

Week 11: *Maps*

 EMSE 4572 / 6572: Exploratory Data Analysis

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 November 06, 2024

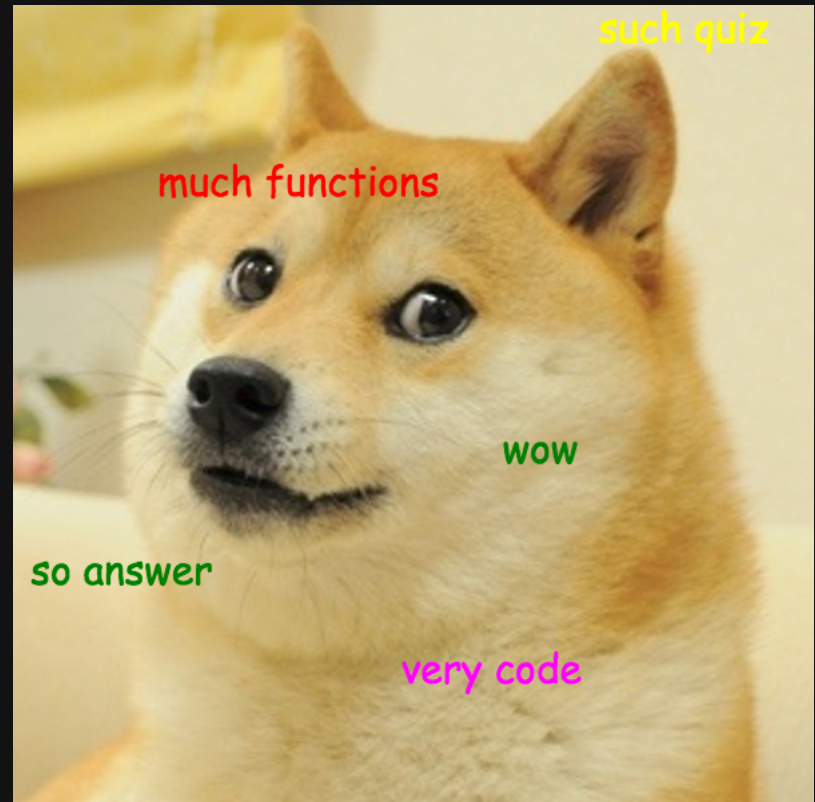
Quiz 4

Download the template from the #class channel

Make sure you unzip it!

When done, submit your **quiz4.qmd** on Blackboard

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('rnaturalearth')  
devtools::install_github("ropensci/rnaturalearthhires")  
devtools::install_github("ropensci/rnaturalearthdata")
```

Week 11: *Maps*

1. Plotting maps

2. Adding data to maps

BREAK

3. Projections

Week 11: *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>
```

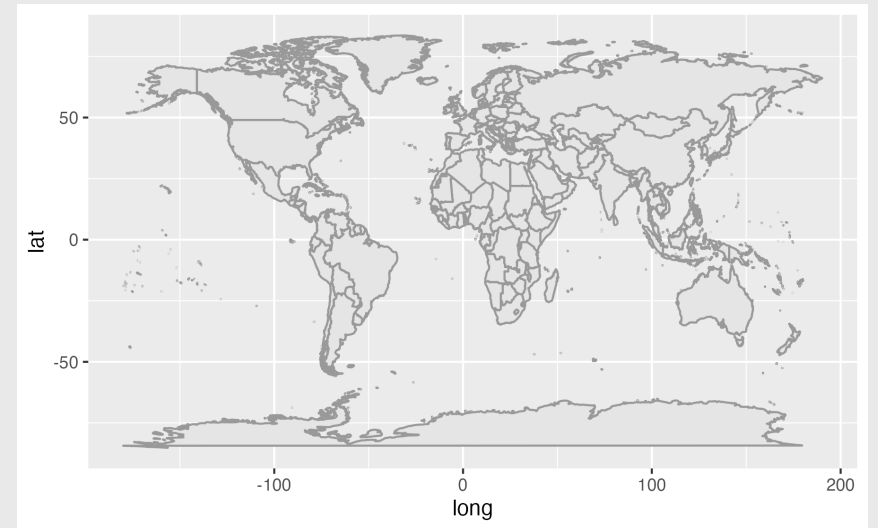
Polygon maps

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"  
  )
```



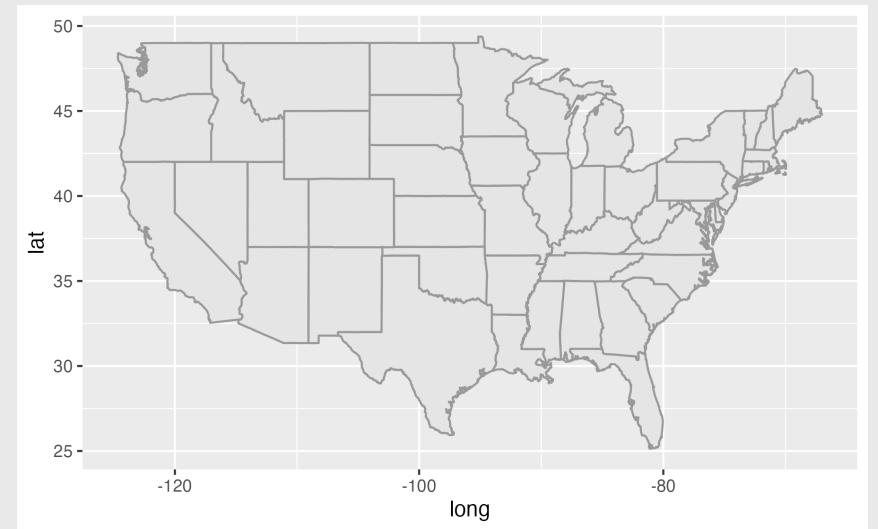
Polygon maps

Get the "US States" shape file

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

Make the plot with `geom_polygon()`

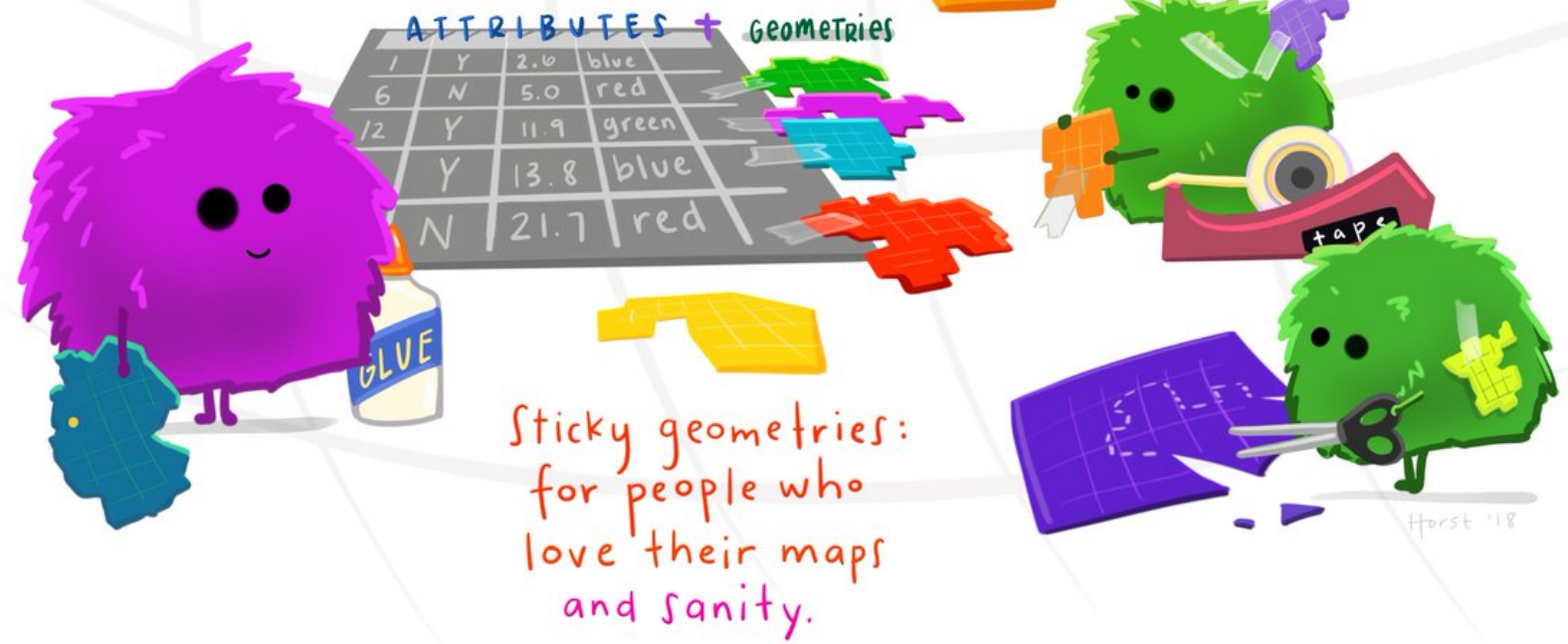
```
ggplot(us_states) +  
  geom_polygon(  
    aes(x = long, y = lat, group = group),  
    fill = "grey90", color = "grey60"  
  )
```



sf: SPATIAL DATA ... SIMPLIFIED.

Simple Features package: {sf}

Art by [Allison Horst](#)



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: 1
#> Geodetic CRS: WGS 84
#>   name geometry
#> 1 Zimbabwe MULTIPOLYGON (((31.28789 -2...
#> 2 Zambia MULTIPOLYGON (((30.39609 -1...
#> 3 Yemen MULTIPOLYGON (((53.08564 16...
#> 4 Vietnam MULTIPOLYGON (((104.064 10....
#> 5 Venezuela MULTIPOLYGON (((-60.82119 9...
#> 6 Vatican MULTIPOLYGON (((12.43916 41...
```

Simple Features (sf) maps

Get the "World" shape file

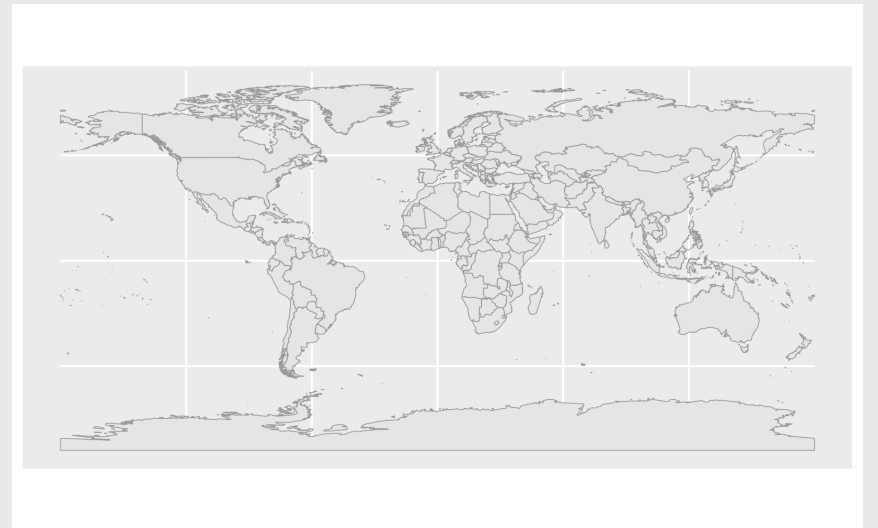
```
library(rnaturalearth)
library(rnaturalearthdata)

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

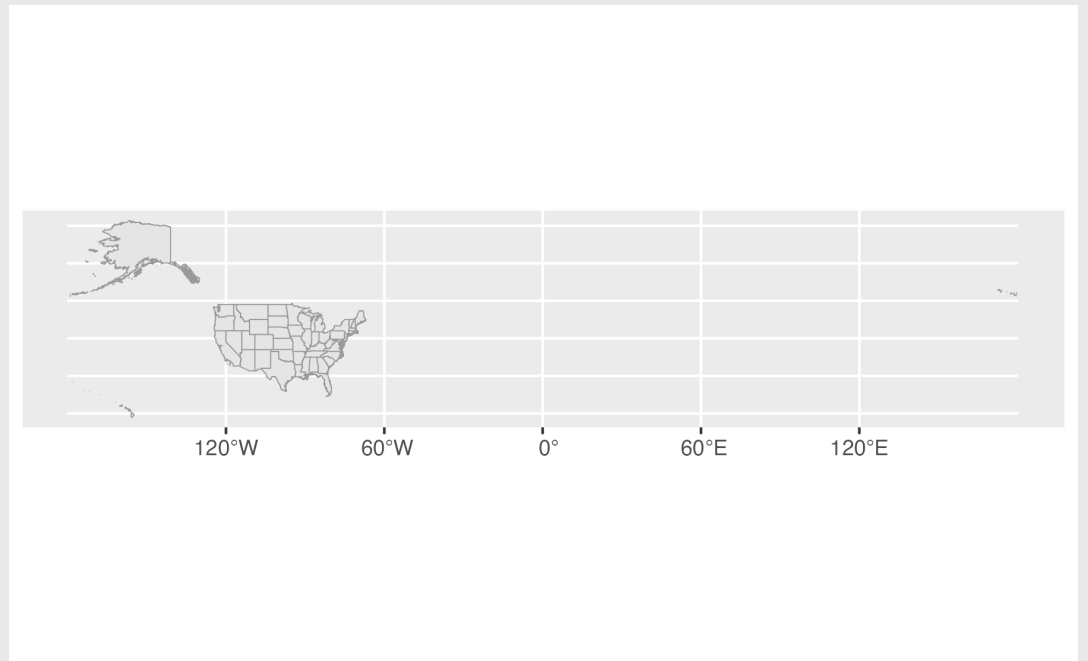
```
library(rnaturalearth)
library(rnaturalearthdata)

