

Week 12: *Maps*

☰ EMSE 4575: Exploratory Data Analysis

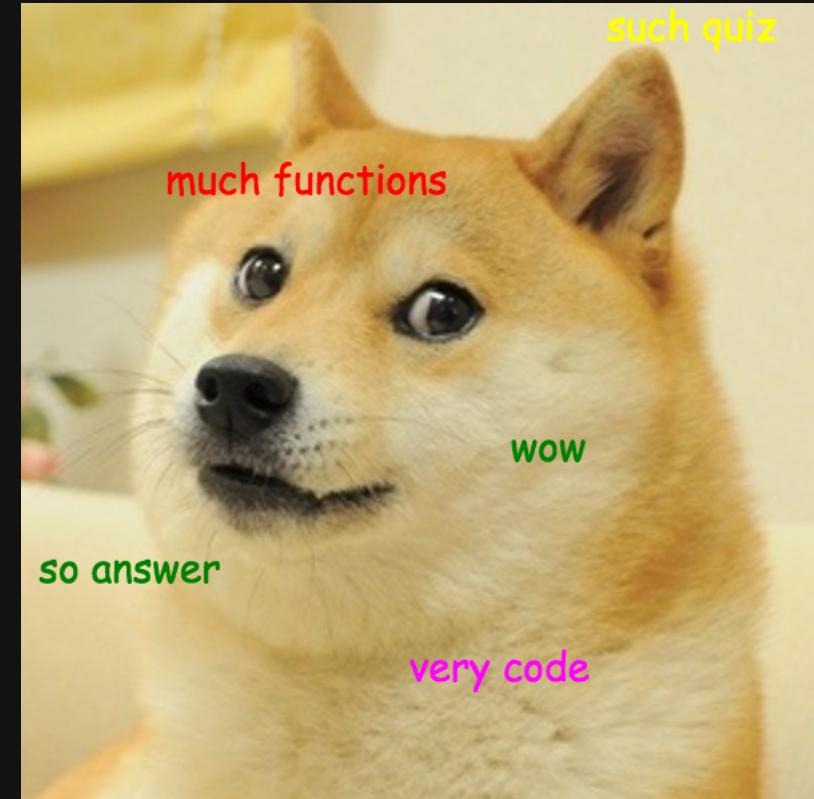
👤 John Paul Helveston

📅 March 31, 2021

Quiz 4

Link is on the [schedule](#)

10 : 00



Today's data

```
milk_production <- read_csv(here::here('data', 'milk_production.csv'))  
us_coffee_shops <- read_csv(here::here('data', 'us_coffee_shops.csv'))
```

New packages:

```
install.packages('maps')  
install.packages('mapproj')  
install.packages('sf')  
install.packages('rgeos')  
install.packages('rnaturalearth')  
devtools::install_github("ropensci/rnaturalearthhires")  
devtools::install_github("ropensci/rnaturalearthdata")
```

Week 12: *Maps*

1. Plotting maps
2. Adding data to maps

BREAK

3. Projections

Week 12: *Maps*

1. Plotting maps
2. Adding data to maps

BREAK

3. Projections

How to make a map

Step 1: Load a shape file

- a. Use a library
- b. Read in a shape file

Step 2: Plot the shape file

- a. Polygon data: `geom_polygon()`
- b. Simple Features data: `geom_sf()`

Polygon maps

Get the "World" shape file

```
library(ggplot2)  
world <- map_data("world")  
head(world)
```

```
#>      long      lat group order region subregion  
#> 1 -69.89912 12.45200     1     1 Aruba    <NA>  
#> 2 -69.89571 12.42300     1     2 Aruba    <NA>  
#> 3 -69.94219 12.43853     1     3 Aruba    <NA>  
#> 4 -70.00415 12.50049     1     4 Aruba    <NA>  
#> 5 -70.06612 12.54697     1     5 Aruba    <NA>  
#> 6 -70.05088 12.59707     1     6 Aruba    <NA>
```

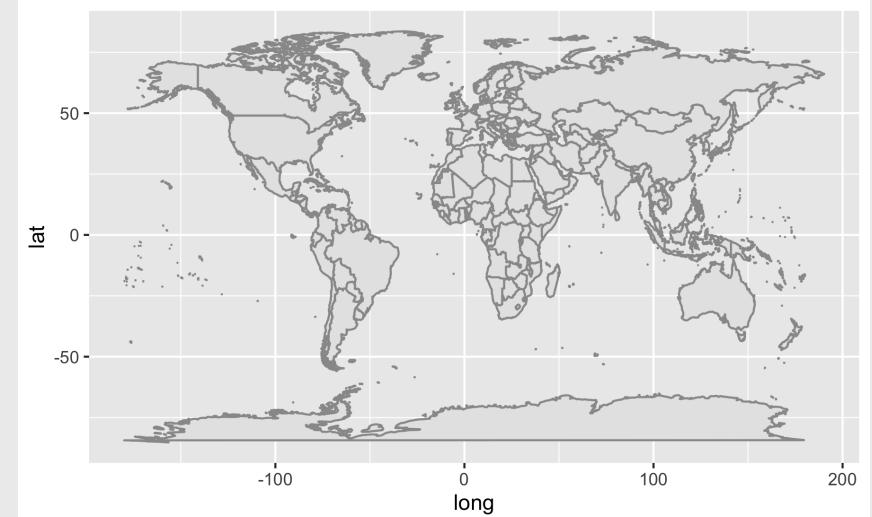
Polygon maps

Get the "World" shape file

```
library(ggplot2)  
world <- map_data("world")
```

Make the plot with `geom_polygon()`

```
ggplot(world) +  
  geom_polygon(aes(x = long, y = lat, group = group),  
               fill = "grey90", color = "grey60")
```



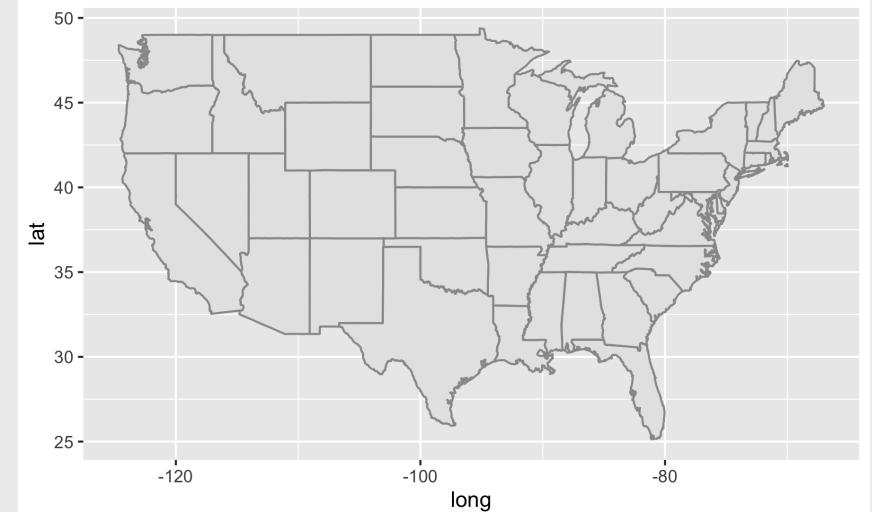
Polygon maps

Get the "US States" shape file

```
library(ggplot2)  
us_states <- map_data("state")
```

Make the plot with `geom_polygon()`

```
ggplot(us_states) +  
  geom_polygon(aes(x = long, y = lat, group = group),  
               fill = "grey90", color = "grey60")
```



Simple Features (sf) maps

Library data from Natural Earth

```
library(rnaturalearth)
library(rnaturalearthdata)

world <- ne_countries(
  scale = "medium",
  returnclass = "sf")

world %>%
  select(name, geometry) %>%
  head()
```

```
#> Simple feature collection with 6 features and 1 field
#> Geometry type: MULTIPOLYGON
#> Dimension:     XY
#> Bounding box: xmin: -73.36621 ymin: -22.40205 xmax: 180.0 ymax: 55.9636
#> CRS:           +proj=longlat +datum=WGS84 +no_defs +ellps=WGS84 +towgs84=0,0,0
#>
#>   name               geometry
#> 0  Zimbabwe MULTIPOLYGON (((31.28789 -2...
#> 1  Zambia  MULTIPOLYGON (((30.39609 -1...
#> 2  Yemen   MULTIPOLYGON (((53.08564 16...
#> 3  Vietnam  MULTIPOLYGON (((104.064 10...
#> 4  Venezuela MULTIPOLYGON ((((-60.82119 9...
#> 5  Vatican  MULTIPOLYGON (((12.43916 41...
```

Simple Features (sf) maps

Get the "World" shape file

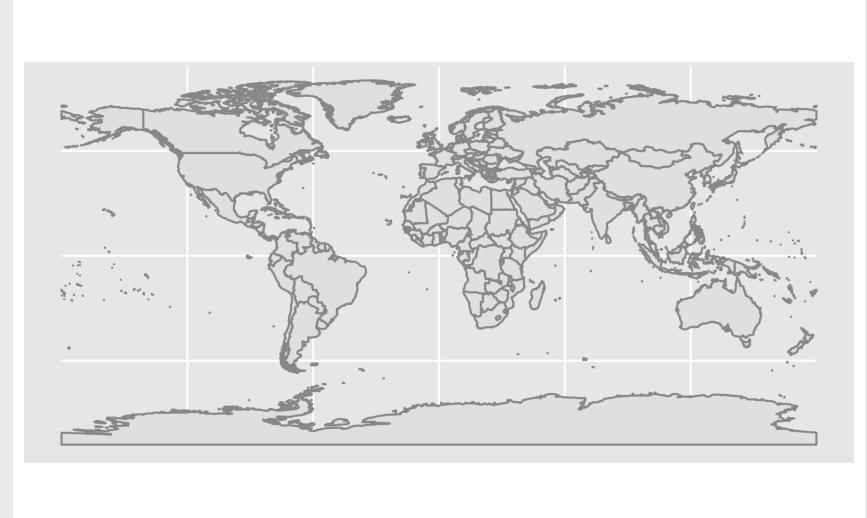
```
library(rnaturalearth)
library(rnaturalearthdata)

world <- ne_countries(
  scale = "medium",
  returnclass = "sf")
```

Make the plot with `geom_sf()`

```
library(sf)

ggplot(data = world) +
  geom_sf(fill = "grey90", color = "grey60")
```



Simple Features (sf) maps

Get the "US States" shape file

```
library(rnaturalearth)
library(rnaturalearthdata)

us_states <- ne_states(
  country = 'united states of america',
  returnclass = 'sf')
```

Simple Features (sf) maps

Get the "US States" shape file

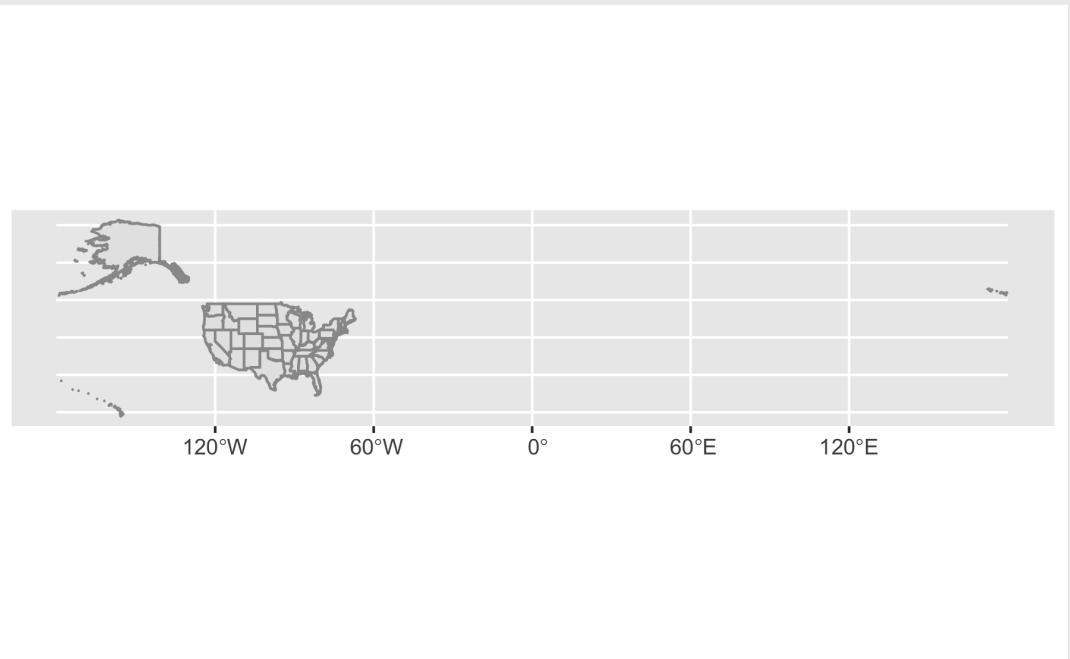
```
library(rnaturalearth)
library(rnaturalearthdata)

us_states <- ne_states(
  country = 'united states of america',
  returnclass = 'sf')
```

Make the plot with `geom_sf()`

```
library(sf)

ggplot(data = us_states) +
  geom_sf(fill = "grey90", color = "grey60")
```



Simple Features (sf) maps

Get the **Continental** "US States" shape file

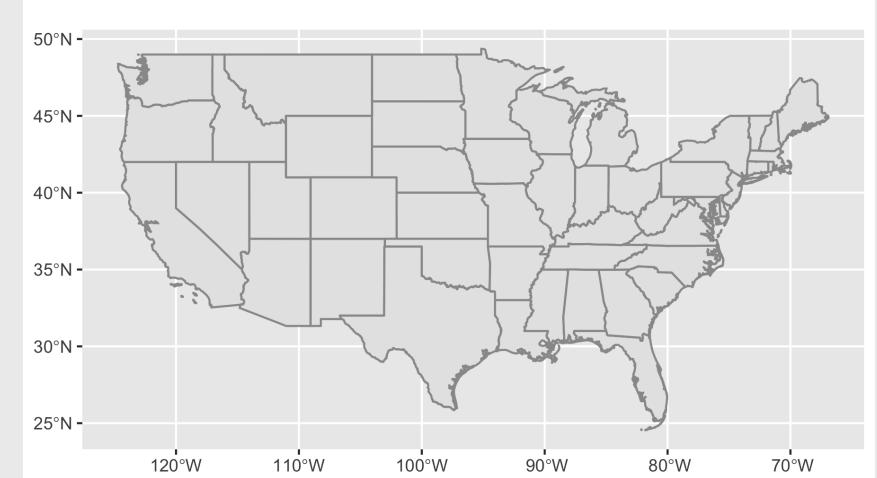
```
library(rnaturalearth)
library(rnaturalearthdata)

us_states_cont <- ne_states(
  country = 'united states of america',
  returnclass = 'sf') %>%
  filter(! name %in% c('Alaska', 'Hawaii'))
```

