

Space

Session 12

PMAP 8921: Data Visualization with R
Andrew Young School of Policy Studies
Fall 2023

Plan for today

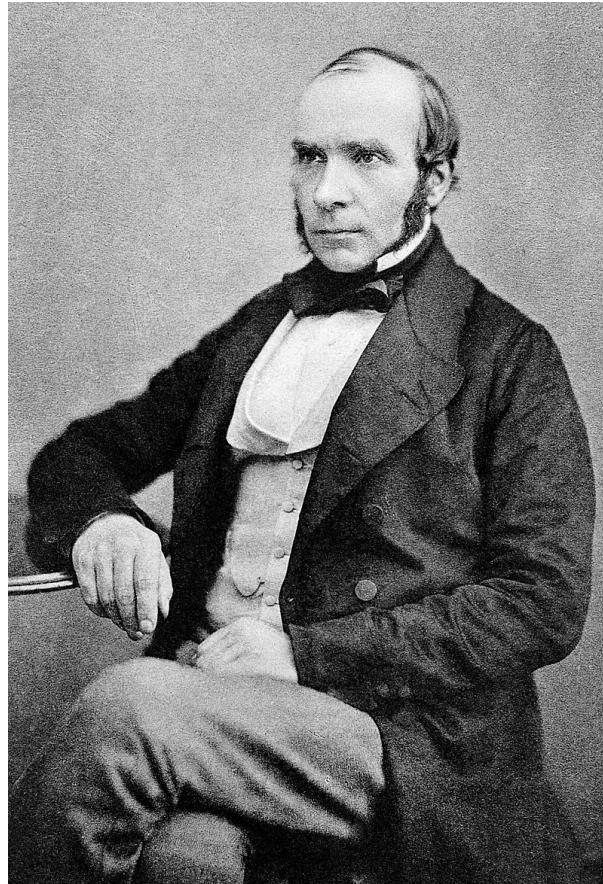
Maps and truth

Putting data on maps

GIS in R with {sf}

Maps and truth

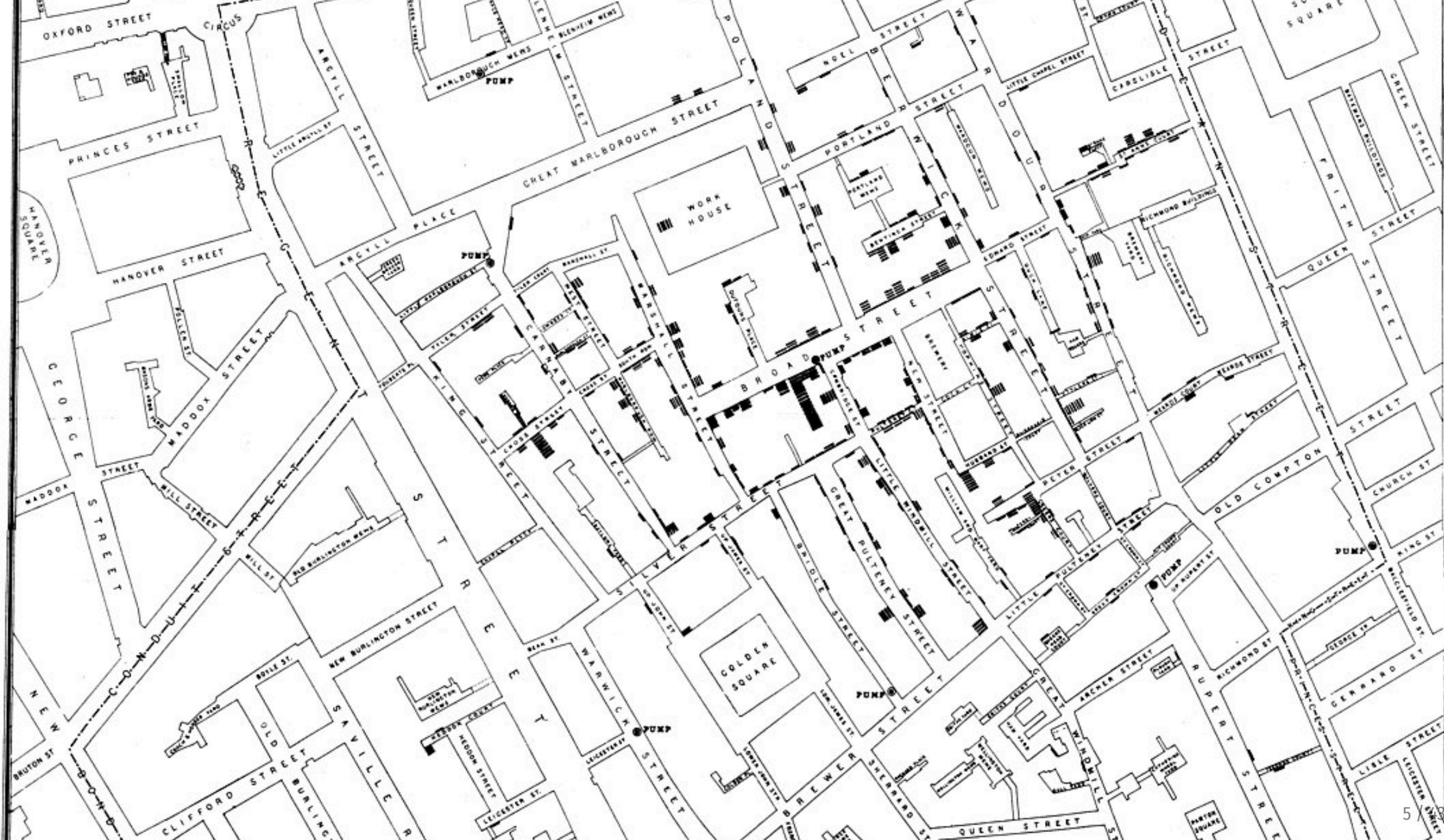
John Snow and 1854 cholera epidemic



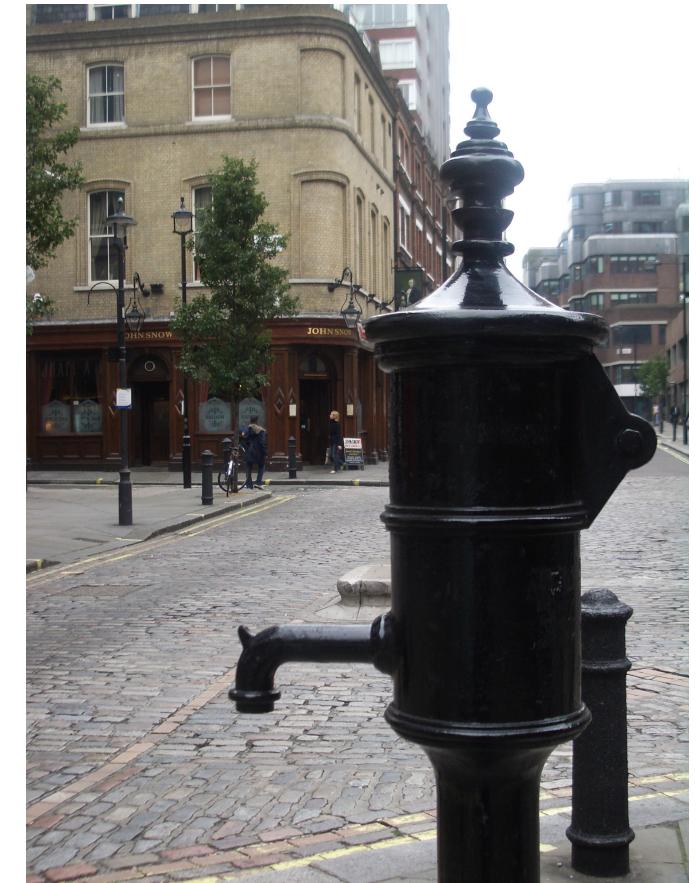
This Jo(h)n Snow knows things

10% of the population of Soho died in a week (!!)

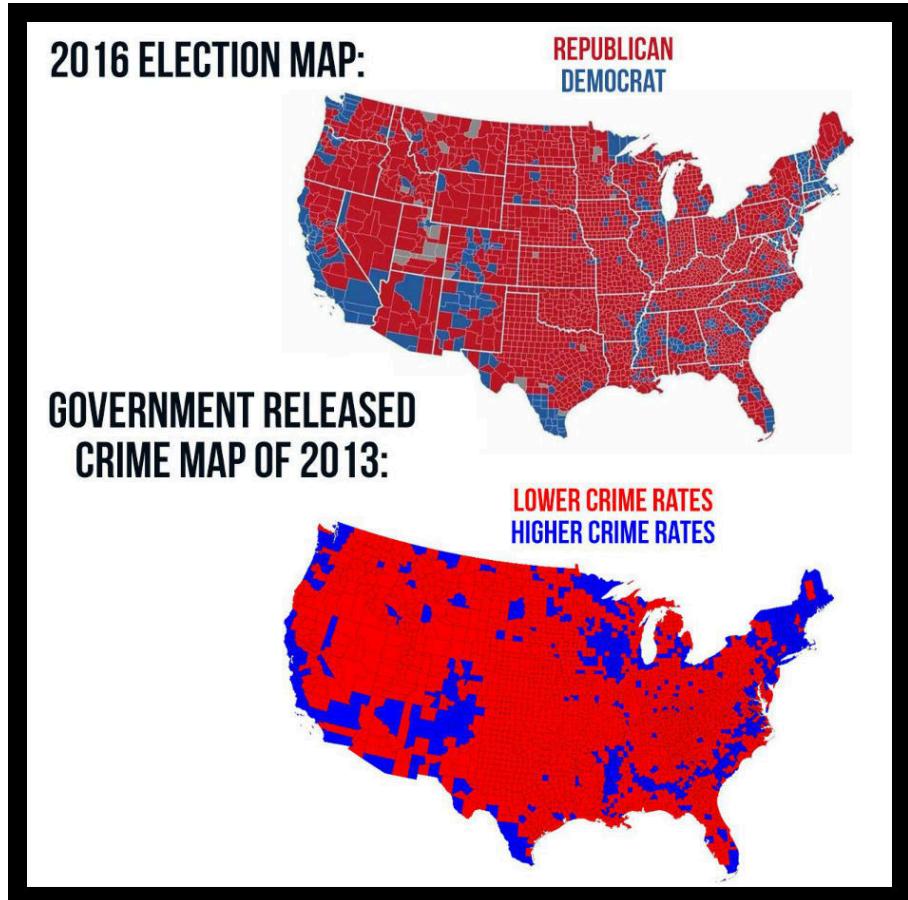
Miasma theory said it was because the air was bad



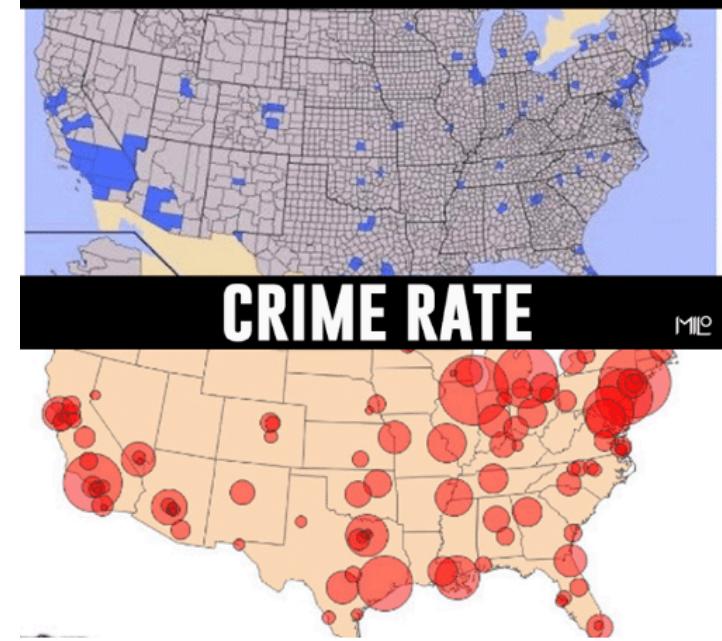
The Broad Street pump



Outright lies



ELECTORAL MAP 2016 ELECTION



Democrats are as consistent in voting as they are in crime I guess...