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

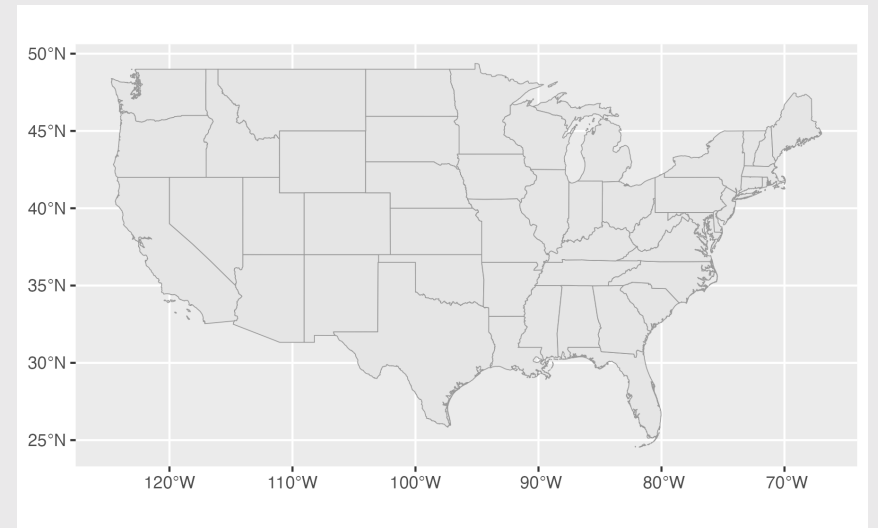
```
library(rnaturalearth)
library(rnaturalearthdata)

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")
```



Inset Hawaii and Alaska

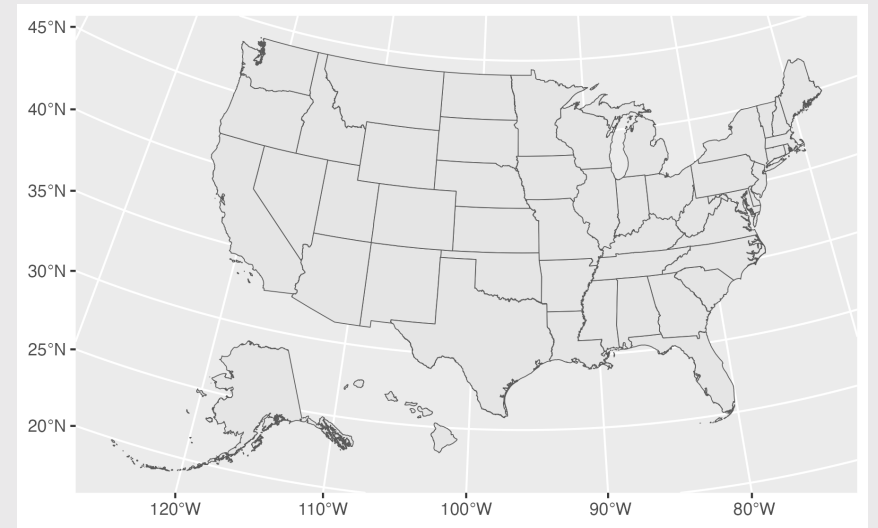
Get the shape file from {tigris} package

```
library(tigris)

us_sf <- tigris::states(class = "sf", cb = TRUE) %>%
  shift_geometry() %>%
  filter(GEOID < 60)
```

Make the plot with `geom_sf()`

```
us_sf %>%
  ggplot() +
  geom_sf()
```



The `maps` package

Includes data on:

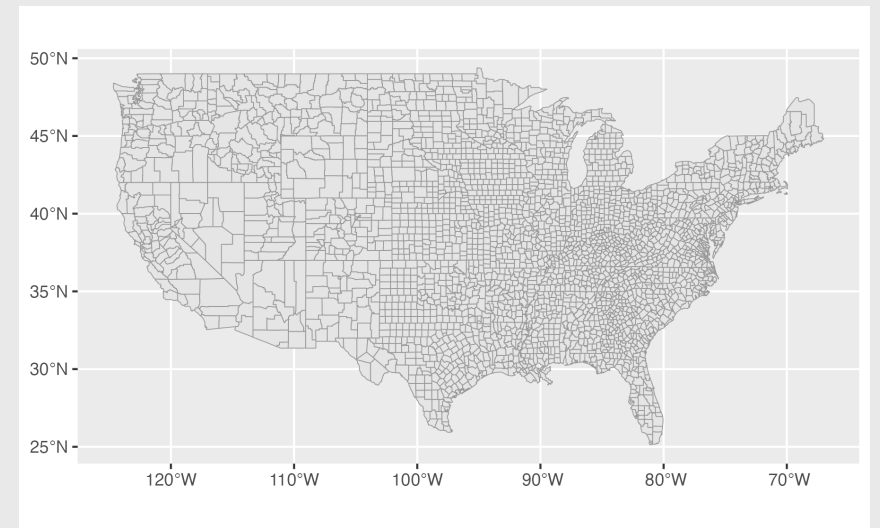
- World: `world`, `world.cities`, `lakes`
- US: `states`, `county`, `state`, `usa`
- France: `france`
- Italy: `italy`
- New zealand: `nz`

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: 89.99893  
#> Geodetic CRS: WGS 84
```

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

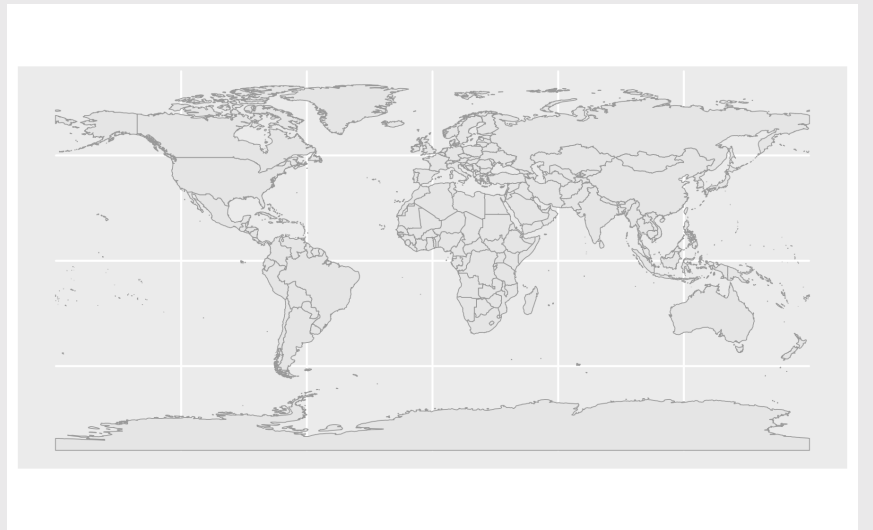
Read in the "World" shape file

