More Data Visualization Tools

Fall 2022

September 21 2022

So far ..

We know

- A basic set of geometries
- How to map variables to aesthetics
- How to layer `geoms`
- How to change axis labels and titles
- Statistical transformations

More to learn ...

Today

- Changing scales (e.g., color, shape, linetype)
- Changing coordinates
- Changing themes
- Adding annotations
- Mapping spatial data

Changing scales

```
scale_<aes>_<method>()
```

Examples:

- `scale_fill_manual()`
- `scale_fill_brewer()`
- `scale_color_viridis()`
- `scale_shape_manual()`

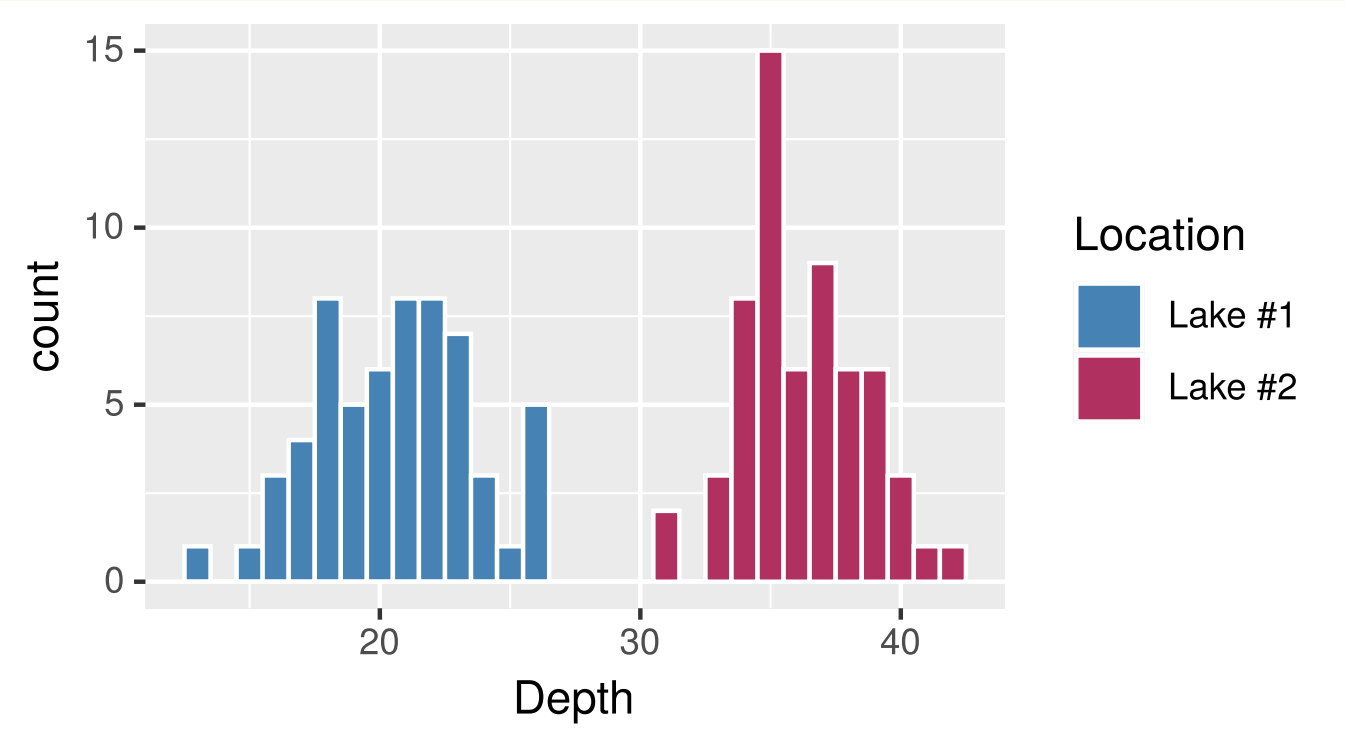
Recommended reading:

- Using colors in R
- Taking control of qualitative colors in ggplot2

Example

Let's make Lake #1 `steelblue` and Lake #2 `maroon`

Plot Code

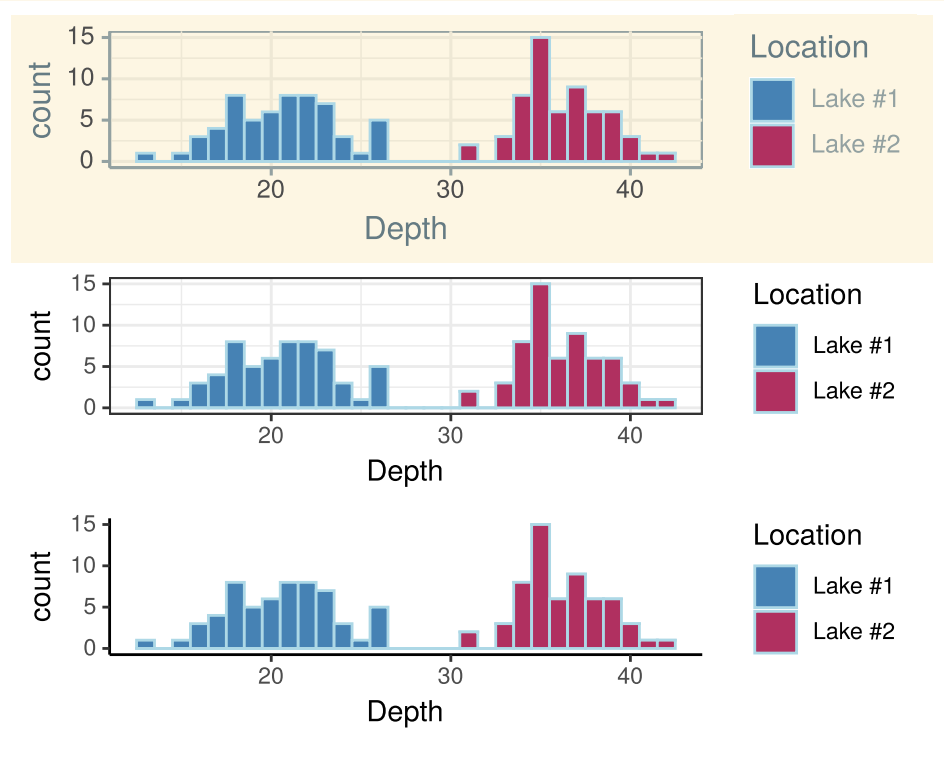


Changing themes

Theme: The non-data ink on your plots

Examples:

- background color
- tick marks
- grid lines
- legend position and appearance

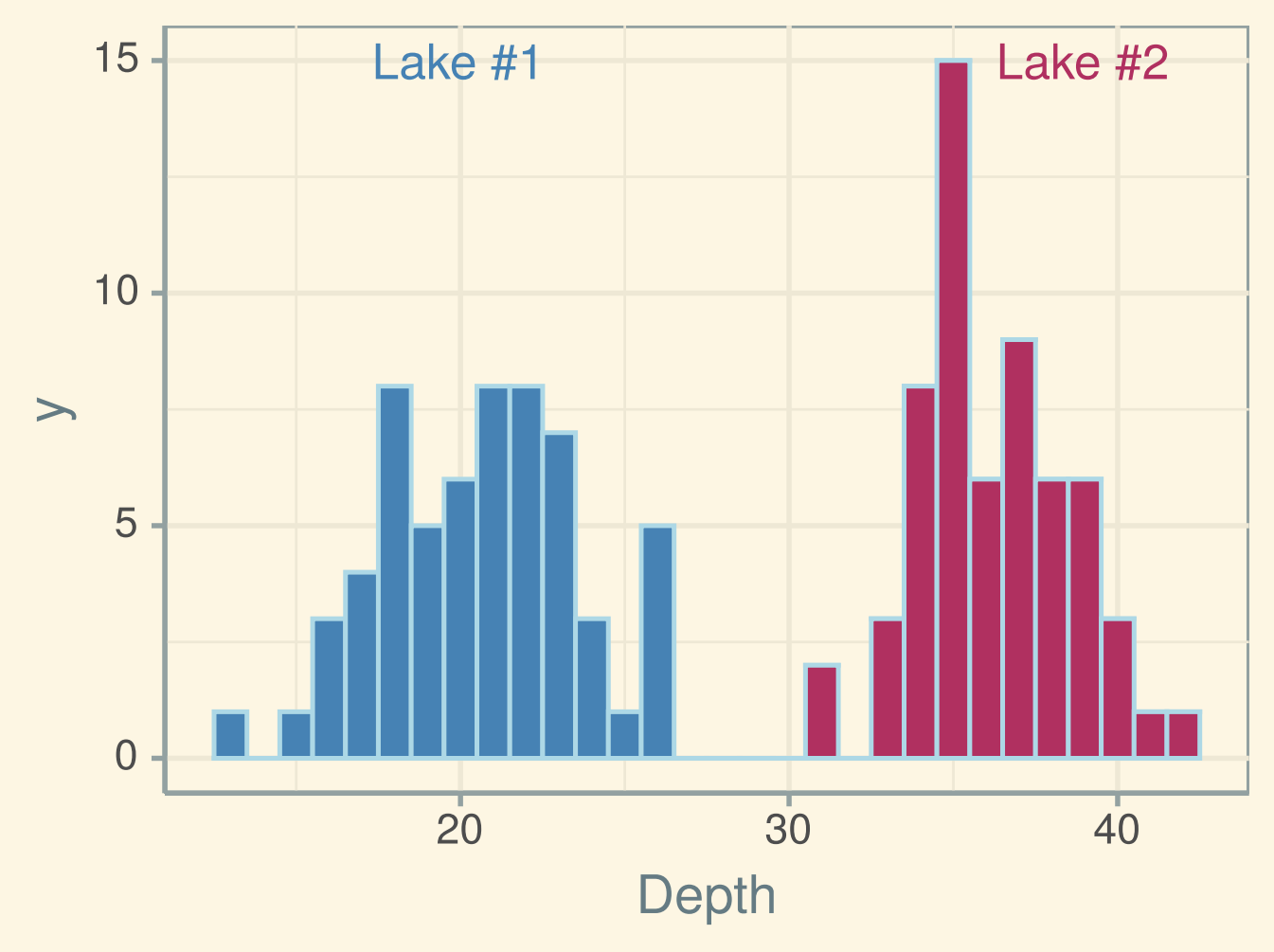


Top to bottom: solarized, bw, and classic themes resp.

Click for various basic ggplot2 themes and for ggthemes

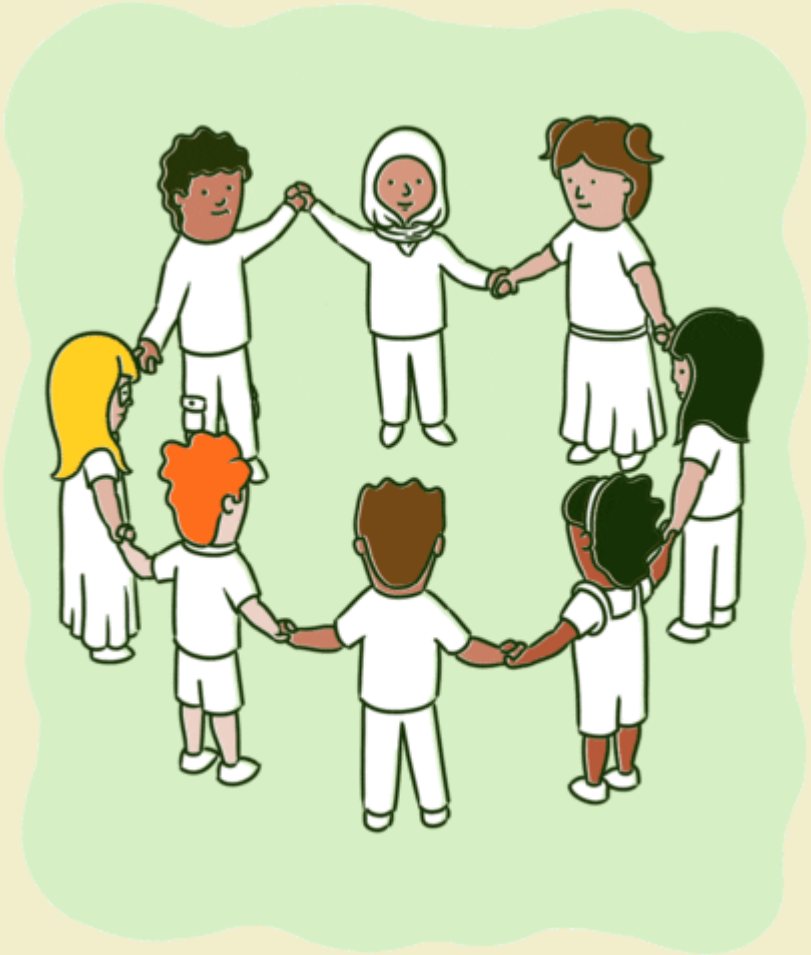
Annotations

Plot Code



Group Activity 1

06:00



- Let's go over to maize server/ local Rstudio and our class moodle
- Get the class activity 5 .Rmd file
- Work on problem 1
- Ask me questions