Make the plot with `geom_sf()`

```
library(sf)

ggplot(data = us_states_cont) +
  geom_sf(fill = "grey90", color = "grey60")
```



The `maps` package

Includes data on:

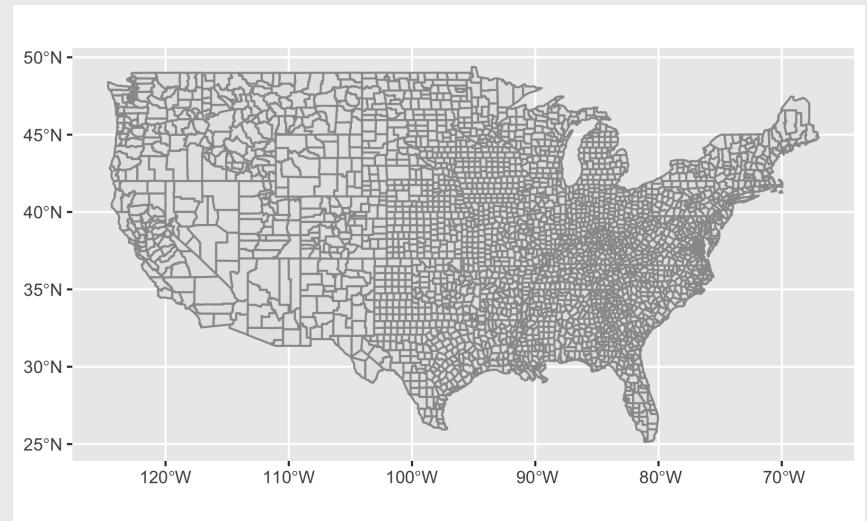
- World: world, world.cities, lakes
- US: states, county, state, usa
- France: france
- Italy: italy
- New Zealand: nz

Example:

```
library(maps)

us_counties <- st_as_sf(
  map("county", plot = FALSE, fill = TRUE))

ggplot(data = us_counties) +
  geom_sf(fill = 'grey90', color = 'grey60')
```



Simple Features (sf) maps: `st_read()`

Read in the "World" shape file from [Natural Earth](#)

```
library(sf)  
  
world <- st_read(here::here(  
  'data', 'natural_earth_countries',  
  'ne_50m_admin_0_countries.shp')) %>%  
  clean_names()
```

```
#> Reading layer `ne_50m_admin_0_countries' from data source  
#> Simple feature collection with 241 features and 94 fields  
#> Geometry type: MULTIPOLYGON  
#> Dimension:     XY  
#> Bounding box: xmin: -180 ymin: -89.99893 xmax: 180 ymax: 55.71291  
#> Geodetic CRS:  WGS 84
```

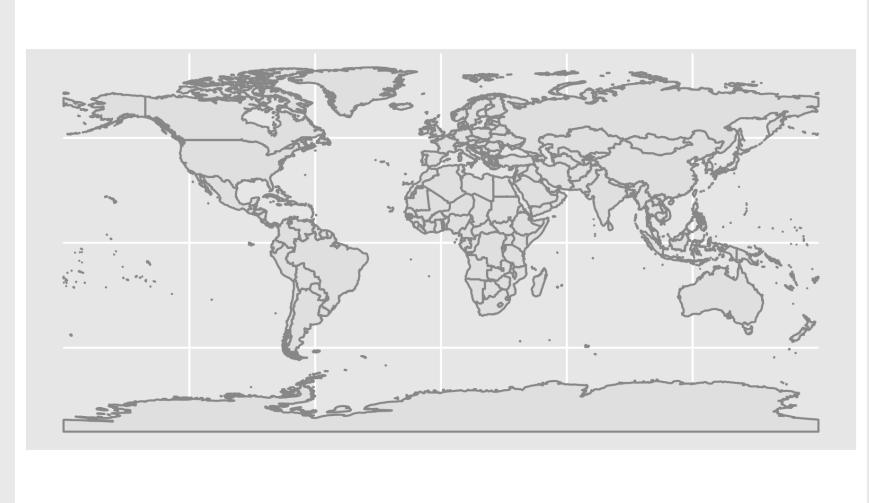
Simple Features (sf) maps: `st_read()`

Read in the "World" shape file

```
library(sf)  
  
world <- st_read(here::here(  
  'data', 'natural_earth_countries',  
  'ne_50m_admin_0_countries.shp')) %>%  
  clean_names()
```

```
#> Reading layer `ne_50m_admin_0_countries' from data source  
#> Simple feature collection with 241 features and 94 fields  
#> Geometry type: MULTIPOLYGON  
#> Dimension:     XY  
#> Bounding box: xmin: -180 ymin: -89.99893 xmax: 180 ymax: 80.00000  
#> Geodetic CRS:  WGS 84
```

```
ggplot(data = world) +  
  geom_sf(fill = "grey90", color = "grey60")
```



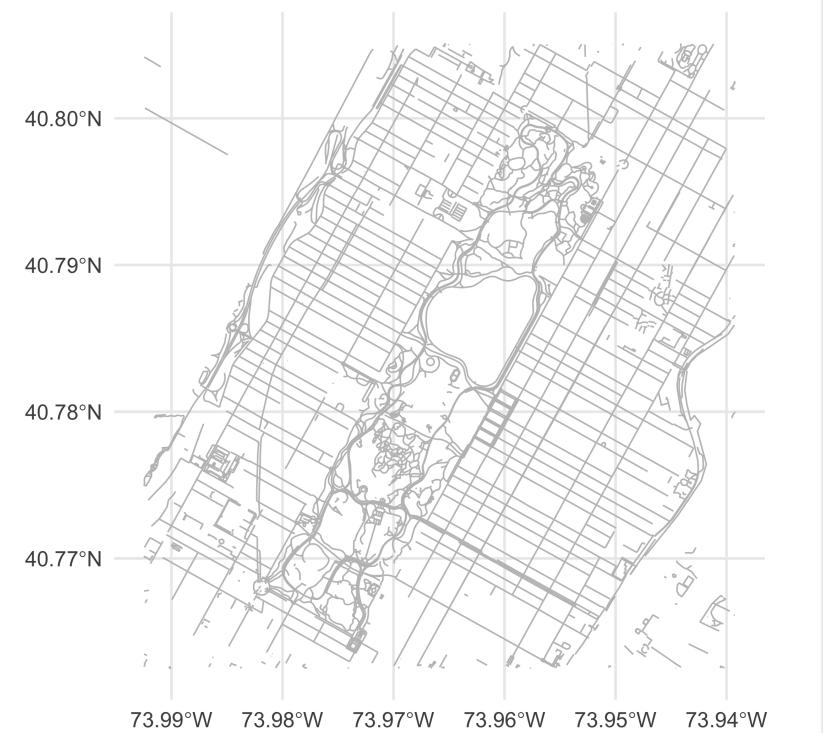
Simple Features (sf) maps: `st_read()`

Read in the "Central Park" shape file [\[source\]](#)

```
library(sf)  
  
central_park <- st_read(here::here(  
  'data', 'central_park', 'CentralPark.shp'))
```

```
#> Reading layer `CentralPark' from data source `/Users/...'  
#> Simple feature collection with 2550 features and 6 fields  
#> Geometry type: LINESTRING  
#> Dimension:     XY  
#> Bounding box: xmin: -73.99249 ymin: 40.7625 xmax: -73.  
#> Geodetic CRS:  WGS 84
```

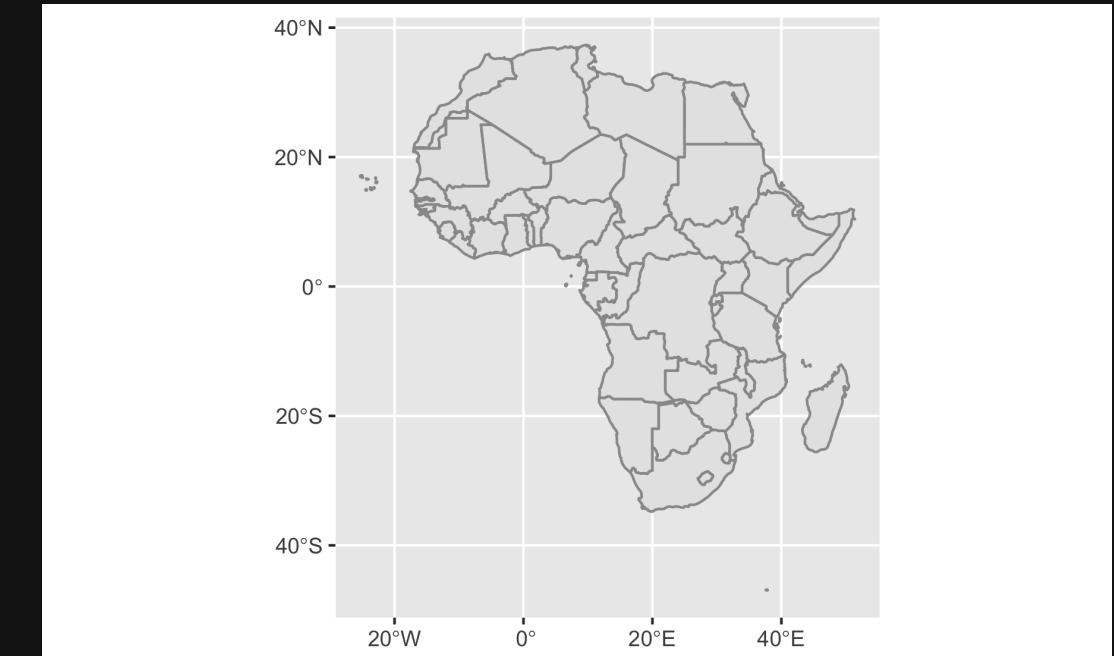
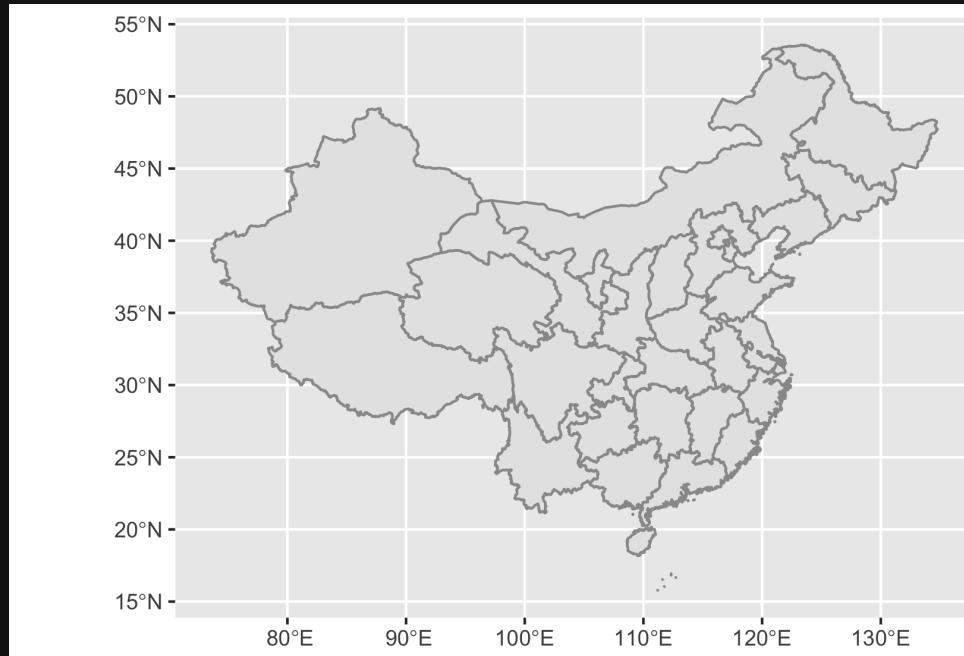
```
ggplot(data = central_park) +  
  geom_sf(color = 'grey75')
```



10:00

Your turn

Use the **rnatuearth** library to extract and plot the shape files for China and Africa:



Week 12: *Maps*

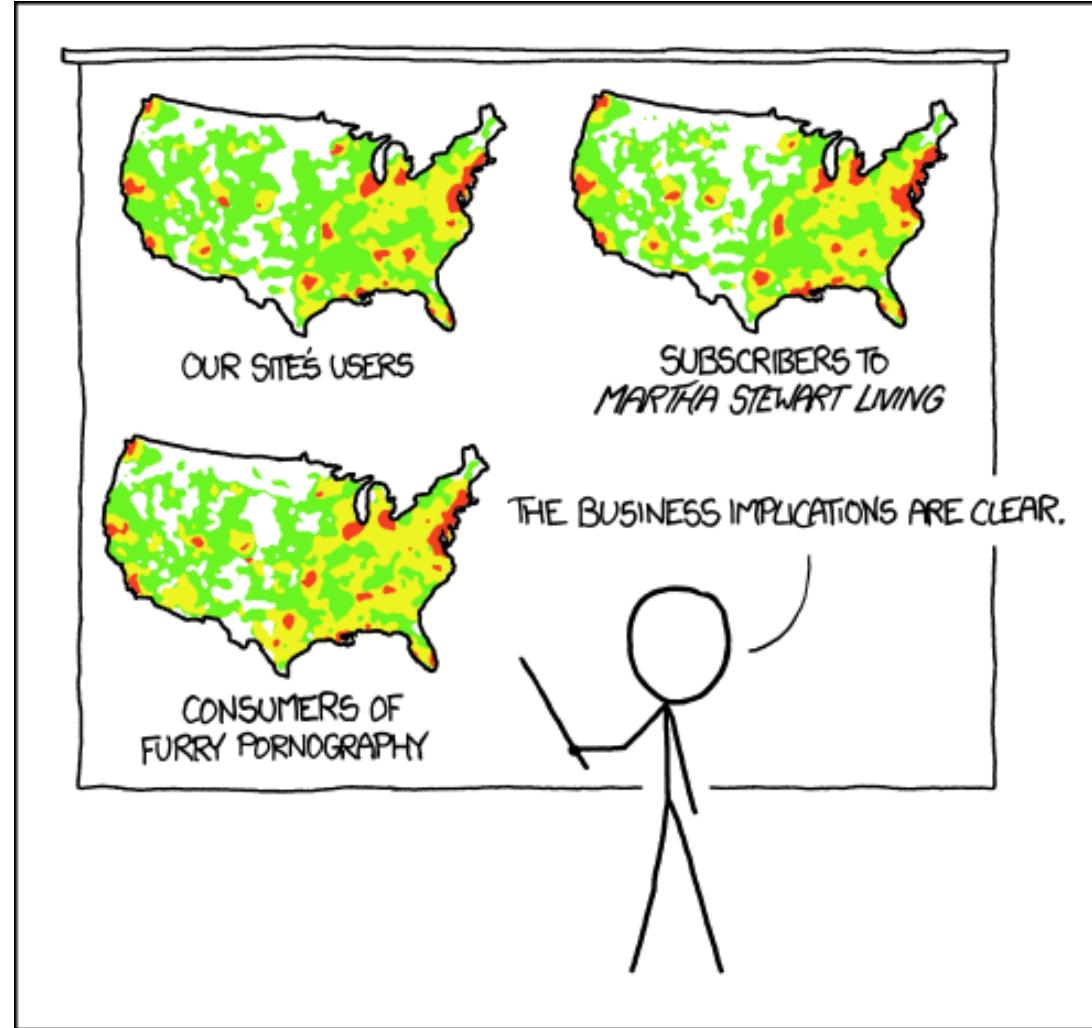
1. Plotting maps
2. Adding data to maps

BREAK

3. Projections

First rule of adding data to maps:

Do you need to make a map?