Fake maps and junk maps

FAST COMPANY

09-05-18

The next great fake news threat? Bot-designed maps

A new study reveals how maps go viral—and why they've become the perfect tool for misinformation.

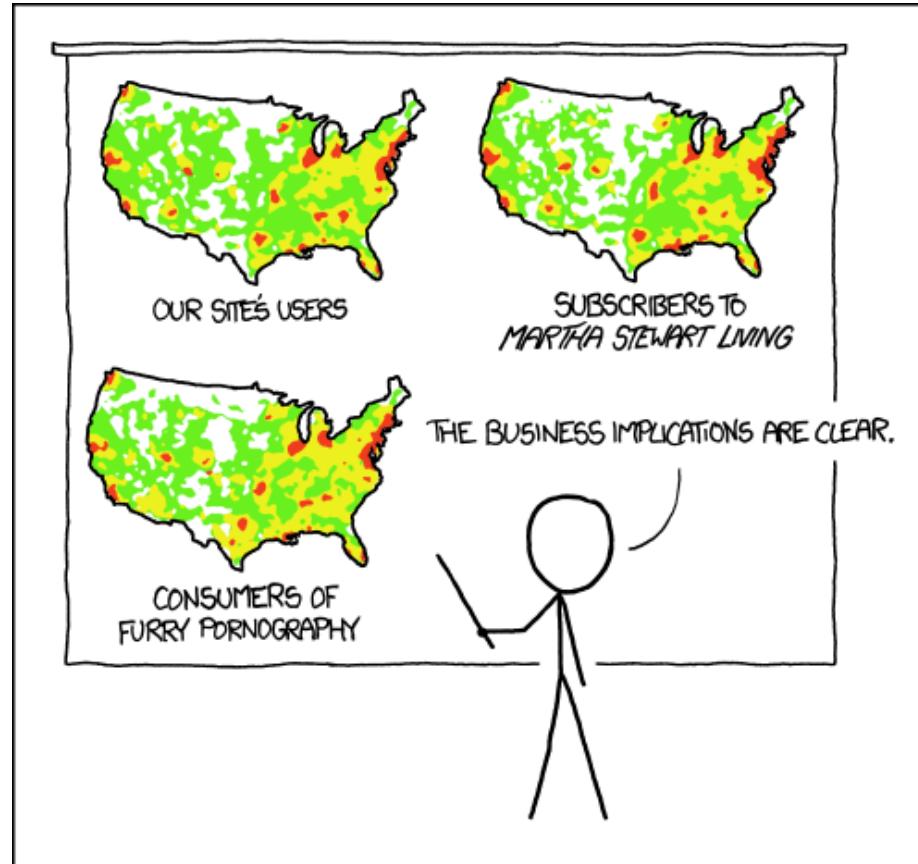


"The next great fake news threat? Bot-designed maps"

AMERICA'S FAVORITE CANDY BY STATE



Points can be useless

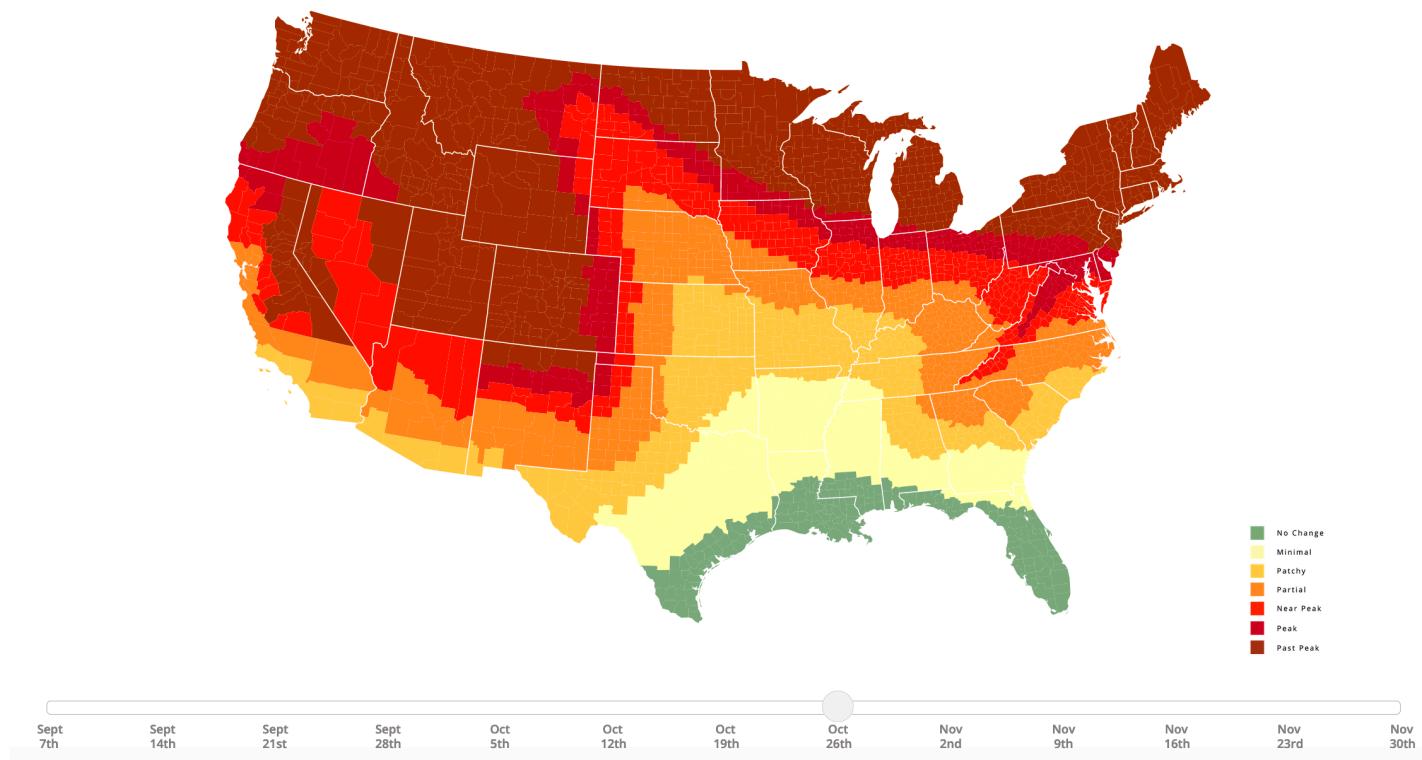


PET PEEVE #208:
GEOGRAPHIC PROFILE MAPS WHICH ARE
BASICALLY JUST POPULATION MAPS

Choropleths can be great

THE 2019

Fall Foliage Prediction Map



Smoky Mountains 2019 Fall Foliage Prediction Map

Choropleths can distort



Trey Yingst @TreyYingst



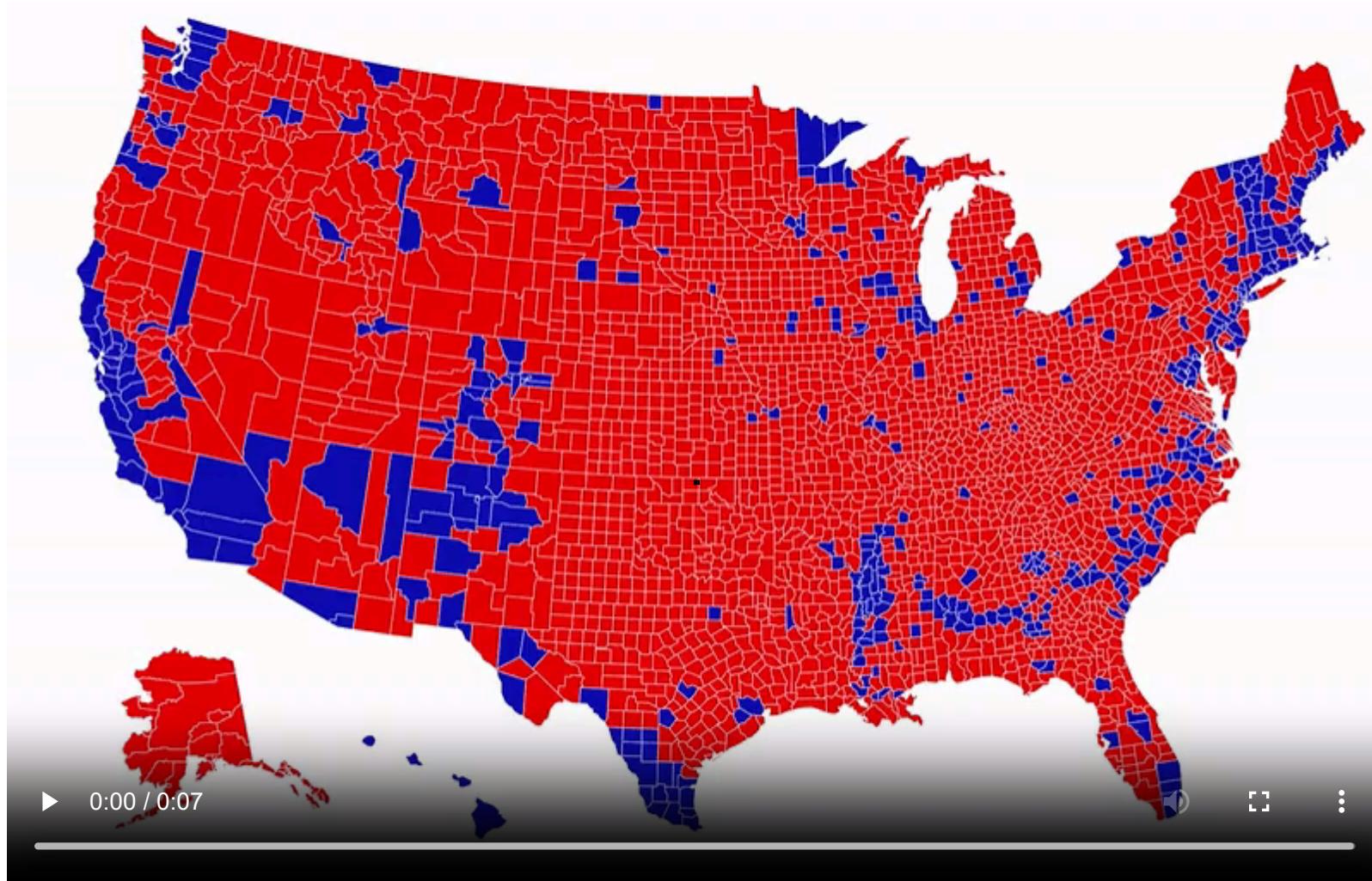
Spotted: A map to be hung somewhere in the West Wing



