(opiates$year),
                    max(opiates$year) + 1))
```



Opiates Time Series plot

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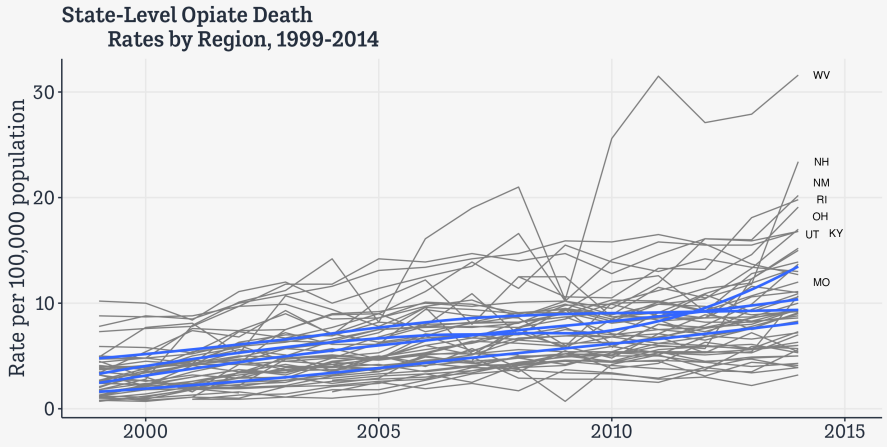
    size = 3,
    segment.color = NA,
    nudge_x = 0.5) +
  coord_cartesian(c(min(opiates$year),
                    max(opiates$year) + 1)) +
  labs(x = NULL,
       y = "Rate per 100,000 population",
```



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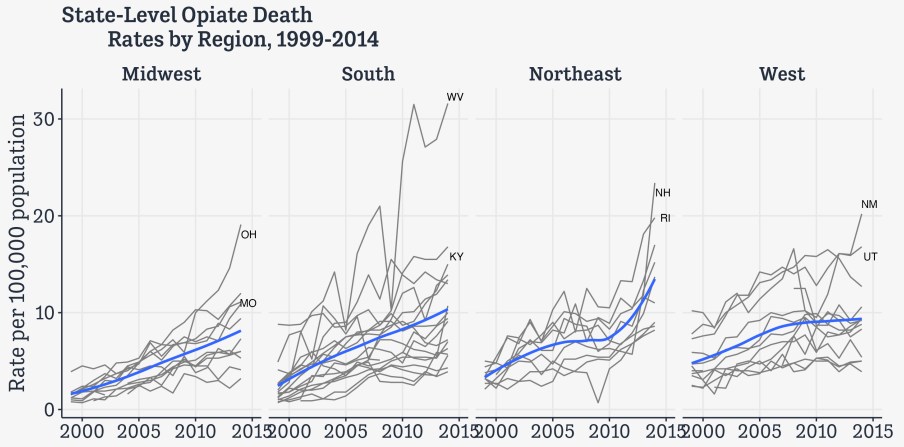