```
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: 90  
#> 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: -73.94249 ymax: 40.7825
#> Geodetic CRS: WGS 84
```

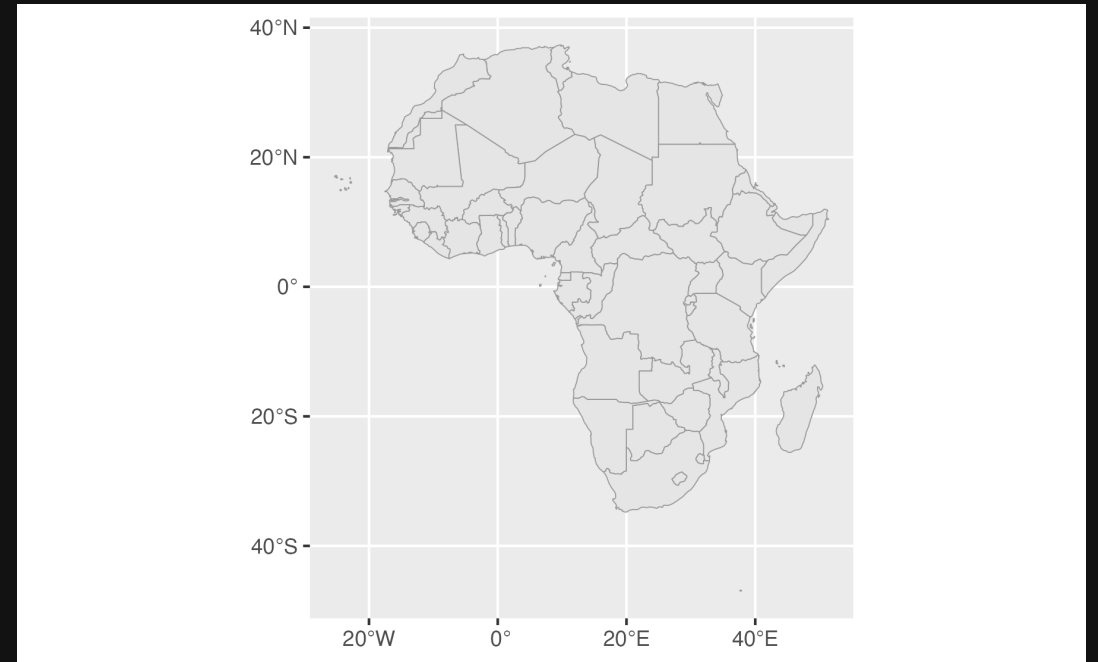
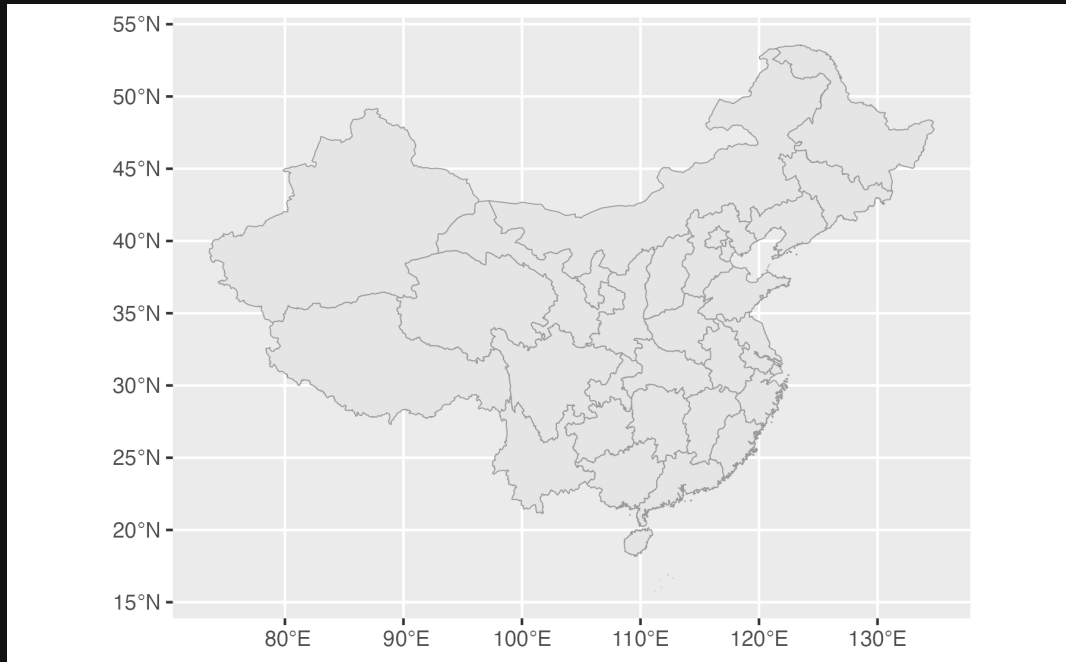
```
ggplot(data = central_park) +
  geom_sf(color = 'grey75')
```



Your turn

10:00

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



Week 11: *Maps*

1. Plotting maps

2. Adding data to maps

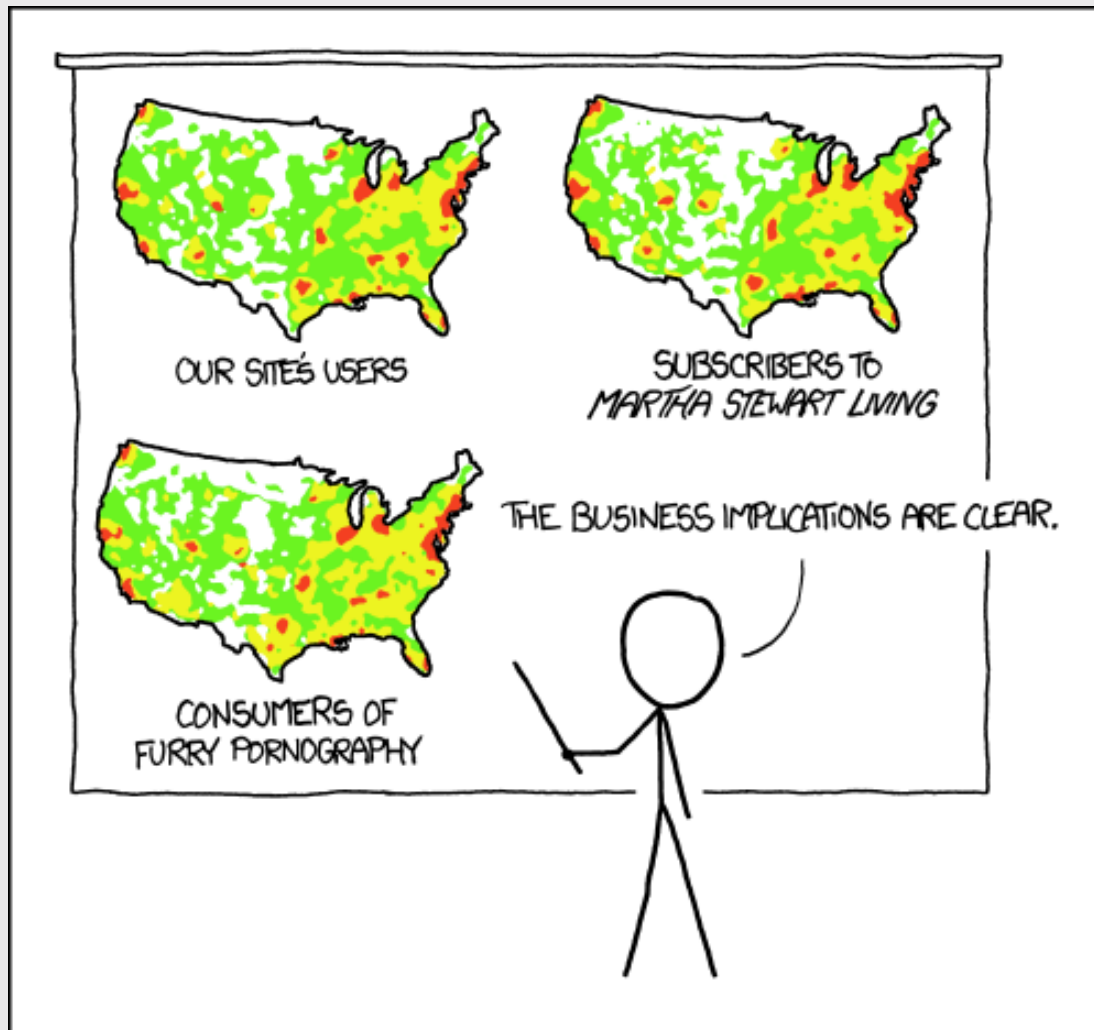
BREAK

3. Projections

First rule of adding data to maps:

Do you need to make a map?

Not all maps
are useful...

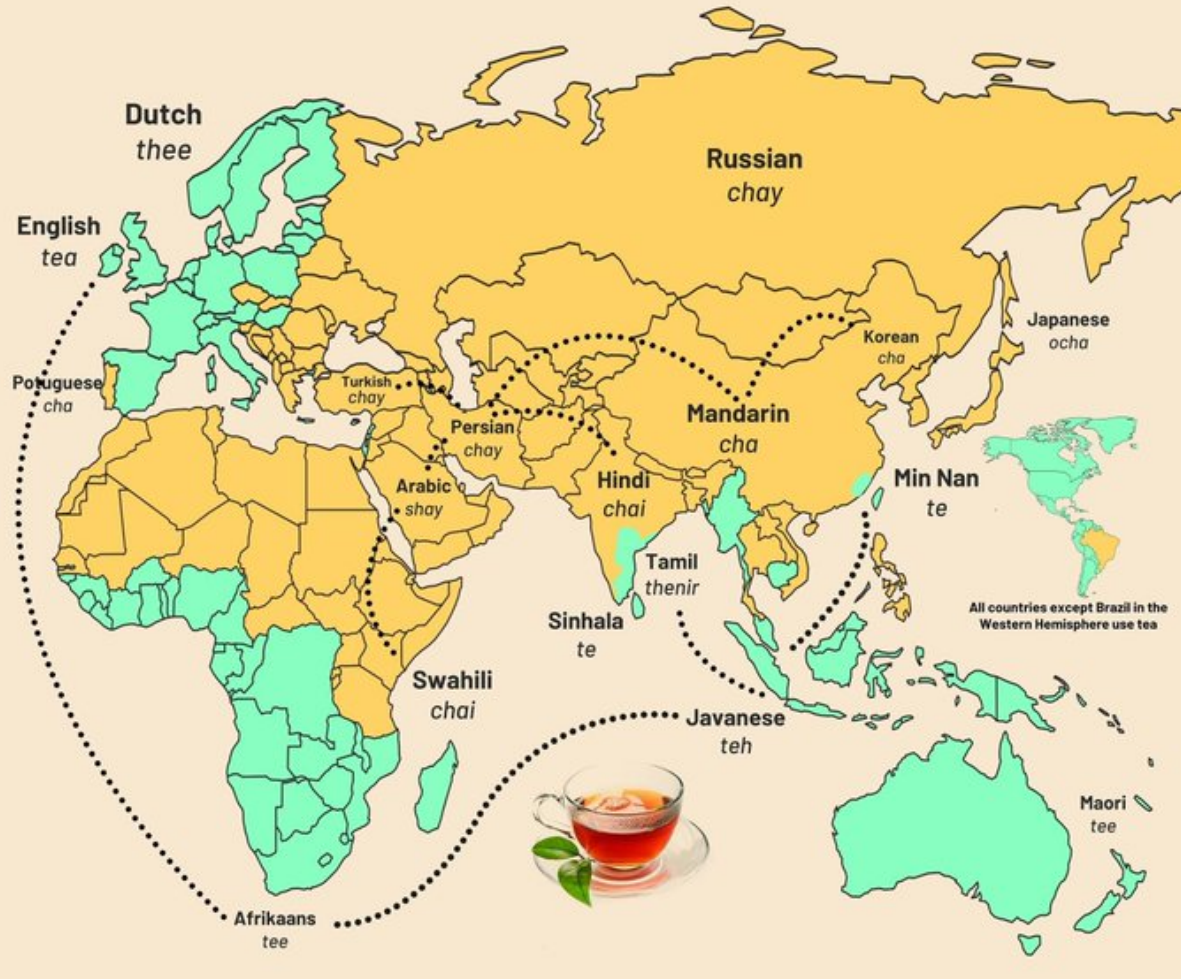


PET PEEVE #208:
GEOGRAPHIC PROFILE MAPS WHICH ARE
BASICALLY JUST POPULATION MAPS

Cha, if by the land. Tea, if by the sea.

● Tea

● Chai



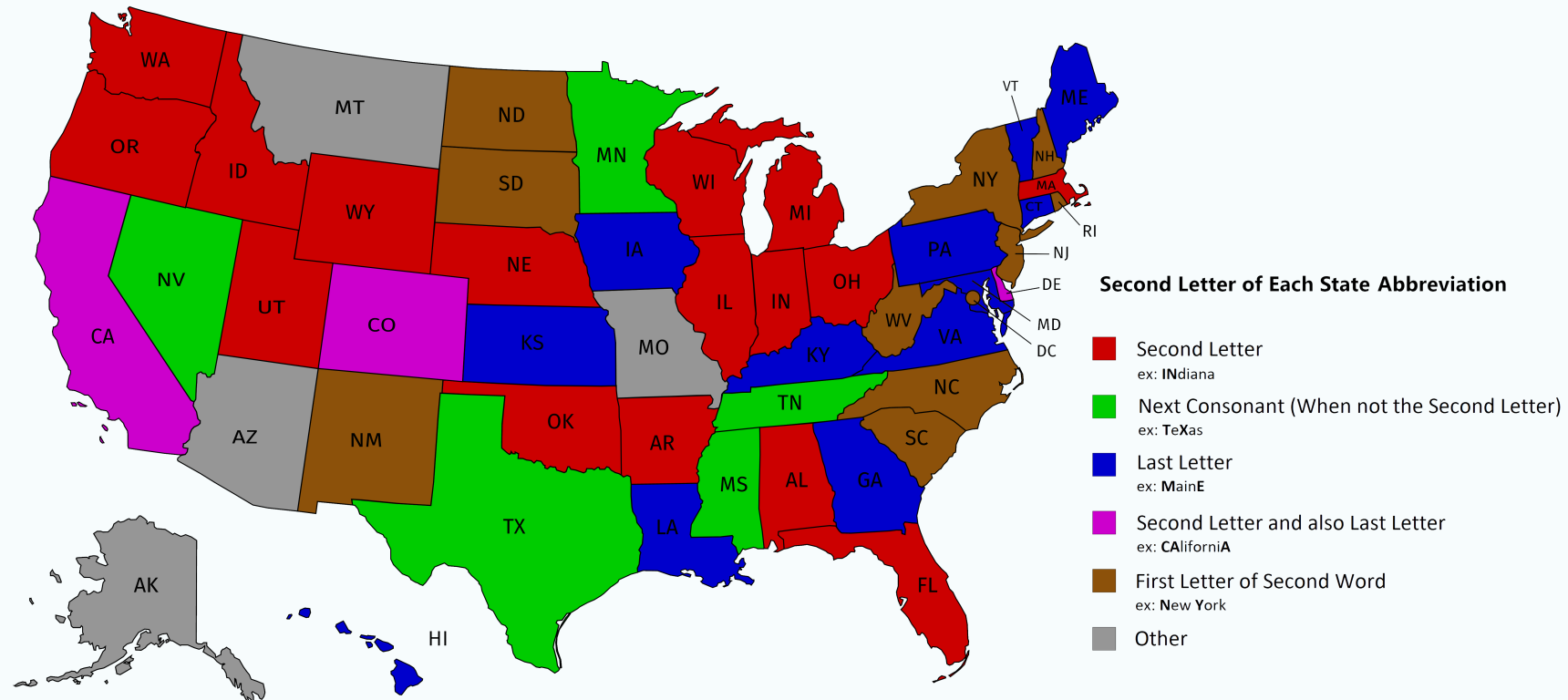
...but some maps are

1. Choropleth maps

2. Point maps

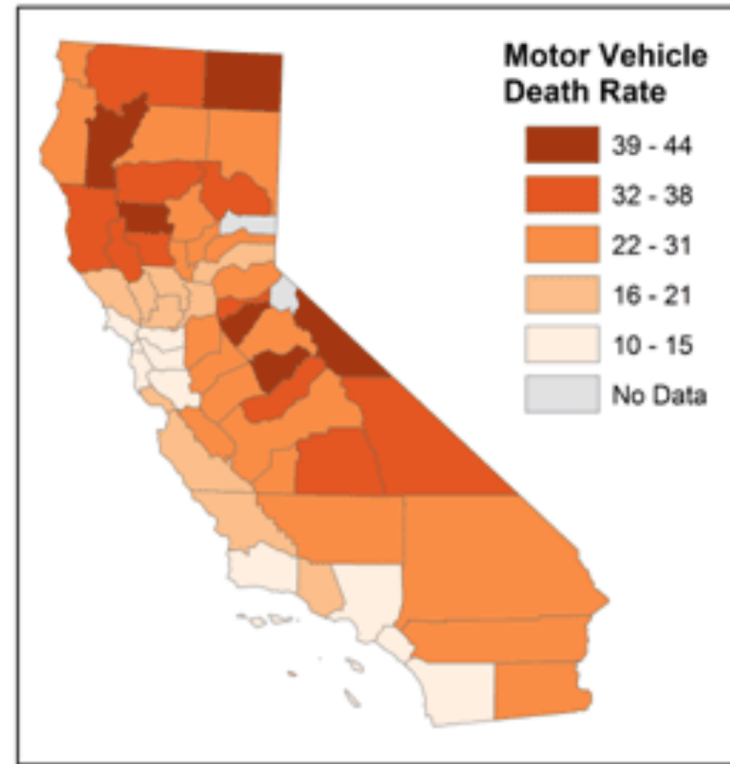
