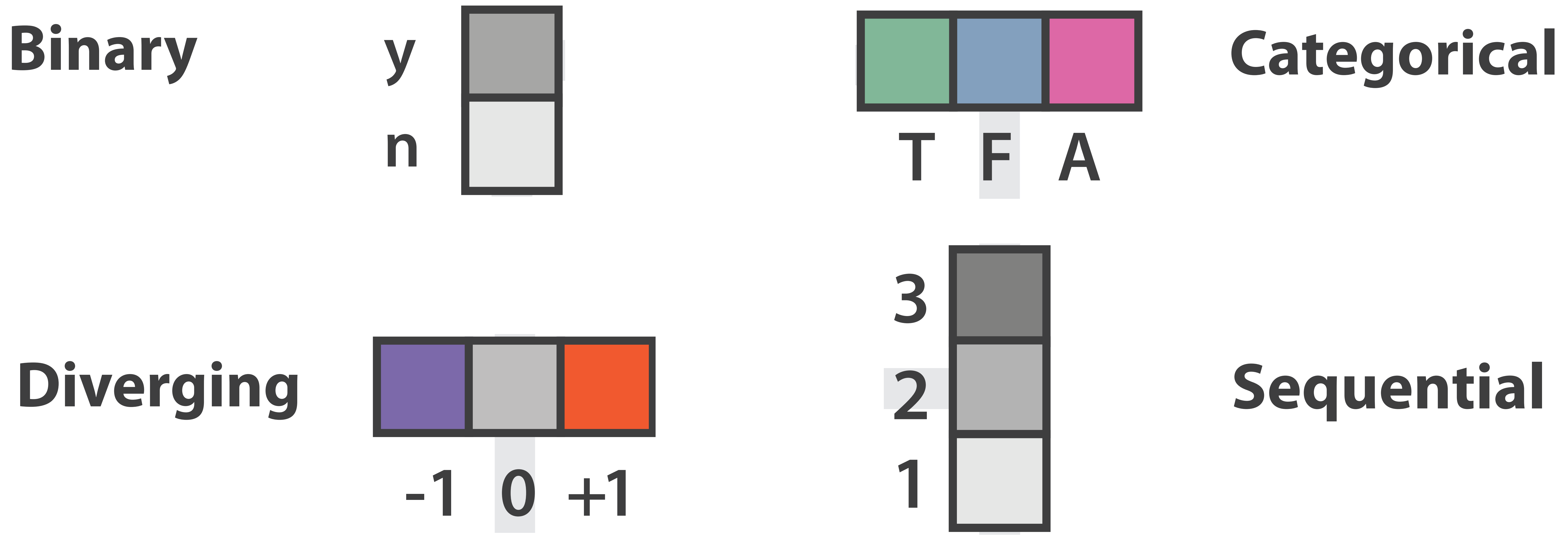
Data Visualization (CSCI 627/490)

Geospatial Data

Dr. David Koop

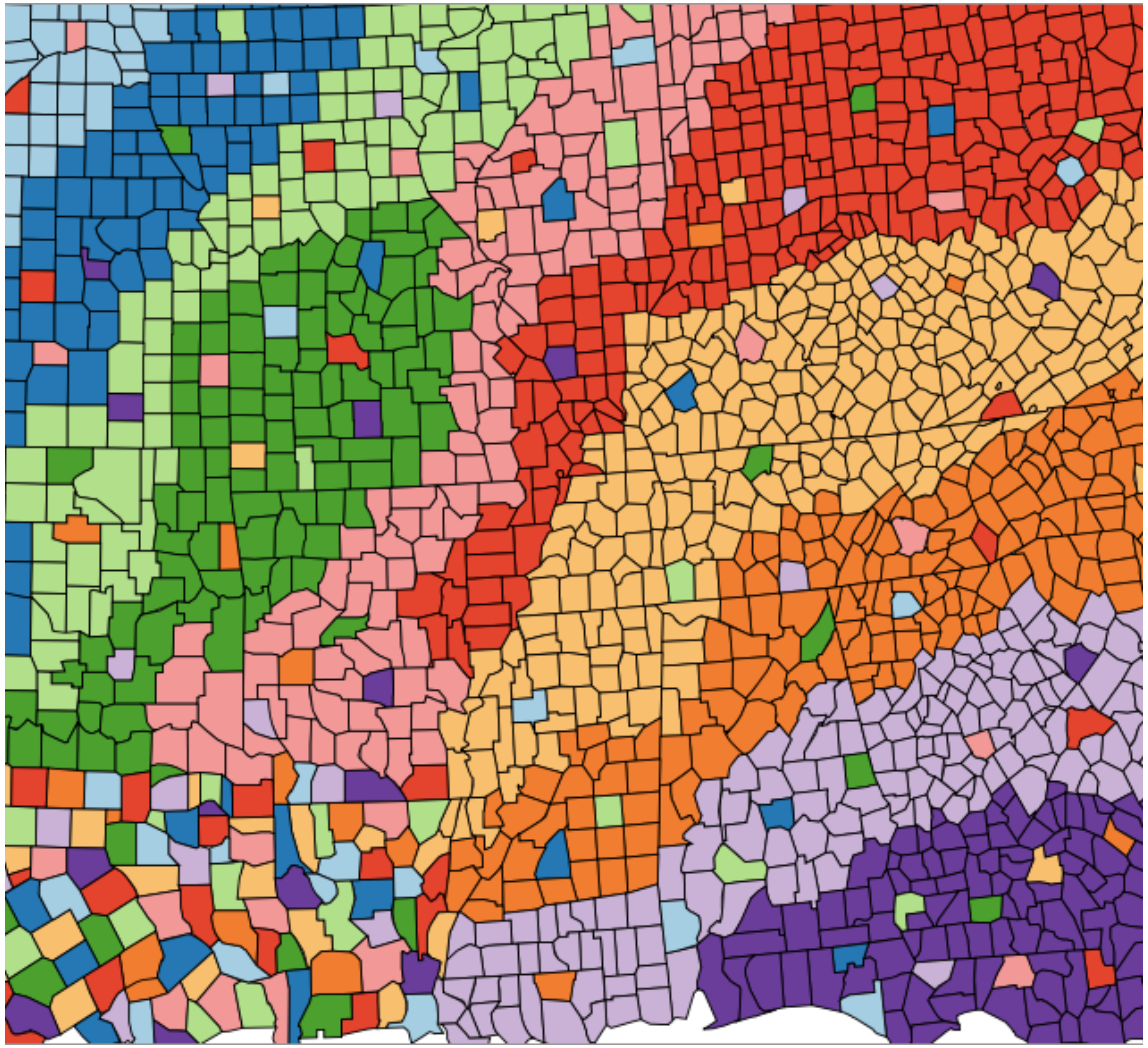
Colormap

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



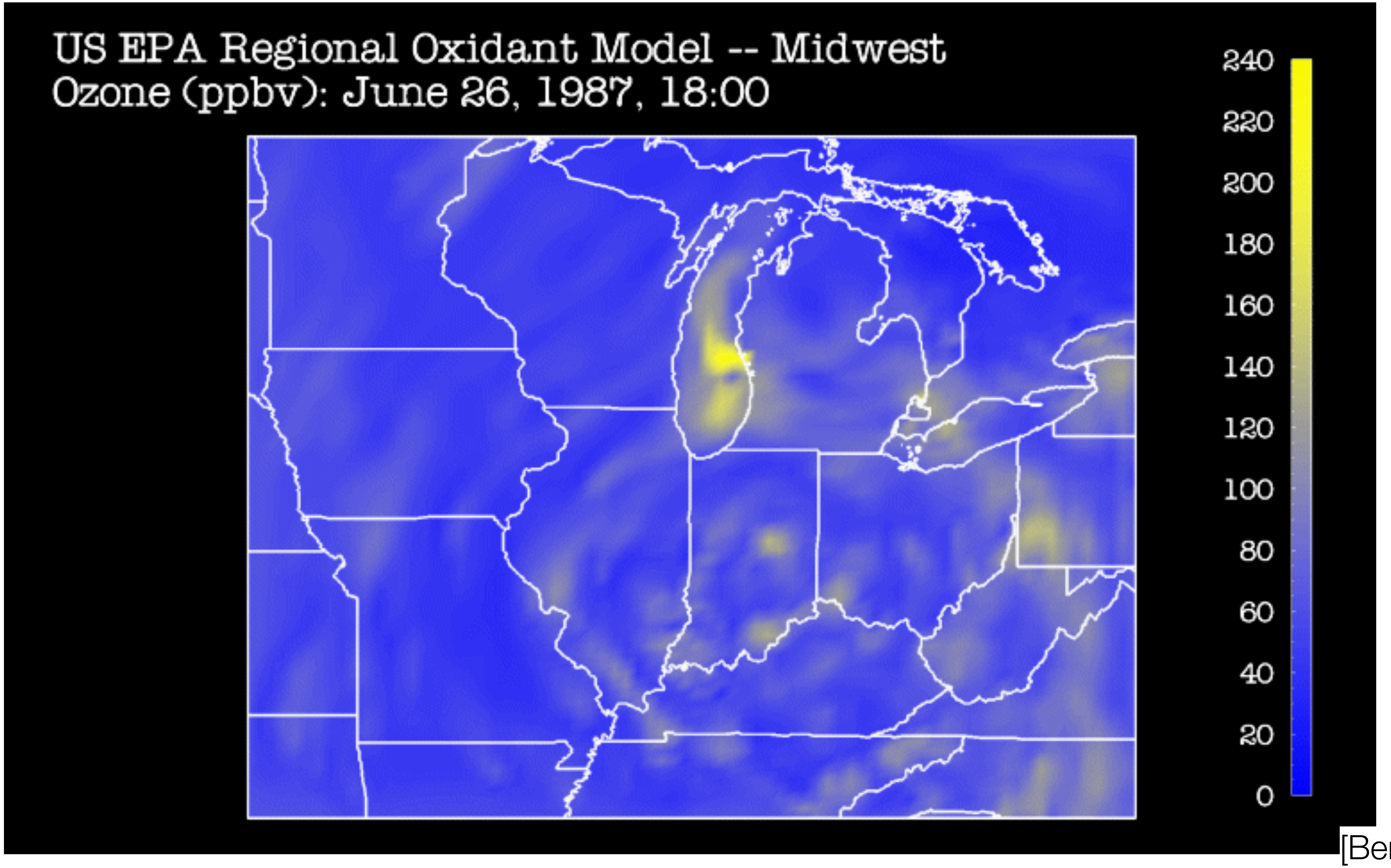
[Munzner (ill. Maguire), 2014]

