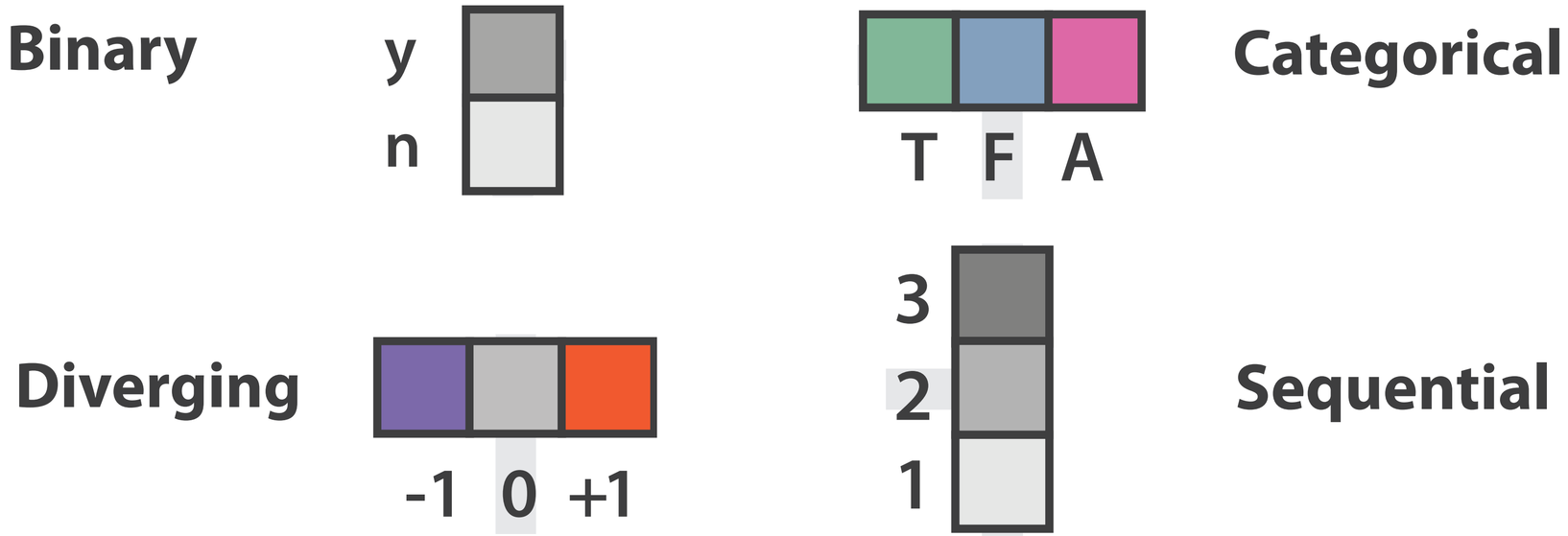
Data Visualization (CSCI 627/490)

Geospatial Data

Dr. David Koop

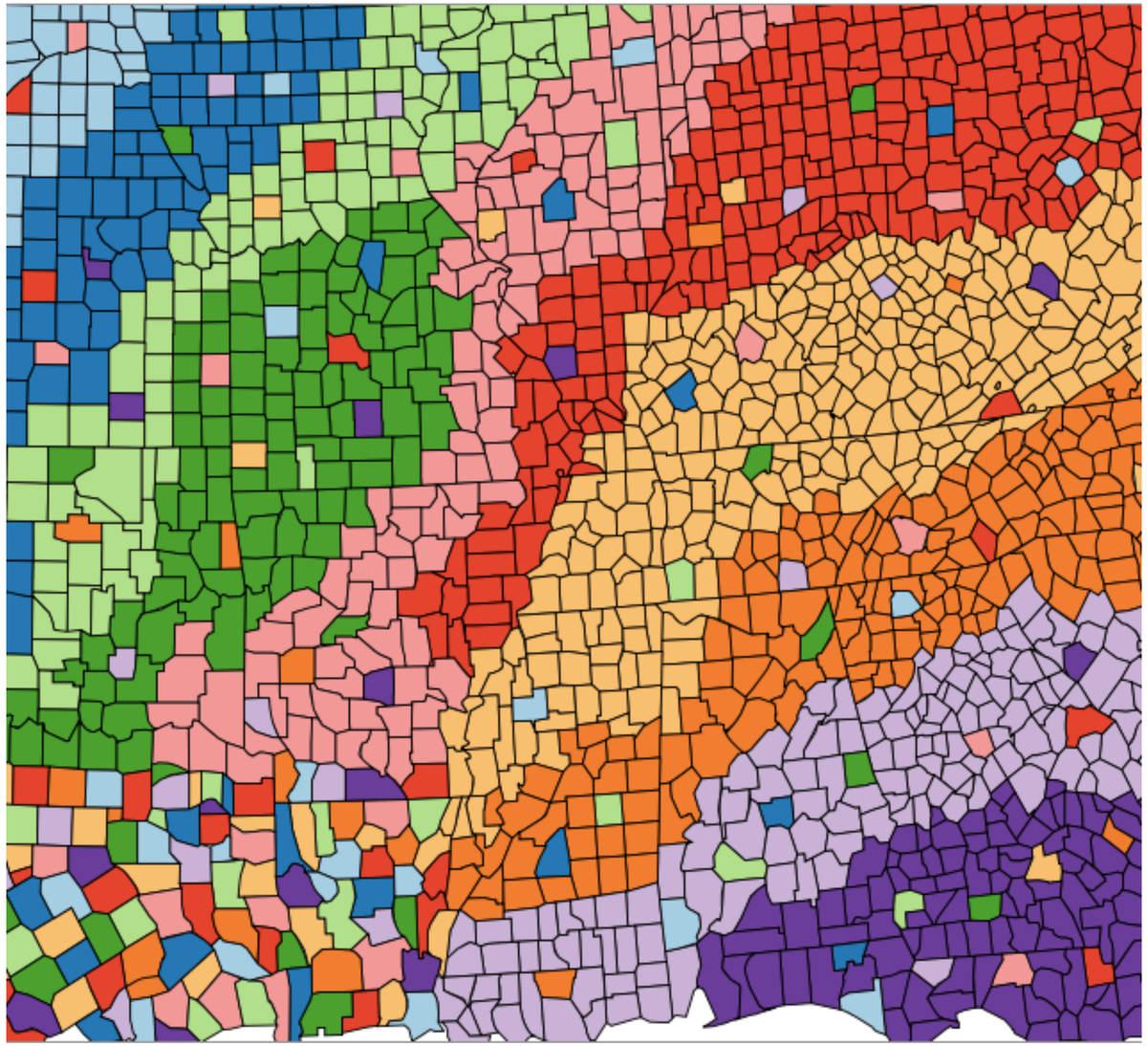
Colormap

- A colormap specifies a mapping between colors and data values
- Colormap should follow the expressiveness principle
- Types of colormaps:



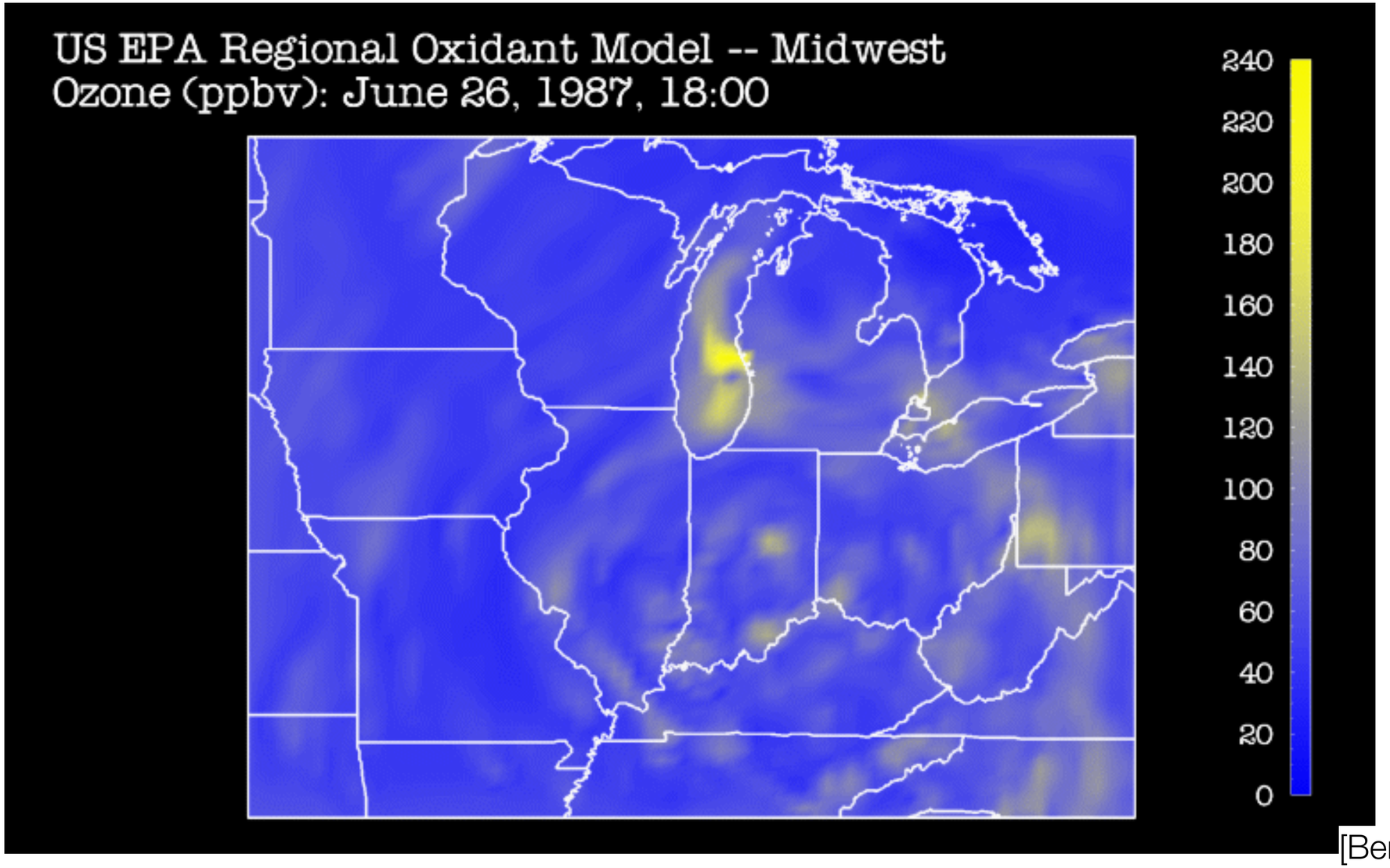
[Munzner (ill. Maguire), 2014]

Categorical Colormap Guidelines



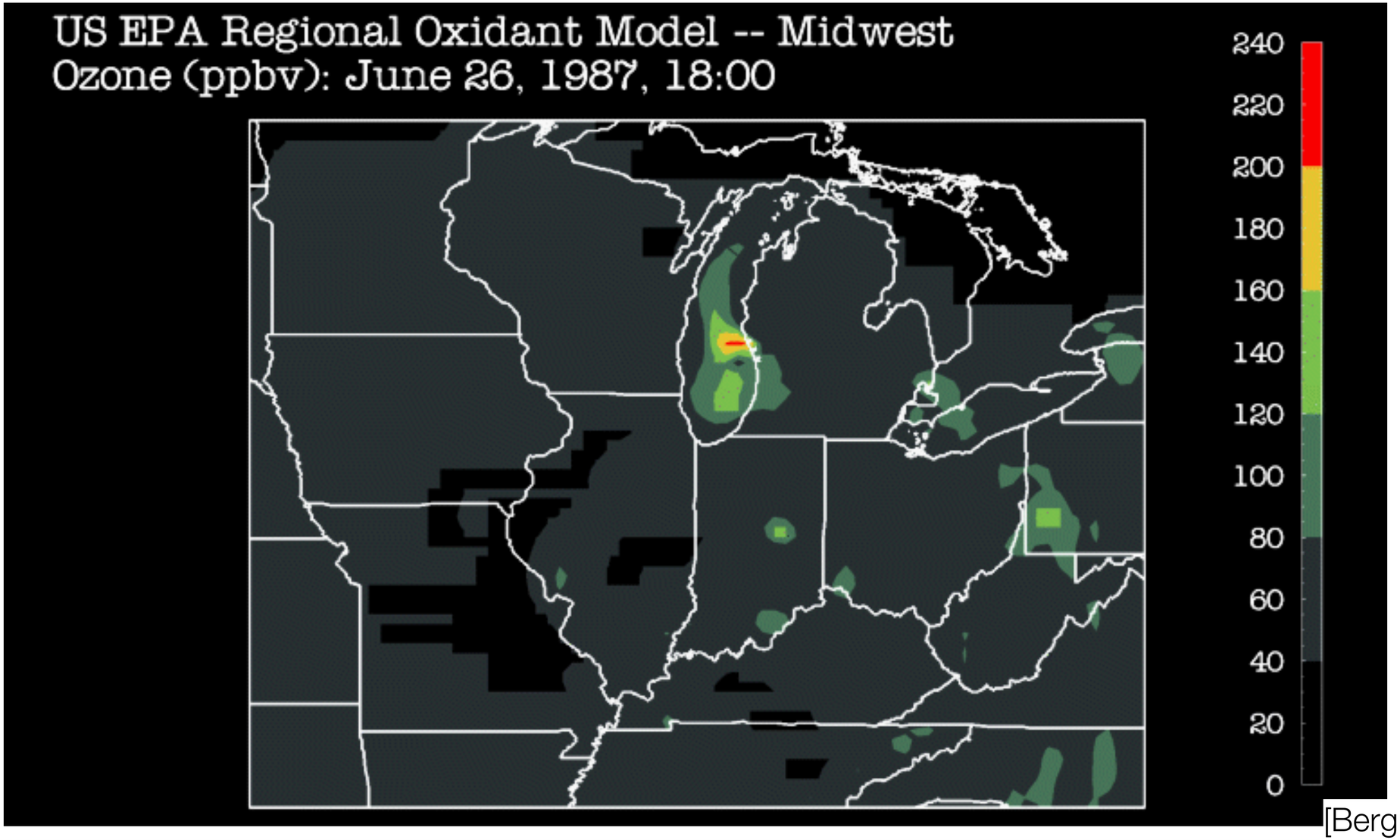
- Don't use too many colors (~12)
- Use other categories or create groups if you have too many values!
- Nameable colors help
- Be aware of luminance (e.g. difference between blue and yellow)
- Think about other marks you might wish to use in the visualization

Continuous Colormap for Ordered Data



[Bergman et al., 1995]

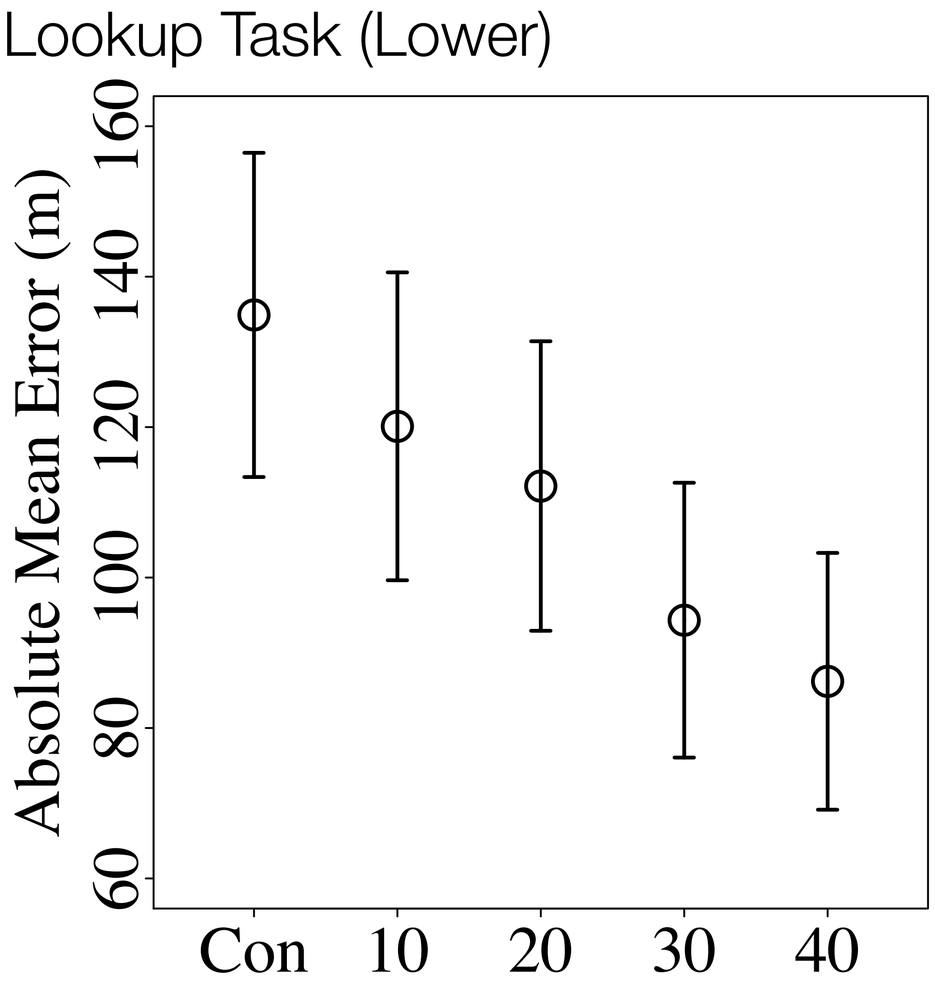
Segmented Colormap for Ordered Data



[Bergman et al., 1995]

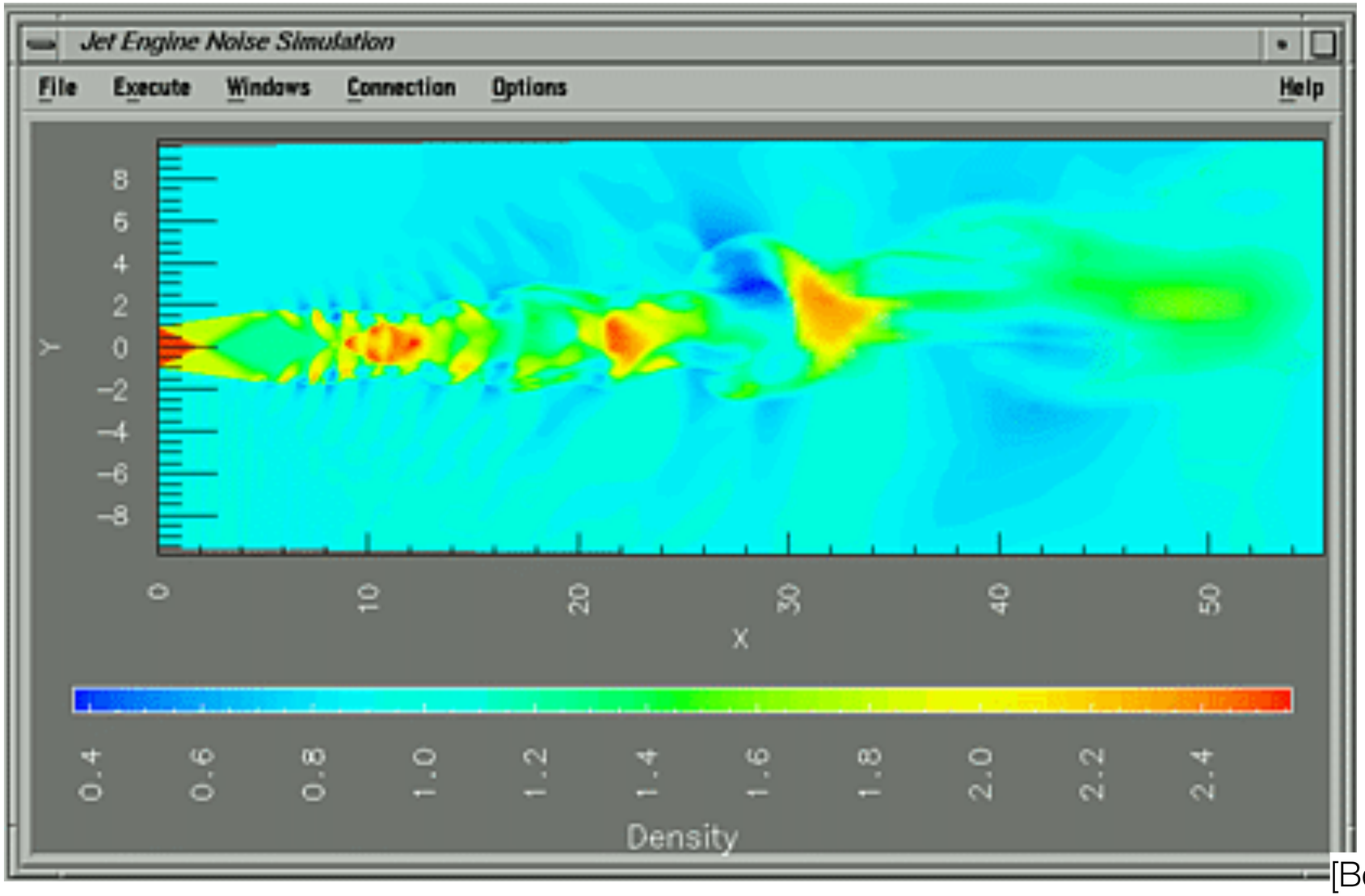
Continuous vs. Segmented Test Results

- "[C]ontrary to the expressiveness principle, no cases were found in which a continuous encoding of 2D scalar field data was advantageous for task accuracy, and for some tasks, specific binned encodings facilitated accuracy."
- "[S]upport for the counterintuitive finding that decisions with binned encoding were slower than those made with continuous encoding"
- Word of caution: single image!



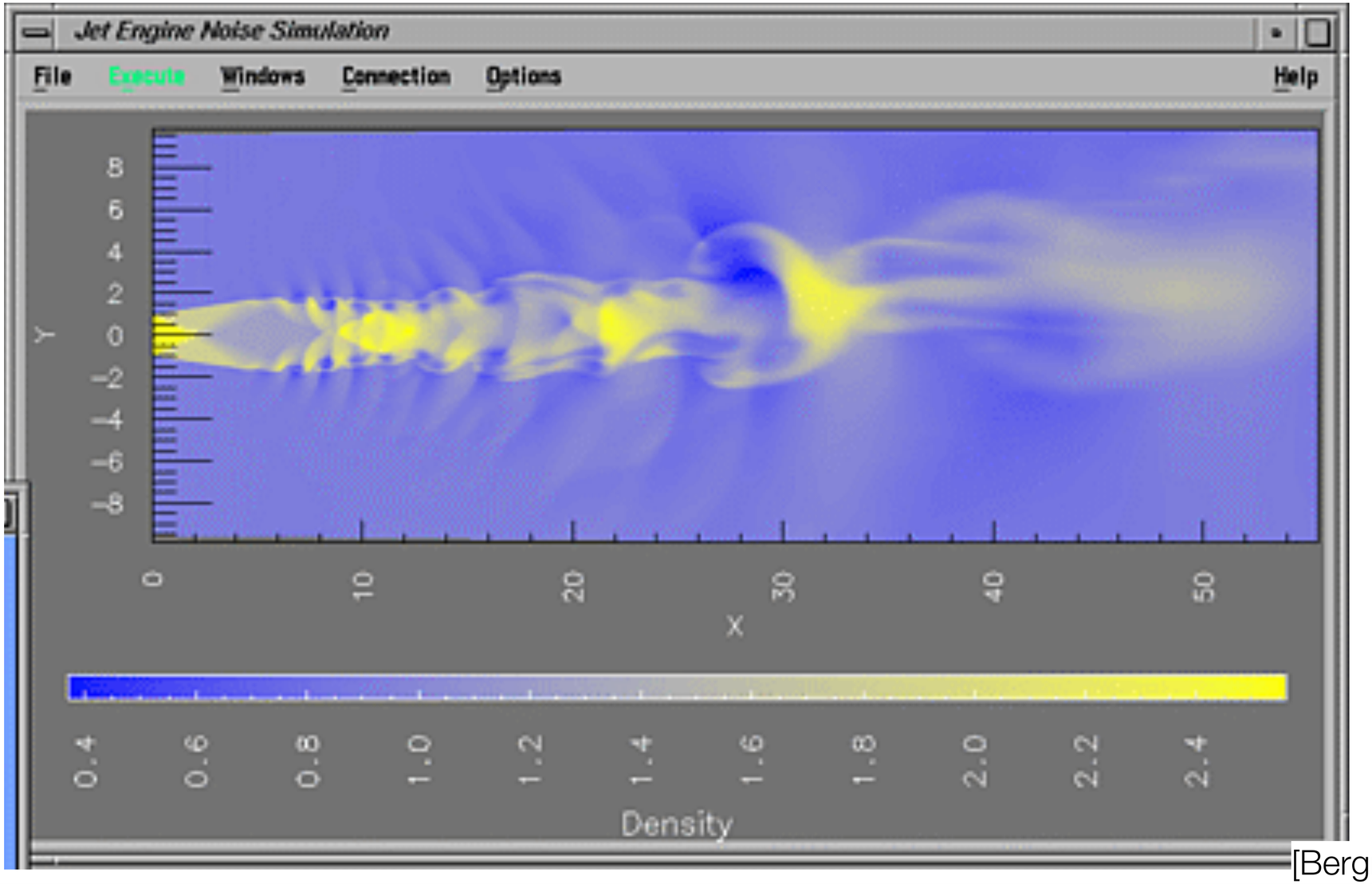
[Padilla et al., 2017]

Rainbow Colormap



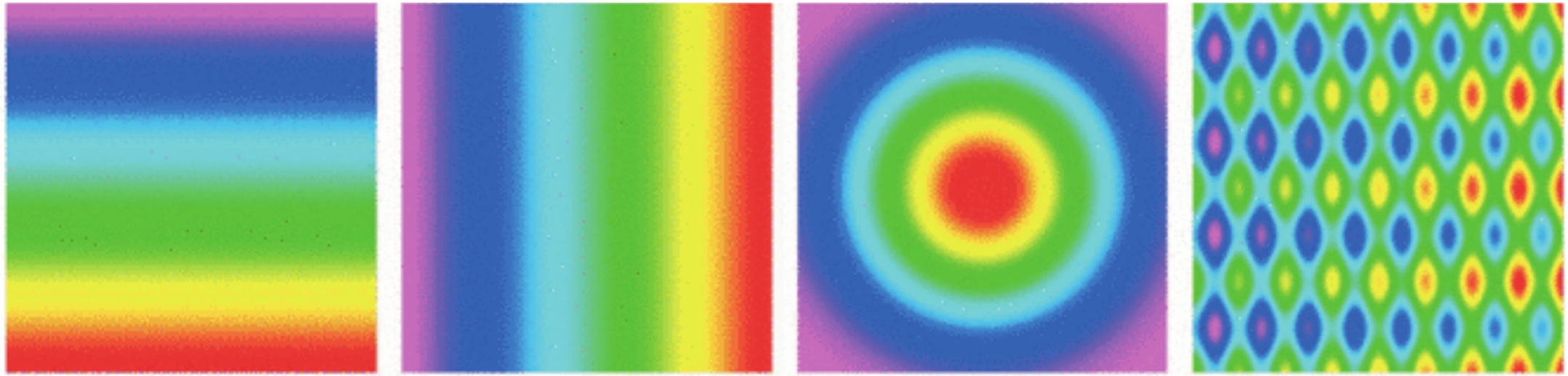
[Bergman et al., 1995]

Two-Hue Colormap



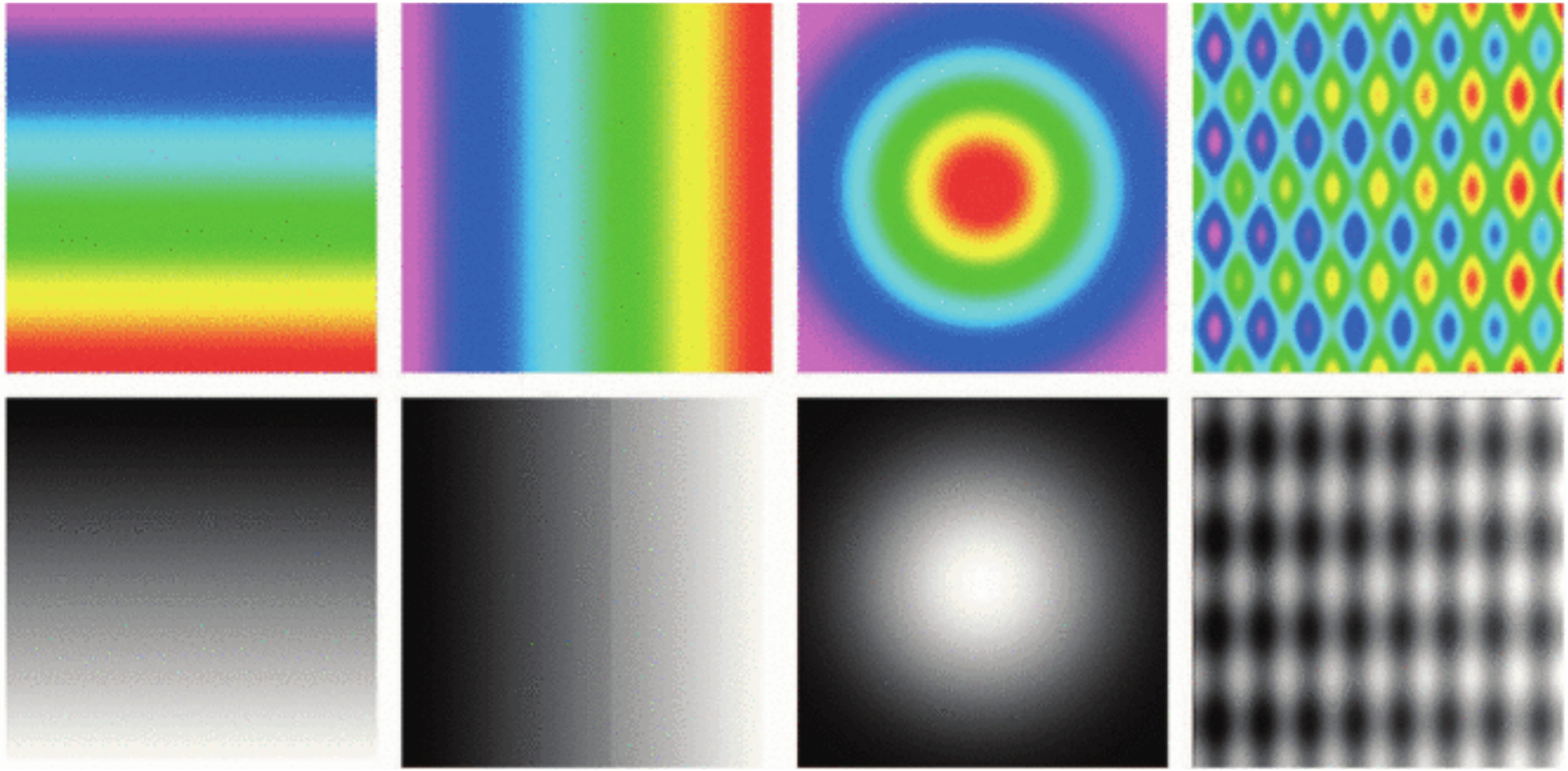
[Bergman et al., 1995]

Artifacts from Rainbow Colormaps



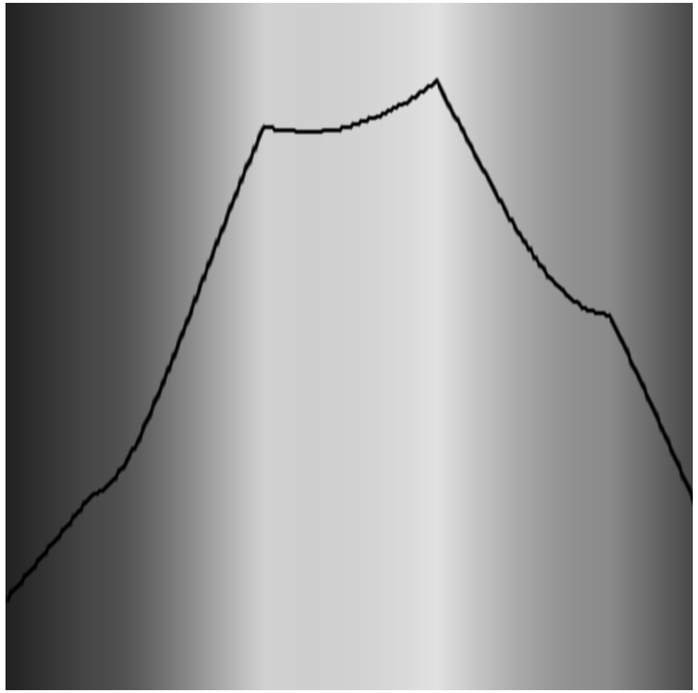
[Borland & Taylor, 2007]

Artifacts from Rainbow Colormaps

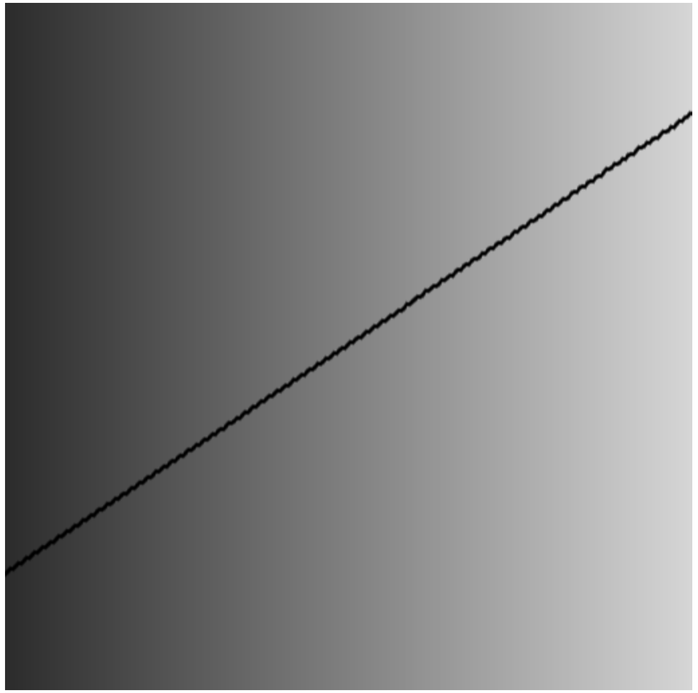


[Borland & Taylor, 2007]

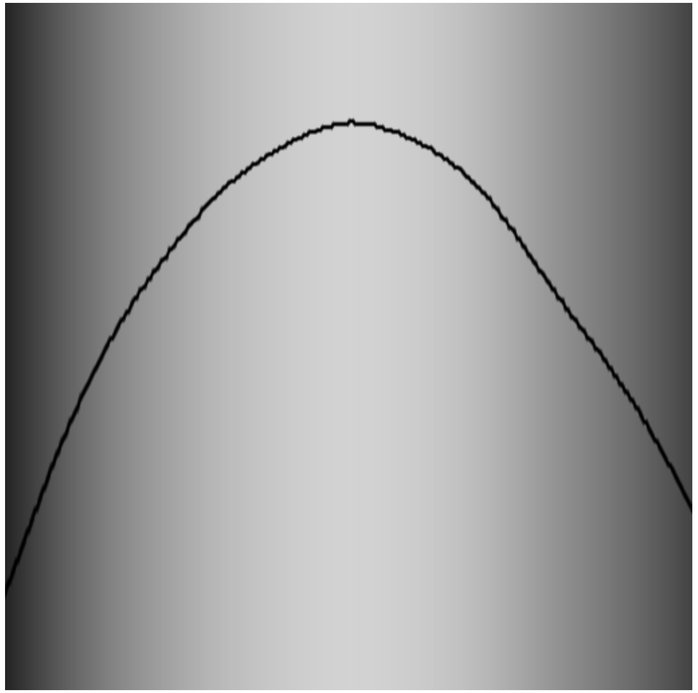
Turbo: Improving Rainbow Colormaps



Jet



Viridis



Turbo

[A. Mikhailov]

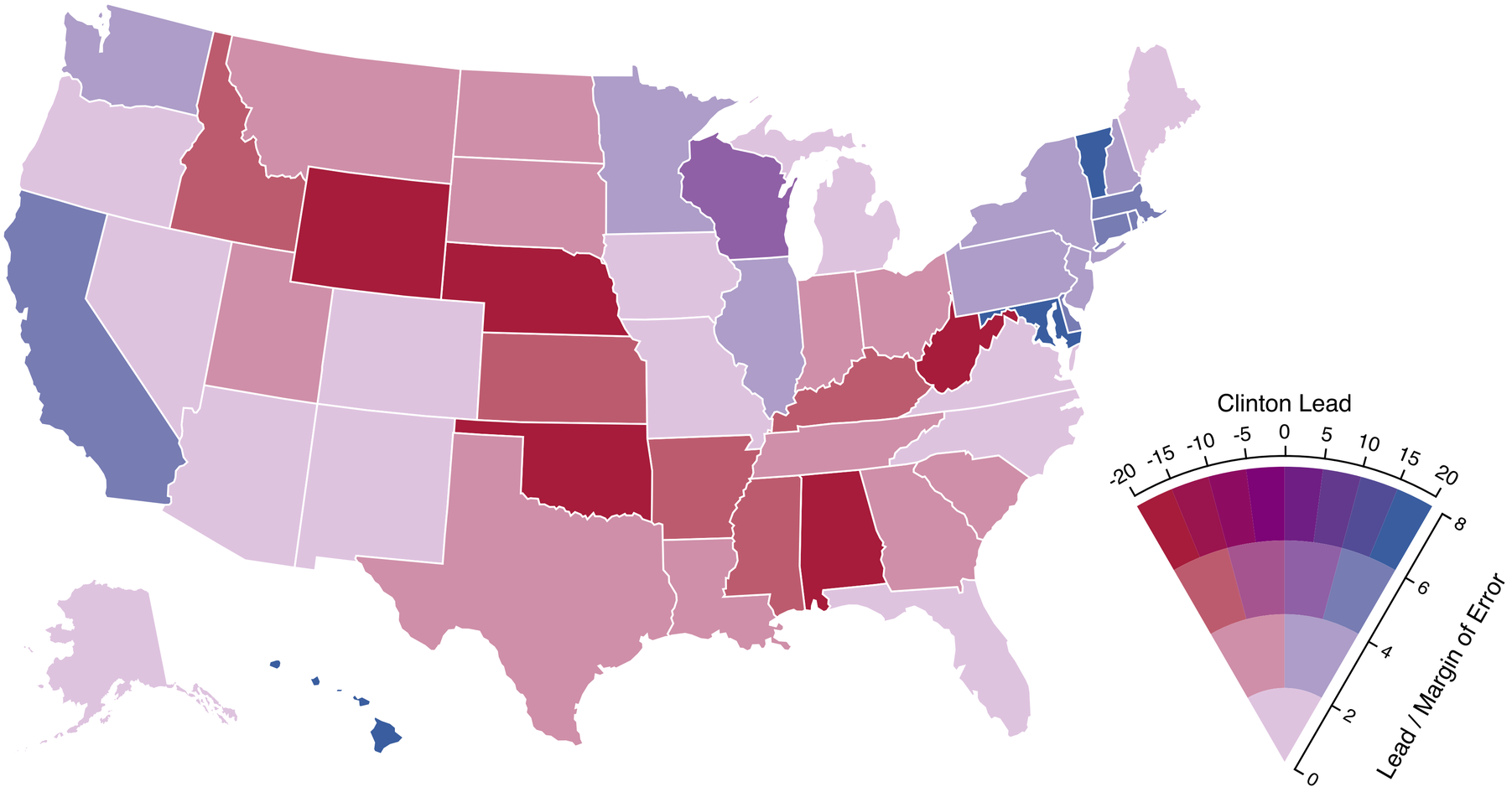
Also… Guidelines from Graphic Design

NOT IDEAL

BETTER

[L. C. Rost]

Value-Suppressing Uncertainty Palette



[Correll et al., 2018]

Midterm

- Thursday, October 15
- Covers material through this week
- Format:
  - Multiple Choice
  - Free Response (often multi-part)
  - CS 627 students will have extra questions related to the research papers discussed

Project

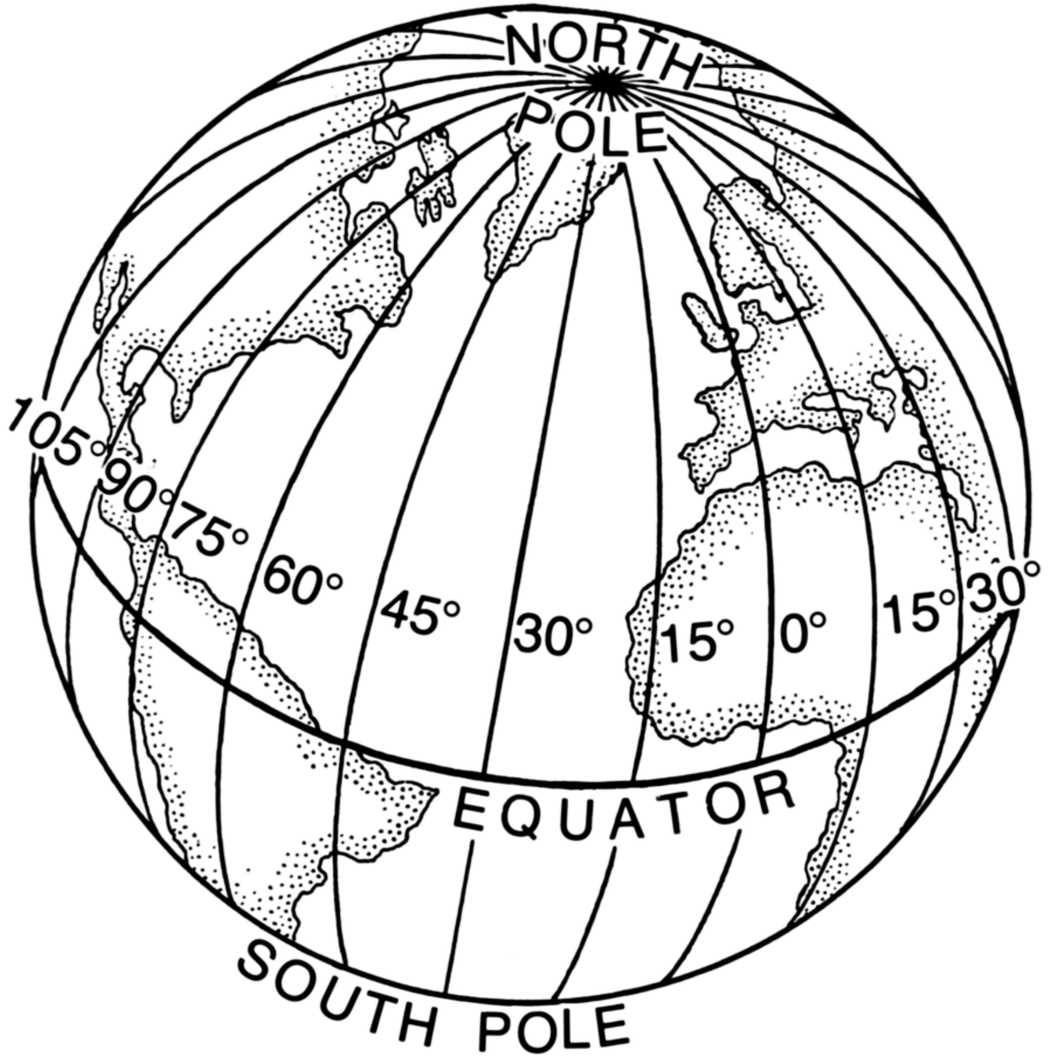
- Two Possibilities:
  - Create an interactive visualization
  - Work on a research project
- Dataset Choices:
  - Information Wanted: A dataset of immigrants looking for family & relatives
  - Vessel Tracking: A dataset of ship movements near the United States
  - Prescription Drug Costs: A dataset of medicine costs in the United States
- First step:
  - Examine data, determine format, attribute characteristics, etc.
  - Think of questions a visualization can help answer

Geospatial Data

Geographic Data

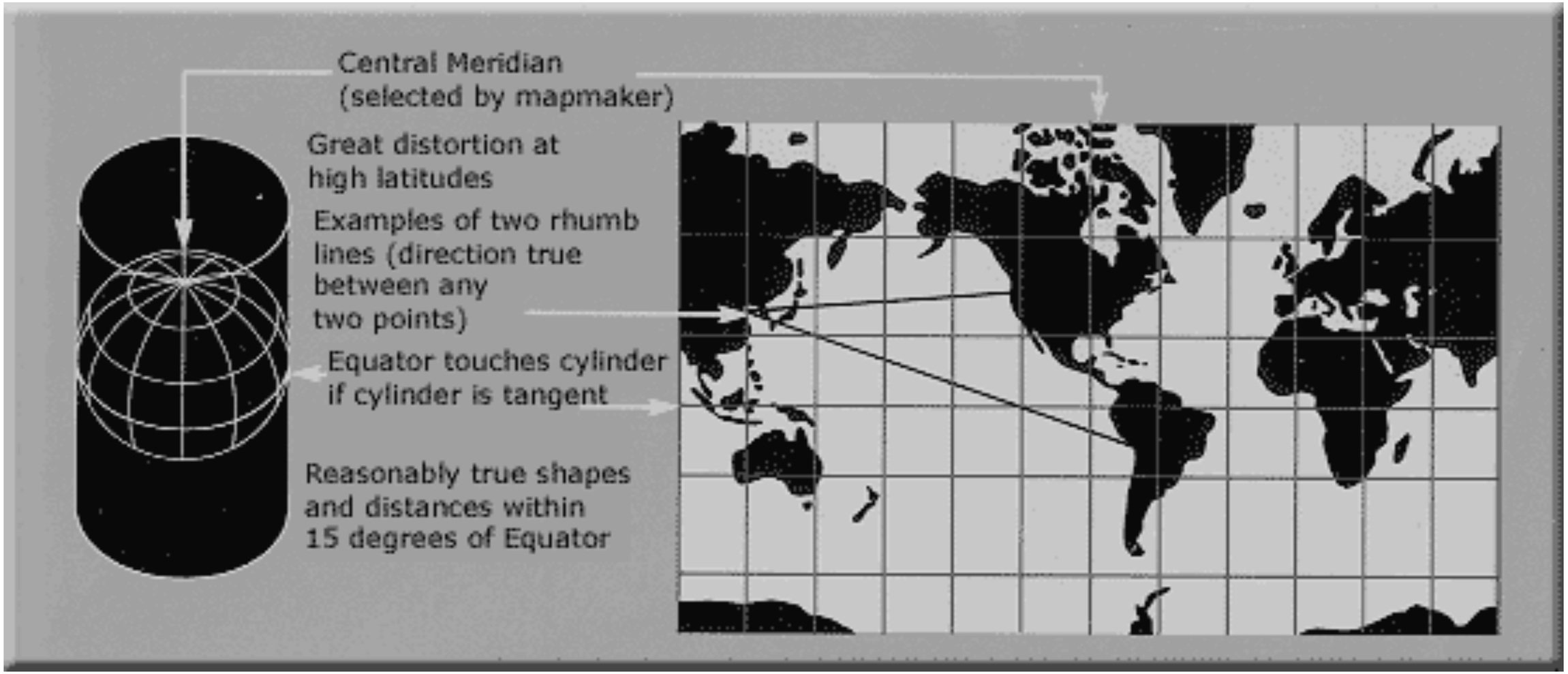
- Spatial data (have positions)
- Cartography: the science of drawing maps
  - Lots of history and well-established procedures
  - May also have non-spatial attributes associated with items
  - Thematic cartography: integrate these non-spatial attributes (e.g. population, life expectancy, etc.)
- Goals:
  - Respect cartographic principles
  - Understand data with geographic references with the visualization principles

Map Projection



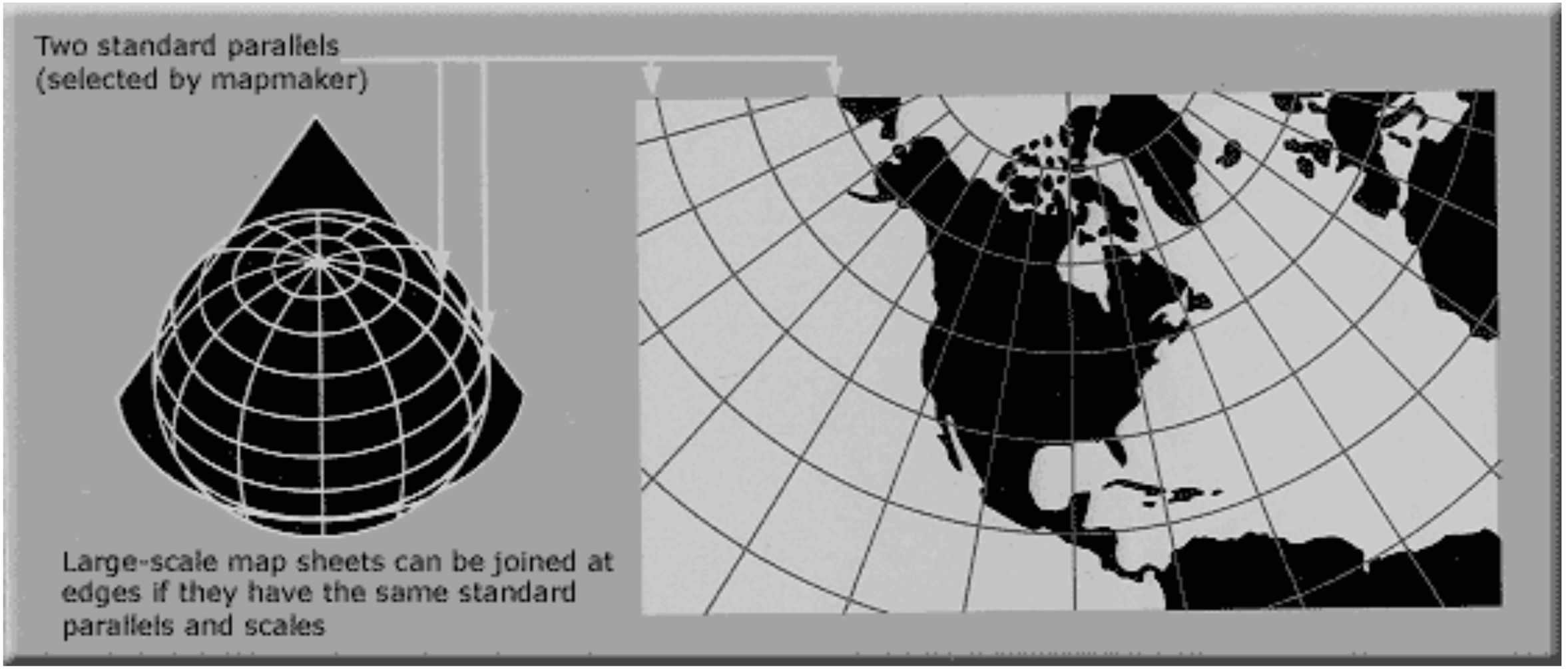
[P. Foresman, Wikimedia]

Flattening the Sphere?



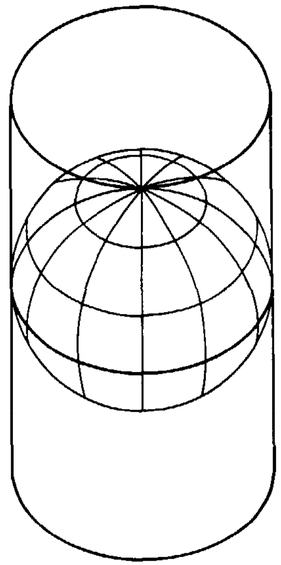
[USGS Map Projections]

Lambert Conformal Conic Projection

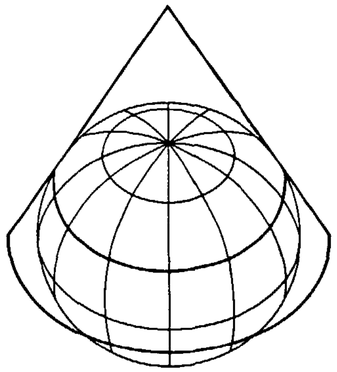


[USGS Map Projections]

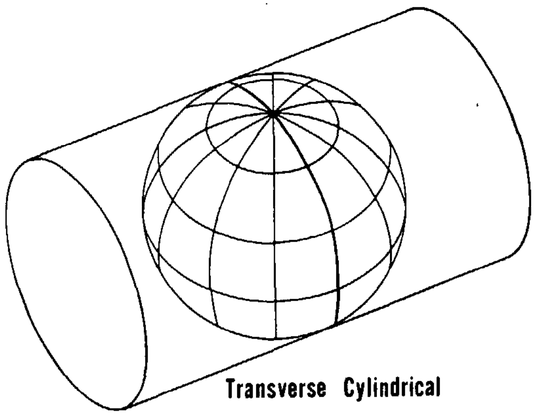
Standard Projections



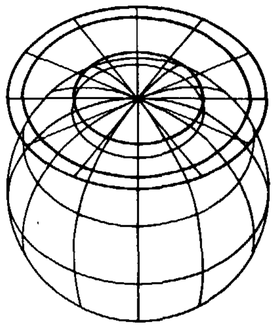
Regular Cylindrical



Regular Conic



Transverse Cylindrical



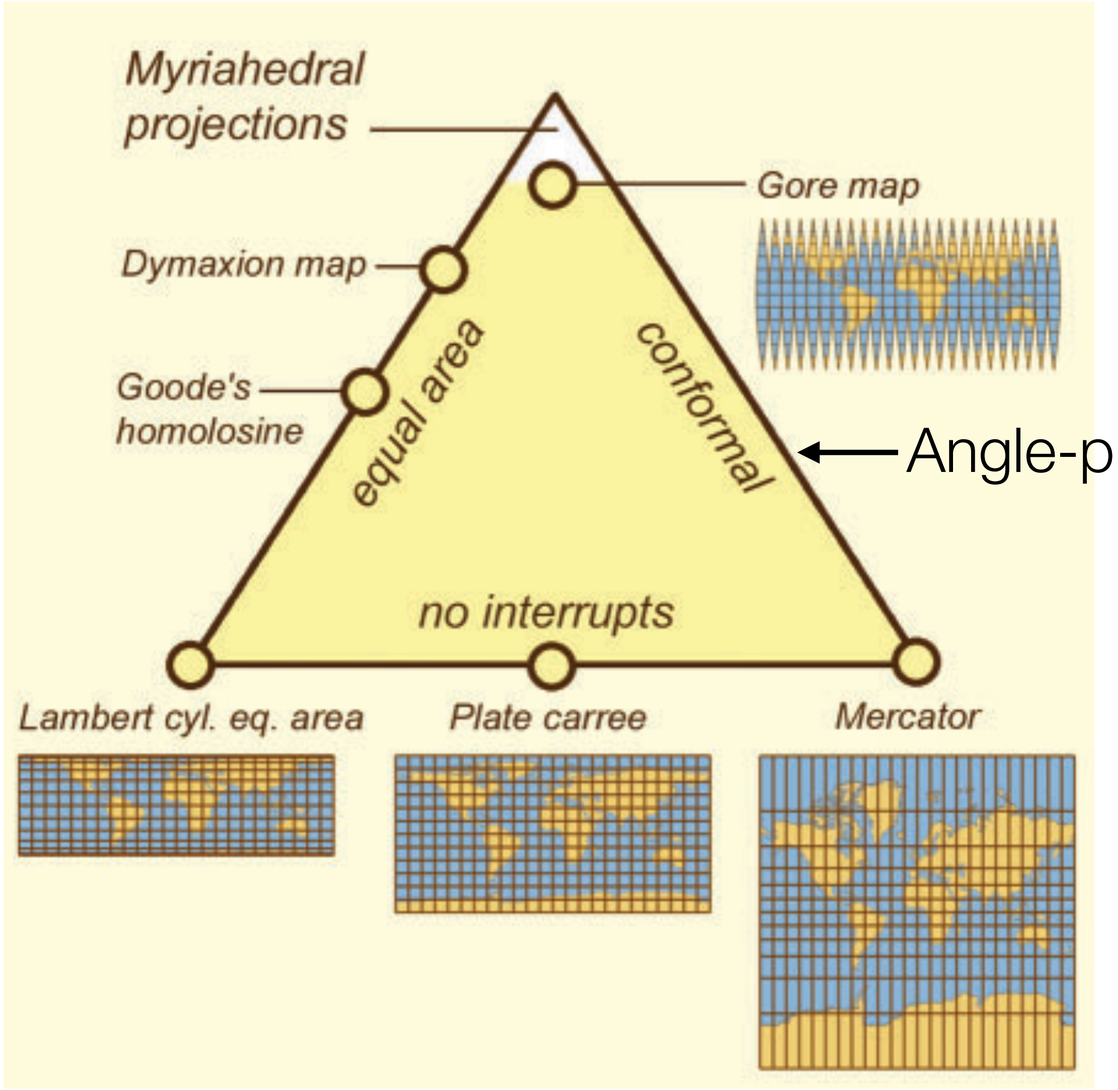
Polar Azimuthal (plane)

[J. P. Snyder, USGS]

Map Projections

[xkcd]

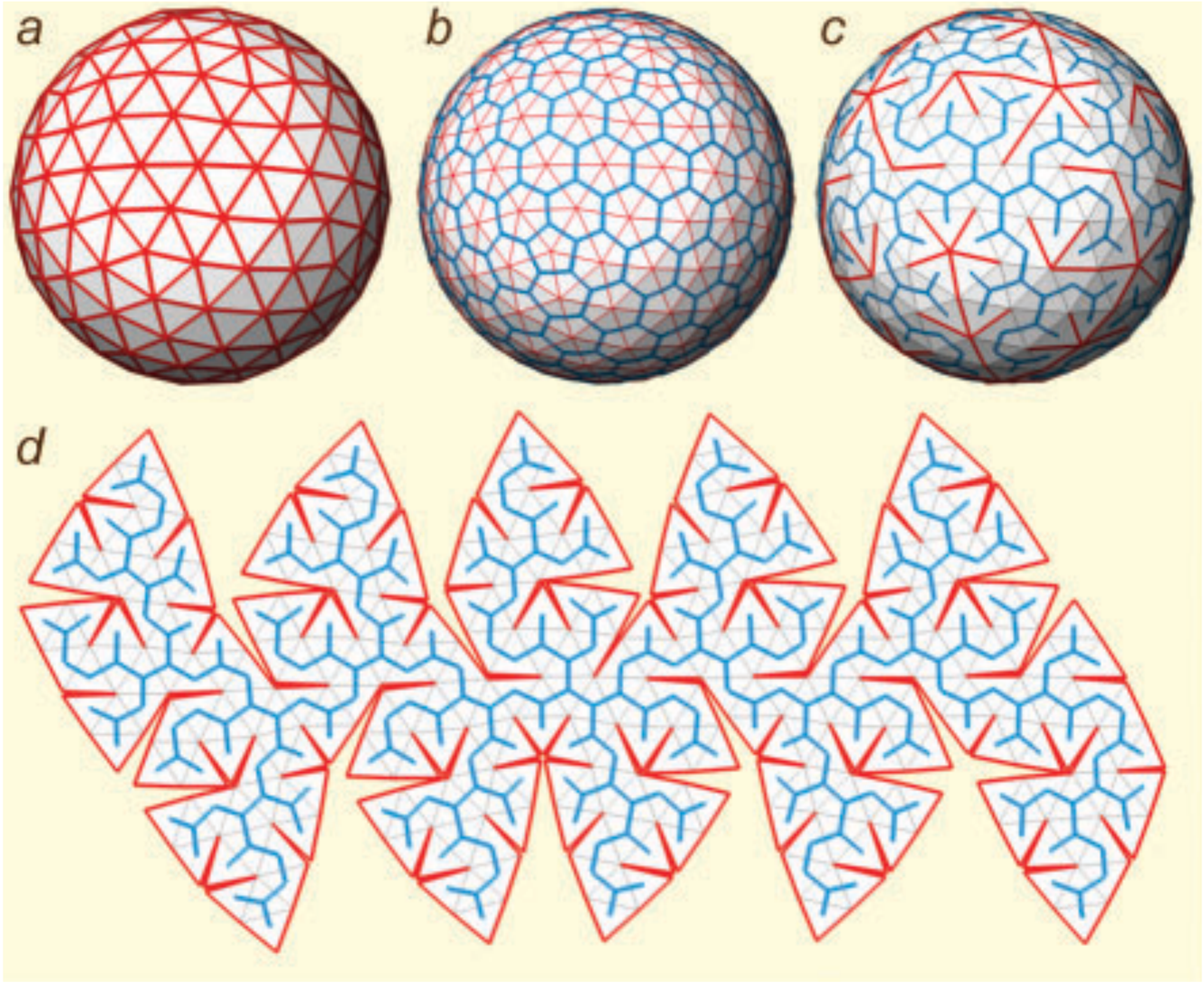
Projection Classification



← Angle-preserving

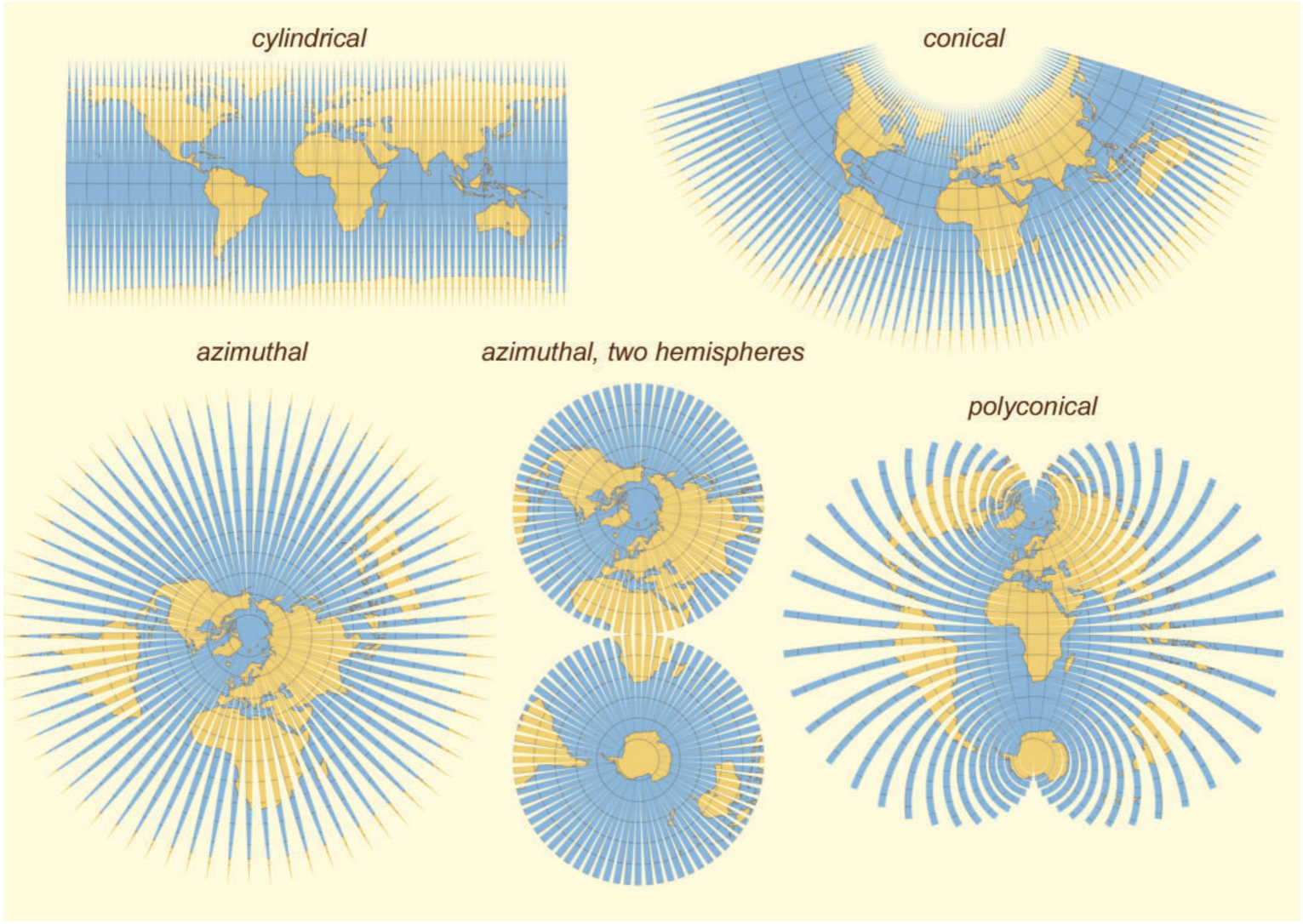
[J. van Wijk, 2008]

Myriahedral Projections



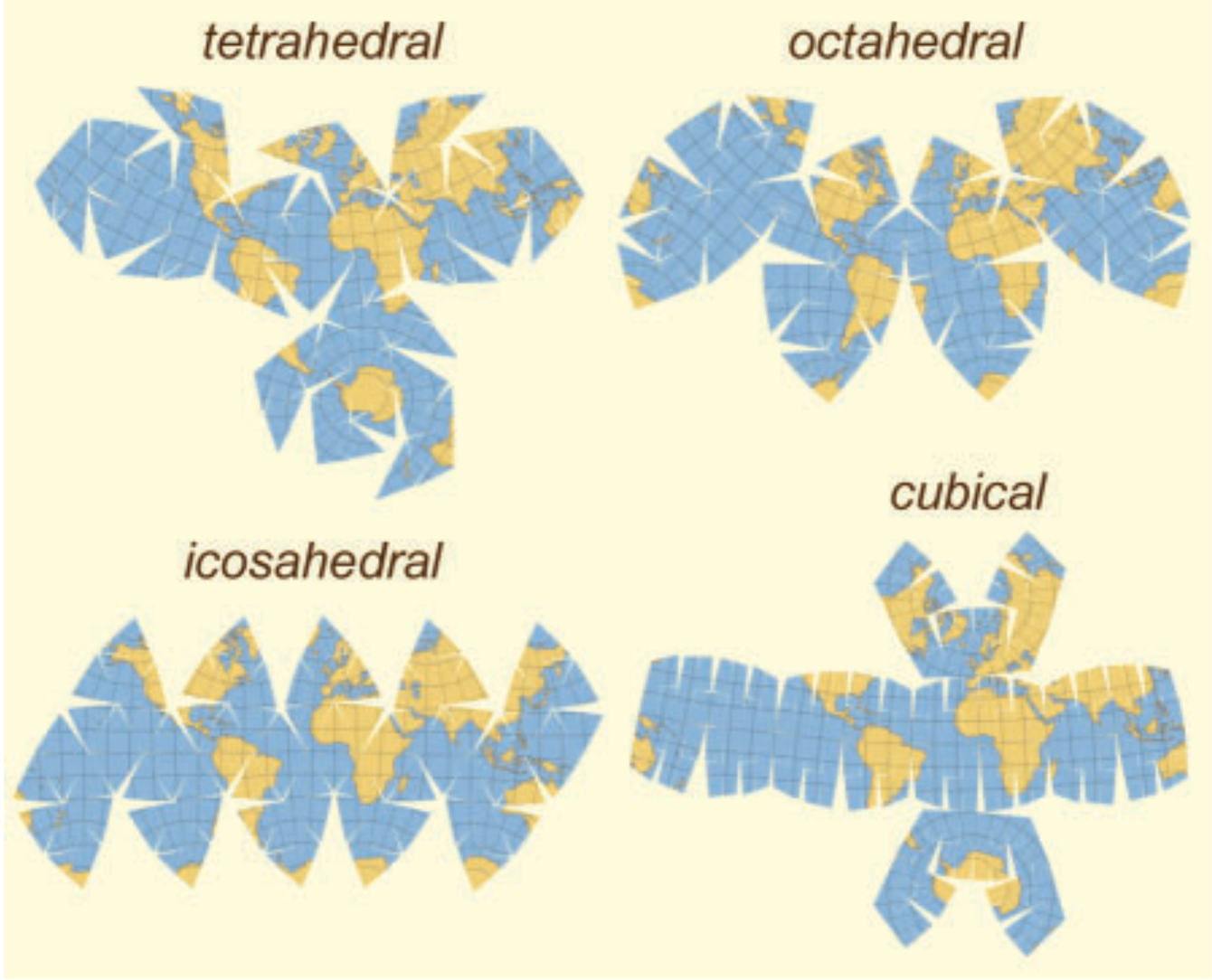
[J. van Wijk, 2008]

Cut along parallels or meridians (graticules)



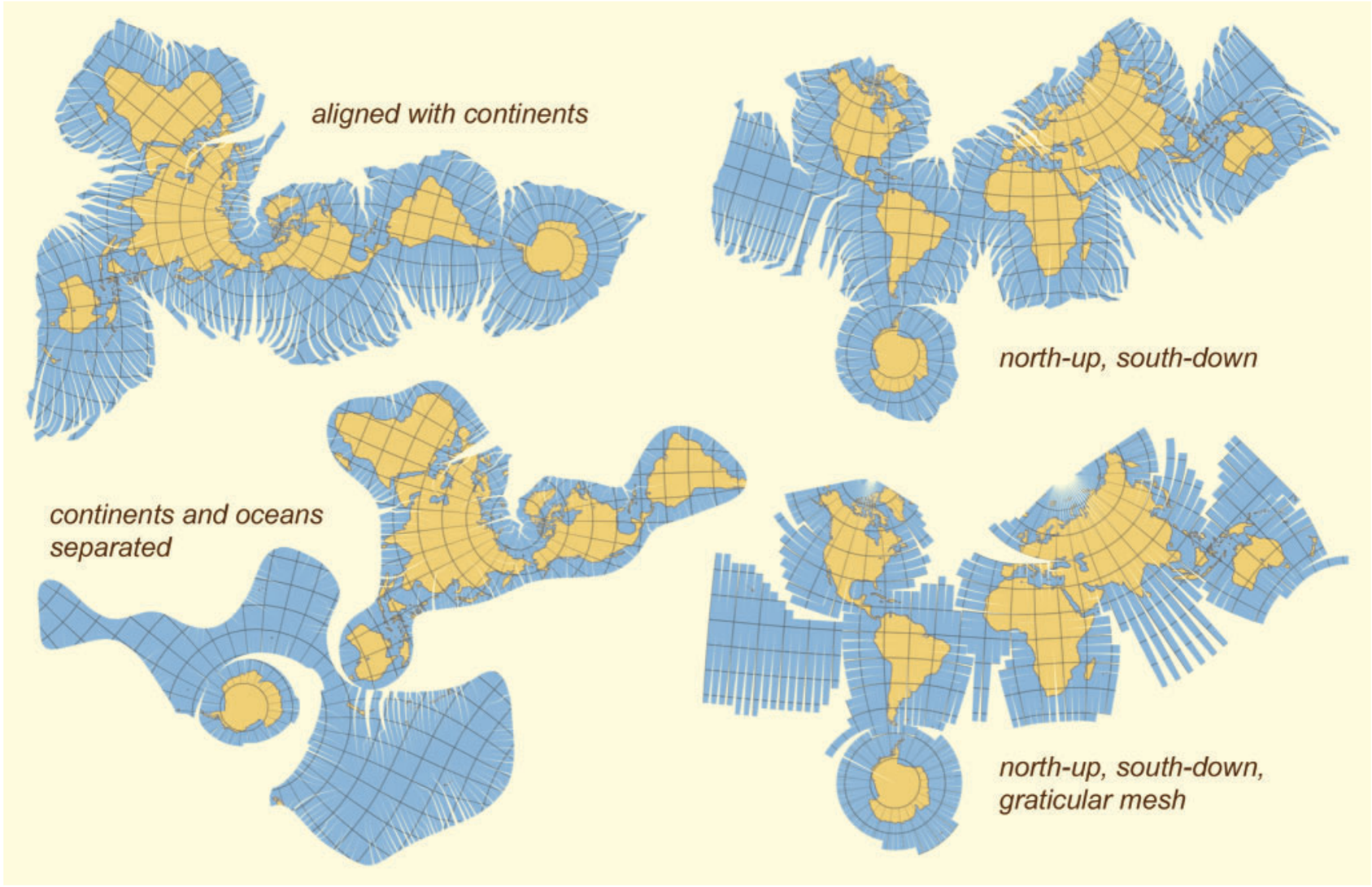
[J. van Wijk, 2008]

Subdividing regular polyhedra



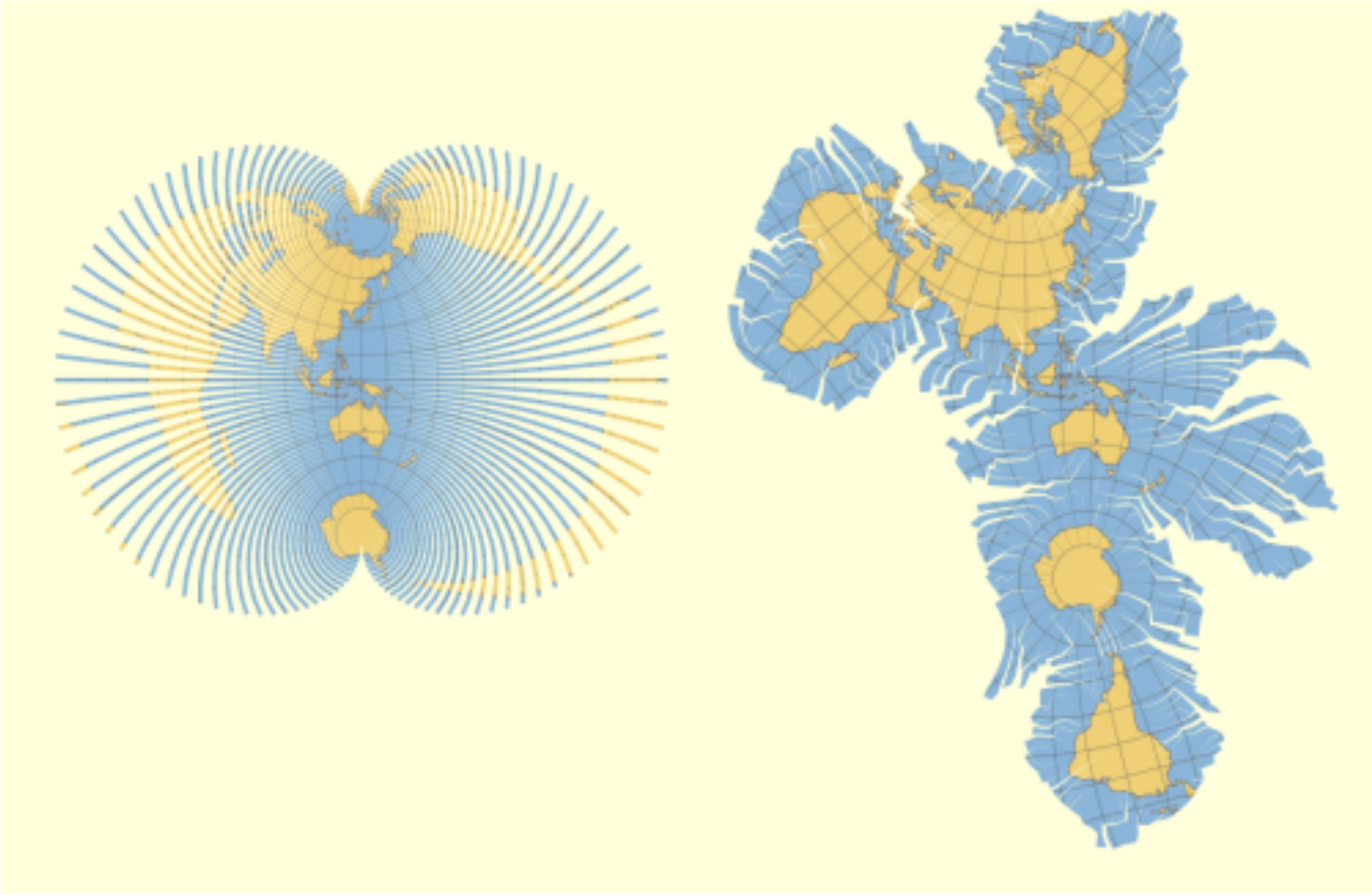
[J. van Wijk, 2008]

Geographically-aligned



[J. van Wijk, 2008]

Australia-centric



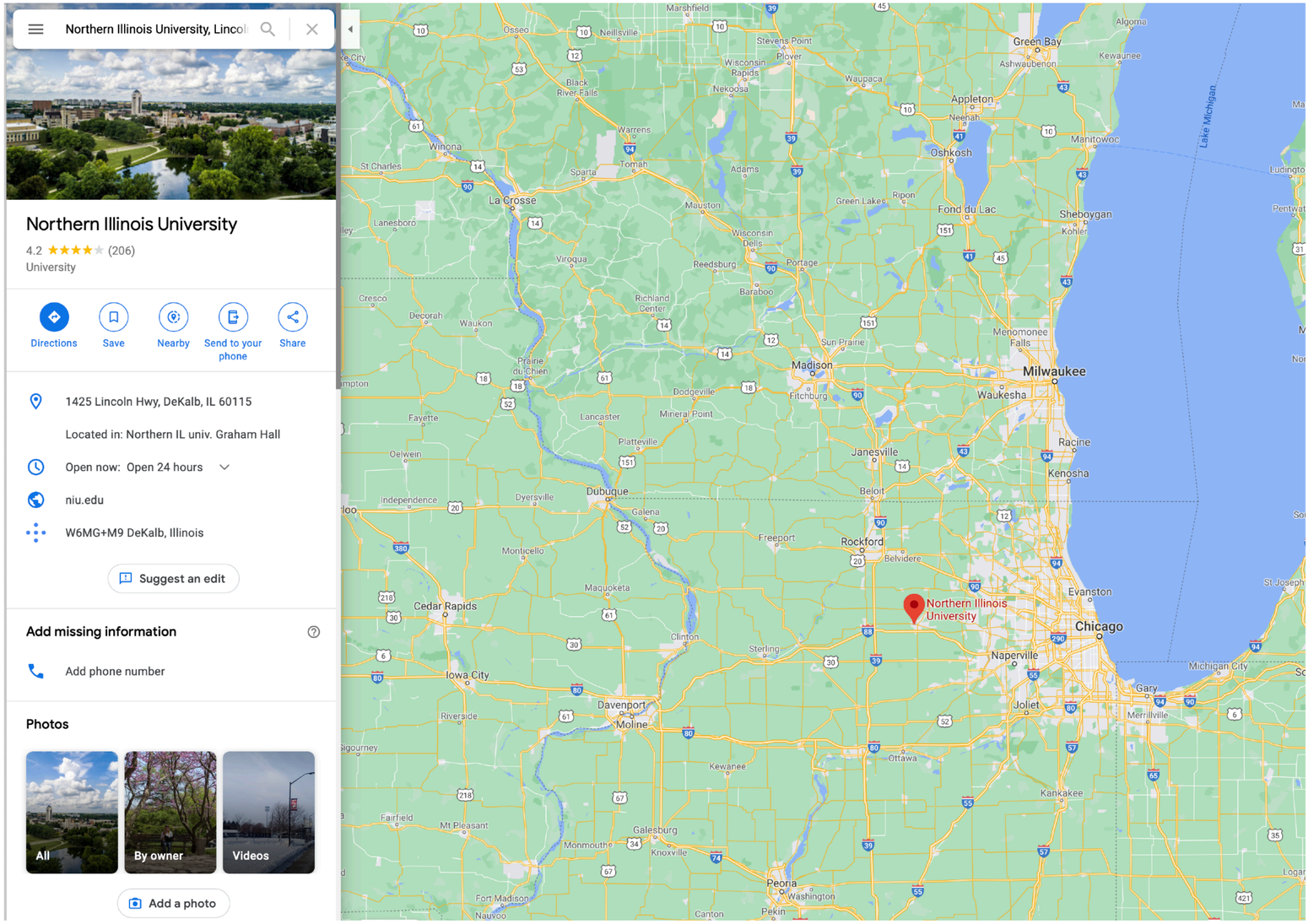
[J. van Wijk, 2008]

Search Tasks

	Target known	Target unknown
Location known	 *Lookup*	 *Browse*
Location unknown	 *Locate*	 *Explore*

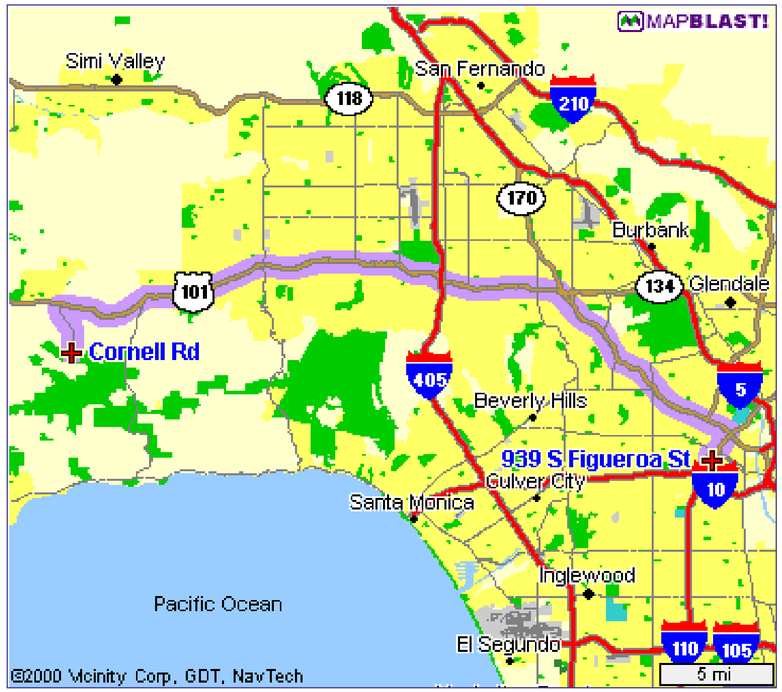
[Munzner (ill. Maguire), 2014]

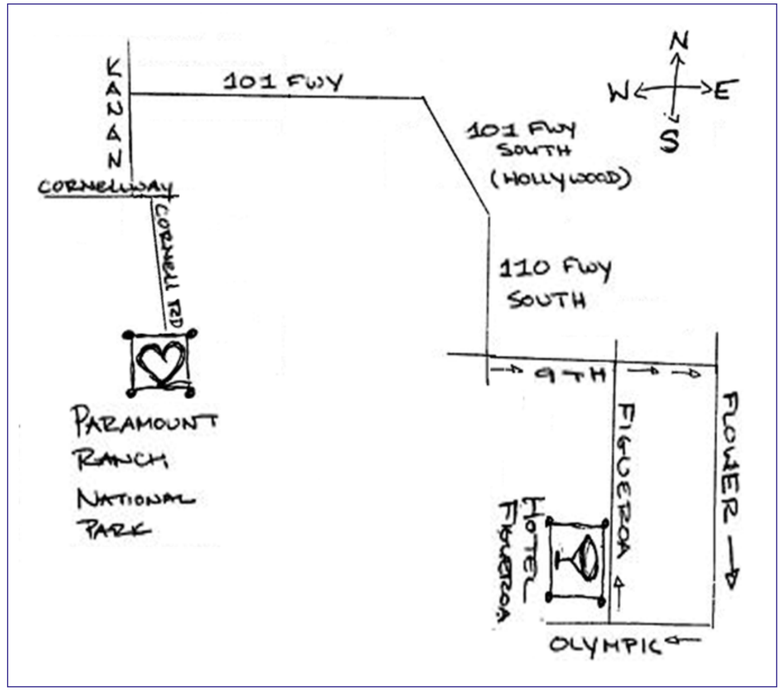
Lookup

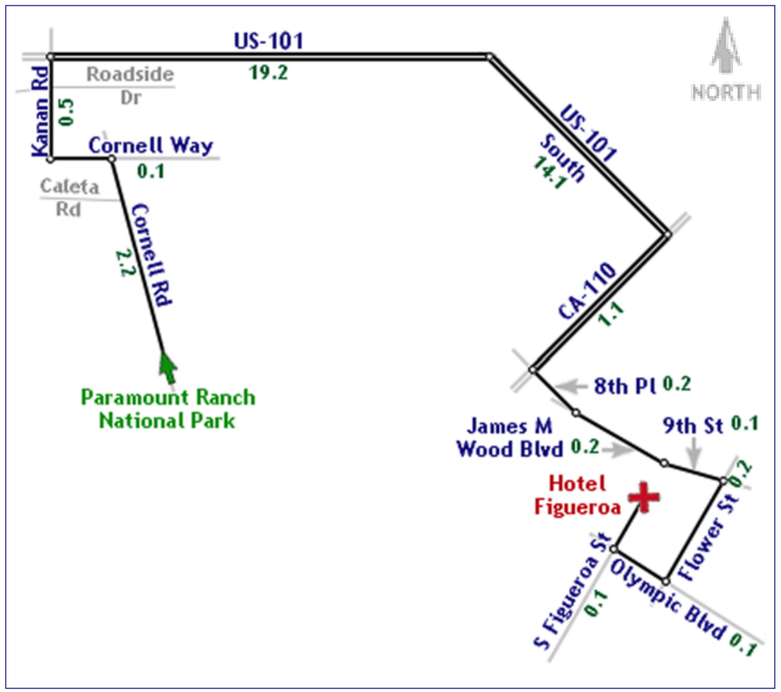


[Google Maps]

Route Maps

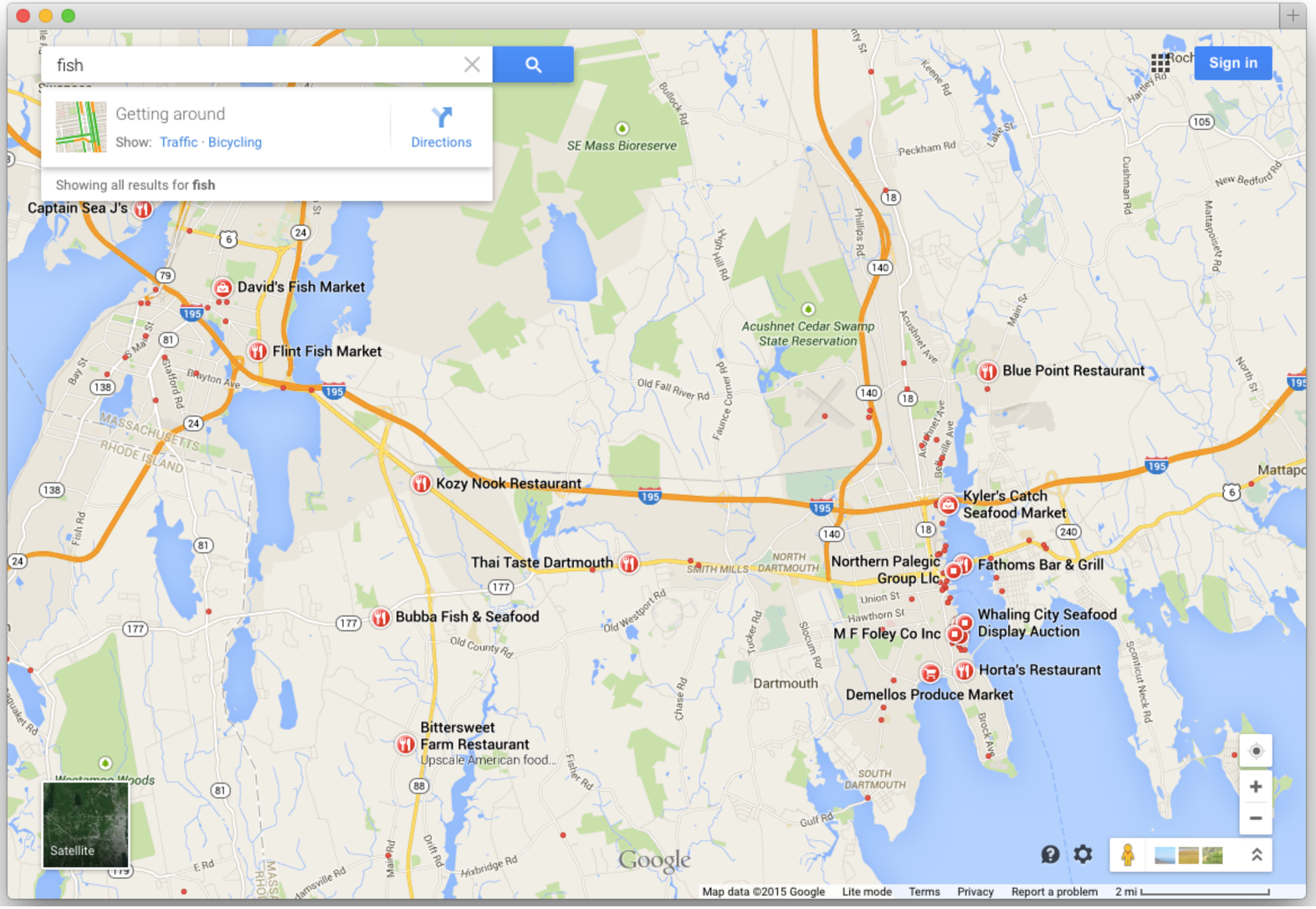






[Agrawala & Stolte, 2001]

Locate


fish
Sign in
Getting around
Show: Traffic · Bicycling
Directions
Showing all results for fish
Captain Sea J's
David's Fish Market
Flint Fish Market
Kozy Nook Restaurant
Thai Taste Dartmouth
Bubba Fish & Seafood
Bittersweet
Farm Restaurant
Upscale American food...
SE Mass Bioreserve
Acushnet Cedar Swamp
State Reservation
Blue Point Restaurant
Kyler's Catch
Seafood Market
Northern Palegic
Group Llc
Fathoms Bar & Grill
Whaling City Seafood
Display Auction
M F Foley Co Inc
Horta's Restaurant
Demellos Produce Market
Dartmouth
NORTH DARTMOUTH
SMITH MILLS
SOUTH DARTMOUTH
MASSACHUSETTS
RHODE ISLAND
Satellite
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Map data ©2015 Google
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Adding Data

- Discrete: a value is associated with a specific position
  - Size
  - Color Hue
  - Charts
- Continuous: each spatial position has a value (fields)
  - Heatmap
  - Isolines

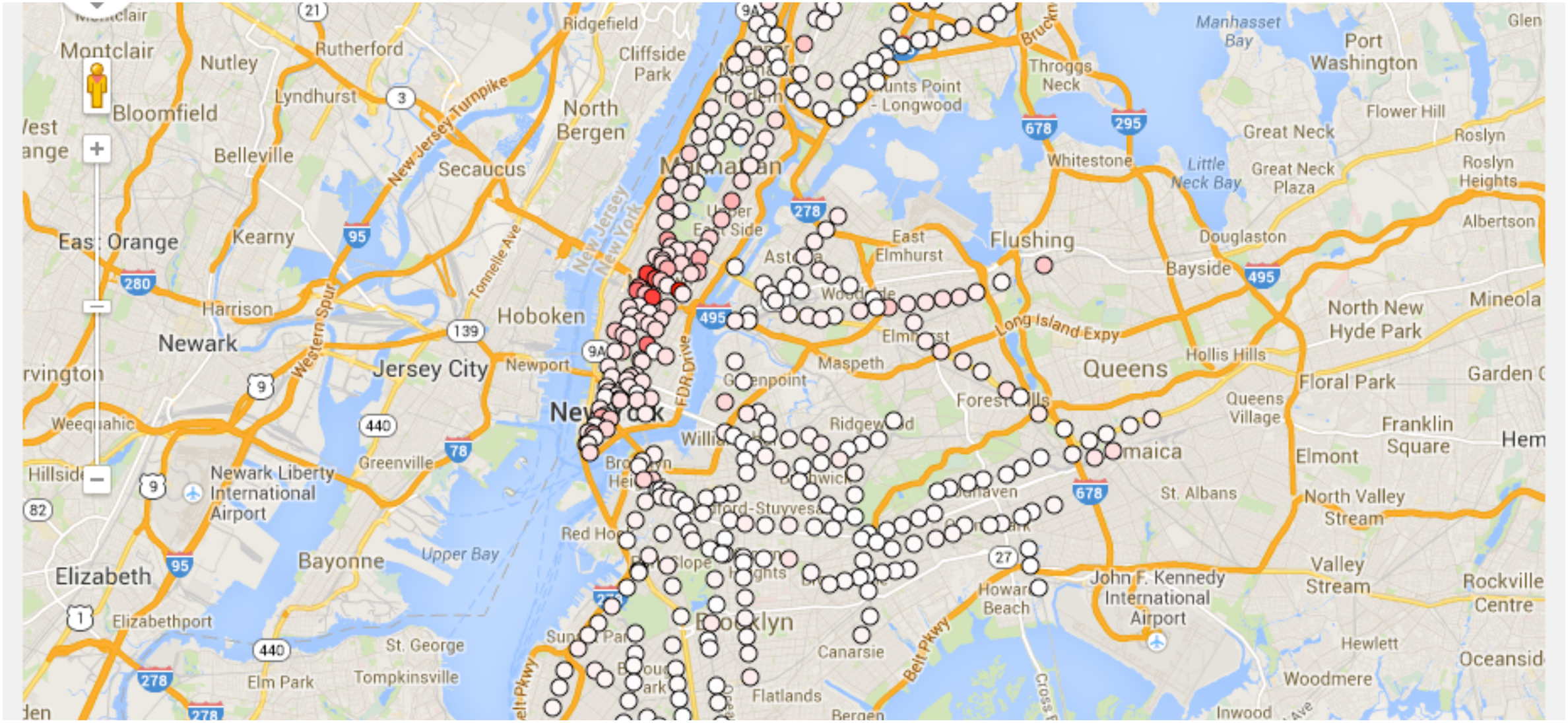
Discrete Categorical Attribute: Shape

[Acadia NP, National Park Service]

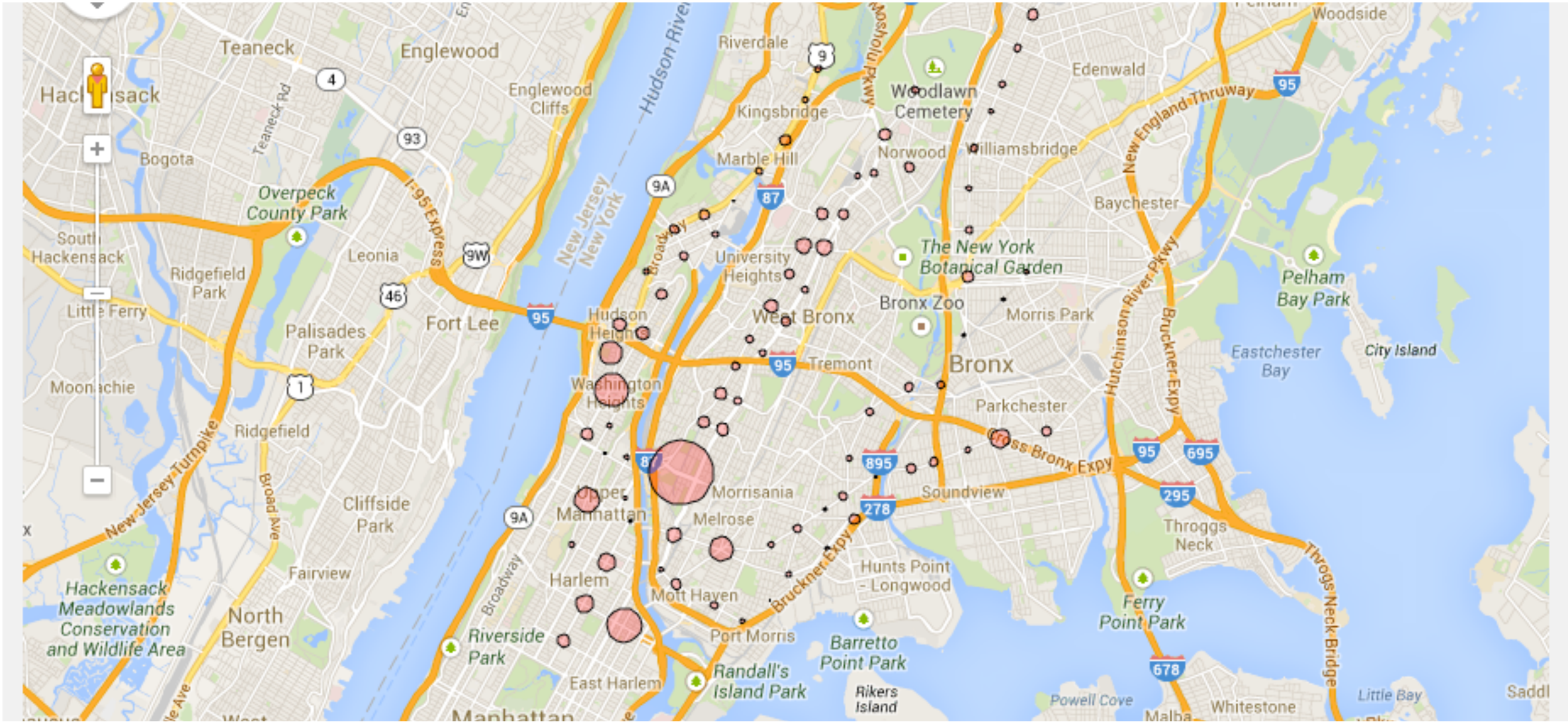
Discrete Categorical Attribute: Shape

[Acadia NP, National Park Service]

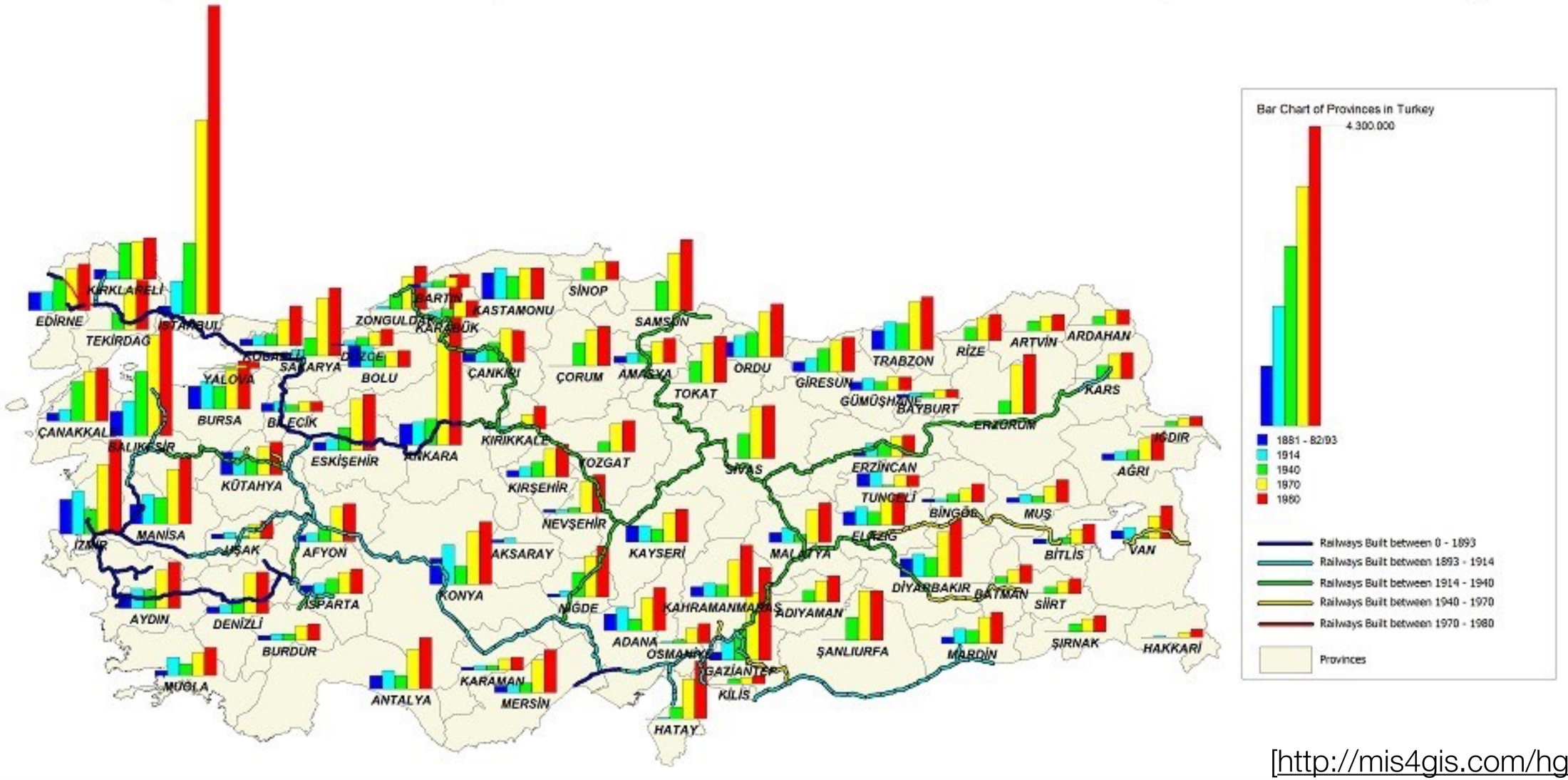
Discrete Quantitative Attribute: Color Saturation



Discrete Quantitative Attribute: Size

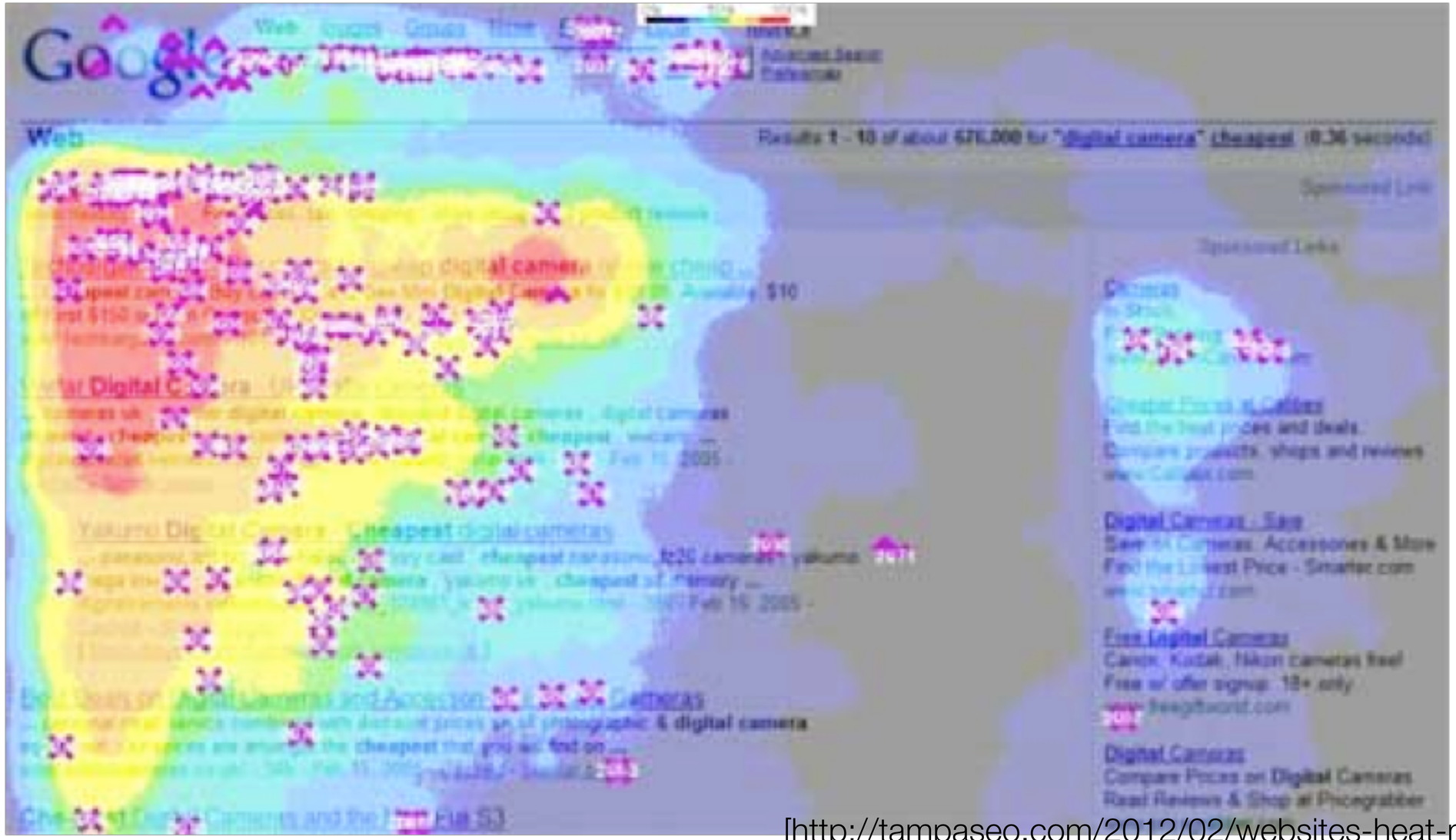


Discrete Quantitative Attributes: Bar Chart



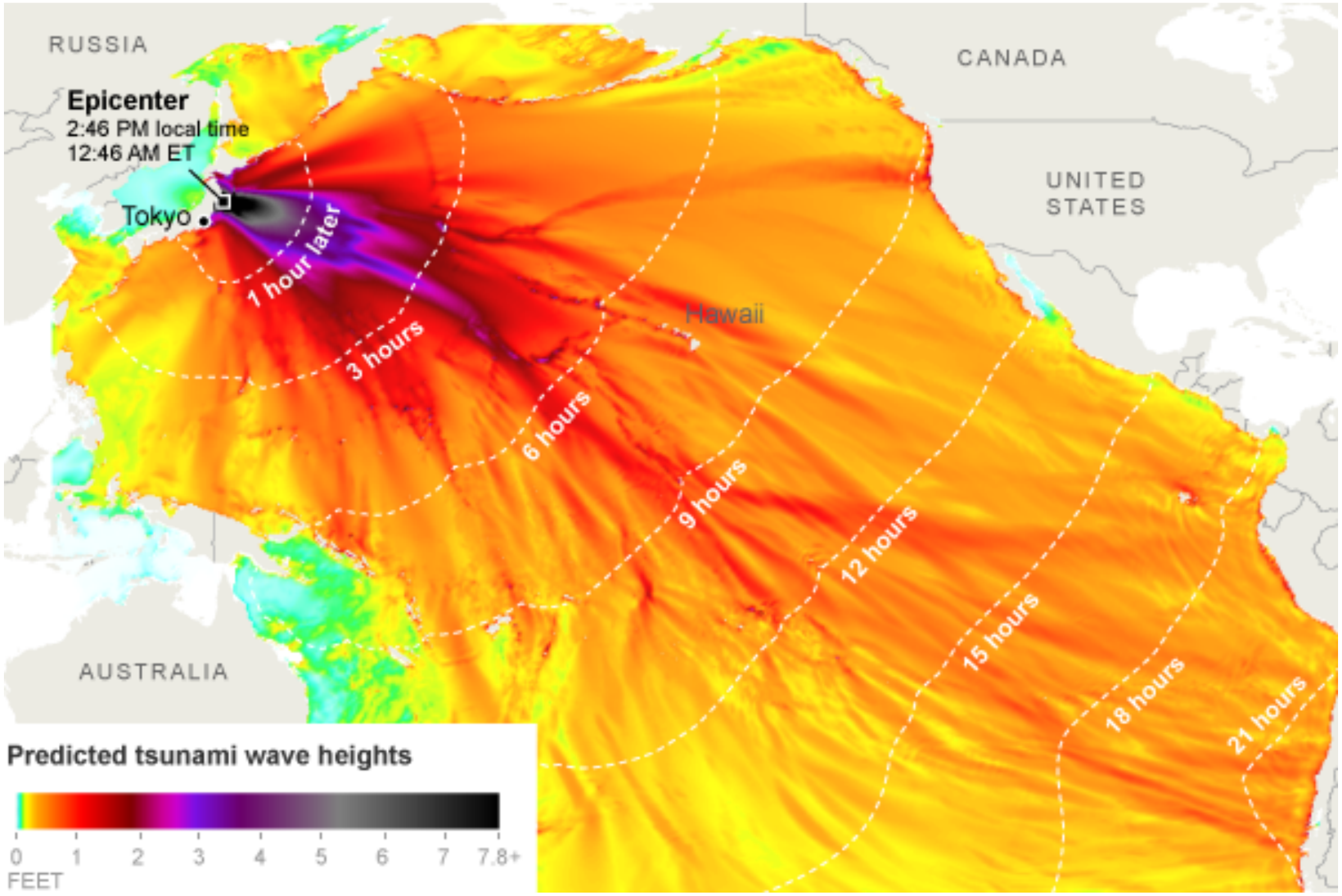
[http://mis4gis.com/hgistr.org/]

Continuous Quantitative Attribute: Color Hue



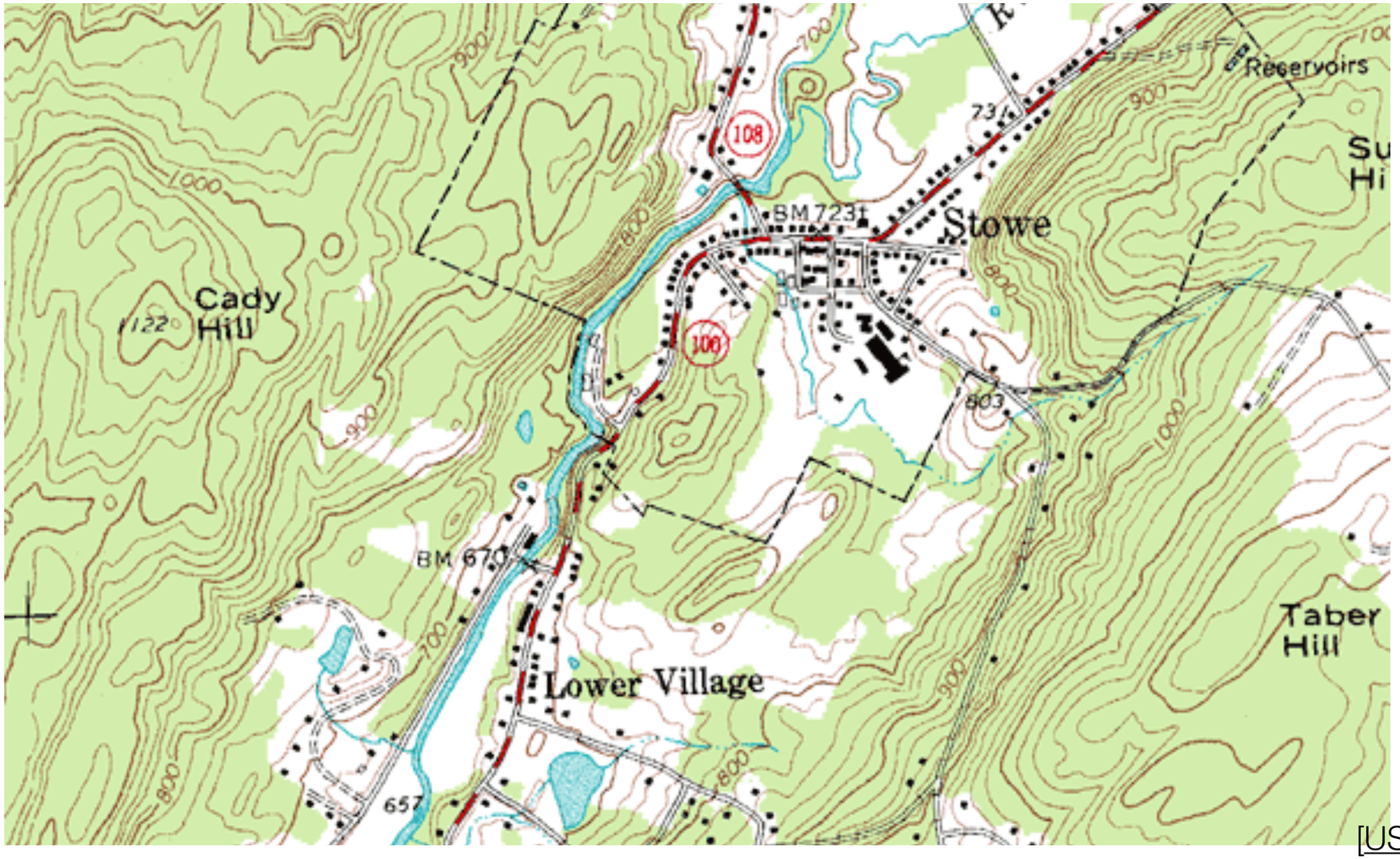
[http://tampaseo.com/2012/02/websites-heat-mapping-users/]

Time as the attribute



[NYTimes]

Isolines

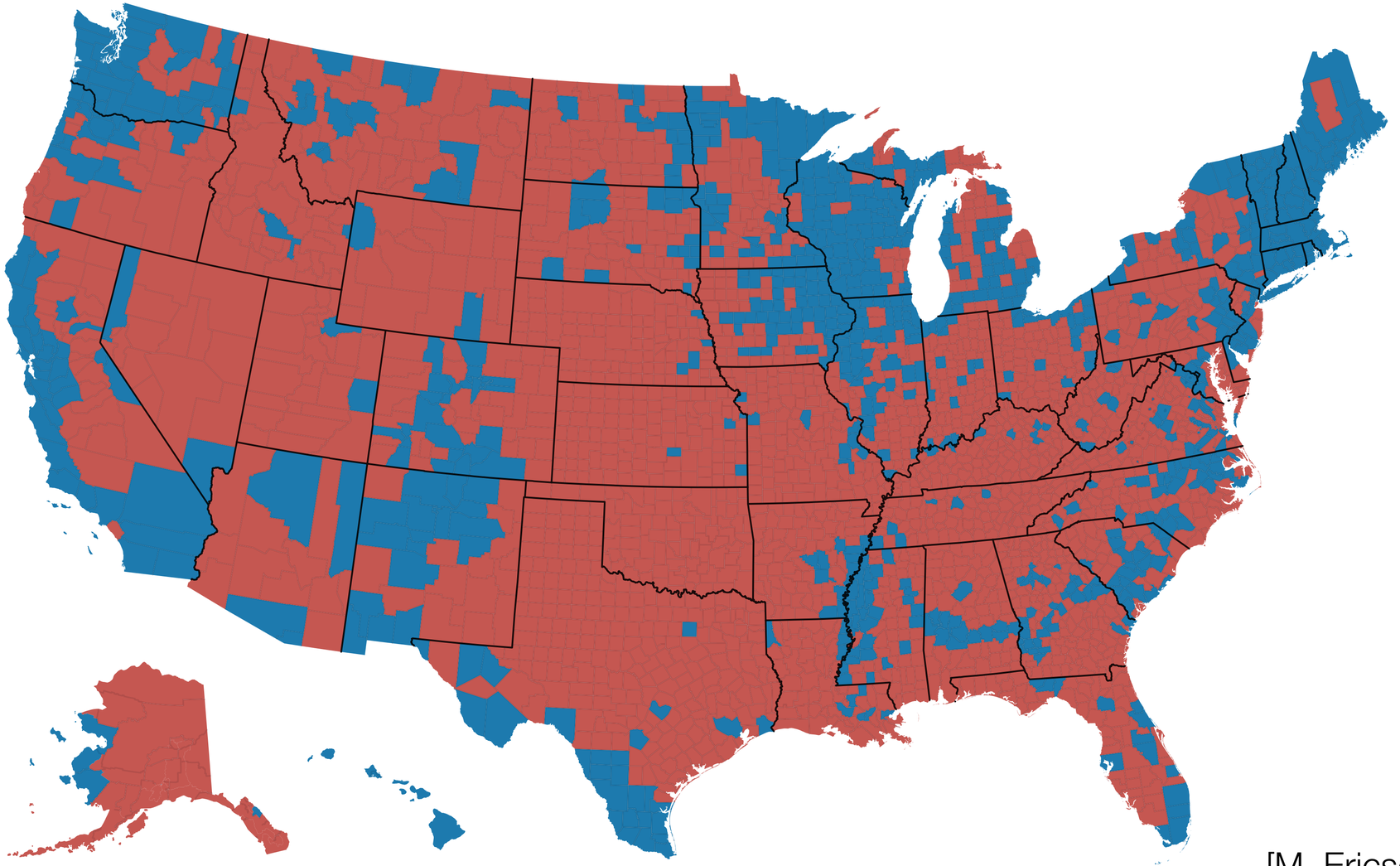


[USGS via Wikipedia]

Isolines

- Scalar fields:
  - value at each location
  - sampled on grids
- Isolines use **derived data** from the scalar field
  - Interpret field as representing continuous values
  - Derived data is **geometry**: new lines that represent the same attribute value
- Scalability: dozens of levels
- Other encodings?

Choropleth (Two Hues)



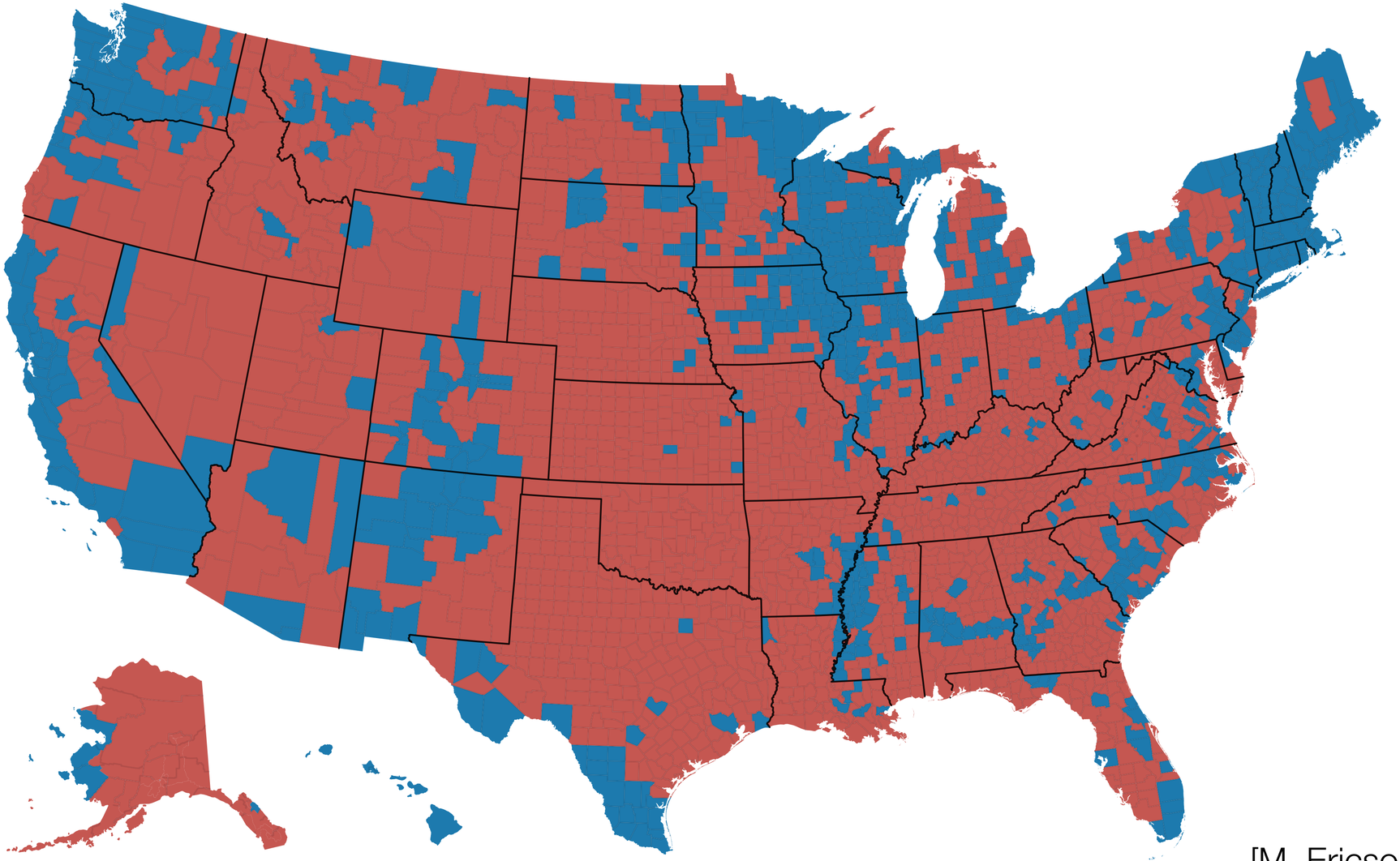
[M. Ericson, New York Times]

Choropleth Map

- Data: geographic geometry data & one quantitative attribute per region
- Tasks: trends, patterns, comparisons
- How: area marks from given geometry, color hue/saturation/luminance
- Scalability: thousands of regions

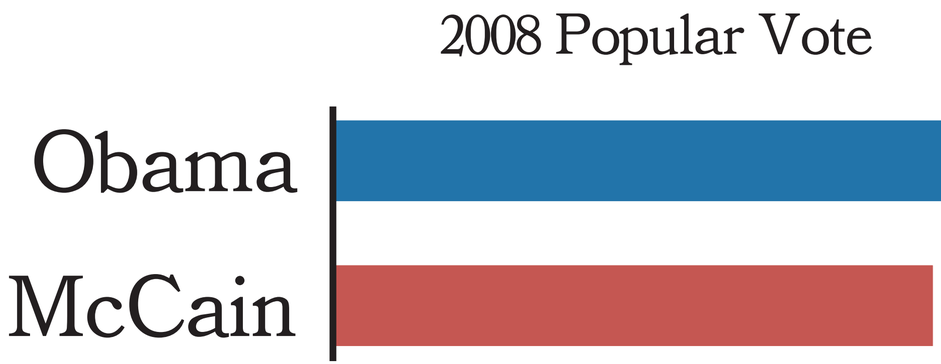
- Design choices:
  - Colormap
  - Region boundaries (level of summarization)

Choropleth (Two Hues)



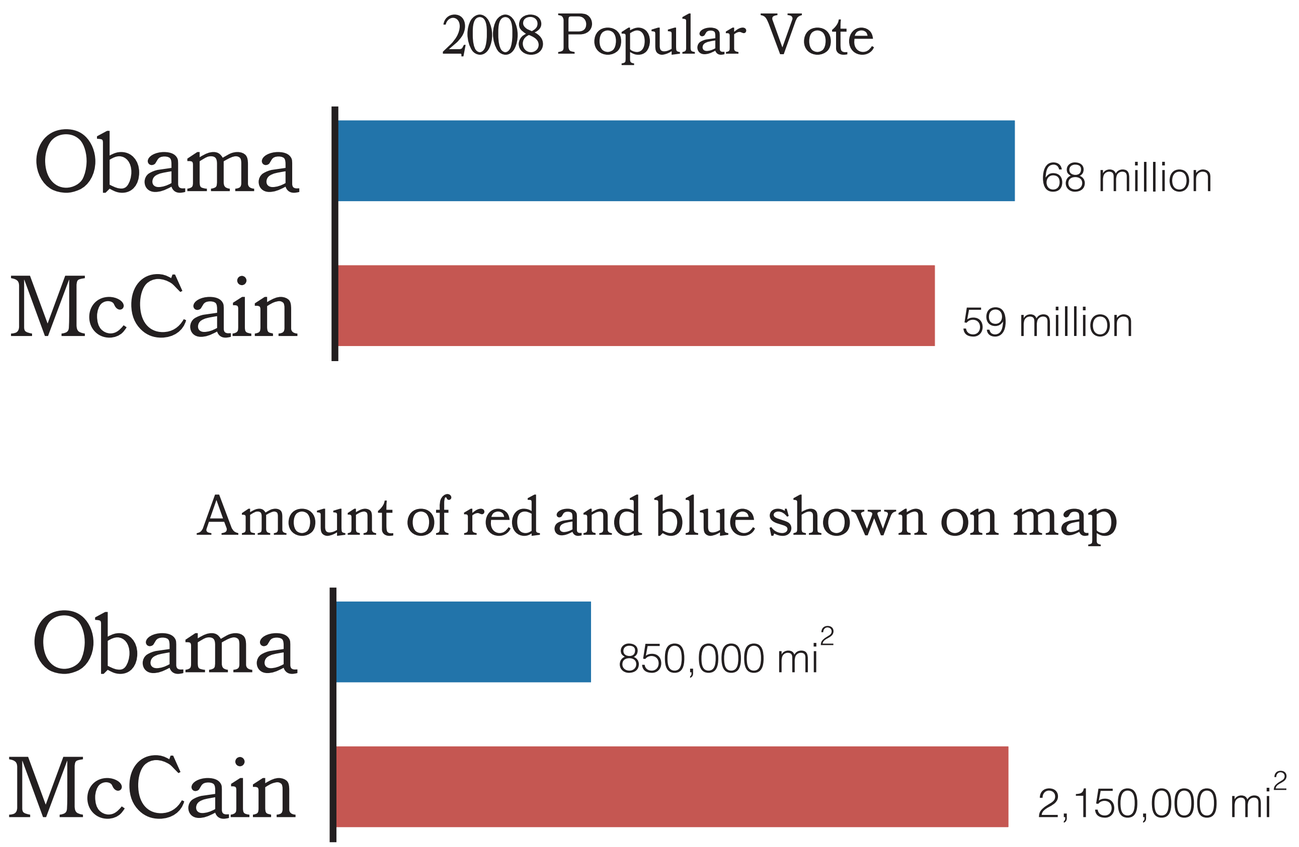
[M. Ericson, New York Times]

Problem?



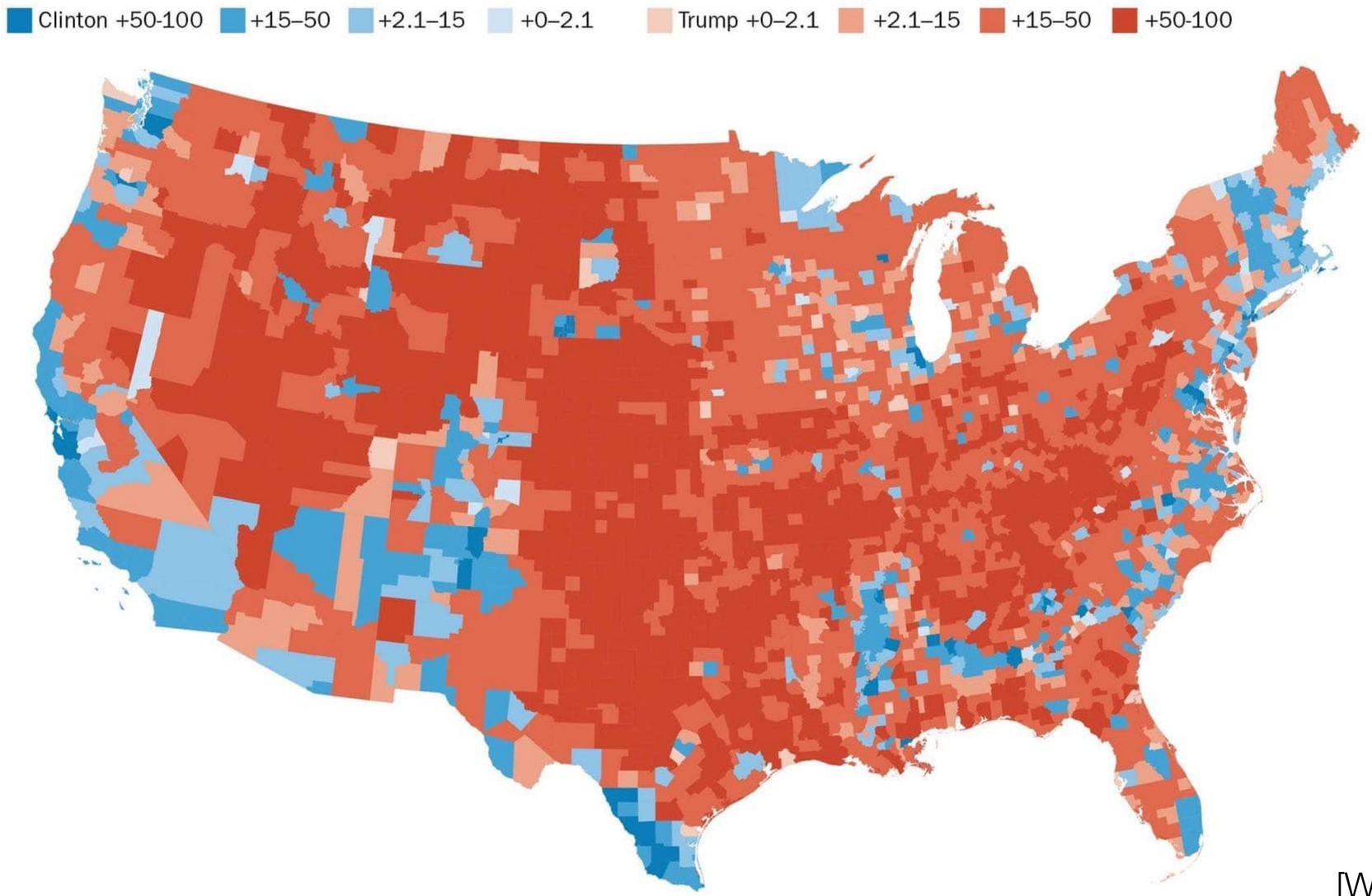
[M. Ericson, New York Times]

Problem?



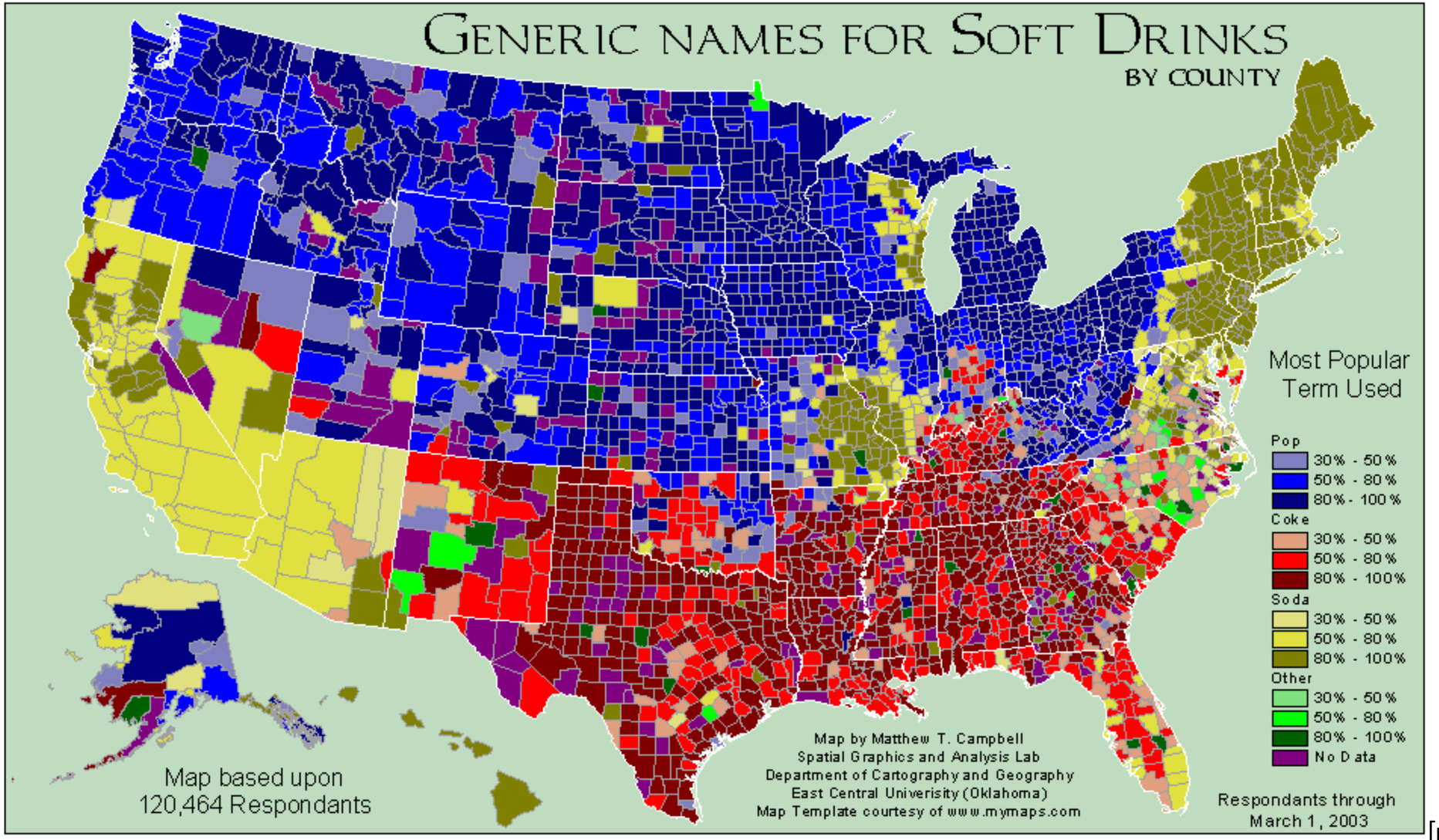
[M. Ericson, New York Times]

Adding Saturation



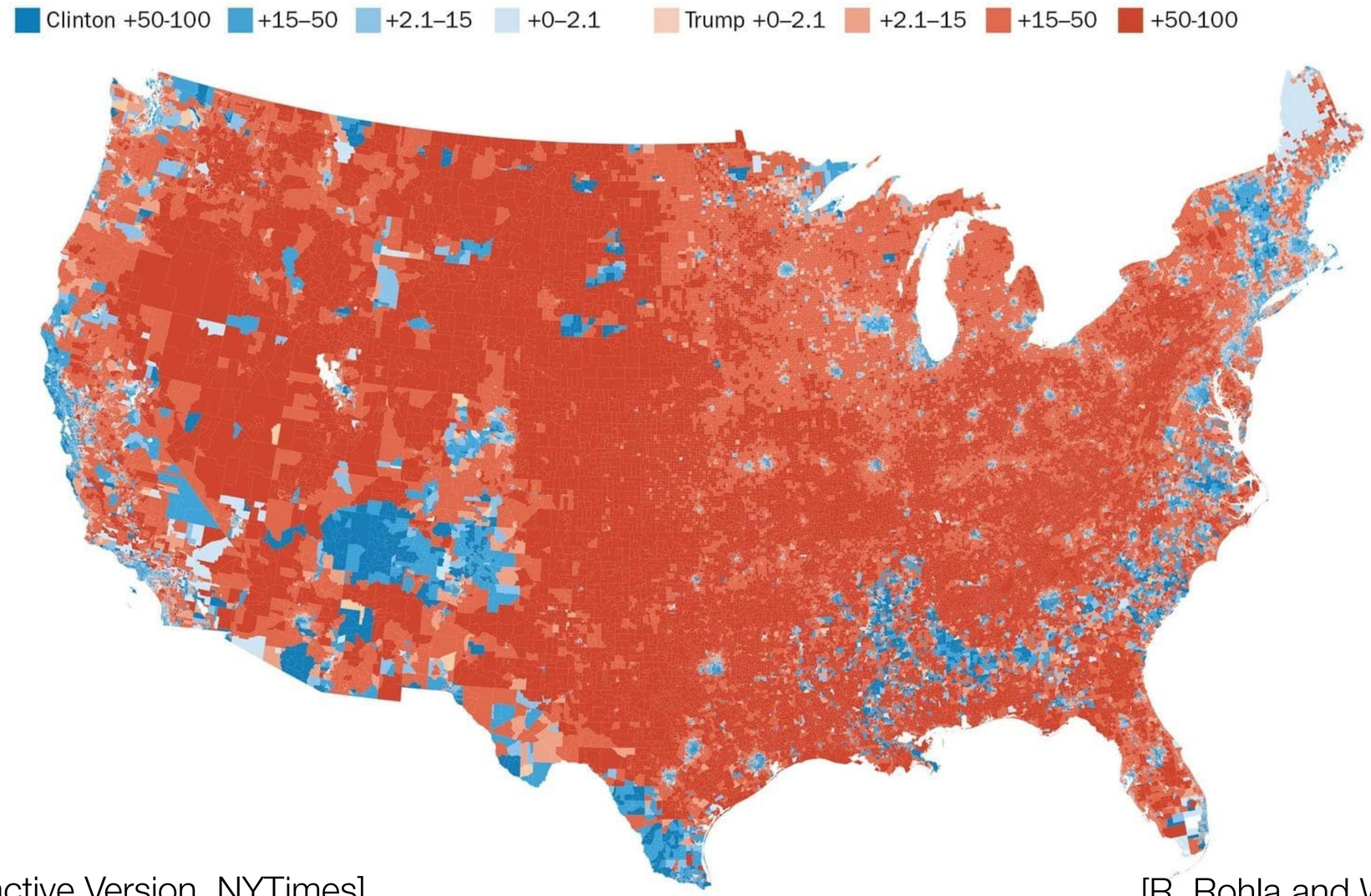
[Washington Post, 2018]

Area Marks and Color Hue & Saturation



[popvssoda.com]

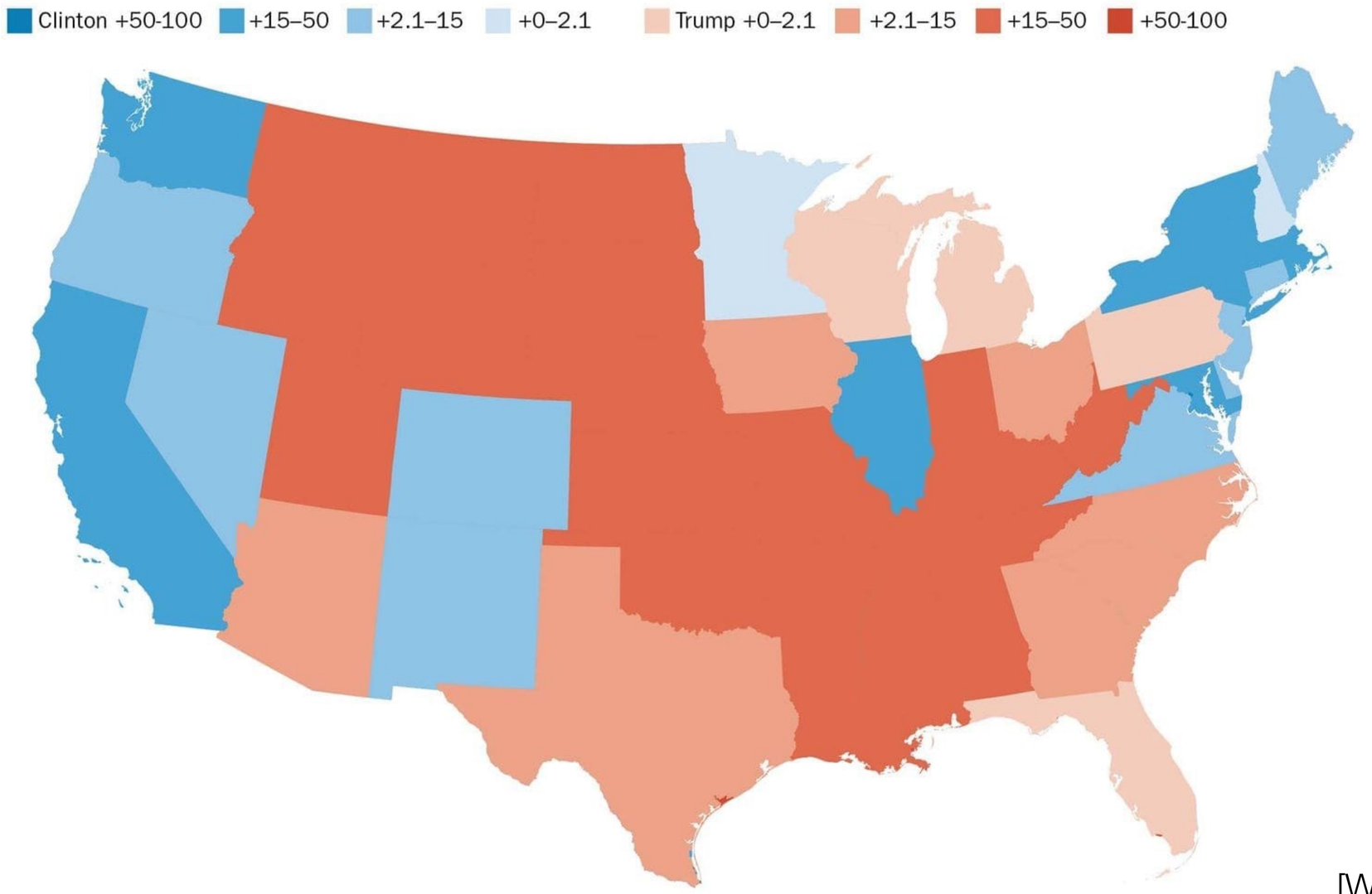
Aggregation: 2016 Election by Precinct



[Interactive Version, NYTimes]

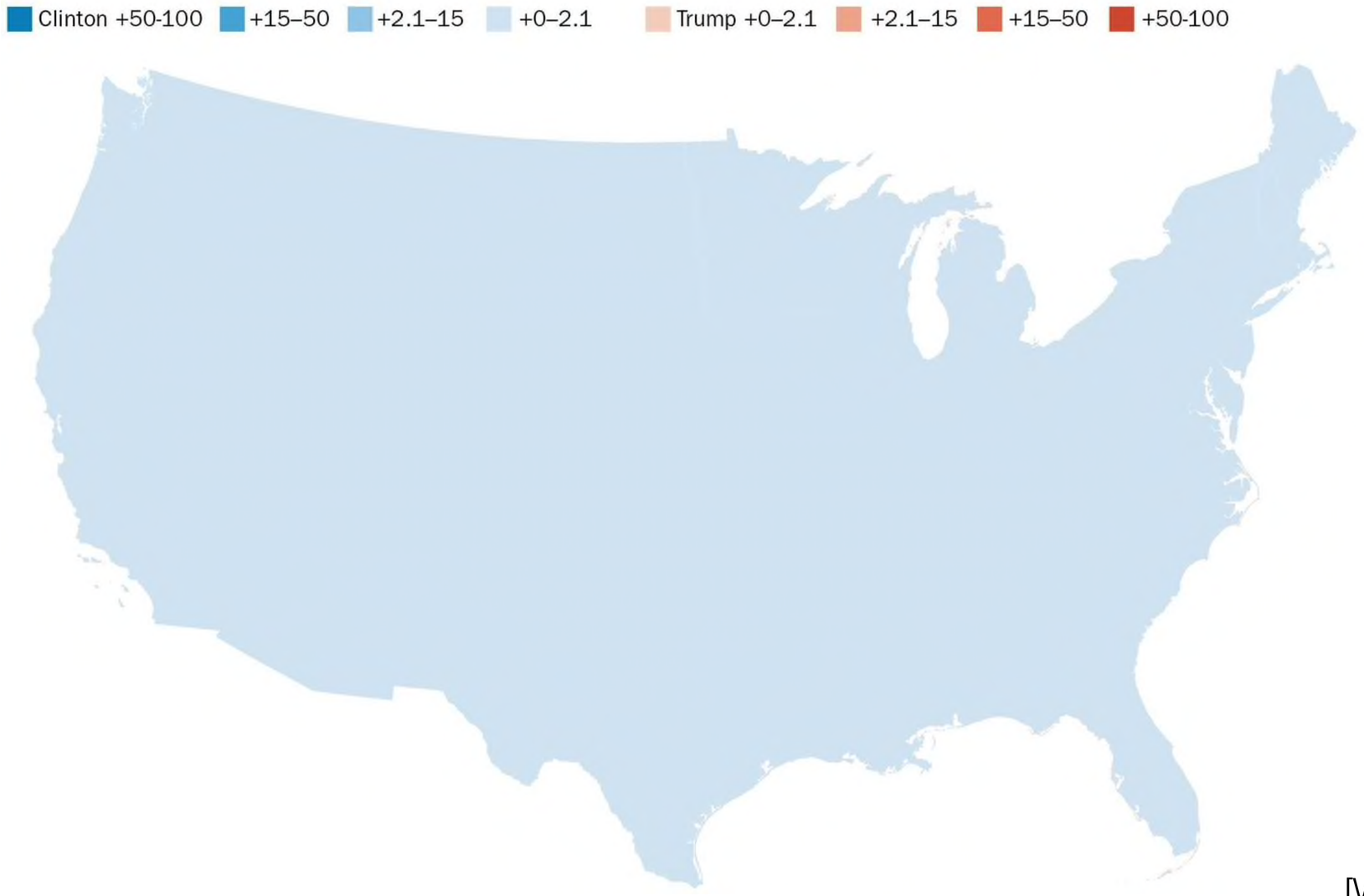
[R. Rohla and Washington Post, 2018]

Aggregation: 2016 Election by State



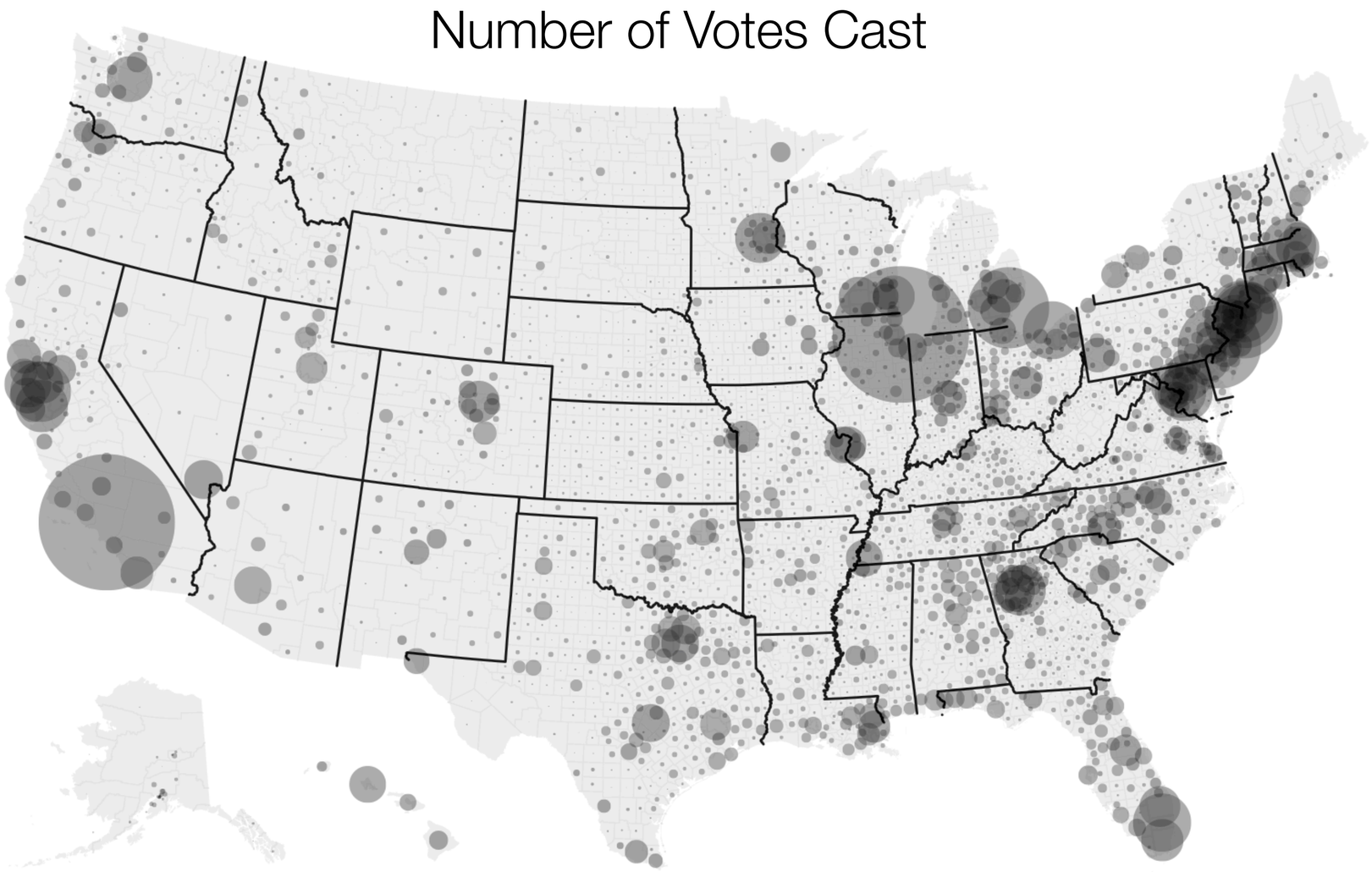
[Washington Post, 2018]

Aggregation: 2016 Election by Country



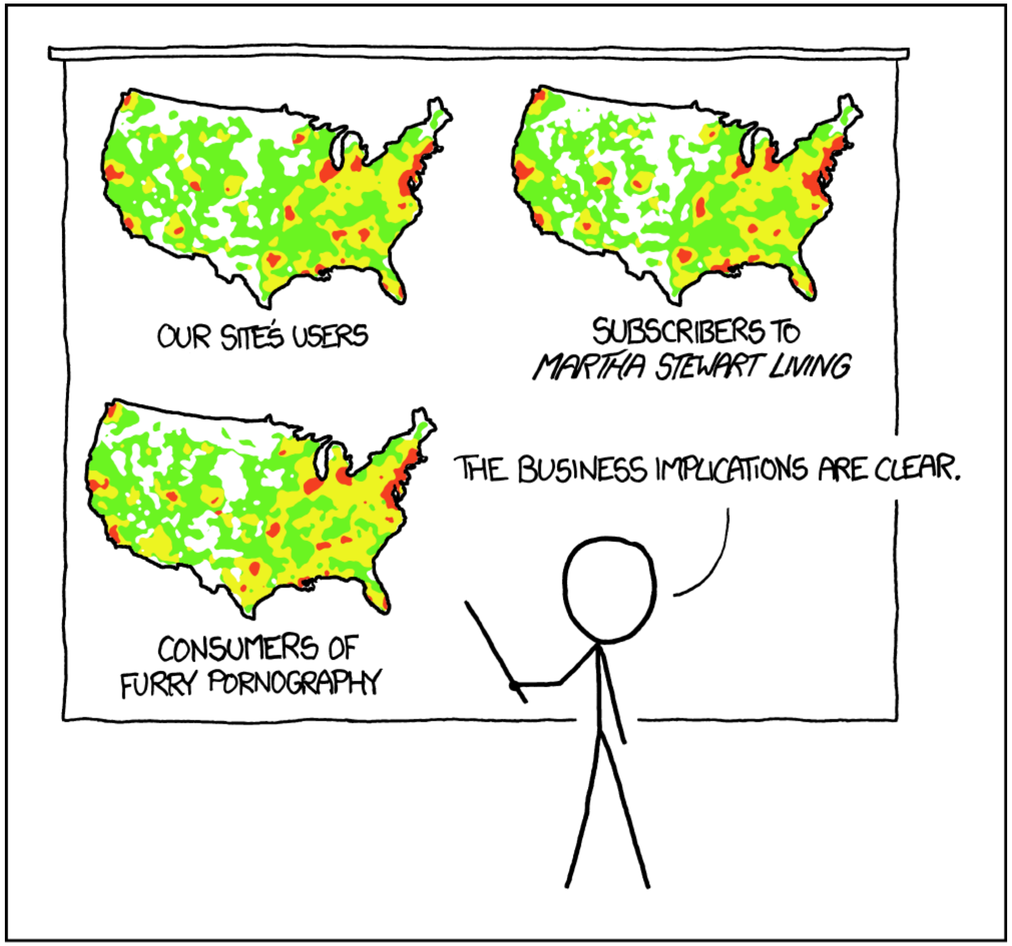
[Washington Post, 2018]

Maps: What trends do you see?



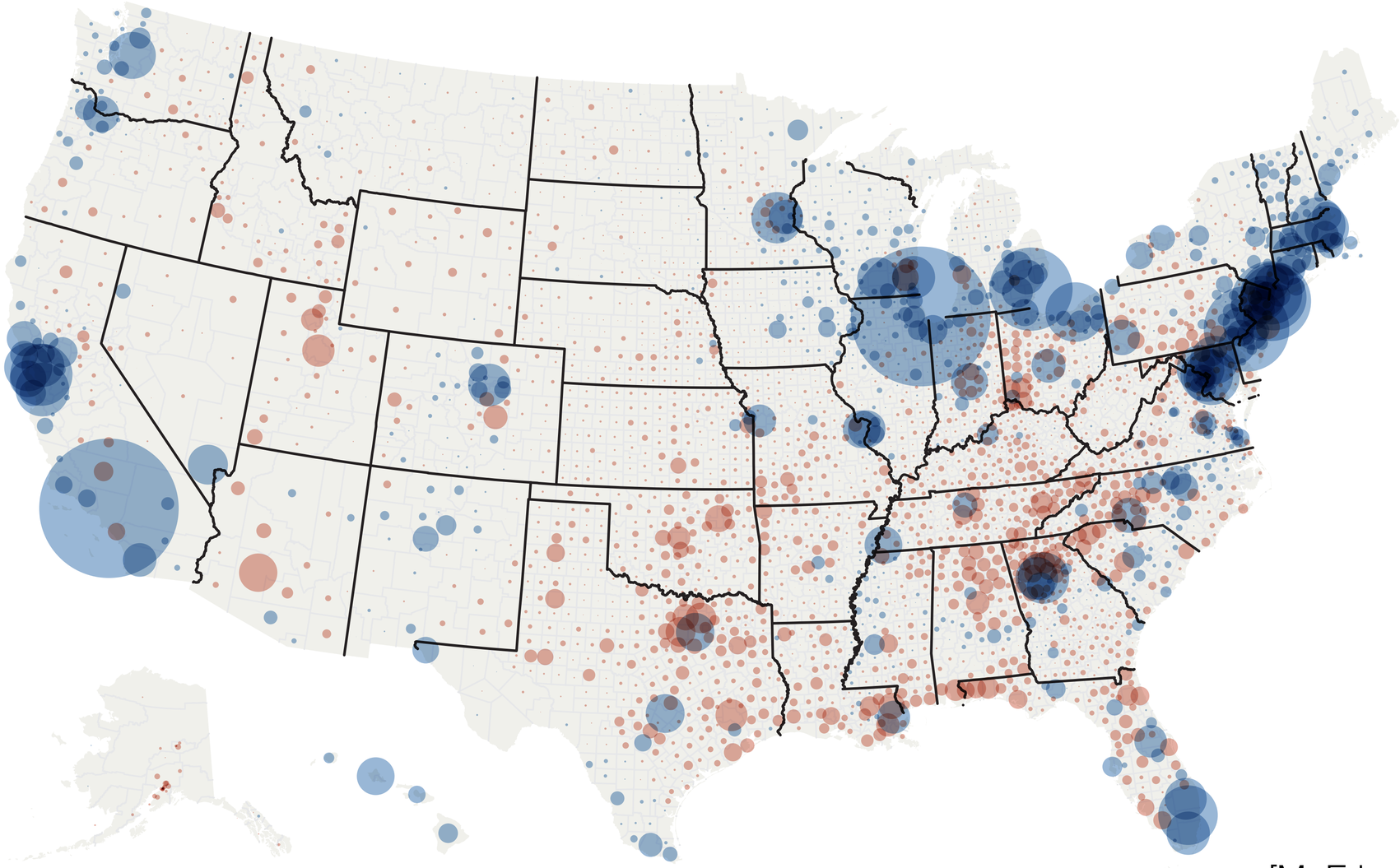
[Desaturated by D. Koop, M. Ericson, New York Times]

Don't Just Create Population Maps!



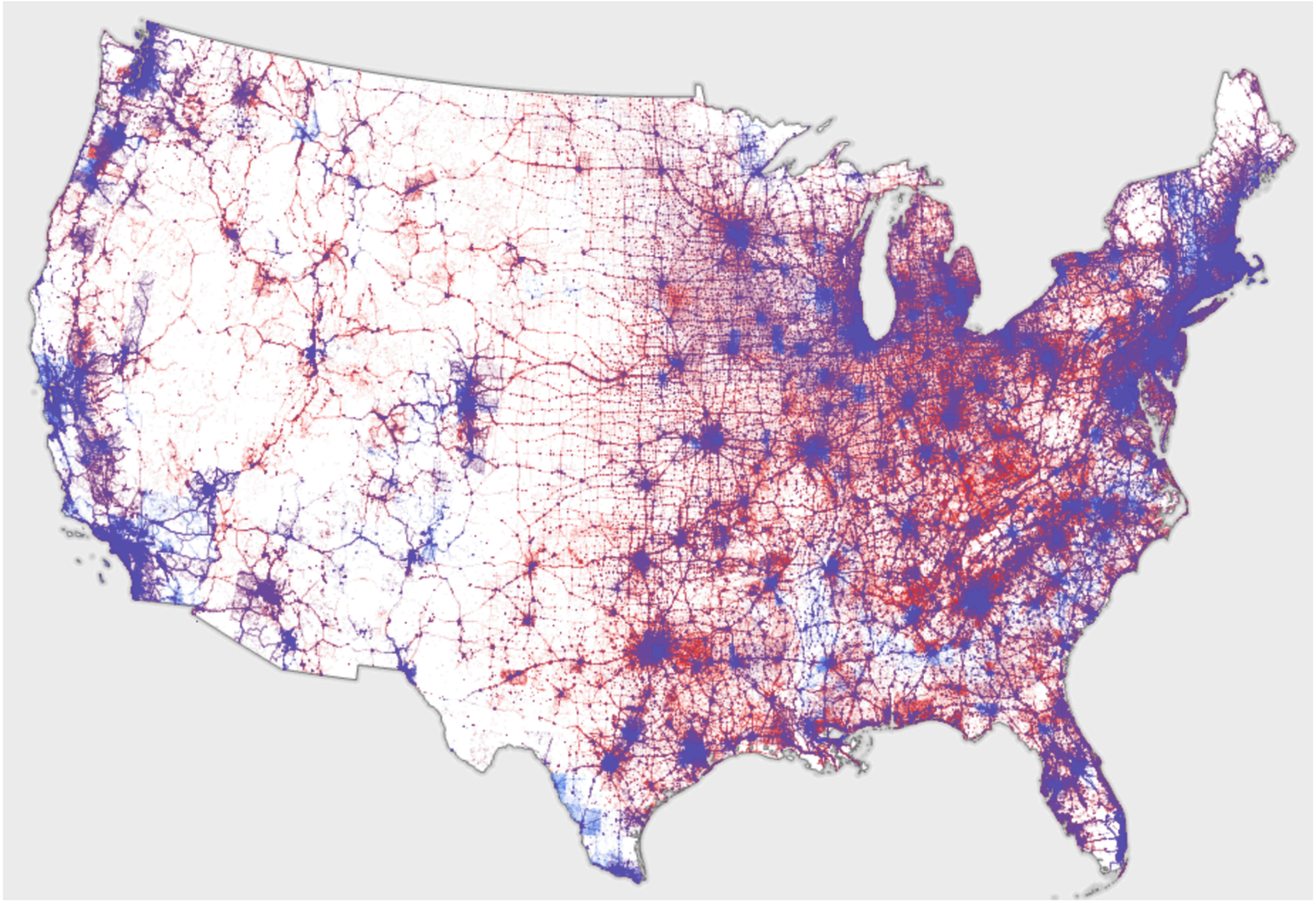
[xkcd]

Size Encoding



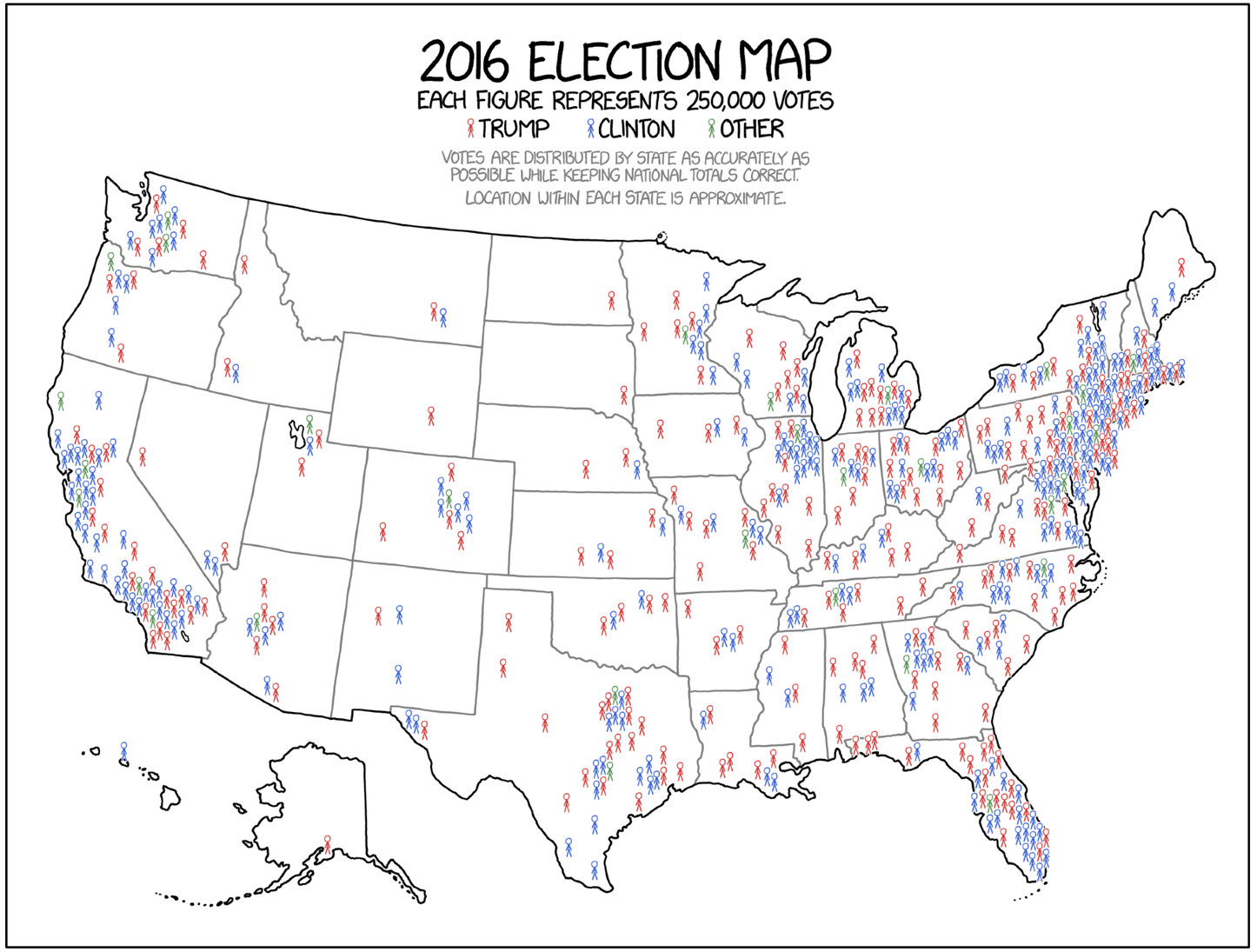
[M. Ericson, New York Times]

Dasymetric Dot Density



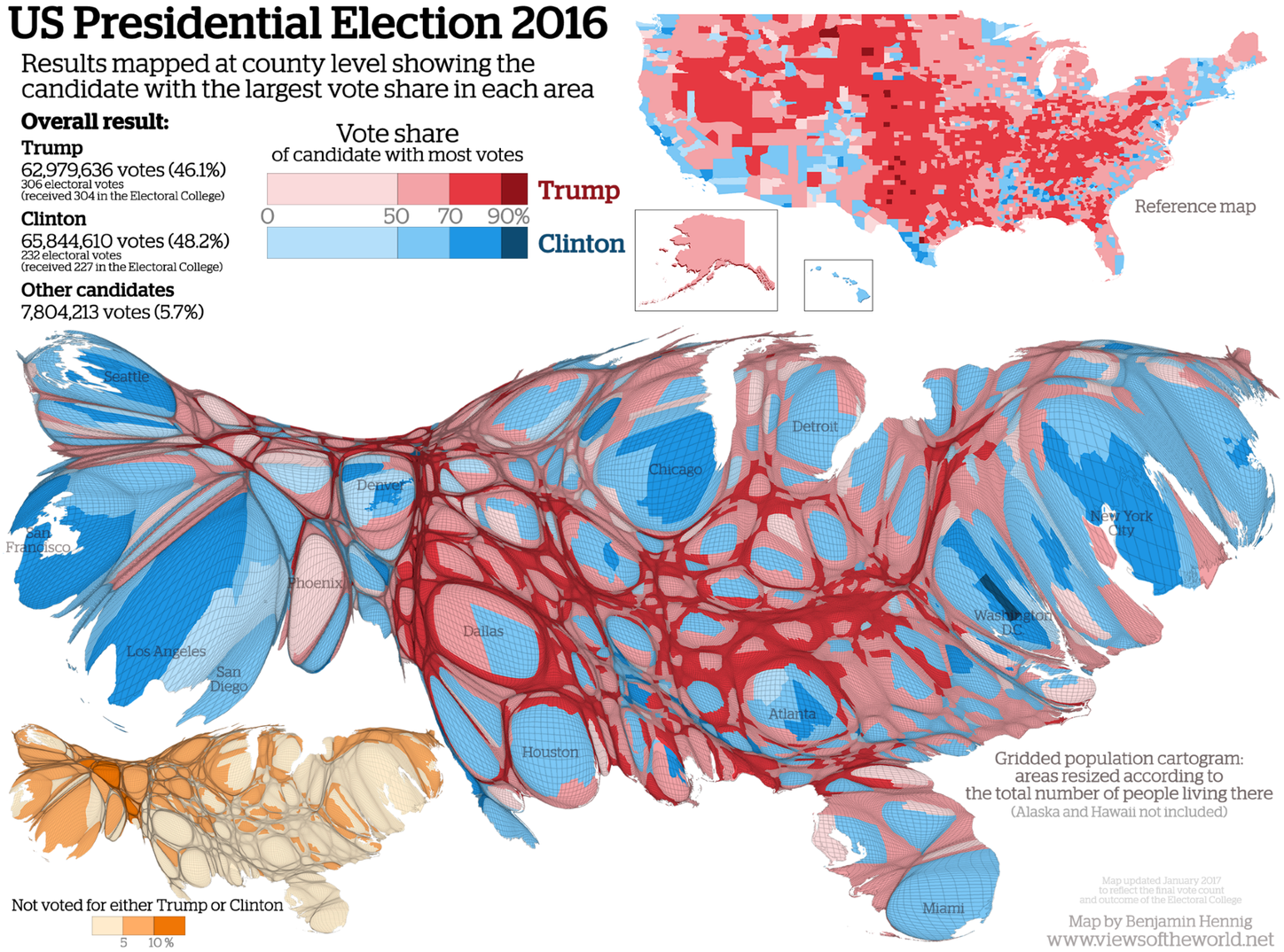
[K. Field]

Glyphs: xkcd's Map



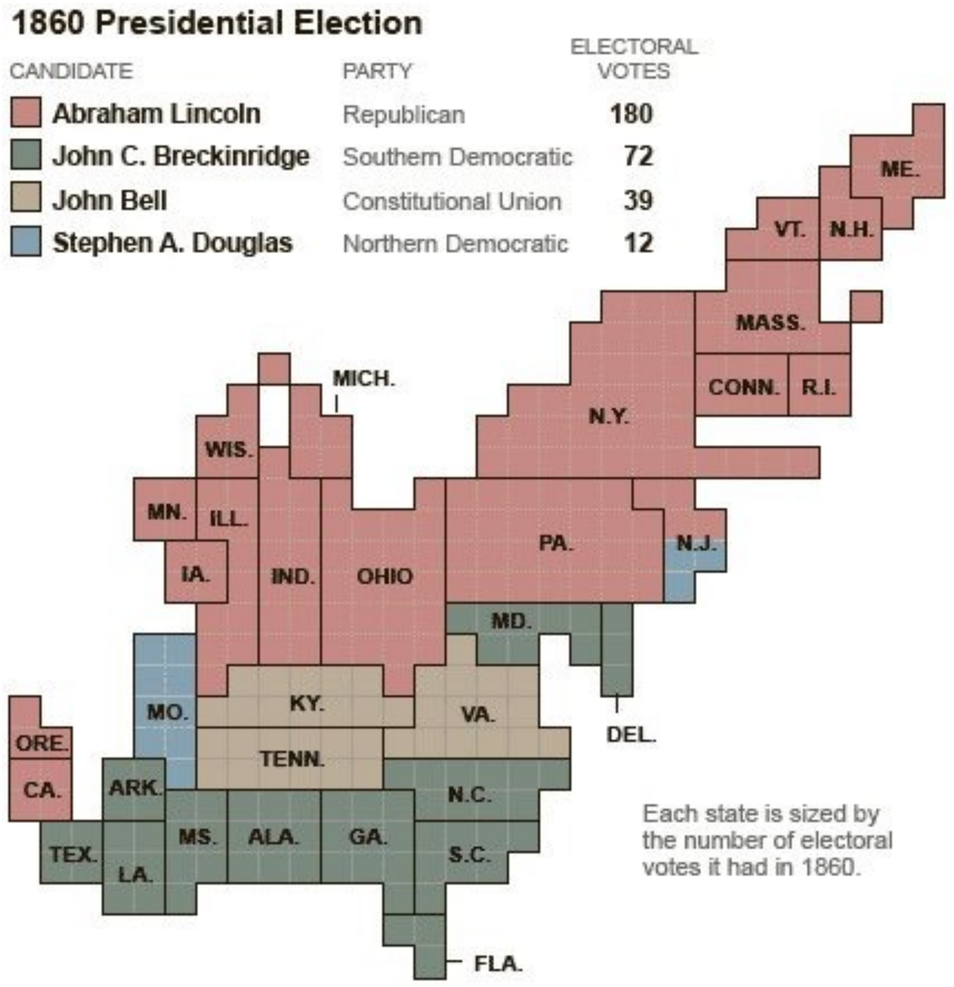
[xkcd]

Cartograms



[B. Hennig]

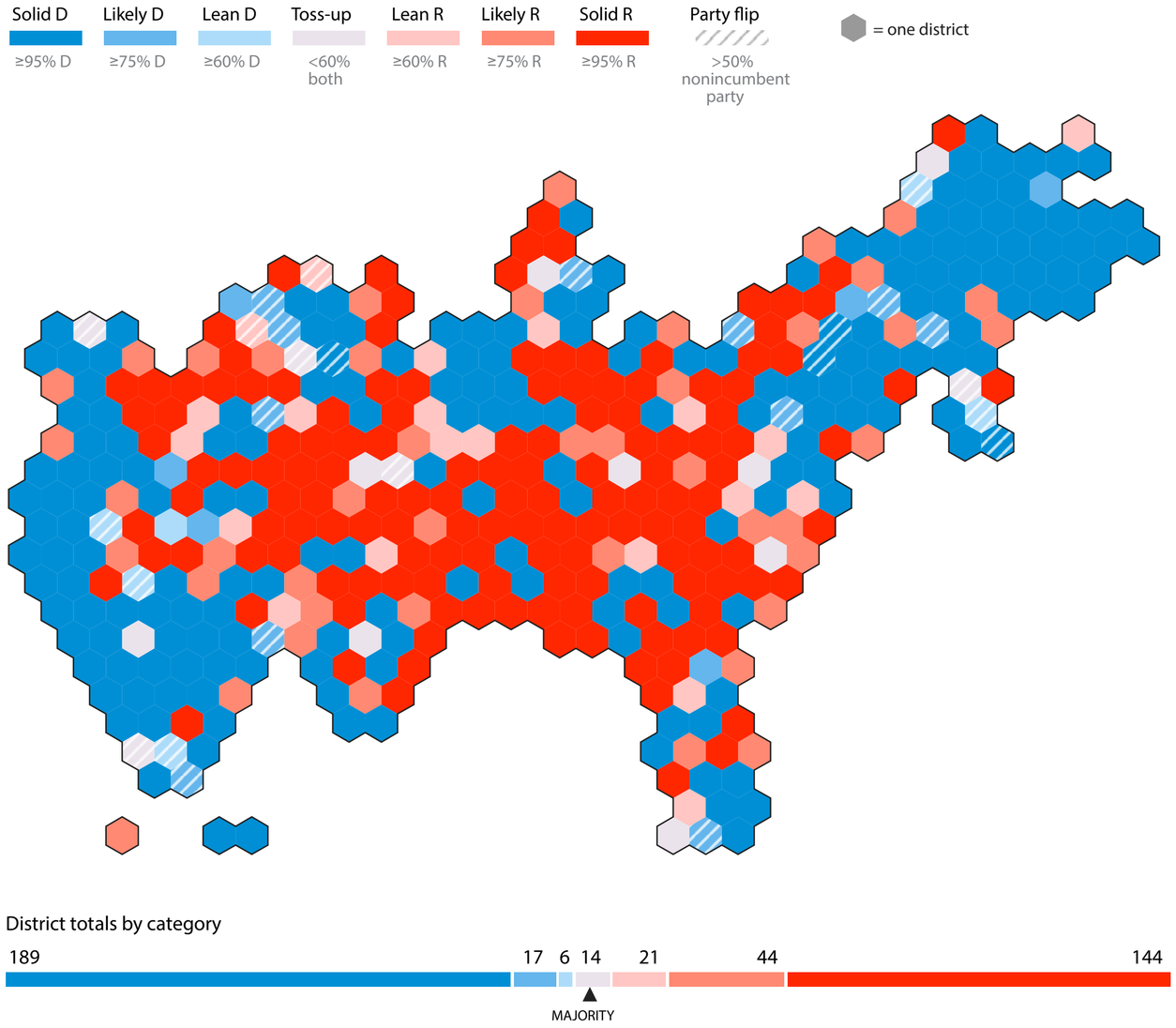
Cartograms



- Data: geographic geometry data & **two** quantitative attributes (one part-of-whole)
- Derived data: new geometry derived from the part-of-whole attribute
- Tasks: trends, comparisons, part-of-whole
- How: area marks from derived geometry, color hue/saturation/luminance
- Scalability: thousands of regions
- Design choices:
  - Colormap
  - Geometric deformation

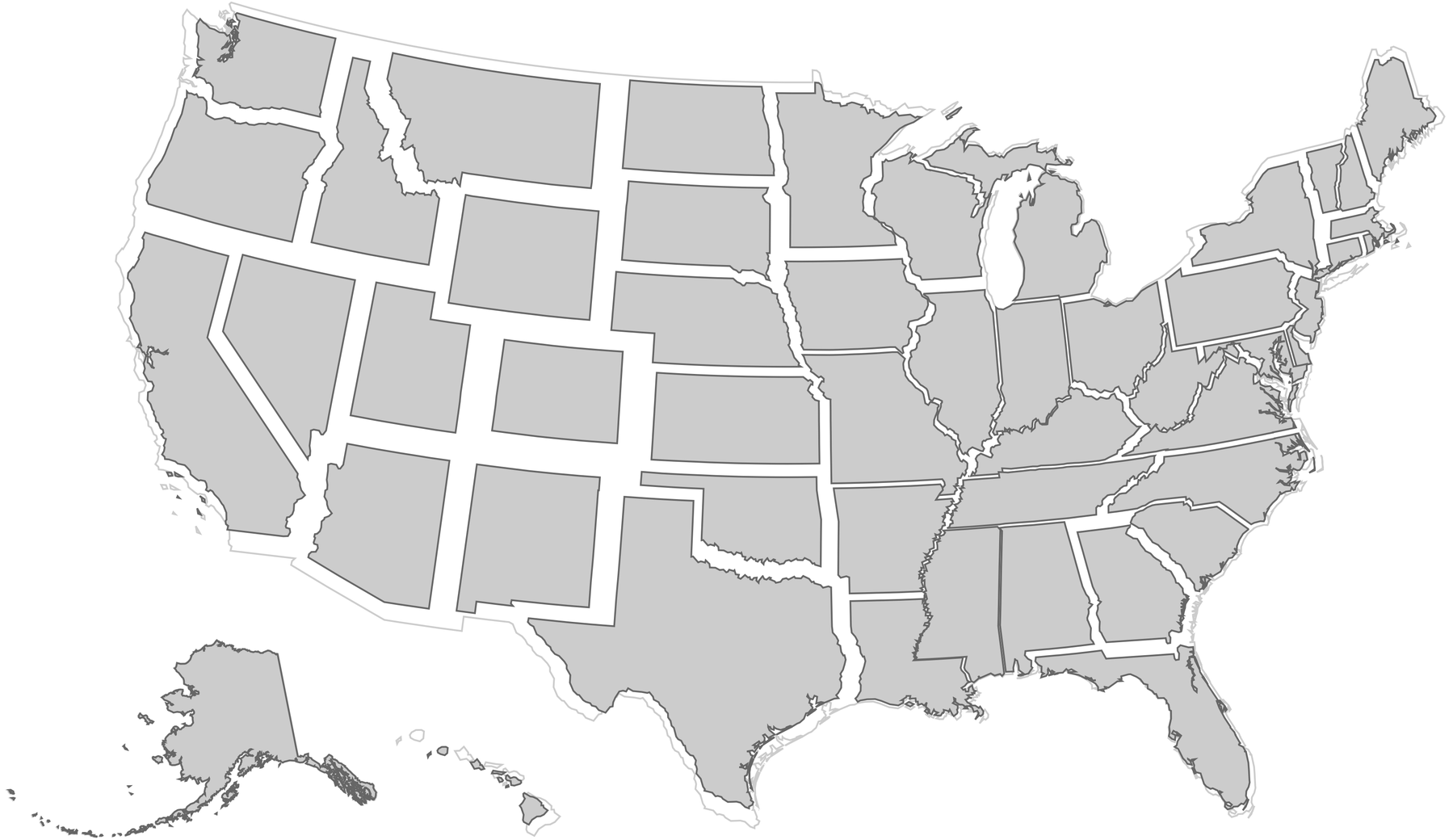
[New York Times]

Hexagonal Cartogram



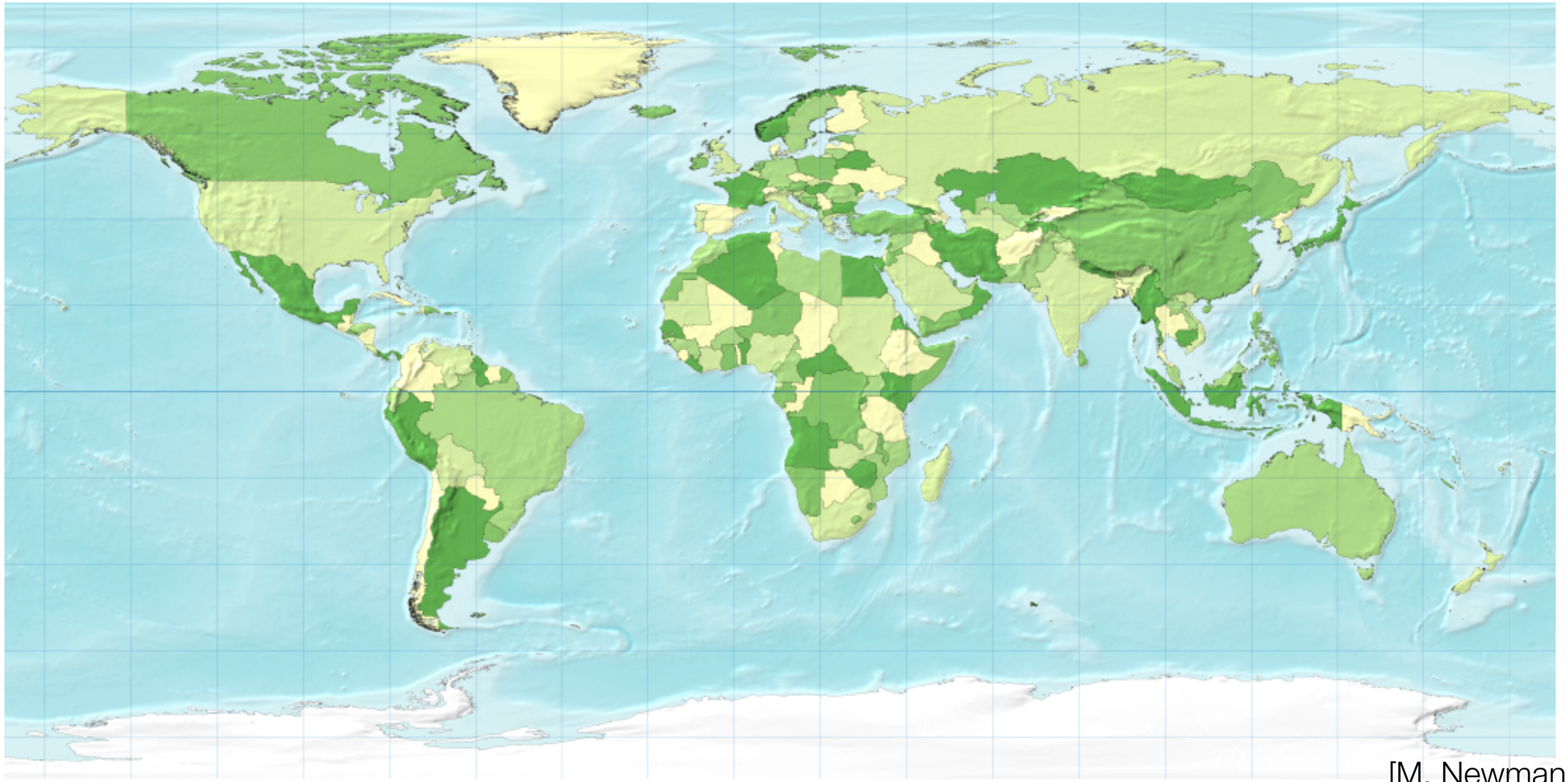
[FiveThirtyEight, 2018]

Non-Contiguous Cartogram



[M. Bostock, 2012]

World Cartograms

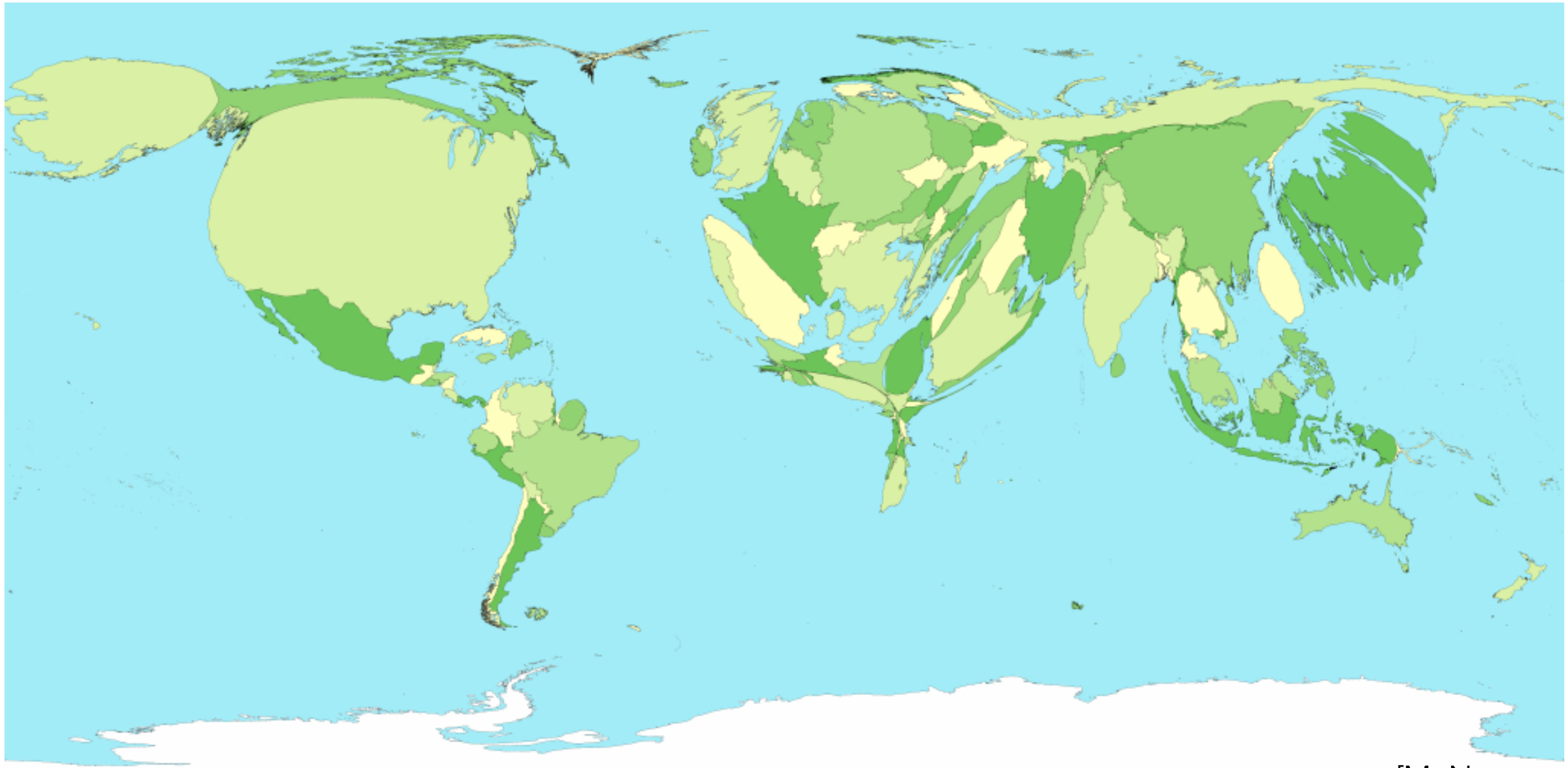


[M. Newman, 2009]

World Population

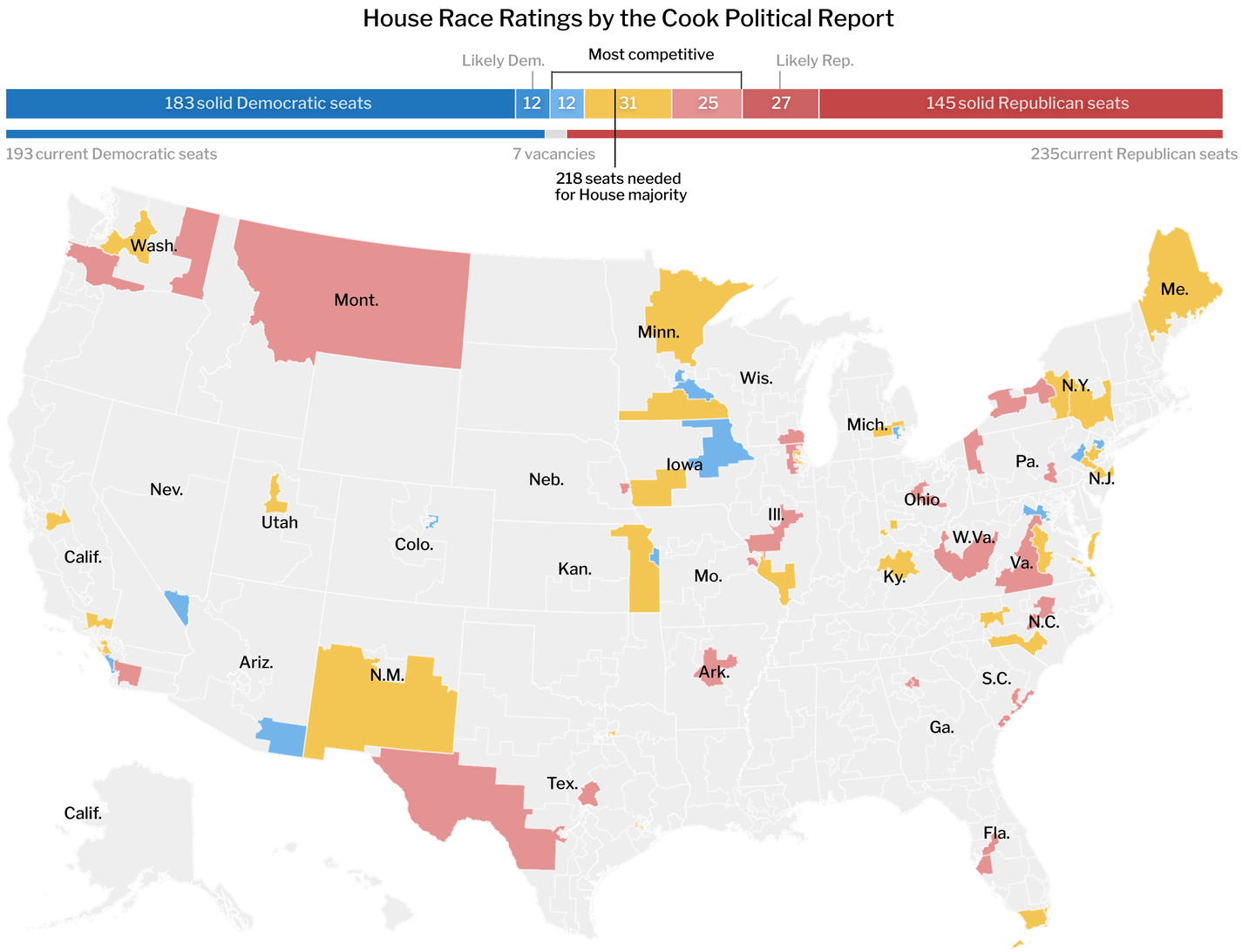
[M. Newman, 2009]

World Energy Consumption



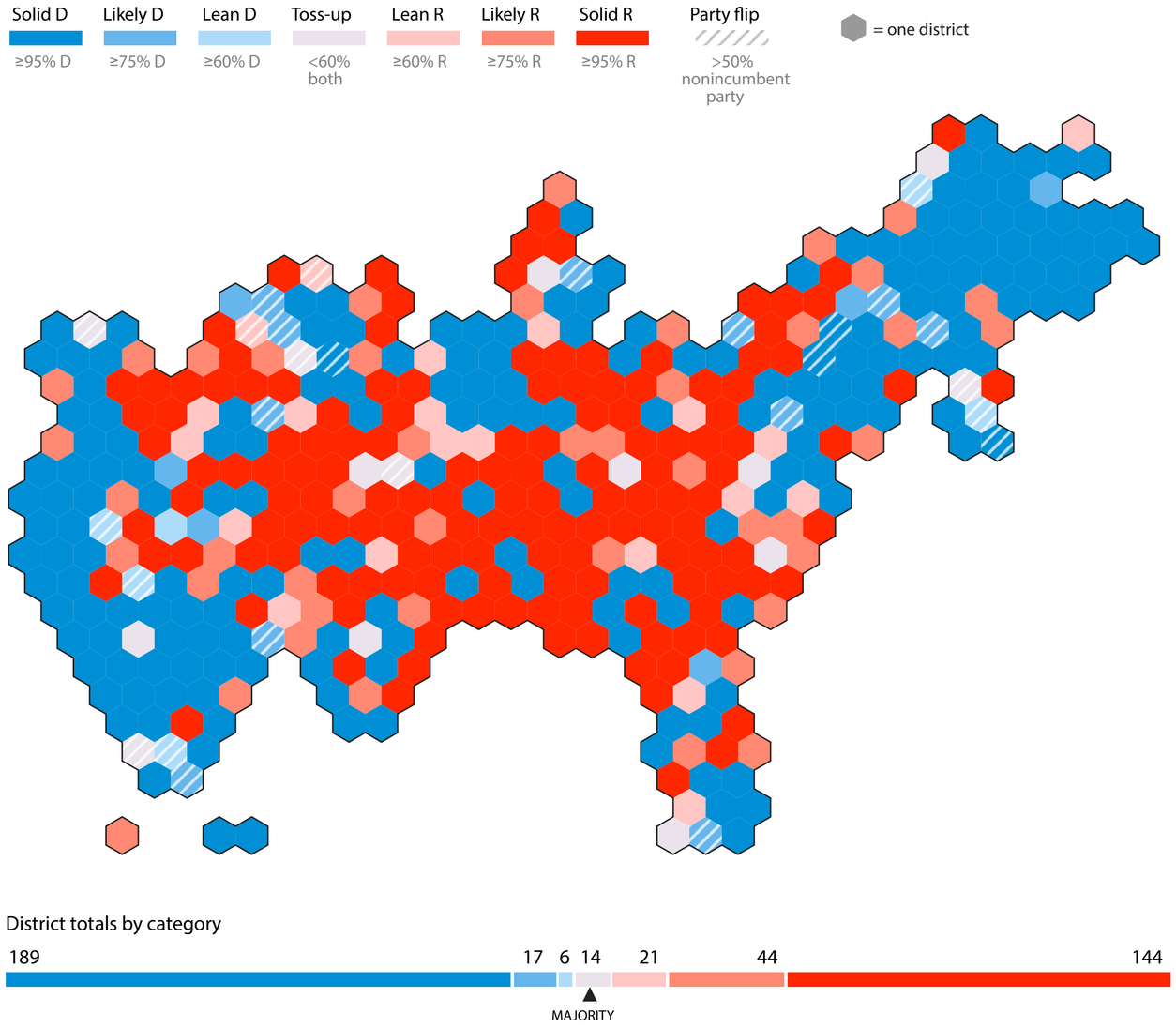
[M. Newman, 2009]

House Races: Map?



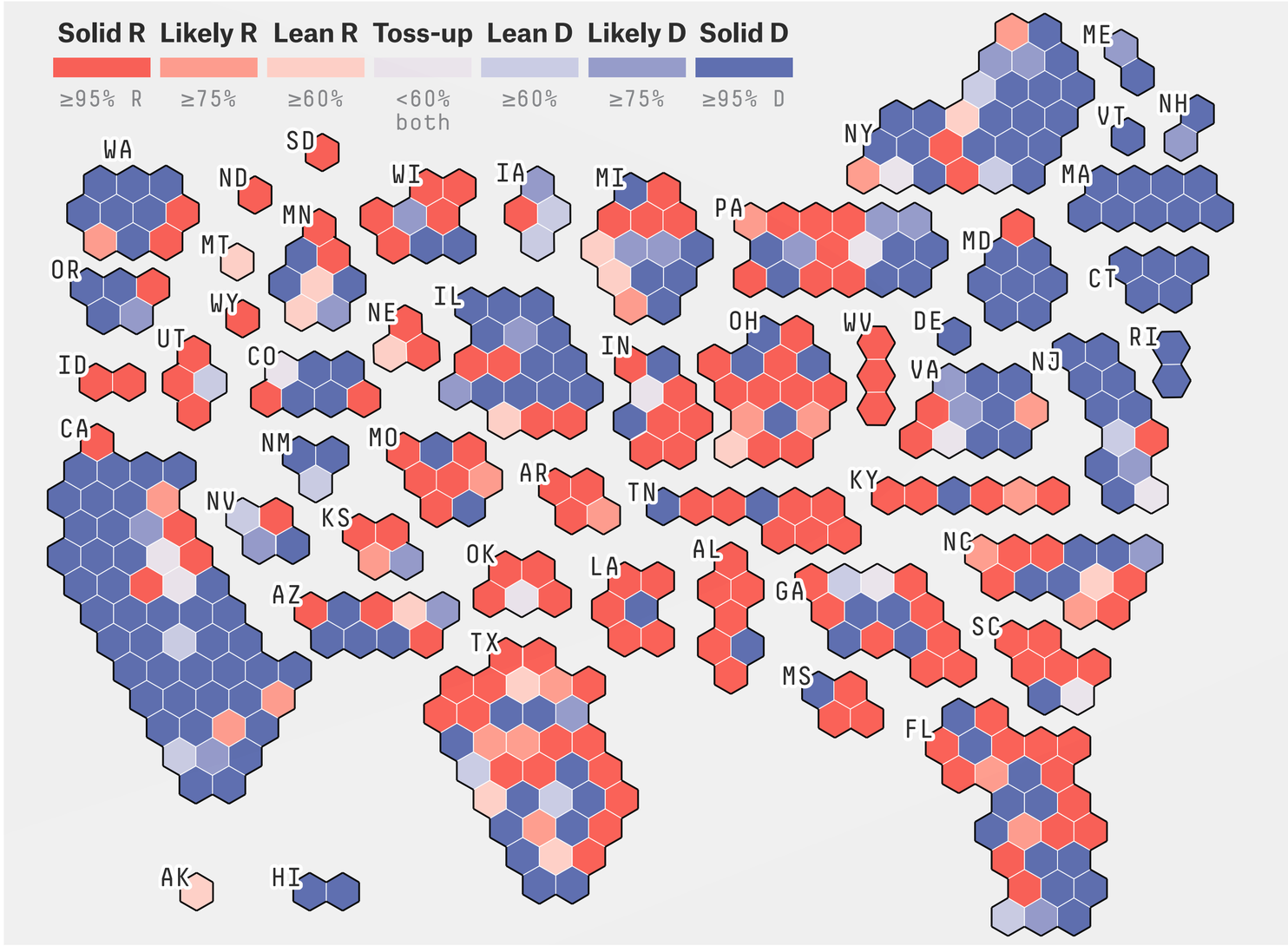
[New York Times, 2018]

House Races: Cartogram?



[FiveThirtyEight, 2018]

House Races: Non-Contiguous "Cartogram"



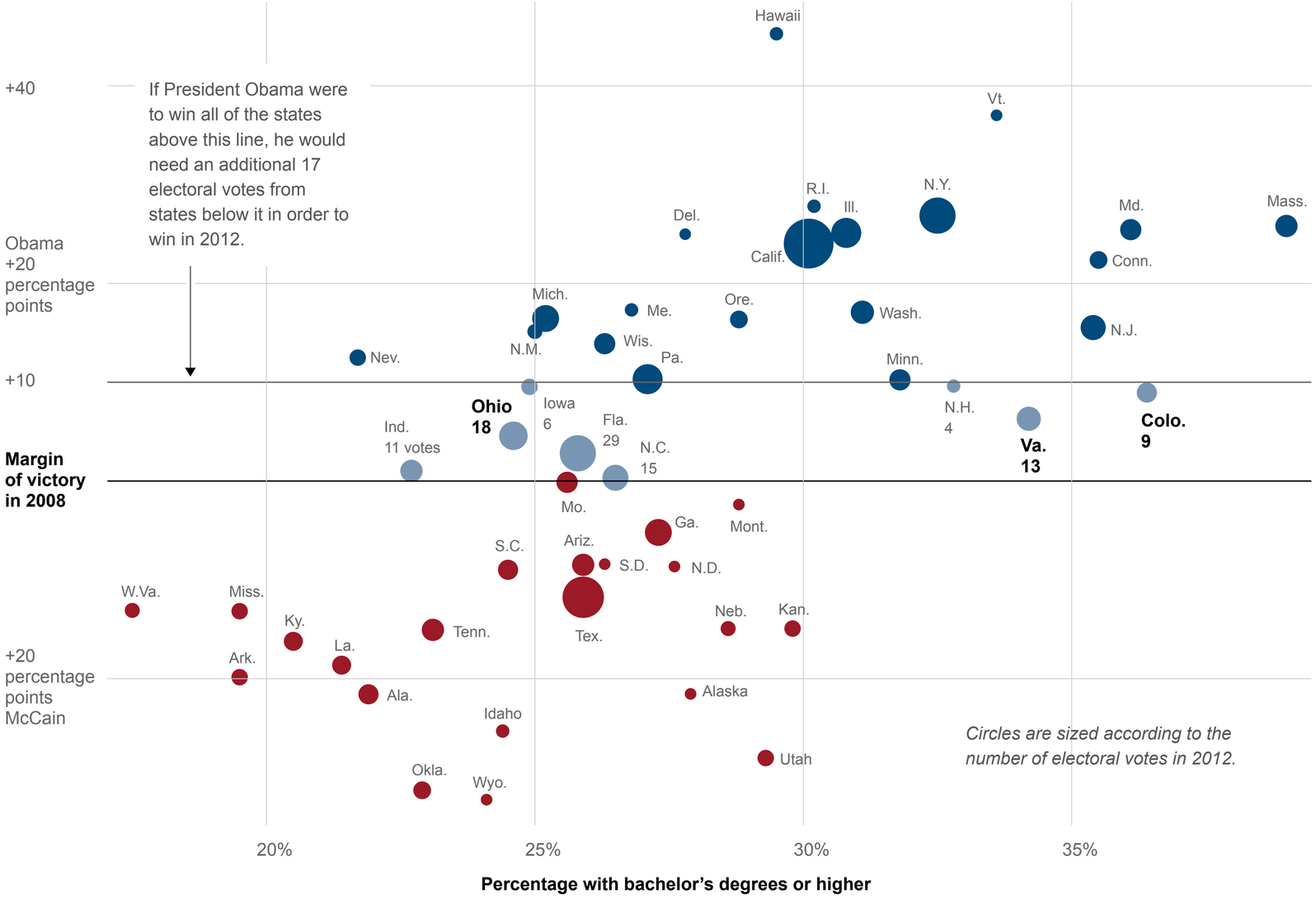
[FiveThirtyEight, 2020]

Maps Aren't Always Best: Close House Races

12 Lean Democratic		31 Tossups		25 Lean Republican	
AZ-02	Open (McSally)	CA-10	Denham	AR-02	Hill
CA-49	Open (Issa)	CA-25	Knight	CA-50	Hunter
CO-06	Coffman	CA-39	Open (Royce)	FL-15	Open (Ross)
IA-01	Blum	CA-45	Walters	FL-16	Buchanan
KS-03	Yoder	CA-48	Rohrabacher	GA-06	Handel
MI-11	Open (Trott)	FL-26	Curbelo	GA-07	Woodall
MN-02	Lewis	FL-27	Open (Ros-Lehtinen)	IL-13	Davis
MN-03	Paulsen	IL-06	Roskam	IL-14	Hultgren
NV-03	Open (Rosen)	IL-12	Bost	MO-02	Wagner
NJ-11	Open (Frelinghuysen)	IA-03	Young	MT-AL	Gianforte
PA-07	Vacant (formerly Dent)	KS-02	Open (Jenkins)	NE-02	Bacon
VA-10	Comstock	KY-06	Barr	NY-24	Katko

[New York Times, 2018]

Maps Aren't Always Best: Obama Targets



[NYTimes]