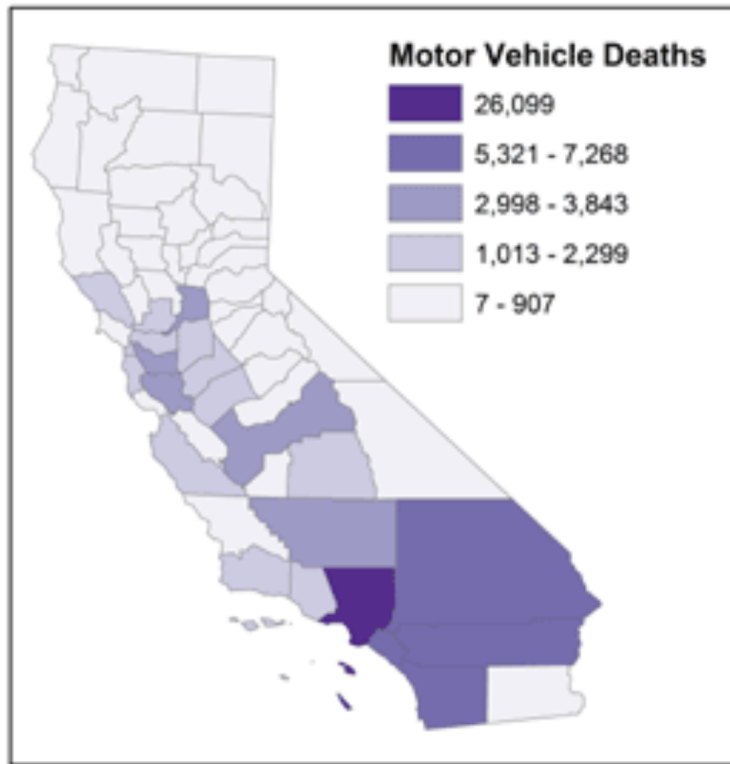
Choropleth - from Greek:

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



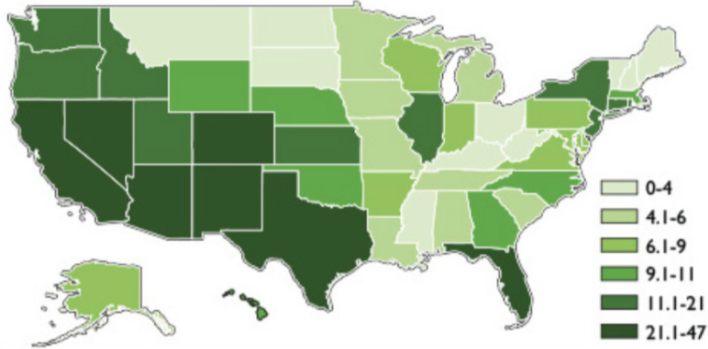
Choropleth maps are easily misleading

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

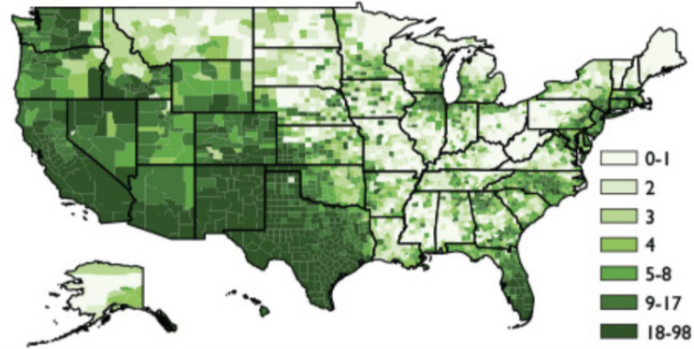


Manipulating fill scale produces wildly different maps

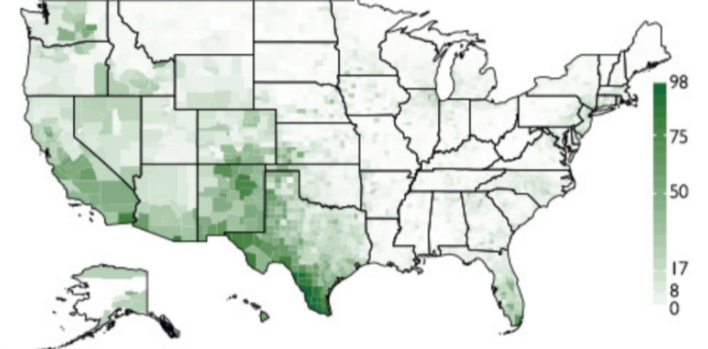
Hispanic population (%)



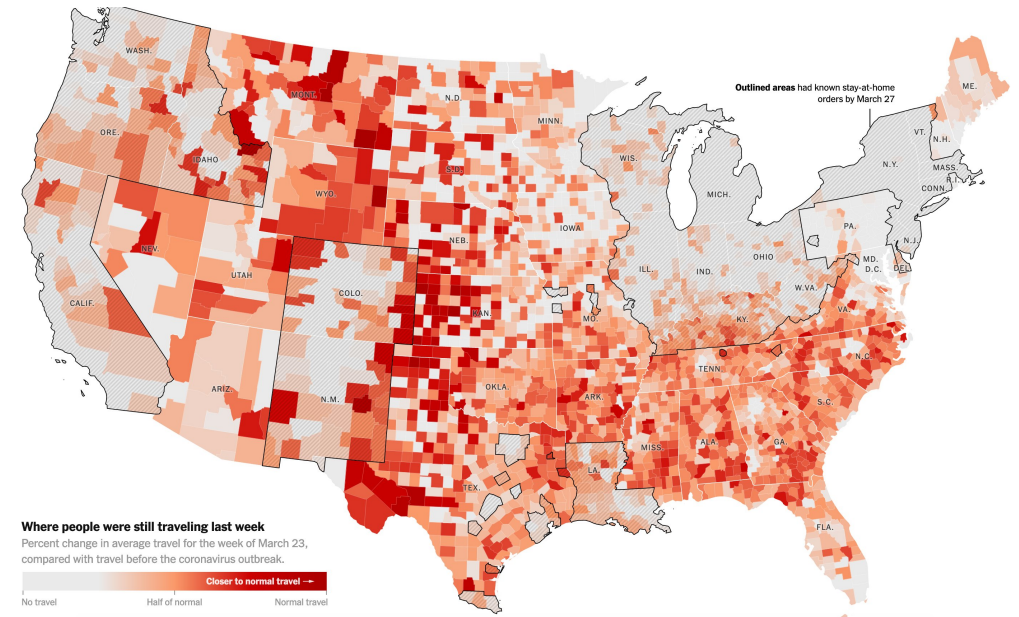
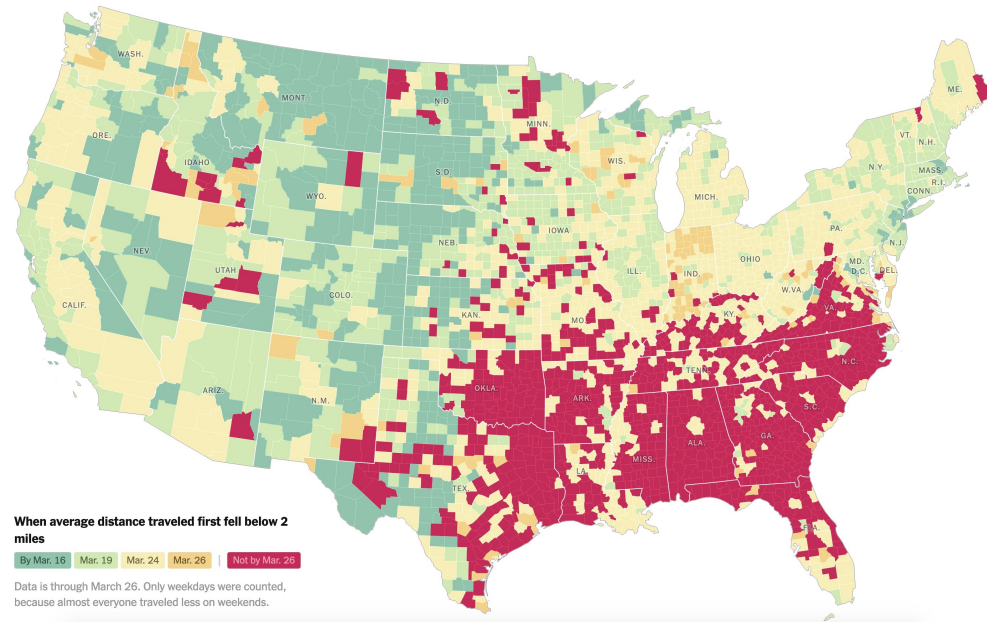
Hispanic population (%)



Hispanic population (%)

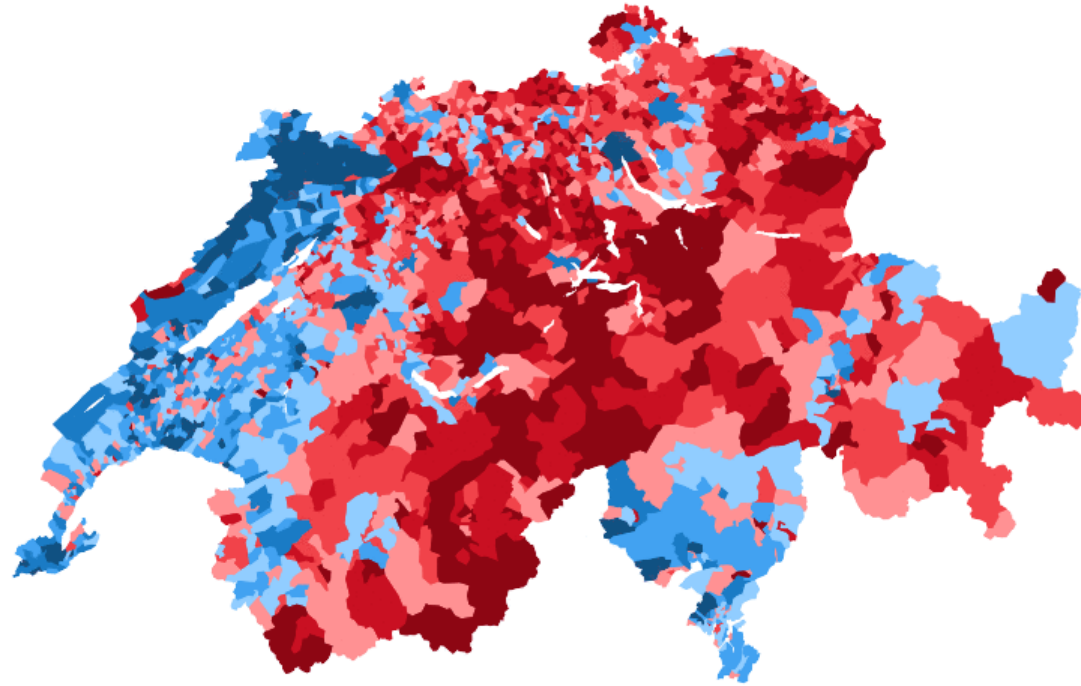


Manipulating fill scale produces wildly different maps



Source: [New York Times](#)

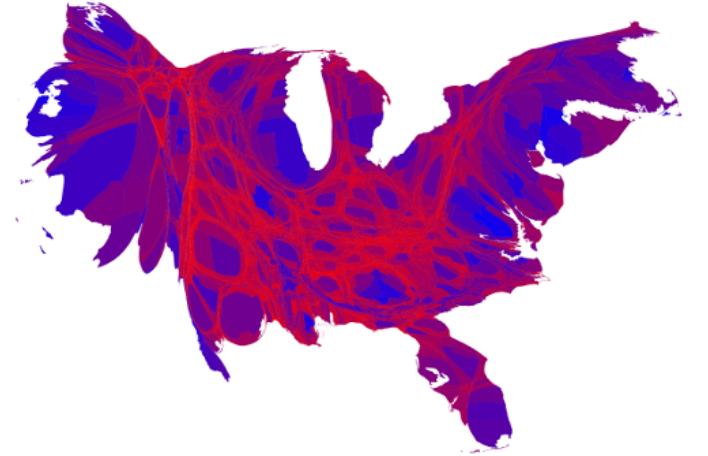
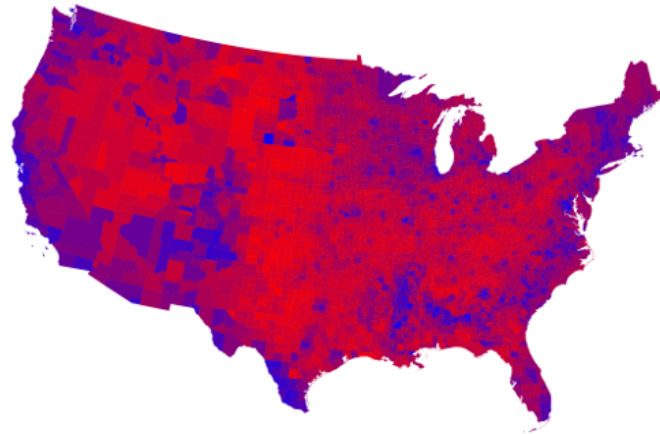
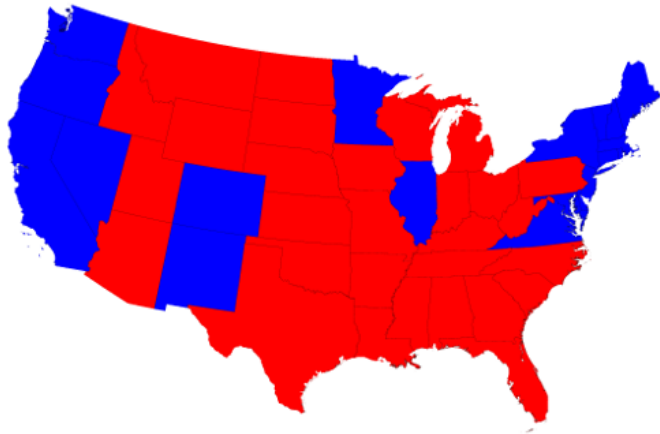
Land doesn't vote - people vote



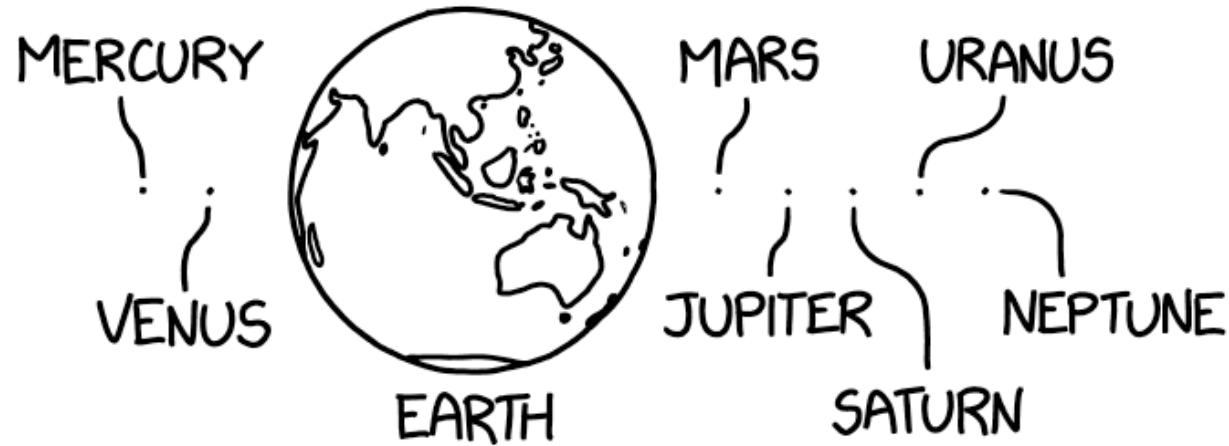
By [David Zumbach](#)

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.