Categorical Colormap Guidelines



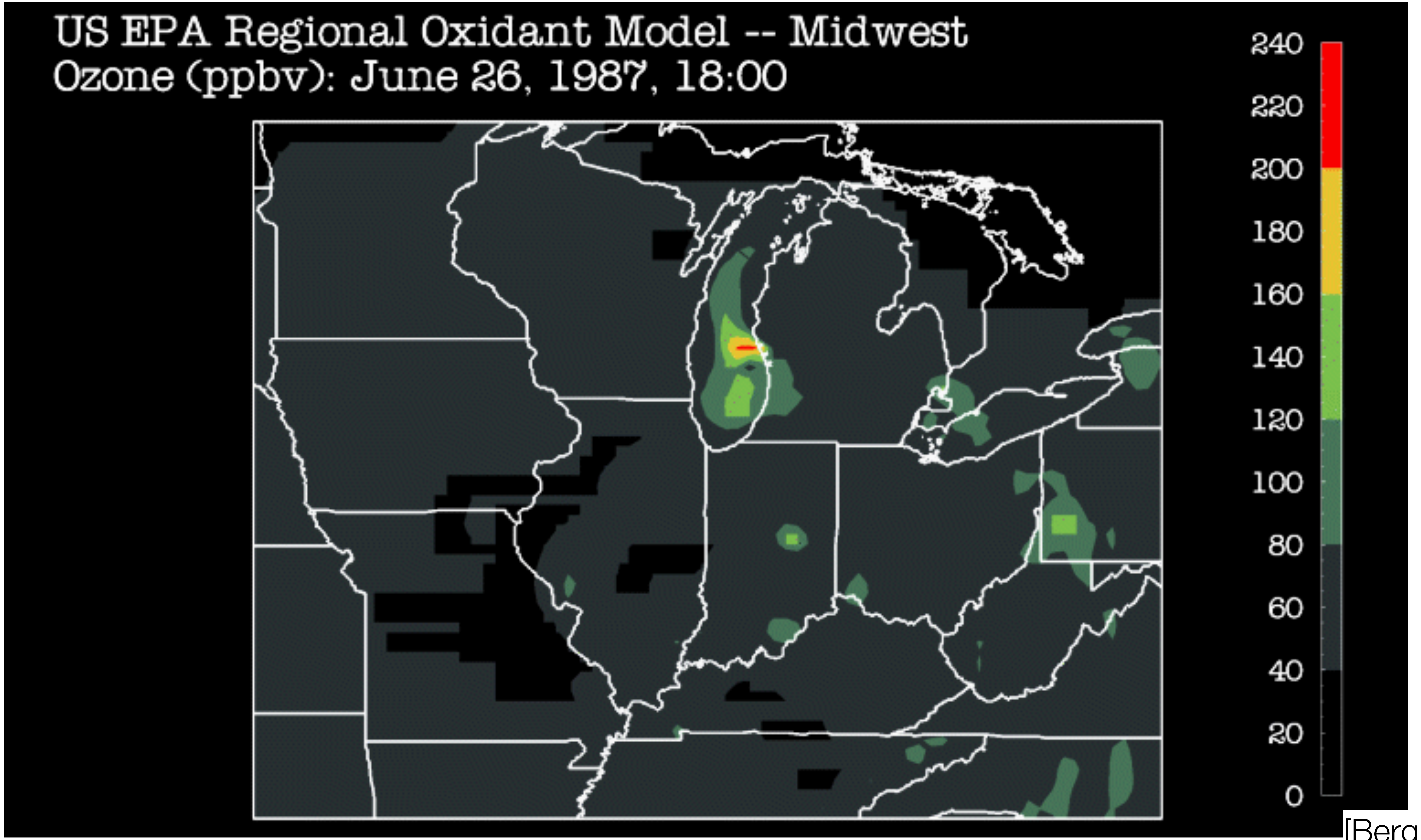
- Don't use too many colors (~12)
- Use other categories or create groups if you have too many values!
- Nameable colors help
- Be aware of luminance (e.g. difference between blue and yellow)
- Think about other marks you might wish to use in the visualization

Continuous Colormap for Ordered Data



[Bergman et al., 1995]

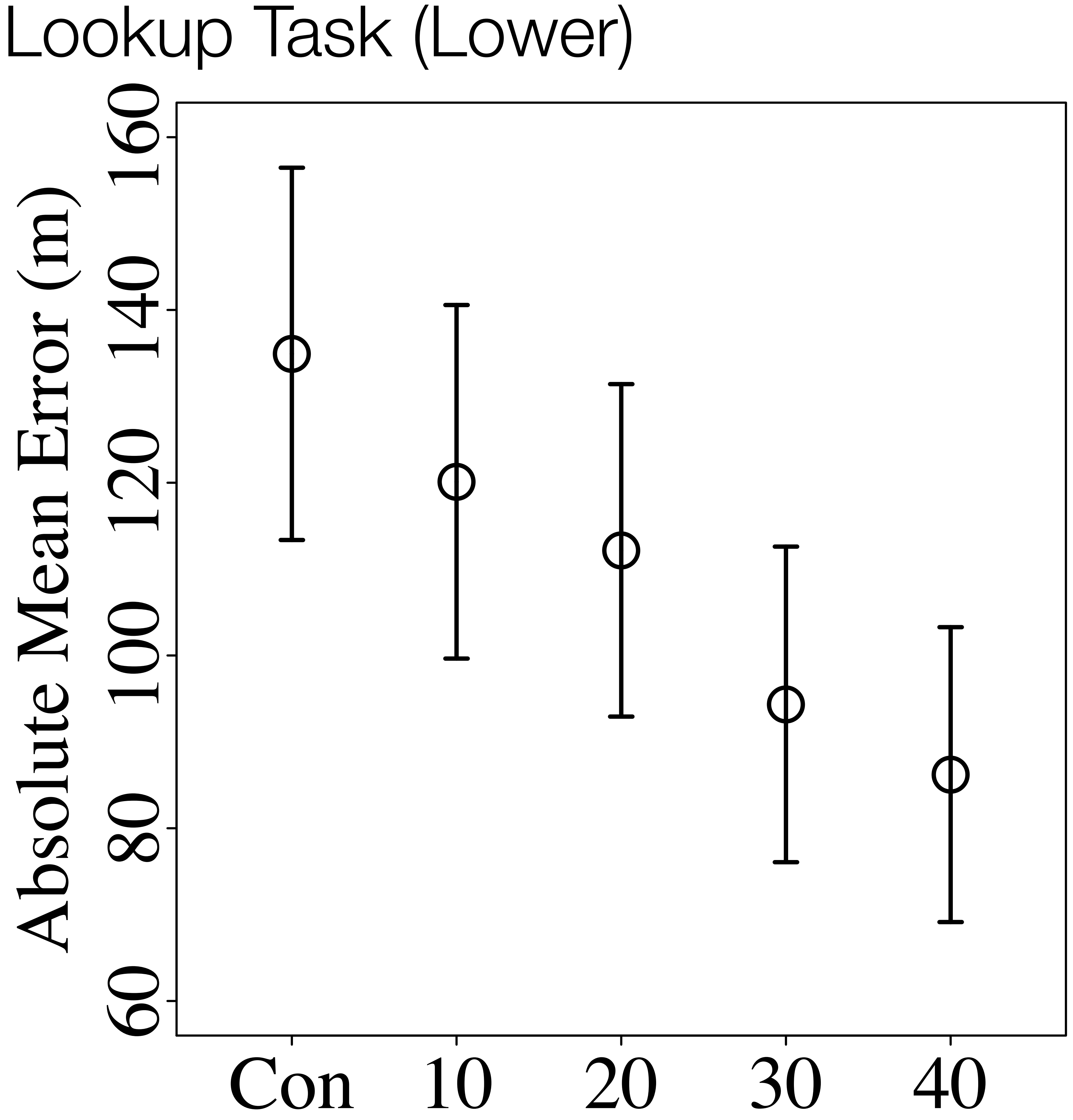
Segmented Colormap for Ordered Data



[Bergman et al., 1995]

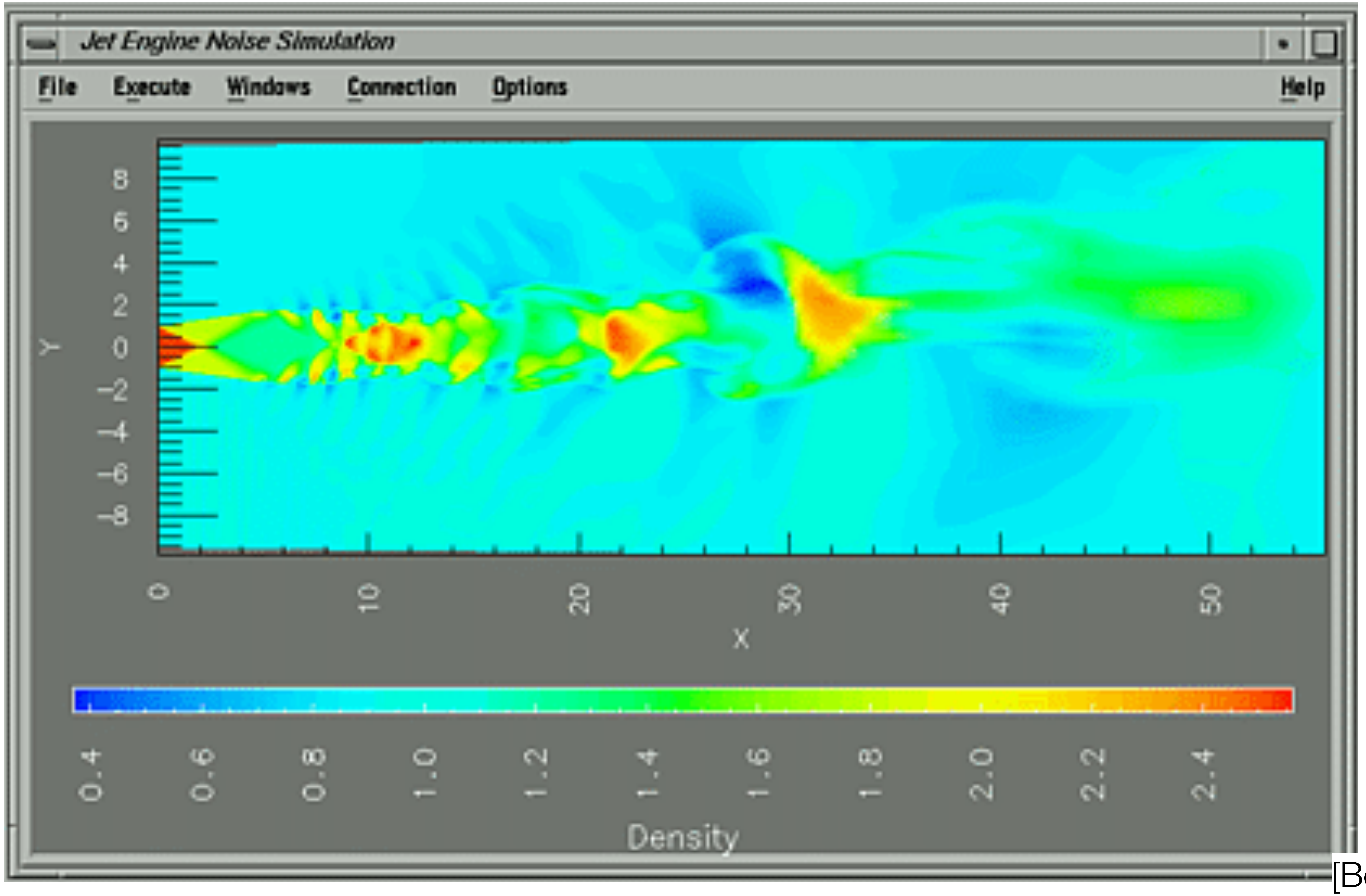
Continuous vs. Segmented Test Results

- "[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!



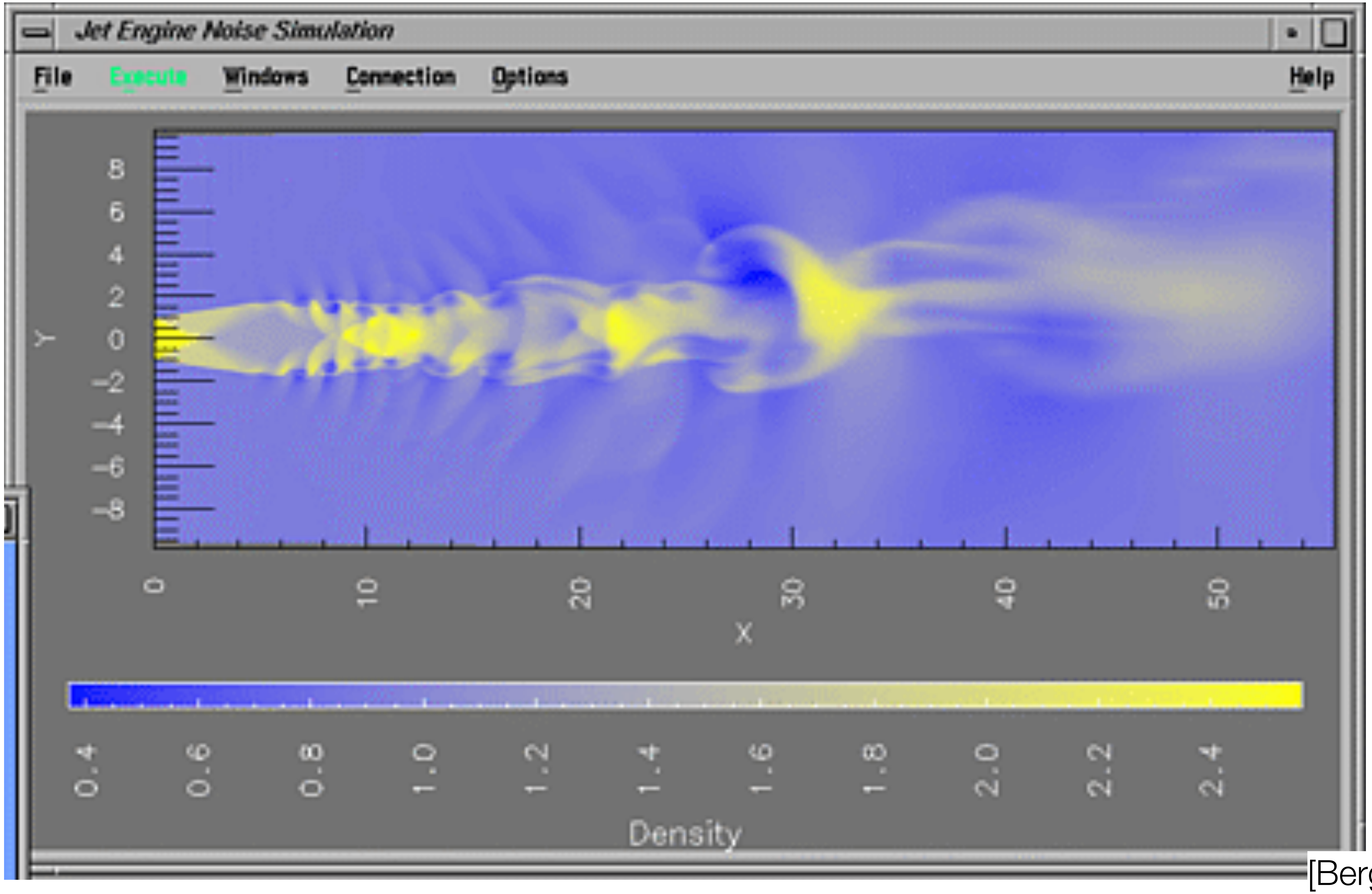
[Padilla et al., 2017]