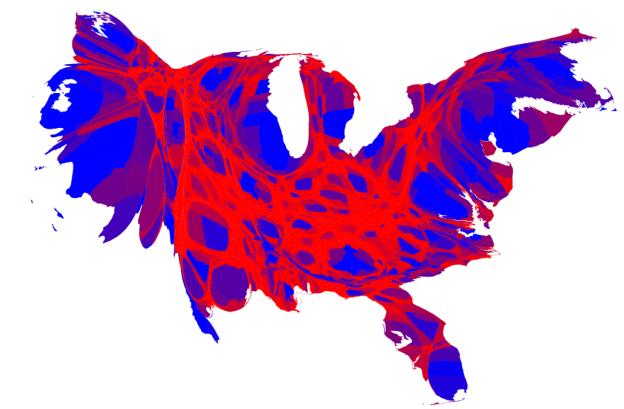
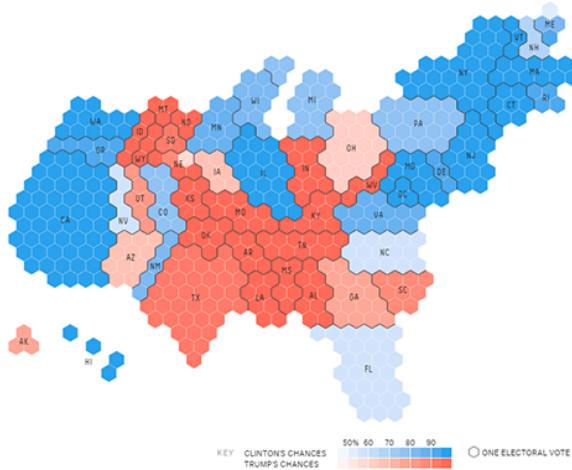
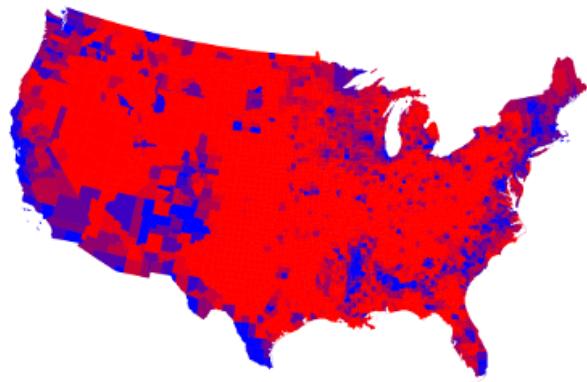
♡ 7,929 10:03 AM - May 11, 2017



Land doesn't vote

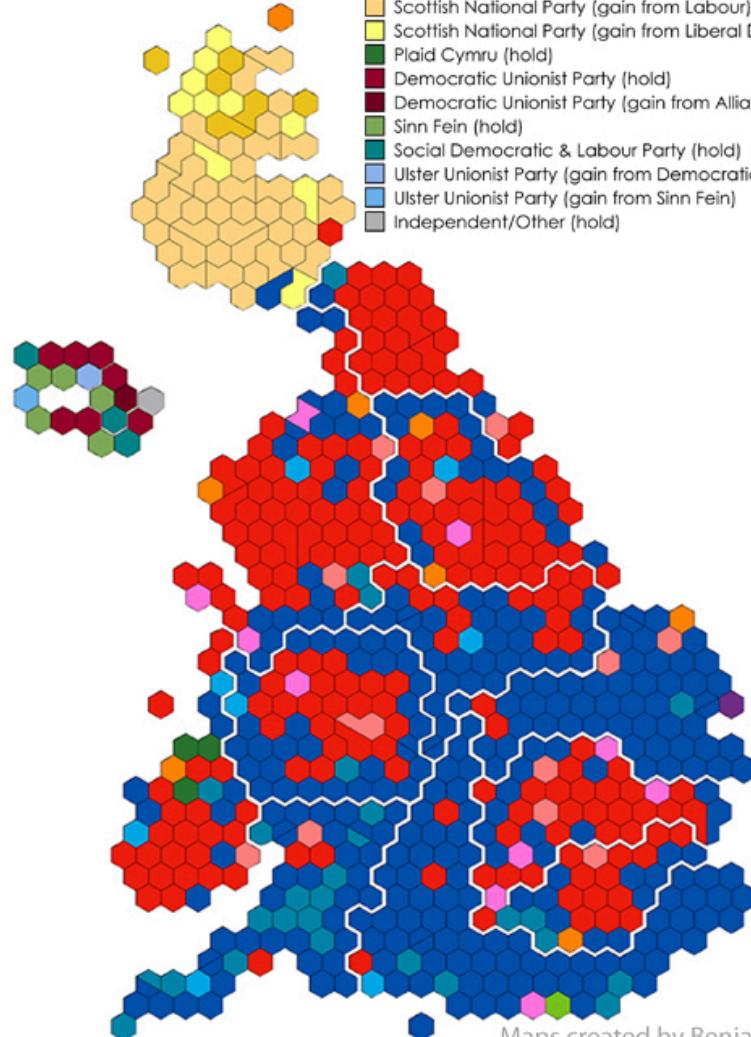
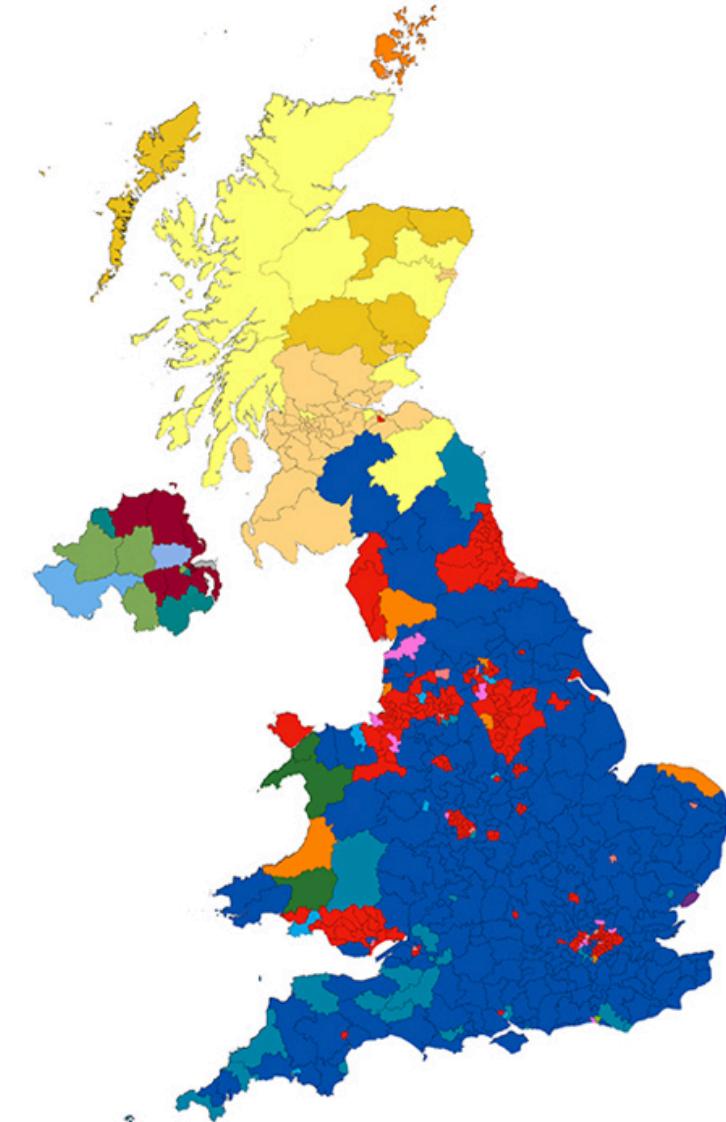


Cartograms



Electoral Doctrine

Mapping the
2015 UK General Election



Winning party (change since 2010)
Conservative (hold)
Conservative (gain from Labour)
Conservative (gain from Liberal Democrat)
Labour (hold)
Labour (gain from Conservative)
Labour (gain from Liberal Democrat)
Liberal Democrat (hold)
Green (hold)
UKIP (win from Conservative)
Scottish National Party (hold)
Scottish National Party (gain from Labour)
Scottish National Party (gain from Liberal Democrat)
Plaid Cymru (hold)
Democratic Unionist Party (hold)
Democratic Unionist Party (gain from Alliance Party)
Sinn Fein (hold)
Social Democratic & Labour Party (hold)
Ulster Unionist Party (gain from Democratic Unionist Party)
Ulster Unionist Party (gain from Sinn Fein)
Independent/Other (hold)