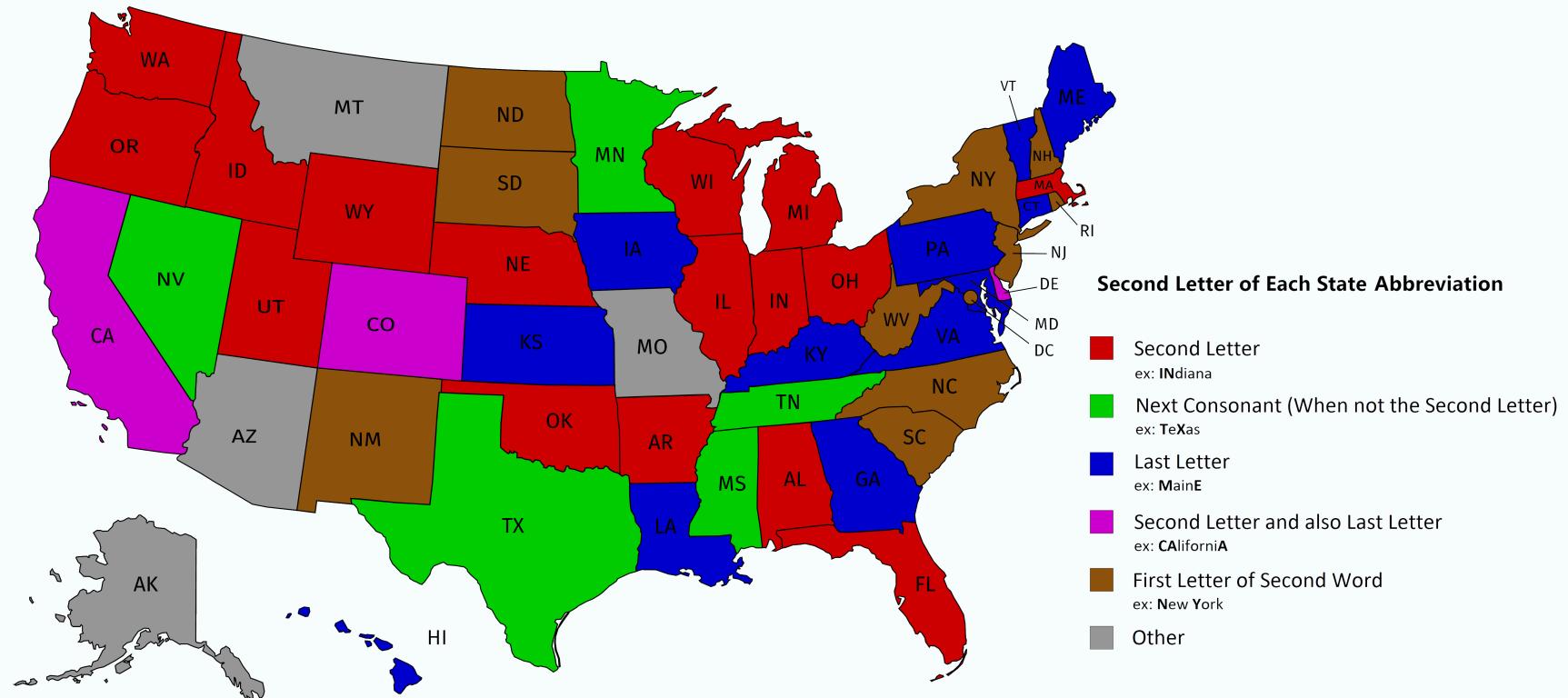


PET PEEVE #208:
GEOGRAPHIC PROFILE MAPS WHICH ARE
BASICALLY JUST POPULATION MAPS

1. Choropleth maps
2. Point maps

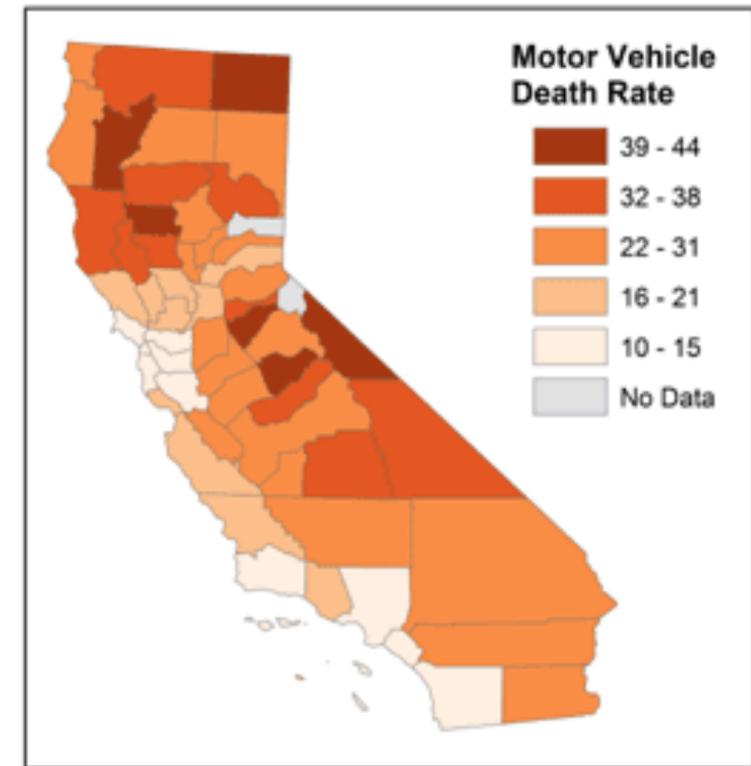
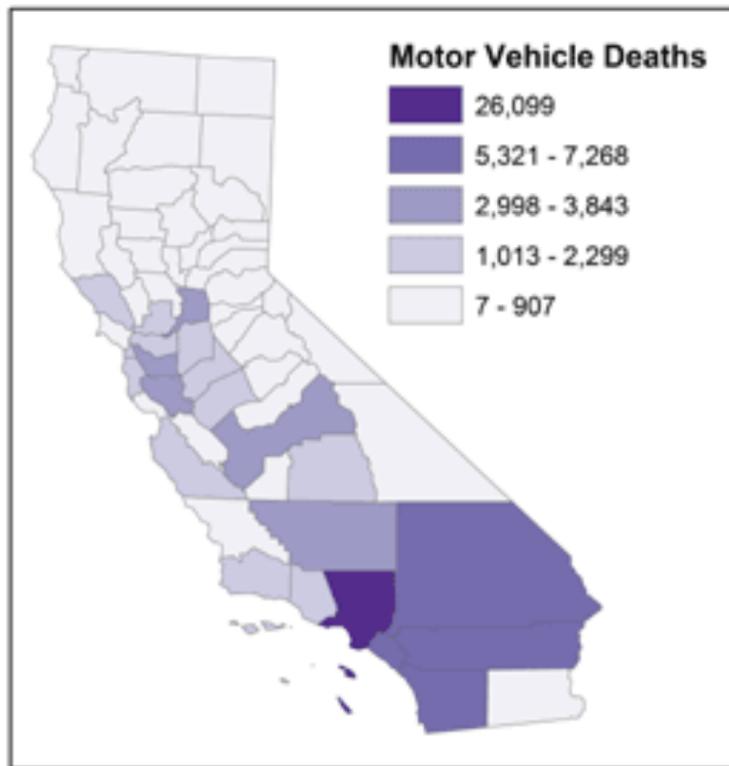
Choropleth - from Greek:

- χῶρος "choros" (area/region)
- πλῆθος "plethos" (multitude)



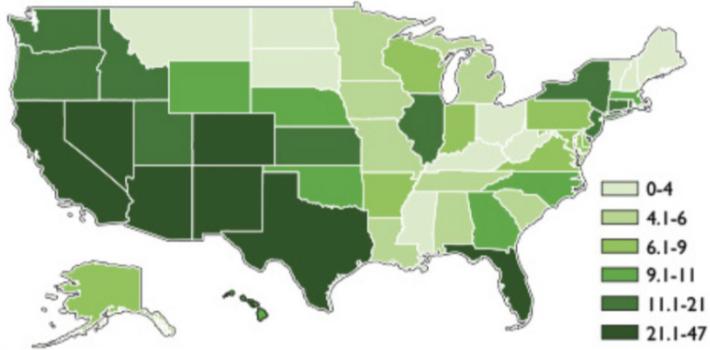
Choropleth maps are easily misleading

Number of events != Number of events **per capita**

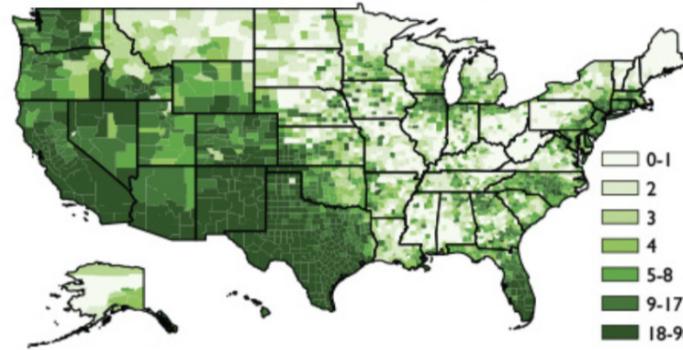


Manipulating fill scale produces wildly different maps

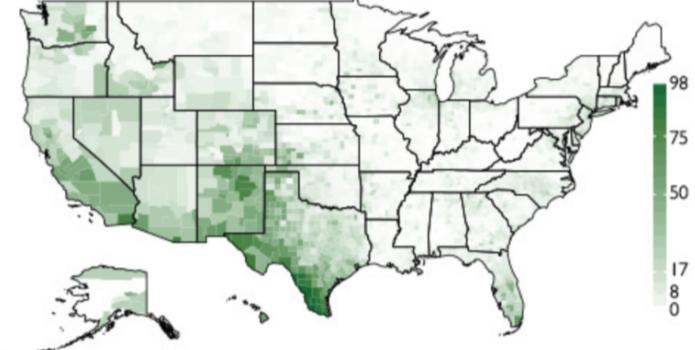
Hispanic population (%)



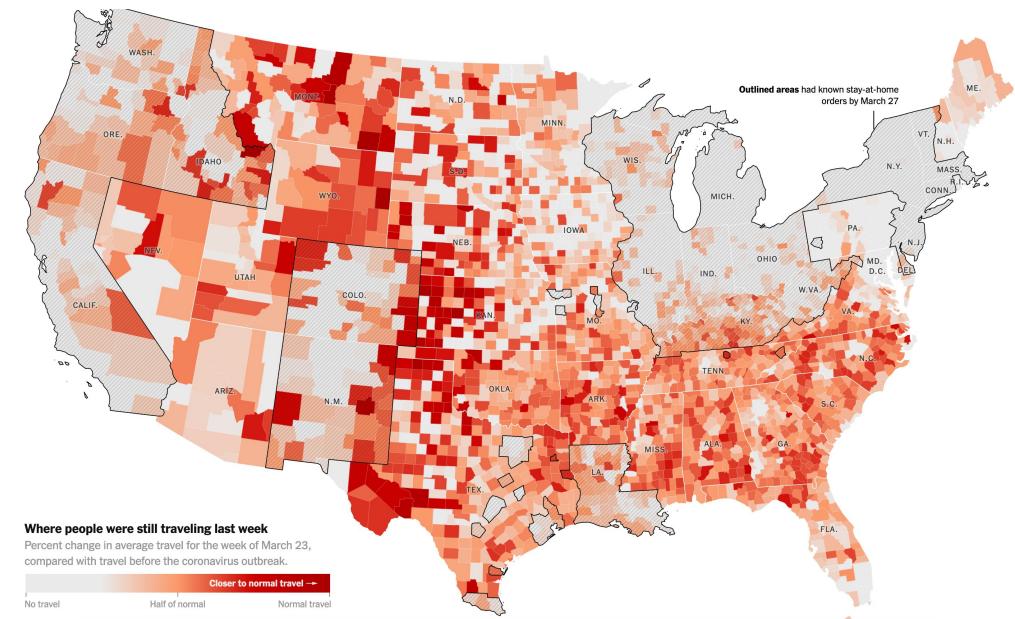
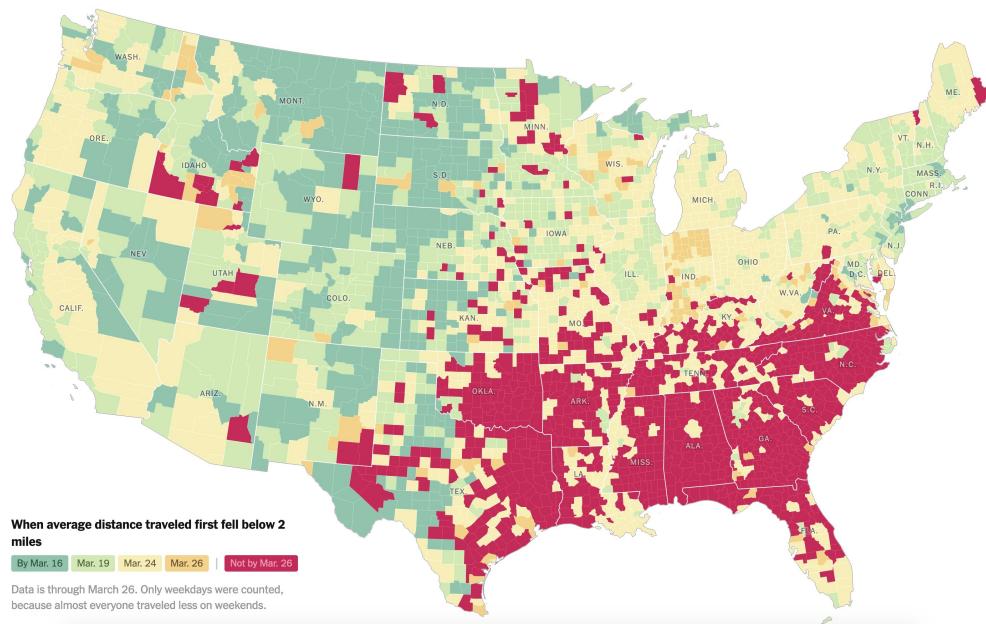
Hispanic population (%)