Rainbow Colormap



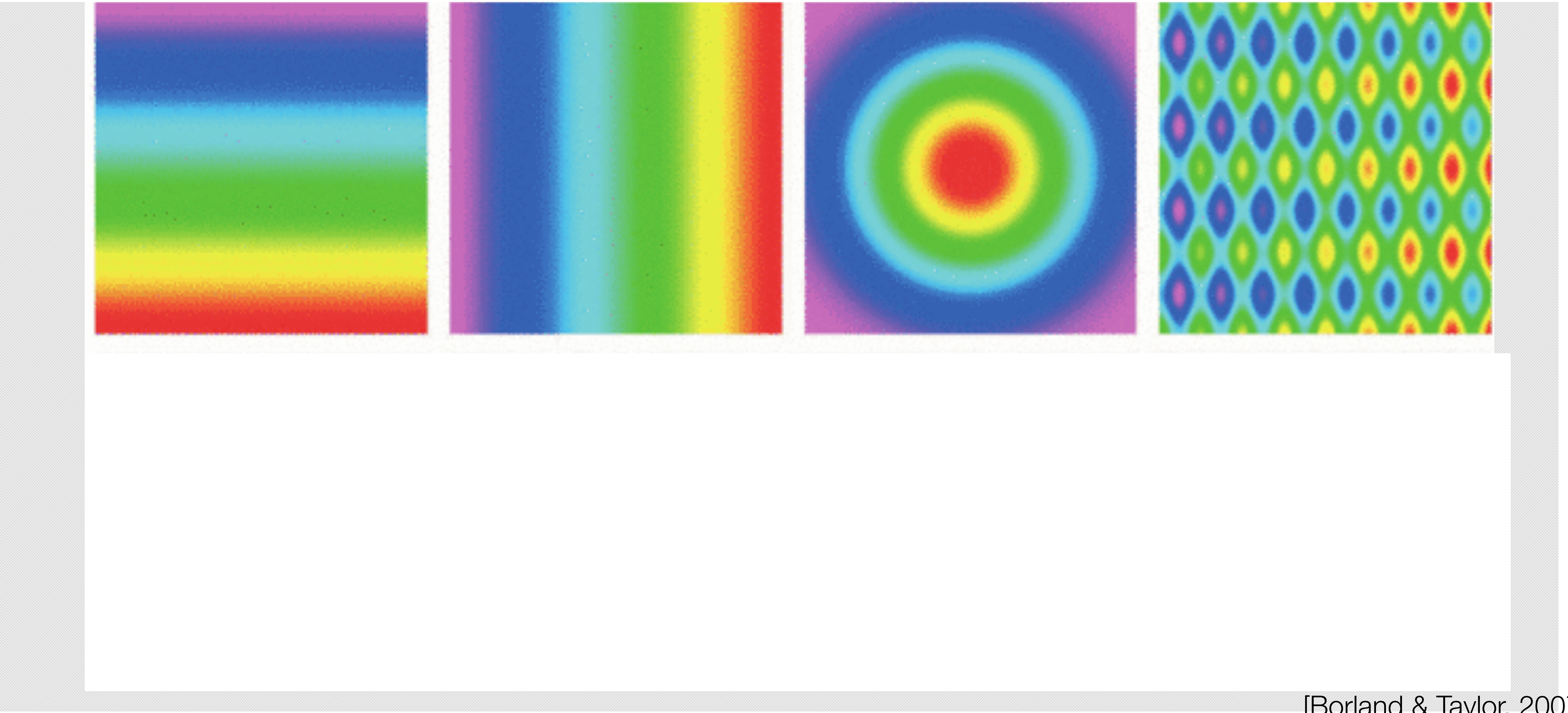
[Bergman et al., 1995]

Two-Hue Colormap



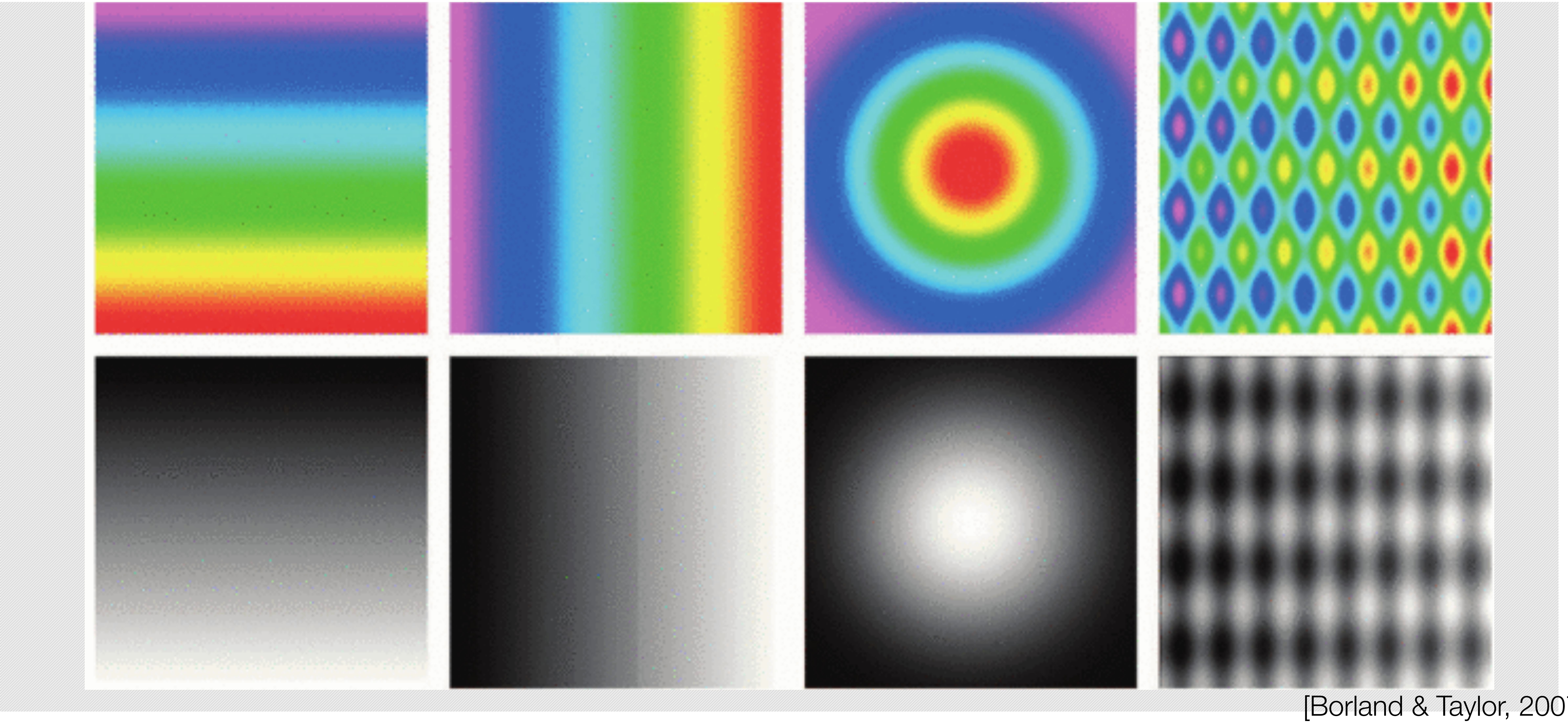
[Bergman et al., 1995]

Artifacts from Rainbow Colormaps



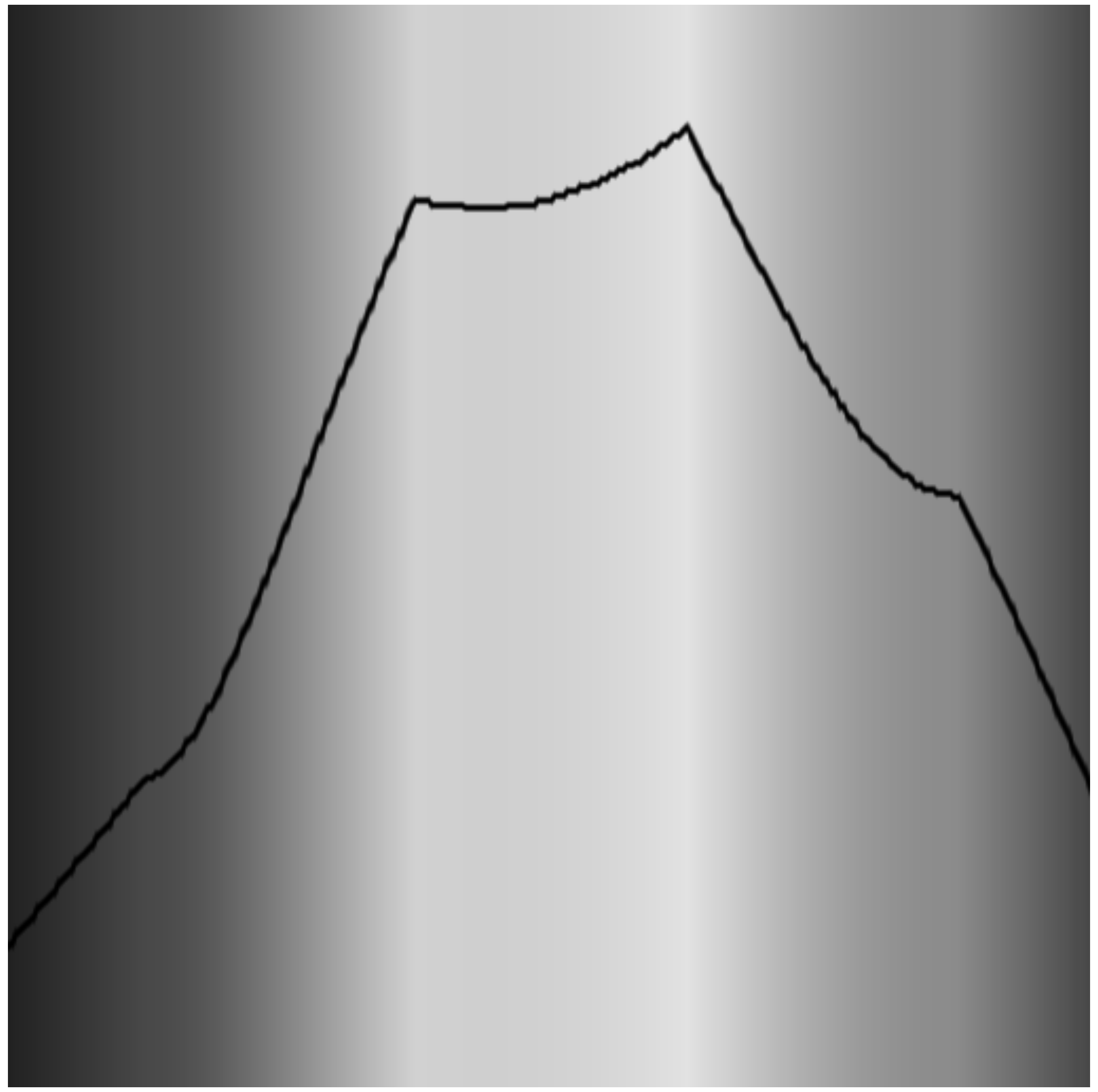
[Borland & Taylor, 2007]