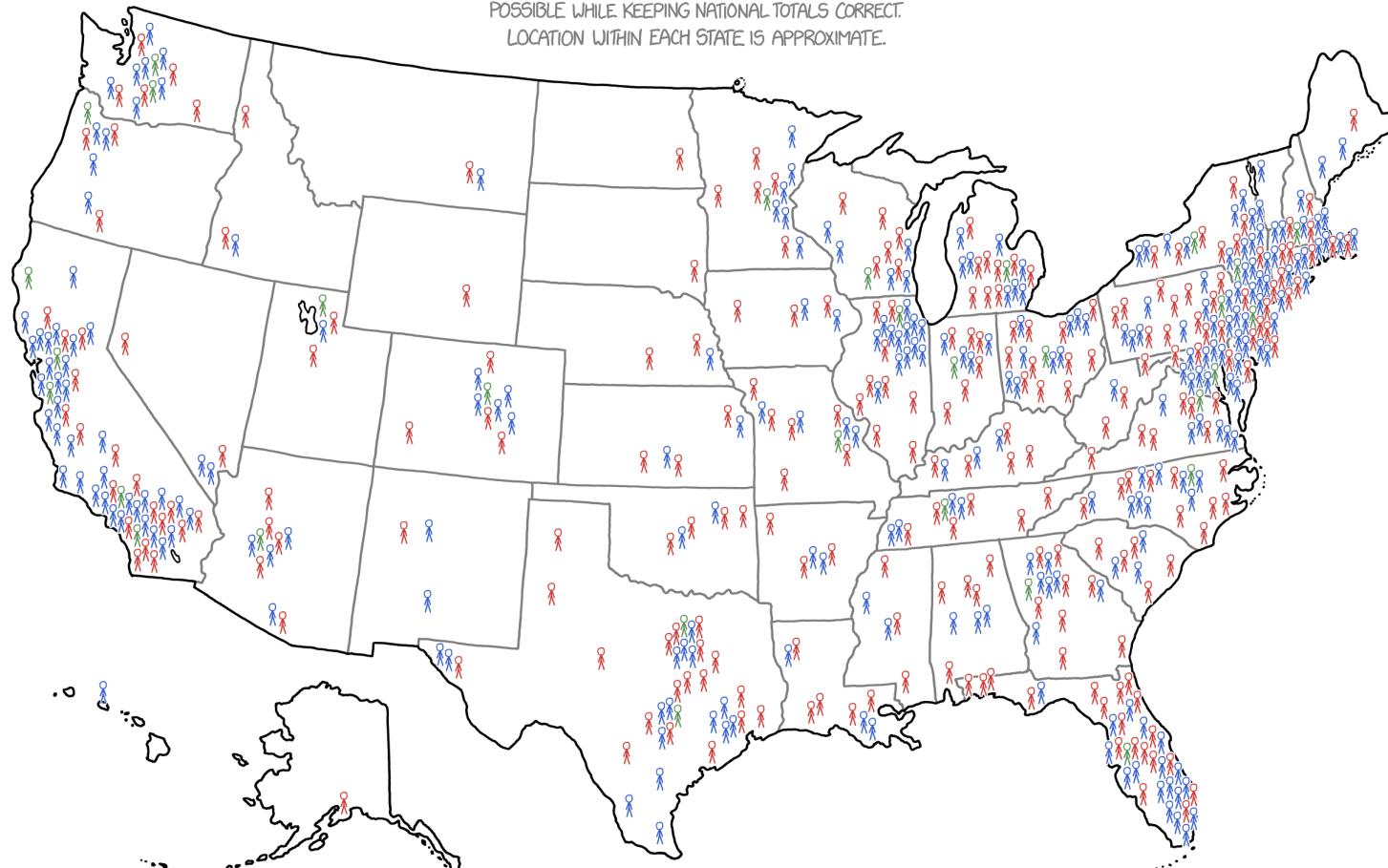
2016 ELECTION MAP

EACH FIGURE REPRESENTS 250,000 VOTES

TRUMP CLINTON OTHER

VOTES ARE DISTRIBUTED BY STATE AS ACCURATELY AS
POSSIBLE WHILE KEEPING NATIONAL TOTALS CORRECT.

LOCATION WITHIN EACH STATE IS APPROXIMATE.



Projections

Animated world projections

World projections

Longitude-latitude



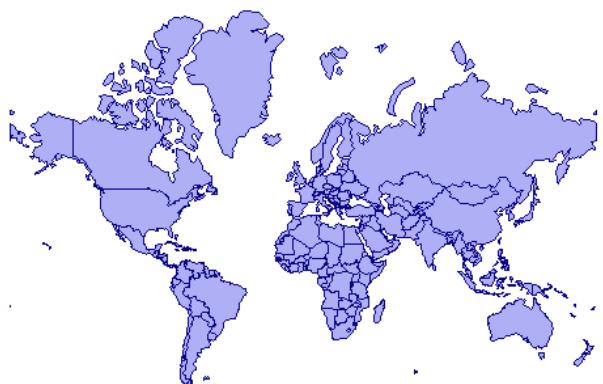
crs = "+proj=longlat +ellps=WGS84"

Gall-Peters



crs = "ESRI:54002"

Mercator



crs = "+proj=merc"

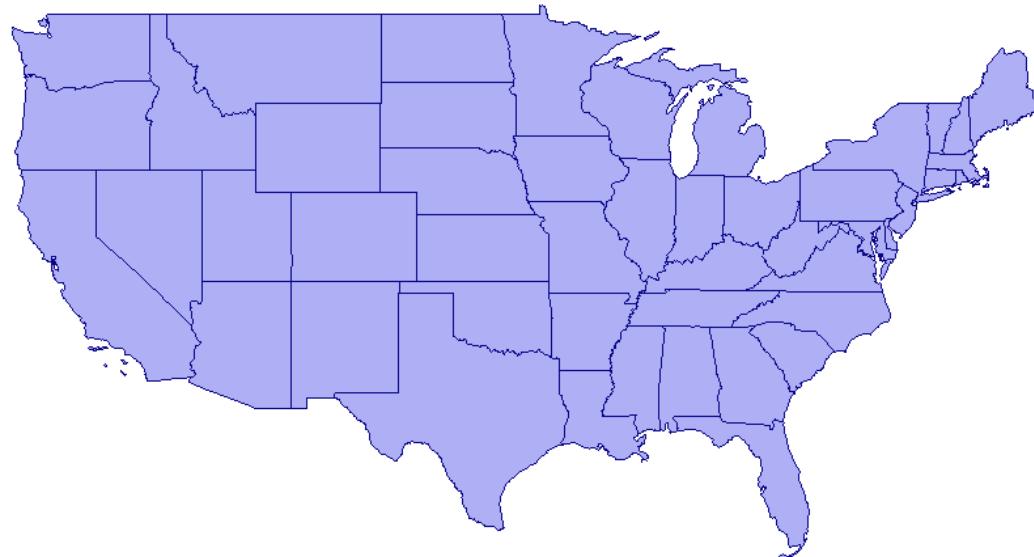
Robinson



crs = "+proj=robin"

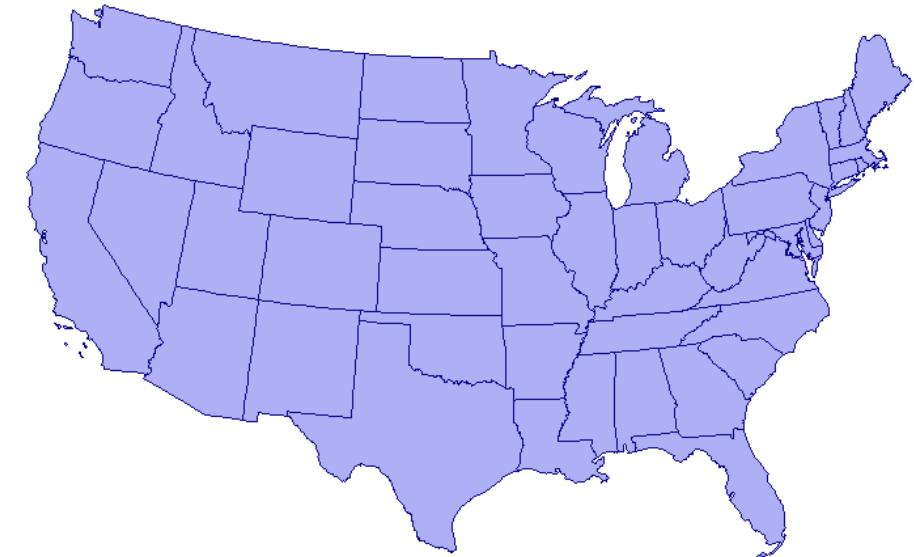
US projections

NAD83



crs = "EPSG:4269"

Albers



crs = "ESRI:102003"

Finding projection codes

spatialreference.org

epsg.io

proj.org

Most common ones listed on the
course website example page

This is an excellent overview of how this all works

And this is a really really helpful overview of all these moving parts

Which projection is best?

None of them

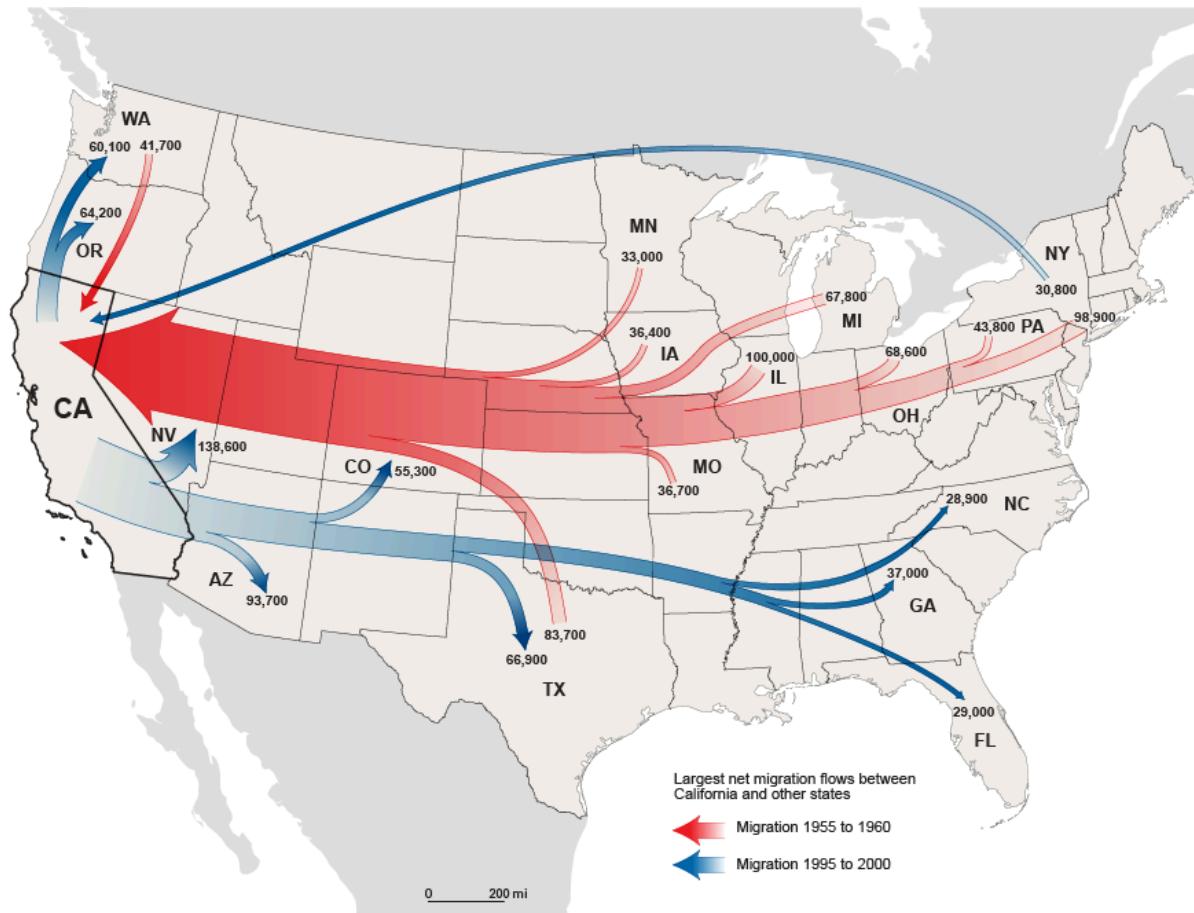
There are no good or bad projections

There are appropriate and
inappropriate projections

(but also ew mercator)