Hispanic population (%)

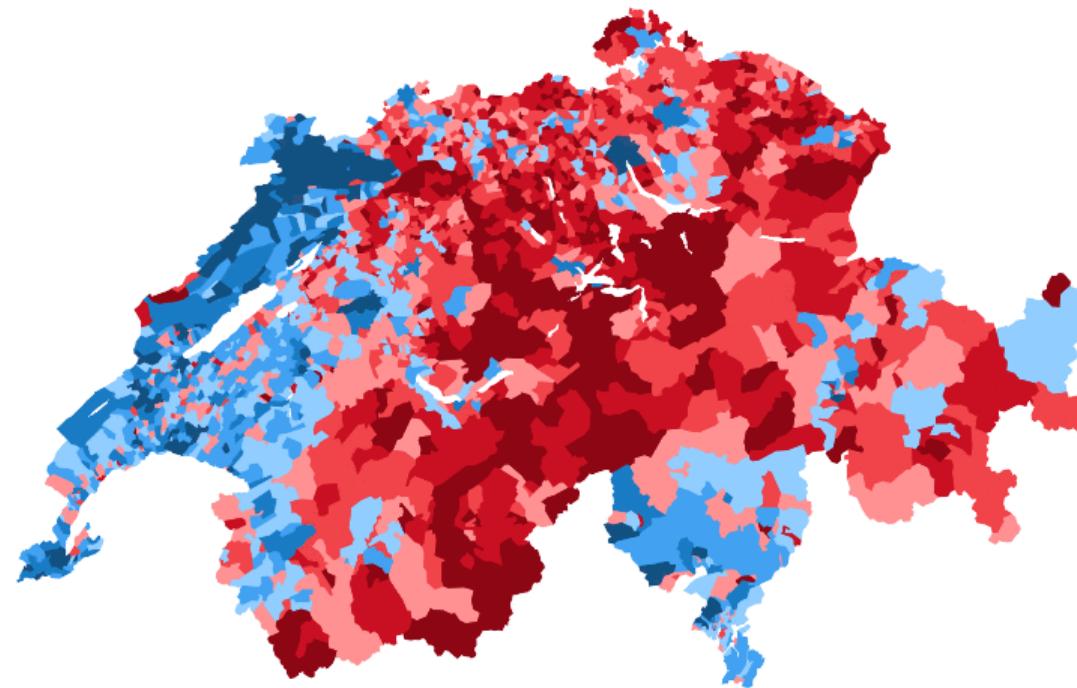


Manipulating fill scale produces wildly different maps



Source: [New York Times](#)

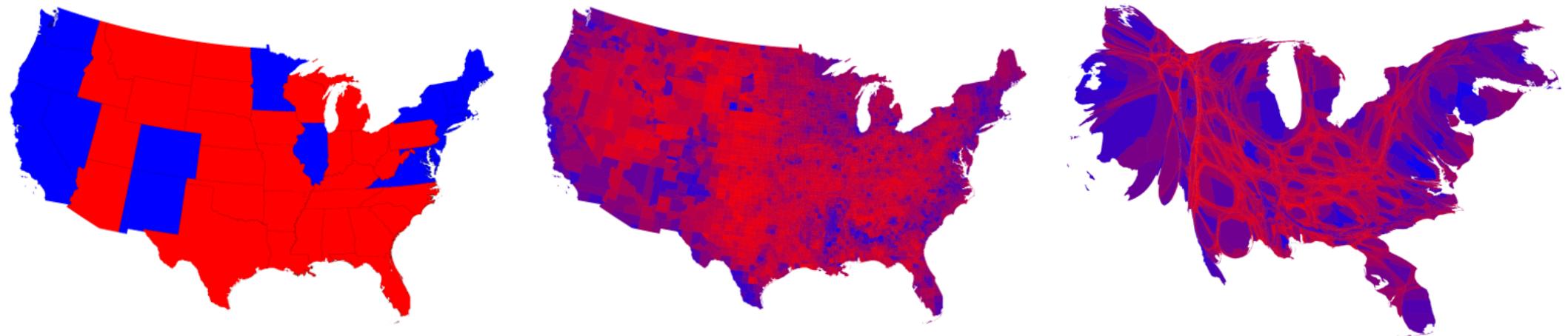
Land doesn't vote - people vote



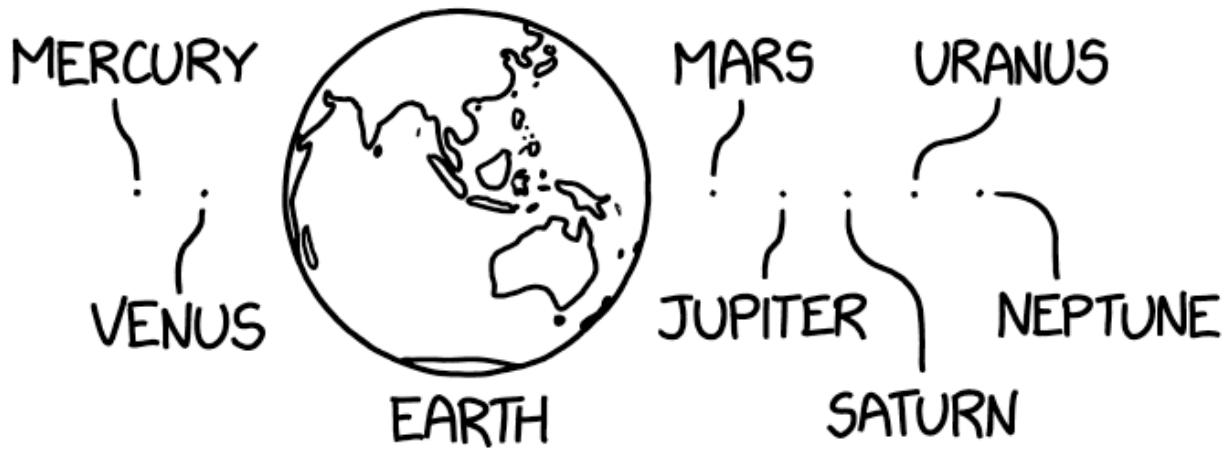
By [David Zumbach](#)

Land doesn't vote - people vote

Election maps from: <http://www-personal.umich.edu/~mejn/election/2016/>



MOST SOLAR SYSTEM DIAGRAMS ARE MISLEADING.
THIS CHART OFFERS A MORE ACCURATE VIEW BY
SHOWING THE PLANETS SIZED BY POPULATION.



<https://xkcd.com/2439/>

Easy to lie with fake news

2016 ELECTION MAP:

REPUBLICAN
DEMOCRAT



GOVERNMENT RELEASED
CRIME MAP OF 2013:

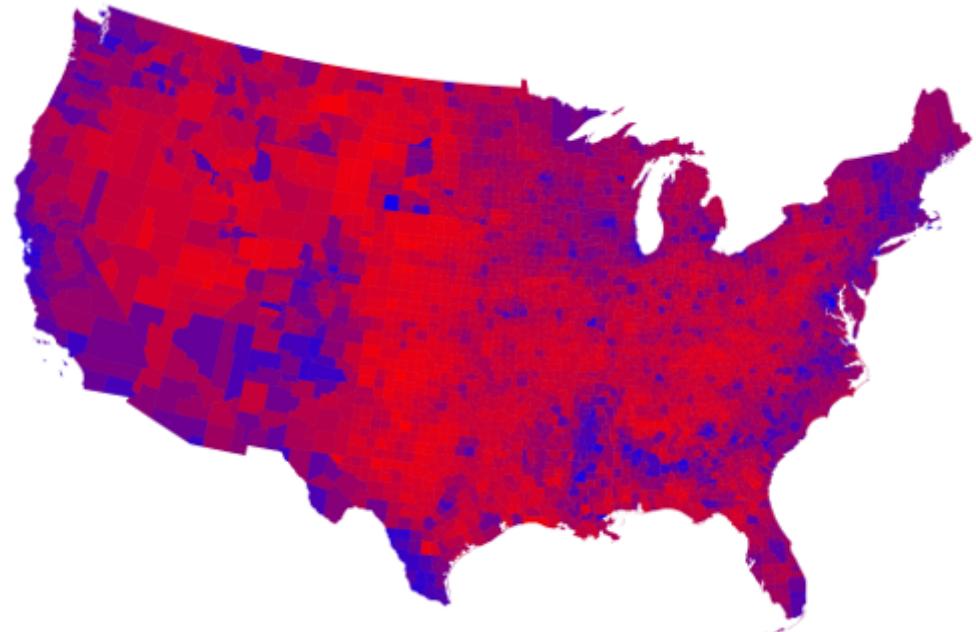
LOWER CRIME RATES
HIGHER CRIME RATES



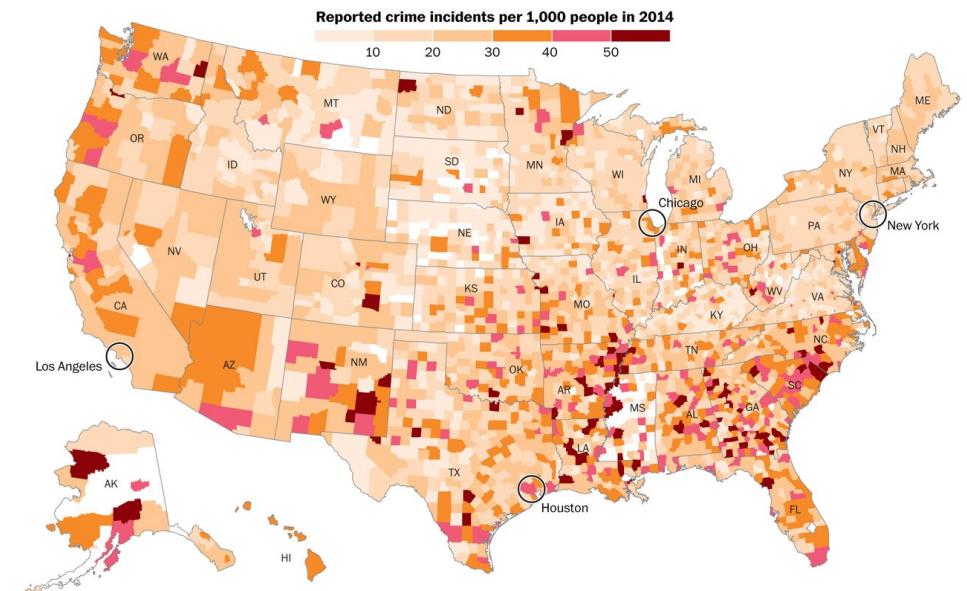
Bottom map is actually [this map](#) of the 2012 election

(here is what actual crime rates look like)