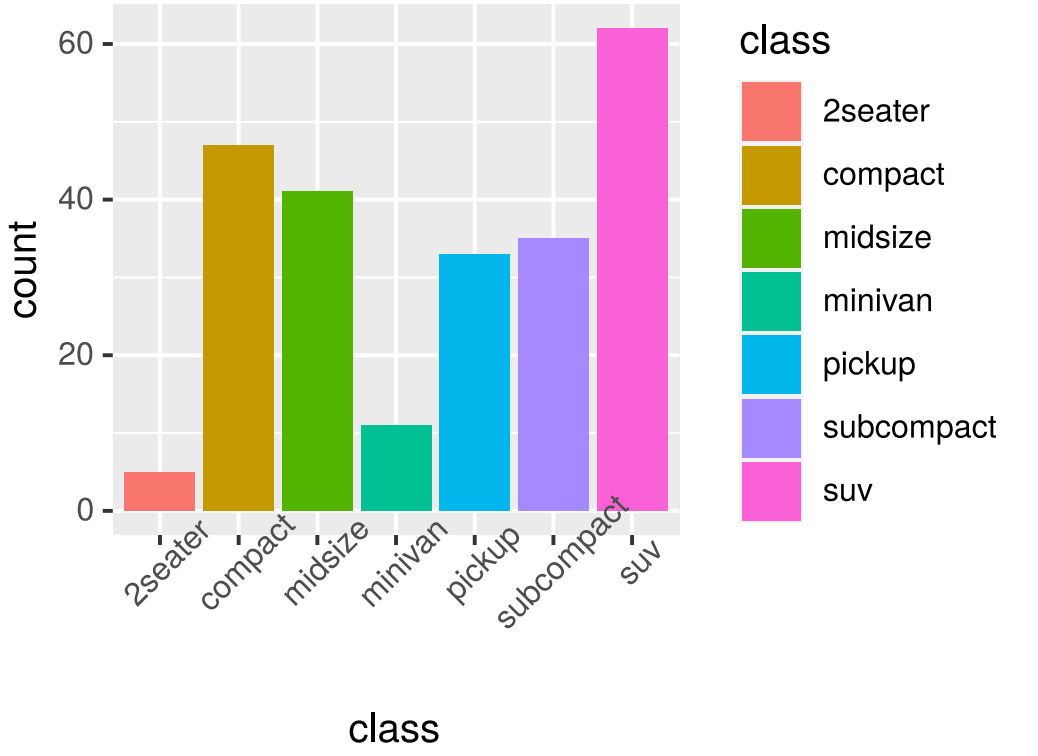
Changing coordinates

By default, `ggplot2` uses a Cartesian coordinate system, but there are others available!

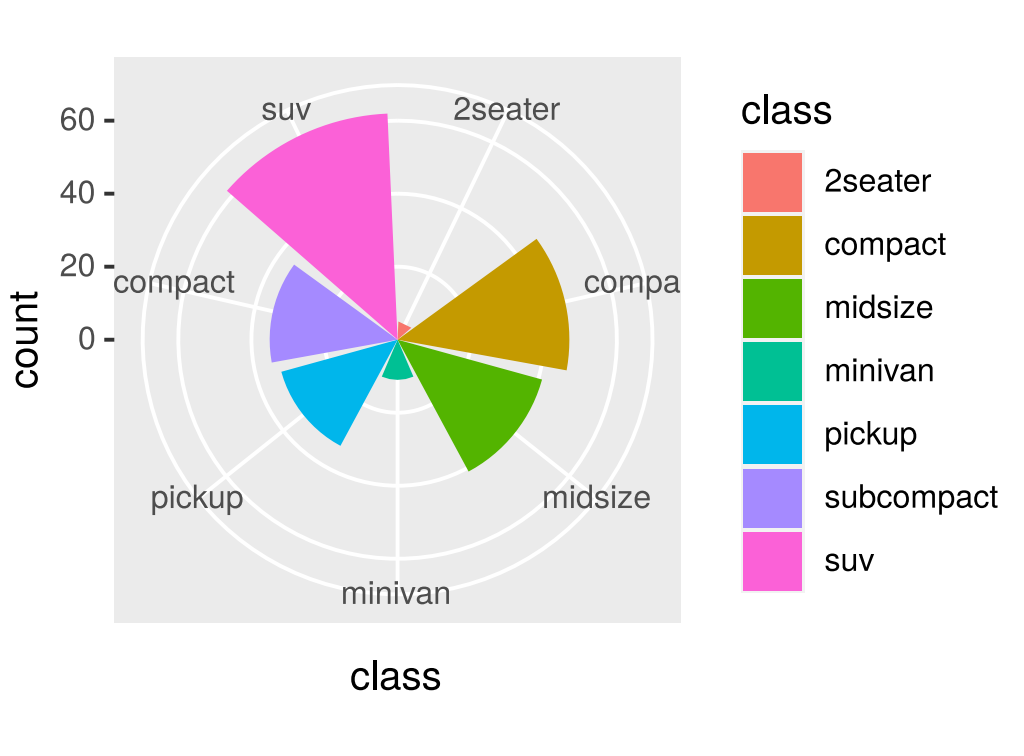
- `coord_cartesian`
- `coord_equal`
- `coord_fixed`
- `coord_flip`
- `coord_map`
- `coord_polar`
- `coord_quickmap`
- `coord_sf`
- `coord_trans`

Cartesian vs. Polar Coordinates

```
ggplot(data = mpg) +
 geom_bar(mapping = aes(x = class, fill = class
 theme(axis.text.x = element_text(angle = 45))
```