Putting data on maps

Maps with lines



US Census Bureau: Net migration between California and other states

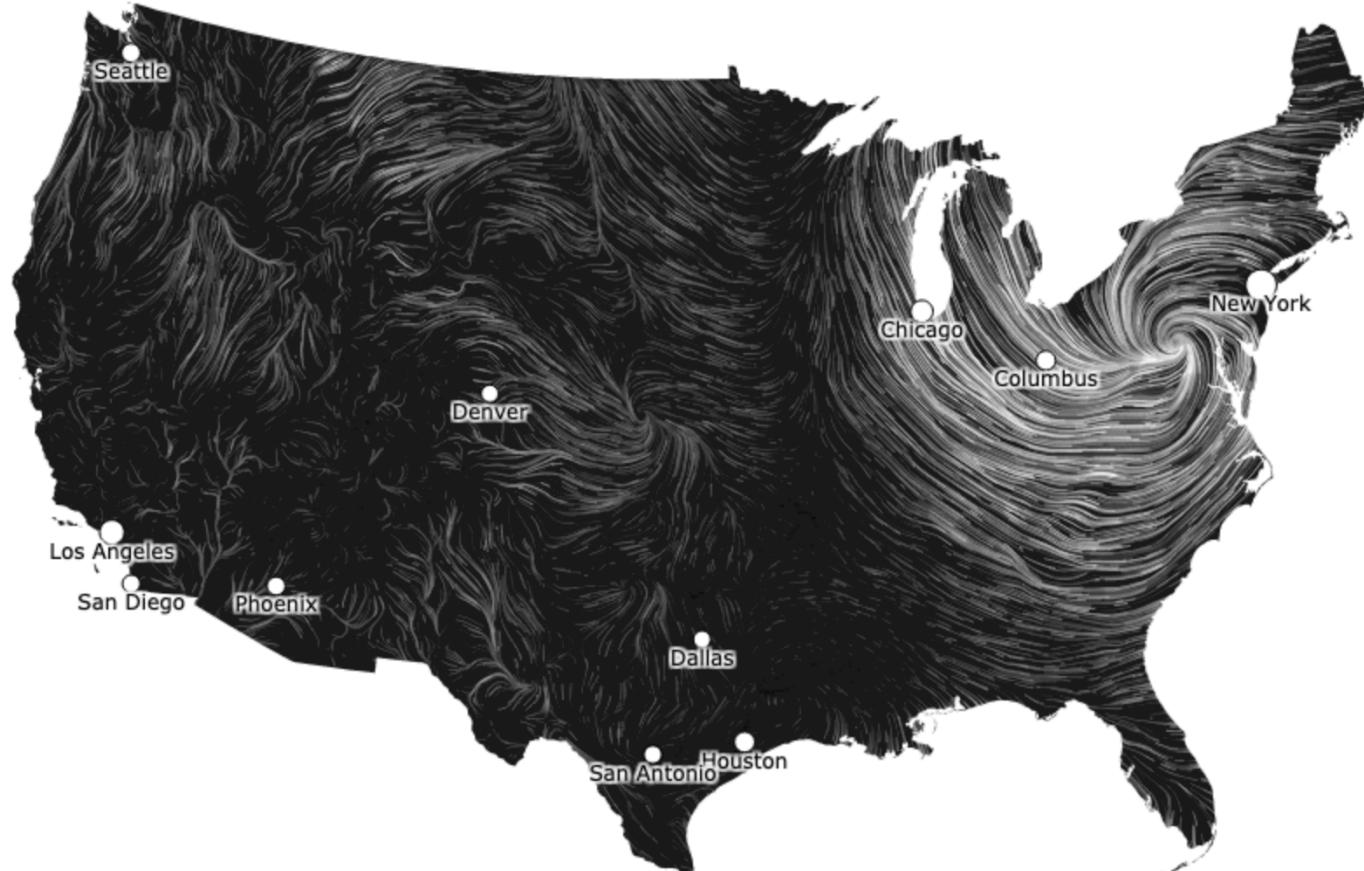
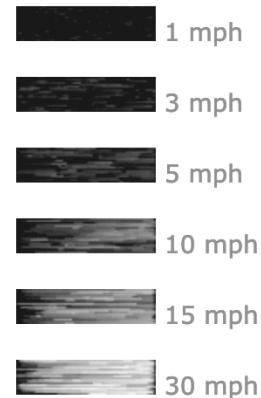
Maps with lines

October 30, 2012

6:59 am EST

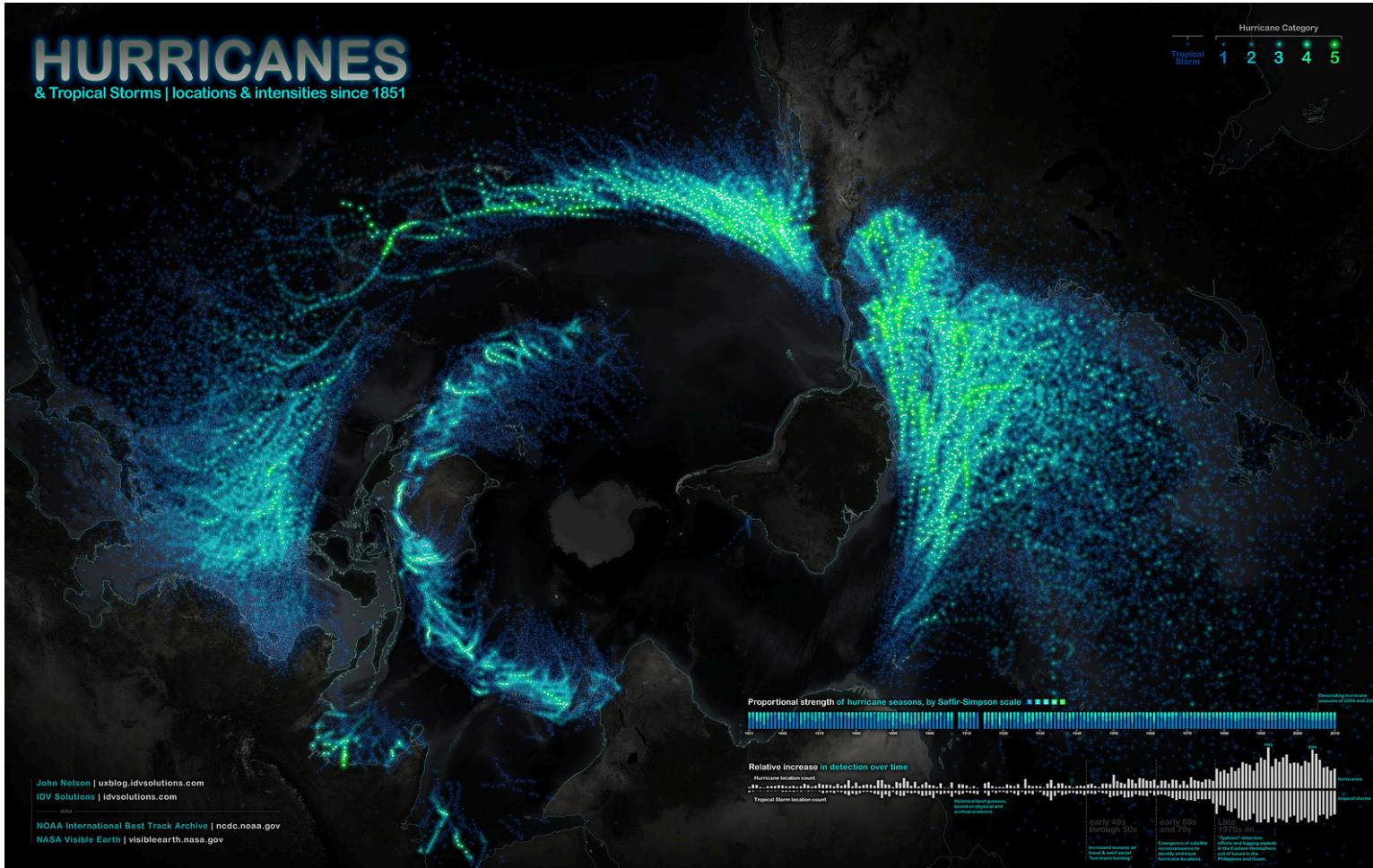
(time of forecast download)