Artifacts from Rainbow Colormaps

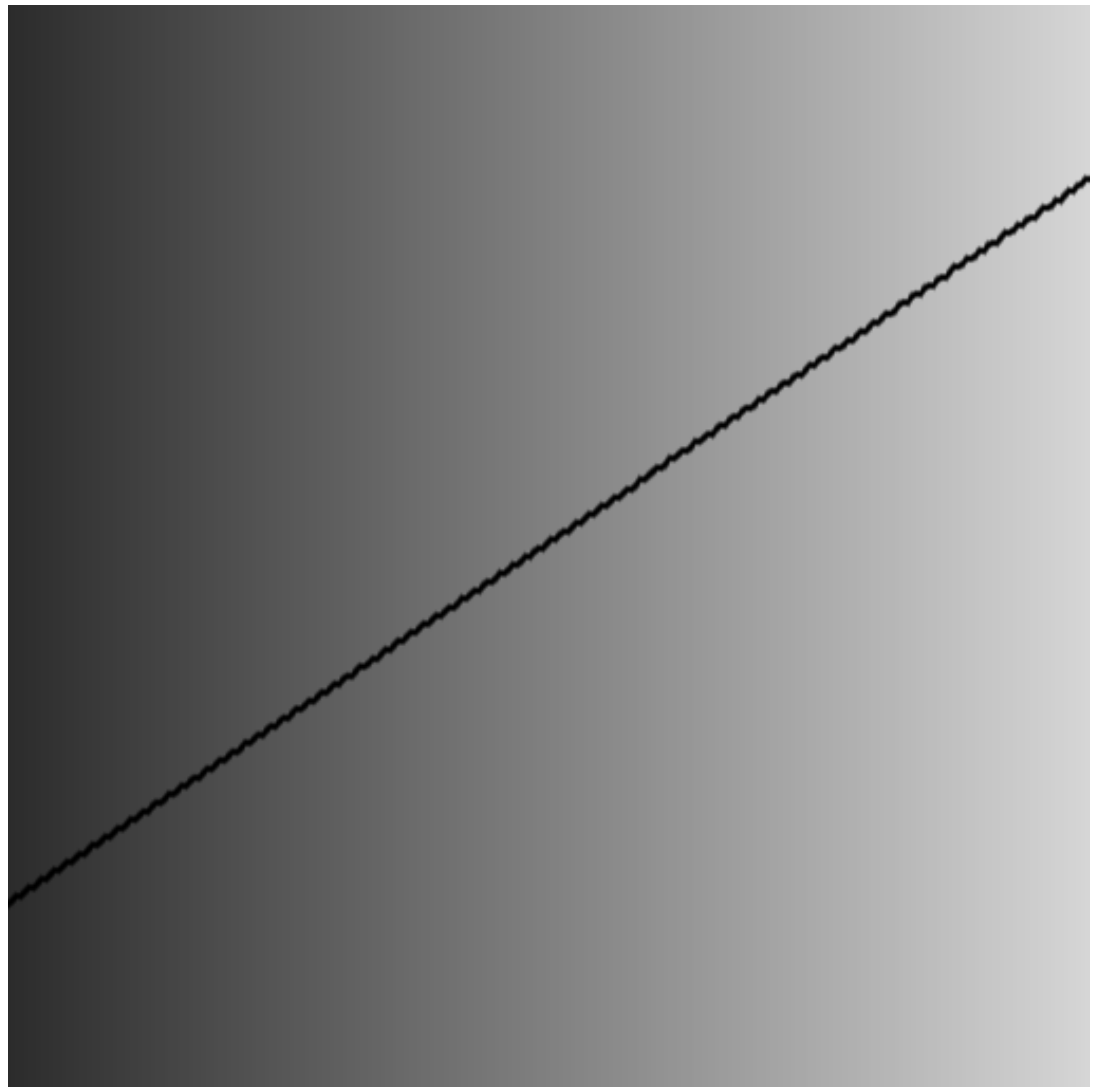


[Borland & Taylor, 2007]

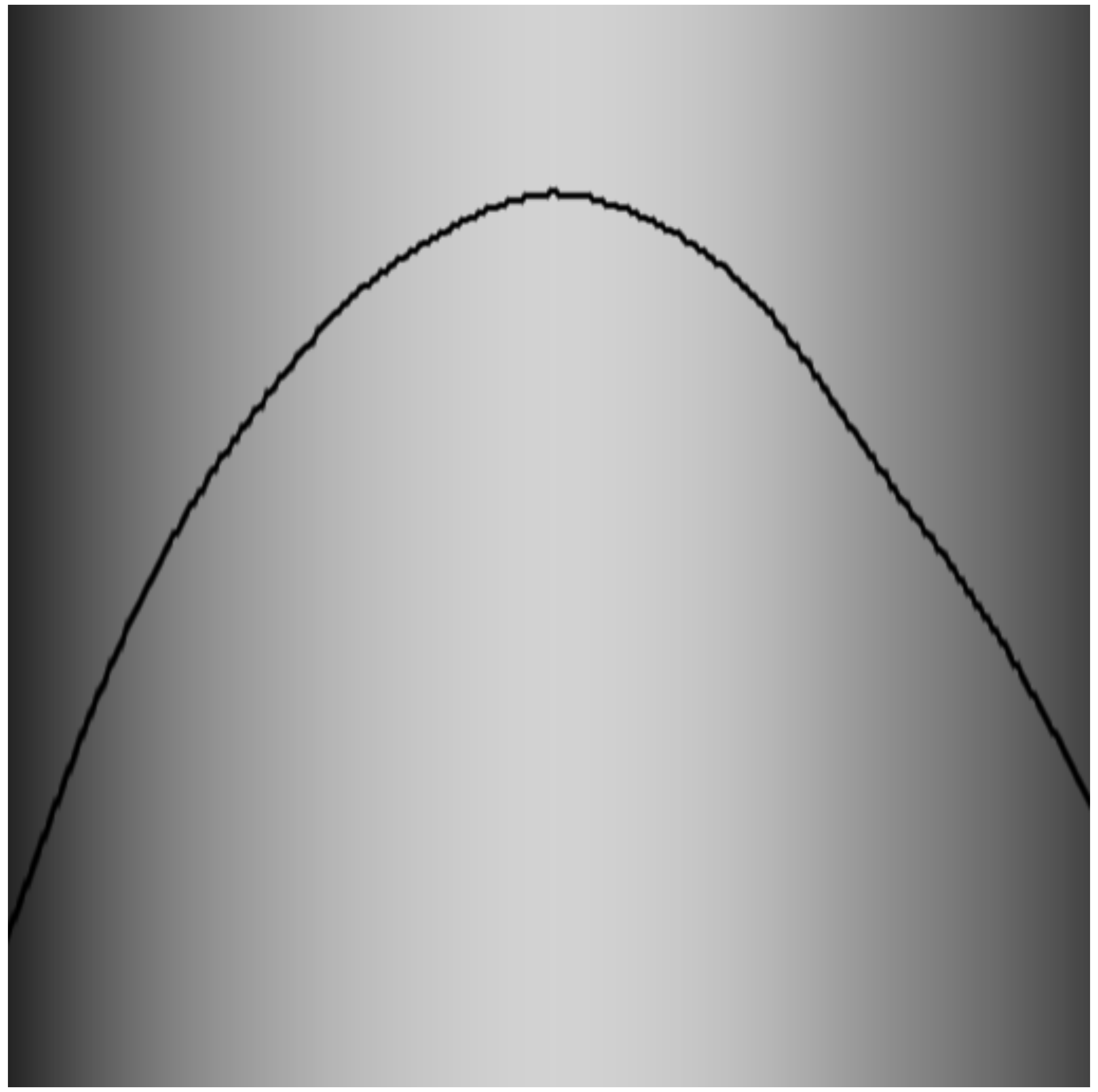
Turbo: Improving Rainbow Colormaps



Jet



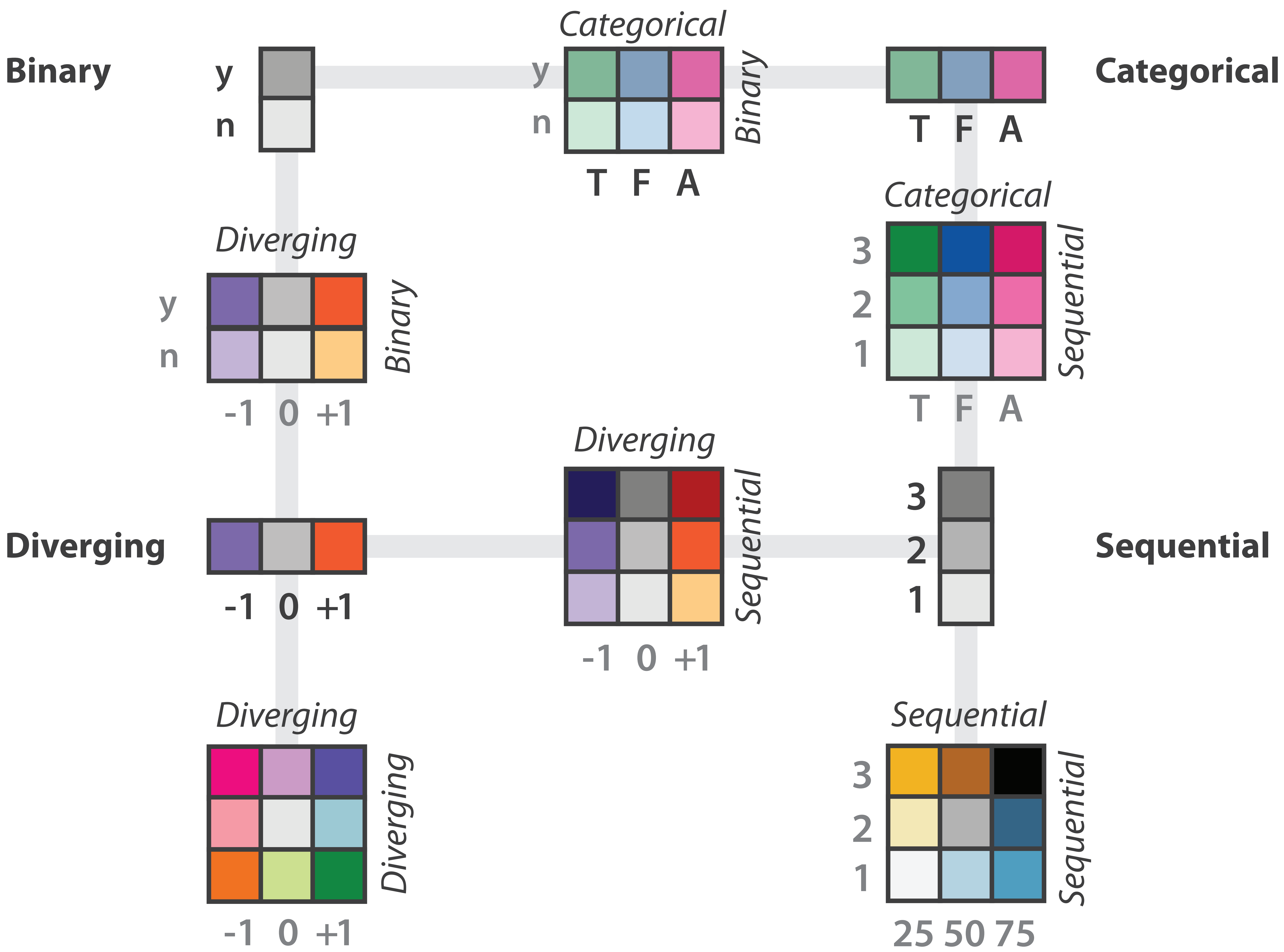
Viridis



Turbo

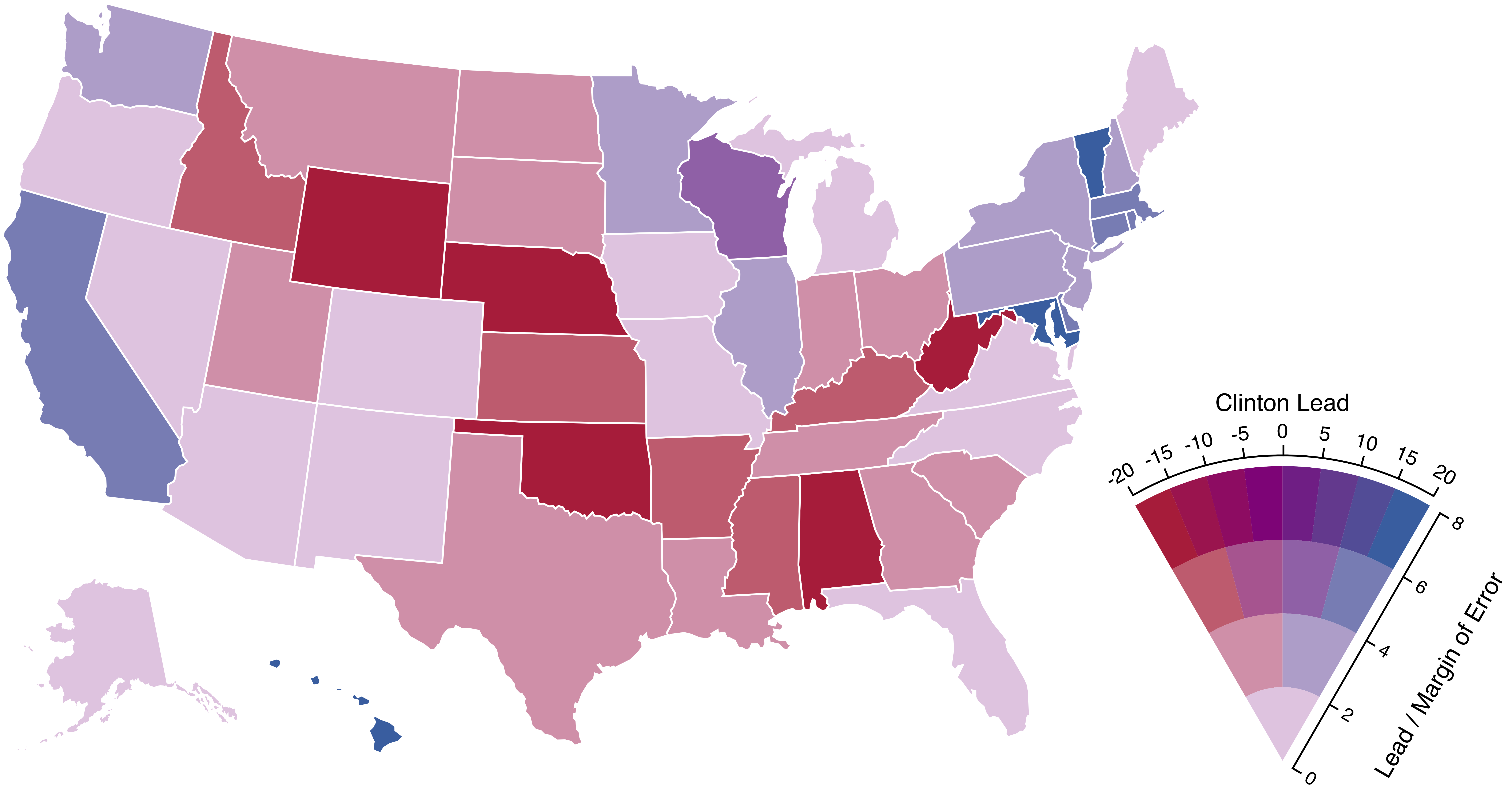
[A. Mikhailov]

Bivariate Colormaps



[Munzner (ill. Maguire), 2014]

Value-Suppressing Uncertainty Palette



[Correll et al., 2018]

Midterm

- Monday, October 23
- Covers material through this week
- Format:
  - In Person, Pen(-cil) & Paper
  - 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
  - Louisiana Home Rebuilding
  - New Mexico School Discipline
  - NFL Data
  - US Severe Storm Data
- Work on Proposal

Next Two Weeks

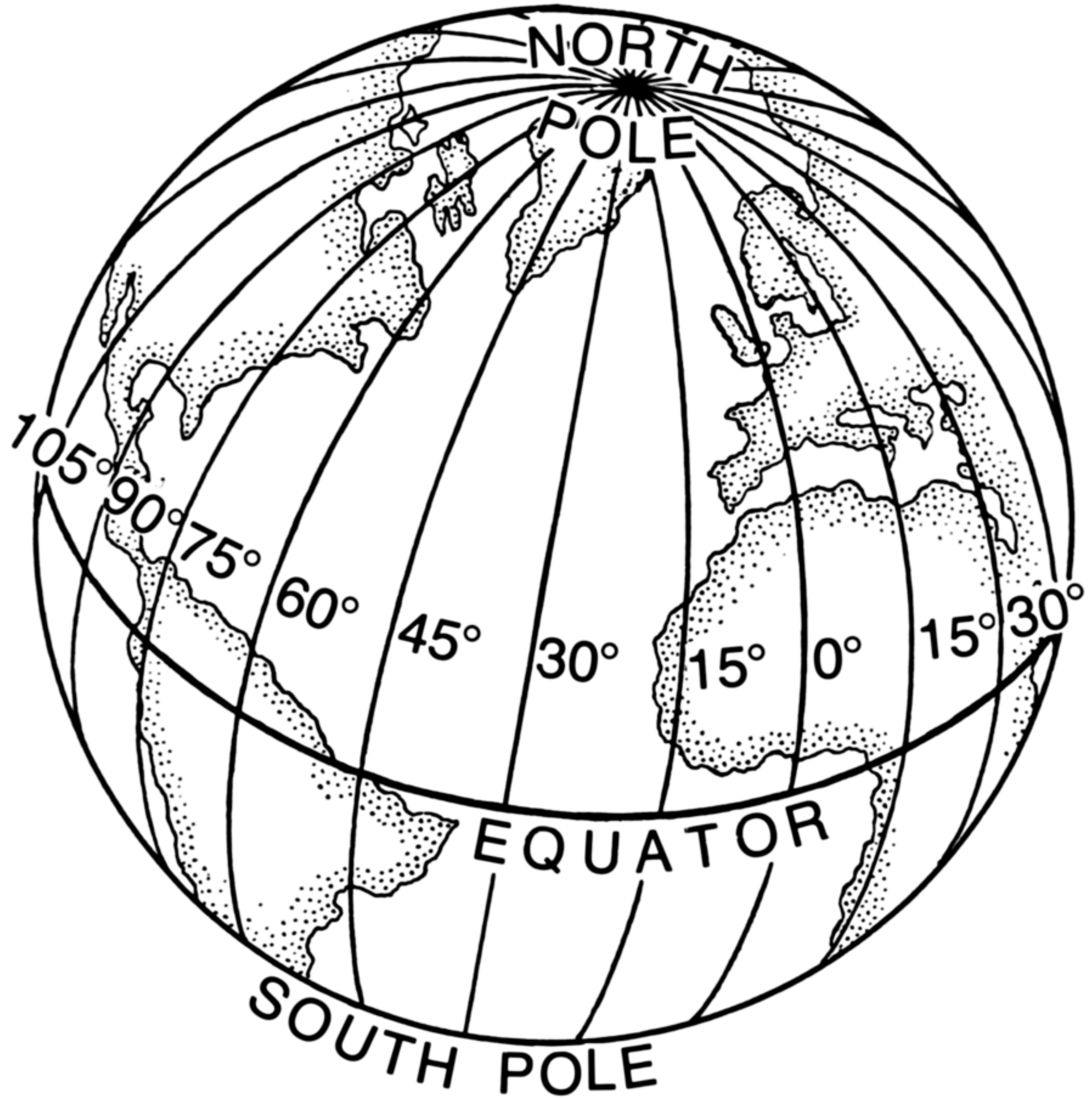
- Wednesday: No Lecture
- Monday, Oct. 23: Midterm Exam
- Wednesday, Oct. 25: Synchronous Zoom Lecture

Geospatial Data

Geographic Data

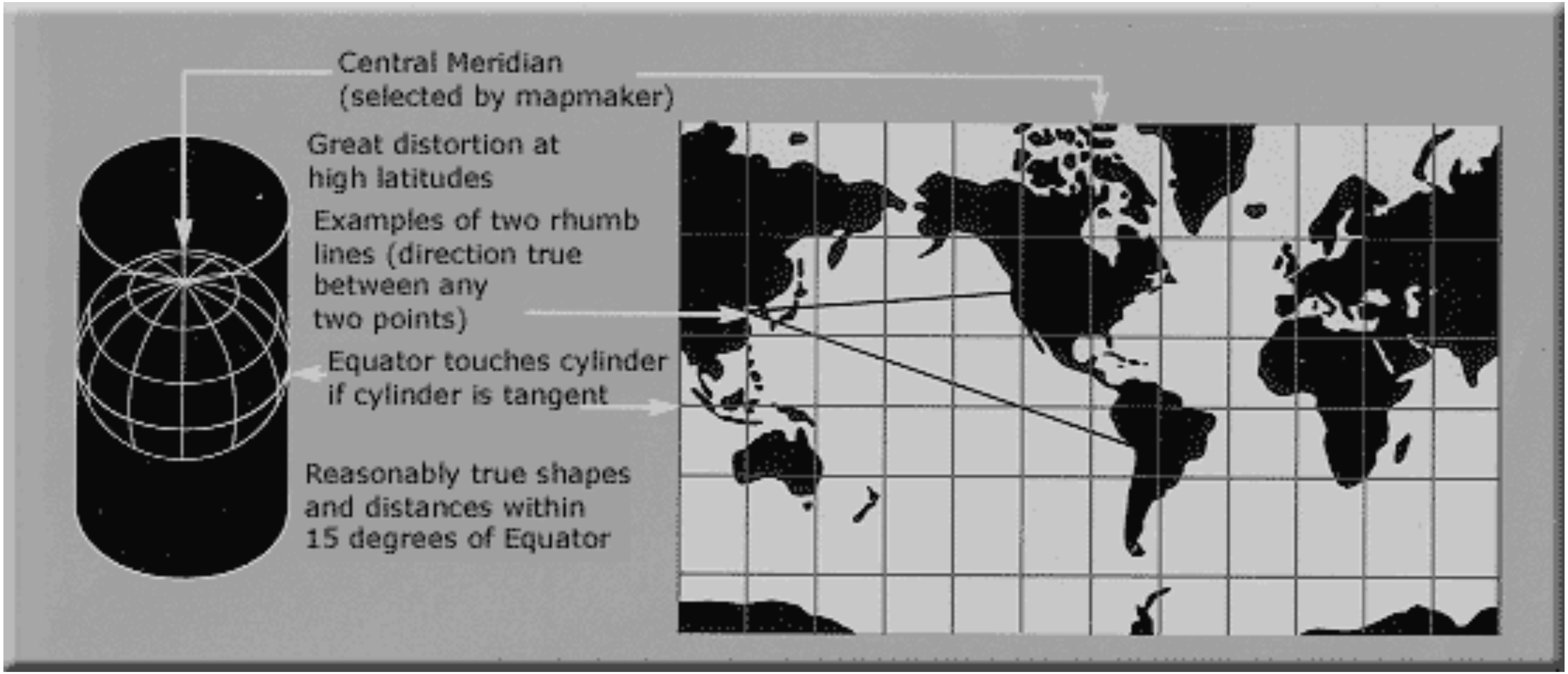
- Spatial data (have positions)
- Cartography: the science of drawing maps
  - Lots of history and well-established procedures
  - May also have non-spatial attributes associated with items
  - Thematic cartography: integrate these non-spatial attributes (e.g. population, life expectancy, etc.)
- Goals: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