Easy to lie with fake news

2016 ELECTION MAP:

REPUBLICAN
DEMOCRAT



GOVERNMENT RELEASED
CRIME MAP OF 2013:

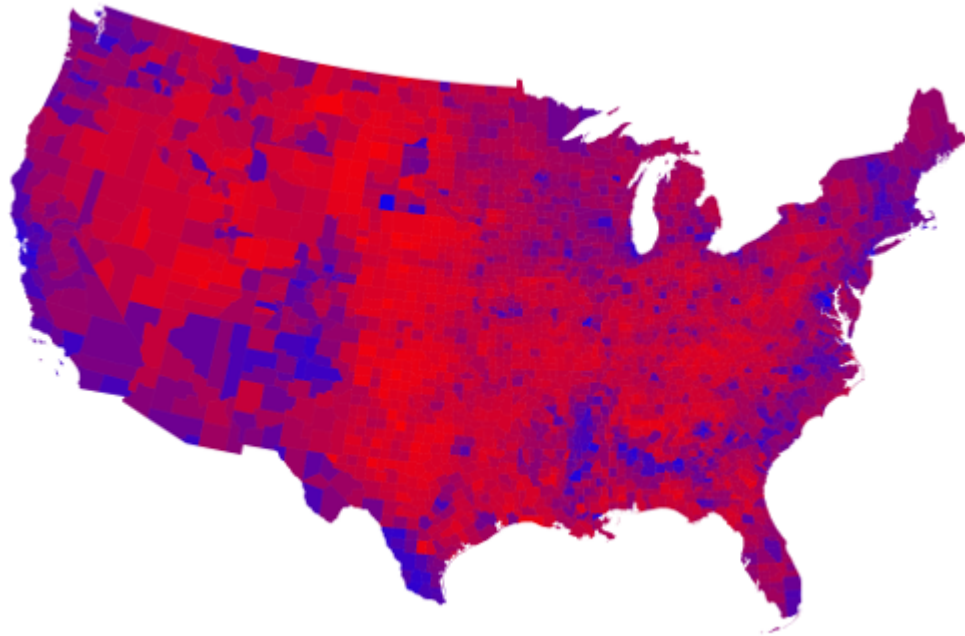
LOWER CRIME RATES
HIGHER CRIME RATES



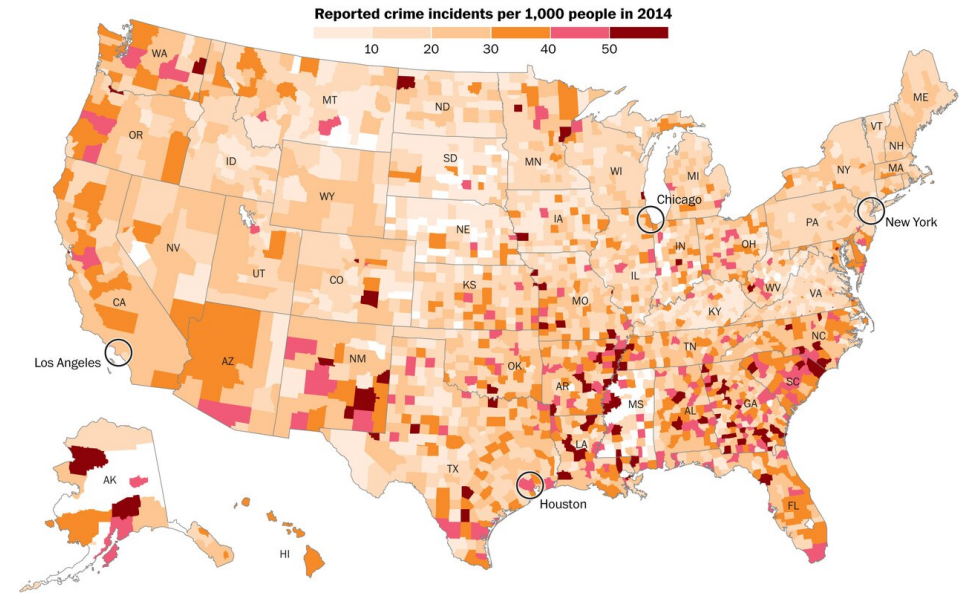
Bottom map is actually [this map](#) of the 2012 election

(here is what actual crime rates look like)

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

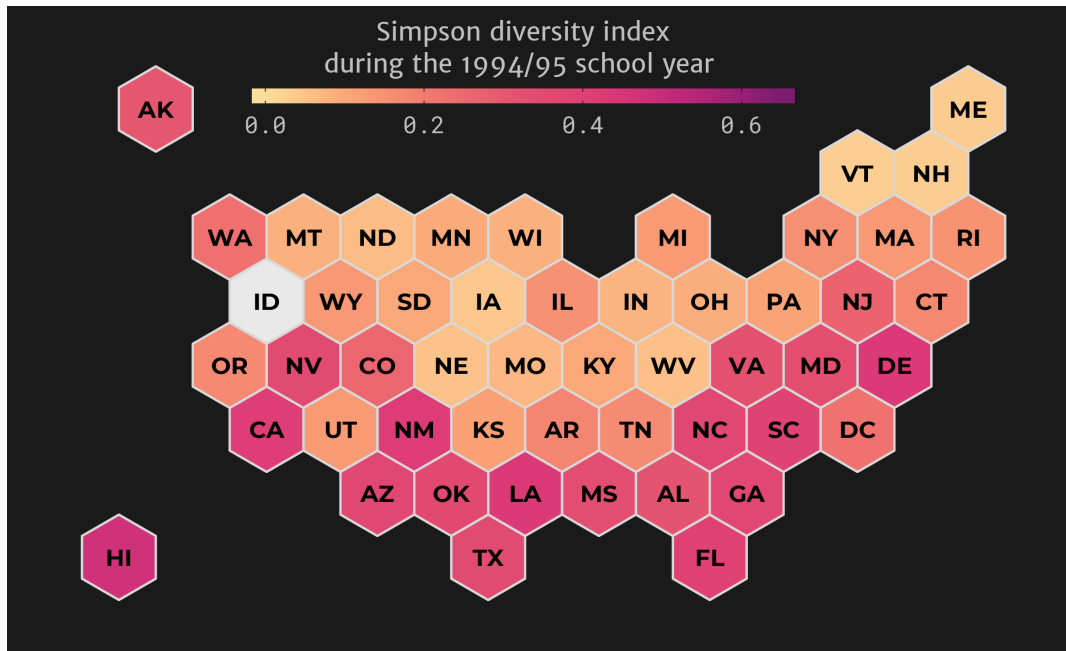


2014 Crime map [\[source\]](#)



A choropleth alternative: hex maps

1994 Simpson Diversity Index in US Schools

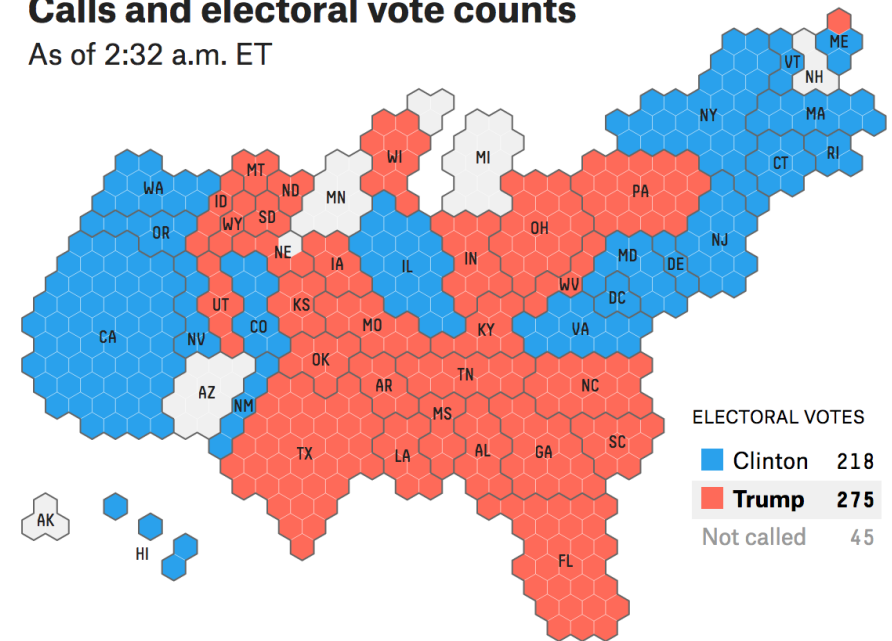


https://github.com/malcolmbarratt/designing_ggplots

2016 Electoral College

Calls and electoral vote counts

As of 2:32 a.m. ET



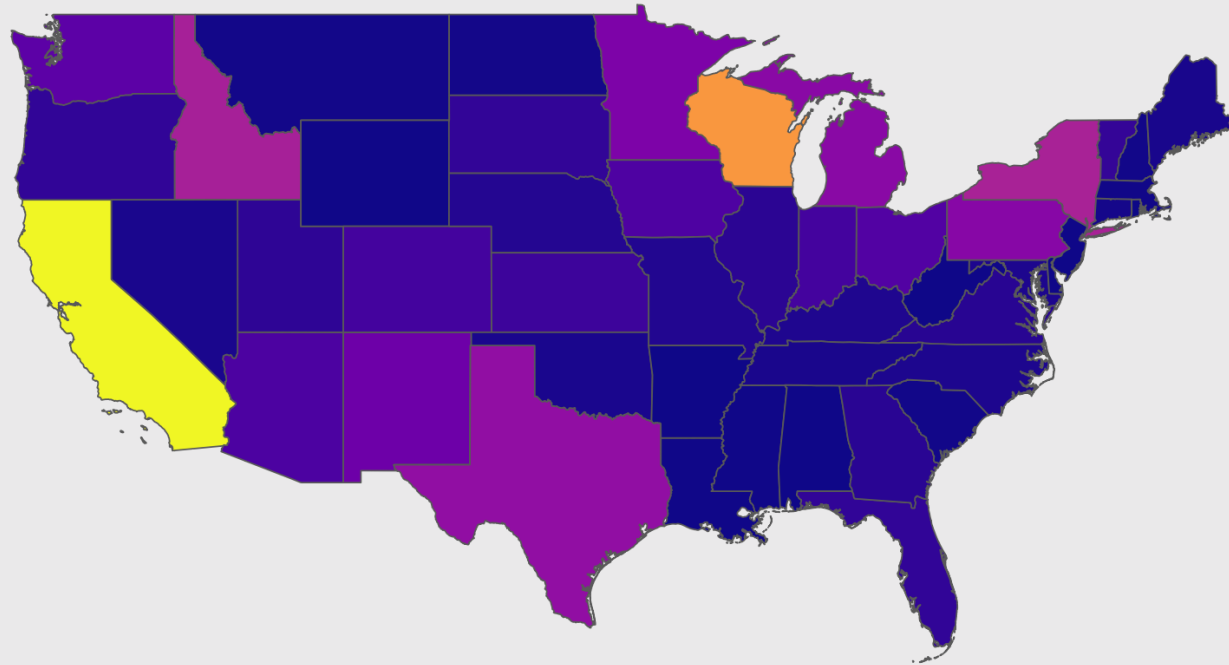
FIVETHIRTYEIGHT

SOURCE: ABC NEWS, AP

<https://fivethirtyeight.com/>

How to make a choropleth map

Milk Production by State in 2017



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')
```