top speed: **39.7 mph**
average: **8.4 mph**



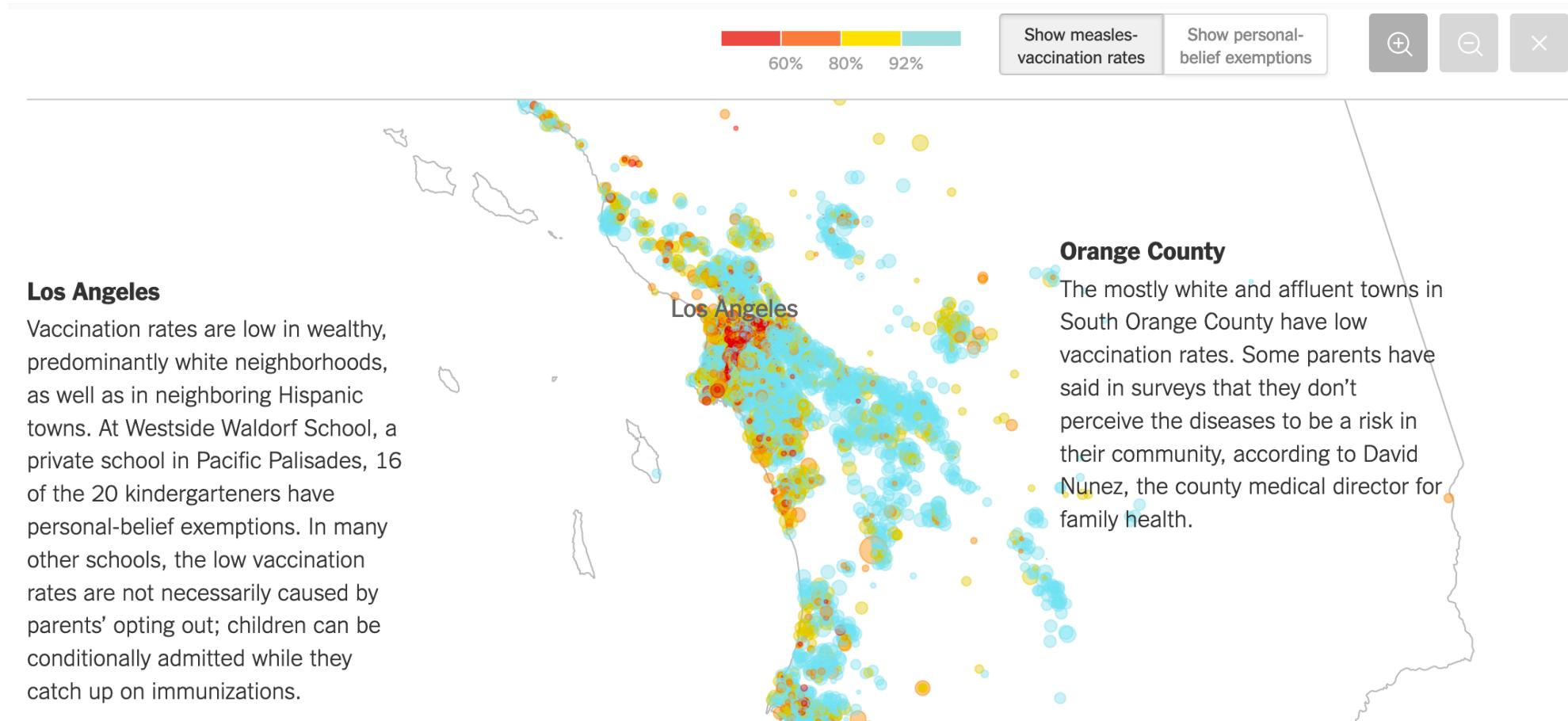


Maps with points



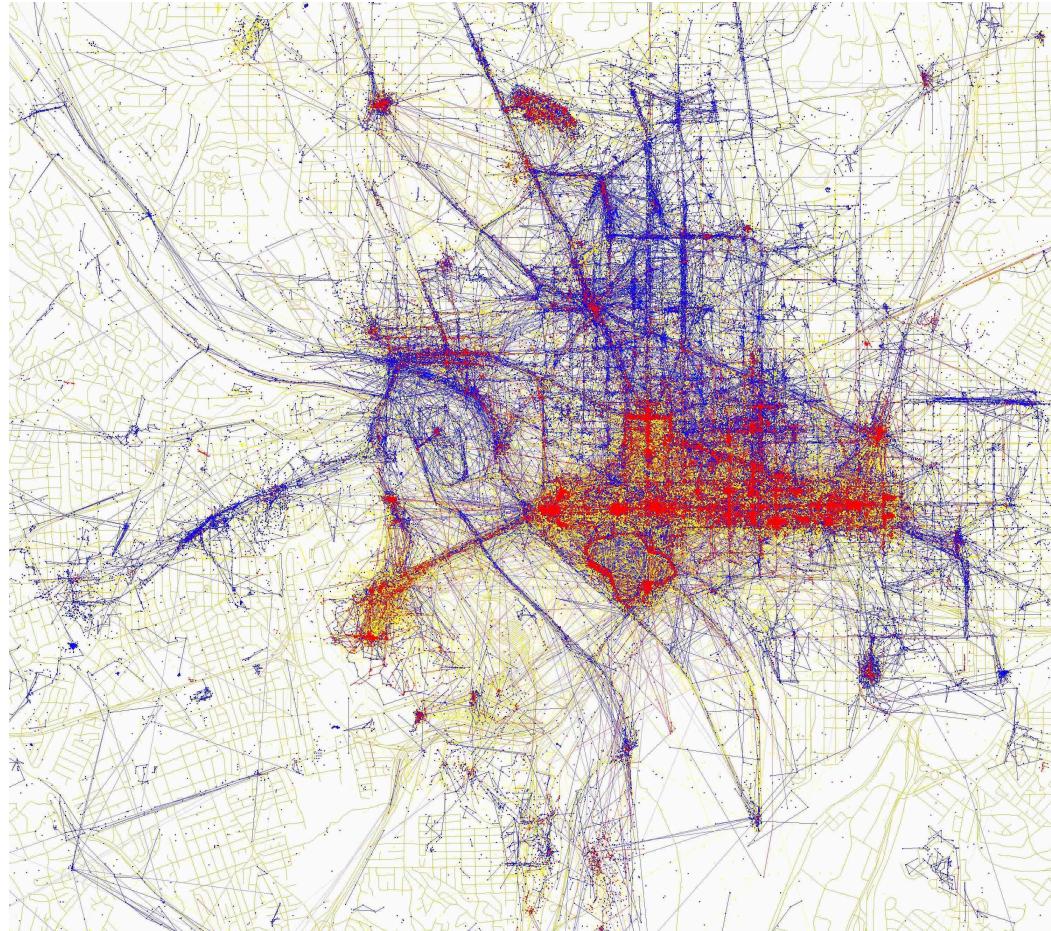
Every hurricane since 1851, by IDV solutions

Maps with points



The New York Times, "Vaccination Rates for Every Kindergarten in California"

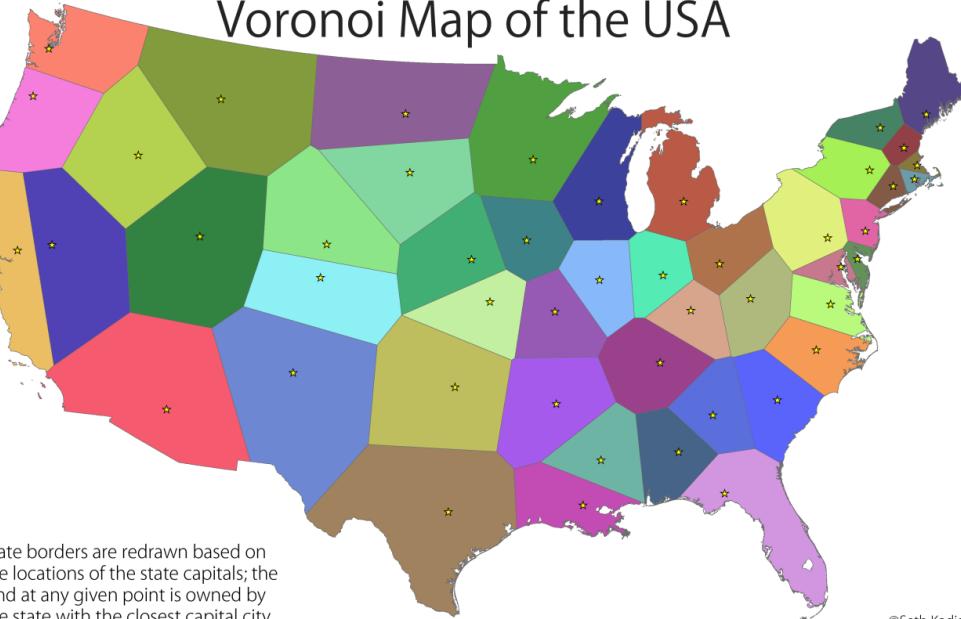
Maps with points



Locals vs. tourists in DC (blue = locals; red = tourists; yellow = unknown)