2016 Election map [\[source\]](#)

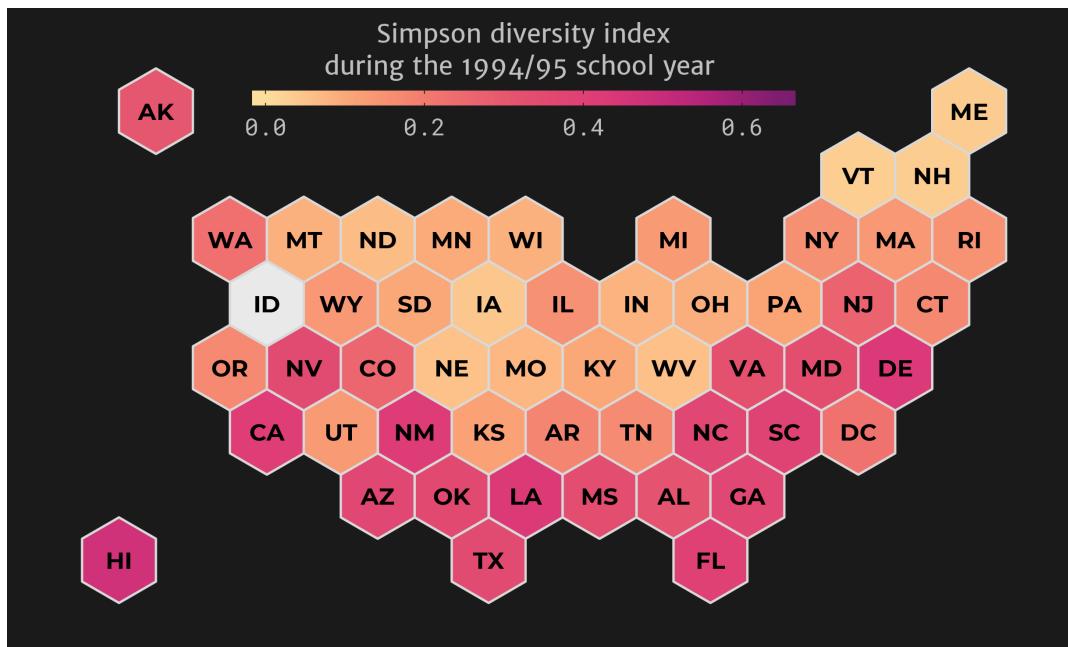


2014 Crime map [\[source\]](#)



A choropleth alternative: hex maps

1994 Simpson Diversity Index in US Schools

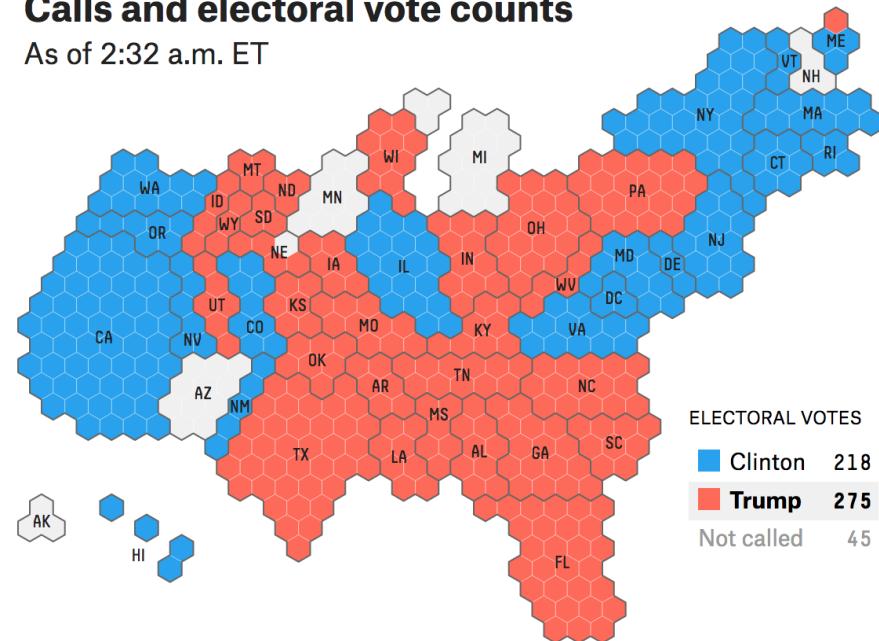


https://github.com/malcolmbarrett/designing_ggplots

2016 Electoral College

Calls and electoral vote counts

As of 2:32 a.m. ET



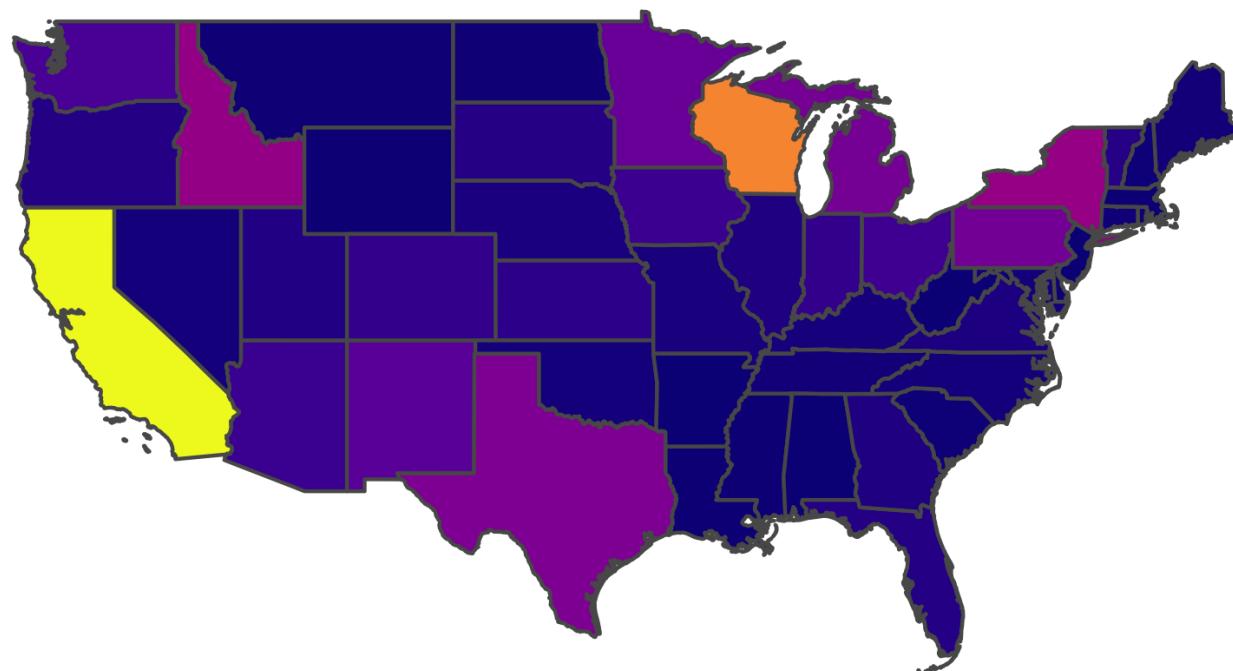
FIVETHIRTYEIGHT

SOURCE: ABC NEWS, AP

<https://fivethirtyeight.com/>

How to make a choropleth map

Milk Production by State in 2017



Milk produced
(billions lbs)

0	10	20	30	40
---	----	----	----	----

How to make a choropleth map

Get the "fill" data

```
milk_2017 <- milk_production %>%
  filter(year == 2017) %>%
  select(name = state, milk_produced) %>%
  mutate(milk_produced = milk_produced / 10^9)
```

Get the "map" data

```
us_states <- ne_states(
  country = 'united states of america',
  returnclass = 'sf') %>%
  filter(! name %in% c('Alaska', 'Hawaii')) %>%
  left_join(milk_2017, by = 'name')
```

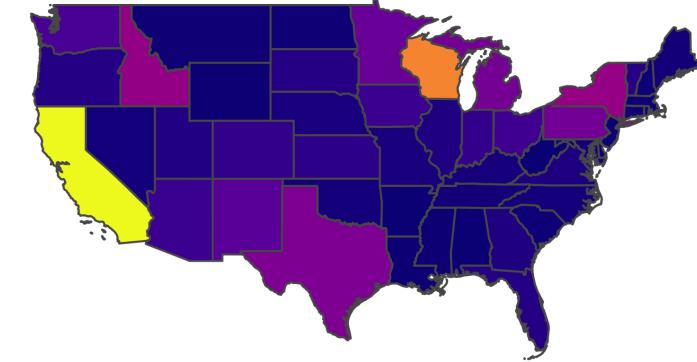
```
us_states %>%
  select(name, milk_produced) %>%
  head()
```

```
#> Simple feature collection with 6 features
#> Geometry type: MULTIPOLYGON
#> Dimension:      XY
#> Bounding box:   xmin: -124.7346 ymin: 33.8741
#>                         xmax: -66.9415 ymax: 49.3858
#> CRS:             +proj=longlat +datum=NAD83
#>                   name milk_produced
#> 1      Minnesota      9.864 MULTIPOLYGON
#> 2      Washington     6.526 MULTIPOLYGON
#> 3          Idaho     14.627 MULTIPOLYGON
#> 4      Montana      0.288 MULTIPOLYGON
#> 5 North Dakota     0.345 MULTIPOLYGON
#> 6      Michigan    11.231 MULTIPOLYGON
```

How to make a choropleth map

```
ggplot(us_states) +  
  geom_sf(aes(fill = milk_produced)) +  
  scale_fill_viridis(  
    option = "plasma",  
    limits = c(0, 40)) +  
  theme_void(base_size = 15) +  
  theme(legend.position = 'bottom') +  
  labs(fill = 'Milk produced\n(billions lbs)',  
       title = 'Milk Production by State in 2017')
```

Milk Production by State in 2017

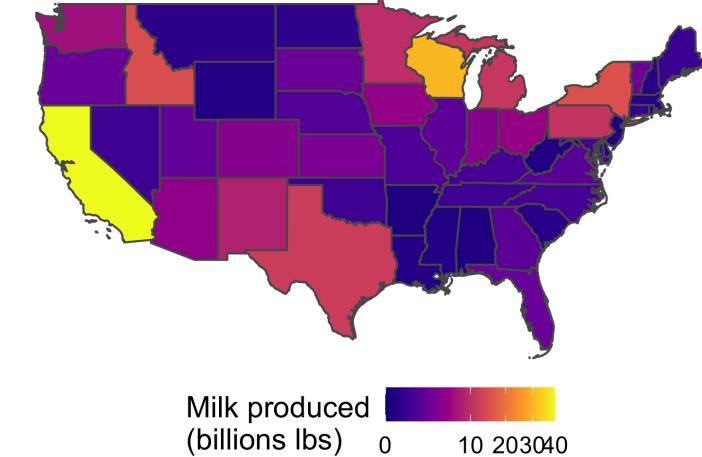


How to make a choropleth map

```
ggplot(us_states) +  
  geom_sf(aes(fill = milk_produced)) +  
  scale_fill_viridis(  
    trans = 'sqrt',  
    option = "plasma",  
    limits = c(0, 40)) +  
  theme_void(base_size = 15) +  
  theme(legend.position = 'bottom') +  
  labs(fill = 'Milk produced\n(billions lbs)',  
       title = 'Milk Production by State in 2017')
```

Non-linear scale:

Milk Production by State in 2017

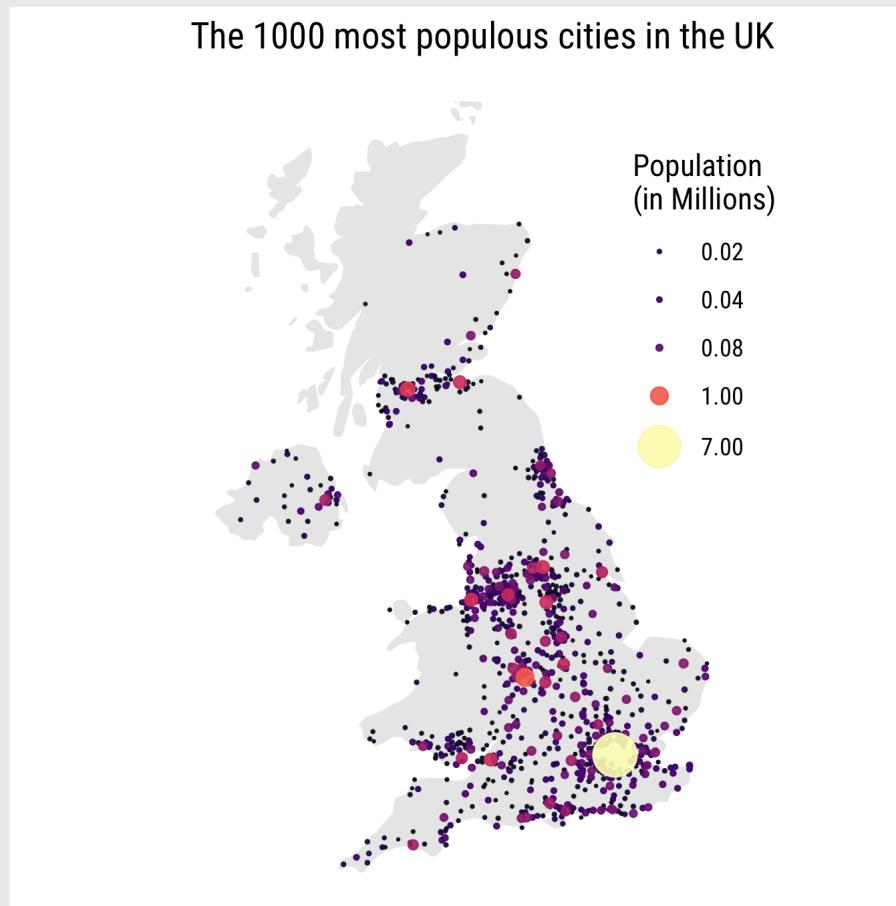


1. Choropleth maps
2. Point maps

Points as locations



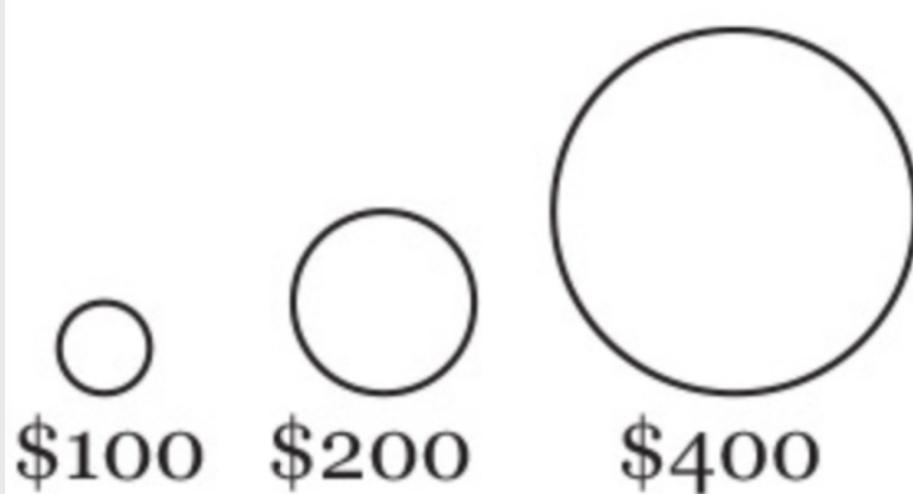
Points encoding a variable



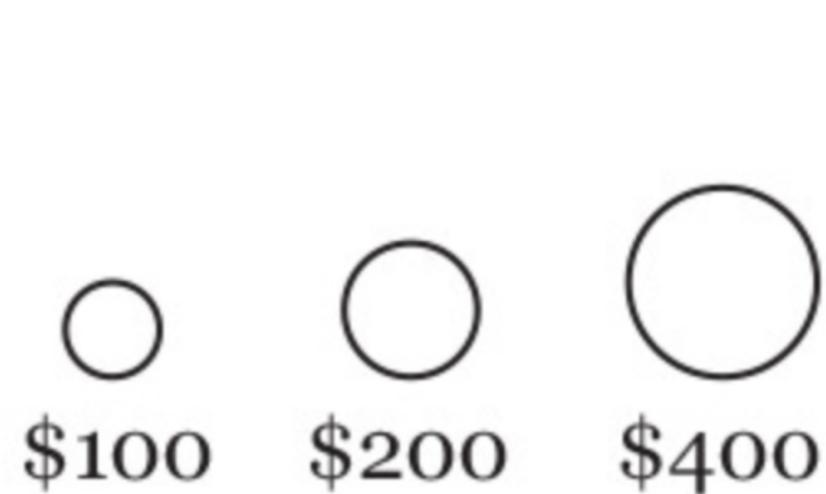
For point size, use **area**, not radius