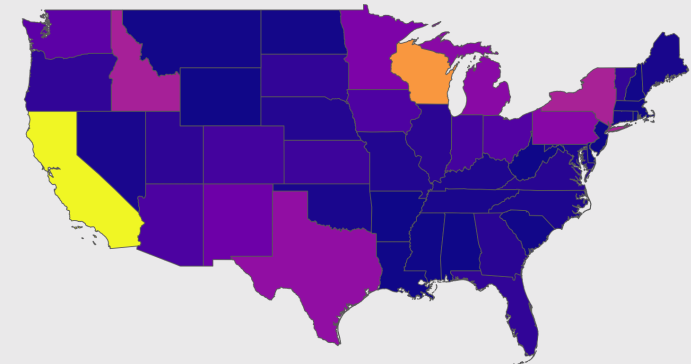
```
us_states %>%  
  select(name, milk_produced) %>%  
  head()
```

```
#> Simple feature collection with 6 features and 2 fields  
#> Geometry type: MULTIPOLYGON  
#> Dimension: XY  
#> Bounding box: xmin: -124.7346 ymin: 32.26694 xmax: -71.05118 ymax: 49.00027  
#> Geodetic CRS: WGS 84  
#>   name milk_produced  
#> 1 Washington 6.526 MUL  
#> 2 Idaho 14.627 MUL  
#> 3 Montana 0.288 MUL  
#> 4 North Dakota 0.345 MUL  
#> 5 Minnesota 9.864 MUL  
#> 6 Michigan 11.231 MUL
```