Opiates Time Series plot

```
st_top ← opiates ▷  filter(year == max(year), abbr ≠ "DC")
  group_by(region) ▷
  slice_max(order_by = adjusted, n = 2)

opiates ▷
  ggplot(aes(x = year,
             y = adjusted)) +
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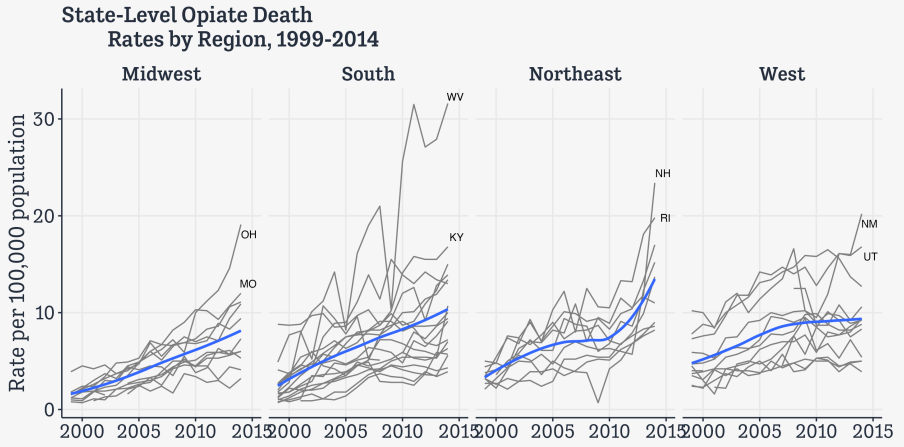

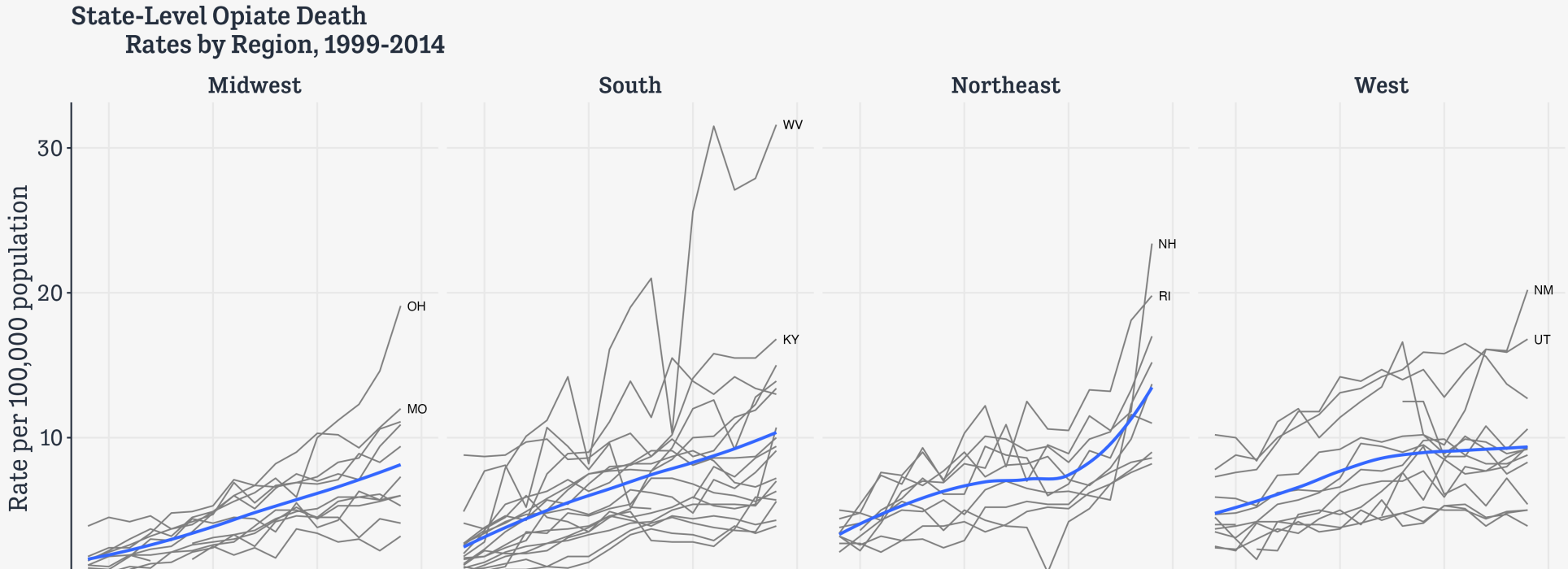
State-Level Opiate Death
Rates by Region, 1999-2014
Midwest
South
Northeast
West
Rate per 100,000 population
30
20
10
OH
MO
WV
KY
NH
RI
NM
UT