$$Area = \pi r^2$$

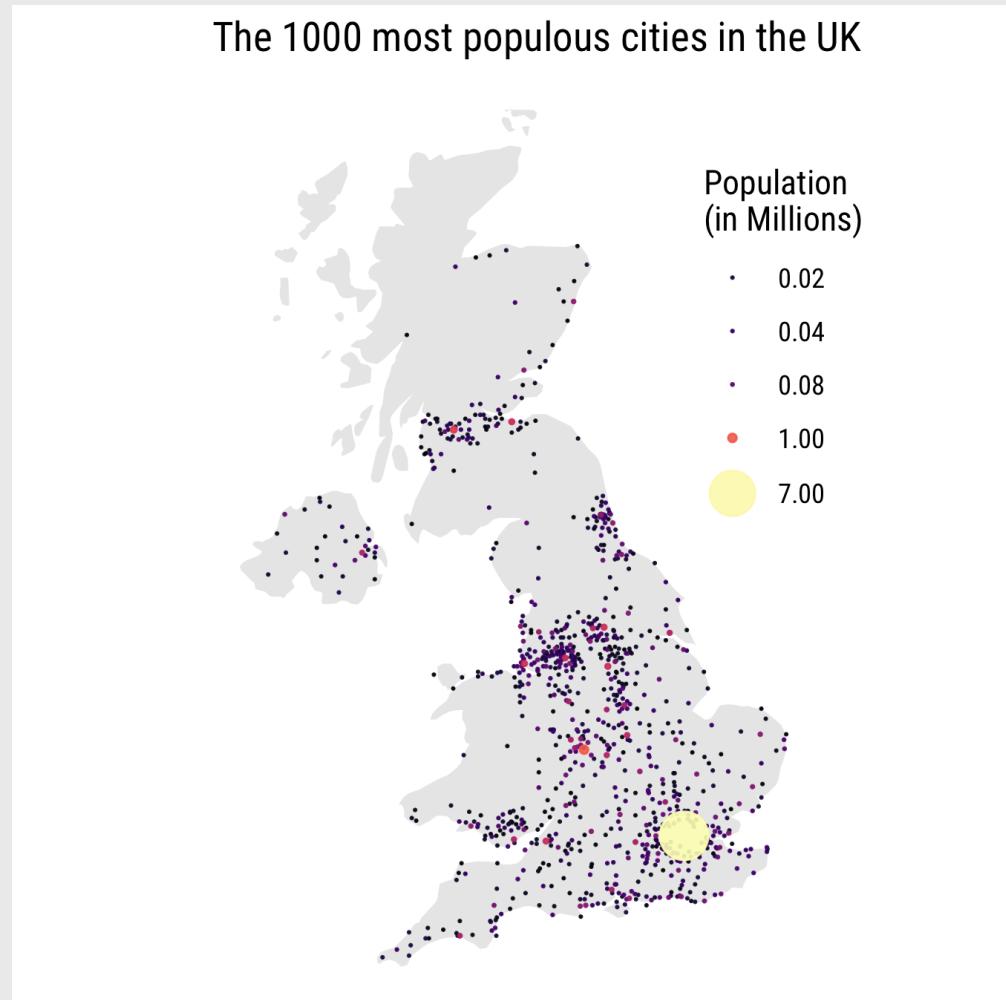
Radius



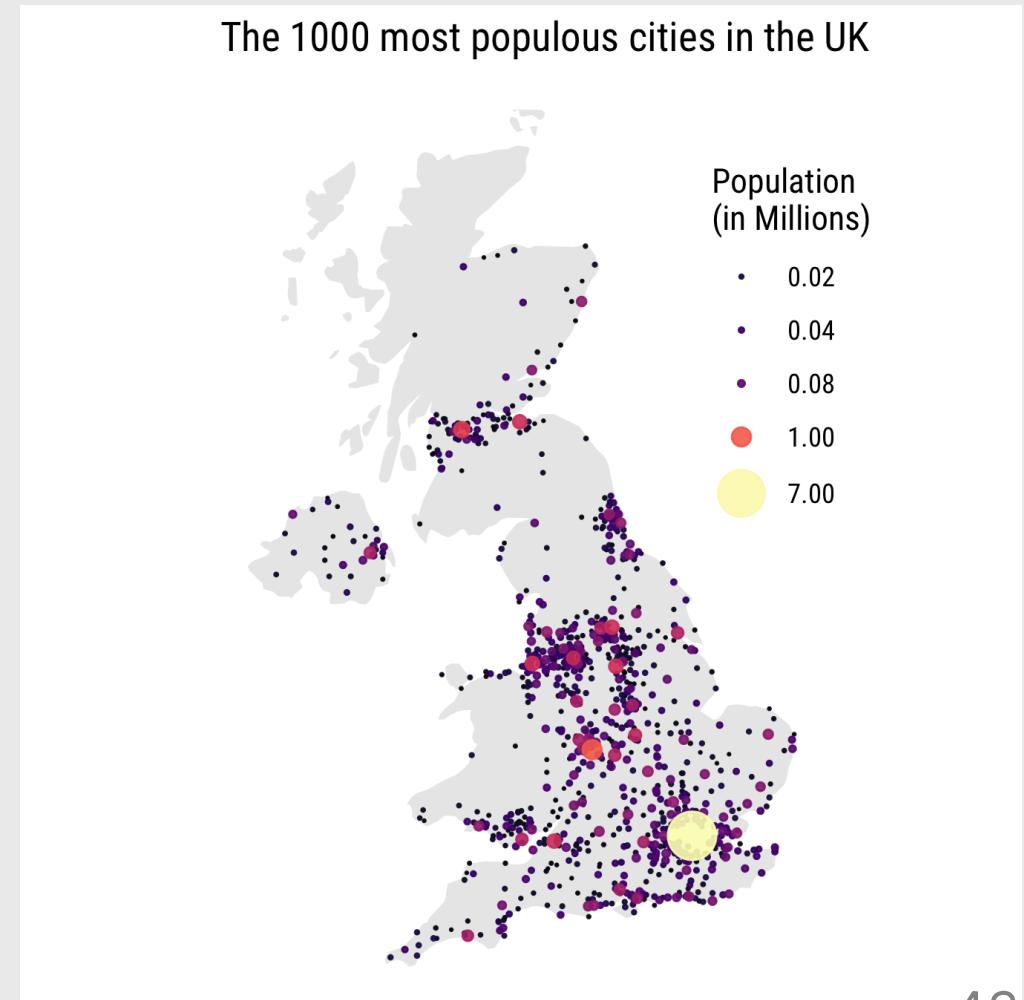
Area



Radius

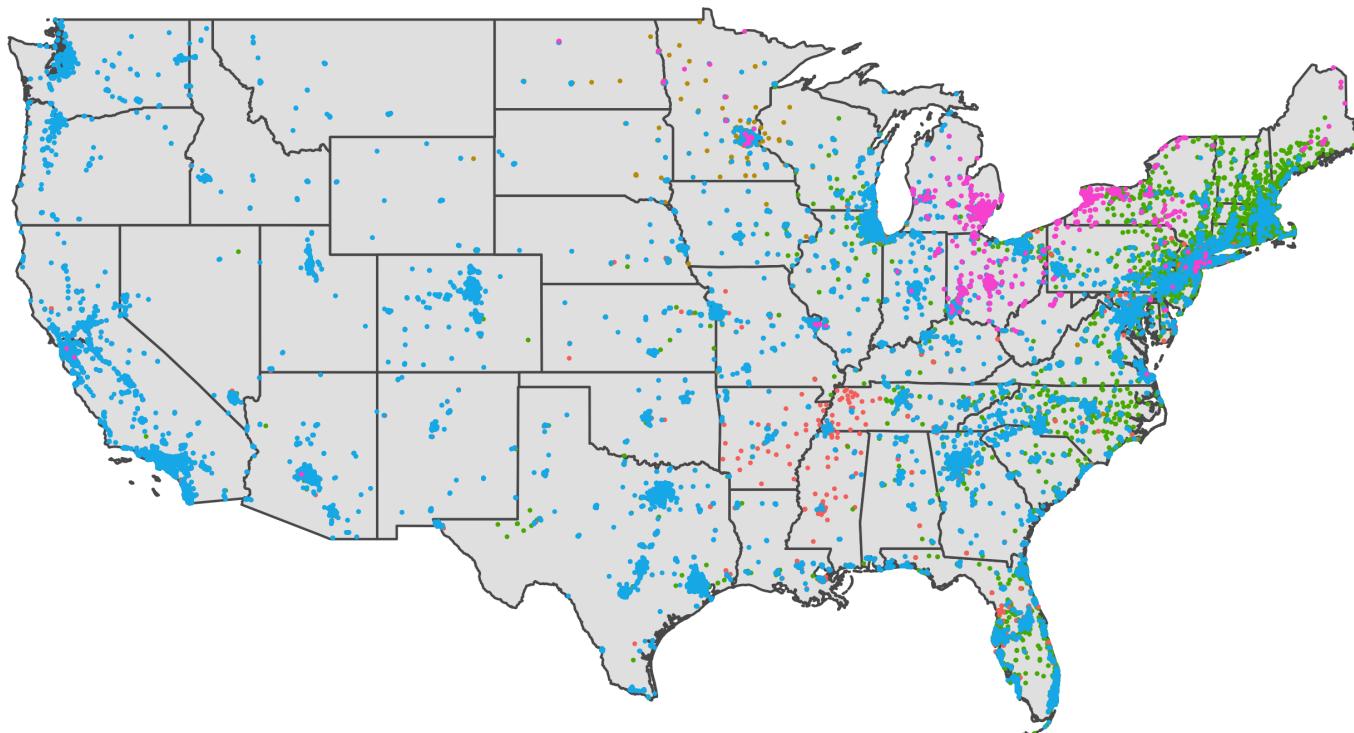


Area



How to add points to a map

Coffee Shops in the US



Coffee shop

● Baskin Robbins

● Dunkin' Donuts

● Starbucks

● Tim Hortons

● Caribou Coffee

● Peet's Coffee & Tea

● The Coffee Bean & Tea Leaf

How to add points to a map

Load the continental US shape file

```
us_states_cont <- ne_states(  
  country = 'united states of america',  
  returnclass = 'sf') %>%  
  filter(! name %in% c('Alaska', 'Hawaii'))
```

Read in the coffee shop data

```
us_coffee_shops <- read_csv(here::here(  
  'data', 'us_coffee_shops.csv'))  
  
# Only keep data in continental US  
us_coffee_shops <- us_coffee_shops %>%  
  filter(lat > 22, lat < 50,  
        long > -150, long < -66)
```

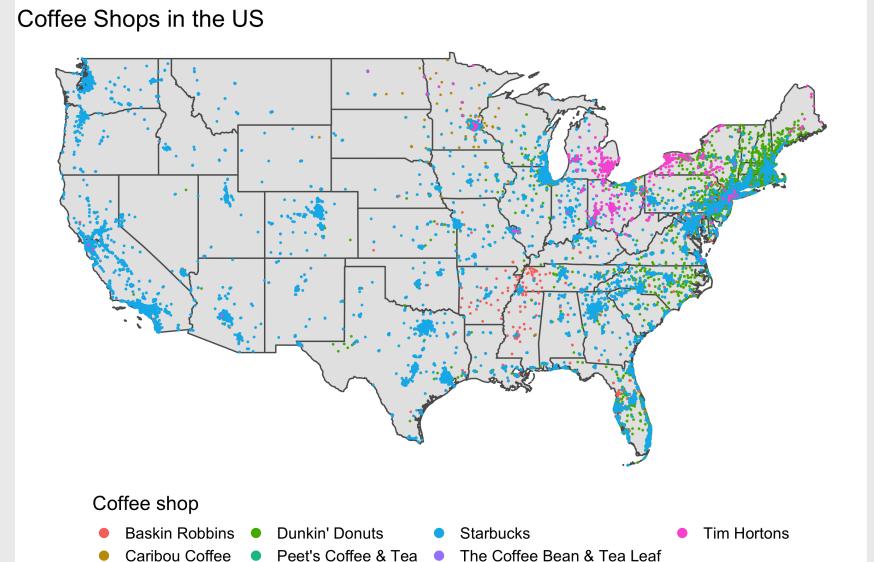
```
head(us_coffee_shops)
```

```
#> # A tibble: 6 x 8  
#>   name          lat   long unique_id ci  
#>   <chr>       <dbl> <dbl>     <dbl> <dbl>  
#> 1 Baskin Robbins  40.8 -73.4    3304448 Hu  
#> 2 Baskin Robbins  42.1 -88.0    11342048 Ro  
#> 3 Baskin Robbins  34.0 -84.5    3304169 Ma  
#> 4 Baskin Robbins  29.8 -95.6    3304006 Ho  
#> 5 Baskin Robbins  36.4 -89.5    3303959 Ti  
#> 6 Baskin Robbins  40.7 -73.6    3304507 Me
```

How to add points to a map

Plot coffee shop locations over map

```
ggplot() +  
  geom_sf(data = us_states_cont) +  
  geom_point(  
    data = us_coffee_shops,  
    aes(x = long, y = lat, color = name),  
    size = 0.3) +  
  theme_void(base_size = 15) +  
  theme(legend.position = 'bottom') +  
  guides(color = guide_legend(  
    # Move legend title to top  
    title.position = "top",  
    # Increase legend point size  
    override.aes = list(size = 3))) +  
  labs(color = 'Coffee shop',  
       title = 'Coffee Shops in the US')
```



15:00

Your turn

Create the following map of squirrels in NYC's Central Park using the following data from the [Squirrel Census](#):

