

Information Visualization (Geographic) Maps

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University of British Columbia

Lect 11, 11 Feb 2020

<https://www.cs.ubc.ca/~tmm/courses/436V-20>

Upcoming

- **Programming 2: due Wed, Feb 11, 11:59pm**
- **Project team formation: due Fri, Feb 14, 11:59pm**
Canvas → People → Groups
- Programming 3: out Thu Feb 13, due Wed Mar 4 11:59pm
- Foundations 4: out Thu Feb 13, due Wed Feb 26 11:59pm
- D3 videos/readings week 4
 - Color and Size legends with D3.js [30 min]
 - Scatter Plot with Menus [46 min]
 - Circles on a Map [42 min]
 - Line Charts with Multiple Lines [42 min]
- Quiz 6, due by Fri Feb 14, 8am

Spatial Data

- Given spatial position is the attribute of primary importance
 - Central tasks revolve around understanding spatial relationships
 - State borders on a map, shape of a brain region, etc.
- » We focus on **geographical data** but not all spatial data is geographical.

We use geographic visualization when:

- (1) The data contains geographical attributes
- (2) Visualizing spatial relationships is an important task

A dataset may contain *geographical information* and yet creating a *geographical visualization* may not be relevant.

Key question:

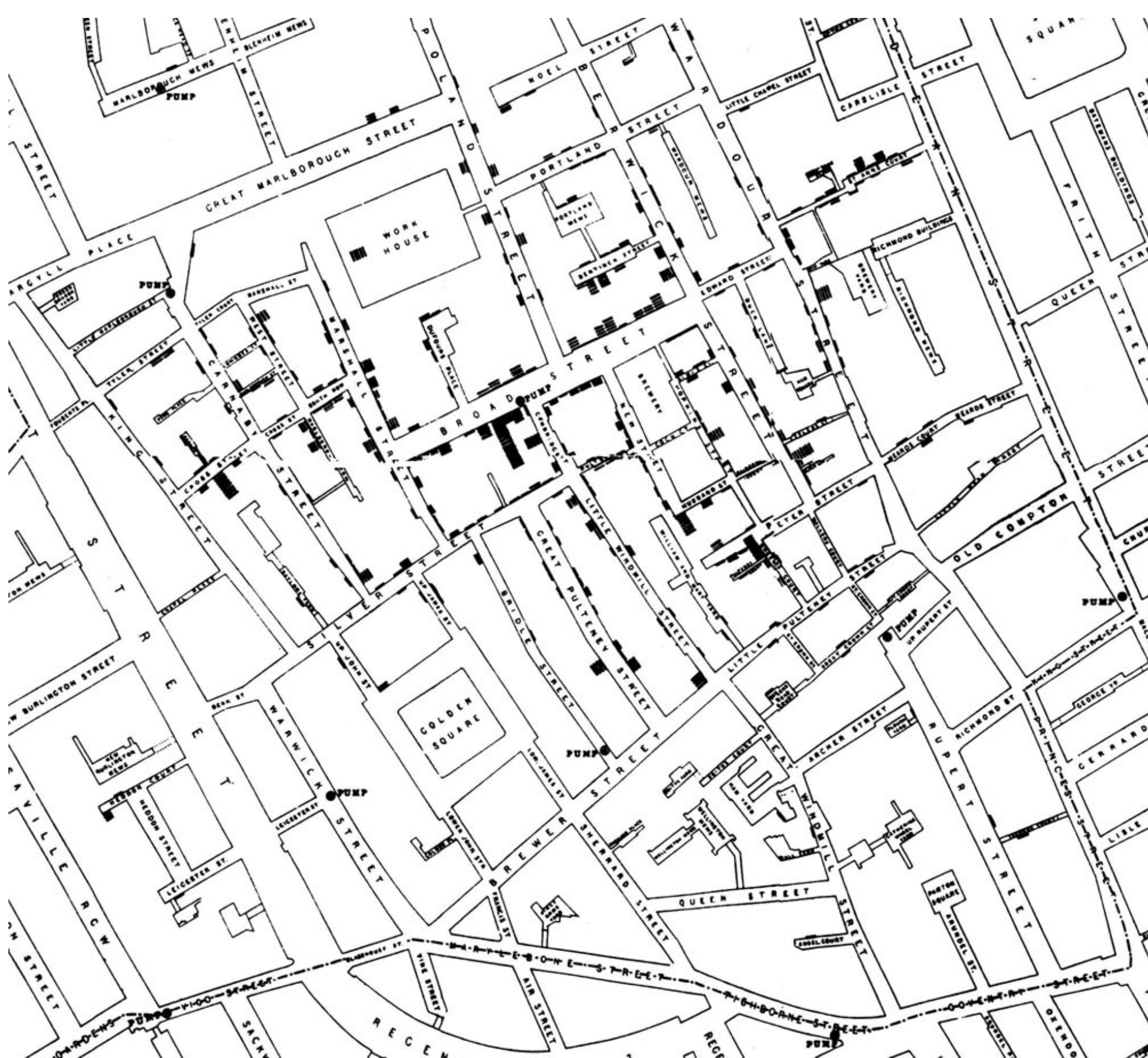
Does the given spatial position matter for my task?

- » *Spatial position* is the most effective visual channel and we don't want to waste it for non-relevant spatial information.
- » A geo map is not always the best or only solution.

That said, there is an advantage of maps over other representations ... **Which?**

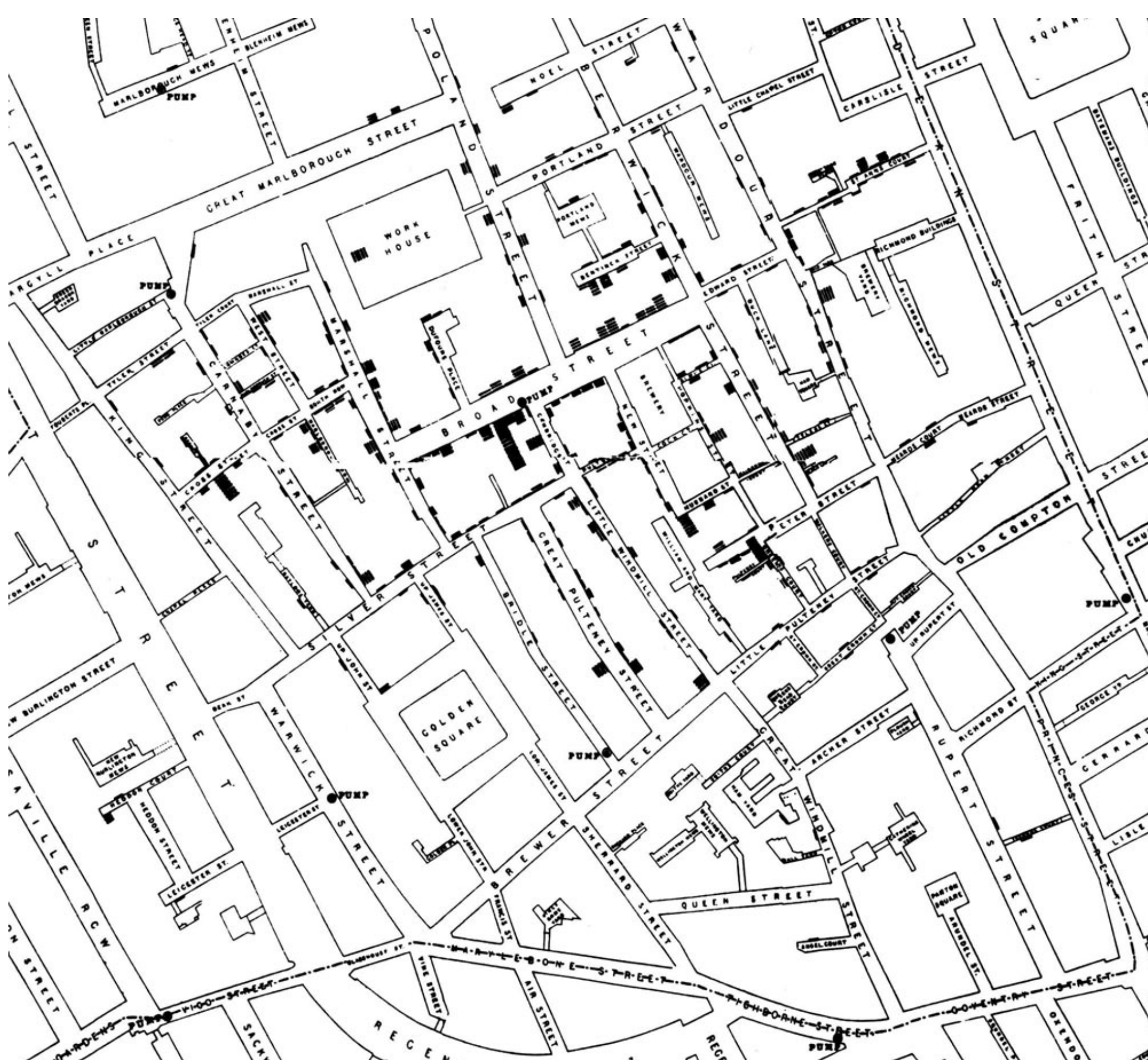
... familiarity!

- » People know where something on a map is (assuming they are familiar with the region).
- » Maps act as an index from spatial to semantic information and vice versa.
- » Visually encode given spatial geometry as marks using 2D position channels.



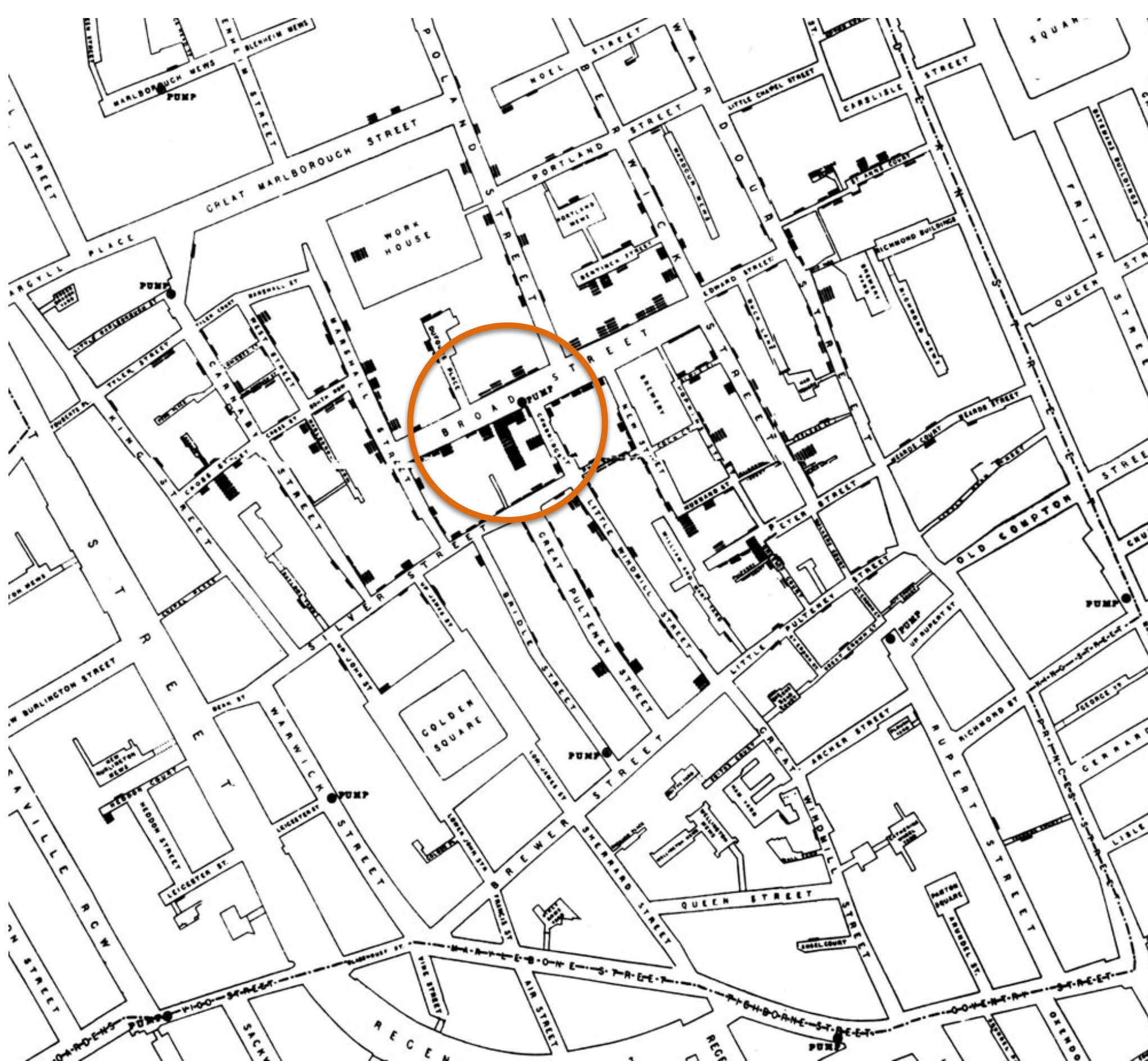
John Snow's Cholera Map

- London, 1854
- Cholera outbreak was a mystery
- Snow mapped deaths as *bars* on a geo map
- Cases clustered around a water pump
- One part of a detailed statistical analysis



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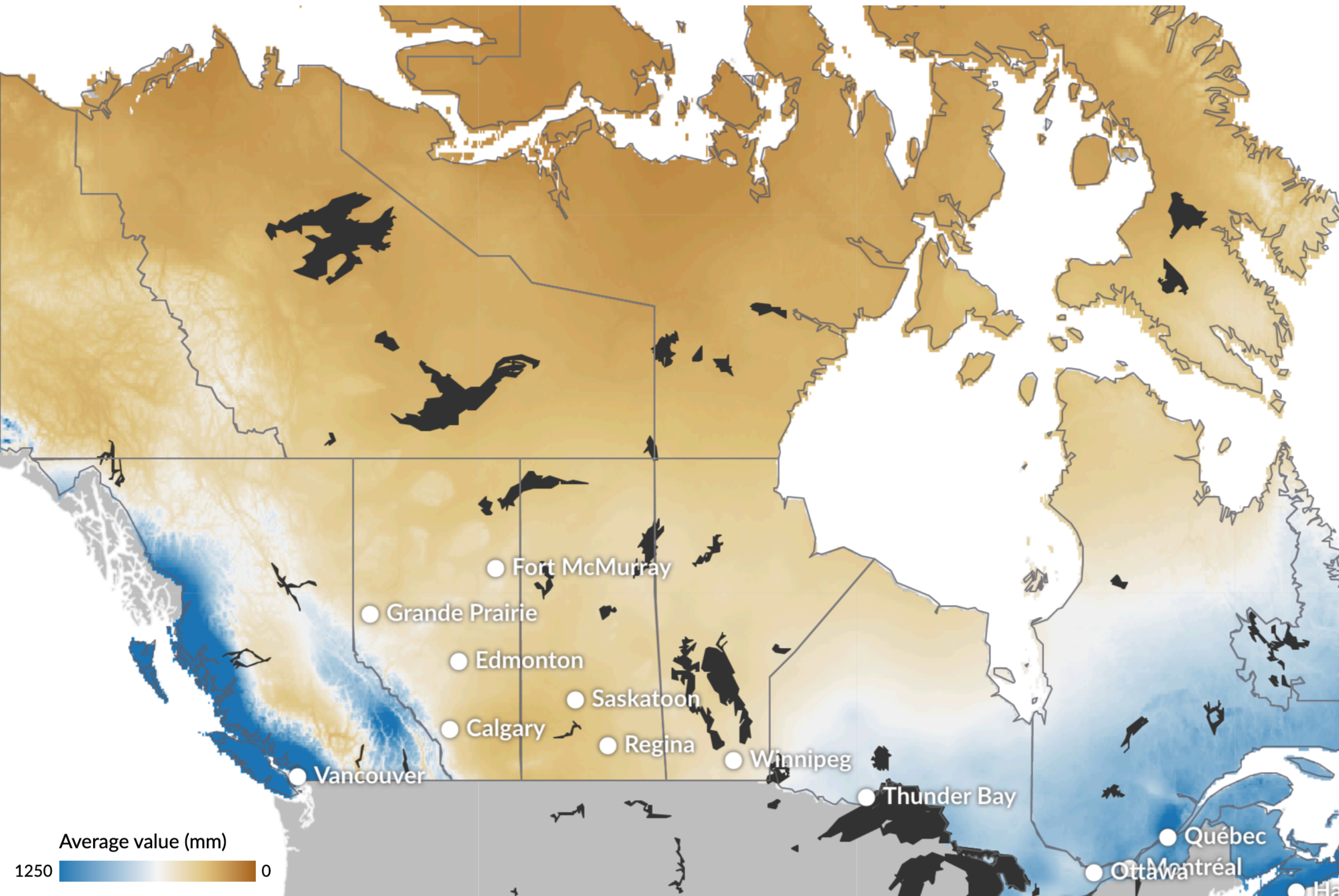
Geographic Map



Interlocking marks

- **shape coded**
- **area coded**
- **position coded**

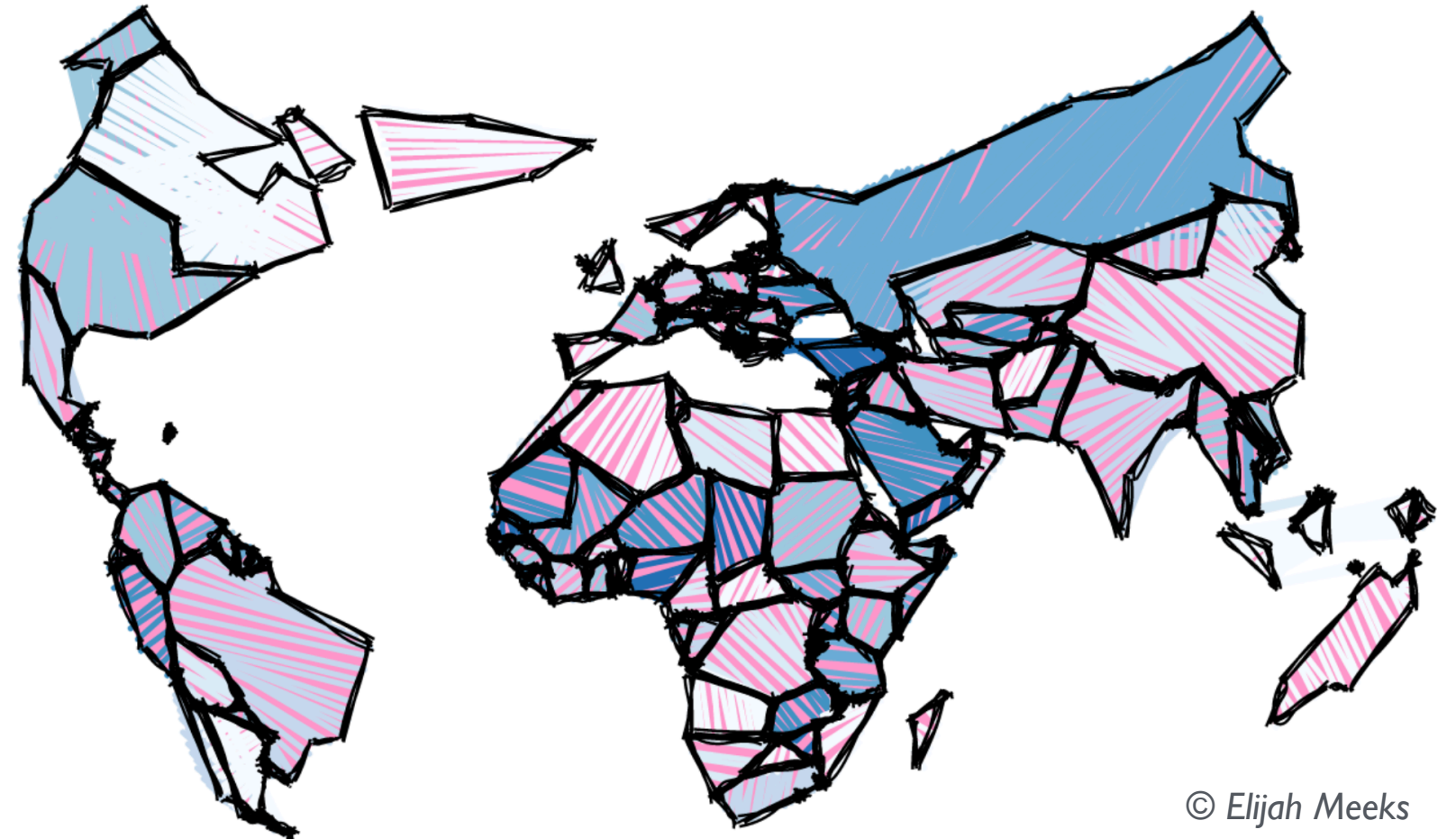
Density Maps (Annual Precipitation in Canada)