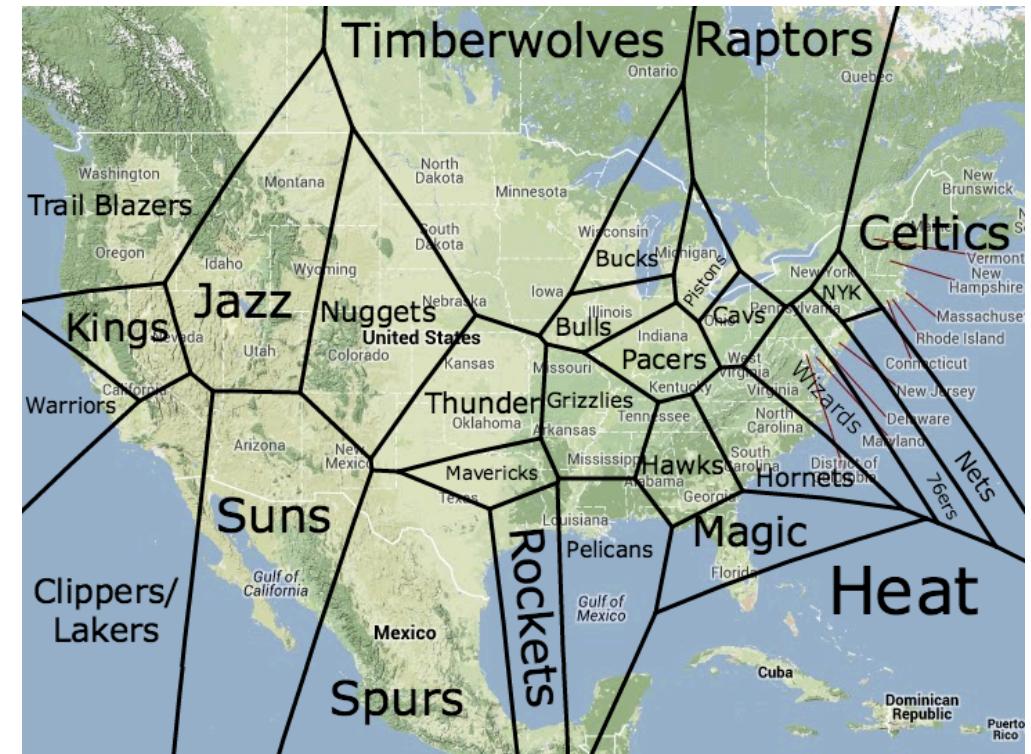
Voronoi maps

Voronoi Map of the USA



©Seth Kadish

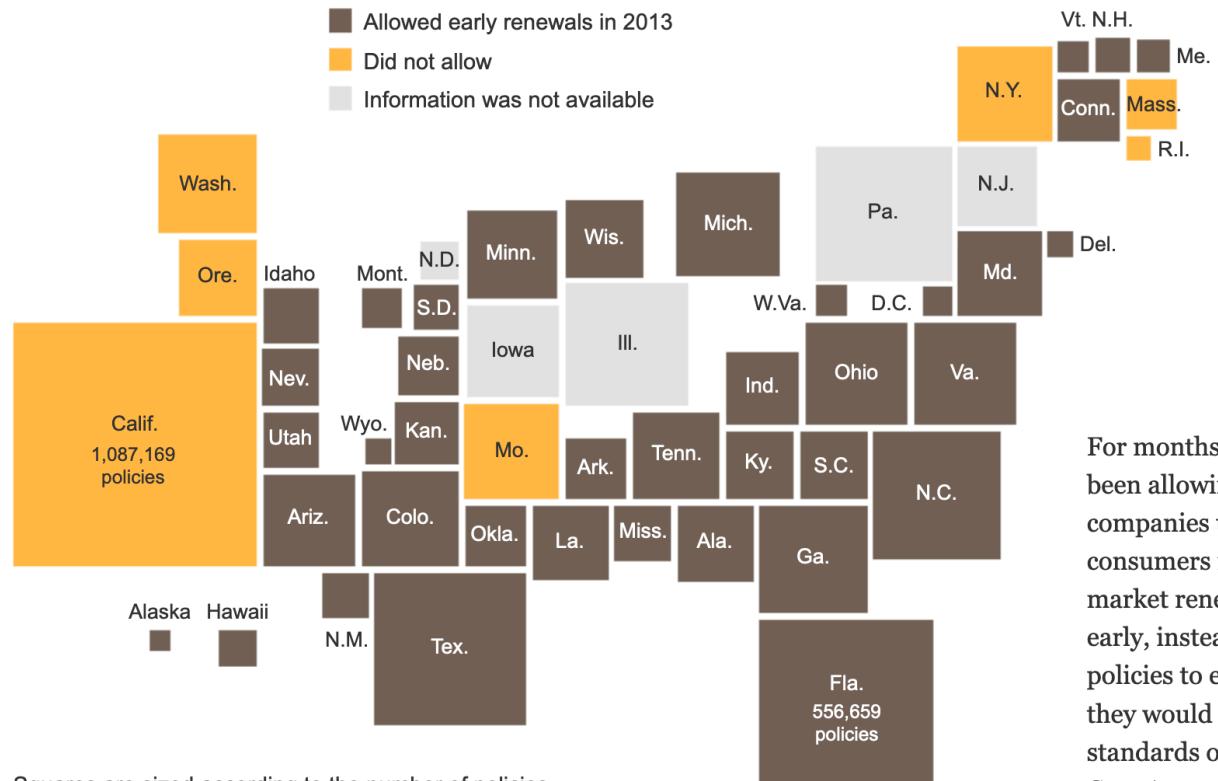
Voroni state boundaries, by Seth Kadish



Closest NBA teams

Maps with shapes

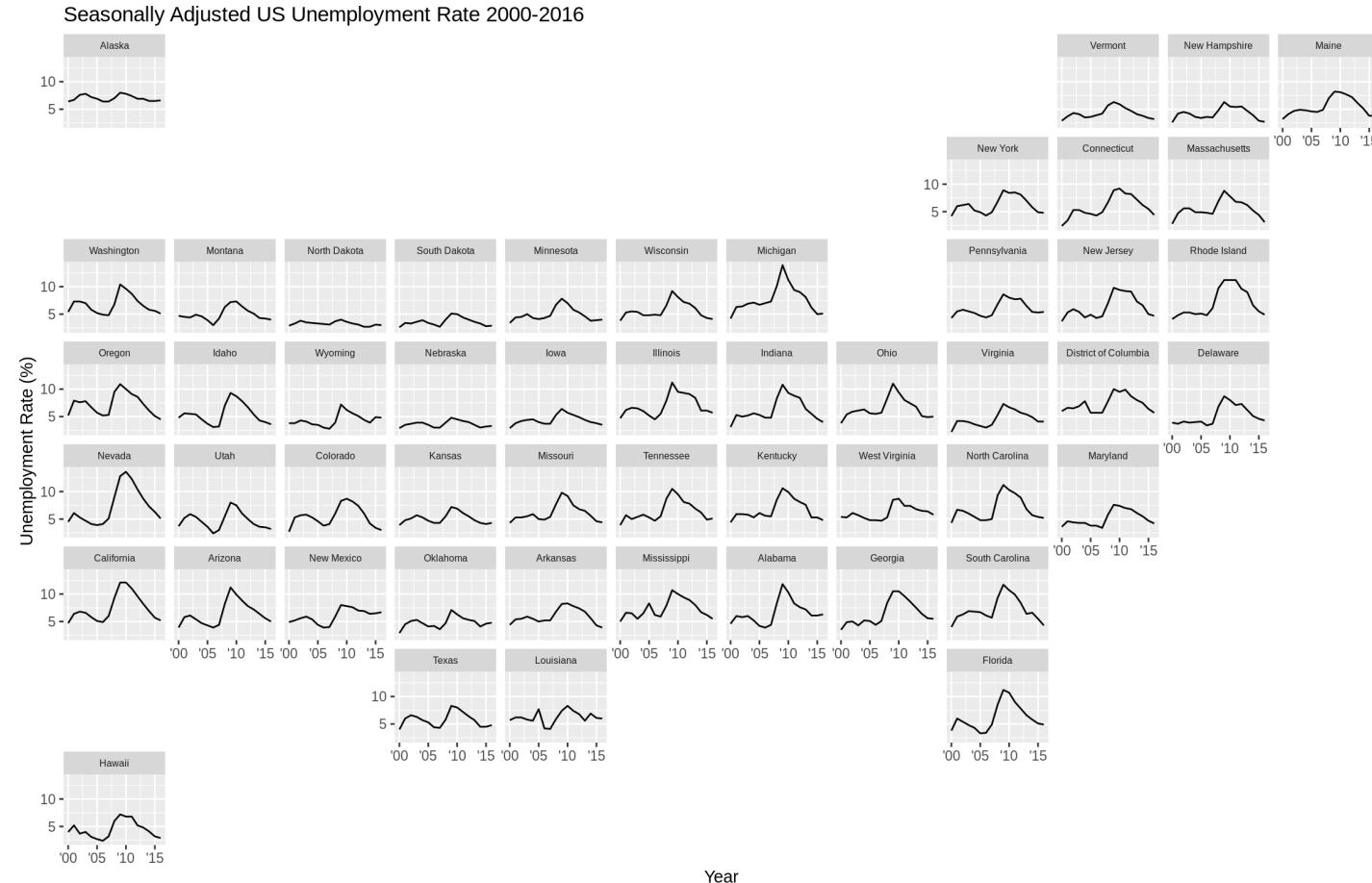
States Where Insured Could Renew Plans Before Change by Obama



Squares are sized according to the number of policies in each state's individual insurance market in 2012.

For months, many states have been allowing insurance companies the option of letting consumers in the individual market renew their policies early, instead of waiting for the policies to expire in 2014, when they would not meet the standards of the Affordable Care Act. [Related Article »](#)

Small multiples that look like maps



facet_geo() in the **geofacet** package

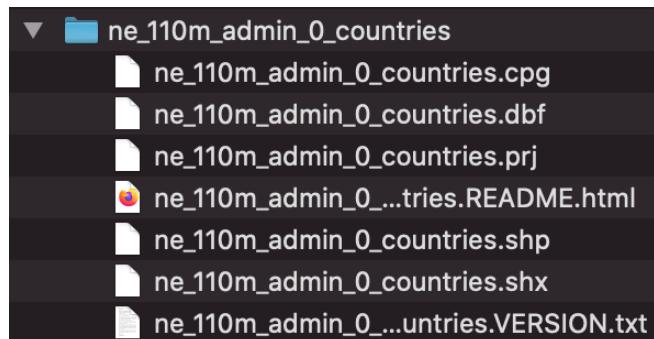
GIS in R with {sf}

Shapefiles

Geographic information is shared as **shapefiles**

These are *not* like regular single CSV files!

Shapefiles come as zipped files with
a bunch of different files inside



Structure of a shapefile

```
library(sf)
world_shapes <- read_sf("data/ne_110m_admin_0_countries/ne_110m_admin_0_countries.shp")

## Simple feature collection with 7 features and 3 fields
## Geometry type: MULTIPOLYGON
## Dimension: XY
## Bounding box: xmin: -180 ymin: -18 xmax: 180 ymax: 83
## Geodetic CRS: WGS 84
## # A tibble: 7 × 4
##   TYPE           GEOUNIT      ISO_A3      geometry
##   <chr>          <chr>       <chr>      <MULTIPOLYGON [°]>
## 1 Sovereign country Fiji        FJI        (((180 -16, 180 -17, 179 -17, 179 -17...
## 2 Sovereign country Tanzania  TZA        (((34 -0.95, 34 -1.1, 38 -3.1, 38 -3...
## 3 Indeterminate    Western Sahara ESH        (((-8.7 28, -8.7 28, -8.7 27, -8.7 26...
## 4 Sovereign country Canada     CAN        ((((-123 49, -123 49, -125 50, -126 50...
## 5 Country          United States of America USA        ((((-123 49, -120 49, -117 49, -116 49...
## 6 Sovereign country Kazakhstan KAZ        (((87 49, 87 49, 86 48, 86 47, 85 47, ...
## 7 Sovereign country Uzbekistan UZB        (((56 41, 56 45, 59 46, 59 46, 60 45, ...
```

Where to find shapefiles

Natural Earth for international maps

US Census Bureau for US maps

For anything else...