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



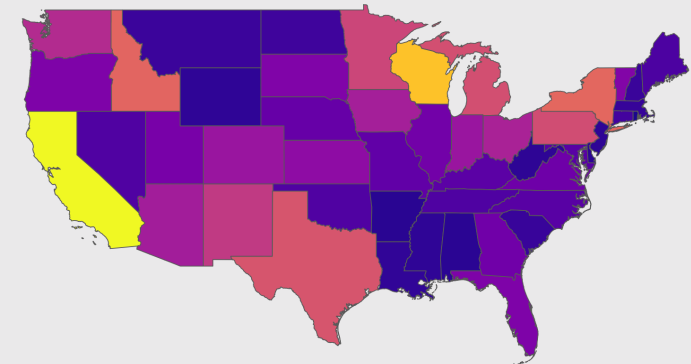
Milk produced
(billions lbs) 0 10 20 30 40

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



Milk produced
(billions lbs) 0 10 20 30 40

1. Choropleth maps

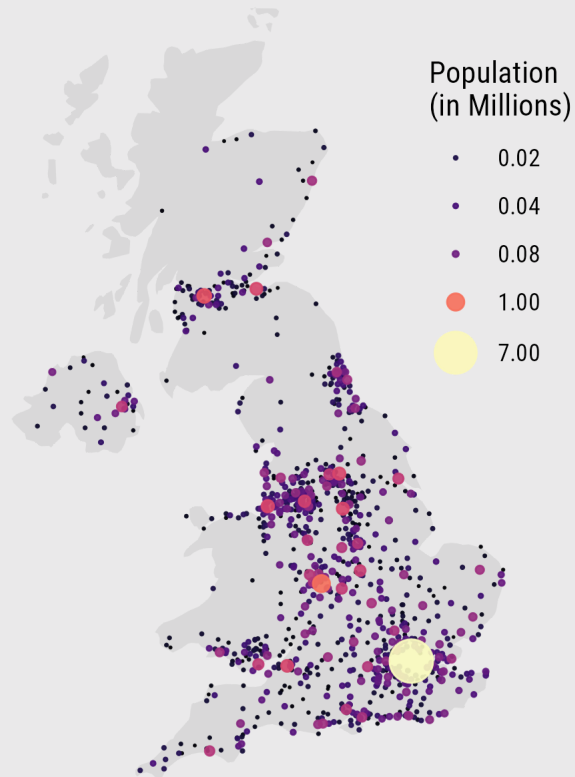
2. Point maps

Points as locations



Points encoding a variable

The 1000 most populous cities in the UK

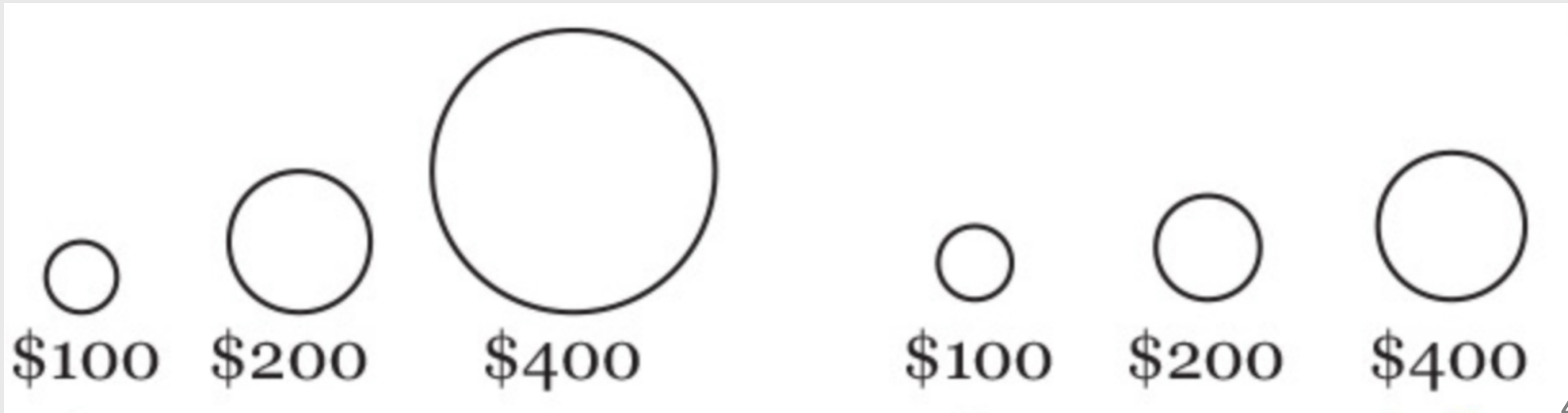


For point size, use **area**, not radius

$$Area = \pi r^2$$

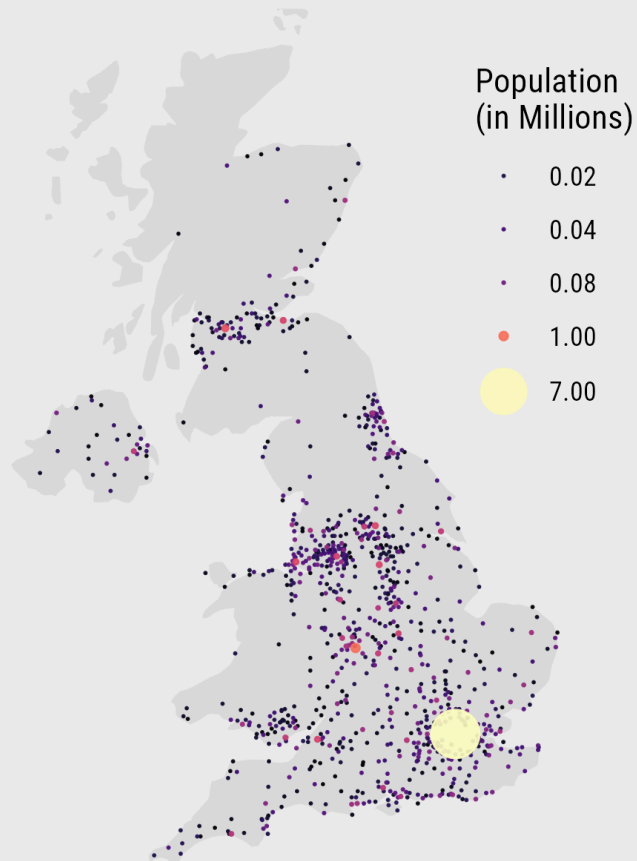
Radius

Area



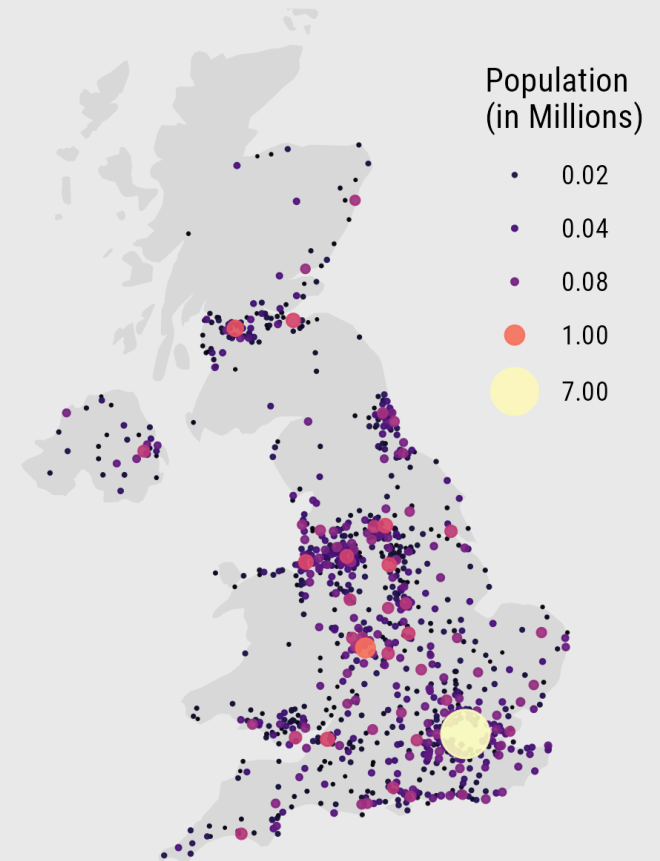
Radius

The 1000 most populous cities in the UK



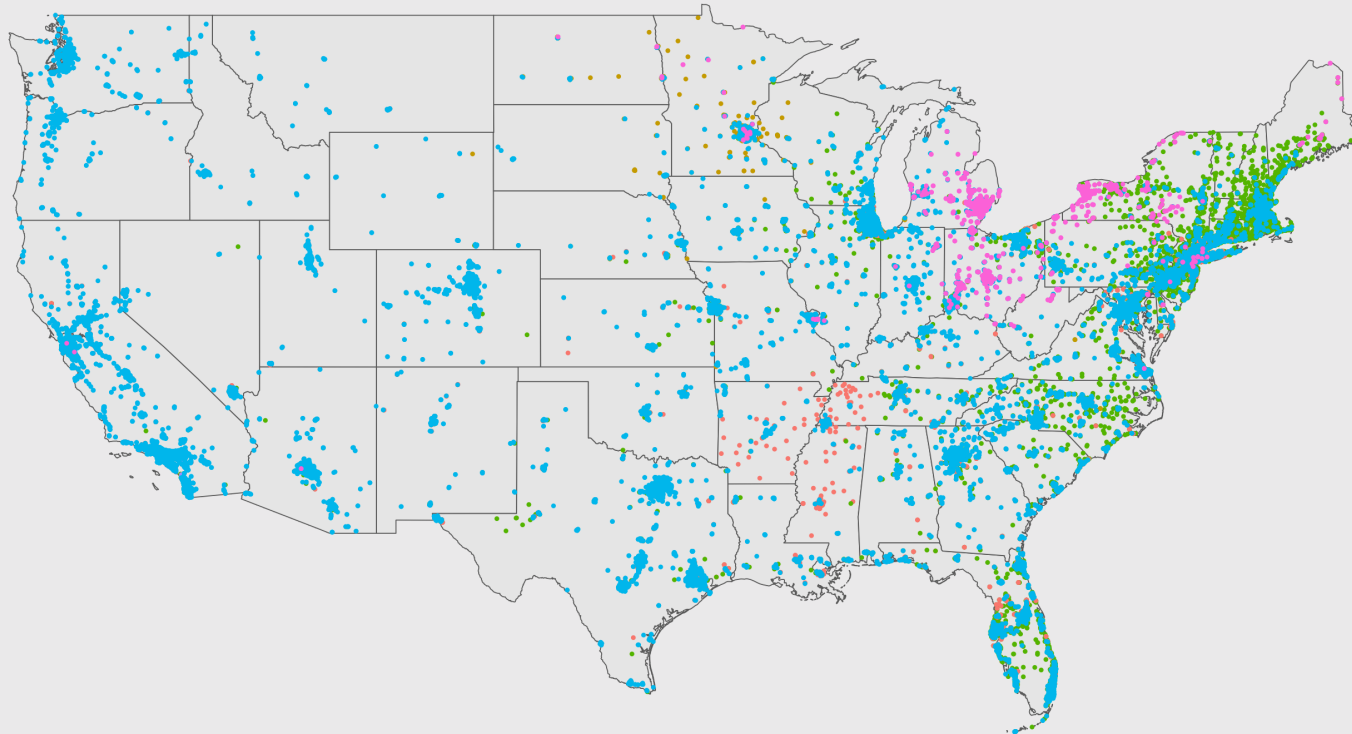
Area

The 1000 most populous cities in the UK



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)
```

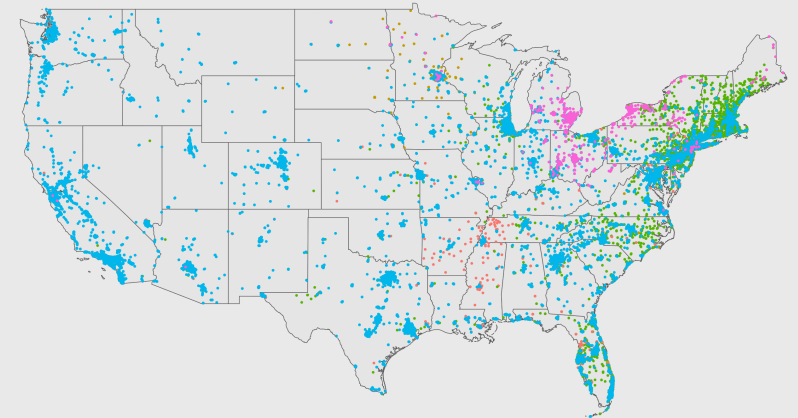
```
#> # A tibble: 6 × 8  
#>   name          lat  long unique_id ci  
#>   <chr>      <dbl> <dbl>   <dbl> <d  
#> 1 Baskin Robbins  40.8 -73.4   3304448 Hu  
#> 2 Baskin Robbins  42.1 -88.0   11342048 Ro  
#> 3 Baskin Robbins  34.0 -84.5    3304169 Ma  
#> 4 Baskin Robbins  29.8 -95.6    3304006 Ho  
#> 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'  
  )
```

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

15:00

Your turn

Create this map of squirrels in NYC's Central Park using this 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 11: *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

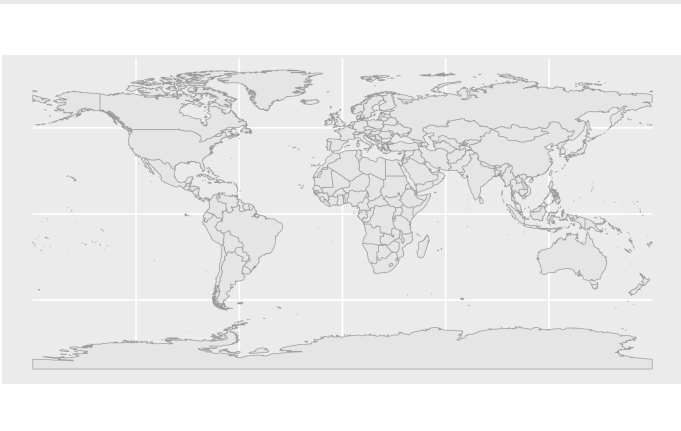
Using projections

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

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

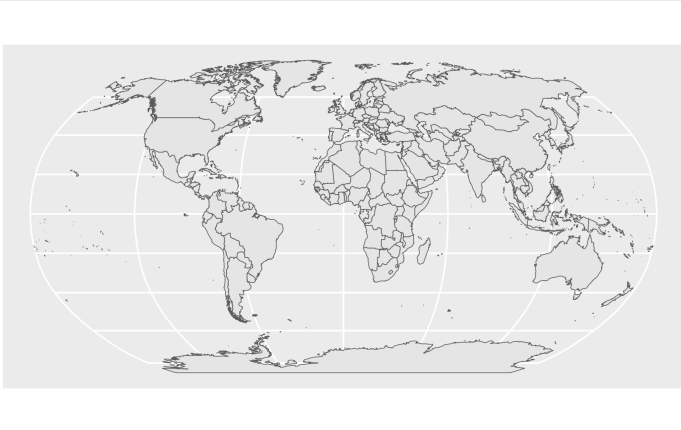
Default (long-lat)

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



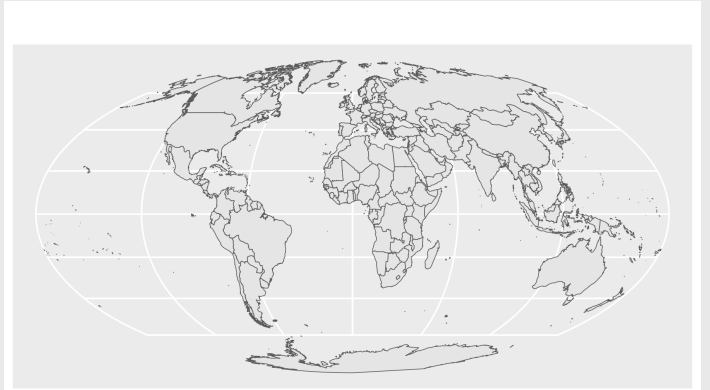
Robinson projection

```
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

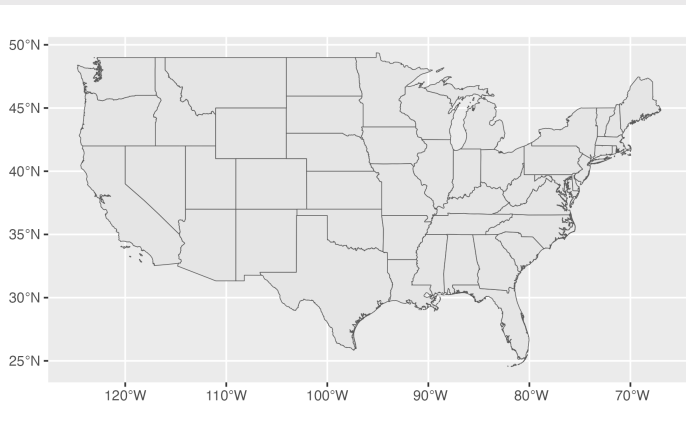
Code	Projection
"ESRI:102003"	Albers
"ESRI:102004"	Lambert Conformal Conic
4269	NAD 83