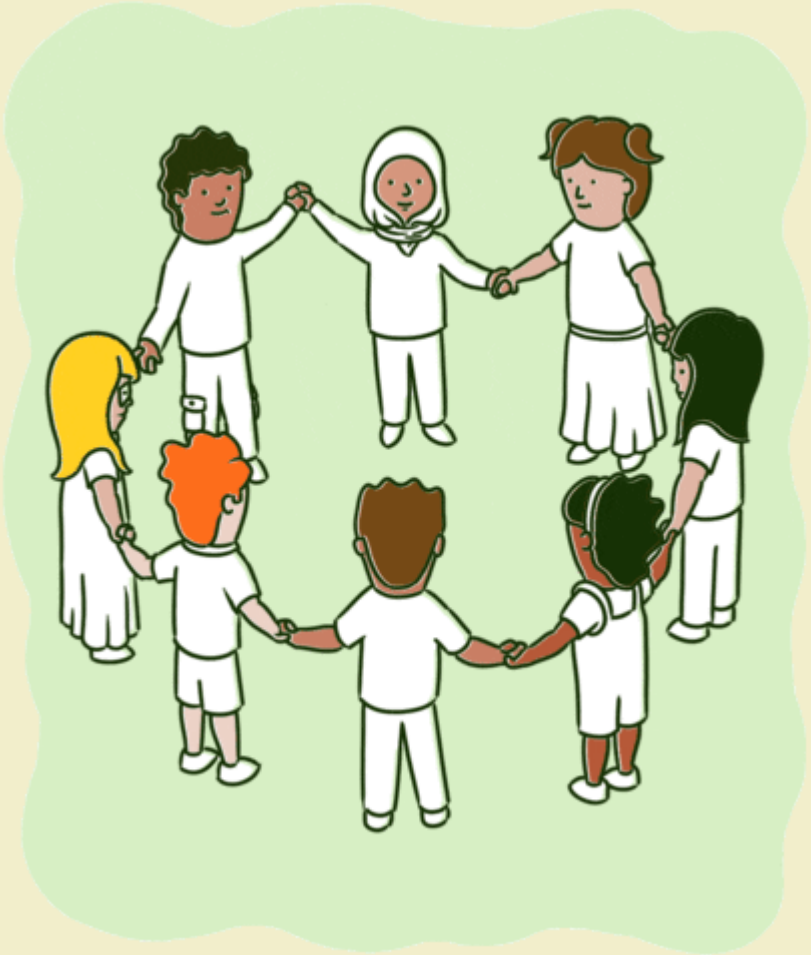



```
ggplot(data = mpg) +
 geom_bar(mapping = aes(x = class, fill = class
 coord_polar(theta = "x")
```



Group Activity 2

06:00



- Read through the article, Florence Nightingale's coxcomb graph
- Please work on problem 2
- Ask me questions

ggplot2 maps

The ggplot2 package contains latitude and longitude to define geographic boundaries

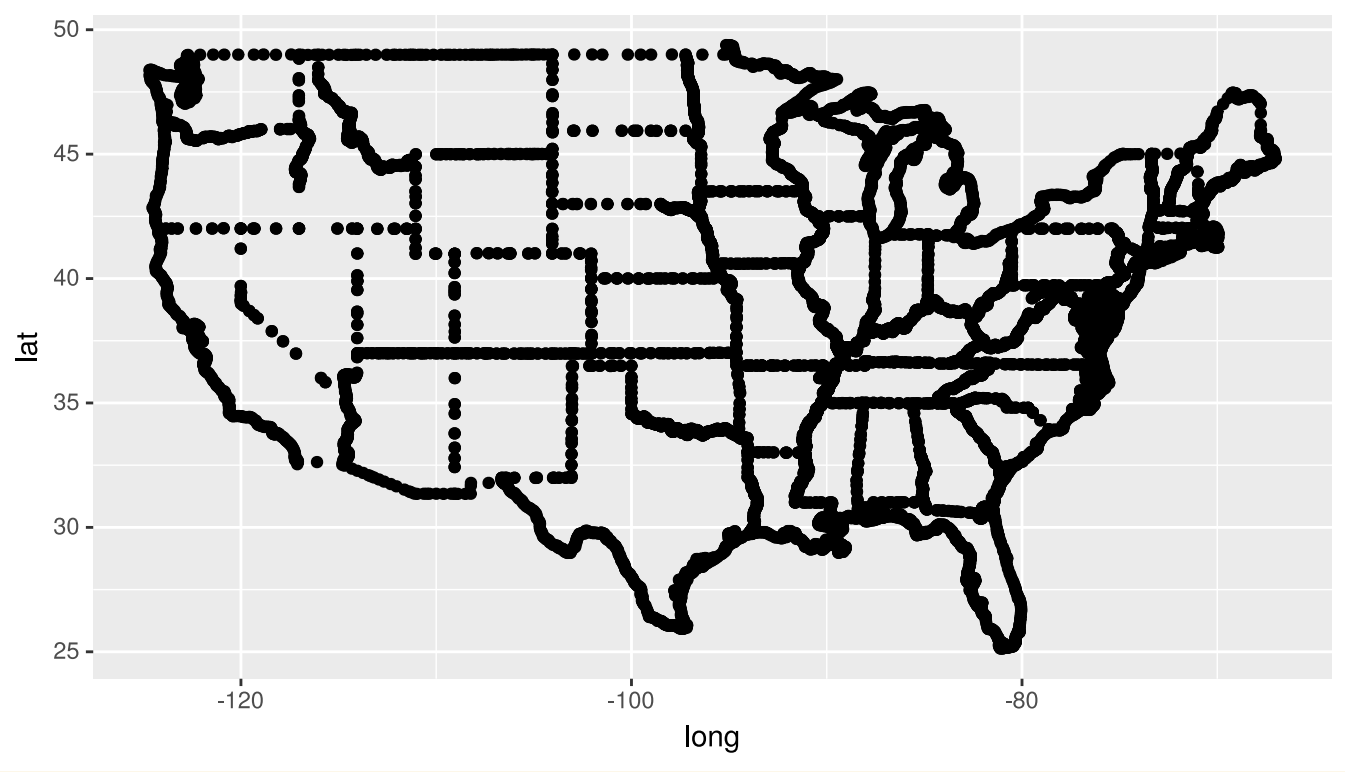
- some regions: state, usa, world, county
- see ?map_data or ?maps for more regions (may need to install maps)

```
states <- map_data("state")
glimpse(states)
Rows: 15,537
Columns: 6
$ long      <dbl> -87.46201, -87.48493, -87.52503, -87.53076, -87.57087, -87.5…
$ lat       <dbl> 30.38968, 30.37249, 30.37249, 30.33239, 30.32665, 30.32665, …
$ group     <dbl> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, …
$ order     <int> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 1…
$ region    <chr> "alabama", "alabama", "alabama", "alabama", "alabama", "alab…
$ subregion <chr> NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, NA, …
```

What is a map?

A set of latitude longitude points...

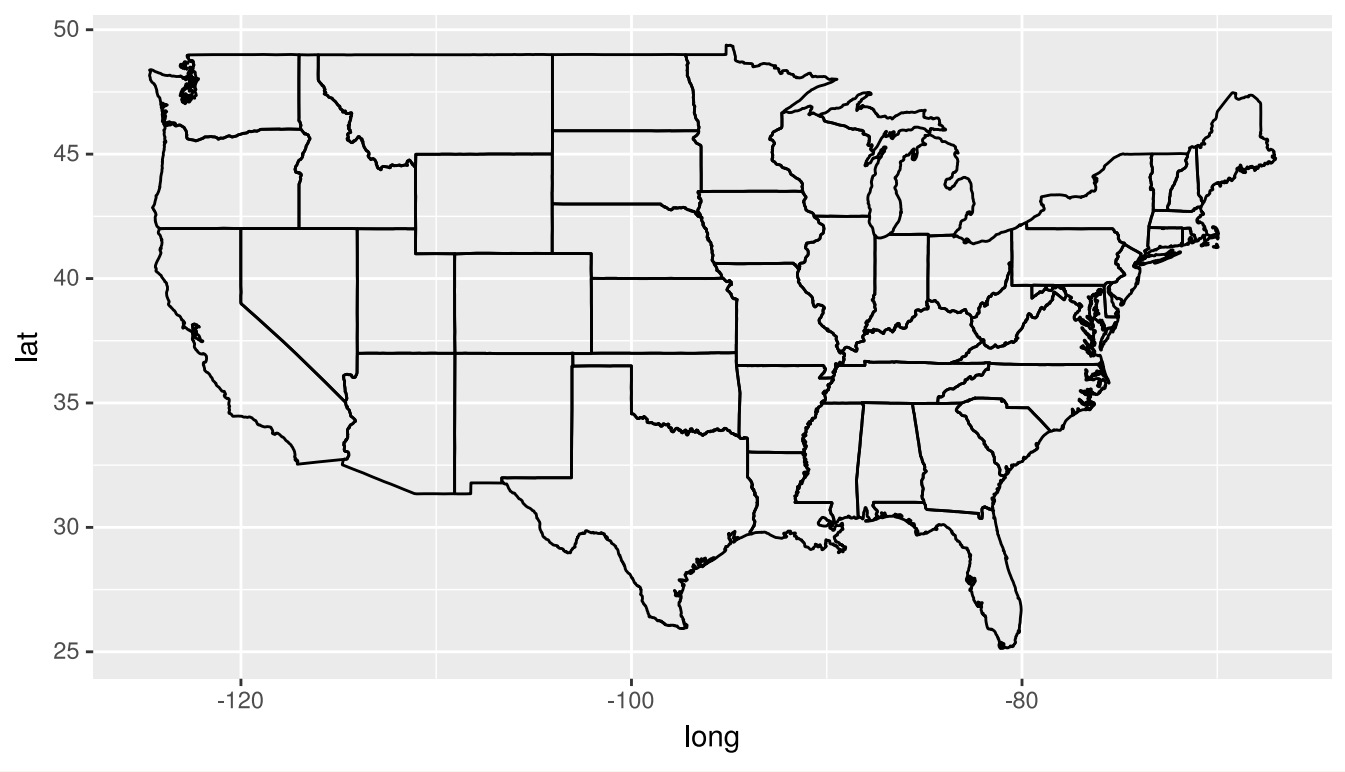
```
ggplot(states) + geom_point(aes(long, lat))
```



What is a map?

... that are connected with lines in a very specific order.

```
ggplot(states) + geom_path(aes(long, lat, group = group))
```



Necessary map data

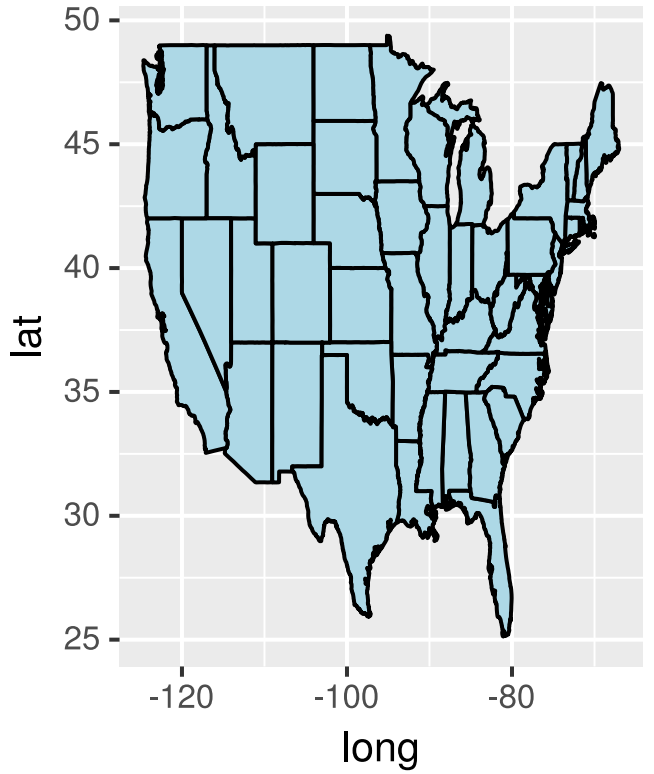
- latitude/longitude points for all map boundaries
- which boundary group all lat/long points belong
- the order to connect points within each group

Adding state-level information

- Add other geographic information by adding geometric layers to the plot
- Add non-geographic information by altering the fill color for each state
  - Use `geom = "polygon"` to treat states as solid shapes to add color
  - Incorporate numeric information using color shade or intensity
  - Incorporate categorical information using color hue

Why is scale so important in a map?

```
ggplot(states, aes(x=long, y=lat, group=group)) +
    geom_polygon(color="black", fill="lightblue") +
    coord_fixed(ratio=3)
```



Covid mapping

```
Rows: 51
Columns: 7
$ State                                  <chr> "Alabama", "Alaska", "Arizona",…
$ `7-day avg. cases`                     <int> 1, 12, 874, 621, 3, 512, 999, 2…
$ `7-day avg. deaths`                    <int> 11, 0, 0, 4, 27, 2, 0, 0, 0, 33…
$ Cases                                  <chr> "1,512,134", "271,895", "2,264,…
$ Deaths                                 <chr> "20,322", "1,306", "29,852", "1…
$ `7-day avg. hospitalizations`          <int> 68, 6, 128, 61, 562, 72, 85, 61…
$ `7-day avg. hospitalizations per 100k` <dbl> 1.0, 0.8, 1.0, 2.0, 1.0, 1.0, 2…
```

Source: https://usafacts.org/visualizations/coronavirus-covid-19-spread-map/

Combining datasets

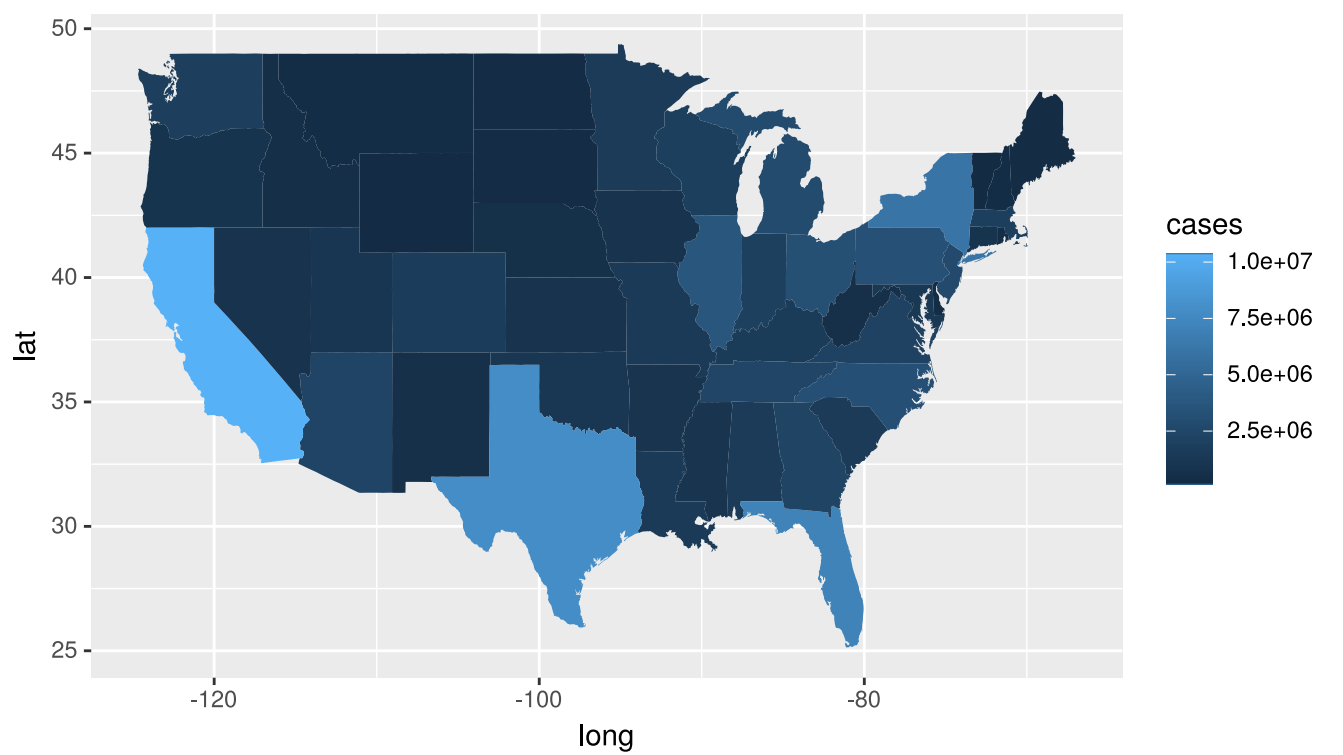
We need to add the covid info to the state polygon data set

```
states <- map_data("state")
covid_data <- left_join(states, covid_clean, by = c("region" = "state"))
```

```
# A tibble: 15,537 × 12
   long   lat group order region  subreg…¹ x7_da…² x7_da…³  cases deaths x7_da…⁴
  <dbl> <dbl> <dbl> <int> <chr>   <chr>      <int>   <int>  <dbl>  <dbl>   <int>
1 -87.5  30.4     1     1 alabama <NA>           1      11 1.51e6  20322      68
2 -87.5  30.4     1     2 alabama <NA>           1      11 1.51e6  20322      68
3 -87.5  30.4     1     3 alabama <NA>           1      11 1.51e6  20322      68
4 -87.5  30.3     1     4 alabama <NA>           1      11 1.51e6  20322      68
5 -87.6  30.3     1     5 alabama <NA>           1      11 1.51e6  20322      68
# … with 15,532 more rows, 1 more variable:
#   x7_day_avg_hospitalizations_per_100k <dbl>, and abbreviated variable names
#   ¹subregion, ²x7_day_avg_cases, ³x7_day_avg_deaths,
#   ⁴x7_day_avg_hospitalizations
```

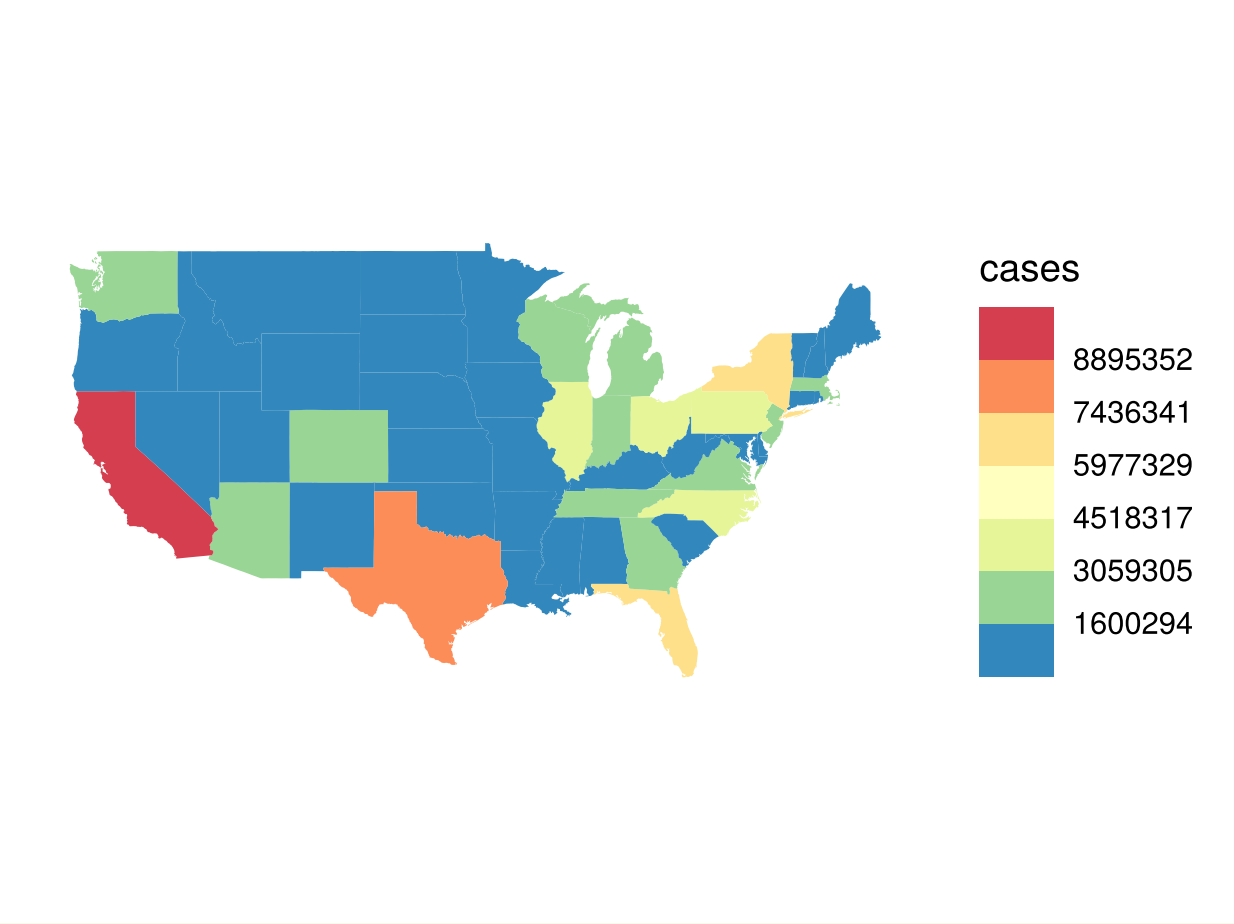
COVID Cases

```
Covid_cases_map <- ggplot(covid_data) +
  geom_polygon(aes(long, lat, group = group, fill = cases))
Covid_cases_map
```