Google



Scales



$1:10m = 1:10,000,000$

$1 \text{ cm} = 100 \text{ km}$



$1:50m = 1:50,000,000$

$1\text{cm} = 500 \text{ km}$

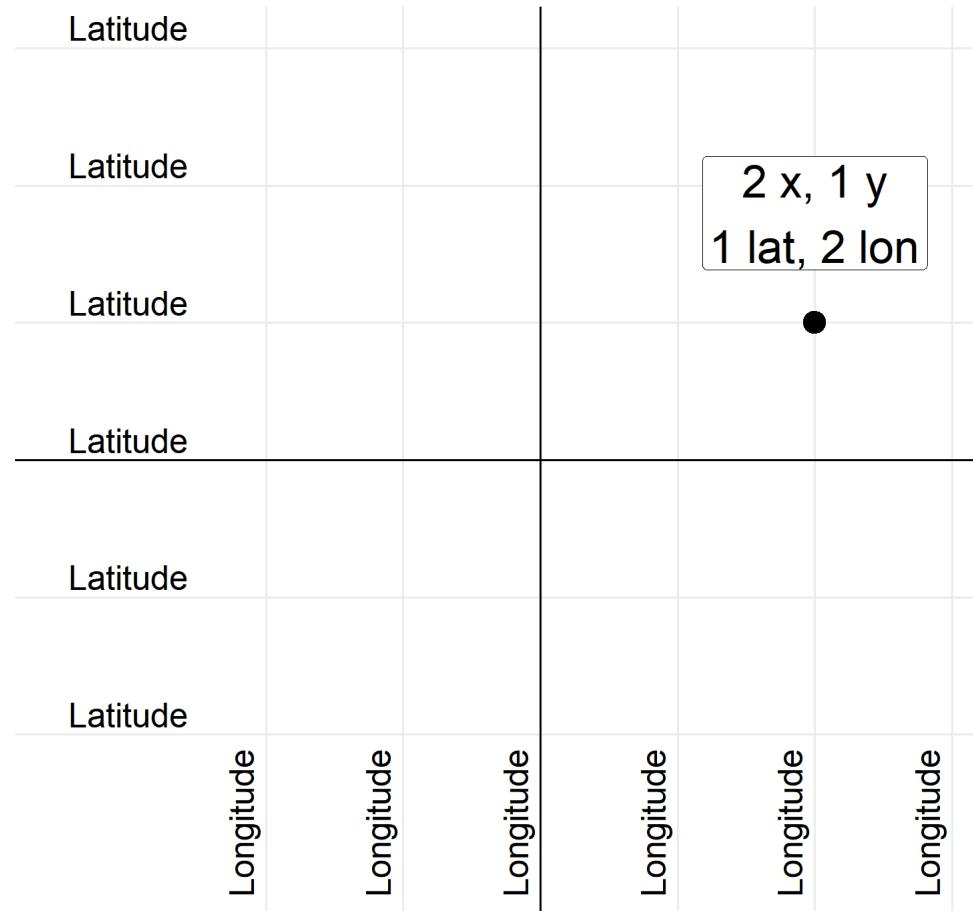


$1:110m = 1:110,000,000$

$1 \text{ cm} = 1,100 \text{ km}$

**Using too high of a resolution
makes your maps slow and huge**

Latitude and longitude

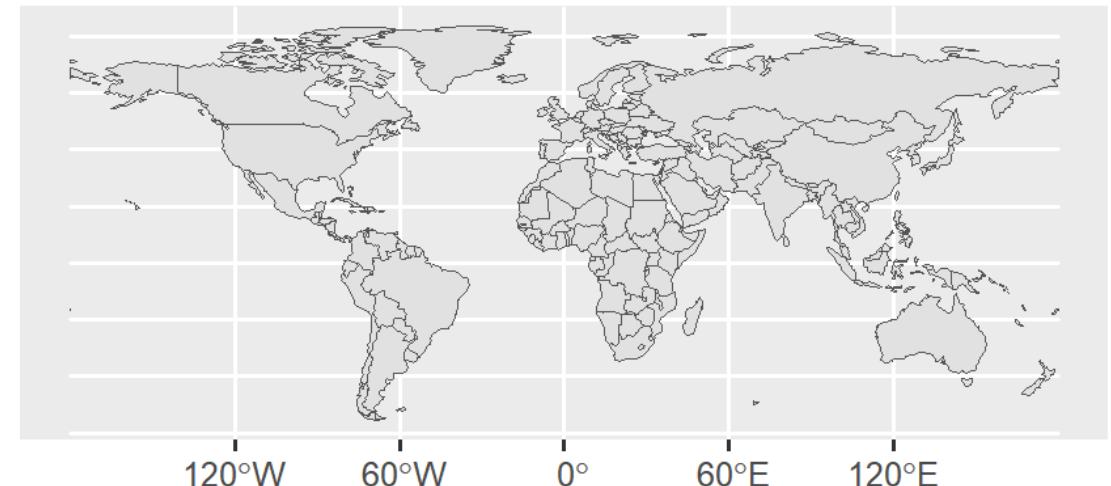


via @sarahbellmaps

The magic geometry column

As long as you have a **magic geometry column**,
all you need to do to plot maps is `geom_sf()`

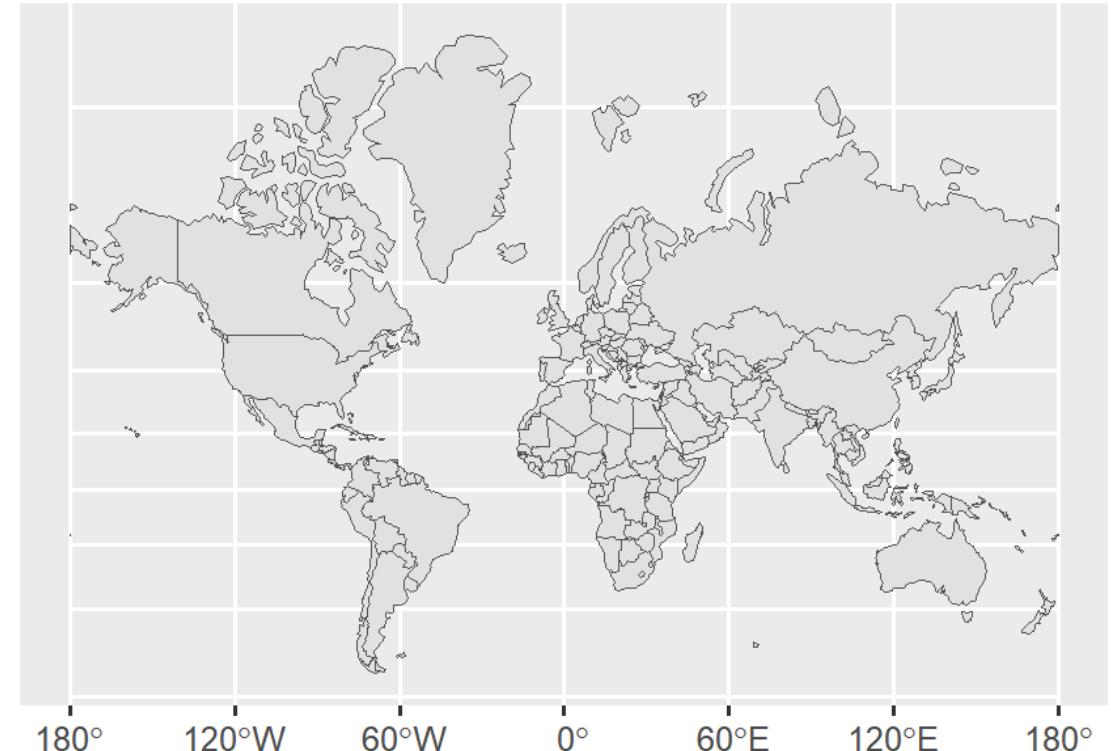
```
ggplot() +  
  geom_sf(data = world_shapes)
```



The magic geometry column

Use `coord_sf()` to change projections

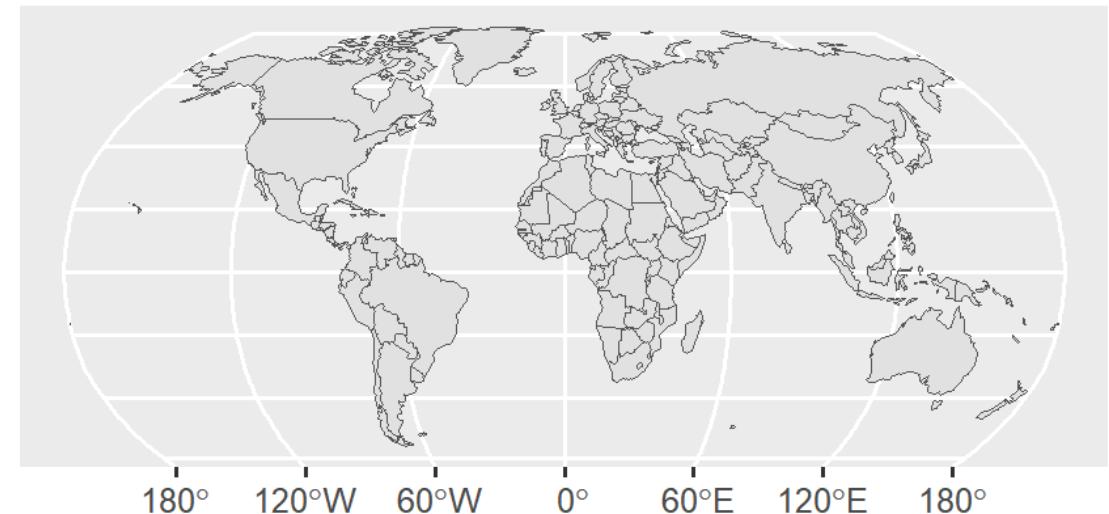
```
ggplot() +  
  geom_sf(data = world_shapes) +  
  coord_sf(crs = "+proj=merc")
```



The magic geometry column

Use `coord_sf()` to change projections

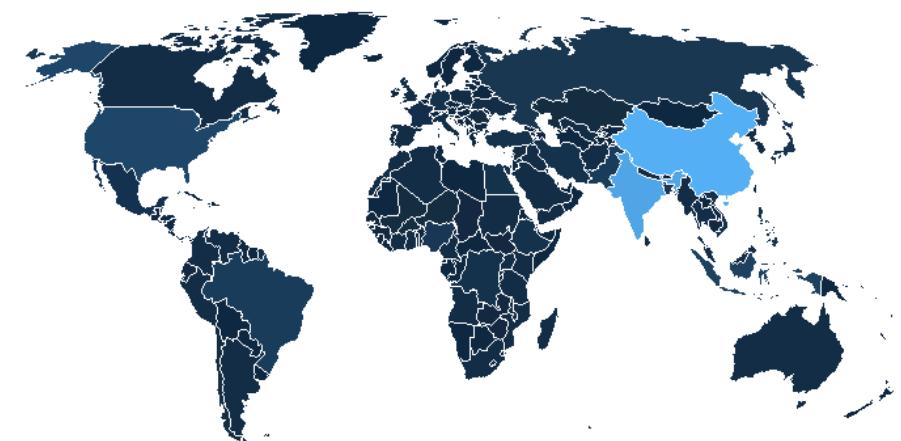
```
ggplot() +  
  geom_sf(data = world_shapes) +  
  coord_sf(crs = "+proj=robin")
```



Use aesthetics like normal

All regular ggplot layers and aesthetics work

```
ggplot() +  
  geom_sf(data = world_shapes,  
          aes(fill = POP_EST),  
          color = "white", linewidth = 0.15)  
  coord_sf(crs = "+proj=robin") +  
  scale_fill_gradient(labels = scales::label.  
    labs(fill = NULL) +  
  theme_void() +  
  theme(legend.position = "bottom")
```



No geometry column?

Make your own with `st_as_sf()`

```
other_data
```

```
## # A tibble: 2 × 3
##   city      long   lat
##   <chr>     <dbl> <dbl> ## Simple feature collection with 2 features and 1 field
## 1 Atlanta    -84.4  33.8 ## Geometry type: POINT
## 2 Washington, DC -77.1  38.9 ## Dimension:      XY
##                               ## Bounding box:  xmin: -84 ymin: 34 xmax: -77 ymax: 39
##                               ## Geodetic CRS:  WGS 84
## # A tibble: 2 × 2
##   city      geometry
##   <chr>     <POINT [°]>
## 1 Atlanta    (-84 34)
## 2 Washington, DC (-77 39)
```

```
other_data %>%
  st_as_sf(coords = c("long", "lat"),
           crs = st_crs("EPSG:4326"))
```

{sf} is for all GIS stuff

Draw maps

Calculate distances between points

Count observations in a given area

Anything else related to geography!

See [here](#) or [here](#) for full textbooks

`geom_sf()` is today's standard

You'll sometimes find older tutorials and StackOverflow answers about using `geom_map()` or `{ggmap}` or other things

Those still work, but they don't use the same magical `{sf}` system with easy-to-convert projections and other GIS stuff

Stick with `{sf}` and `geom_sf()` and your life will be easy