US projections

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

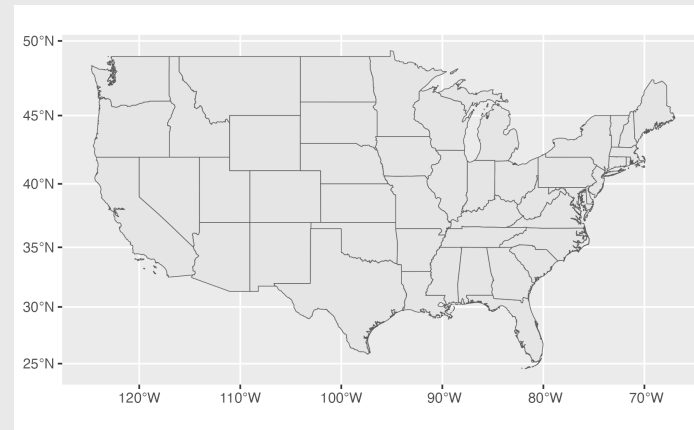
NAD 83 projection

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



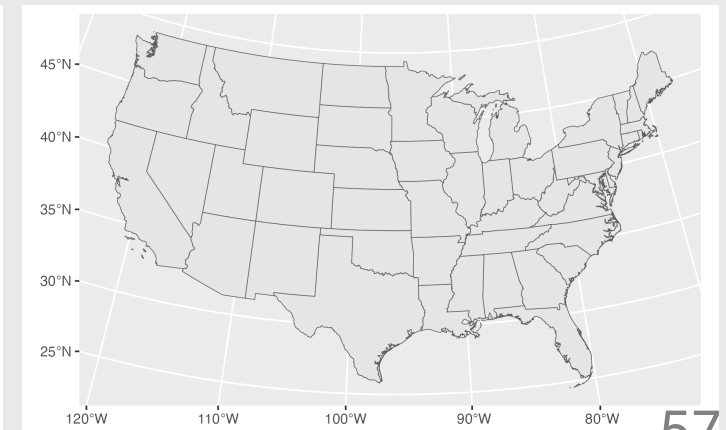
Mercator

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



Albers

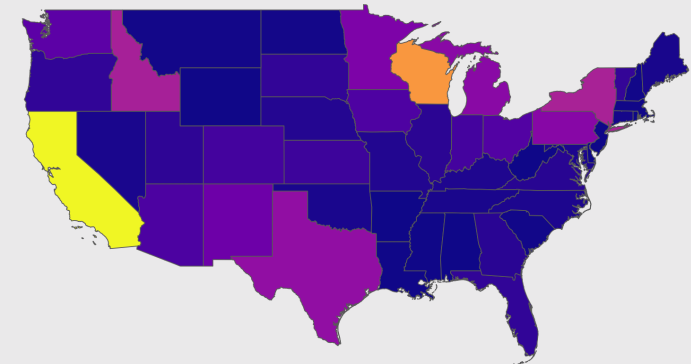
```
ggplot(data = us_states_cont) +  
  geom_sf() +  
  coord_sf(crs = "ESRI:10200")
```



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



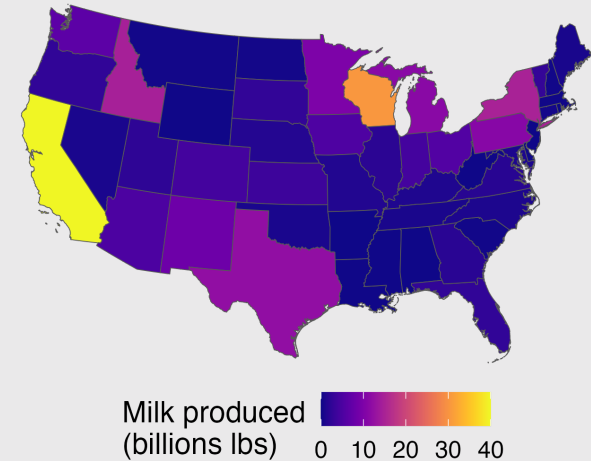
Milk produced
(billions lbs) 0 10 20 30 40

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

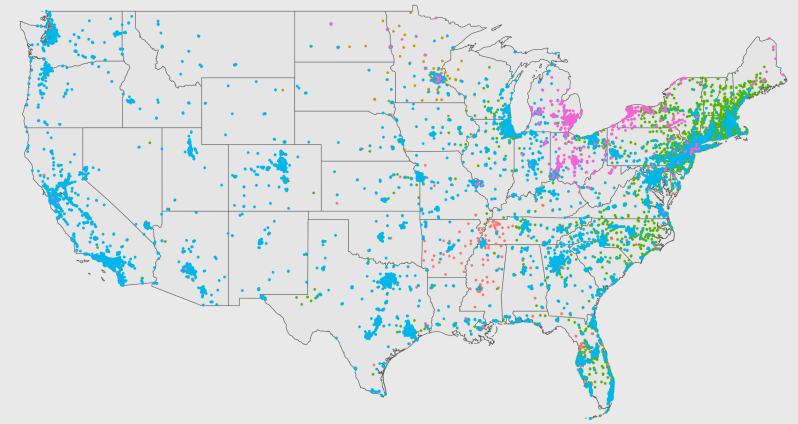
Milk Production by State in 2017



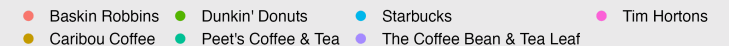
Mapping data to projections - points

```
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



Coffee shop



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



Coffee shop

- Baskin Robbins
- Dunkin' Donuts
- Starbucks
- Tim Hortons
- Caribou Coffee
- Peet's Coffee & Tea
- The Coffee Bean & Tea Leaf

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)
```

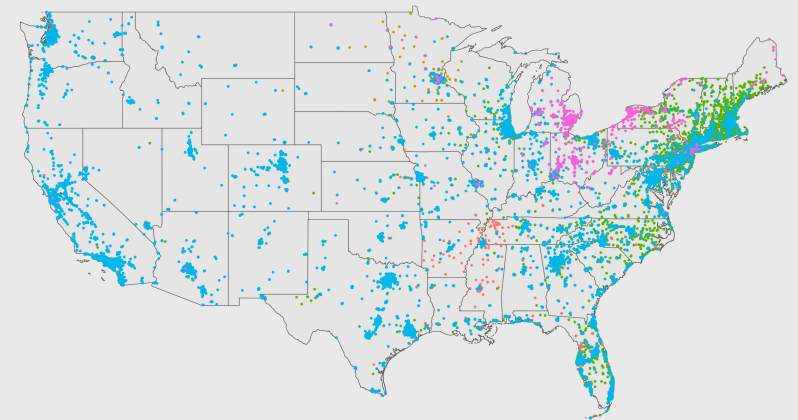
```
#> Simple feature collection with 6  
#> Geometry type: POINT  
#> Dimension: XY  
#> Bounding box: xmin: -95.60337 y  
#> Geodetic CRS: WGS 84  
#> # A tibble: 6 × 7  
#>   name                unique_id city  
#>   <chr>                <dbl> <chr>  
#> 1 Baskin Robbins      3304448 Hunt  
#> 2 Baskin Robbins     11342048 Roll  
#> 3 Baskin Robbins      3304169 Marie  
#> 4 Baskin Robbins      3304006 Houst  
#> 5 Baskin Robbins      3303959 Tipt  
#> 6 Baskin Robbins      3304507 Merr
```

Mapping data to projections - points

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

```
ggplot() +  
  geom_sf(data = us_states_cont) +  
  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'  
  )
```

Coffee Shops in the US



name

● Baskin Robbins ● Dunkin' Donuts ● Starbucks ● Tim Hortons
● Caribou Coffee ● Peet's Coffee & Tea ● The Coffee Bean & Tea Leaf

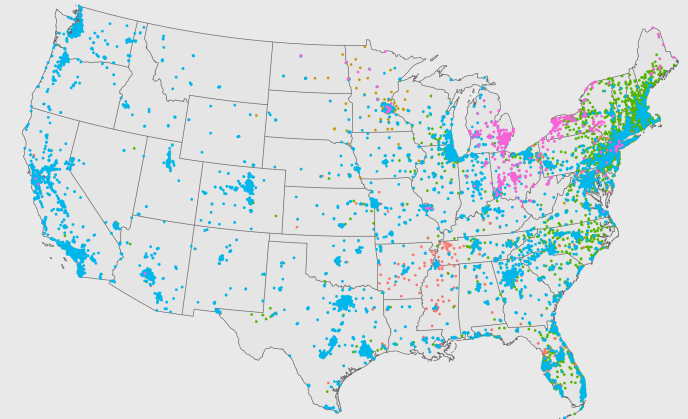
Mapping data to projections - points

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

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

Coffee Shops in the US



name

- Baskin Robbins
- Caribou Coffee
- Dunkin' Donuts
- Peet's Coffee & Tea
- Starbucks
- The Coffee Bean & Tea Leaf
- Tim Hortons

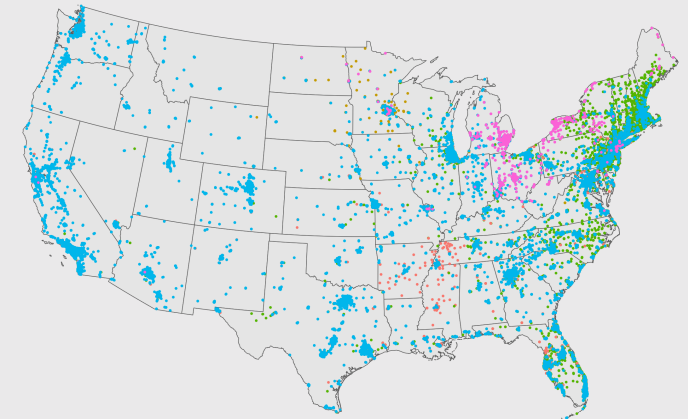
Mapping data to projections - points

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

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

Coffee Shops in the US



name

● Baskin Robbins ● Dunkin' Donuts ● Starbucks ● Tim Hortons
● Caribou Coffee ● Peet's Coffee & Tea ● The Coffee Bean & Tea Leaf

20:00

Your turn

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

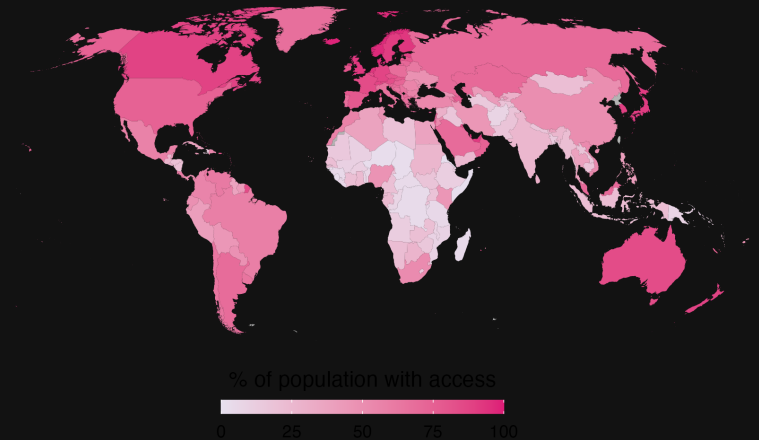
Hints:

- 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))
```

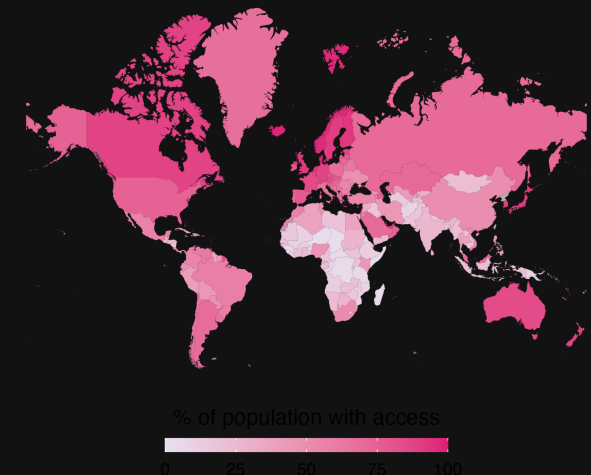
Robinson Projection

Internet access by country in 2015



Mercator Projection

Internet access by country in 2015



Remember: Mini Project 3 Due 11/19

(That's 2 weeks)

<https://eda.seas.gwu.edu/2024-Fall/mini/3-redesign.html>

Extra practice

Your turn

15:00

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