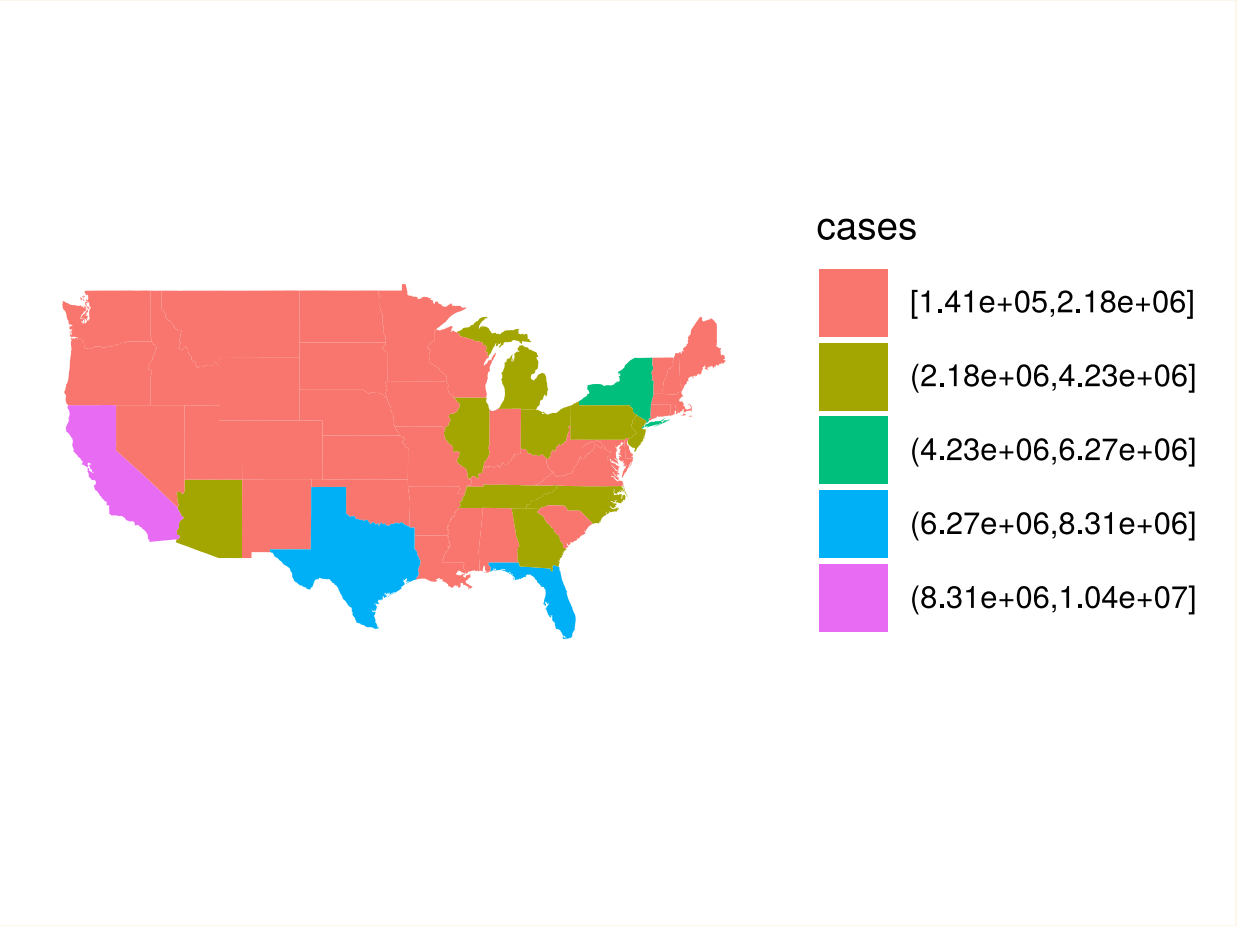
Adjusting the coordinate system + theme + scale + breaks