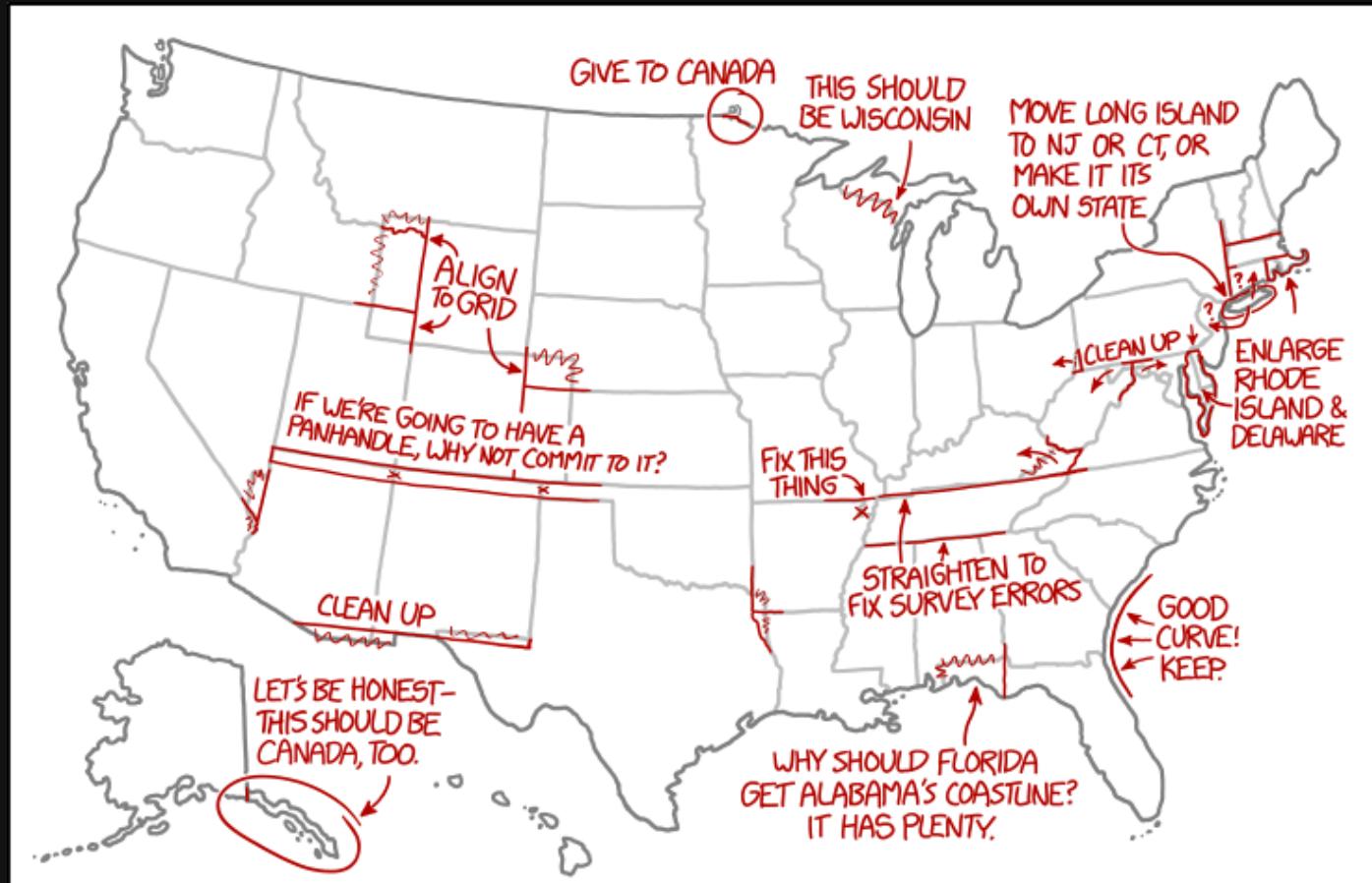
- The **CentralPark.shp** file in the **data/central_park** folder.
- The **nyc_squirrels.csv** file in the **data** folder.

Hint: The color is mapped to the **primary_fur_color** variable

(More about the Squirrel Census [here](#))

Intermission

05:00



IT WAS SCARY WHEN THE GRAPHIC DESIGNERS SEIZED CONTROL OF THE COUNTRY, BUT IT TURNED OUT THEY JUST WANTED TO FIX SOME THINGS ABOUT THE STATE BORDERS THAT HAD ALWAYS BOthered THEM.

Week 12: *Maps*

1. Plotting maps
2. Adding data to maps

BREAK

3. Projections

What's a map projection?



What is the best projection?...it depends

1. Compare projections
2. Compare country sizes

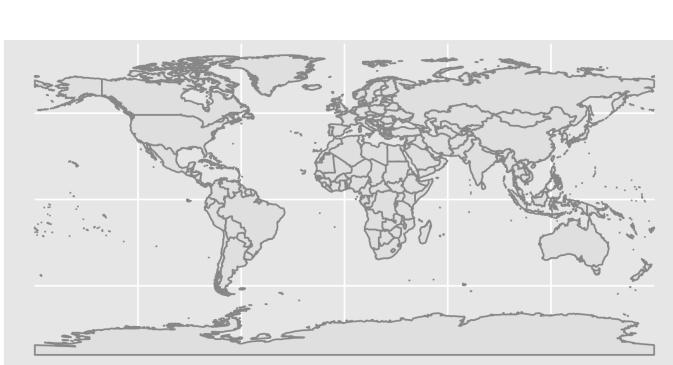
Using projections

To modify the projection of a map, use `coord_sf(crs = st_crs(XXXX))`

```
world <- ne_countries(scale = "medium", returnclass = "sf")
```

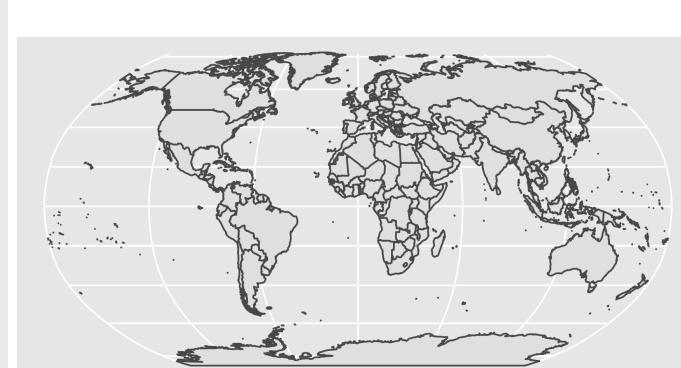
Default (long-lat)

```
ggplot(data = world) +  
  geom_sf()
```



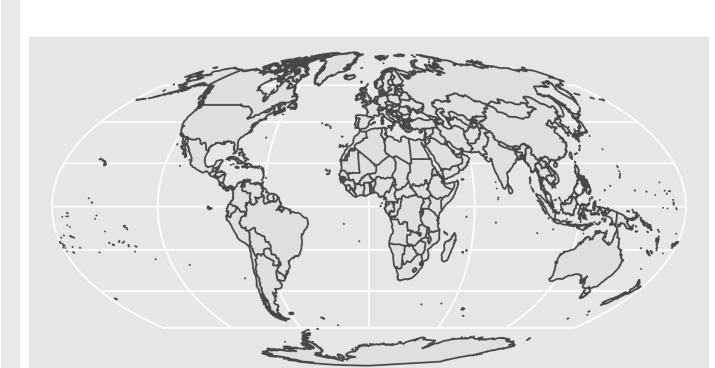
Robinson projection

```
ggplot(data = world) +  
  geom_sf() +  
  coord_sf(crs = "ESRI:54030")
```



Mollweide projection

```
ggplot(data = world) +  
  geom_sf() +  
  coord_sf(crs = "ESRI:54009")
```



Common Projections

ggplot layer:

```
coord_sf(crs = "ESRI:XXXX")
```

World

Code	Projection
"ESRI:54030"	Robinson
"ESRI:54002"	Equidistant cylindrical
"ESRI:54004"	Mercator
"ESRI:54008"	Sinusoidal
"ESRI:54009"	Mollweide

United States

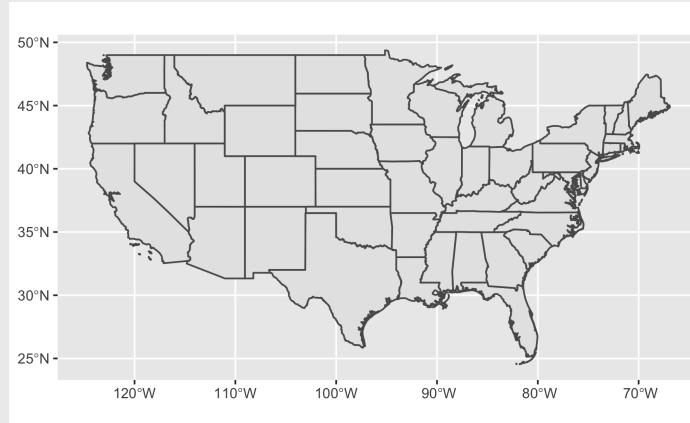
Code	Projection
"ESRI:102003"	Albers
"ESRI:102004"	Lambert Conformal Conic
4269	NAD 83

US projections

```
us_states_cont <- ne_states(country = 'united states of america',
  returnclass = 'sf') %>%
  filter(! name %in% c('Alaska', 'Hawaii'))
```

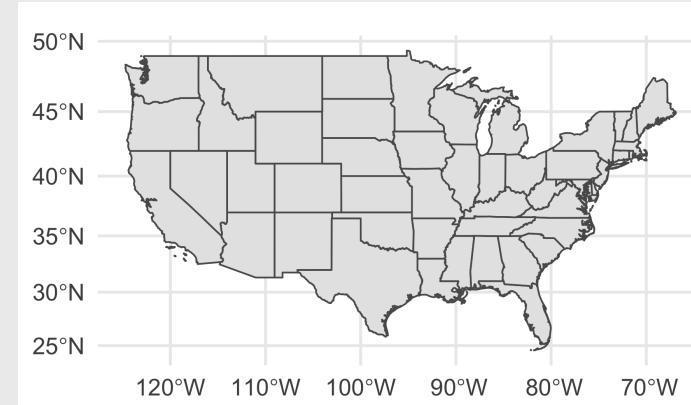
NAD 83 projection

```
ggplot(data = world) +
  geom_sf() +
  coord_sf(crs = 4269)
```



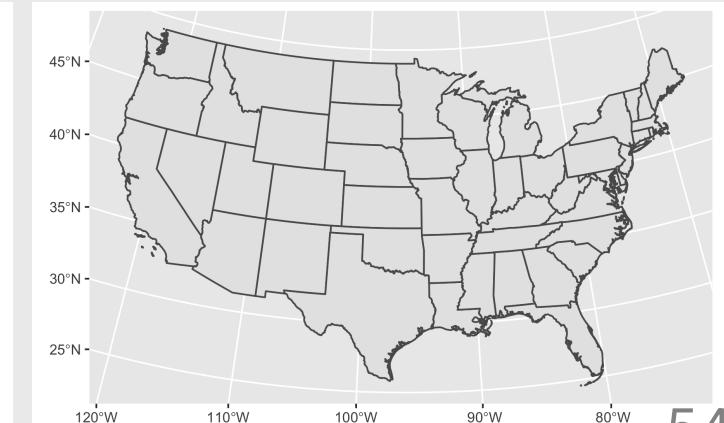
Mercator

```
ggplot(data = world) +
  geom_sf() +
  coord_sf(crs = "ESRI:54004")
```



Albers

```
ggplot(data = us_states_cont) +
  geom_sf() +
  coord_sf(crs = "ESRI:10200")
```



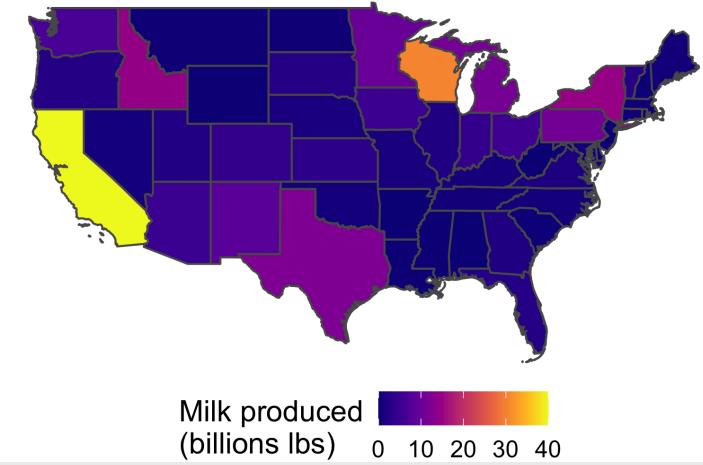
Mapping data to projections - choropleth map

```
milk_2017 <- milk_production %>%
  filter(year == 2017) %>%
  select(name = state, milk_produced) %>%
  mutate(milk_produced = milk_produced / 10^9)

us_states <- ne_states(
  country = 'united states of america',
  returnclass = 'sf') %>%
  filter(! name %in% c('Alaska', 'Hawaii')) %>%
  left_join(milk_2017, by = 'name')

ggplot(us_states) +
  geom_sf(aes(fill = milk_produced)) +
  scale_fill_viridis(
    option = "plasma",
    limits = c(0, 40)) +
  theme_void(base_size = 15) +
  theme(legend.position = 'bottom') +
  labs(fill = 'Milk produced\n(billions lbs)',
       title = 'Milk Production by State in 2017')
```

Milk Production by State in 2017



Mapping data to projections - choropleth map

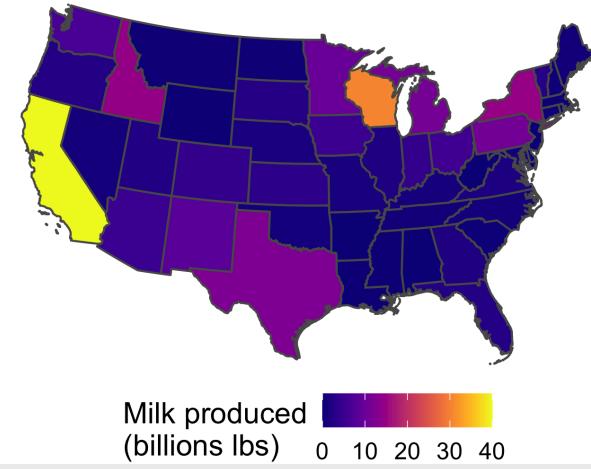
```
milk_2017 <- milk_production %>%
  filter(year == 2017) %>%
  select(name = state, milk_produced) %>%
  mutate(milk_produced = milk_produced / 10^9)

us_states <- ne_states(
  country = 'united states of america',
  returnclass = 'sf') %>%
  filter(! name %in% c('Alaska', 'Hawaii')) %>%
  left_join(milk_2017, by = 'name')

ggplot(us_states) +
  geom_sf(aes(fill = milk_produced)) +
  scale_fill_viridis(
    option = "plasma",
    limits = c(0, 40)) +
  theme_void(base_size = 15) +
  theme(legend.position = 'bottom') +
  labs(fill = 'Milk produced\n(billions lbs)',
       title = 'Milk Production by State in 2017') +
  coord_sf(crs = "ESRI:102003")
```