Map Projection



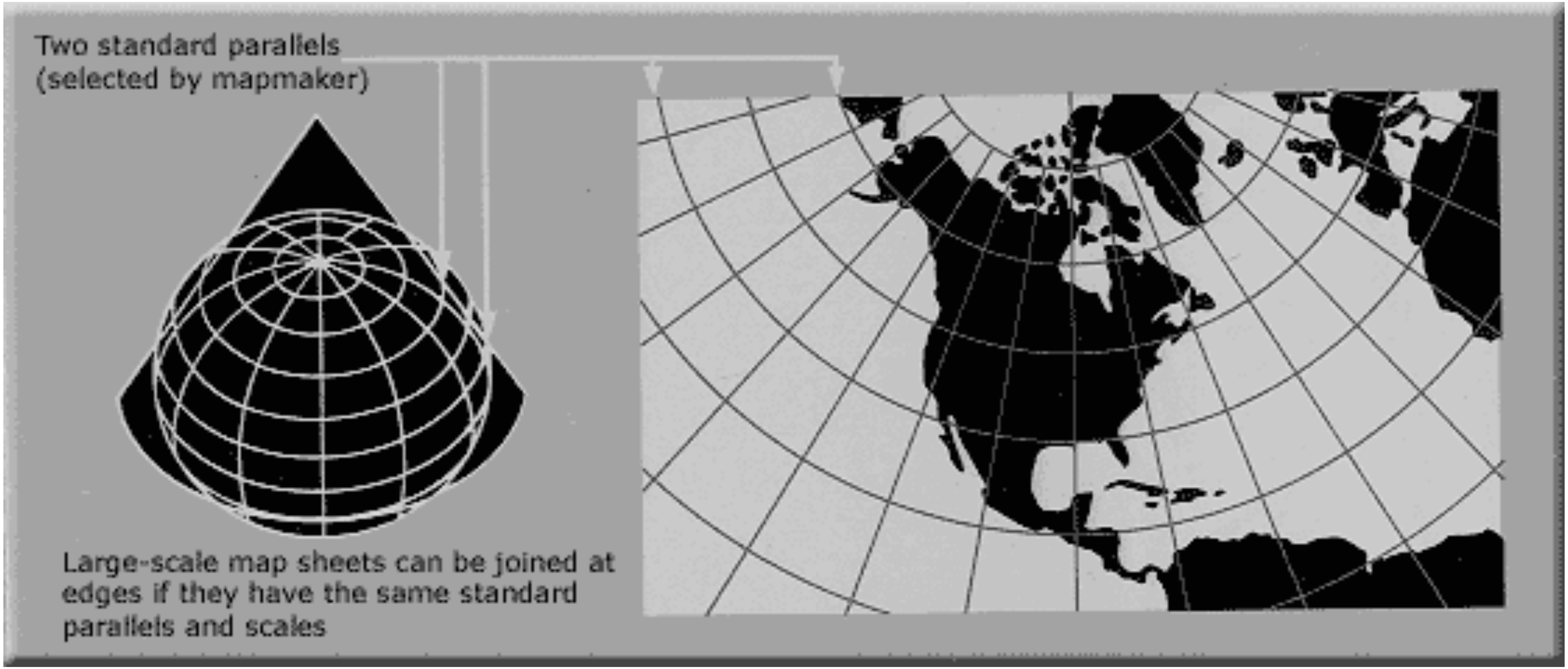
[P. Foresman, Wikimedia]

Flattening the Sphere?



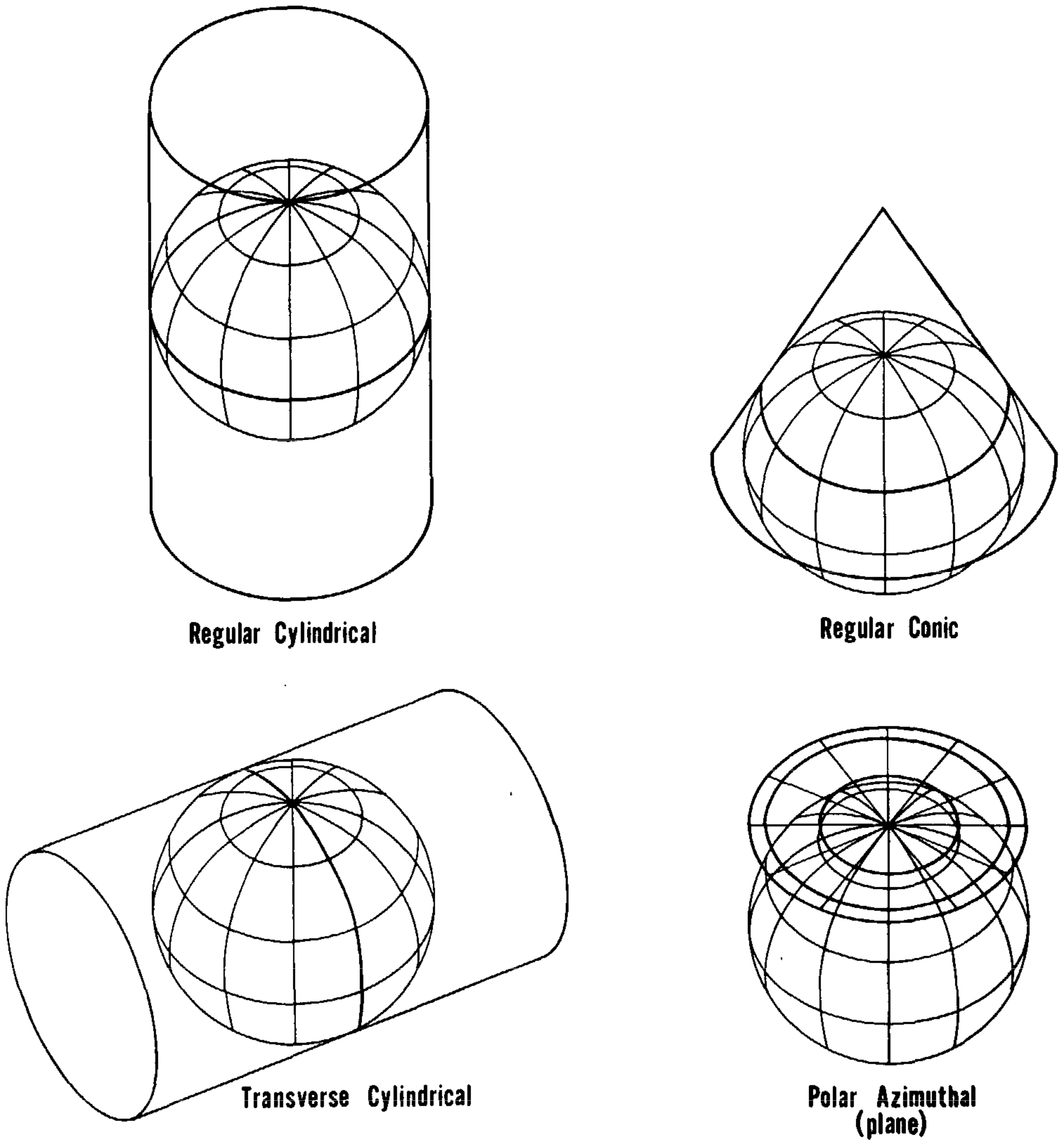
[USGS Map Projections]

Lambert Conformal Conic Projection



[USGS Map Projections]

Standard Projections

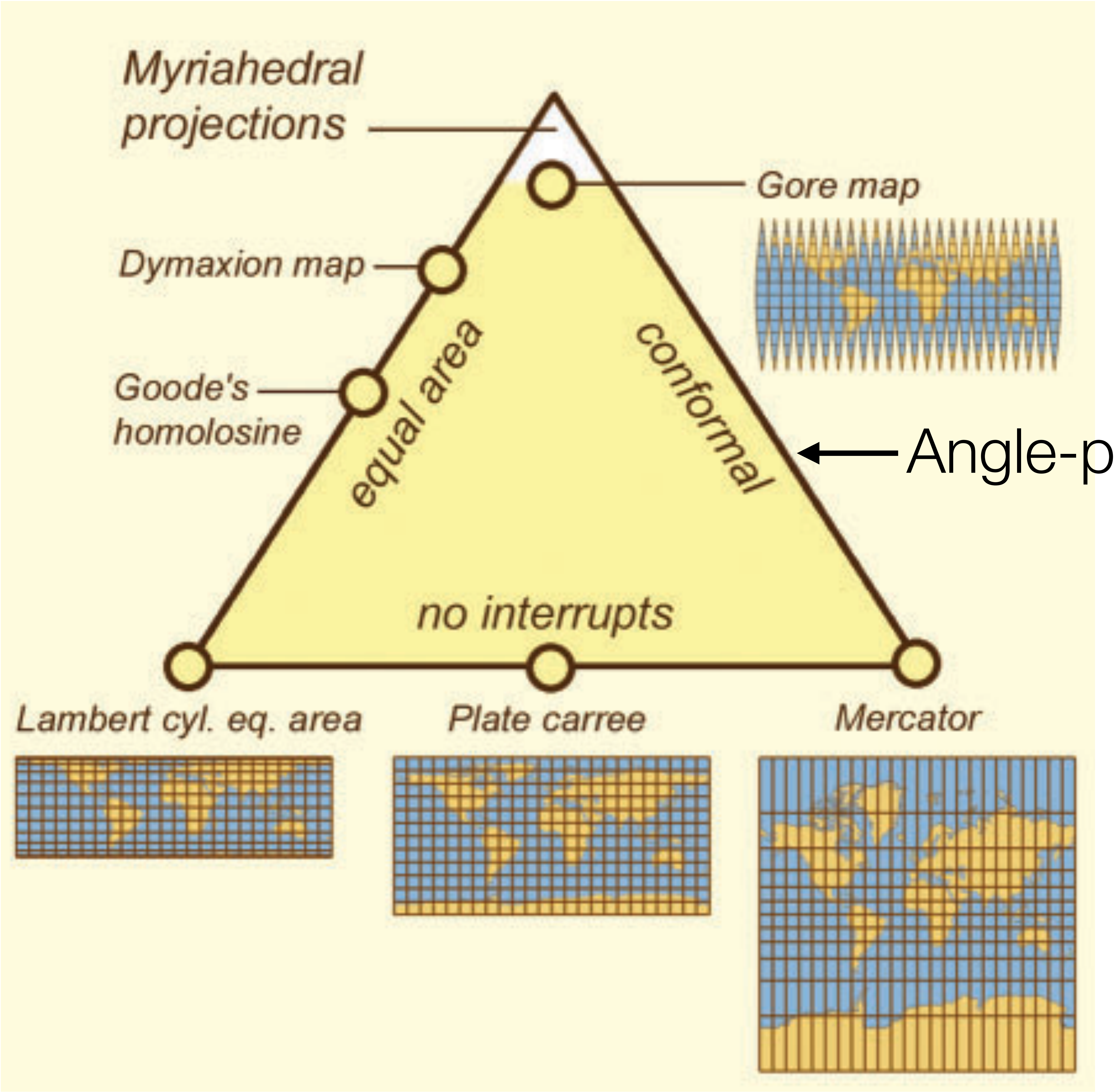


[J. P. Snyder, USGS]

Map Projections

[xkcd]