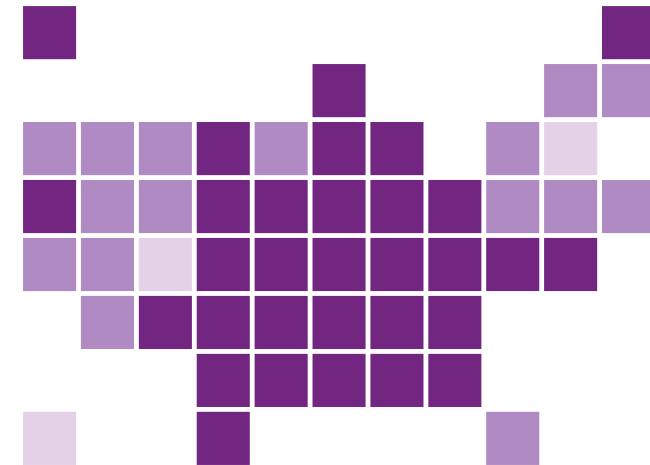
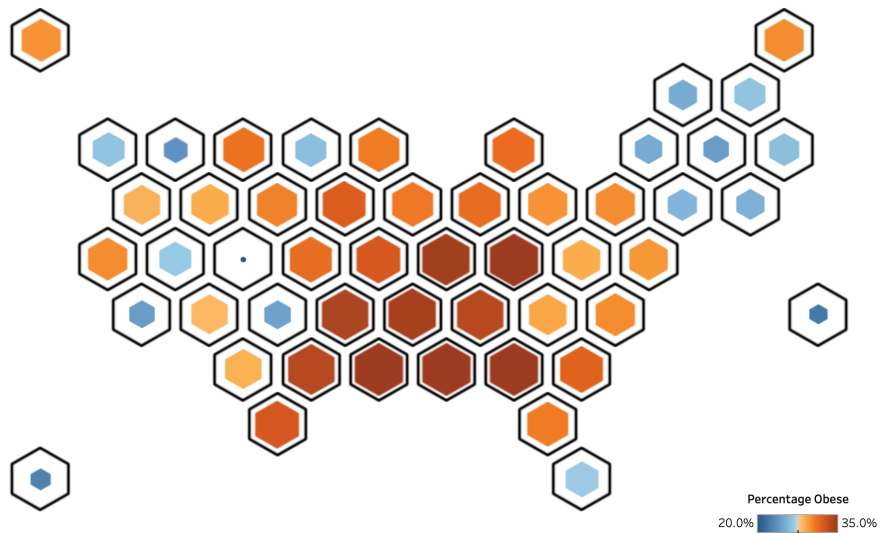
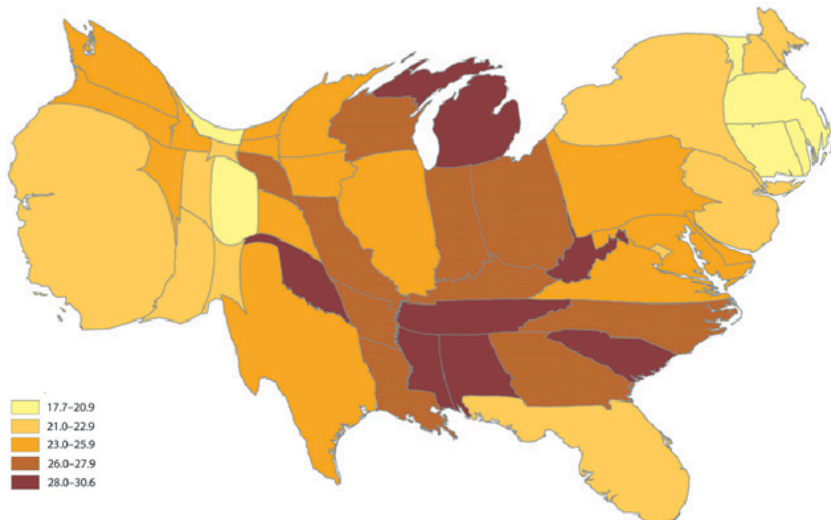
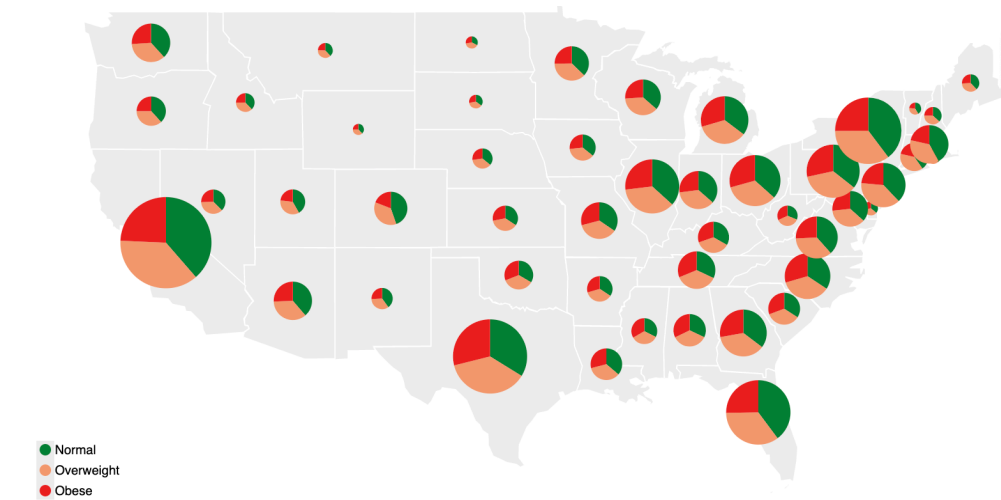
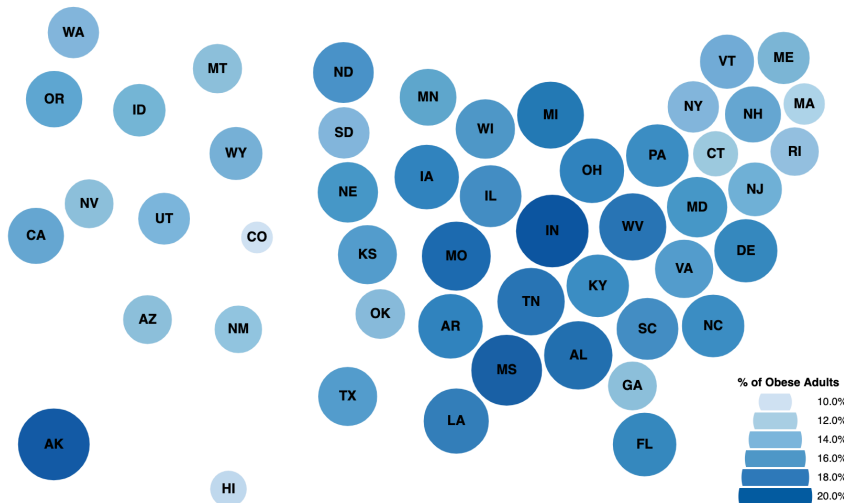
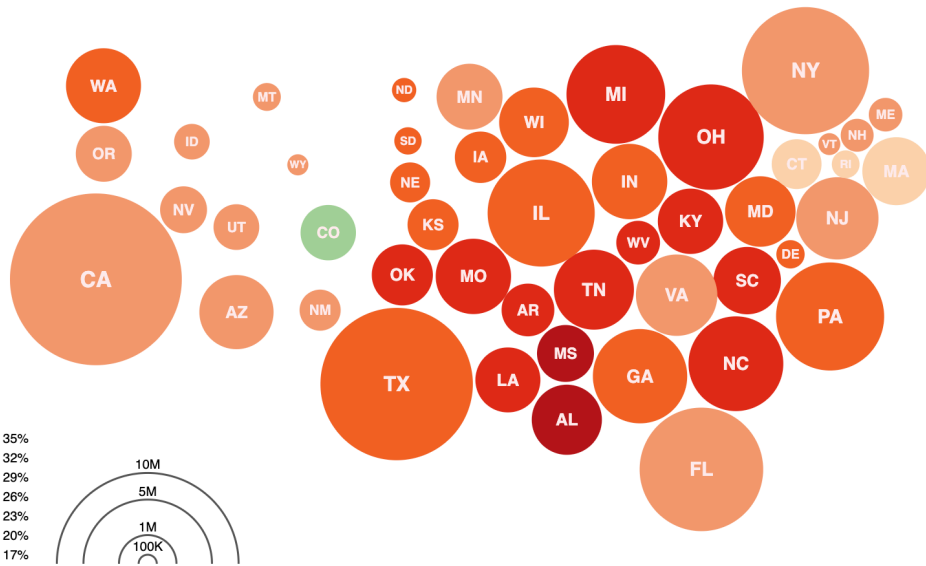
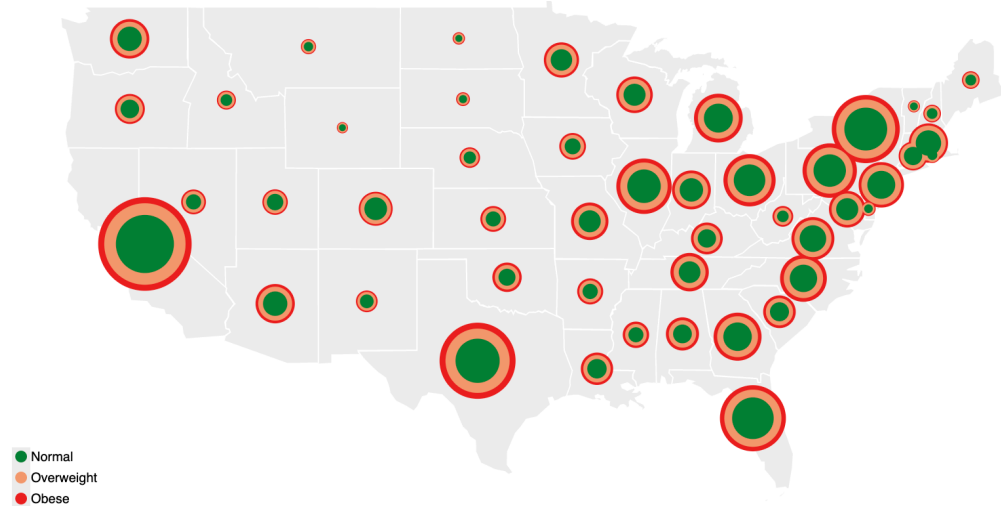
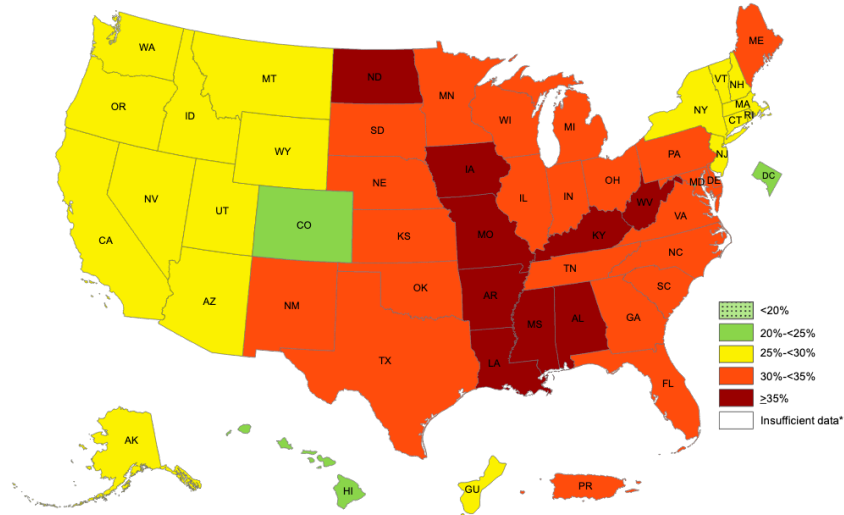
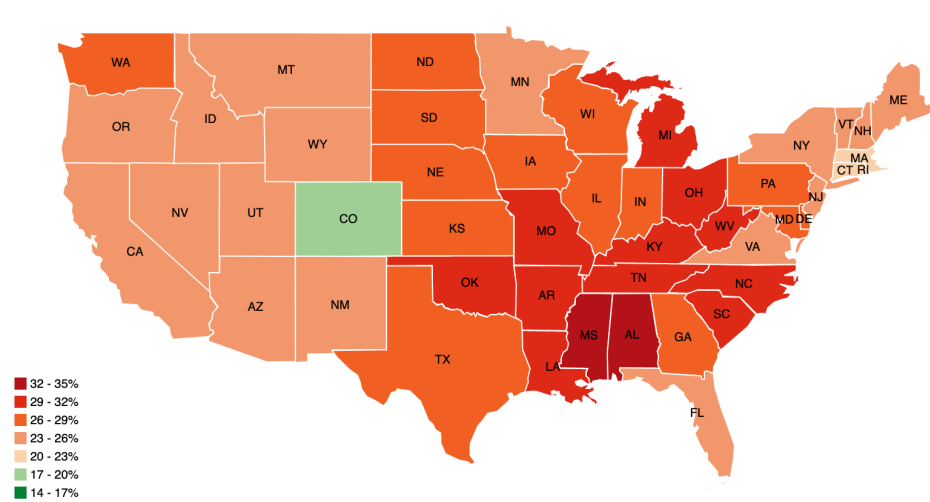
- Diverging color scheme
- Data transformation necessary to turn *discrete* data into *continuous* data
- Typically using some *density estimation function*

Activity: Sketching

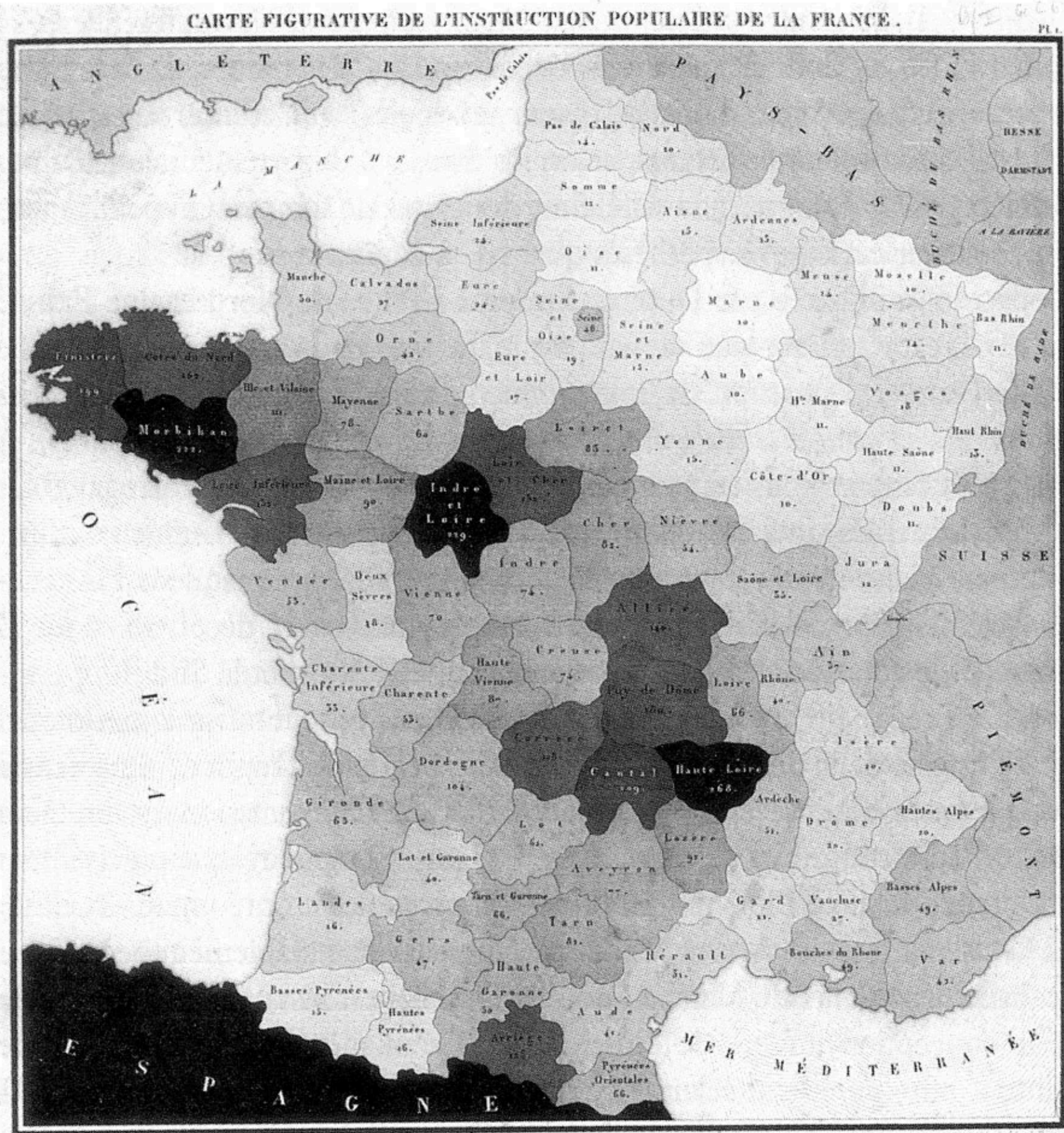
- For each state in the U.S., we have an obesity rate. Sketch (really only sketch) **three** ideas how you would encode that information *geographically*.
- 6 min
- Socrative: Answer *true* when you're done!



© Elijah Meeks



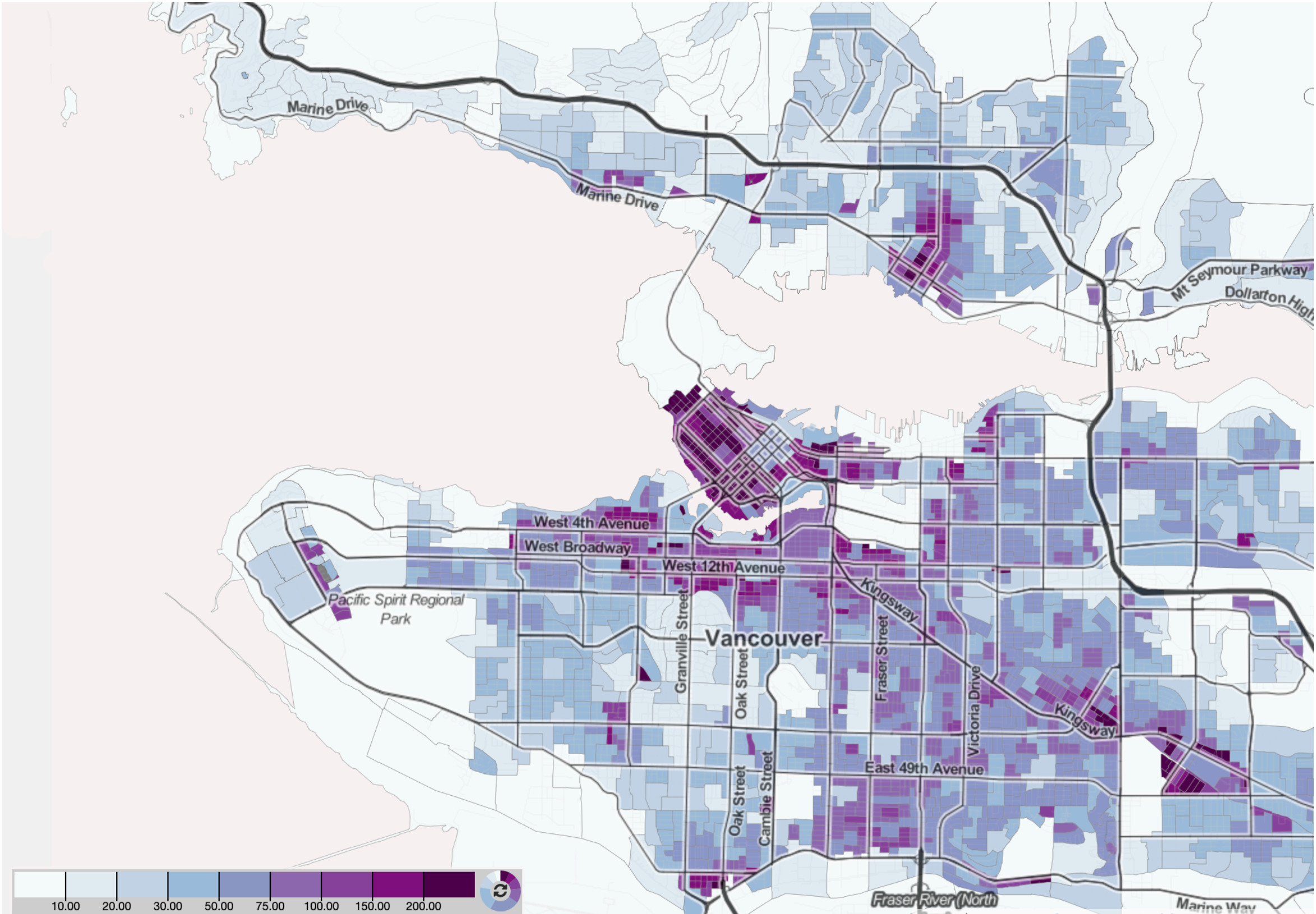
Choropleth Maps



Illiteracy / School Attendance

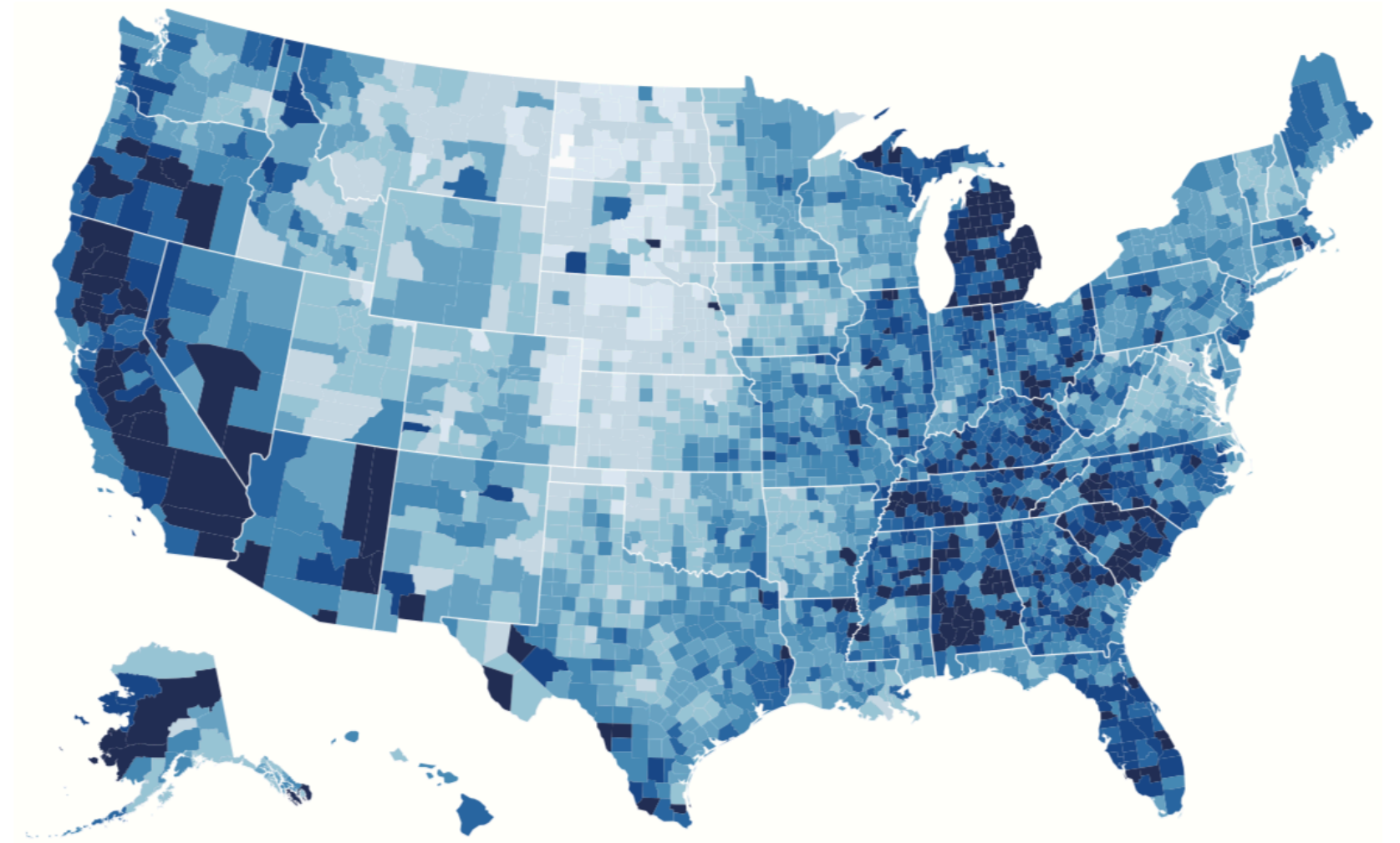
- Choropleth map created by Charles Dupin in 1826
- Data is often collected and aggregated by geographical regions
- Quantitative attribute encoded as color over regions
- Region is determined by using given geographic geometry

Population Density (Census 2016)



Activity: Discuss

- Discuss with your neighbour what the pros and cons of a choropleth map are.
- 3 min



<http://blocks.org/mbostock/4060606>

Choropleth Map: Pros & Cons

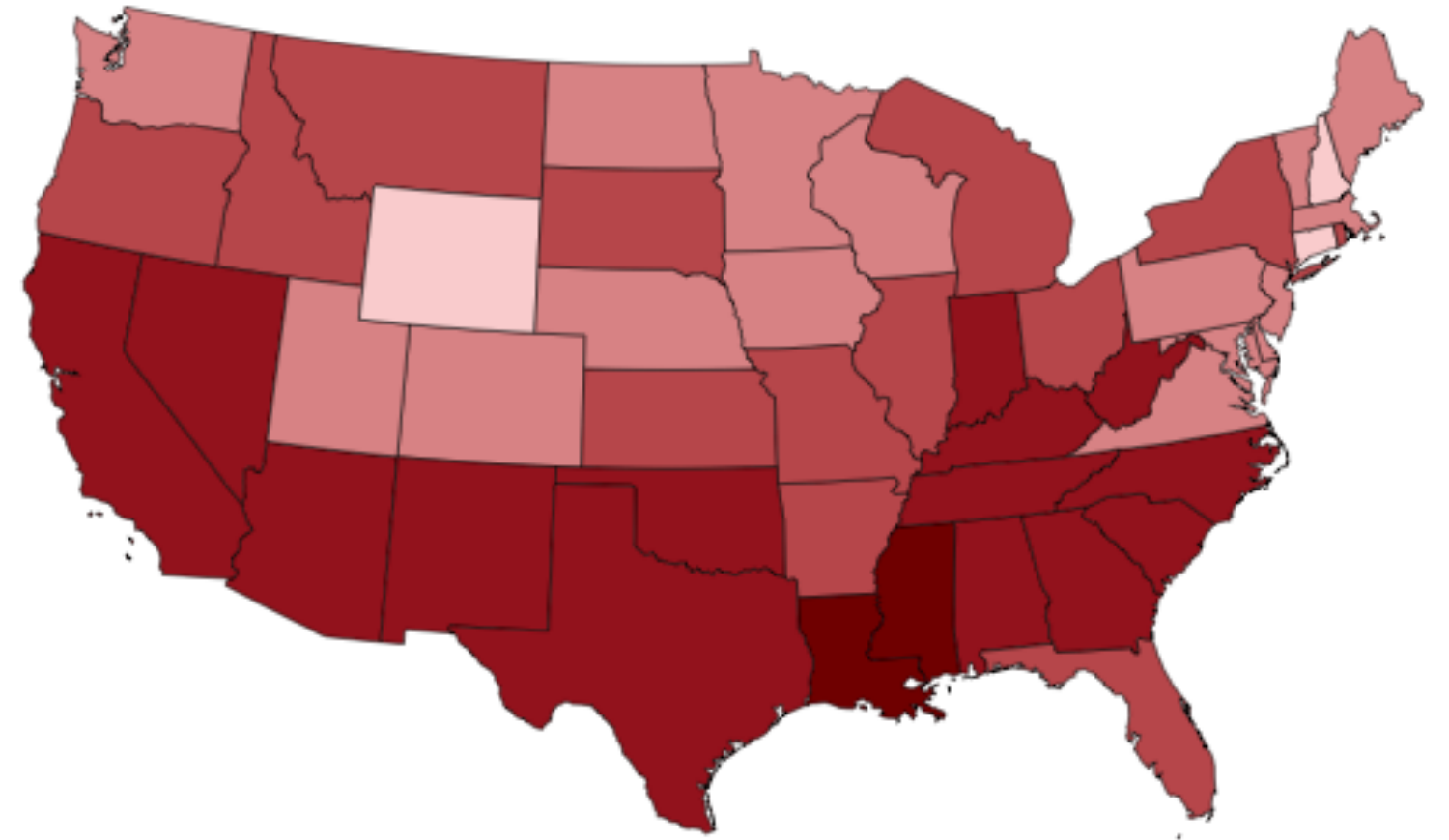
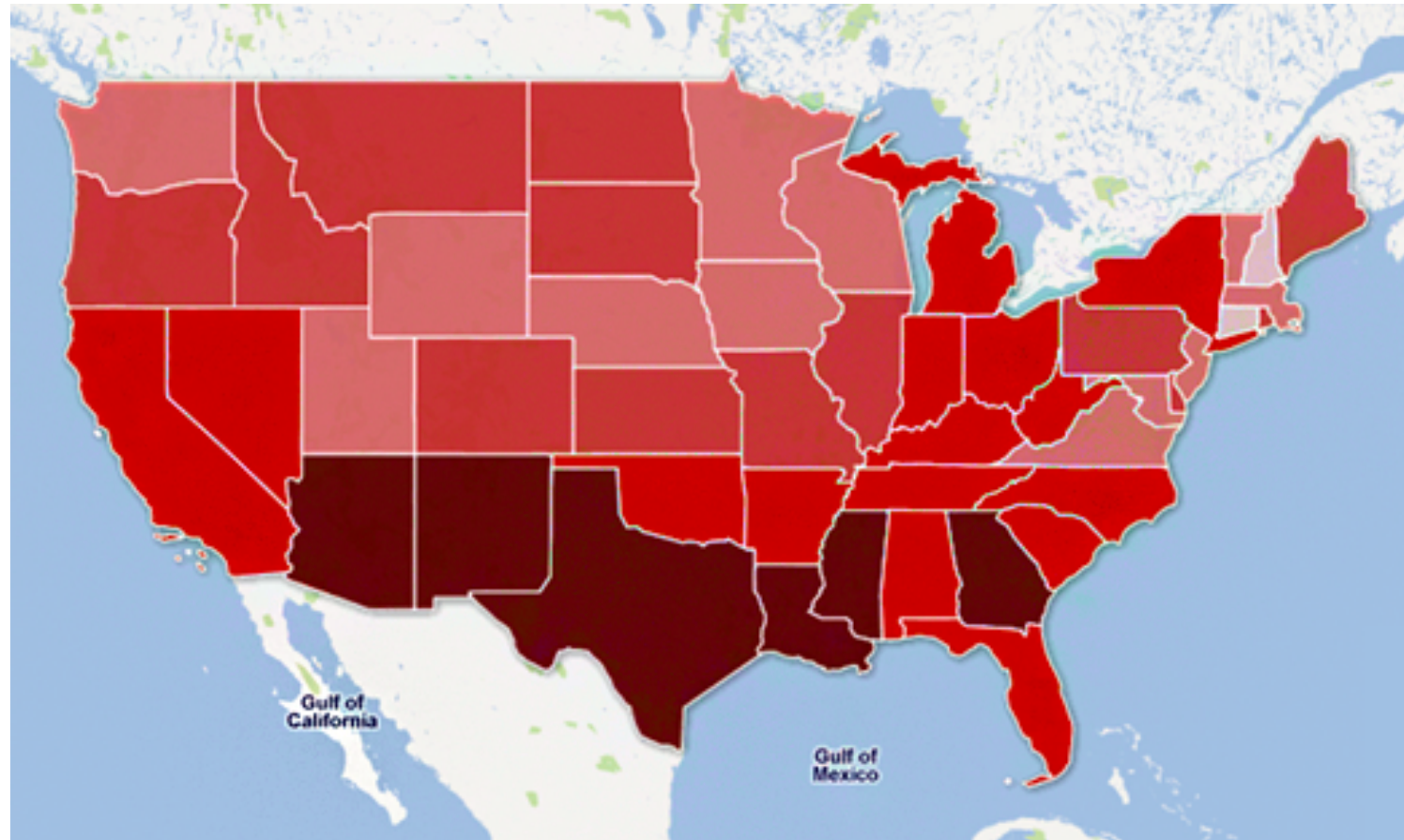
- Pros

- Well established visualization (no learning curve)
- Easy to read and understand
- Much of our geo data is reported by enumeration units (e.g. Census)

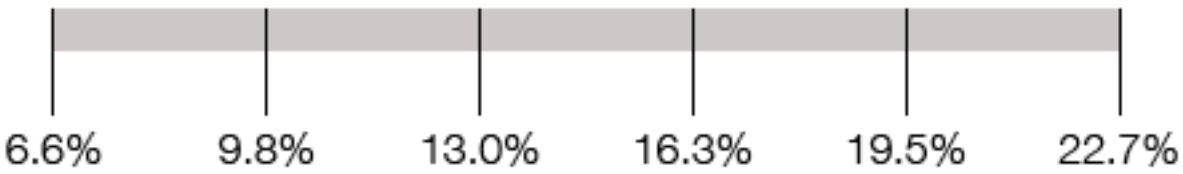
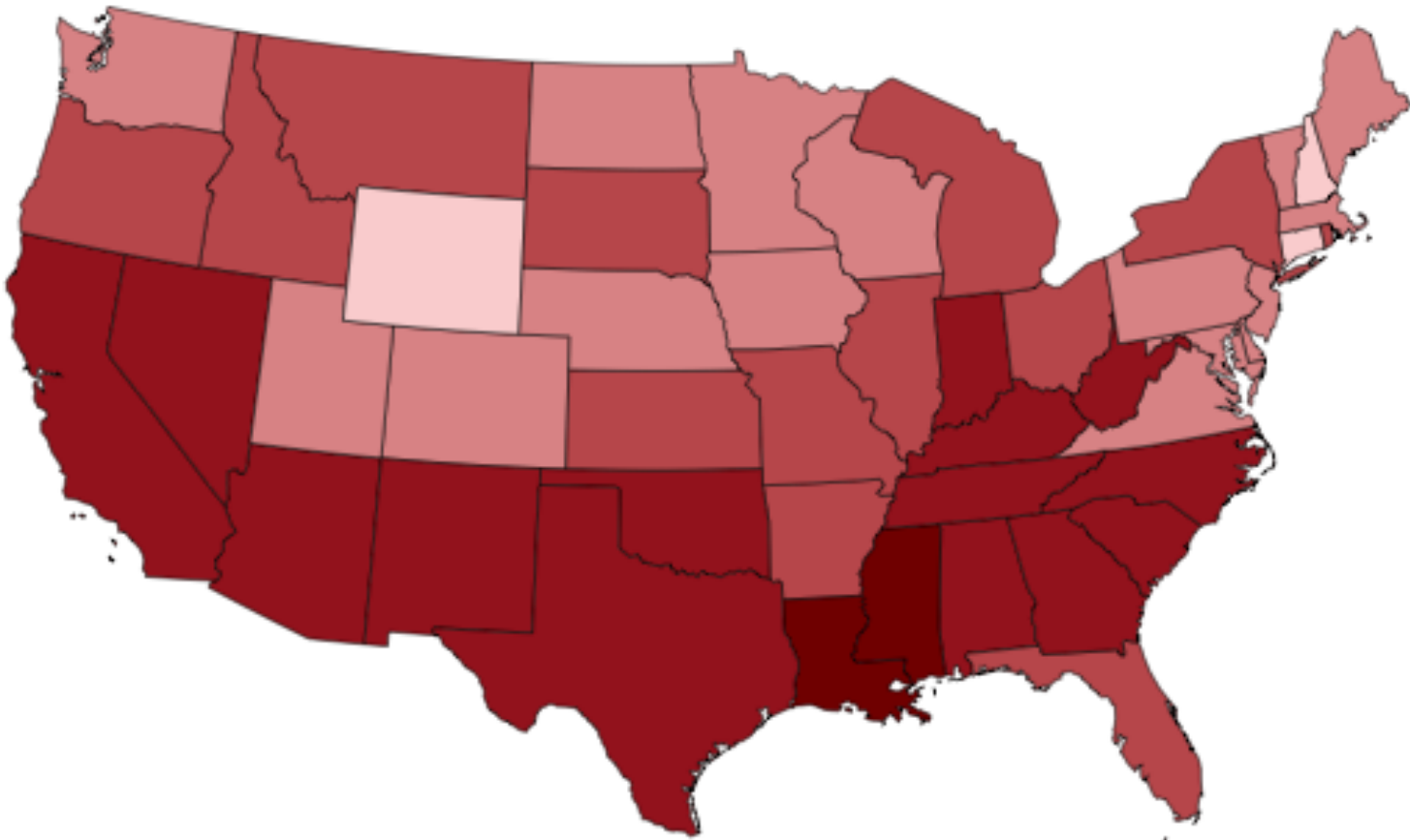
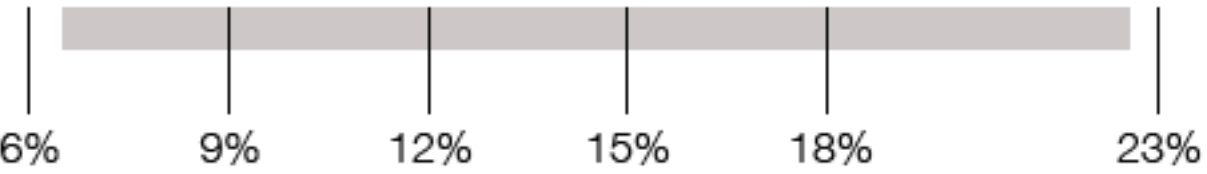
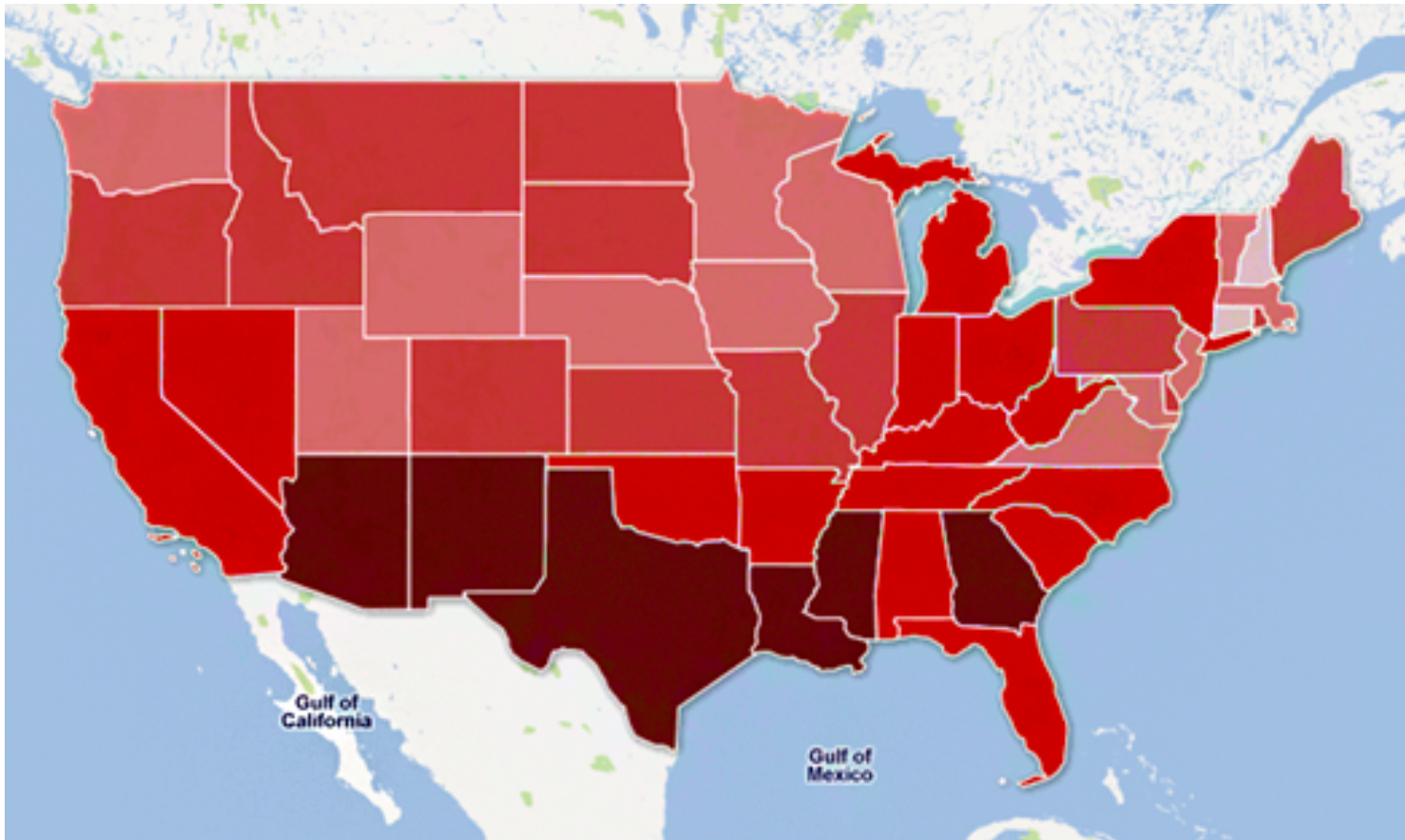
- Cons

- Most effective visual variable used for geographic location
- Visual significance of a coloured map may not correspond to the effects in the data (“Lie Factor”)
- Color palette choice has a huge influence on the result

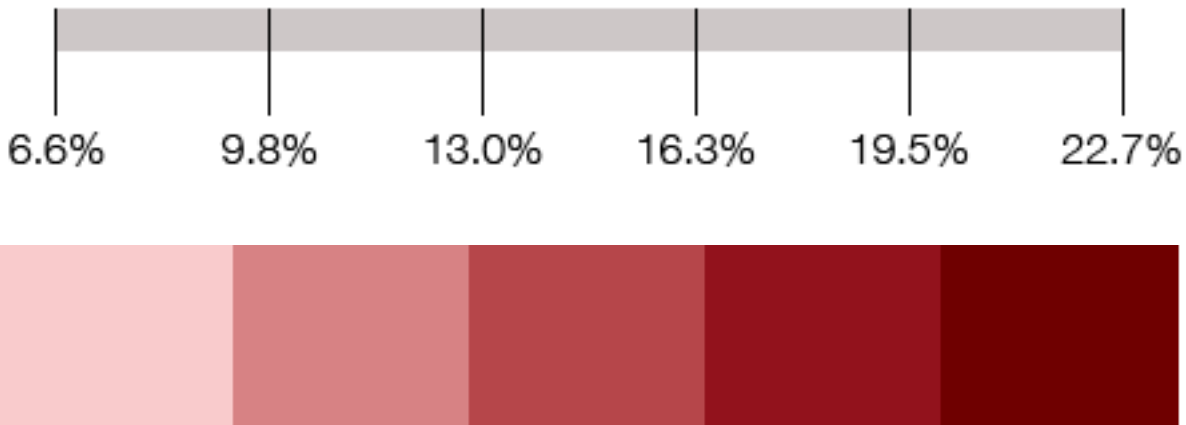
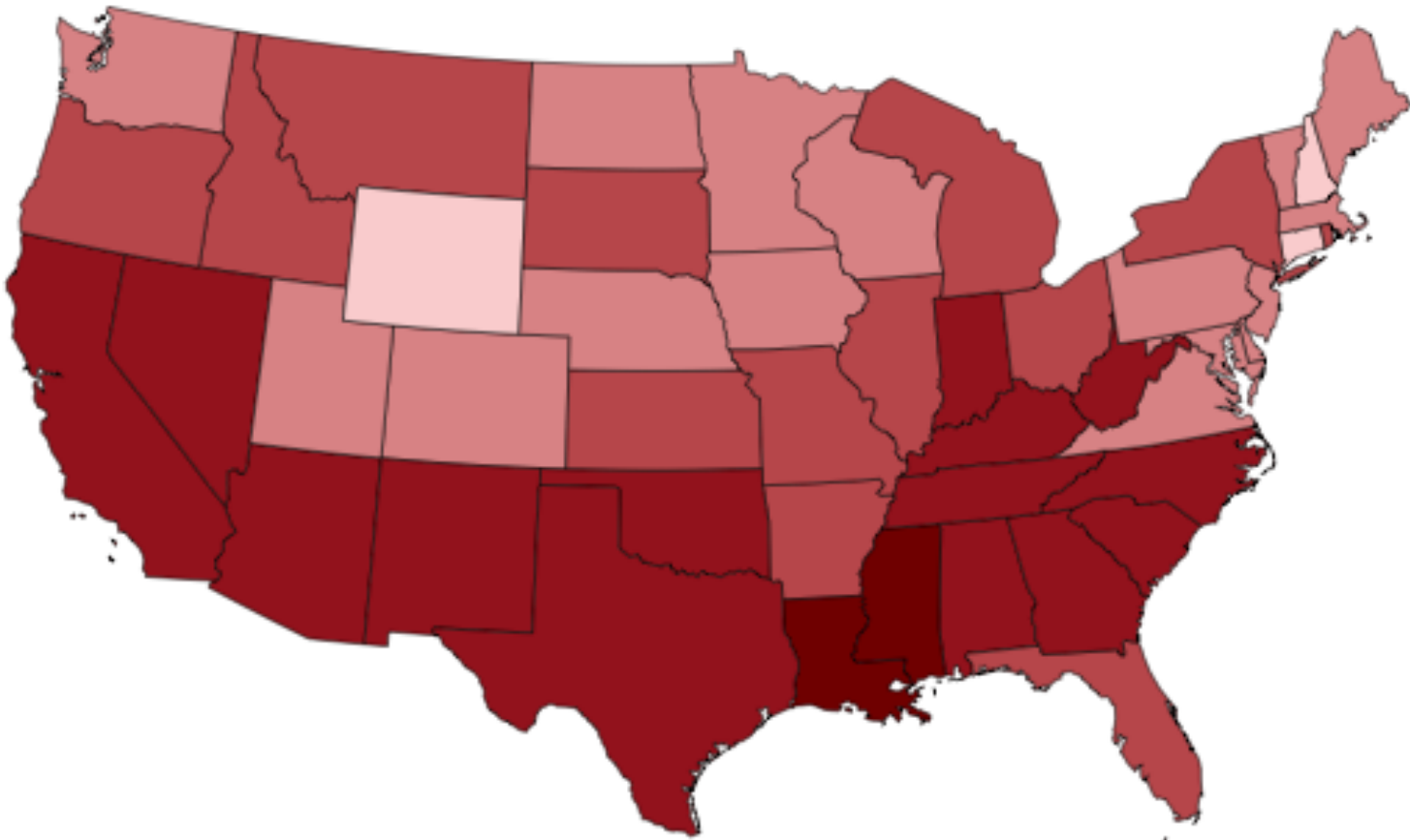
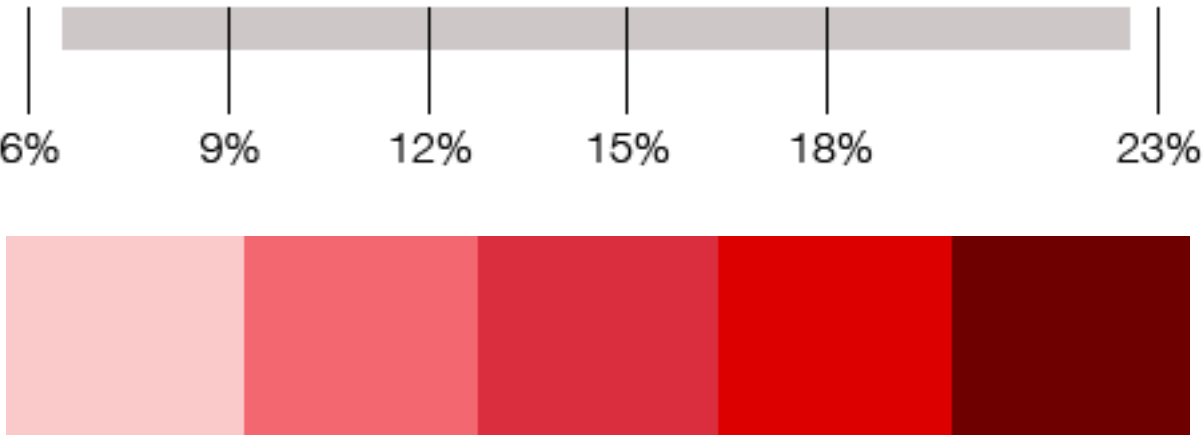
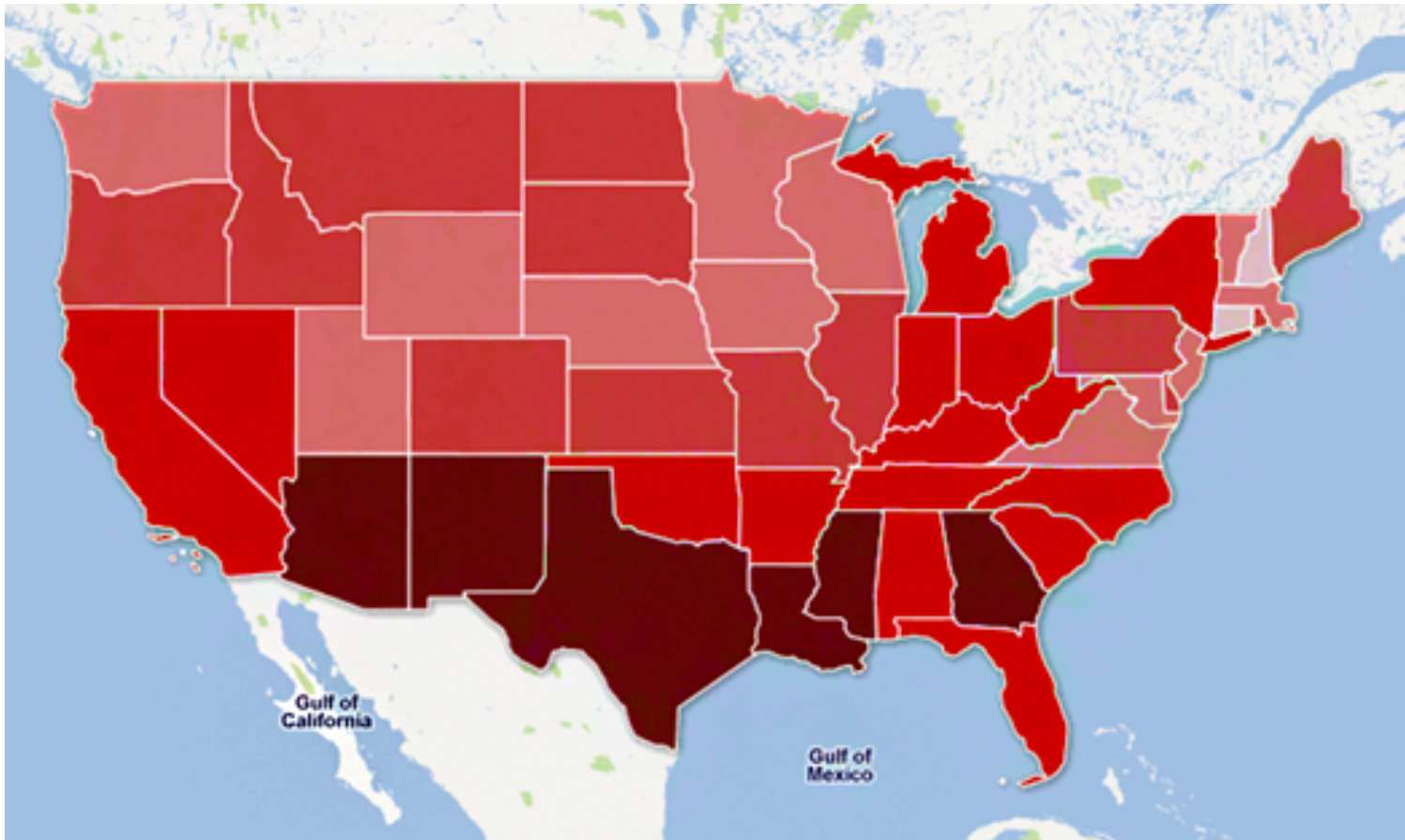
U.S. Poverty Map



U.S. Poverty Map

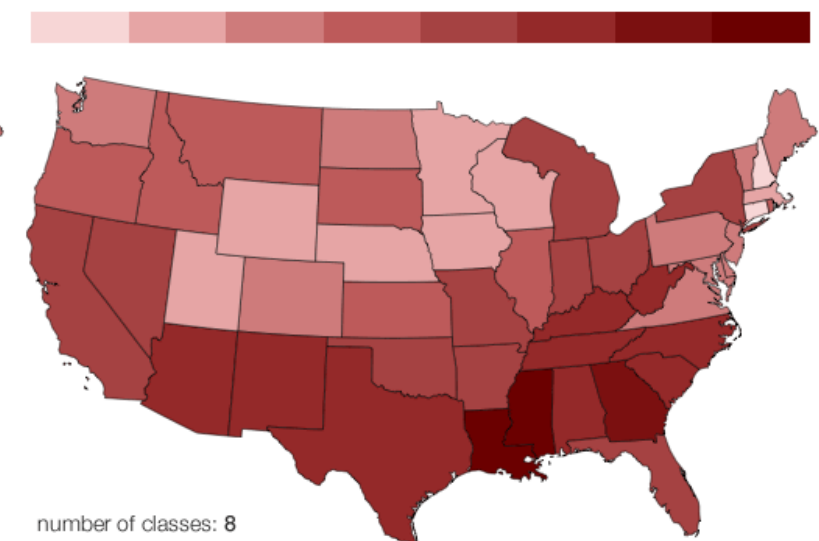
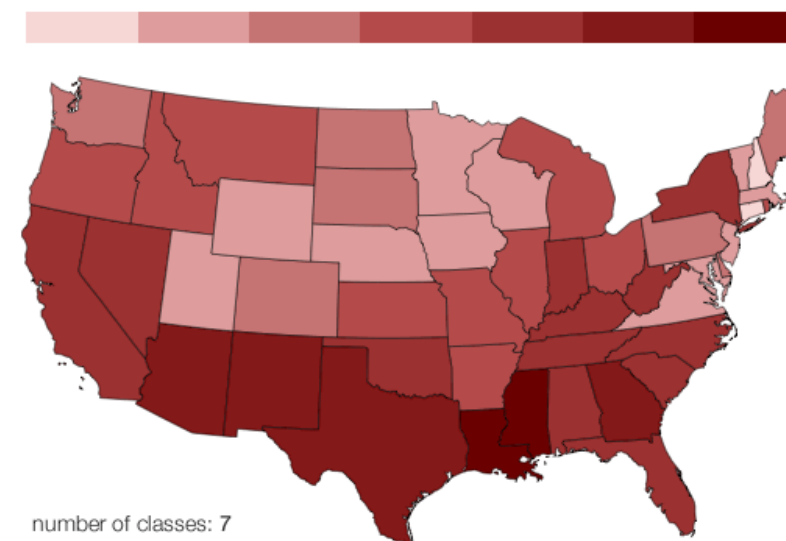
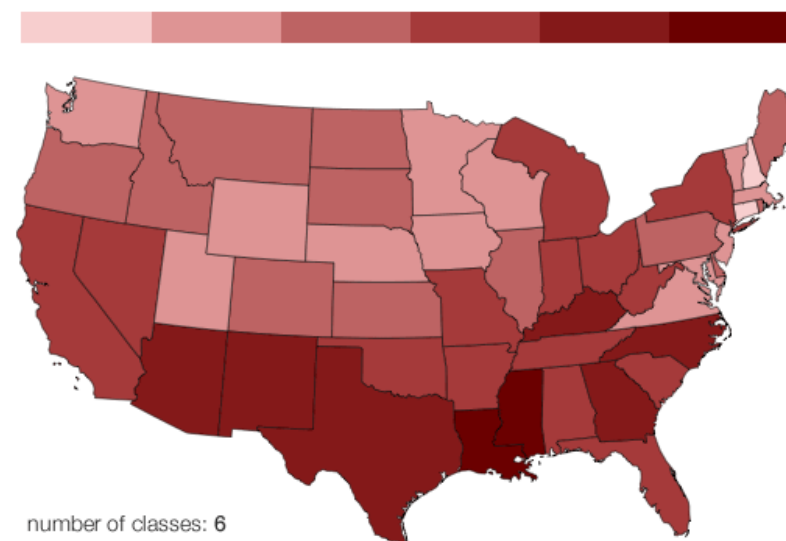
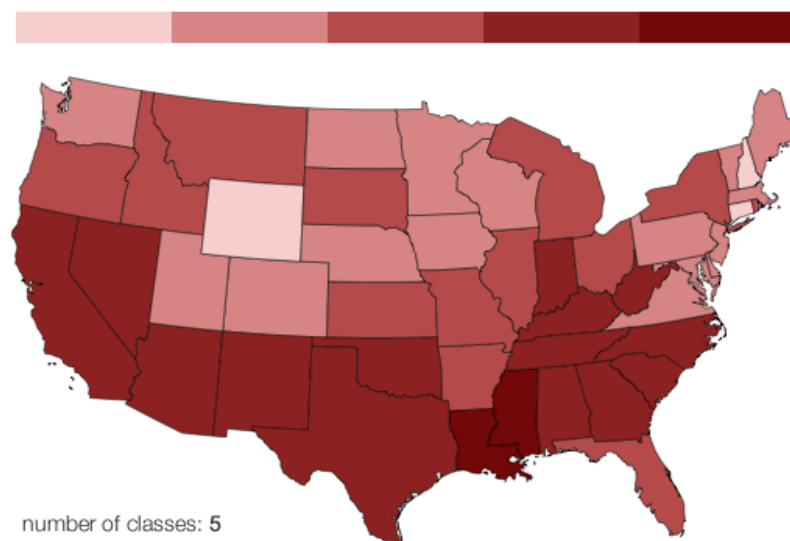
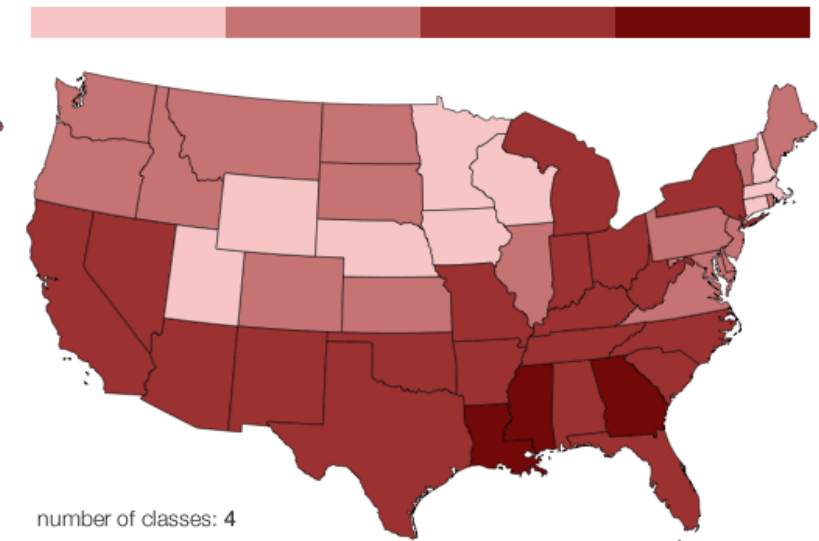
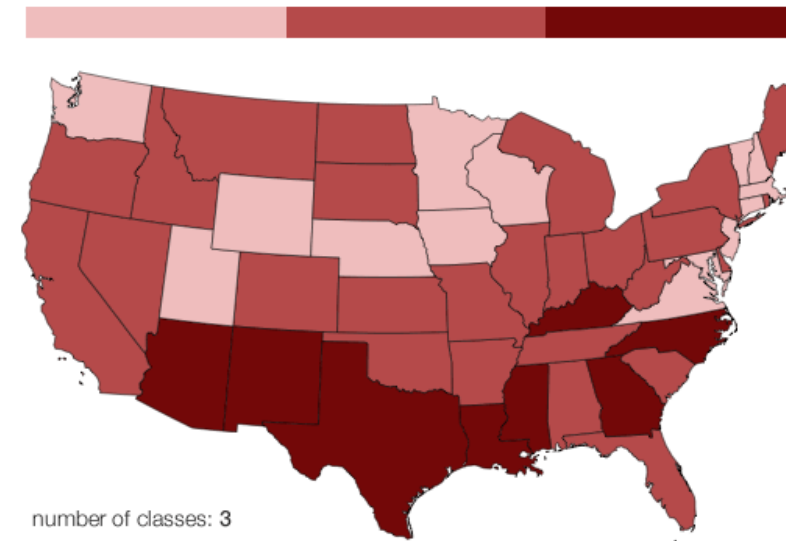
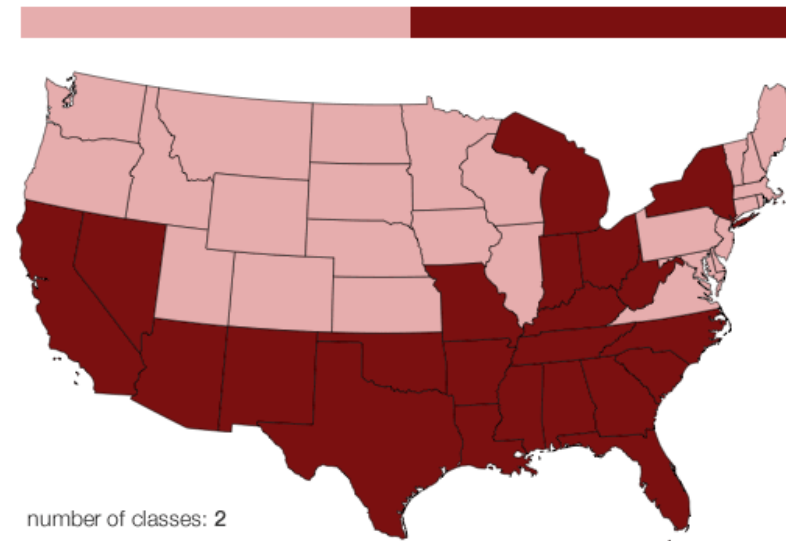


U.S. Poverty Map



U.S. Poverty Map

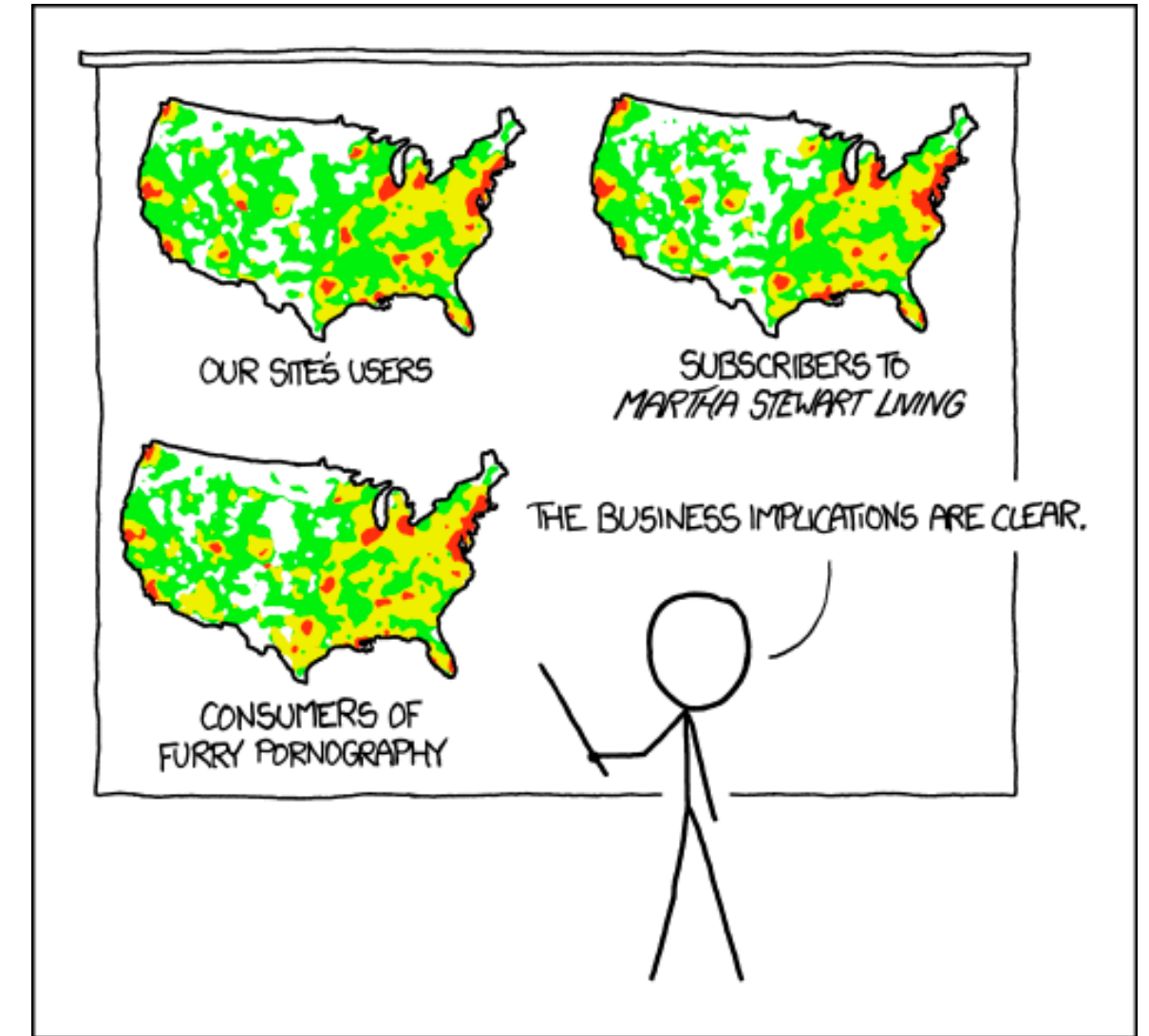
Number of
bins?



» Trade-off between correctness and color distinguishability

Choropleth Maps: Recommendations

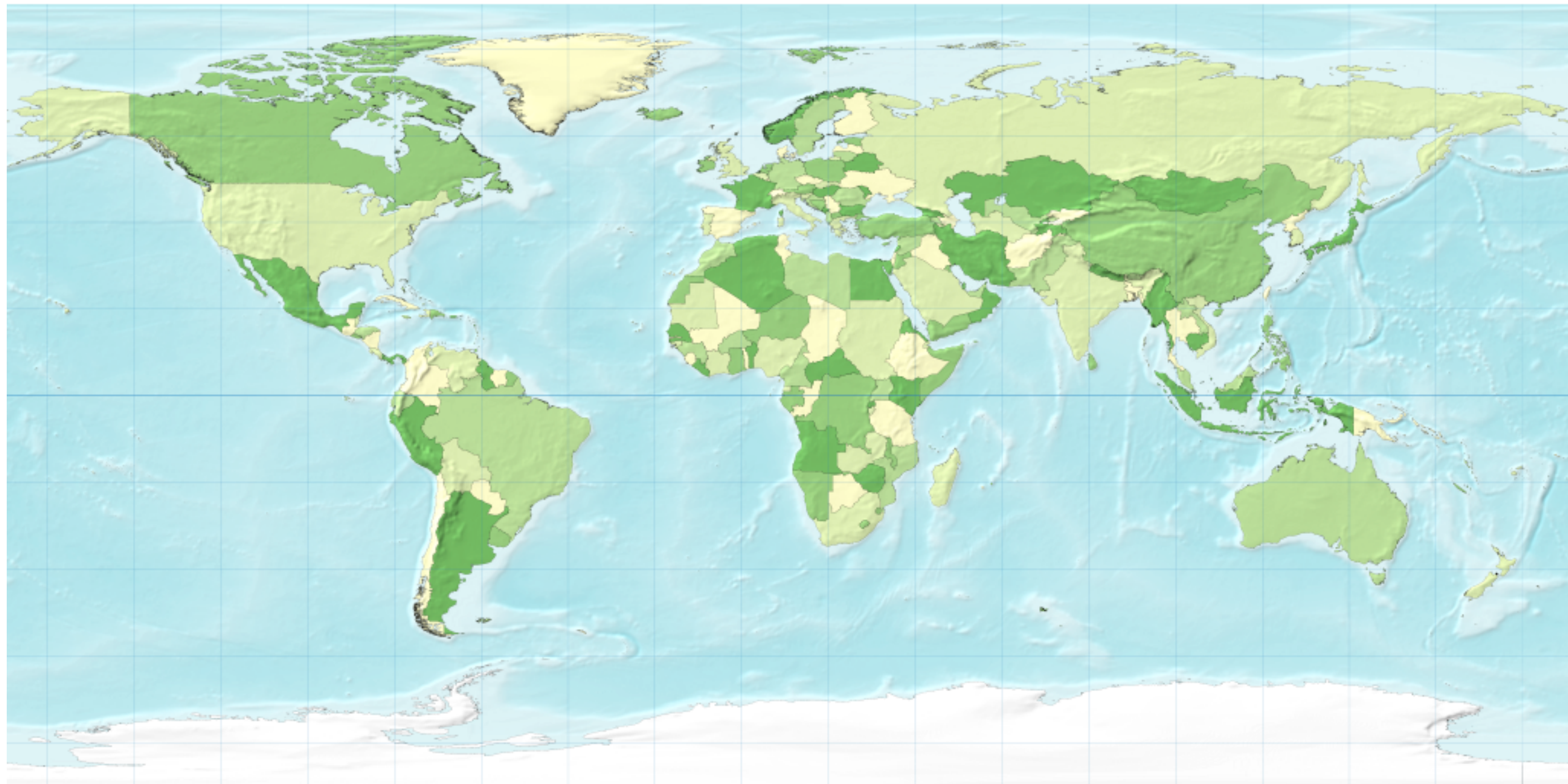
- Only use when central task is understanding spatial relationships
- Show only one variable at a time
- Normalization
 - Common error is to encode raw data values (such as population) rather than using normalized values (unemployed people per 100 citizens, mean family income, ...).
 - You can also derive ratios, such as population growth between 2010 and 2020.
- Be careful when choosing colors & bins



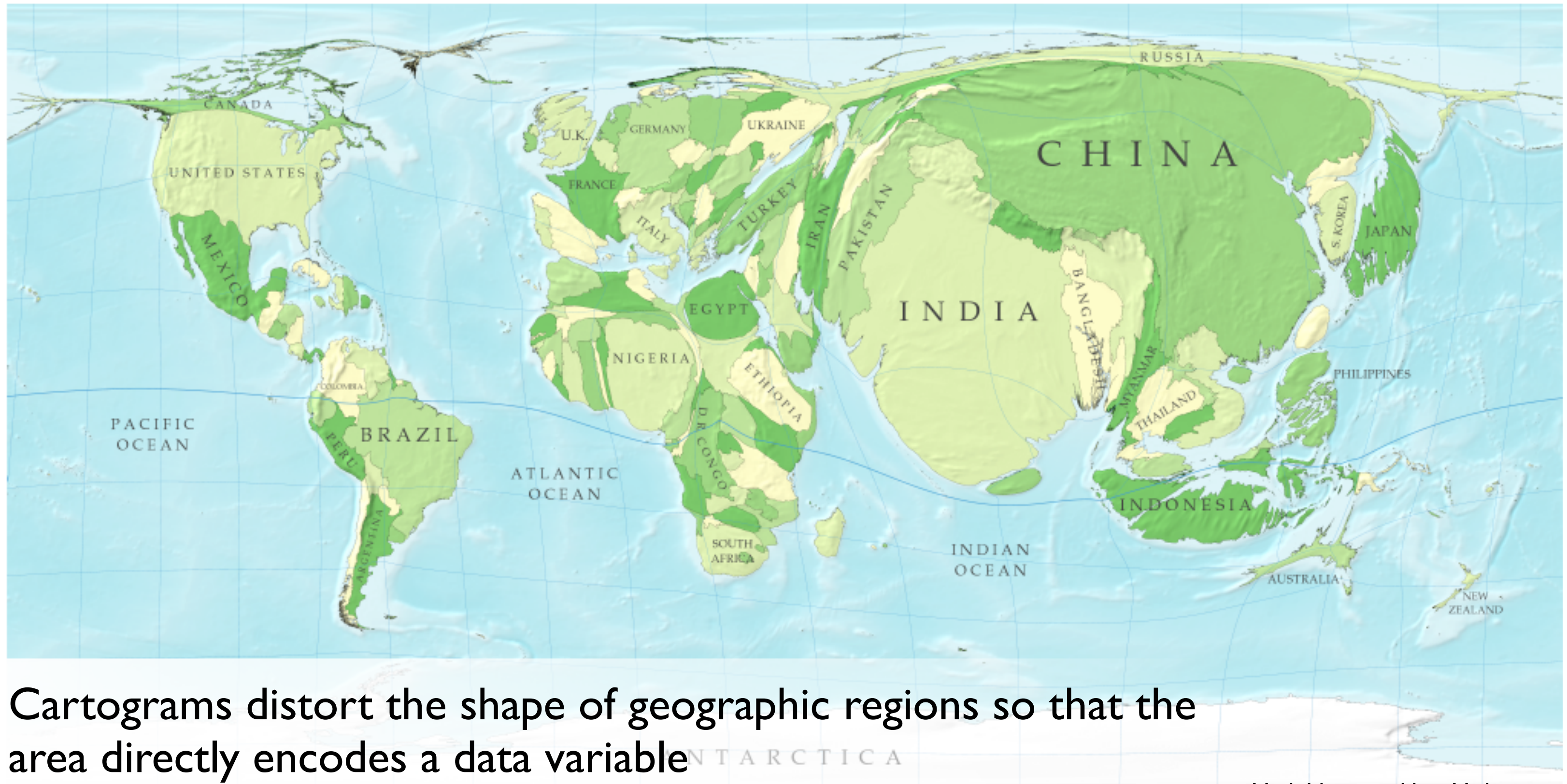
PET PEEVE #208:
GEOGRAPHIC PROFILE MAPS WHICH ARE
BASICALLY JUST POPULATION MAPS

<https://xkcd.com/1138/>

Cartograms

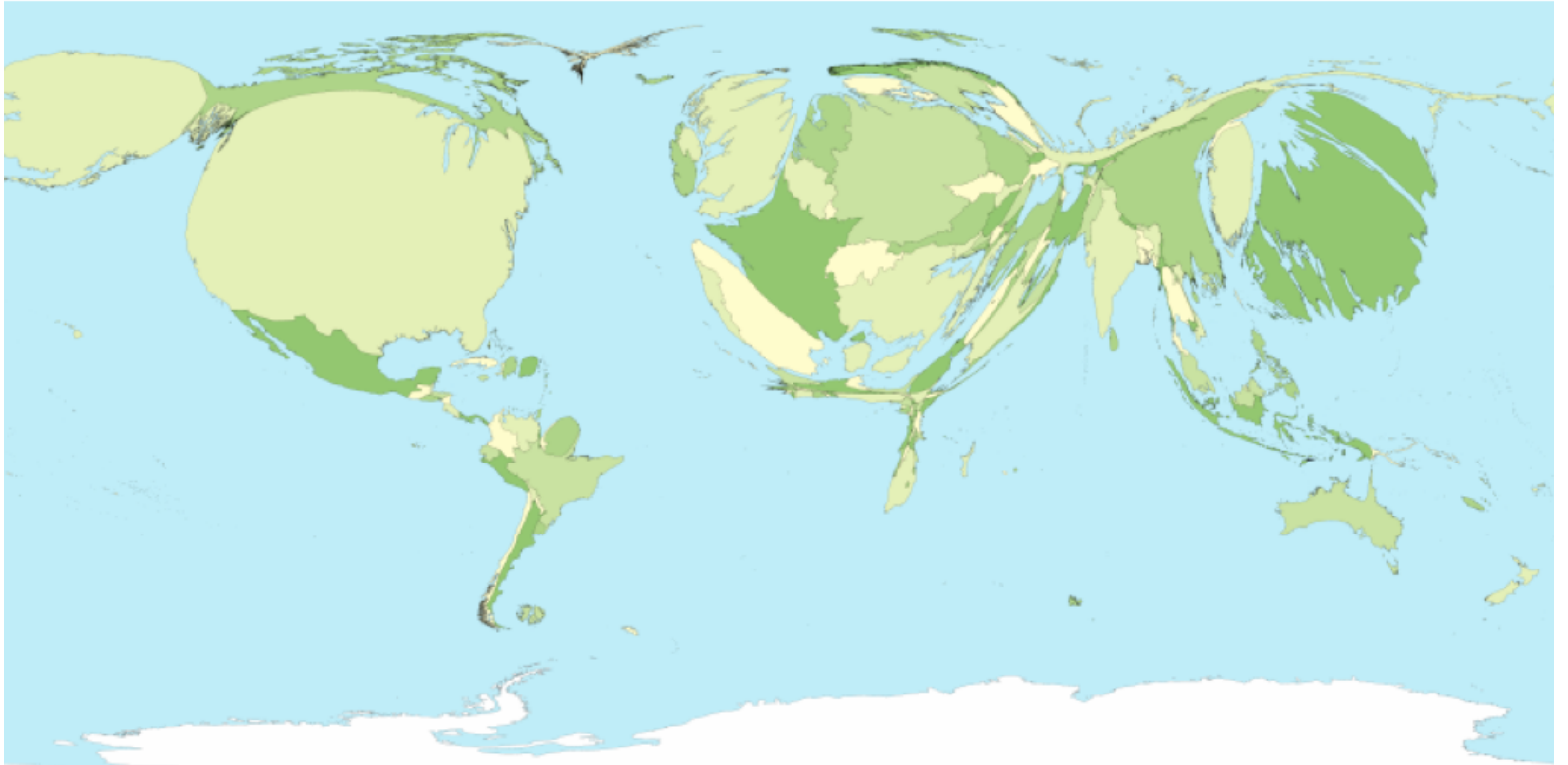


Contiguous Cartogram: Population



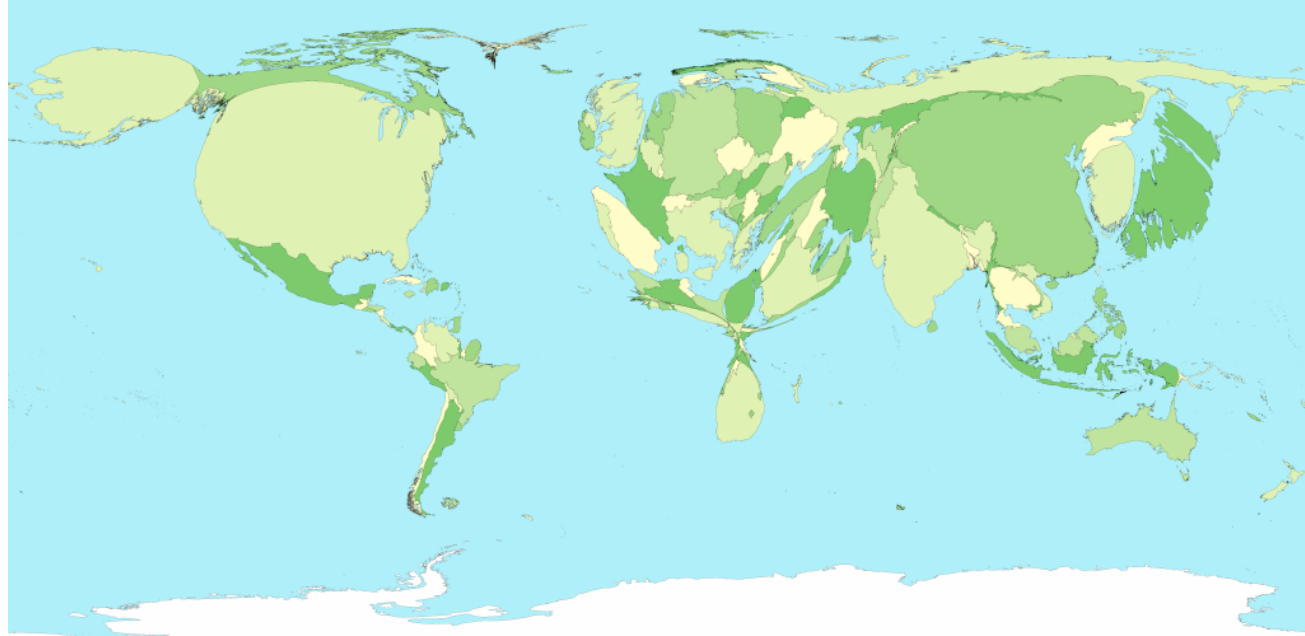
Cartograms distort the shape of geographic regions so that the area directly encodes a data variable

Contiguous Cartogram: GDP (Gross Domestic Product)

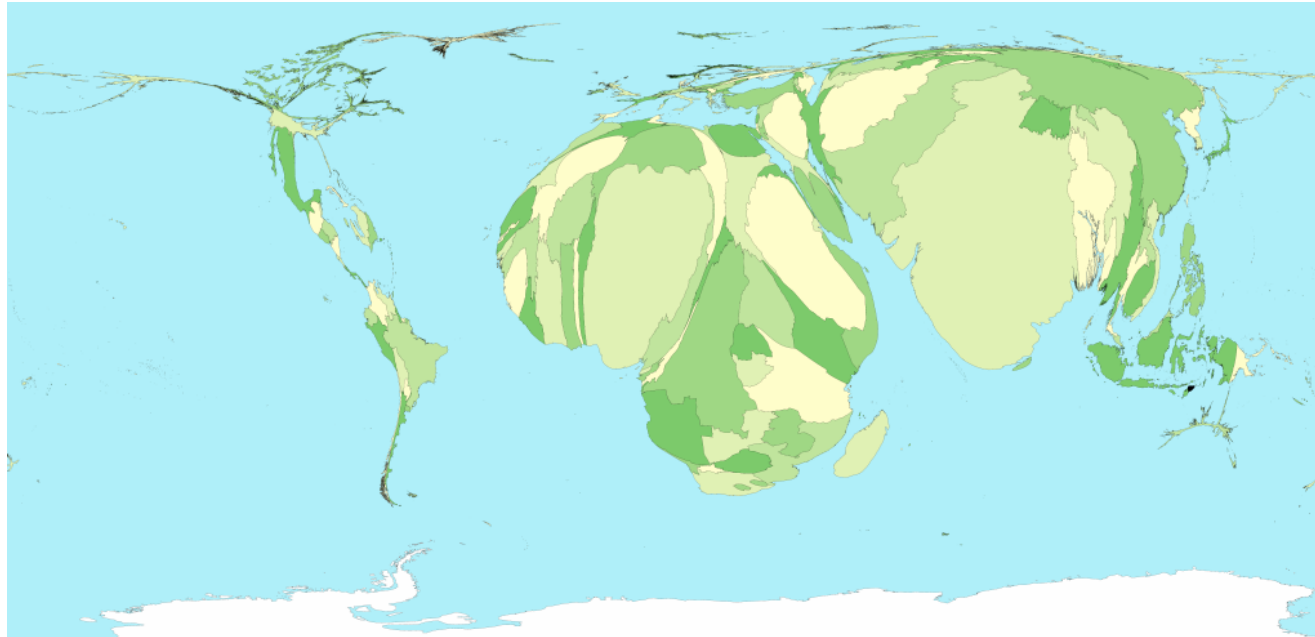


Contiguous Cartogram: Derive New Marks

Greenhouse Emissions

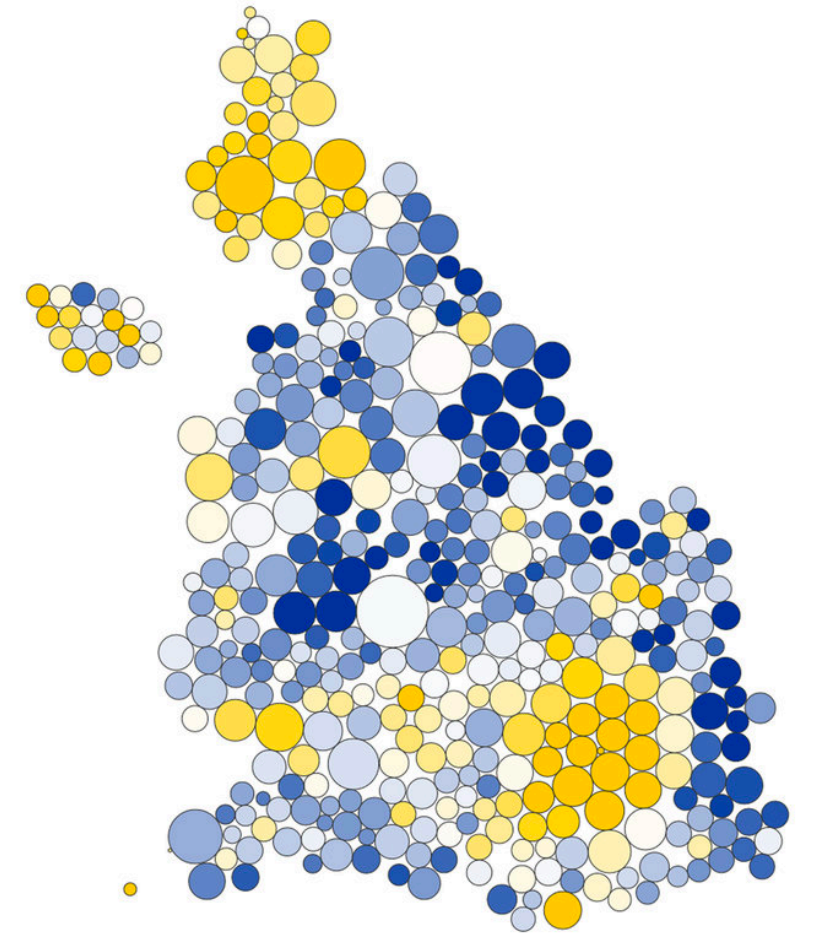
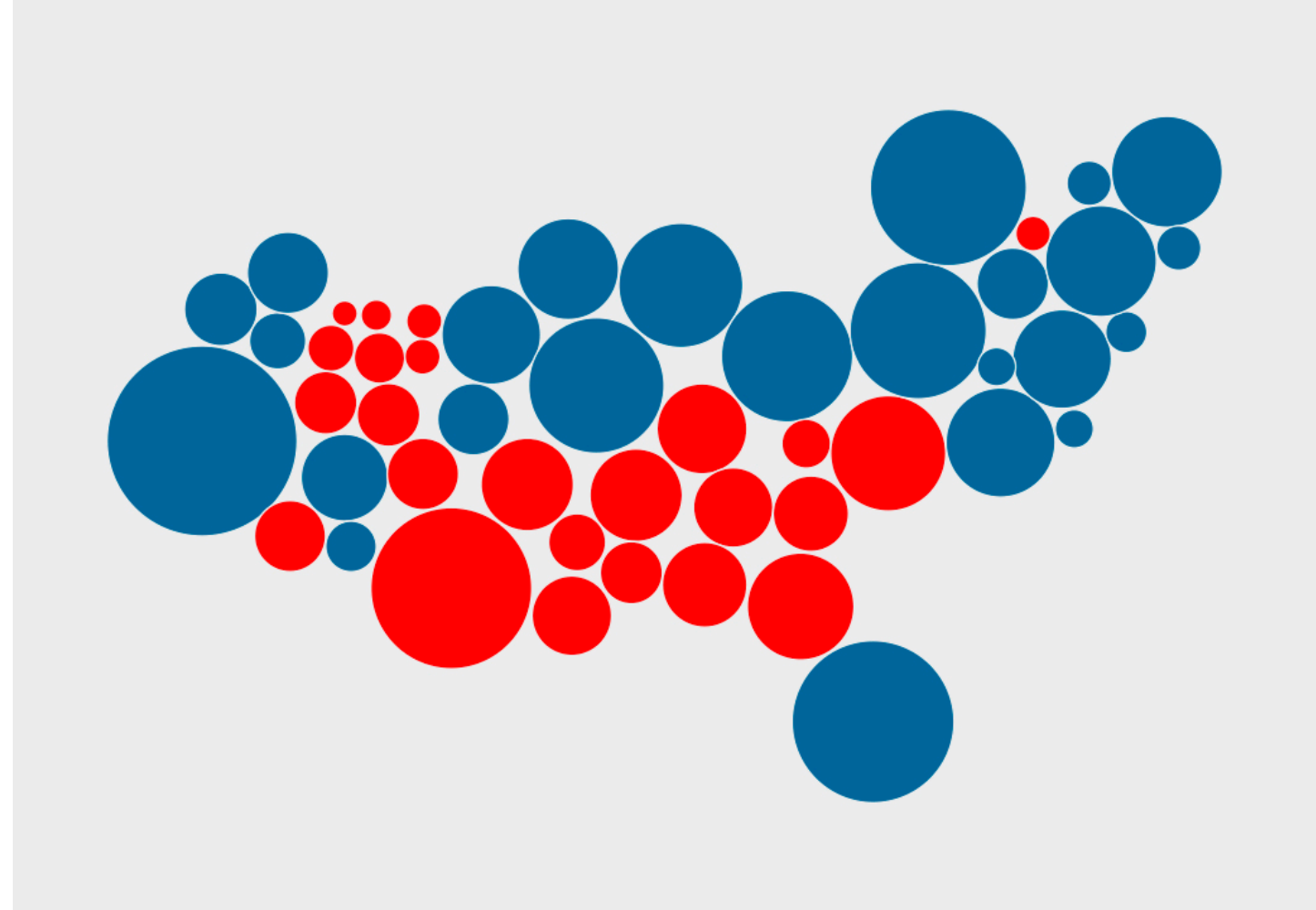
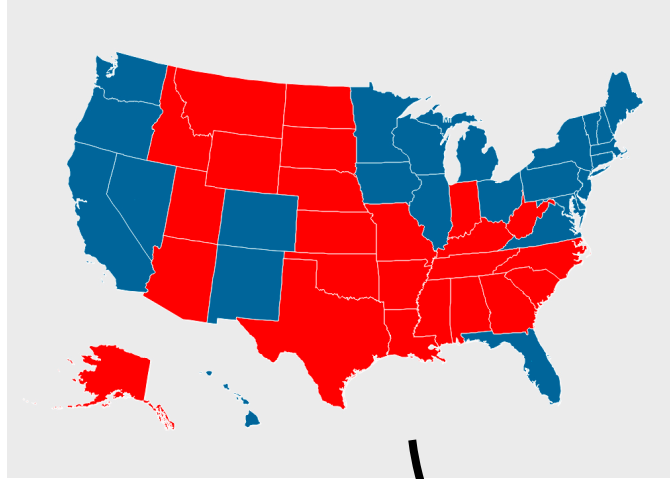


Child Mortality



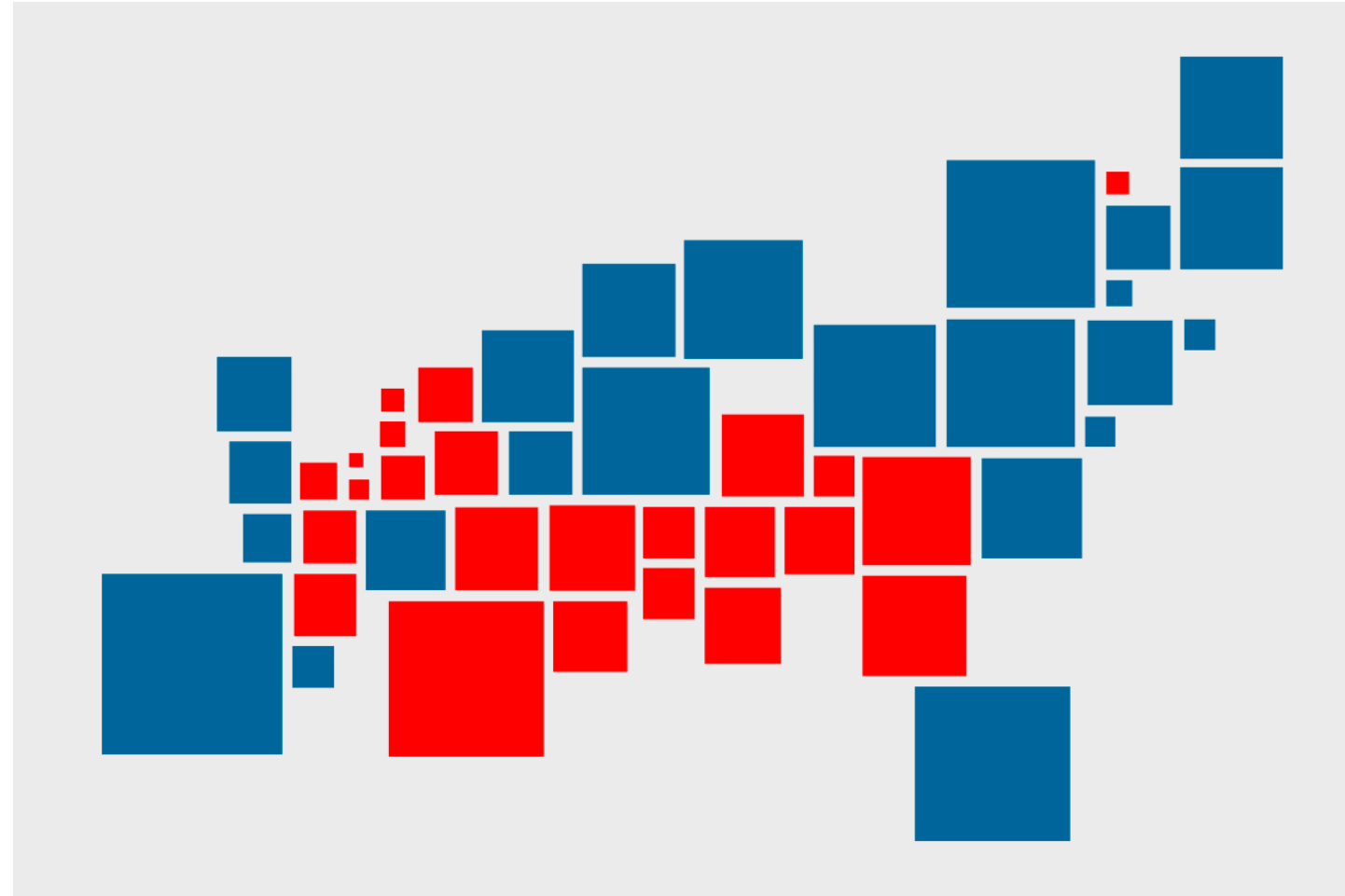
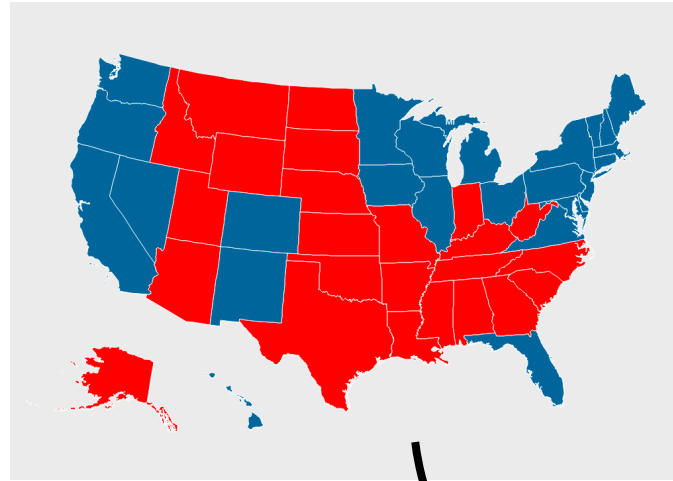
- Interlocking marks:
shape, area, and position coded
- Derive new interlocking marks based on the combination of the original interlocking marks and a new quantitative attribute.
- Algorithm to create new marks
 - Target size
 - Shape as close to the original as possible
 - Maintaining the constraints of relative position and contiguous boundaries with their neighbours

Dorling Cartogram



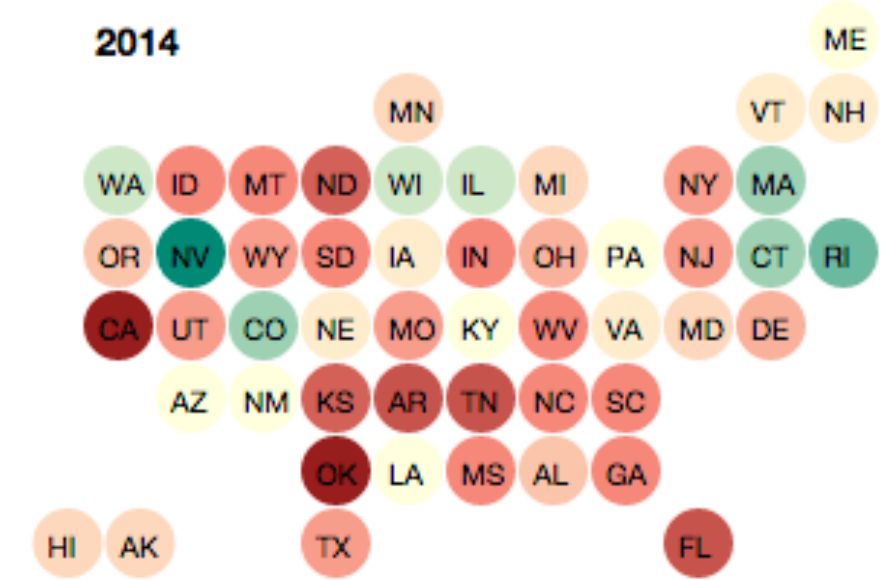
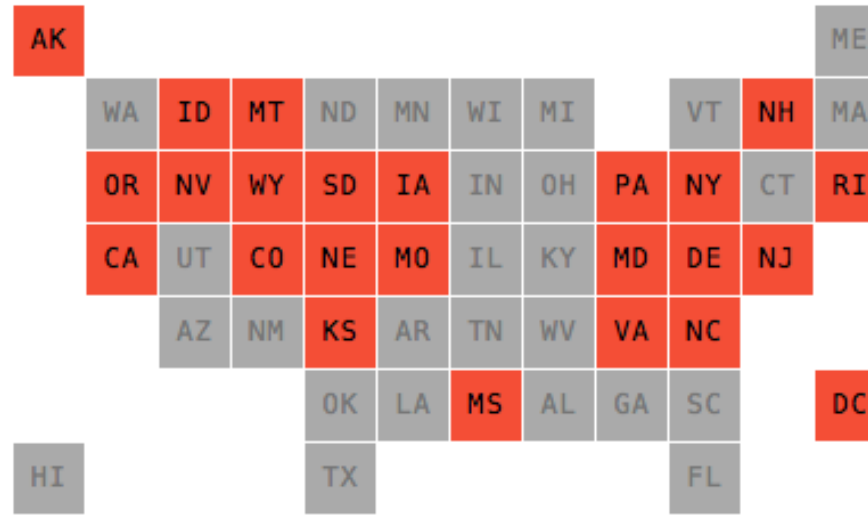
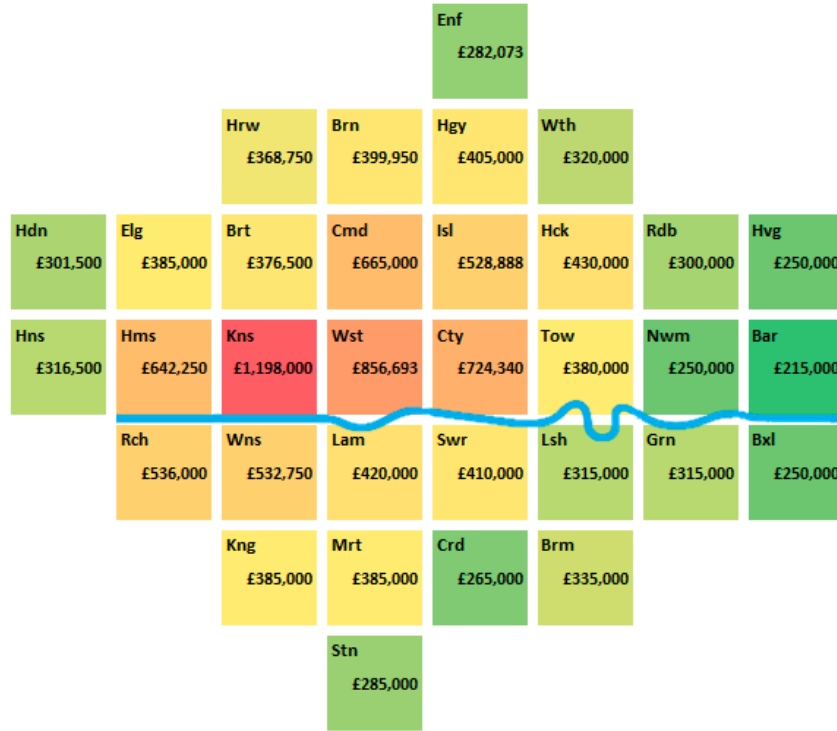
- Sized circles represent quantity of interest per geographic region
- Geometric shapes in place of geographic area

Demers Cartogram



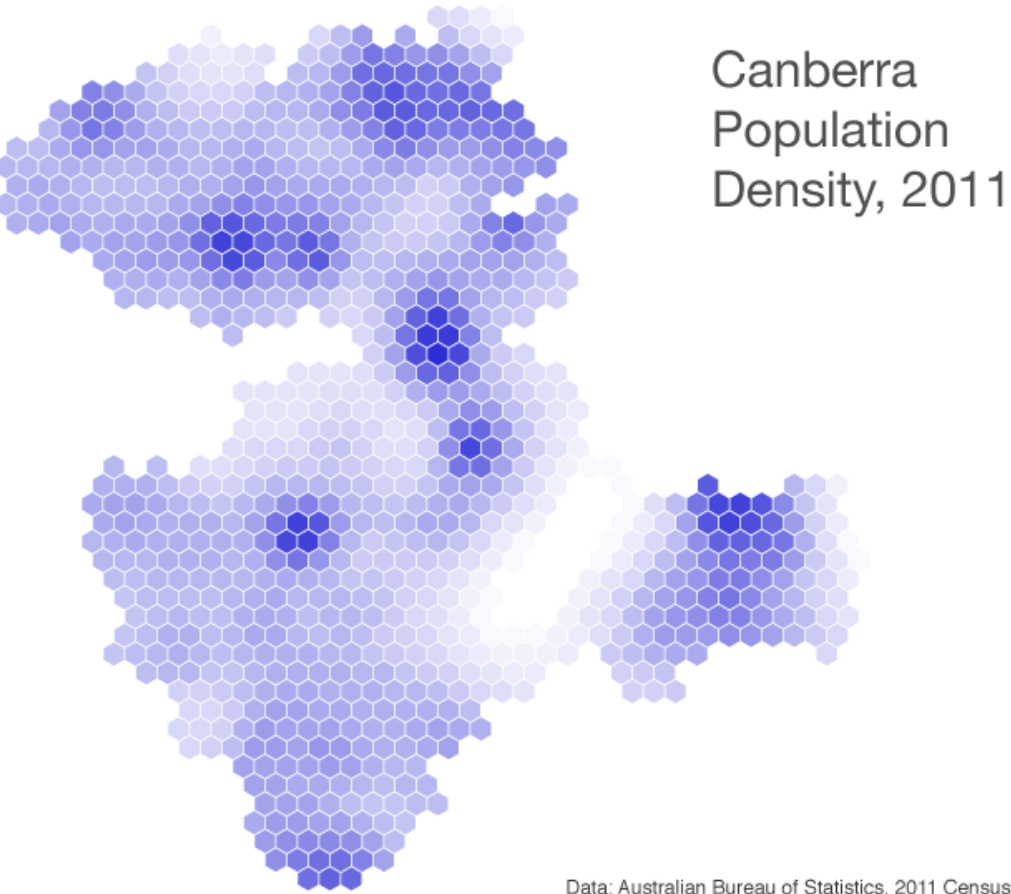
- Variation of Dorling's Cartogram using rectangles

Grid Cartogram

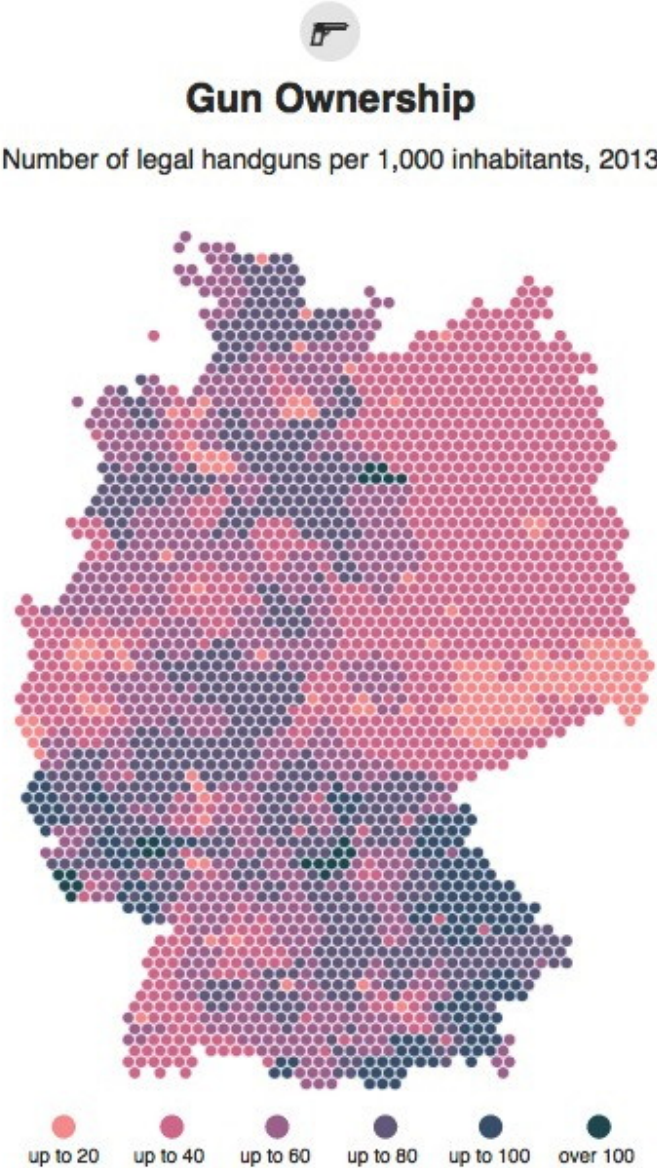


- Uniform-sized shapes arranged in grid
- Maintain approximate spatial position and arrangement

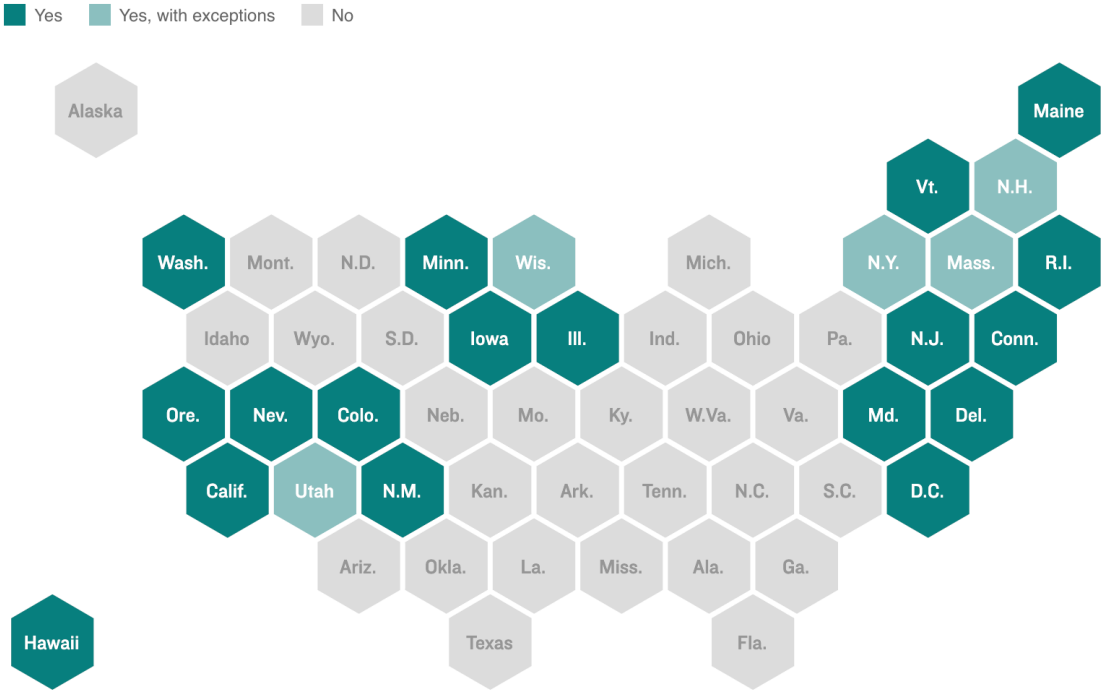
Hexagonal Cartogram



Data: Australian Bureau of Statistics, 2011 Census.



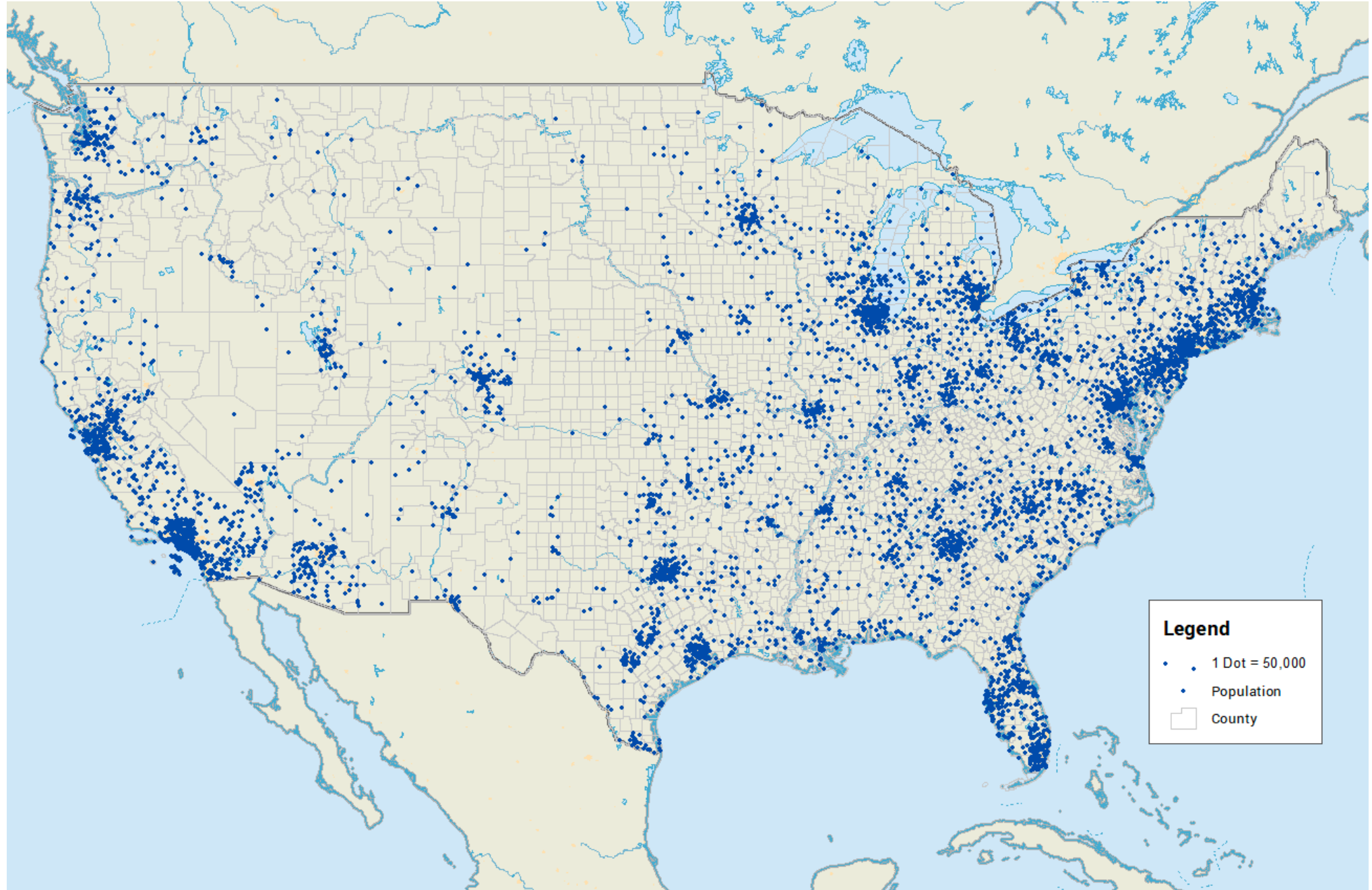
States With Nondiscrimination Laws



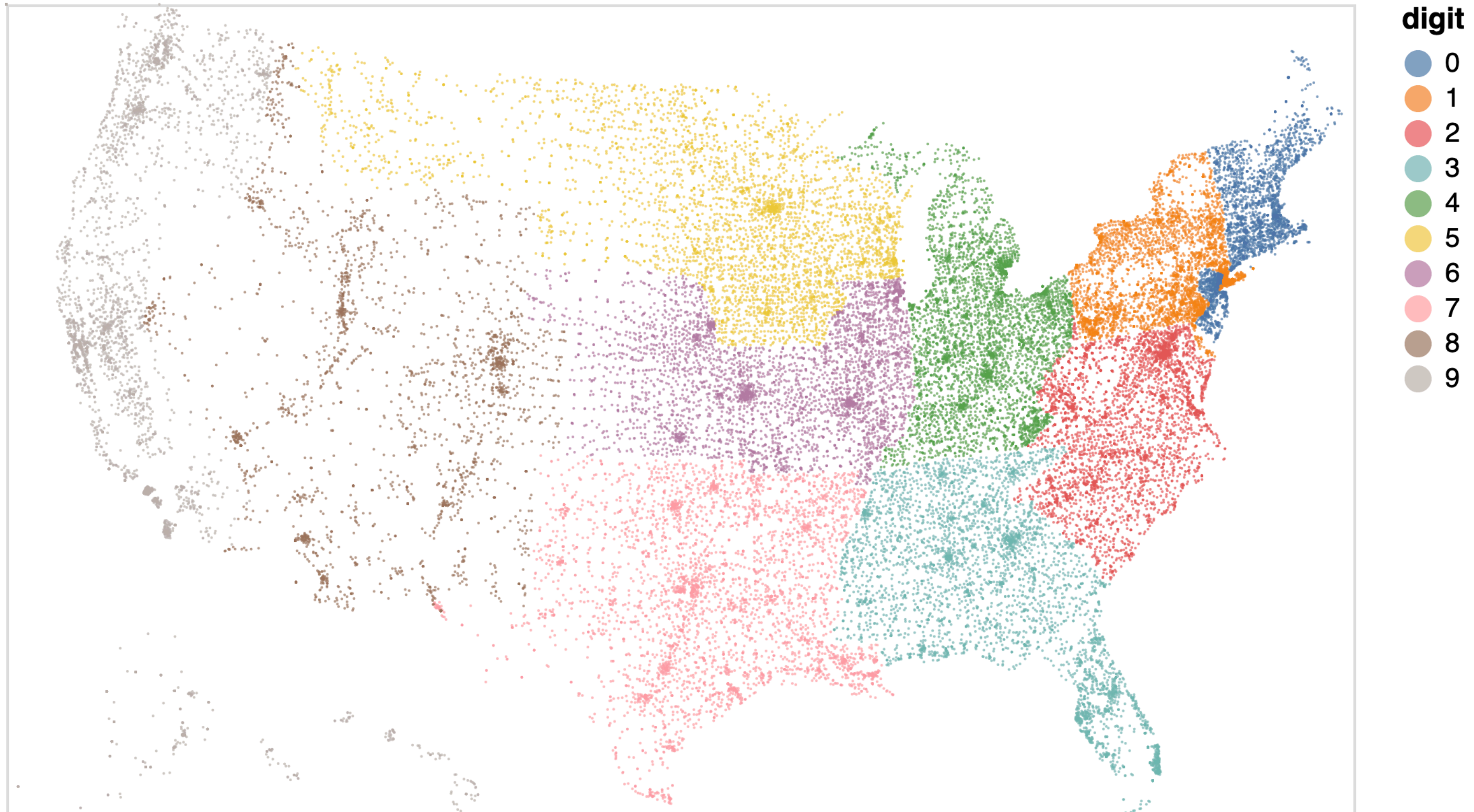
Danny DeBelius

Dot Density Maps

- Visualize distribution of a phenomenon by placing dots
- One symbol represents one object or a constant number of objects
- Goal: See spatial patterns, clusters
- Disadvantage: Difficult to extract quantities



Dot Density Map: One Dot per Zipcode in the U.S.

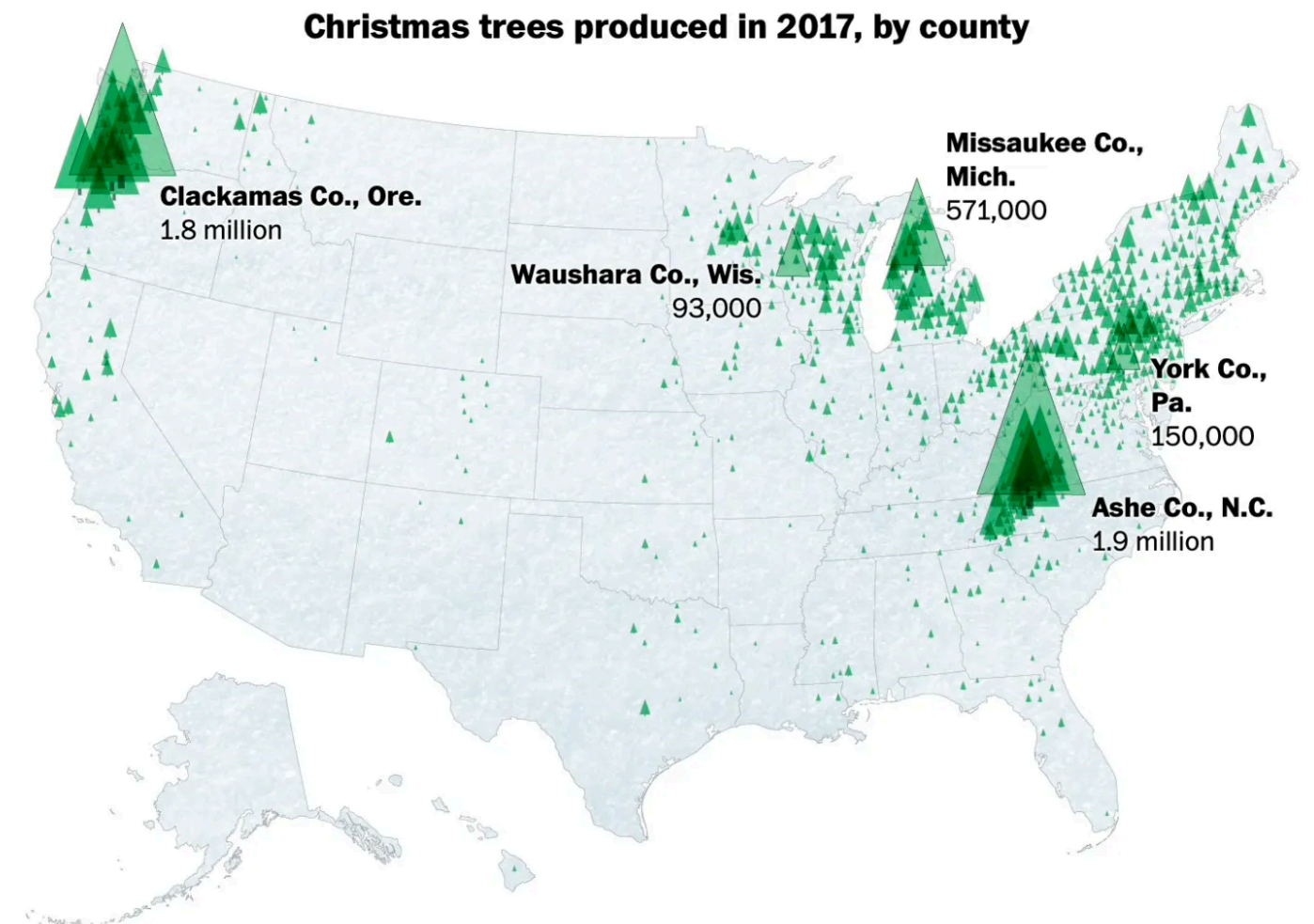
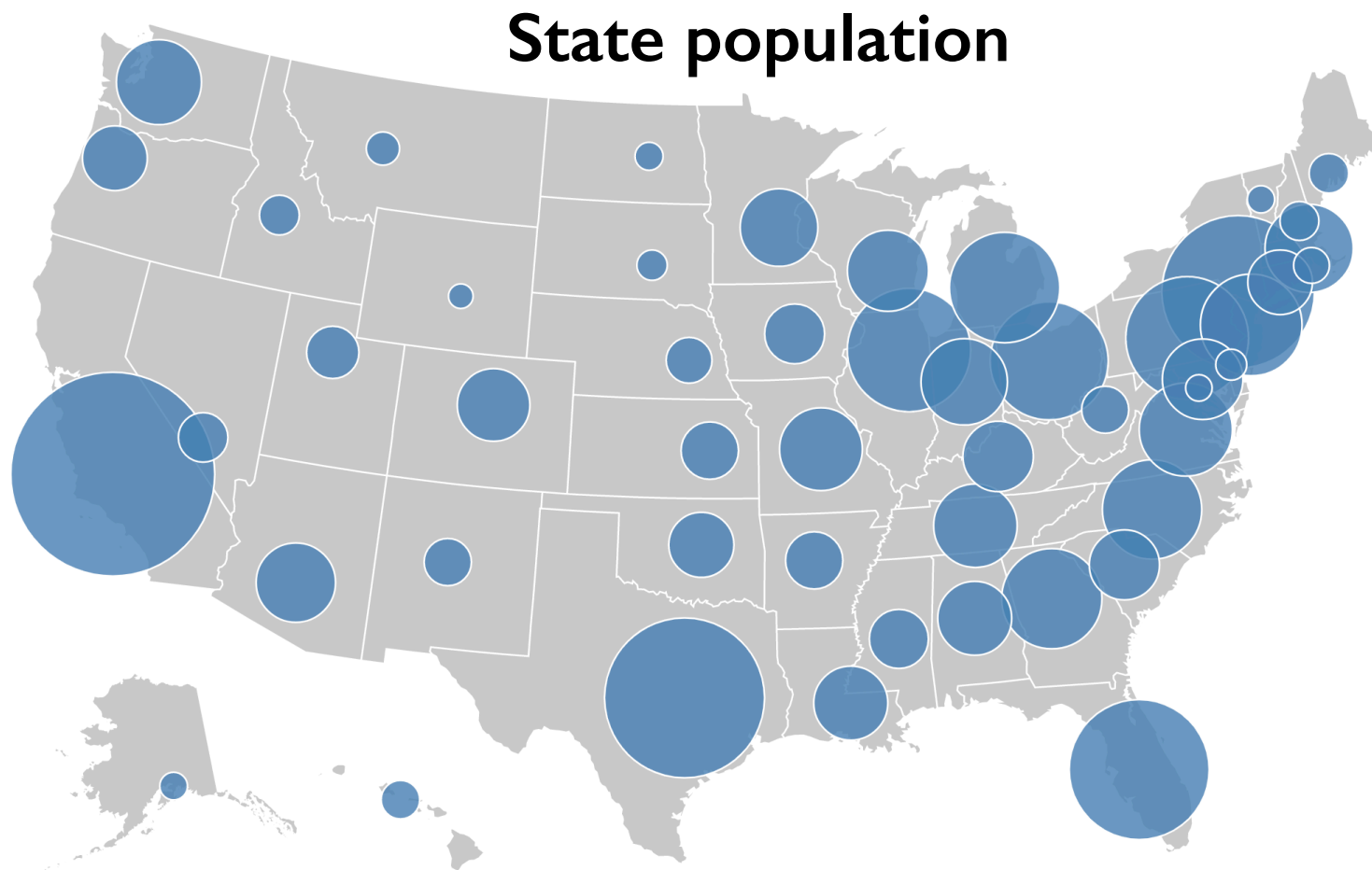


https://vega.github.io/editor/#/examples/vega-lite/geo_circle

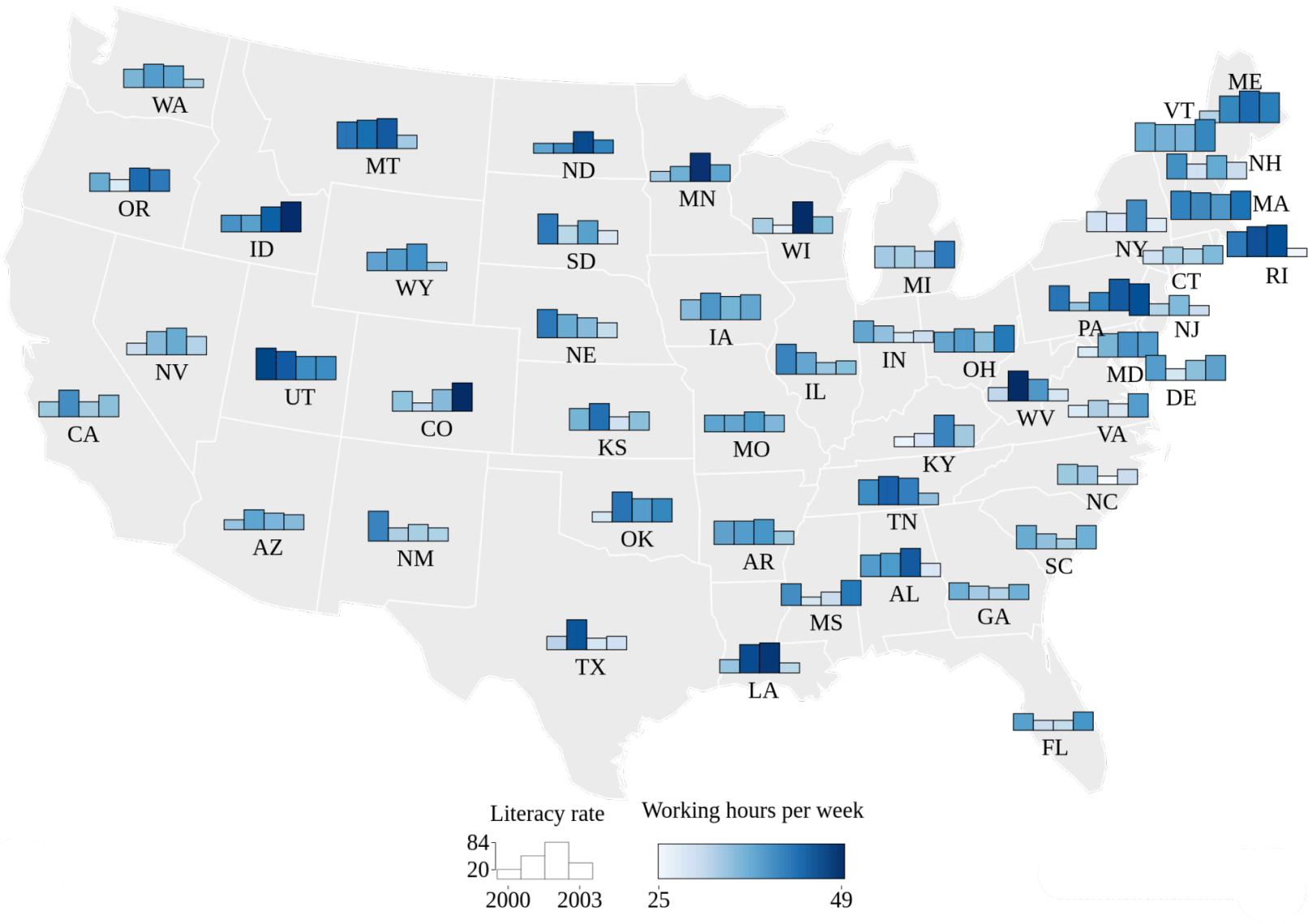
Attention: Many dot maps primarily show the population density with which the target variable is correlated, instead of the effect of interest.

Symbol Maps

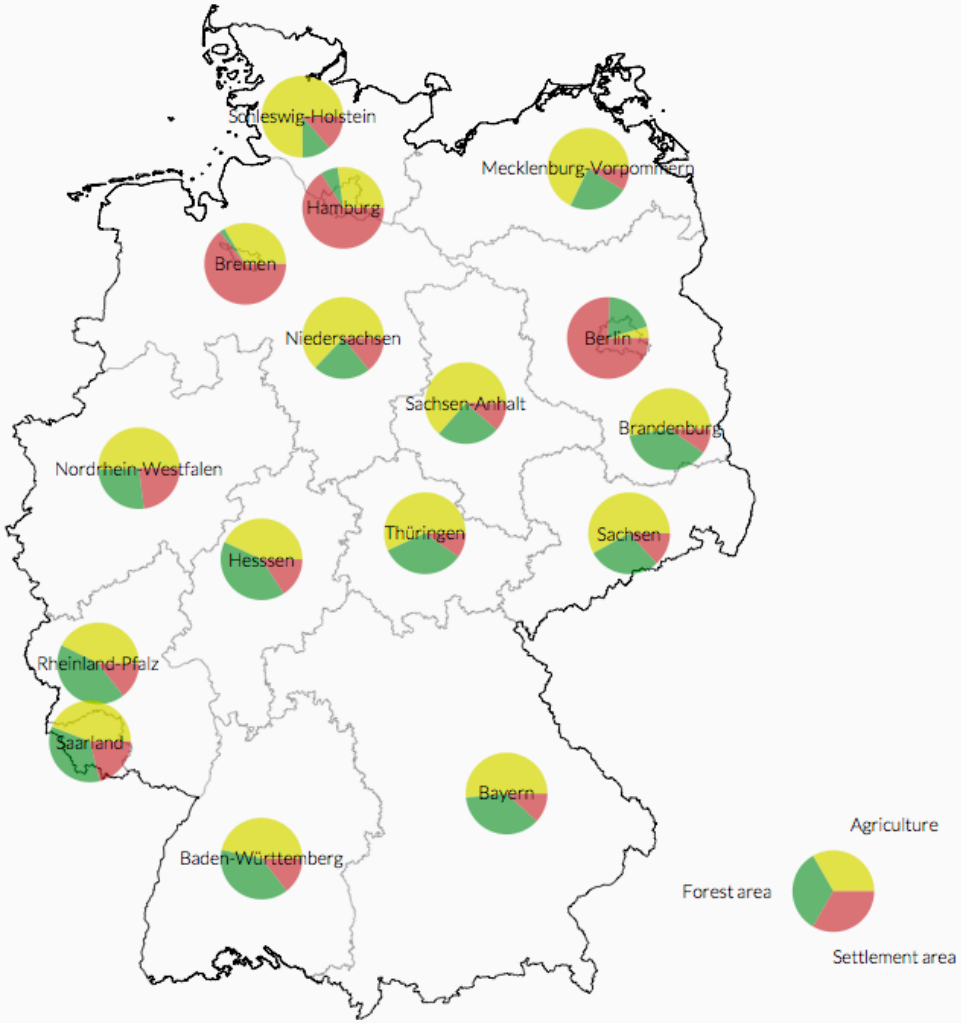
- A symbol is used to represent aggregated data (we can use the size, shape, and color channels)
- Keep original spatial geometry in the background
- Often a good alternative to choropleth maps



Symbol Maps with Glyphs



Shares of agricultural, forest and settlement area



Source: Statistisches Bundesamt Fachserie 3 Reihe 5.1

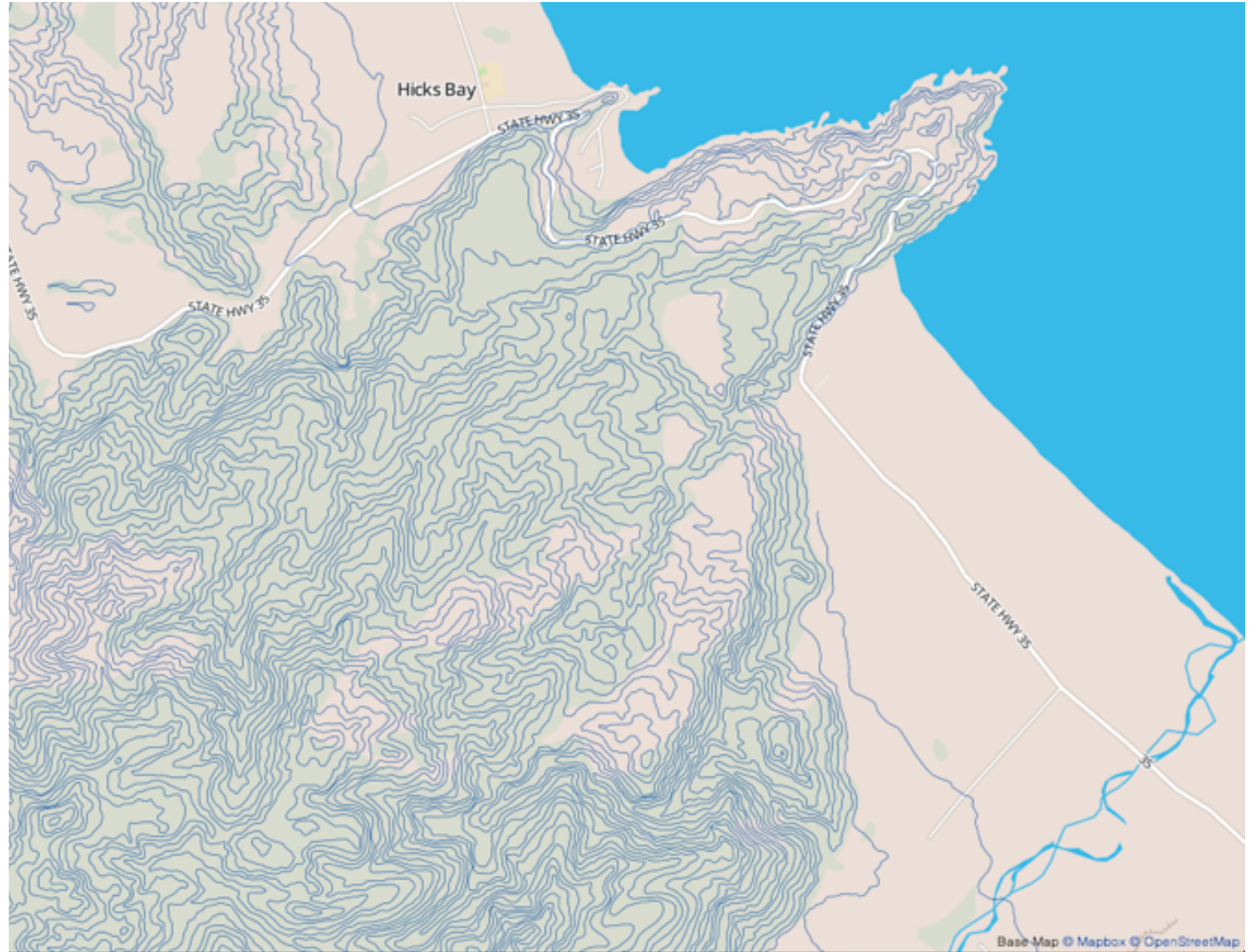
Topographic Map

Data

- Geographic geometry
- Scalar spatial field
 - 1 quant attribute per grid cell

Derived data

- Isoline geometry
 - Isocontours computed for specific levels of scalar values

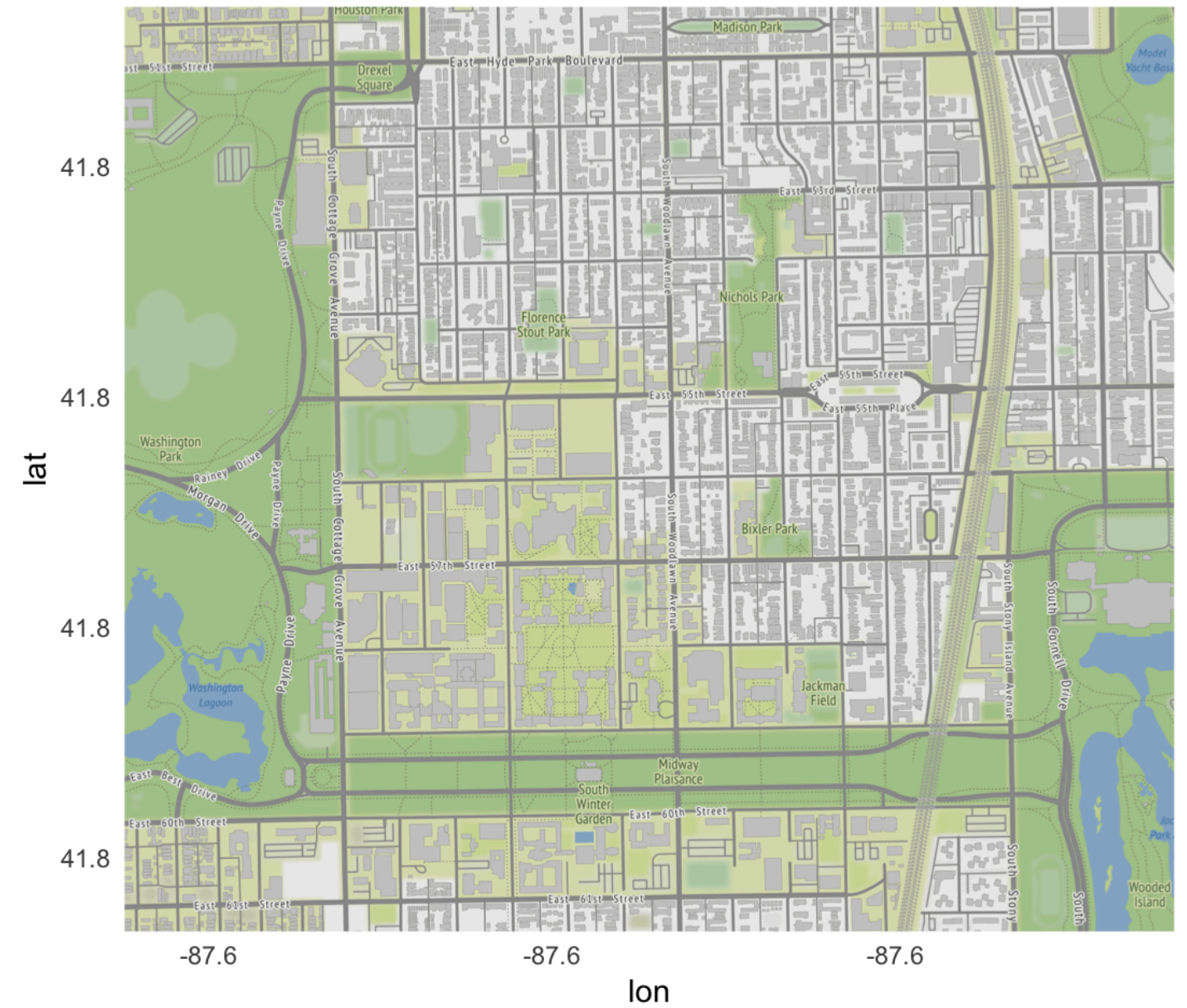


London Tube Lines



https://vega.github.io/vega-lite/examples/geo_layer_line_london.html

Hyde Park

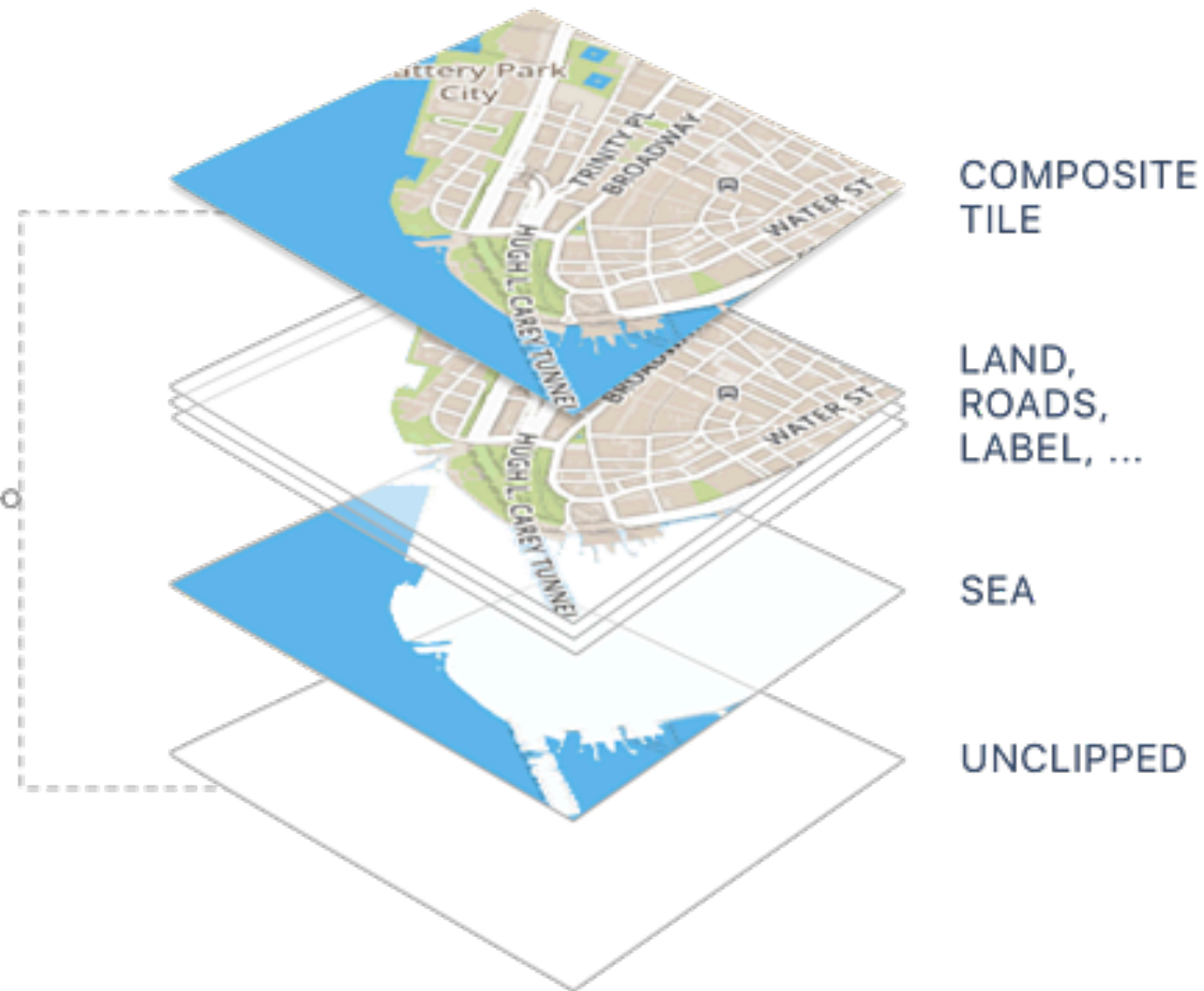


Tile Maps

One map, multiple tiles



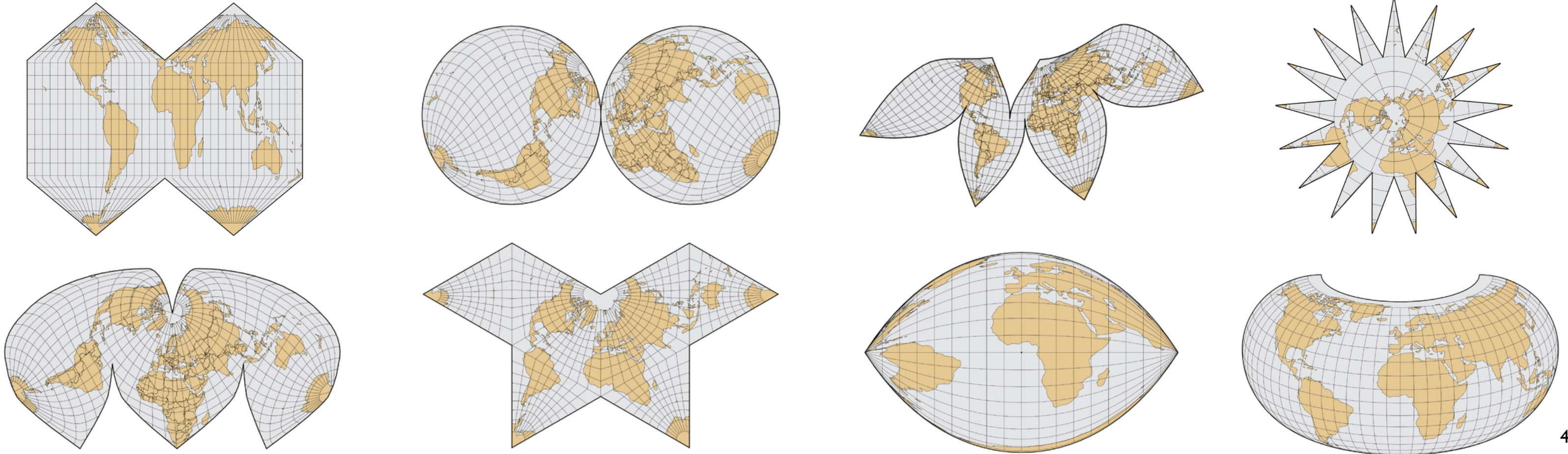
Tile



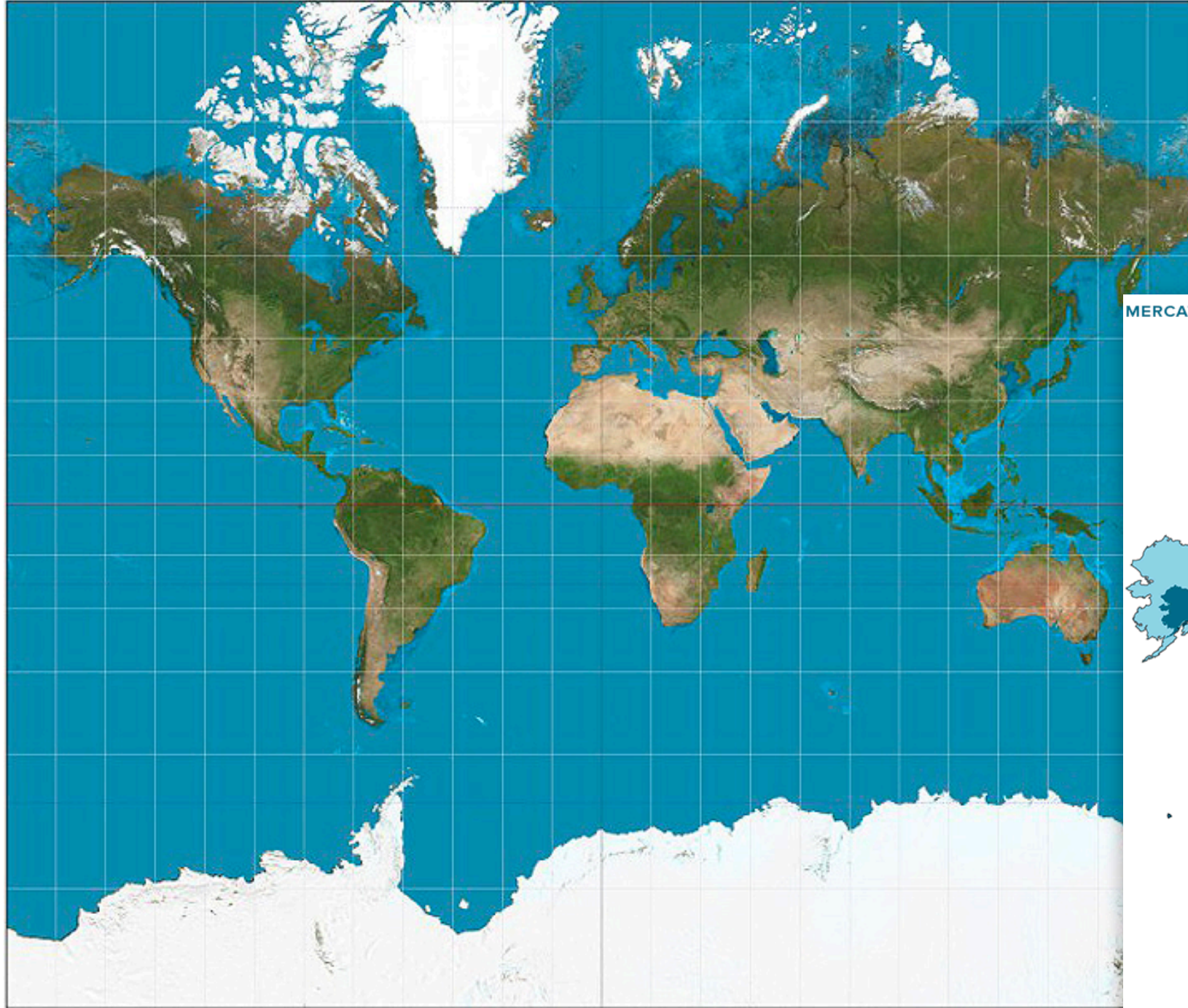
- Open source: leaflet.js framework with Open Street Map tiles
- We can add symbols or D3 visualization as a superimposed layer

Map Projections

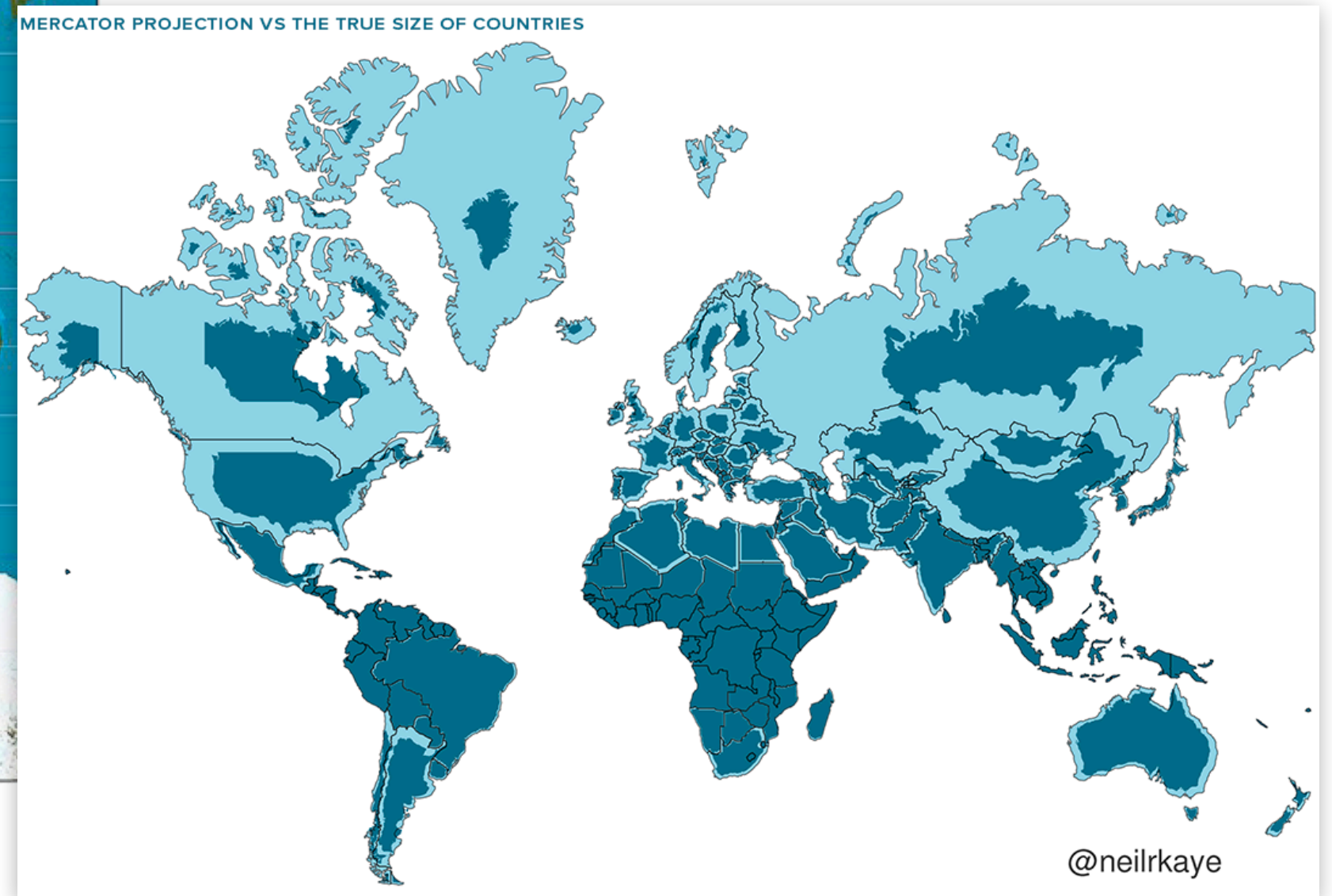
- Mathematical functions that map the 3D surface geometry of the Earth to 2D maps.
- All projections of a sphere on a plane necessarily distort the surface in some way.
- Interactive: philogb.github.io/page/myriahedral/ and jasondavies.com/maps/



Mercator Projection



» Heavily distorts country sizes;
particularly close to the poles.

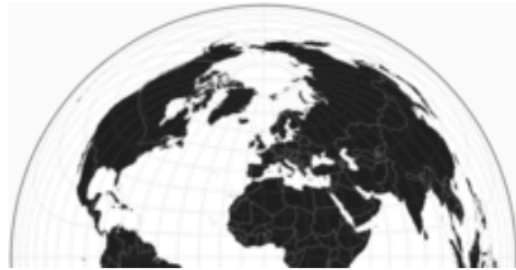


D3 Geo Projections

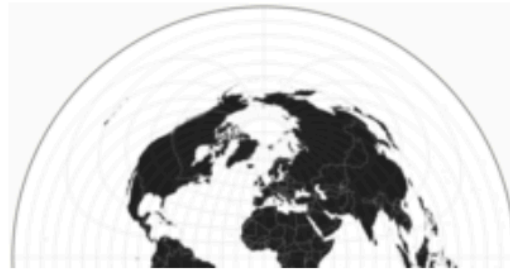
d3.geo.albersUsa



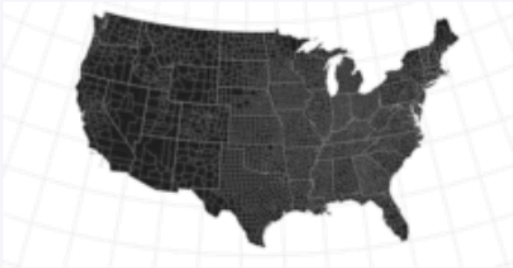
d3.geo.azimuthalEqualArea



d3.geo.azimuthalEquidistant



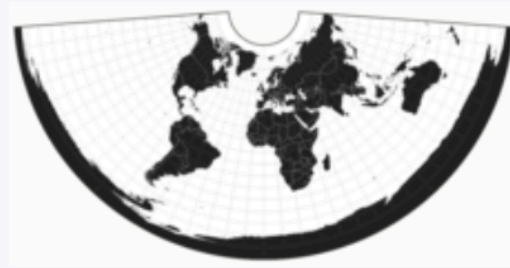
d3.geo.conicEqualArea



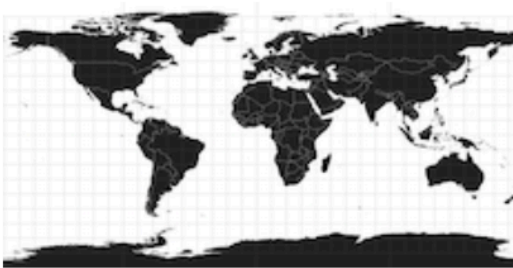
d3.geo.conicConformal



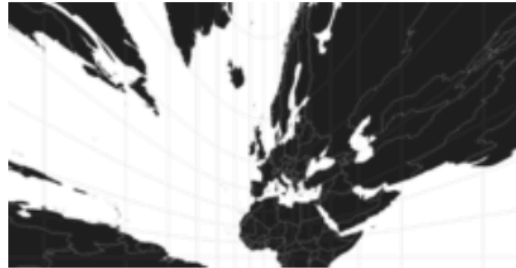
d3.geo.conicEquidistant



d3.geo.equirectangular



d3.geo.gnomonic



d3.geo.mercator



d3.geo.orthographic



d3.geo.stereographic



d3.geo.transverseMercator

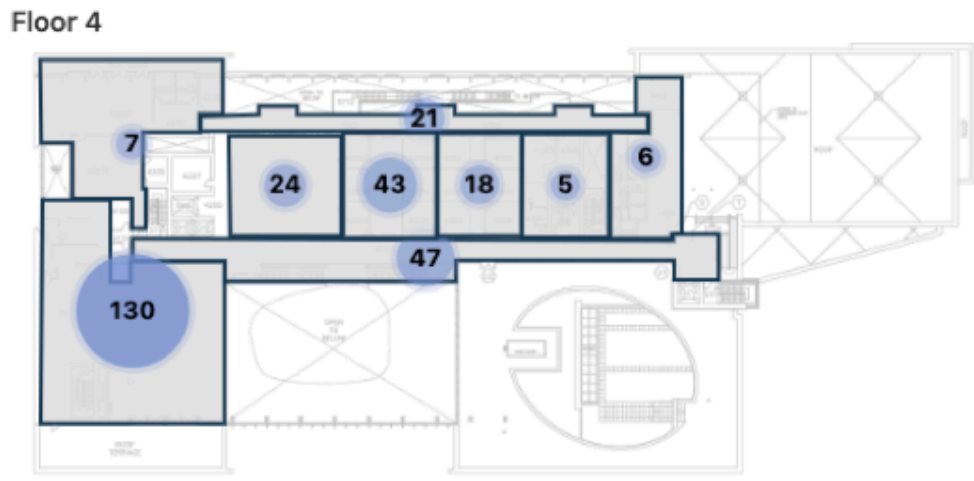
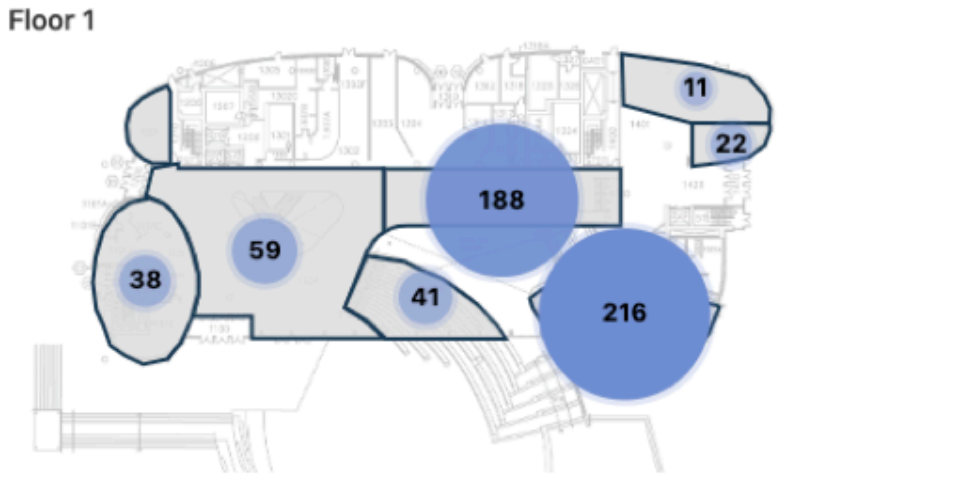
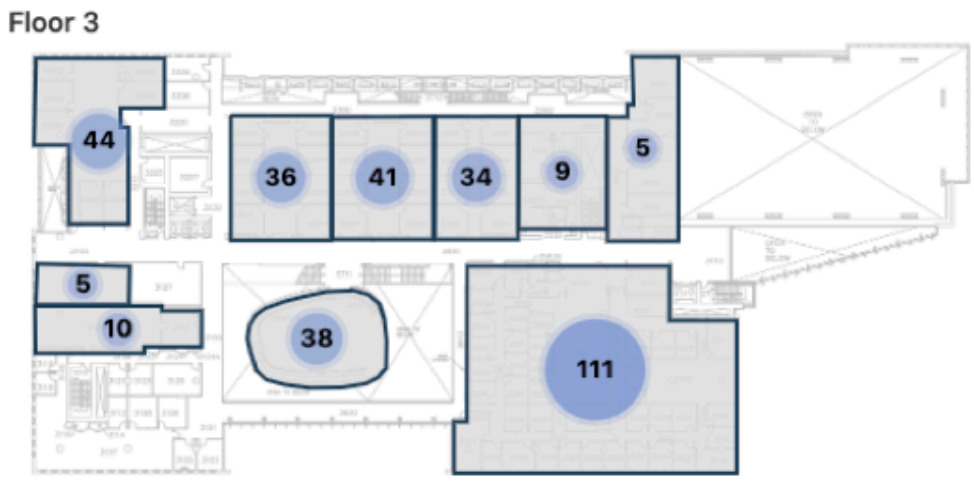
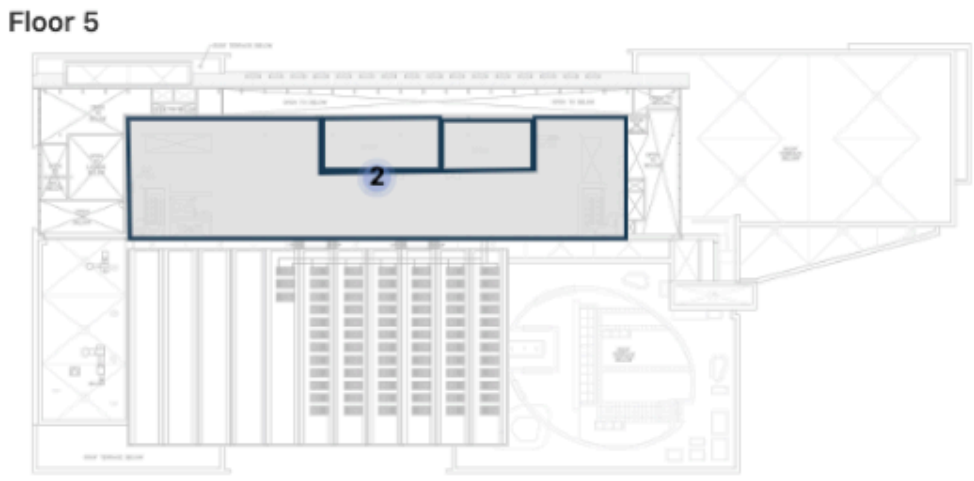
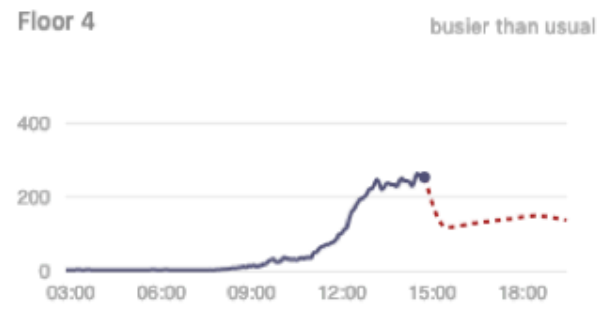
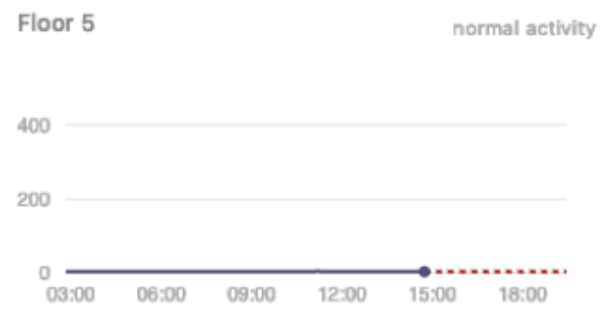


github.com/d3/d3-geo-projection

There is much much more to cartography than this.
We discussed only a few common/popular
techniques today.

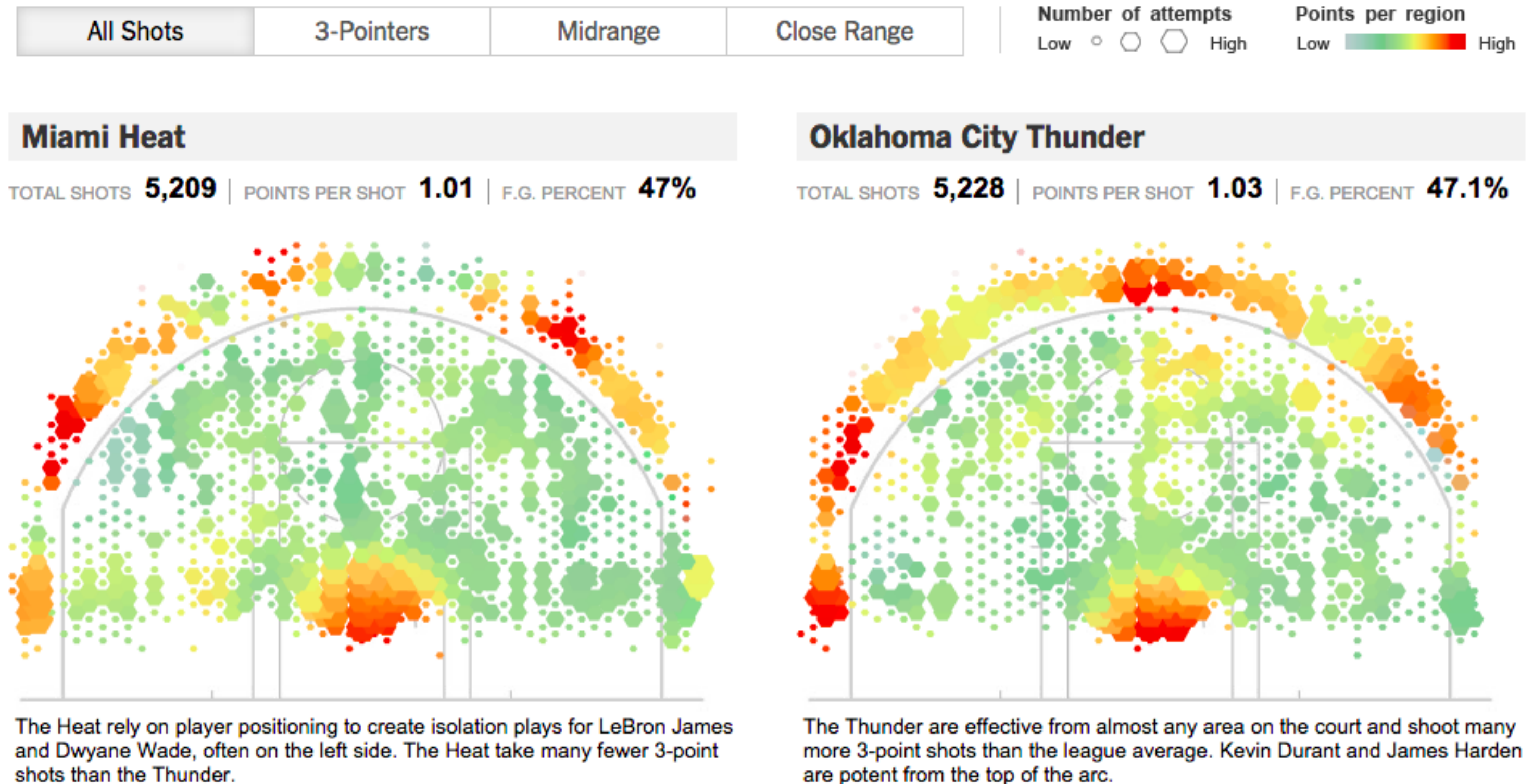
trend

typical day



Where the Heat and the Thunder Hit Their Shots

The shooting patterns for the players on the Miami Heat and the Oklahoma City Thunder reveal where they are most dangerous on the court. Below, compare each player's strengths using court maps and analysis by Kirk Goldsberry, a geography professor at Michigan State. [Related Article »](#)



Upcoming

- Foundations 4: out Thu Feb 13, due Wed Feb 26 11:59pm
- Programming 3: out Thu Feb 13, due Wed Mar 4 11:59pm
- D3 videos/readings week 4
 - Color and Size legends with D3.js [30 min]
 - Scatter Plot with Menus [46 min]
 - Circles on a Map [42 min]
 - Line Charts with Multiple Lines [42 min]
- Quiz 6, due by Fri Feb 14, 8am

Credits

- Visualization Analysis and Design (Ch 8)
- Heer et al.: A Tour Through the Visualization Zoo
<https://homes.cs.washington.edu/~jheer/files/zoo/>
- Enrico Bertini, NYU Tandon
- Pfister, Harvard University
<http://cs171.org/>