Albers Projection

Milk Production by State in 2017



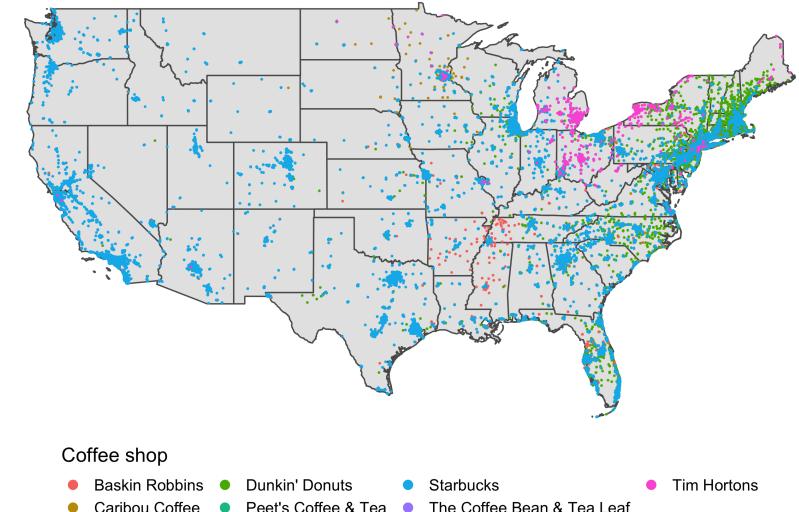
Mapping data to projections - points

```
us_states_cont <- ne_states(
  country = 'united states of america',
  returnclass = 'sf') %>%
  filter(! name %in% c('Alaska', 'Hawaii'))

us_coffee_shops <- us_coffee_shops %>%
  filter(lat > 22, lat < 50,
         long > -150, long < -66)

ggplot() +
  geom_sf(data = us_states_cont) +
  geom_point(
    data = us_coffee_shops,
    aes(x = long, y = lat, color = name),
    size = 0.3) +
  theme_void(base_size = 15) +
  theme(legend.position = 'bottom') +
  guides(color = guide_legend(
    # Move legend title to top
    title.position = "top",
    # Increase legend point size
    override.aes = list(size = 3))) +
  labs(color = 'Coffee shop',
       title = 'Coffee Shops in the US')
```

Coffee Shops in the US



Mapping data to projections - points

```
us_states_cont <- ne_states(  
  country = 'united states of america',  
  returnclass = 'sf') %>%  
  filter(! name %in% c('Alaska', 'Hawaii'))  
  
us_coffee_shops <- us_coffee_shops %>%  
  filter(lat > 22, lat < 50,  
        long > -150, long < -66)  
  
ggplot() +  
  geom_sf(data = us_states_cont) +  
  geom_point(  
    data = us_coffee_shops,  
    aes(x = long, y = lat, color = name),  
    size = 0.3) +  
  theme_void(base_size = 15) +  
  theme(legend.position = 'bottom') +  
  guides(color = guide_legend(  
    # Move legend title to top  
    title.position = "top",  
    # Increase legend point size  
    override.aes = list(size = 3))) +  
  labs(color = 'Coffee shop',  
       title = 'Coffee Shops in the US') +  
  coord_sf(crs = "ESRI:102003")
```

Fail!

Coffee Shops in the US



Mapping data to projections - points

First match `us_coffee_shops` crs to `us_states_cont`

```
us_states_cont <- ne_states(  
  country = 'united states of america',  
  returnclass = 'sf') %>%  
  filter(! name %in% c('Alaska', 'Hawaii'))  
  
us_coffee_shops <- us_coffee_shops %>%  
  filter(lat > 22, lat < 50,  
        long > -150, long < -66)  
  
us_coffee_shops_sf <- st_as_sf(us_coffee_shops,  
  coords = c("long", "lat"),  
  crs = st_crs(us_states_cont))
```

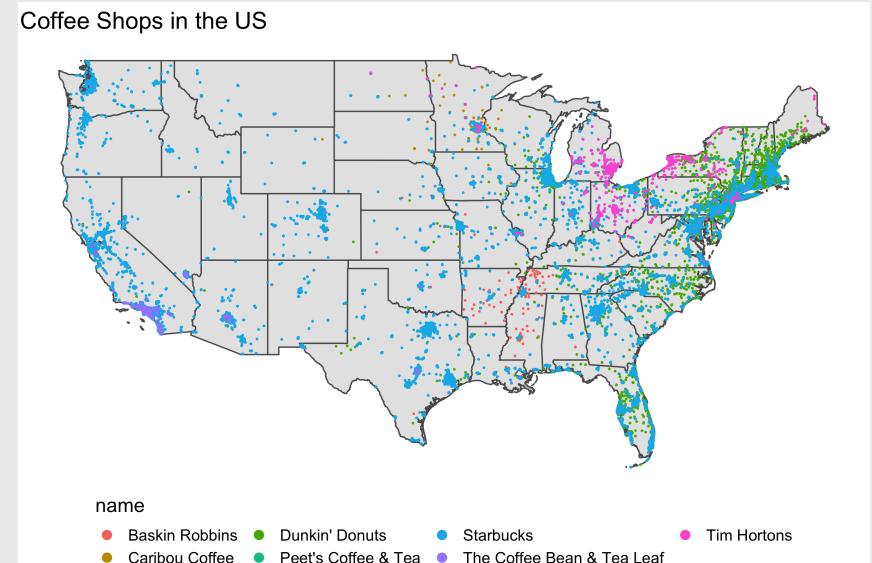
```
head(us_coffee_shops_sf)
```

```
#> Simple feature collection with 6 features  
#> Geometry type: POINT  
#> Dimension: XY  
#> Bounding box: xmin: -95.60337 ymin: 22.00000 xmax: -66.00000 ymax: 50.00000  
#> CRS: +proj=longlat +datum=NAD83  
#> # A tibble: 6 x 7  
#>   name      unique_id city      state      longitude latitude  
#>   <chr>      <dbl> <chr>      <chr>      <dbl>    <dbl>  
#> 1 Baskin Robbins 3304448 Huntley IL     -95.60337 22.00000  
#> 2 Baskin Robbins 11342048 Rollinsville CO    -80.25000 40.00000  
#> 3 Baskin Robbins 3304169 Marieetta GA    -80.00000 34.00000  
#> 4 Baskin Robbins 3304006 Houston TX    -95.36700 29.75000  
#> 5 Baskin Robbins 3303959 Tiptonville TN    -84.50000 35.50000  
#> 6 Baskin Robbins 3304507 Merrimack NH    -71.00000 43.00000
```

Mapping data to projections - points

Plot coffee shop locations over map with `geom_sf()`

```
ggplot() +  
  geom_sf(data = us_states_sf) +  
  geom_sf(  
    data = us_coffee_shops_sf,  
    aes(color = name),  
    size = 0.3) +  
  theme_void(base_size = 15) +  
  theme(legend.position = 'bottom') +  
  guides(color = guide_legend(  
    # Move legend title to top  
    title.position = "top",  
    # Increase legend point size  
    override.aes = list(size = 3))) +  
  labs(fill = 'Coffee shop',  
       title = 'Coffee Shops in the US')
```



Mapping data to projections - points

Plot coffee shop locations over map with `geom_sf()`

```
ggplot() +  
  geom_sf(data = us_states_sf) +  
  geom_sf(  
    data = us_coffee_shops_sf,  
    aes(color = name),  
    size = 0.3) +  
  theme_void(base_size = 15) +  
  theme(legend.position = 'bottom') +  
  guides(color = guide_legend(  
    # Move legend title to top  
    title.position = "top",  
    # Increase legend point size  
    override.aes = list(size = 3))) +  
  labs(fill = 'Coffee shop',  
       title = 'Coffee Shops in the US') +  
  coord_sf(crs = "ESRI:102003")
```

Albers Projection

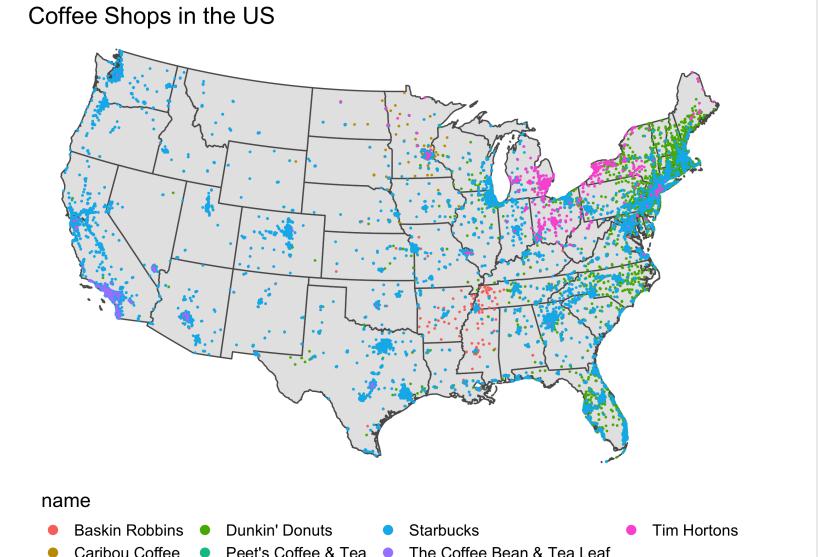


Mapping data to projections - points

Plot coffee shop locations over map with `geom_sf()`

```
ggplot() +  
  geom_sf(data = us_states_sf) +  
  geom_sf(  
    data = us_coffee_shops_sf,  
    aes(color = name),  
    size = 0.3) +  
  theme_void(base_size = 15) +  
  theme(legend.position = 'bottom') +  
  guides(color = guide_legend(  
    # Move legend title to top  
    title.position = "top",  
    # Increase legend point size  
    override.aes = list(size = 3))) +  
  labs(fill = 'Coffee shop',  
       title = 'Coffee Shops in the US') +  
  coord_sf(crs = "ESRI:102004")
```

LCC Projection



20:00

Your turn

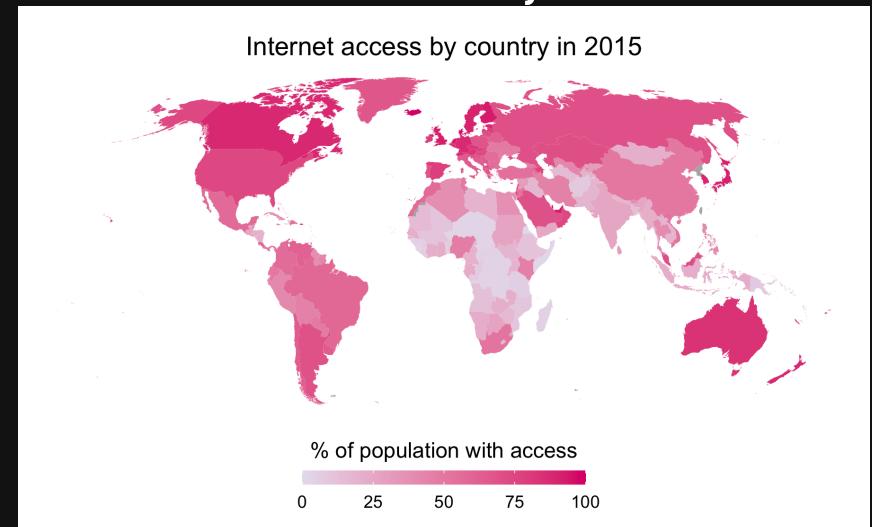
Use the `internet_users_country.csv` data and the `world` data frame from the `rnatuelearth` library to create these two versions of internet access by country in 2015.

Hints:

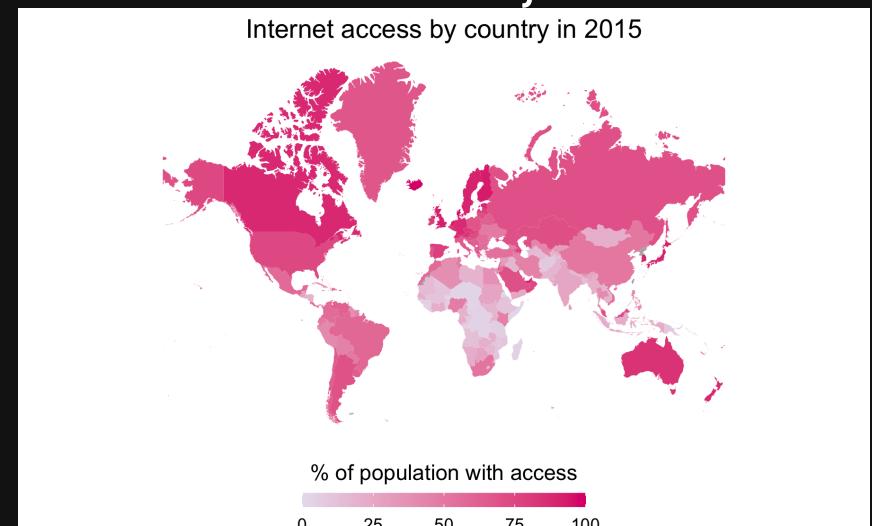
- The `iso_a3` variable in the `worlds` data frame corresponds with the `code` variable in the `internet_users_country.csv` data frame (use this for joining).
- Use `scale_fill_gradient()` to fill the color:

```
scale_fill_gradient(  
  low = "#e7e1ef",  
  high = "#dd1c77",  
  na.value = "grey70",  
  limits = c(0, 100))
```

Robinson Projection



Mercator Projection



Extra practice

15:00

Your turn

Use the `us_states_cont` data frame and the `state_abbs` data frame to create a labeled map of the U.S.:

