# Space

## Session 12

PMAP 8921: Data Visualization with R
Andrew Young School of Policy Studies
Summer 2022

# Plan for today

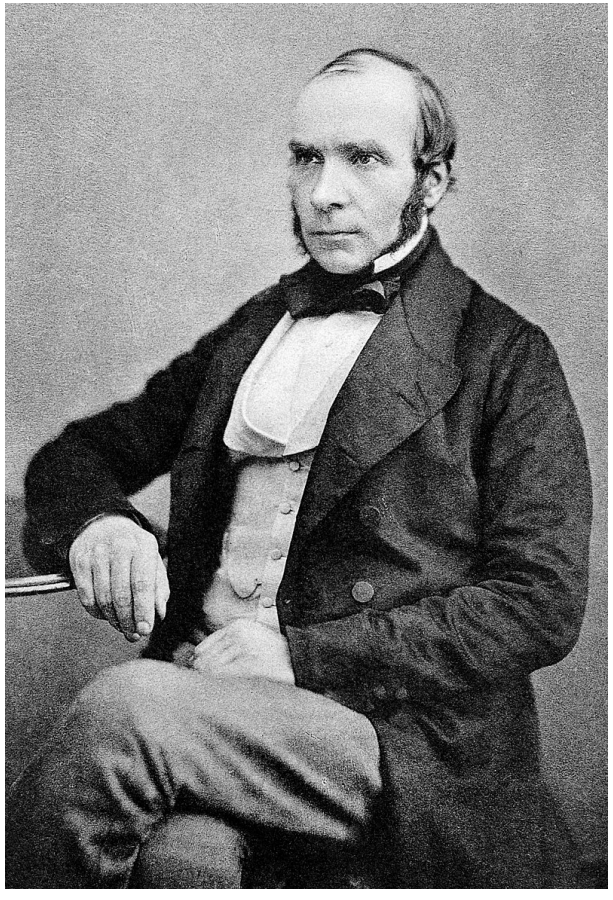
**Maps and truth**

**Putting data on maps**

**GIS in R with *sf***

# Maps and truth

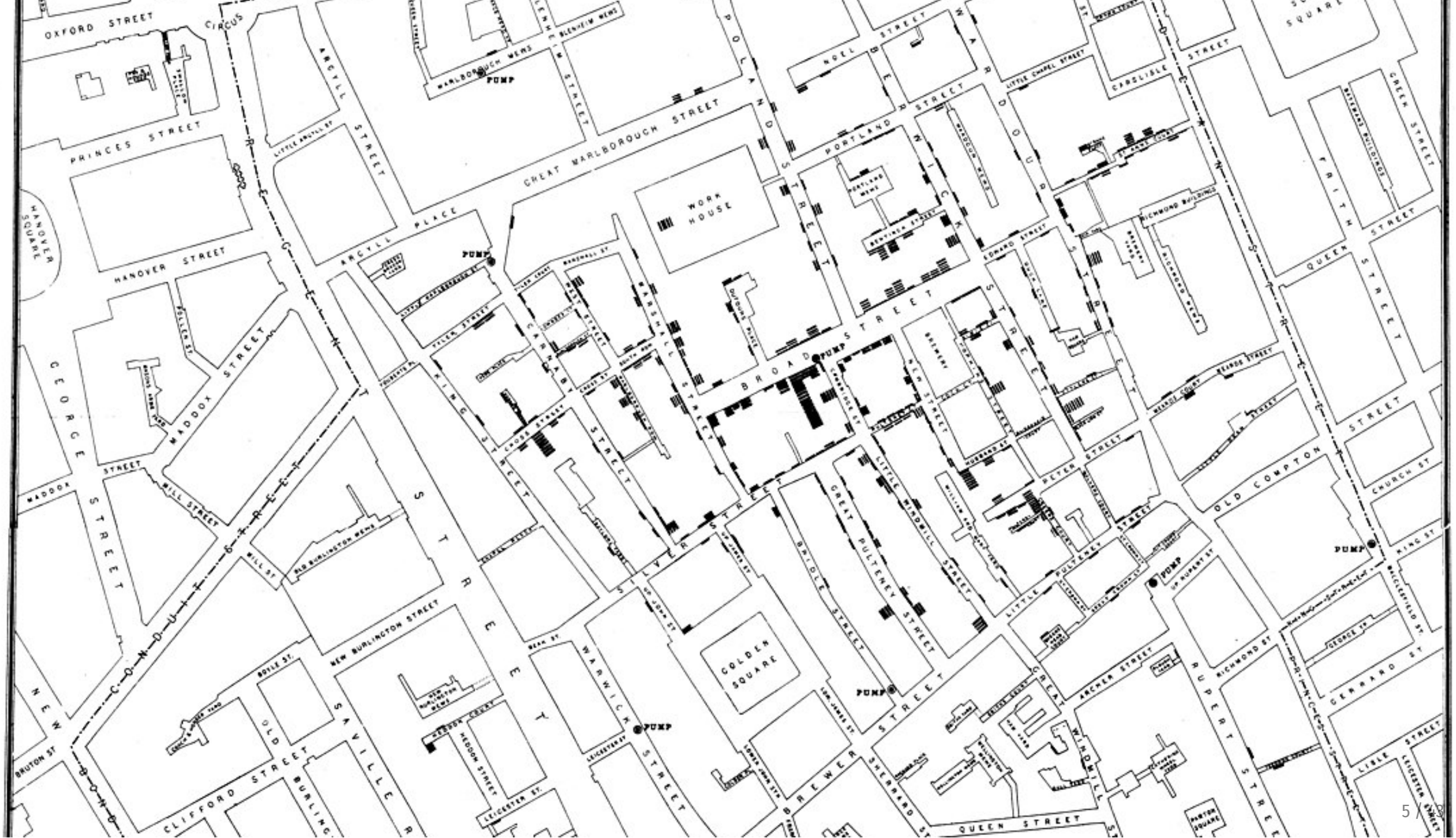
# John Snow and 1854 cholera epidemic



This Jo(h)n Snow knows things

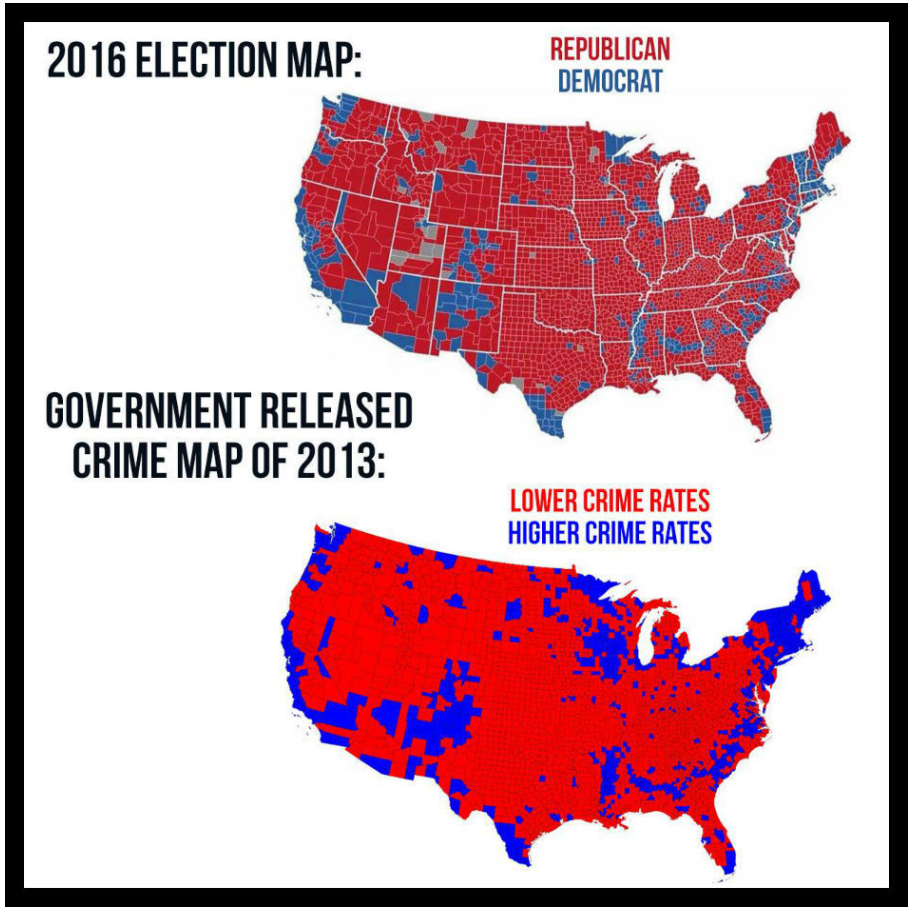
**10% of the population of Soho died in a week (!!)**

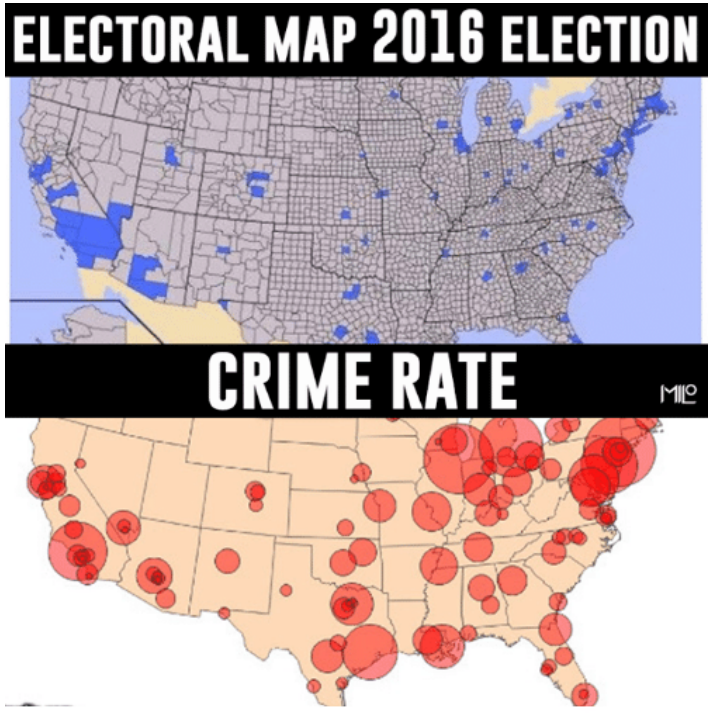
**Miasma theory said it was because the air was bad**


OXFORD STREET
Circus
PRINCES STREET
HANOVER SQUARE
HANOVER STREET
ARGYLL STREET
ARGYLL PLACE
LITTLE ARGYLL ST.
GREAT MARLBOROUGH STREET
MARLBOROUGH MEWS
PUMP
BLENHEIM MEWS
POLAND STREET
WORK HOUSE
NOEL STREET
LITTLE CHAPEL STREET
CARLISLE STREET
PORTLAND STREET
PORTLAND MEWS
BERWICK STREET
EDWARD STREET
RICHMOND BUILDINGS
RICHMOND COURT
GREEK STREET
FRITH STREET
QUEEN STREET
GEORGE STREET
MADDOX STREET
FOLLER ST.
MADDOX
WILL STREET
MARSHALL ST.
CROSS STREET
SILVER STREET
BROAD STREET
PETER STREET
OLD COMPTON
CHURCH ST
KING ST
GEORGE ST
GERRARD ST
LISLE
LEICESTER STREET
NEW BURLINGTON STREET
OLD BURLINGTON MEWS
NEW BURLINGTON MEWS
BOYLE ST.
CLIFFORD STREET
SAVILLE ROW
BRUTON ST
NEW
REGENT STREET
WARWICK STREET
LEICESTER ST.
HEDDON COURT
HEDDON STREET
GOLDEN SQUARE
LOWER JOHN ST
BRAILE STREET
GREAT PULTENEY STREET
LITTLE PULTENEY STREET
BREWER STREET
ARCHER STREET
WINDMILL STREET
RICHMOND ST
RUPERT STREET
QUEEN STREET

# The Broad Street pump


# Outright lies




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

# Fake maps and junk maps

FAST COMPANY

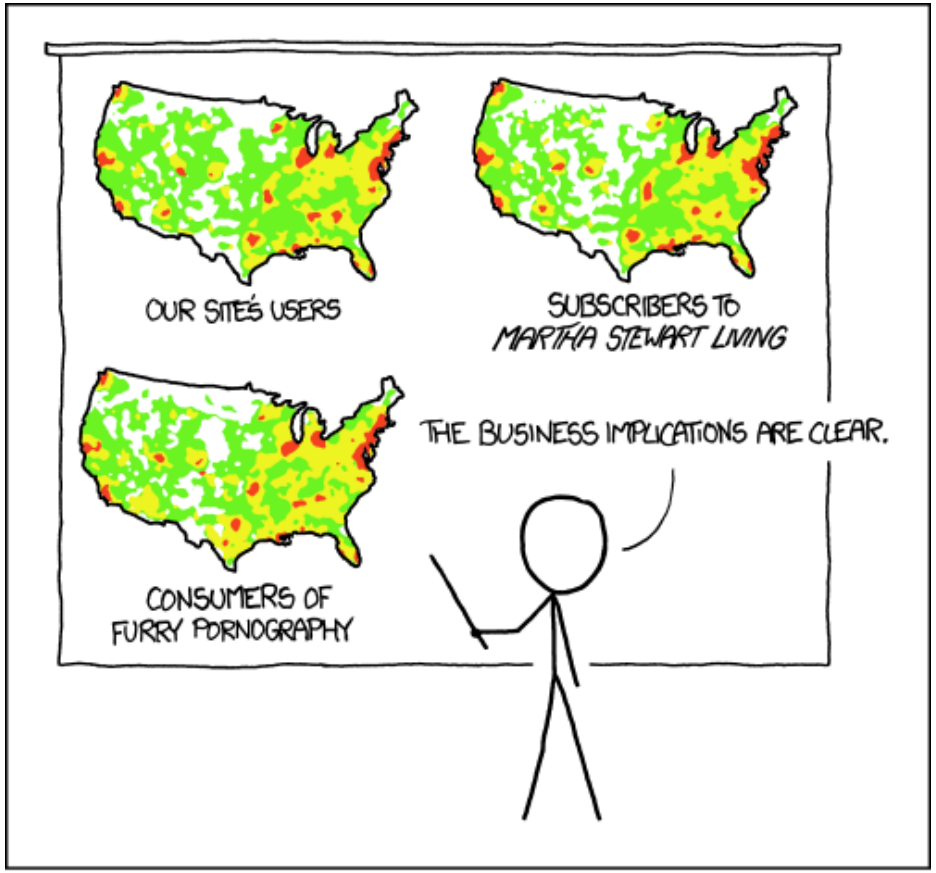
09-05-18

## 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.

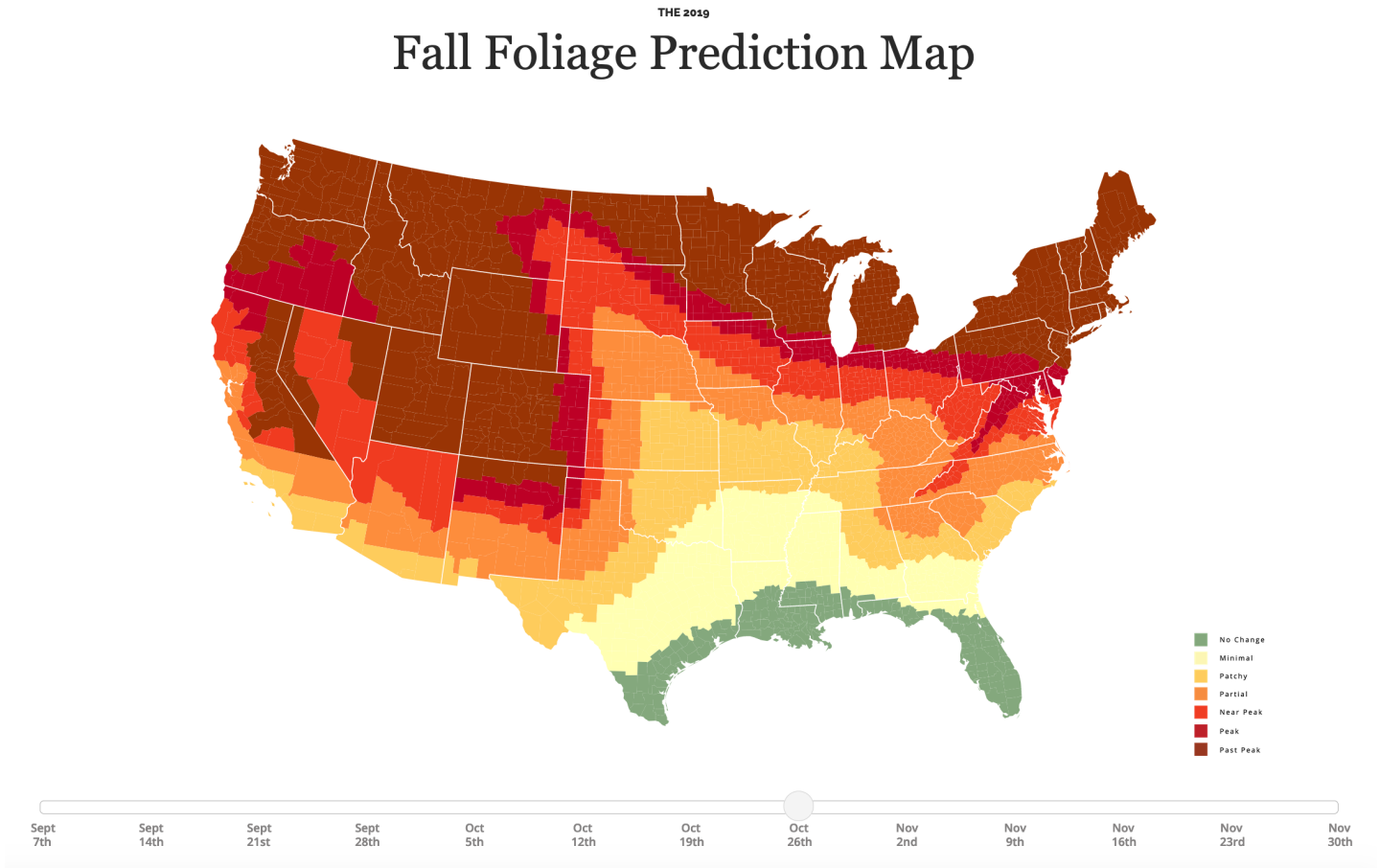
"The next great fake news threat? Bot-designed maps"

# Points can be useless




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

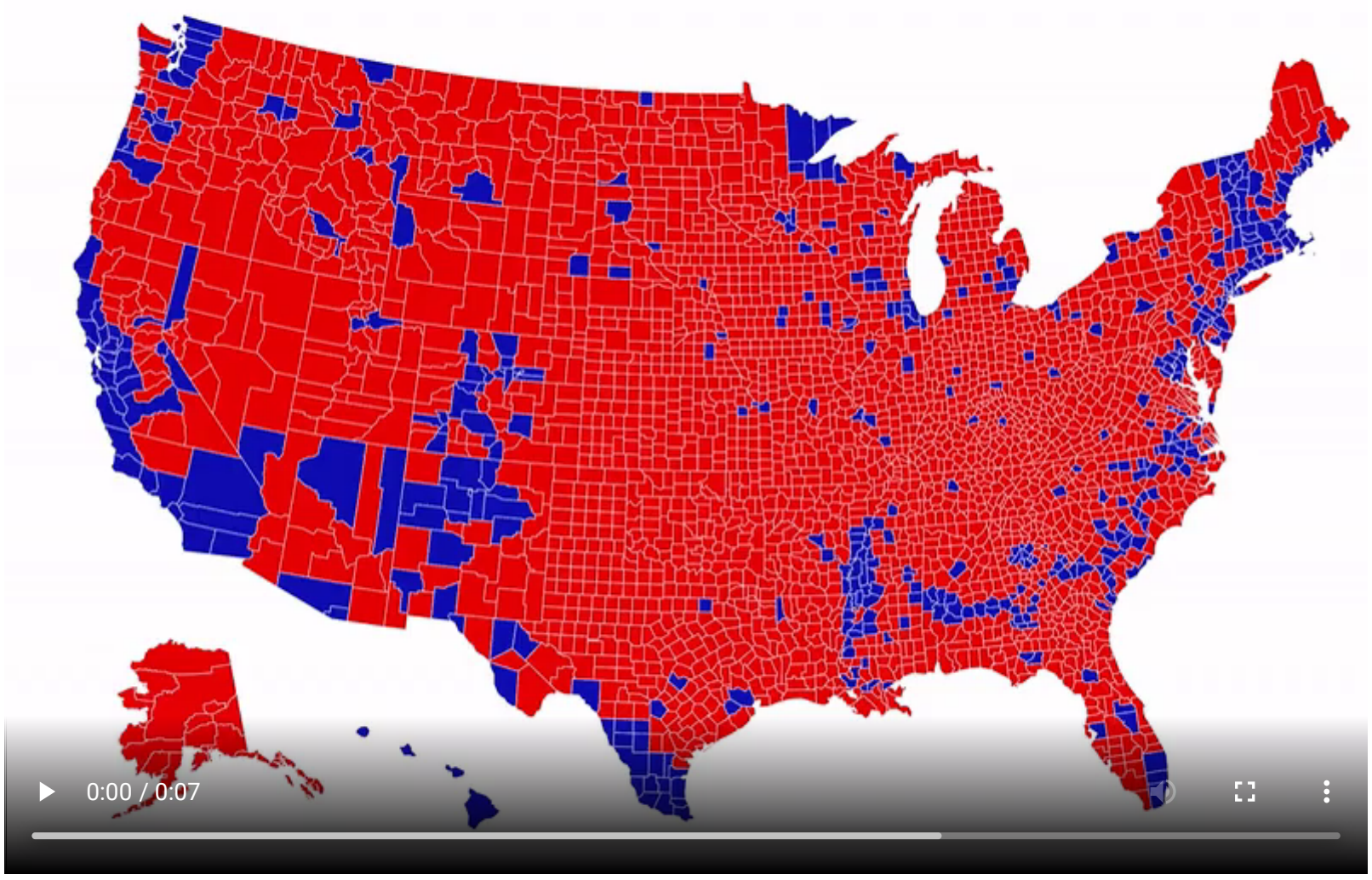
# Choropleths can be great



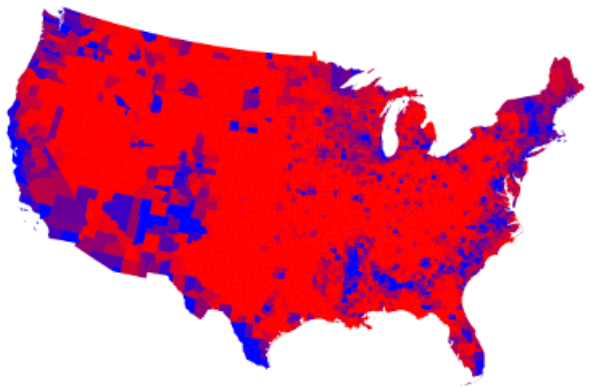

Smoky Mountains 2019 Fall Foliage Prediction Map

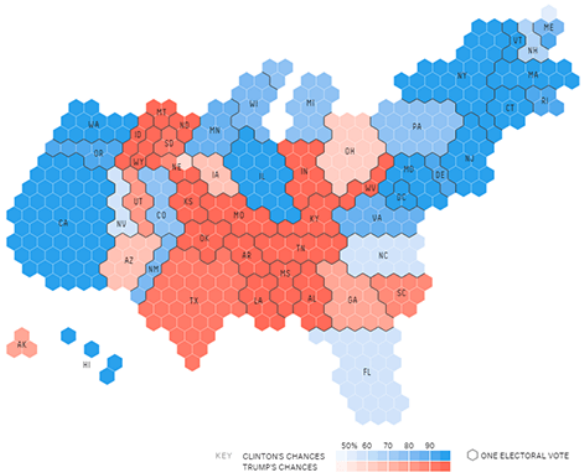
# Choropleths can distort

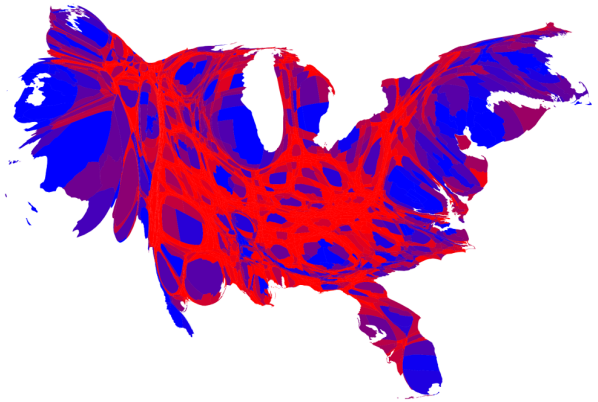
# Land doesn't vote



# Cartograms

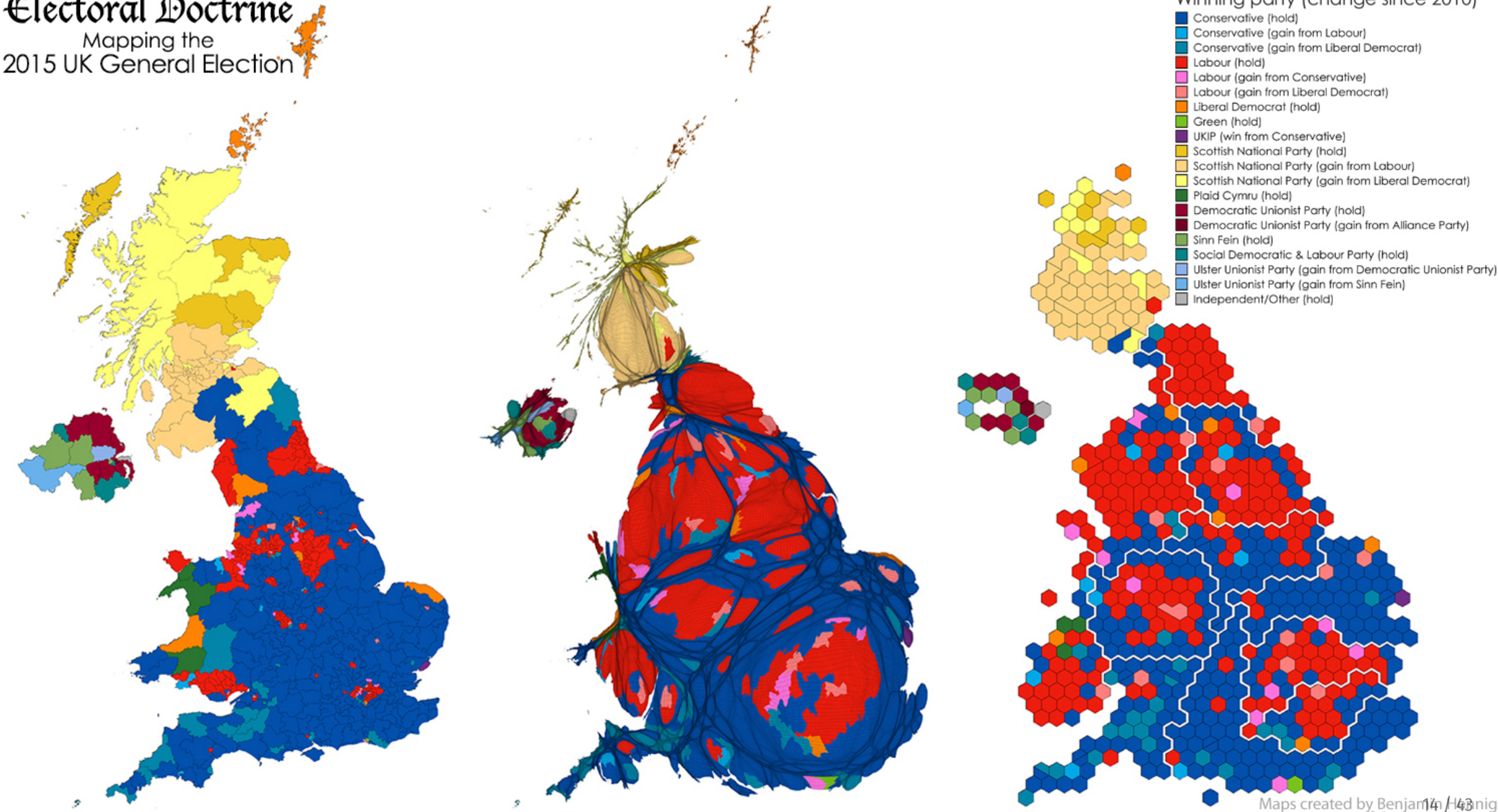



KEY
CLINTON'S CHANCES
TRUMP'S CHANCES
50% 60 70 80 90
ONE ELECTORAL VOTE

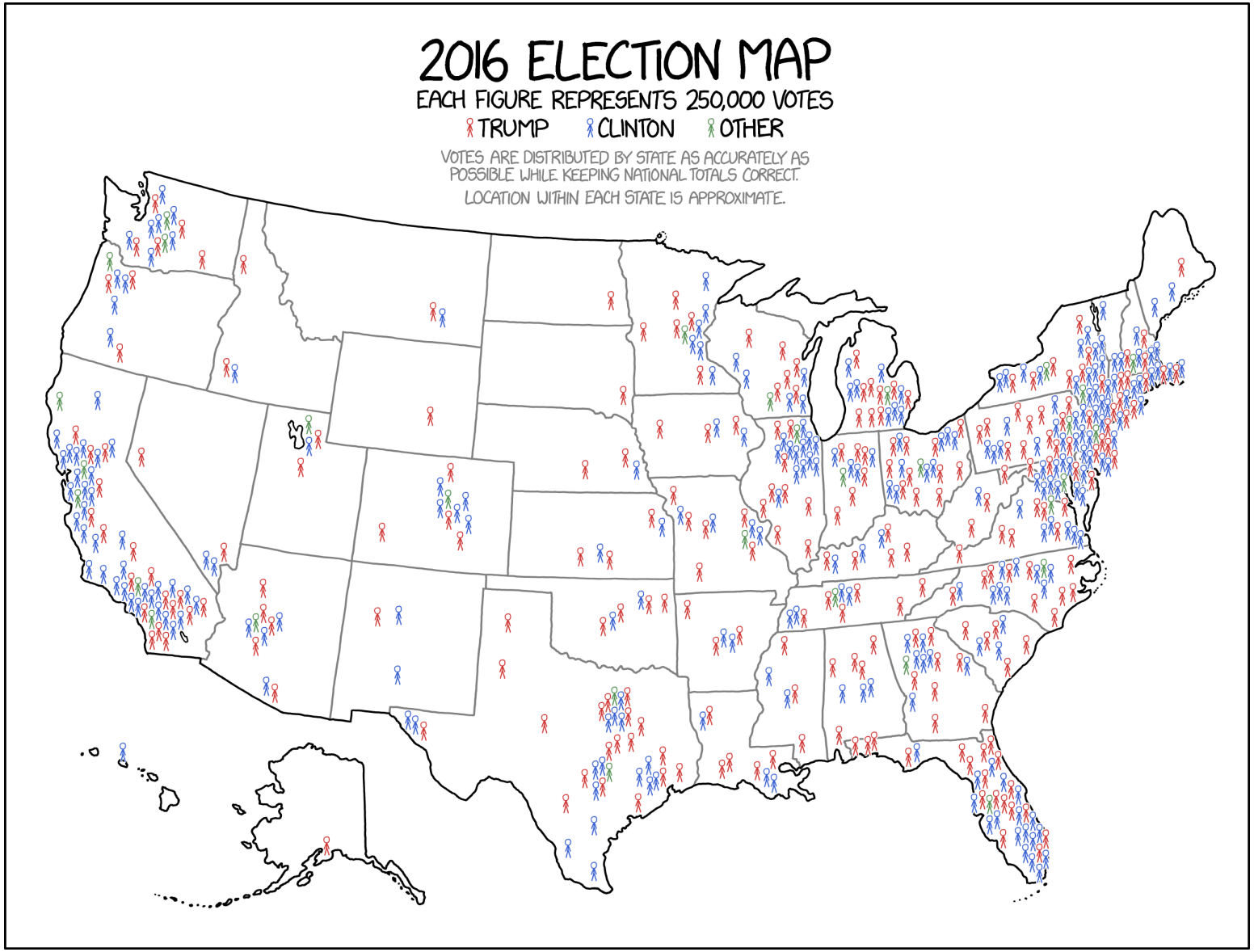


# Electoral Doctrine

## Mapping the 2015 UK General Election




Maps created by Benjamin Hennig
www.viewsoftheworld.net

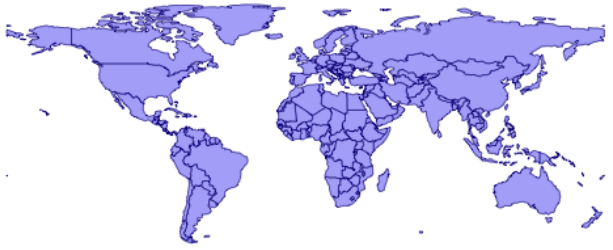

2016 ELECTION MAP
EACH FIGURE REPRESENTS 250,000 VOTES
TRUMP
CLINTON
OTHER
VOTES ARE DISTRIBUTED BY STATE AS ACCURATELY AS POSSIBLE WHILE KEEPING NATIONAL TOTALS CORRECT.
LOCATION WITHIN EACH STATE IS APPROXIMATE.

# Projections

## Animated world projections

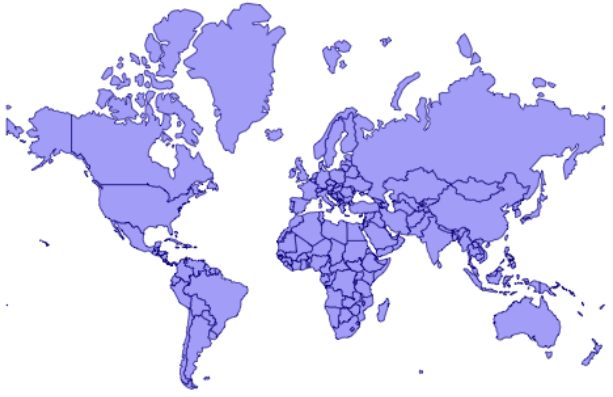
# World projections

### Longitude-latitude



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

### Mercator



```
crs = "+proj=merc"
```

### Gall-Peters

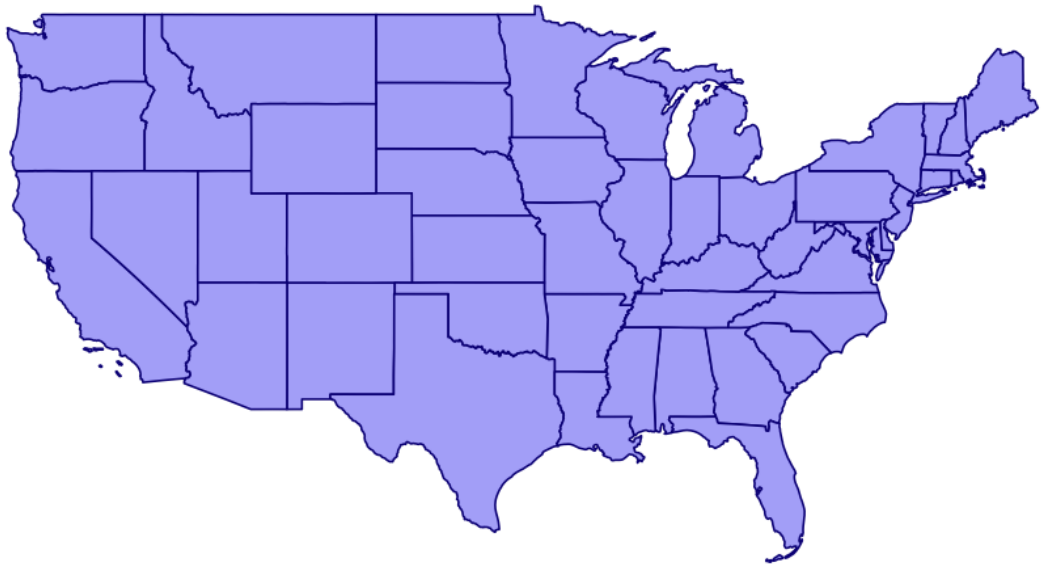
```
crs = "ESRI:54002"
```

### Robinson

```
crs = "+proj=robin"
```

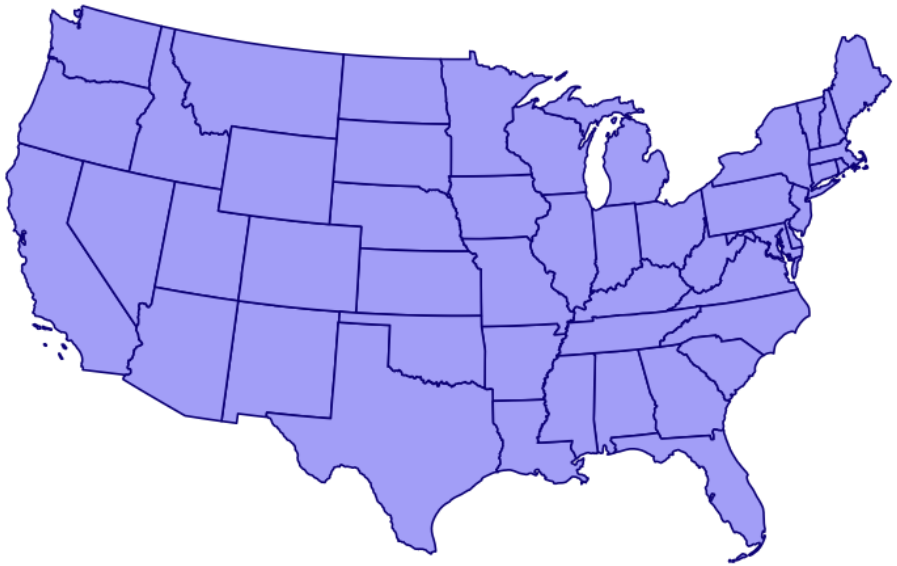
# US projections

**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

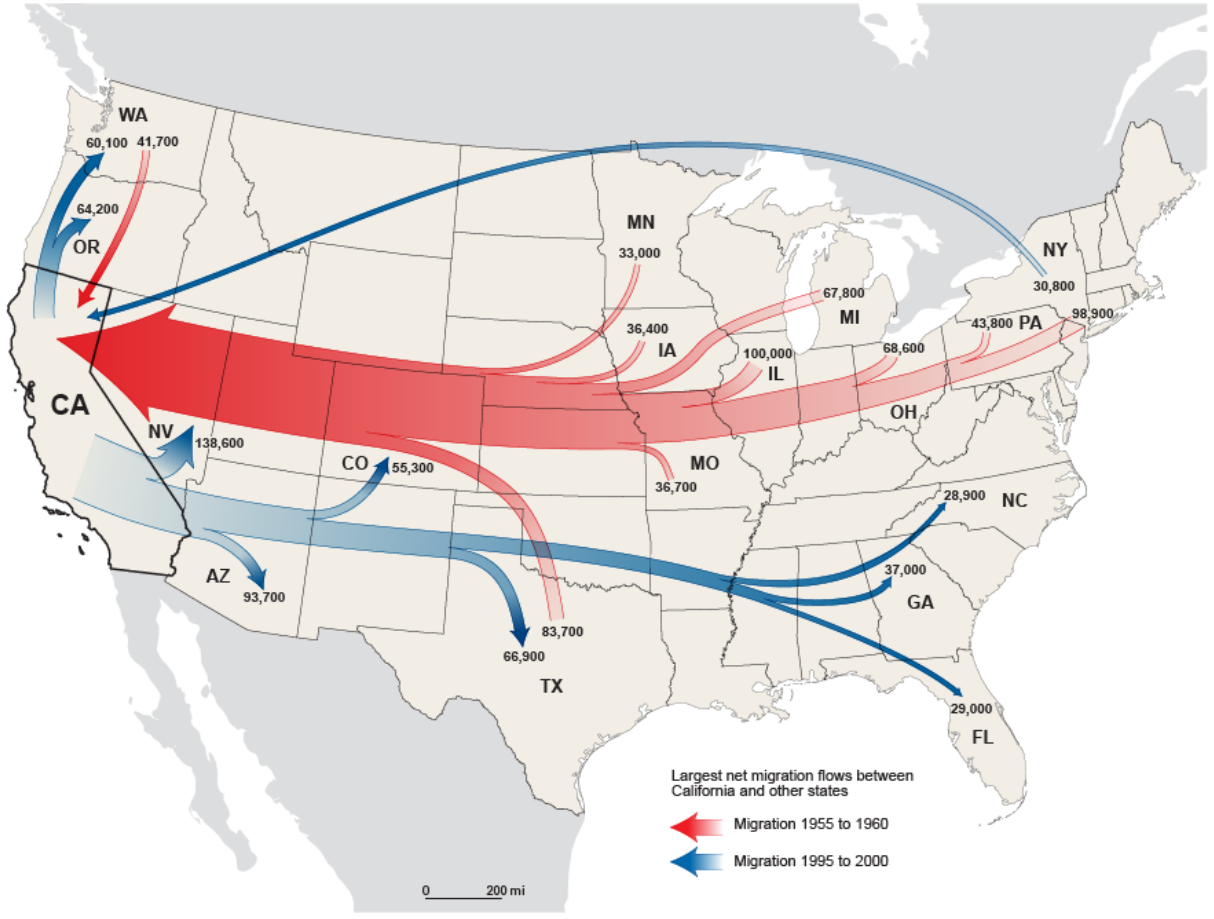
There are no good or bad projections

There are appropriate and inappropriate projections

(but also ew mercator)

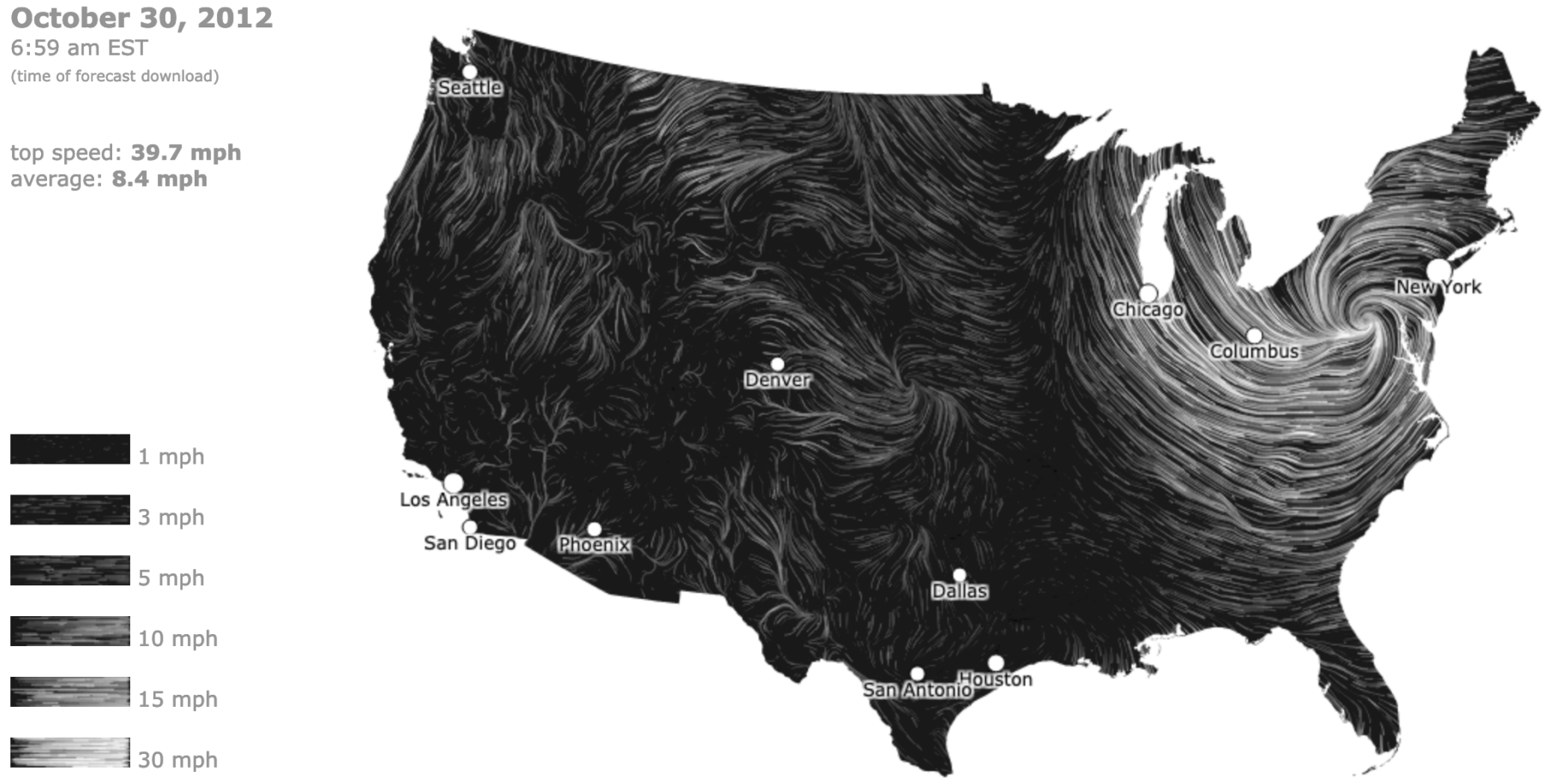
# Putting data on maps

# Maps with lines

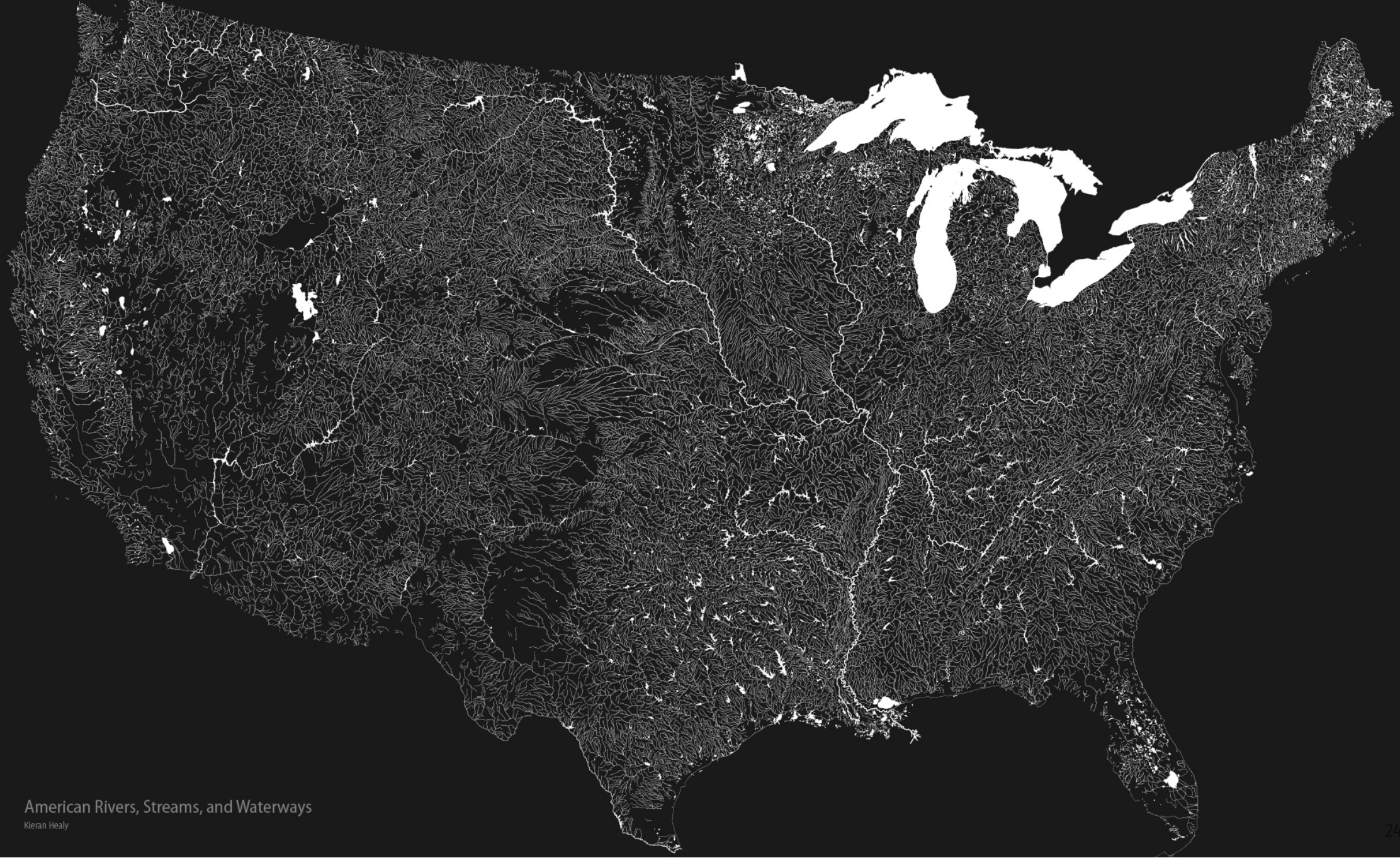



US Census Bureau: Net migration between California and other states

# Maps with lines



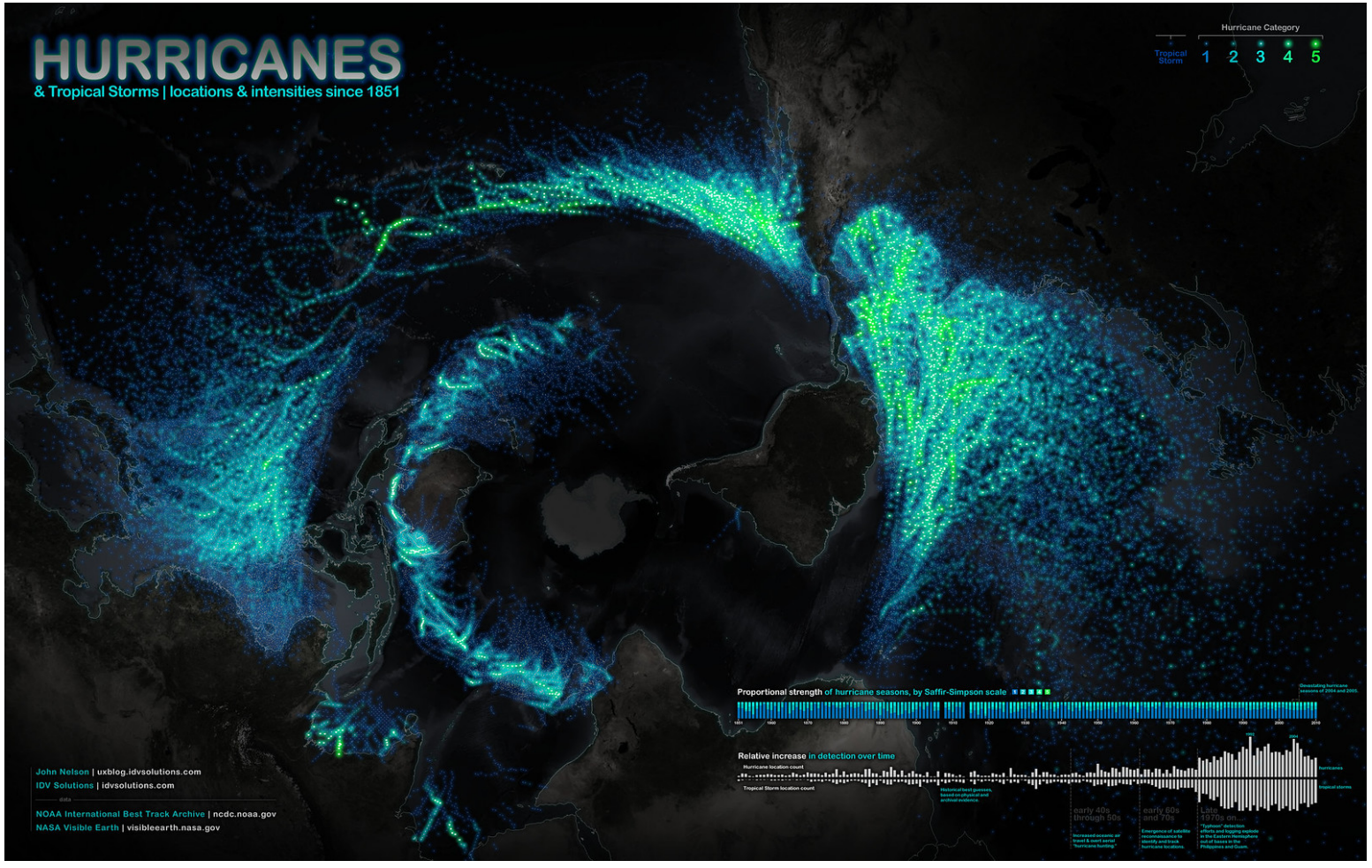

hint.fm Live Wind Map



American Rivers, Streams, and Waterways

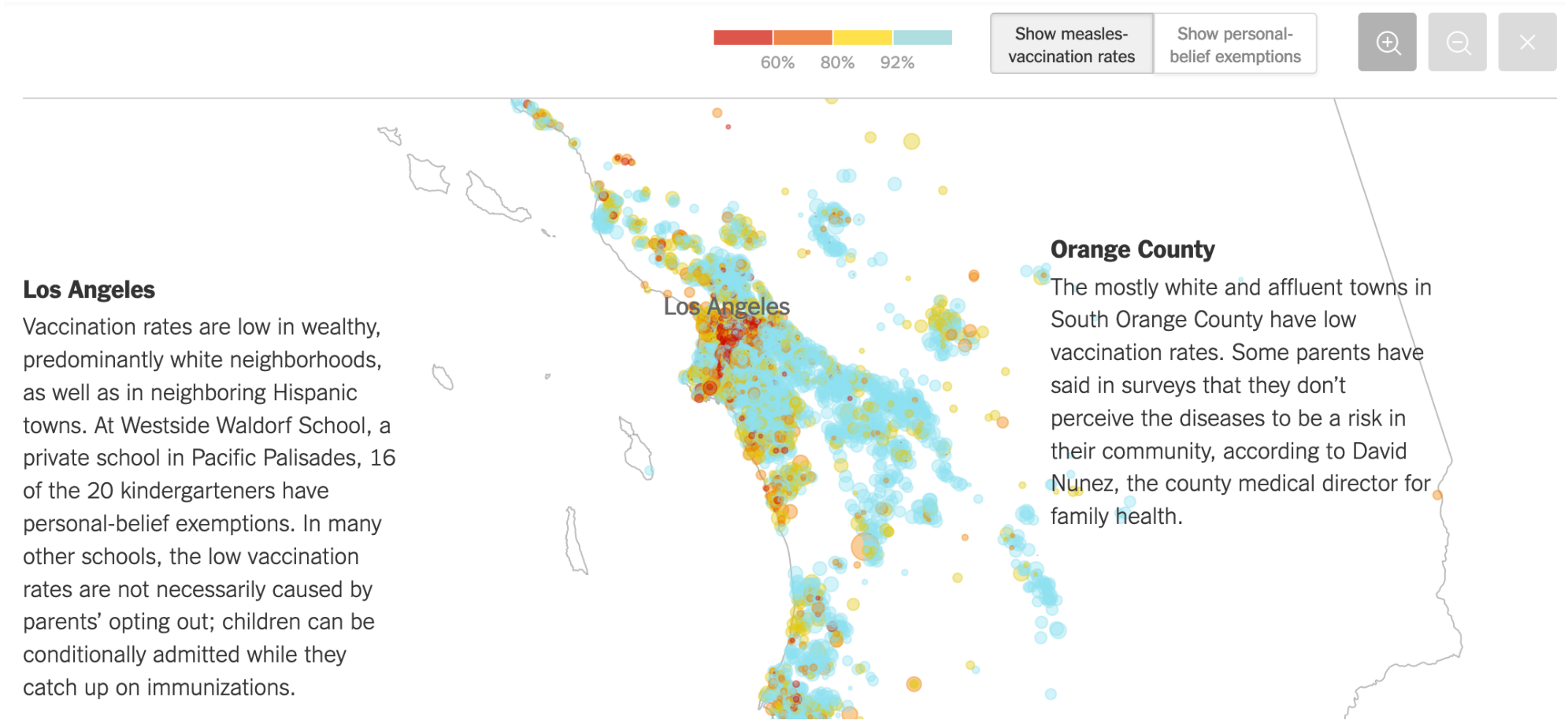
Kieran Healy

# Maps with points



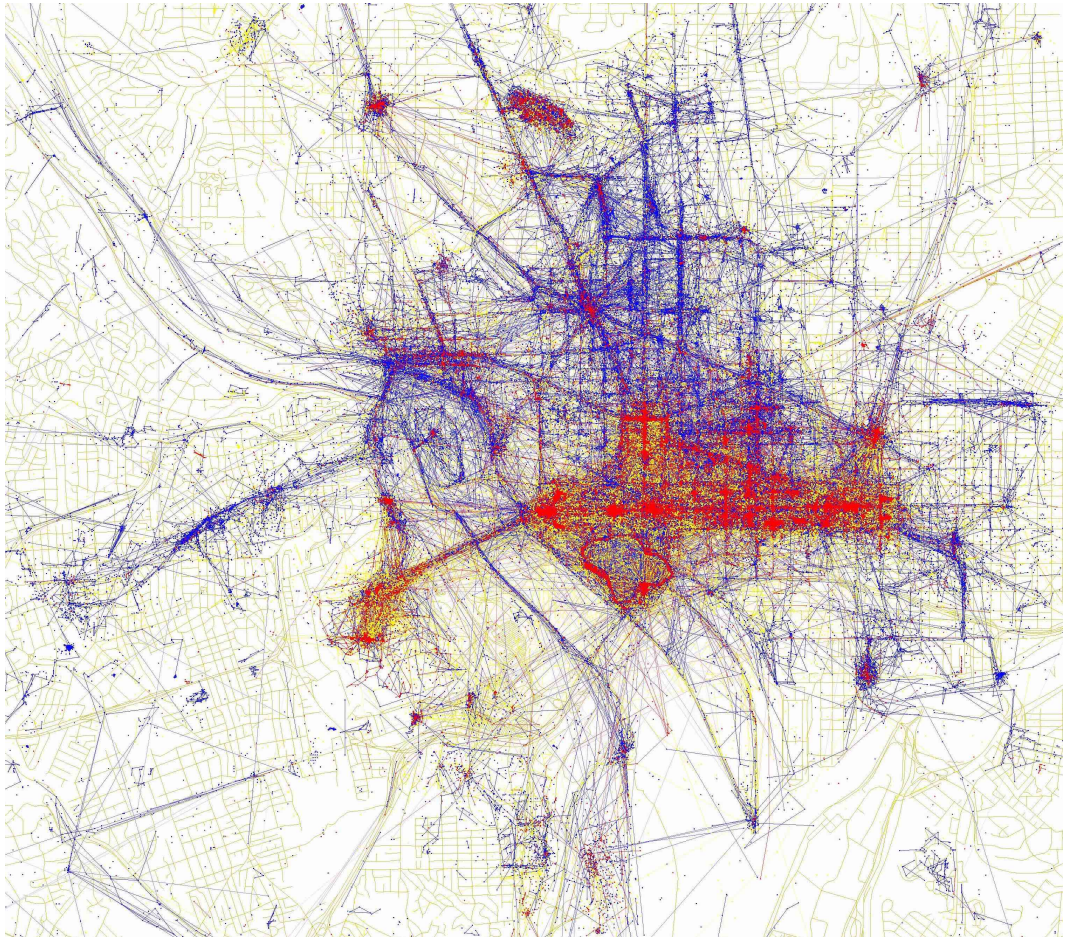

Every hurricane since 1851, by IDV solutions

# Maps with points



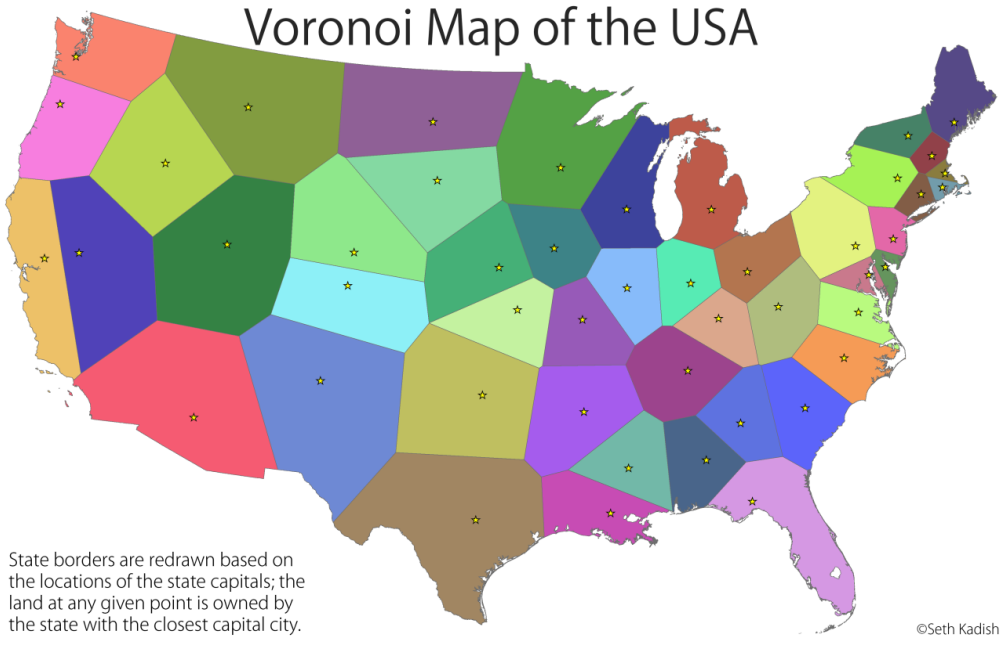

The New York Times, "Vaccination Rates for Every Kindergarten in California

# Maps with points

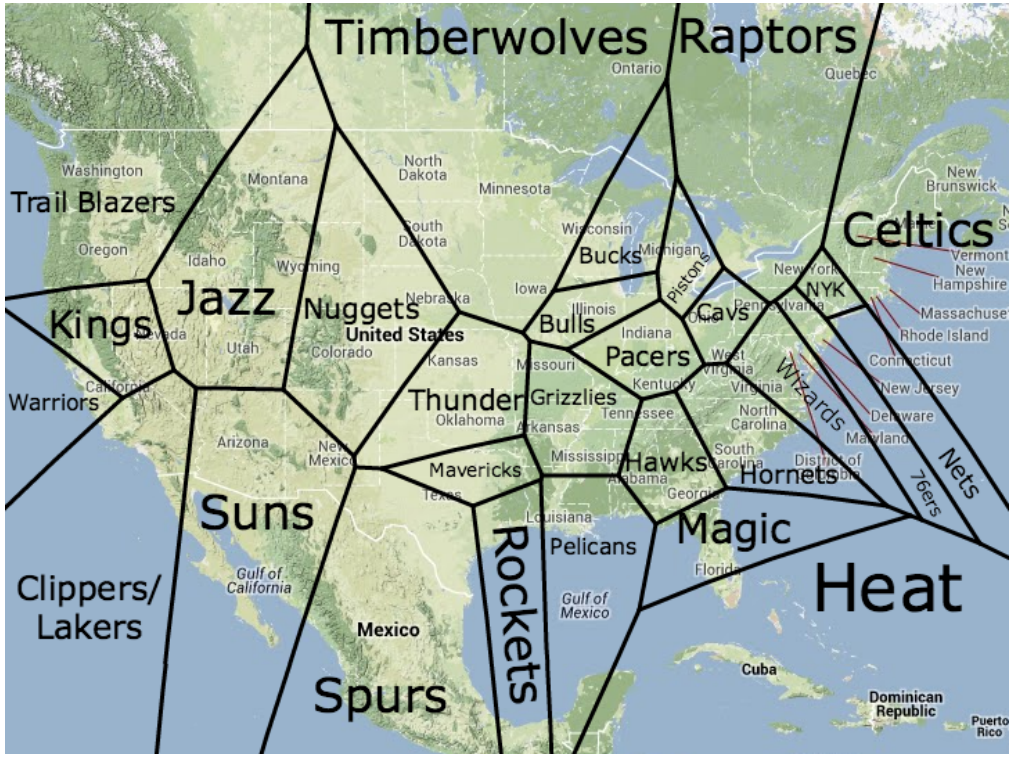


Locals vs. tourists in DC (blue = locals; red = tourists; yellow = unknown)

# Voronoi maps



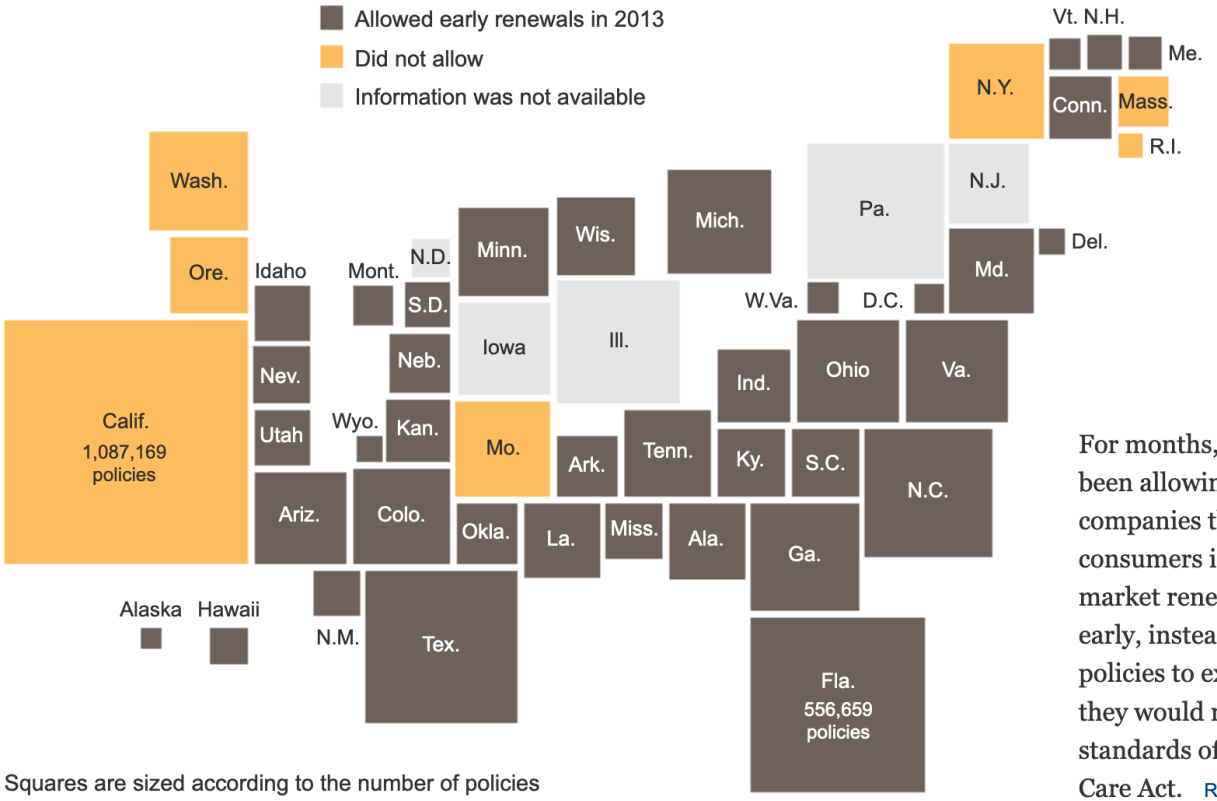

Voroni state boundaries, by Seth Kadish




Closest NBA teams

# Maps with shapes

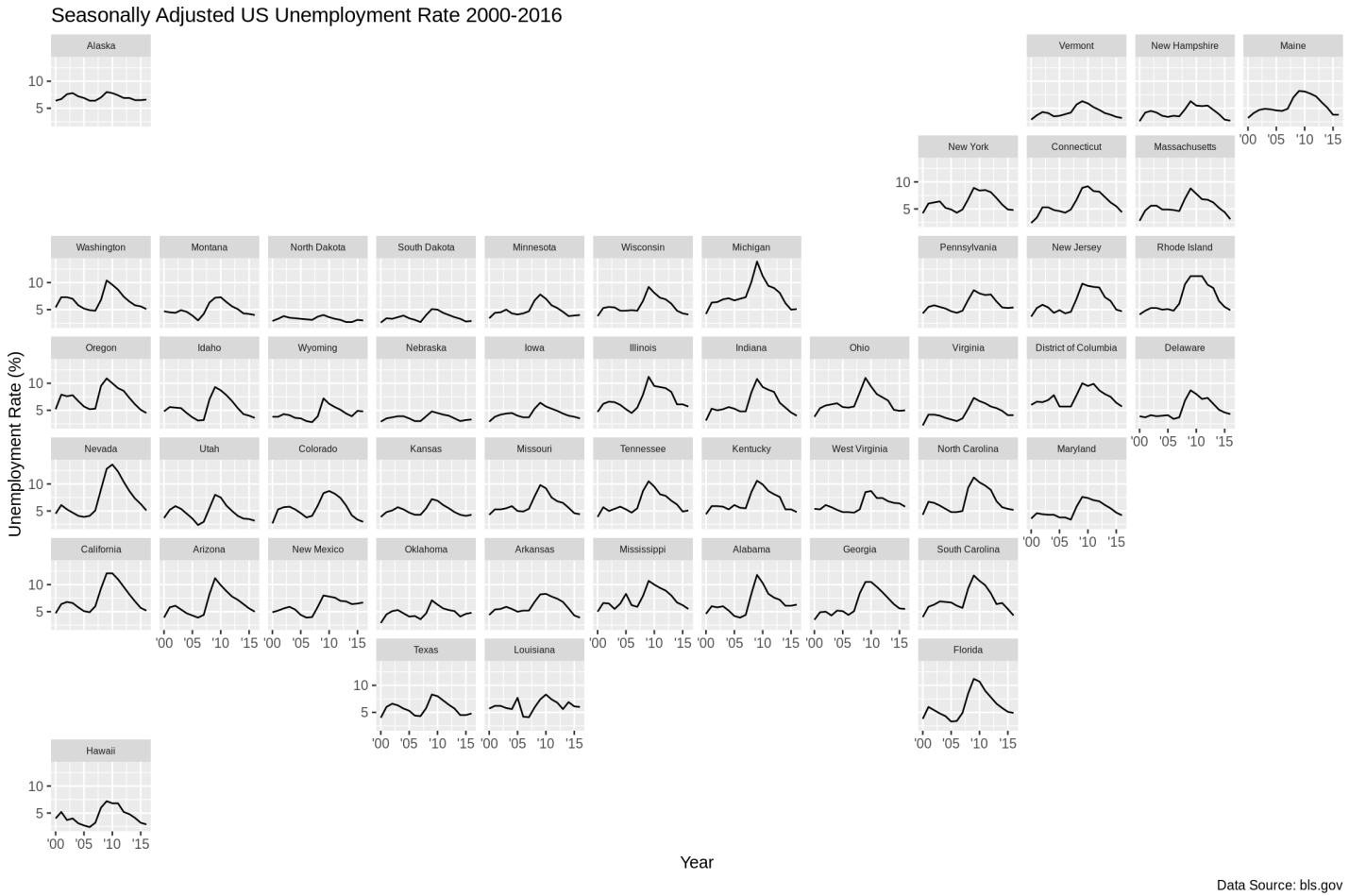
## States Where Insured Could Renew Plans Before Change by Obama




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...

# Scales


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

1 cm = 100 km


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

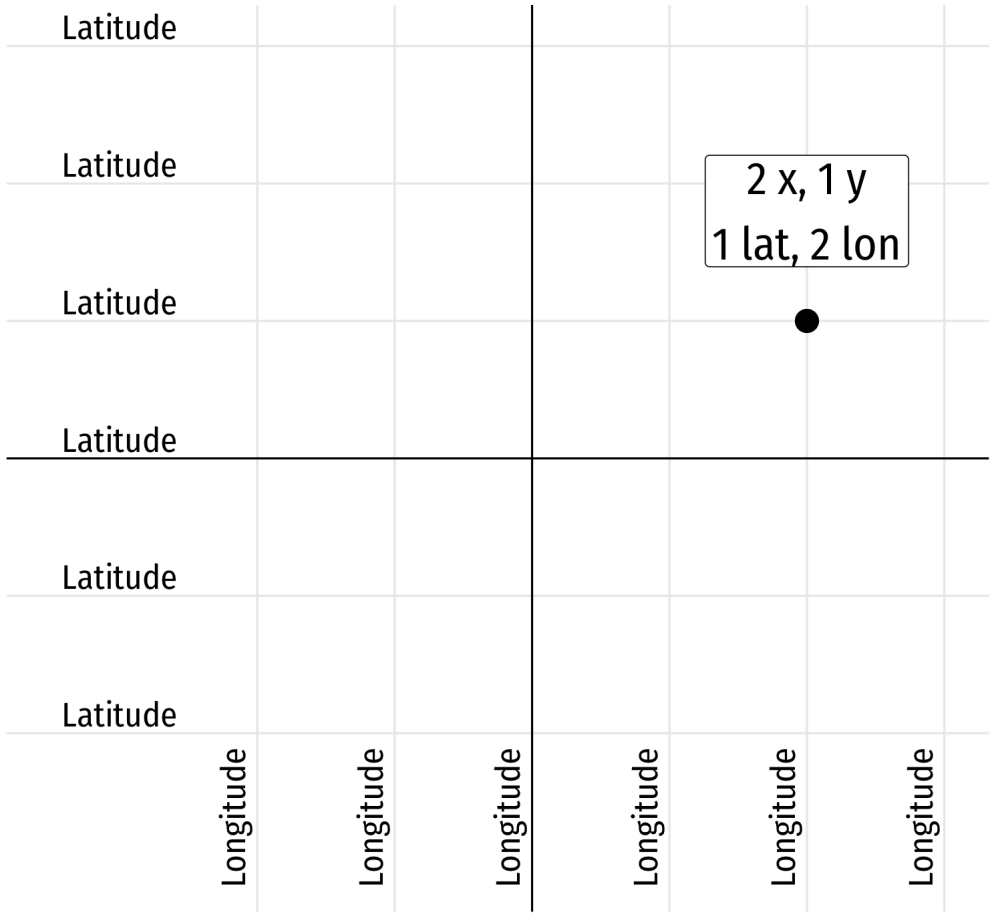
1cm = 500 km


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

1 cm = 1,100 km

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

# Latitude and longitude




via @sarahbellmaps

# The magic `geometry` column

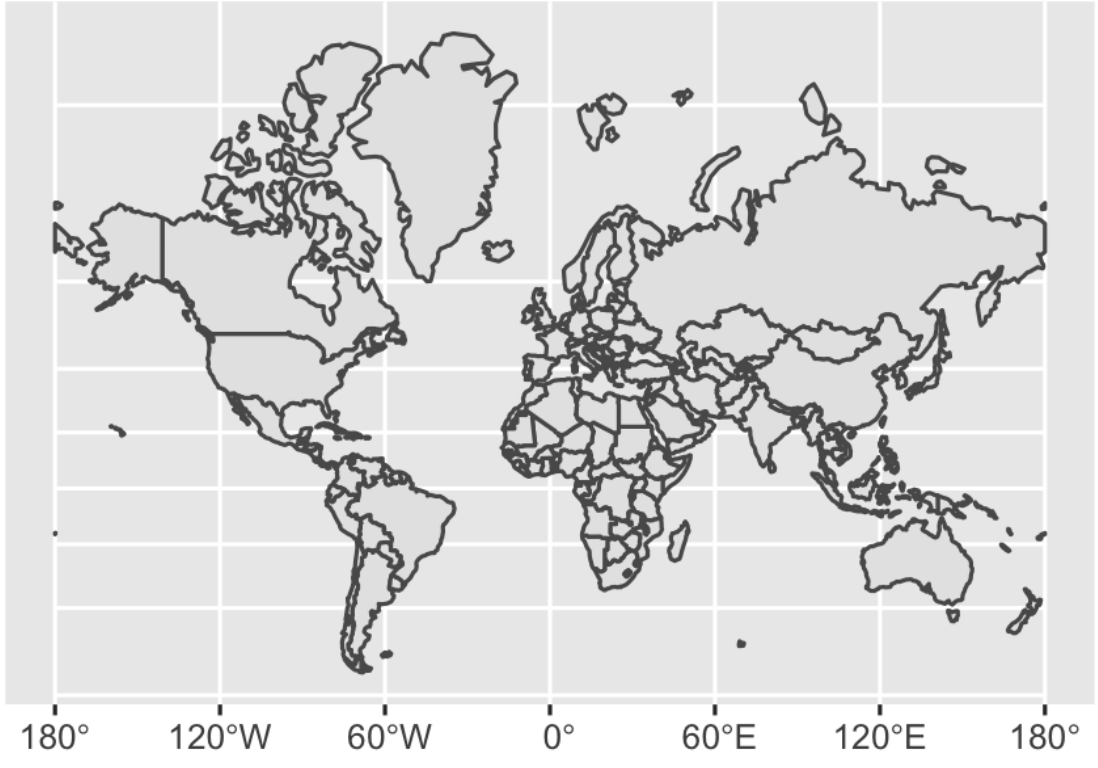
**As long as you have a magic `geometry` column, all you need to do to plot maps is `geom_sf()`**

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

# The magic `geometry` column

## Use `coord_sf()` to change projections

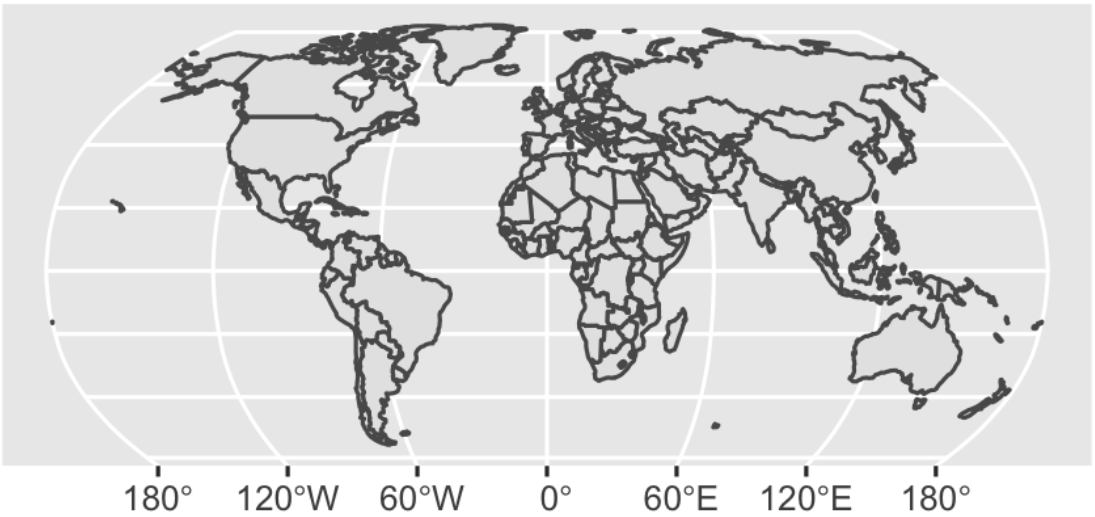
```
ggplot() +
  geom_sf(data = world_shapes) +
  coord_sf(crs = "+proj=merc")
```



# The magic `geometry` column

## Use `coord_sf()` to change projections

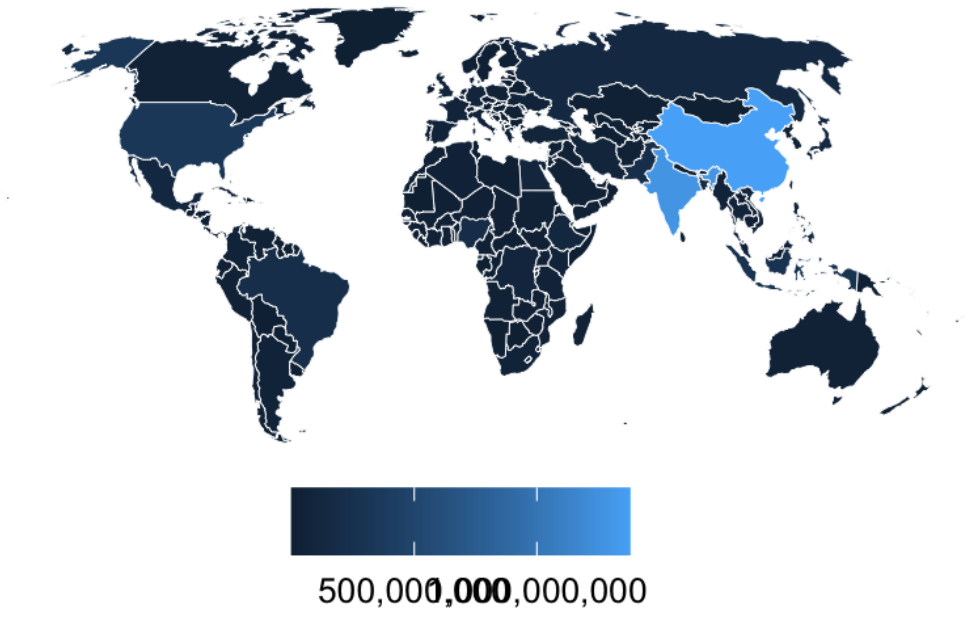
```
ggplot() +
  geom_sf(data = world_shapes) +
  coord_sf(crs = "+proj=robin")
```



# Use aesthetics like normal

## All regular ggplot layers and aesthetics work

```
ggplot() +
  geom_sf(data = world_shapes,
          aes(fill = POP_EST),
          color = "white", size = 0.15) +
  coord_sf(crs = "+proj=robin") +
  scale_fill_gradient(labels = scales::comma)
  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>
## 1 Atlanta        -84.4  33.8
## 2 Washington, DC -77.1  38.9
```

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

```
## Simple feature collection with 2 features and 1 field
## Geometry type: POINT
## 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)
```

# 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**