Plot Code



Adjusting the color: alternate way

Plot Code



Cloropleth maps

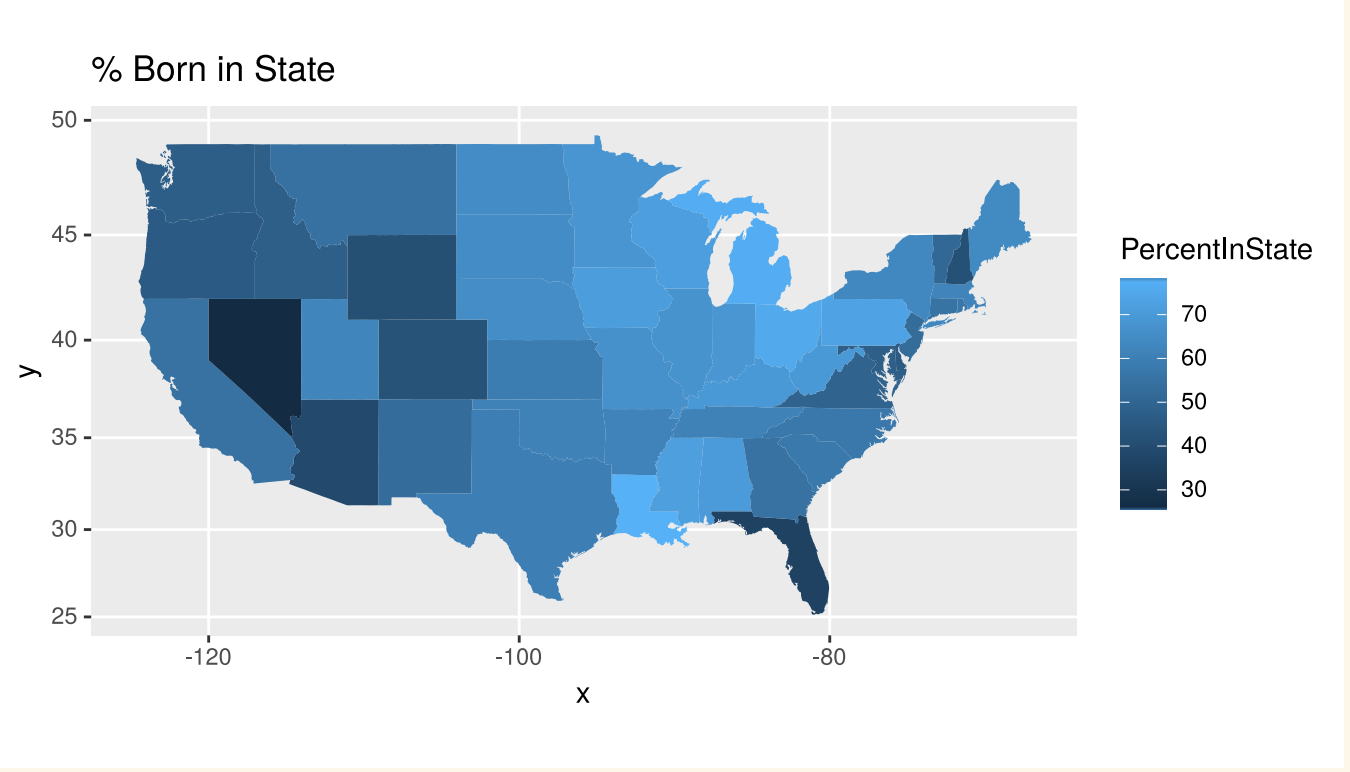
- Uses color or shading of subregions to visual data
- Displays divided geographical areas or regions that are coloured in relation to a numeric variable.

```
ACS <- read.csv("https://raw.githubusercontent.com/deepbas/statdatasets/main/ACS.csv")
ACS <- dplyr::filter(ACS, !(region  %in% c("Alaska", "Hawaii"))) # only 48+D.C.
ACS$region <- tolower(ACS$region)  # lower case (match states regions)
glimpse(ACS)
Rows: 49
Columns: 8
$ X              <int> 1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18,…
$ region         <chr> "alabama", "arizona", "arkansas", "californ…
$ PopSize        <int> 4841164, 6728577, 2968472, 38654206, 5359295, 3588570, …
$ MedianAge      <dbl> 38.6, 37.1, 37.7, 36.0, 36.4, 40.6, 39.6, 33.8, 41.6, 3…
$ PercentFemale  <dbl> 51.5, 50.3, 50.9, 50.3, 49.8, 51.2, 51.6, 52.6, 51.1, 5…
$ BornInState    <int> 3387845, 2623391, 1823628, 21194542, 2294446, 1981427, …
$ MedianIncome   <int> 23527, 26565, 22787, 27772, 31325, 34124, 30648, 41160,…
$ PercentInState <dbl> 69.98, 38.99, 61.43, 54.83, 42.81, 55.21, 45.49, 36.72,…
```

Choropleth maps using geom_map

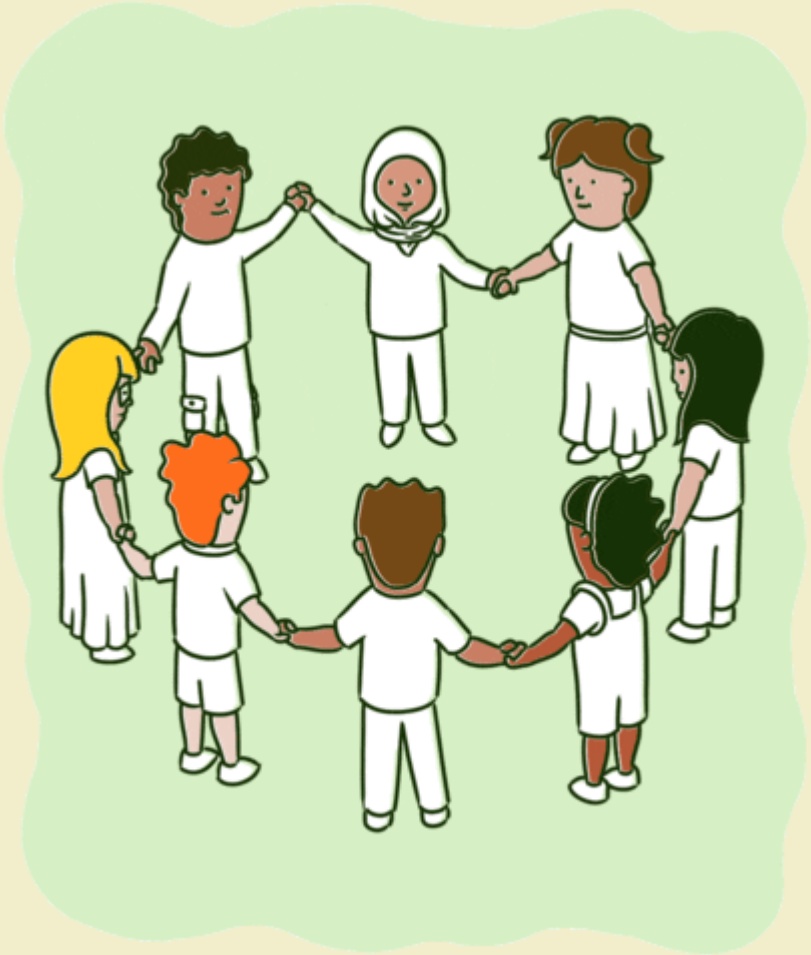
- Don't need to merge `ACS` and `states` data!

```
ggplot(data=ACS) + coord_map() +
  geom_map(aes(map_id = region, fill = PercentInState), map = states) +
  expand_limits(x=states$long, y=states$lat) + ggtitle("% Born in State")
```



Group Activity 3

10:00



- Please work on the problem 3
- Ask me questions
- Any other hw questions?