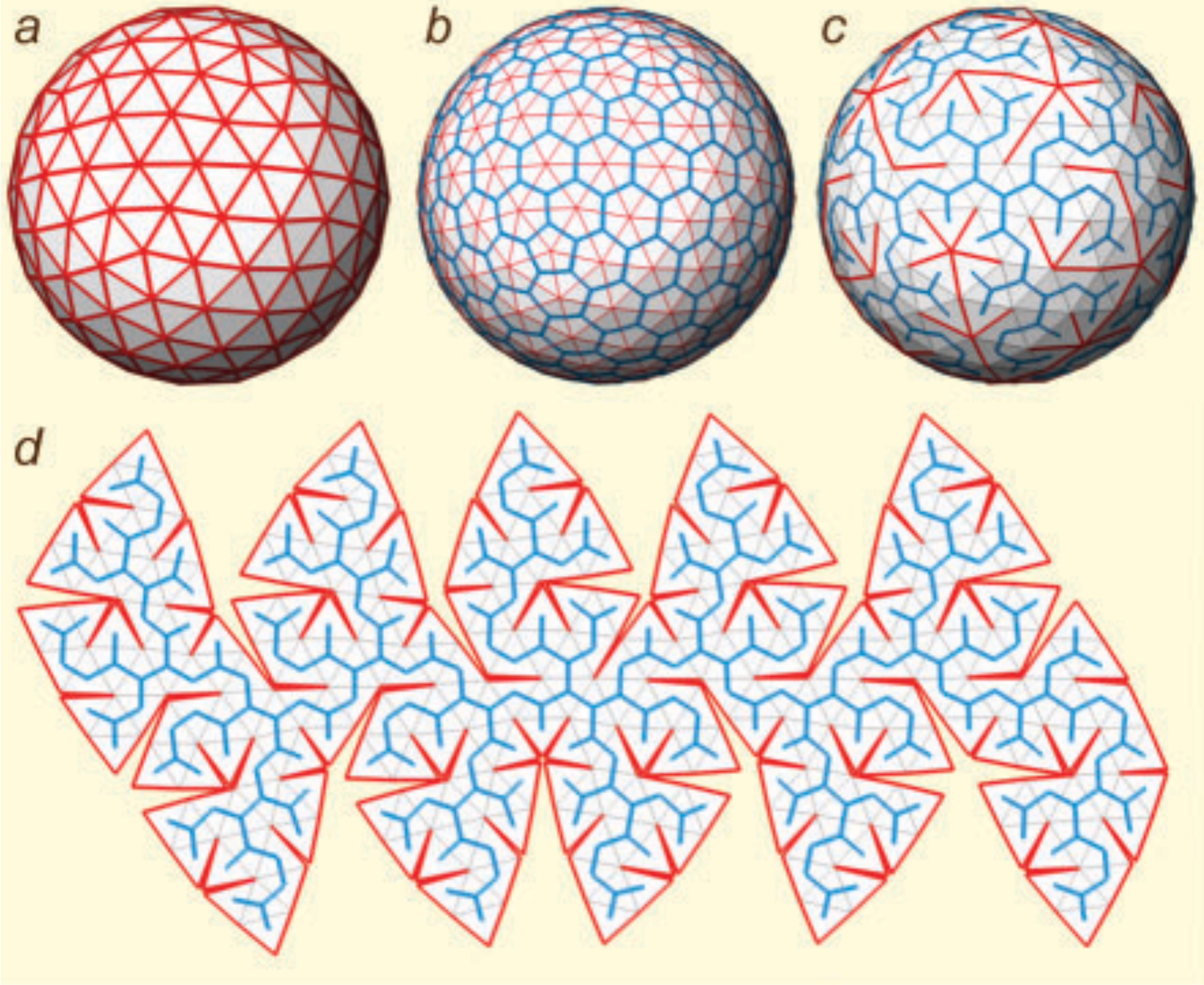
Projection Classification



Angle-preserving

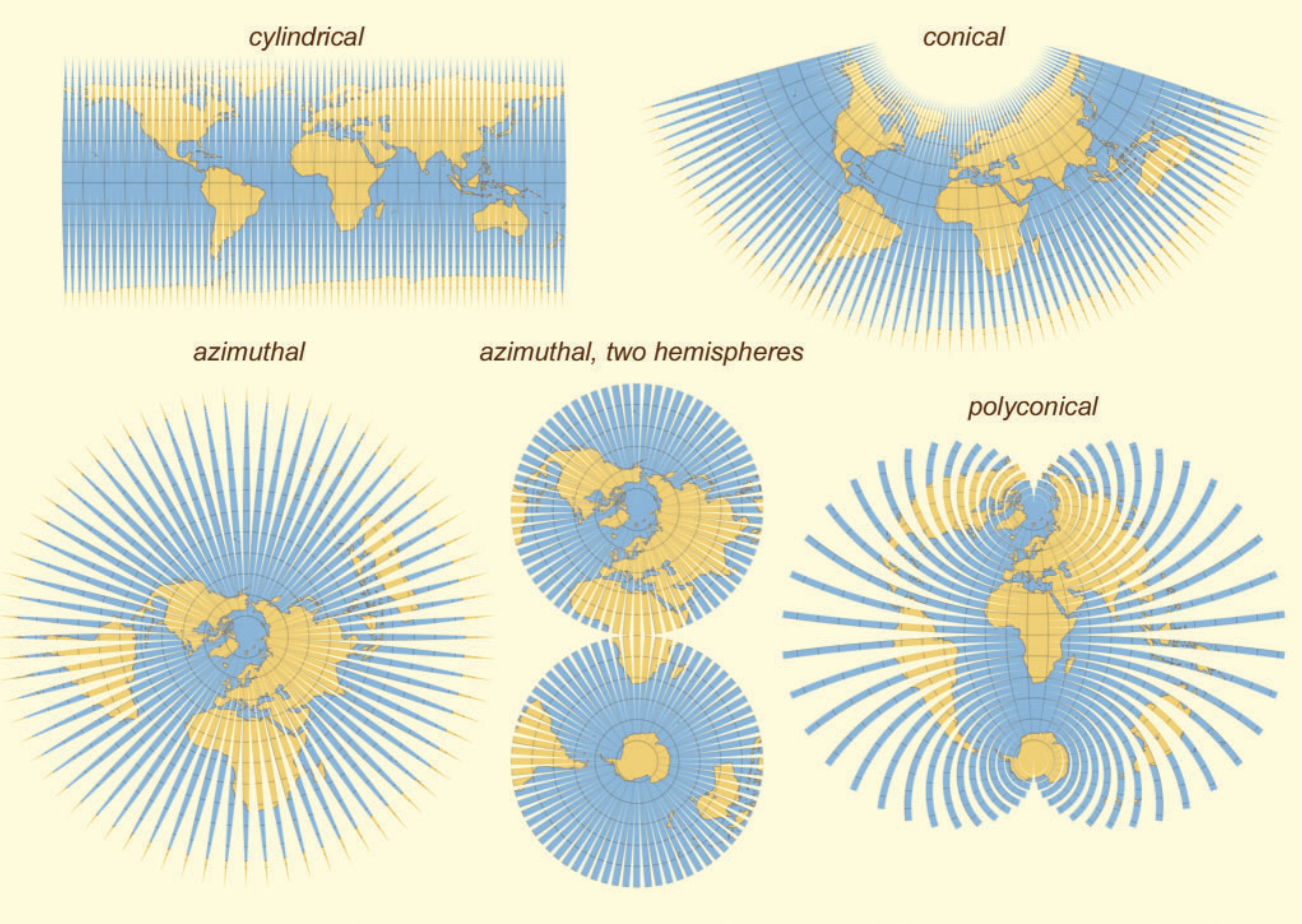
[J. van Wijk, 2008]

Myriahedral Projections



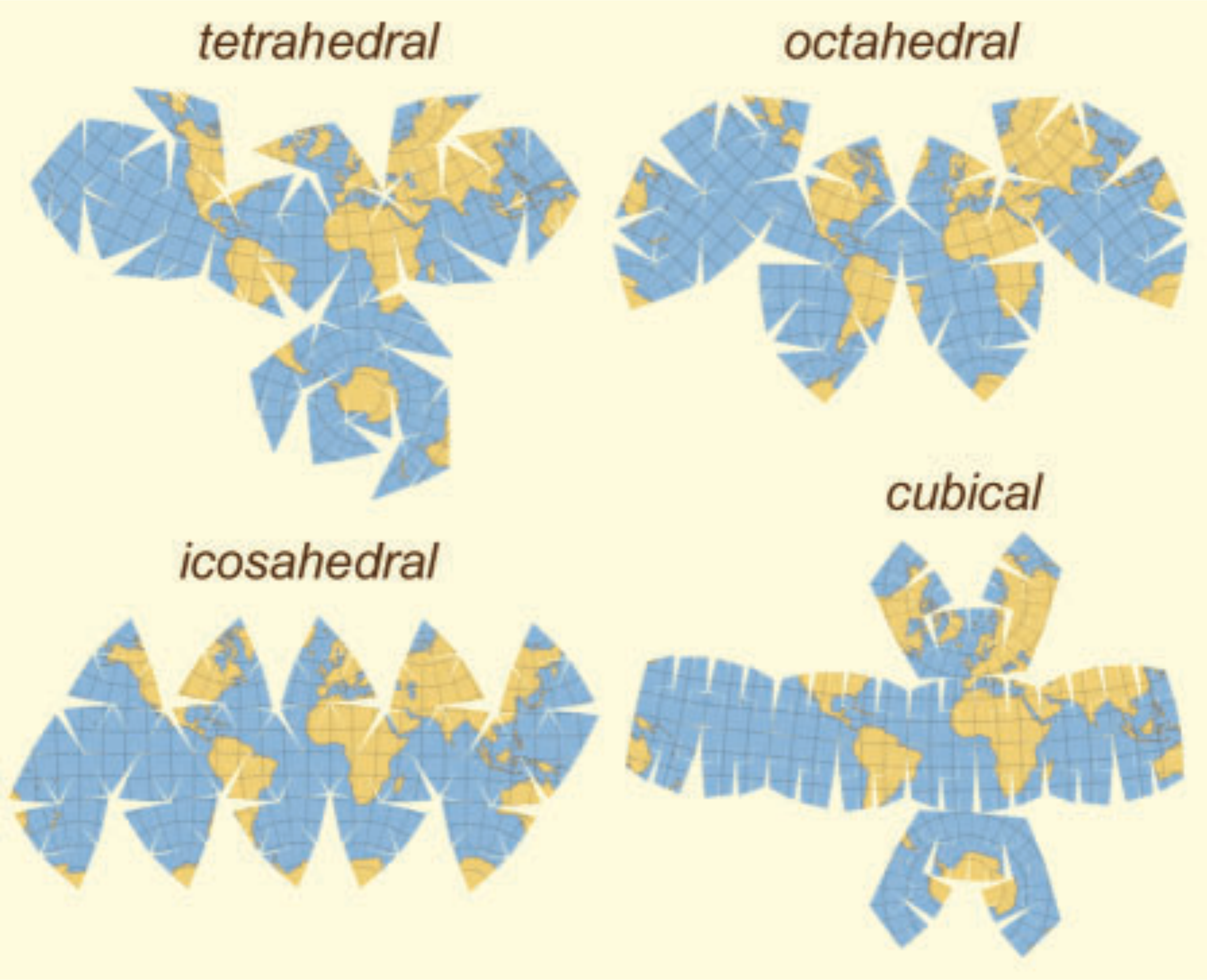
[J. van Wijk, 2008]

Cut along parallels or meridians (graticules)



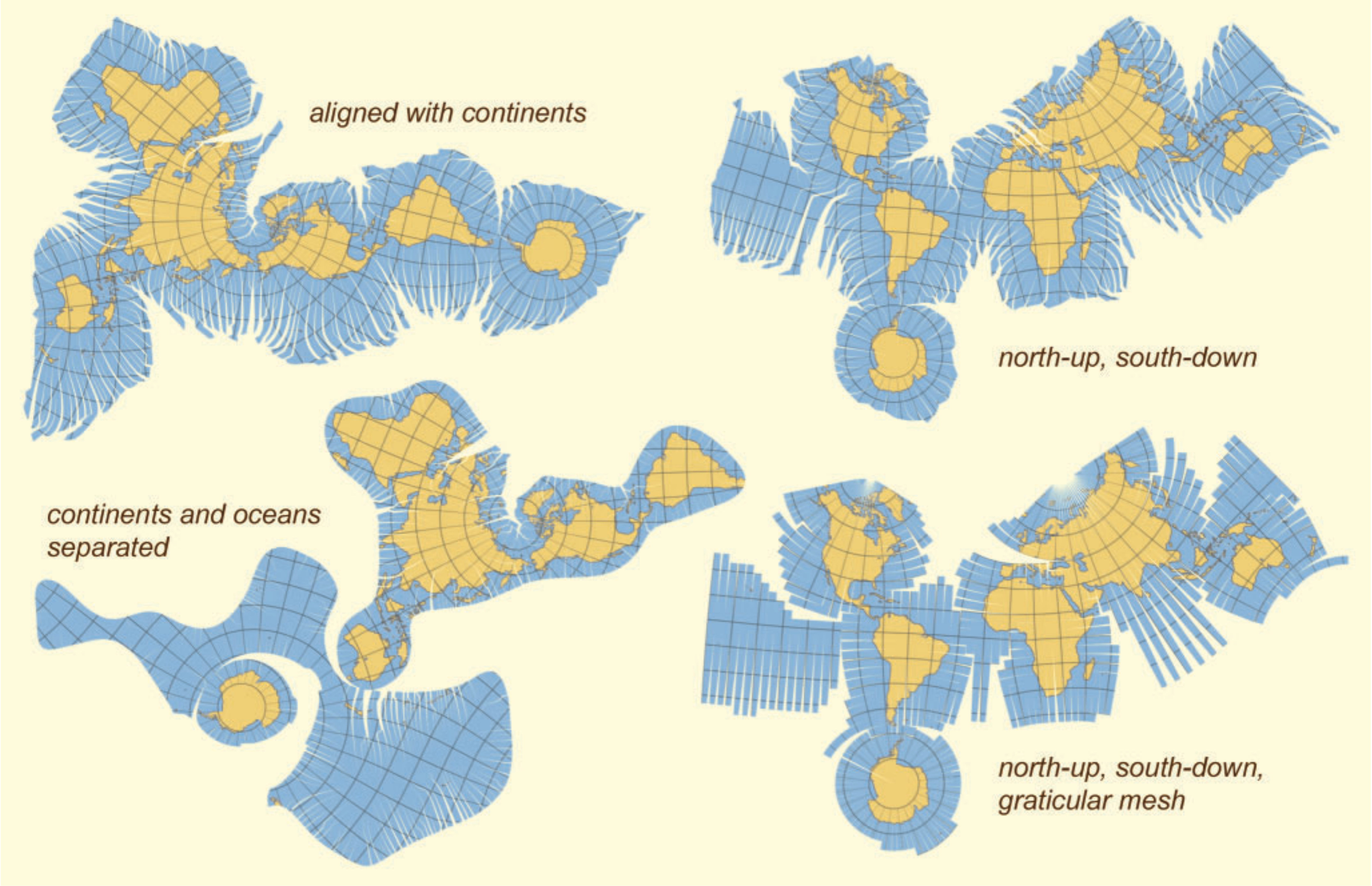
[J. van Wijk, 2008]

Subdividing regular polyhedra



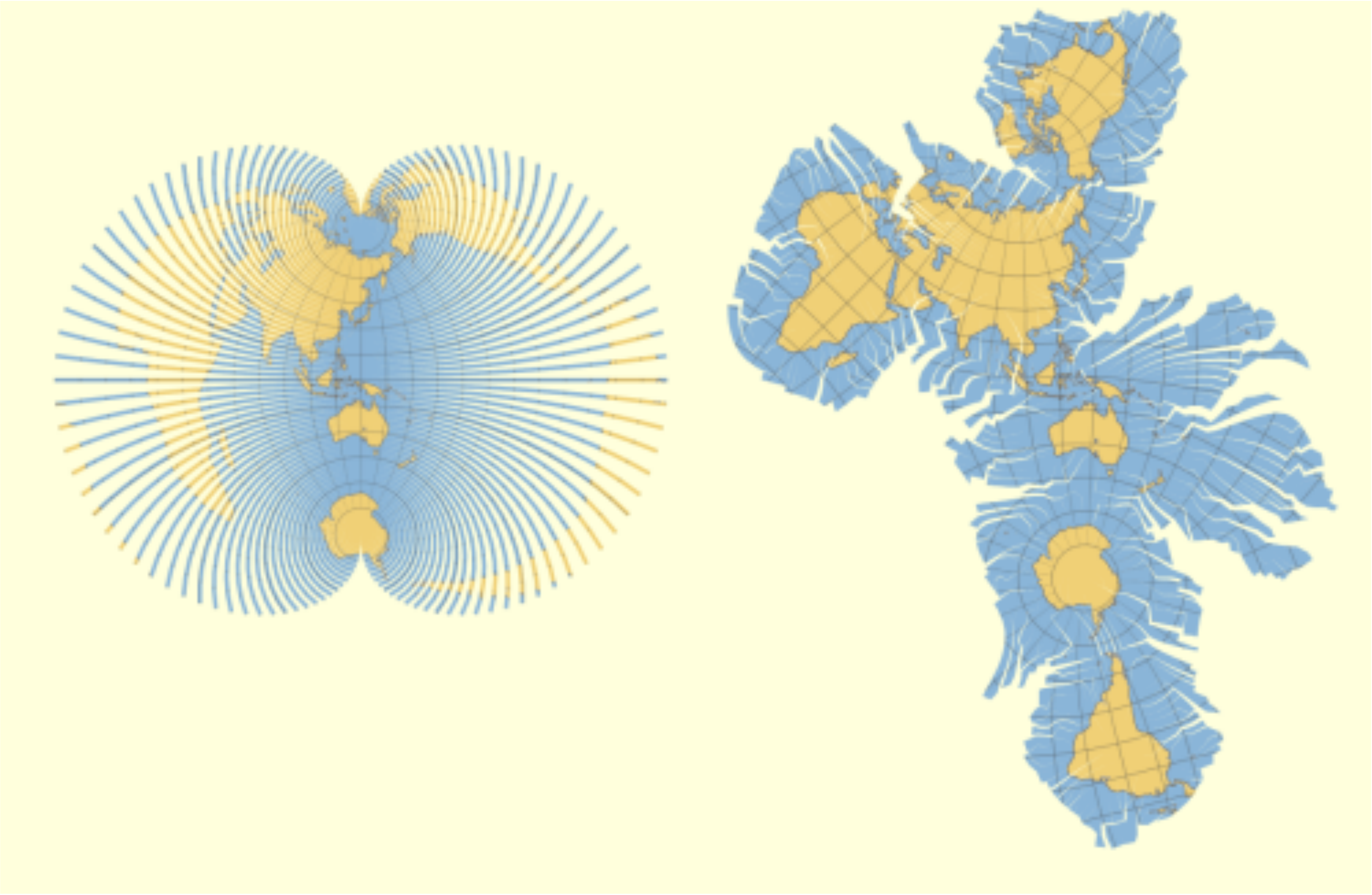
[J. van Wijk, 2008]

Geographically-aligned



[J. van Wijk, 2008]

Australia-centric



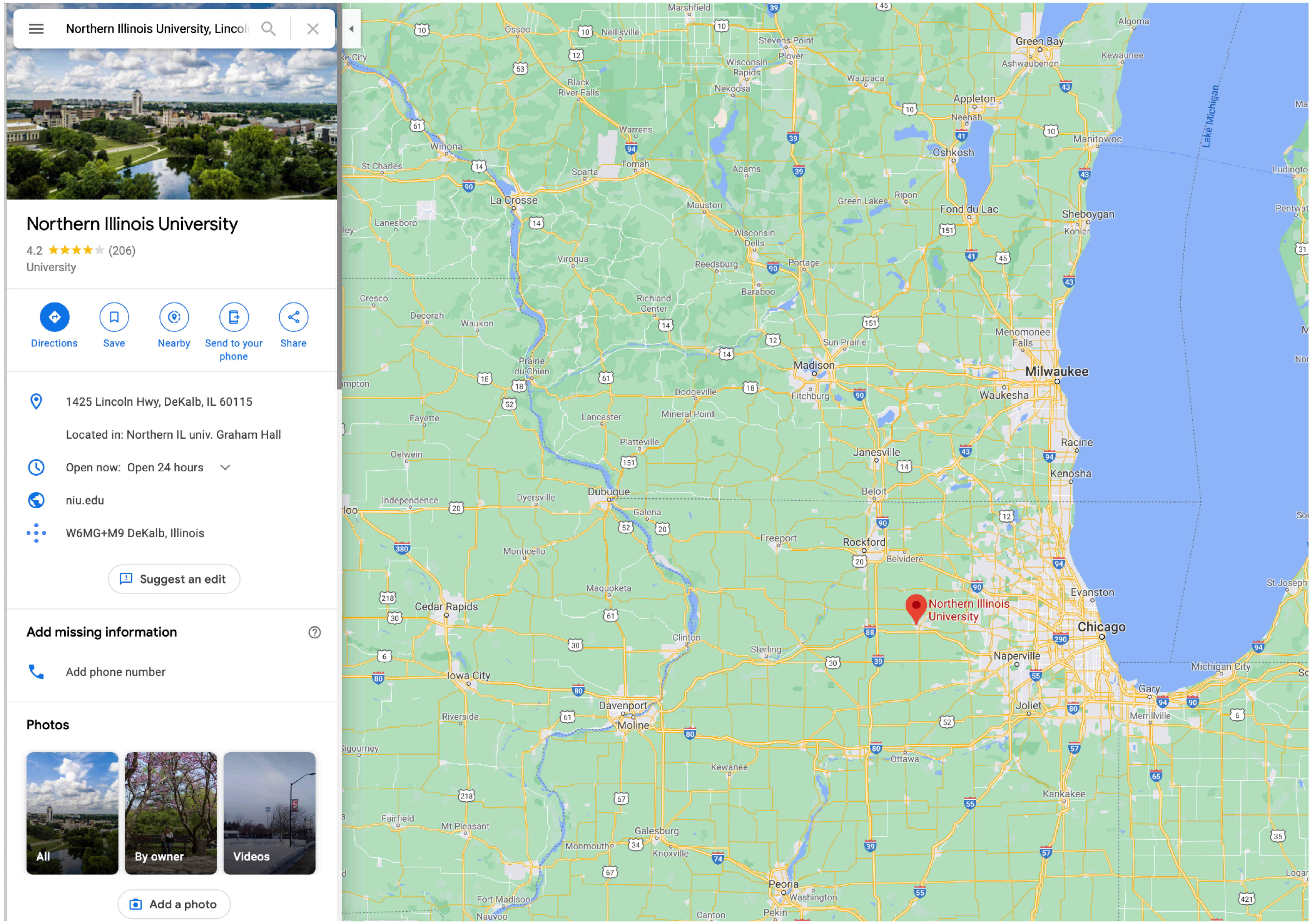
[J. van Wijk, 2008]

Search Tasks

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

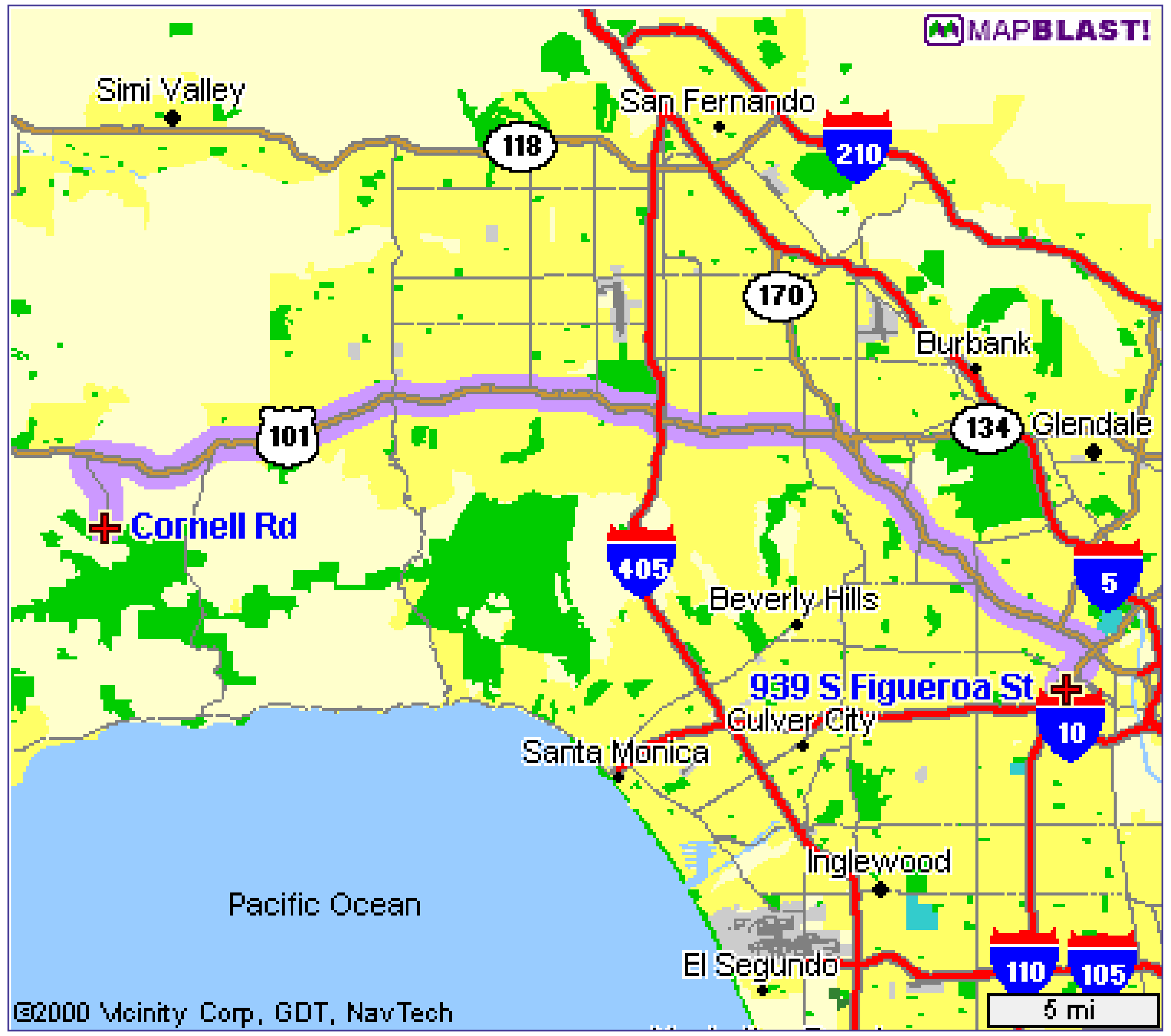
[Munzner (ill. Maguire), 2014]

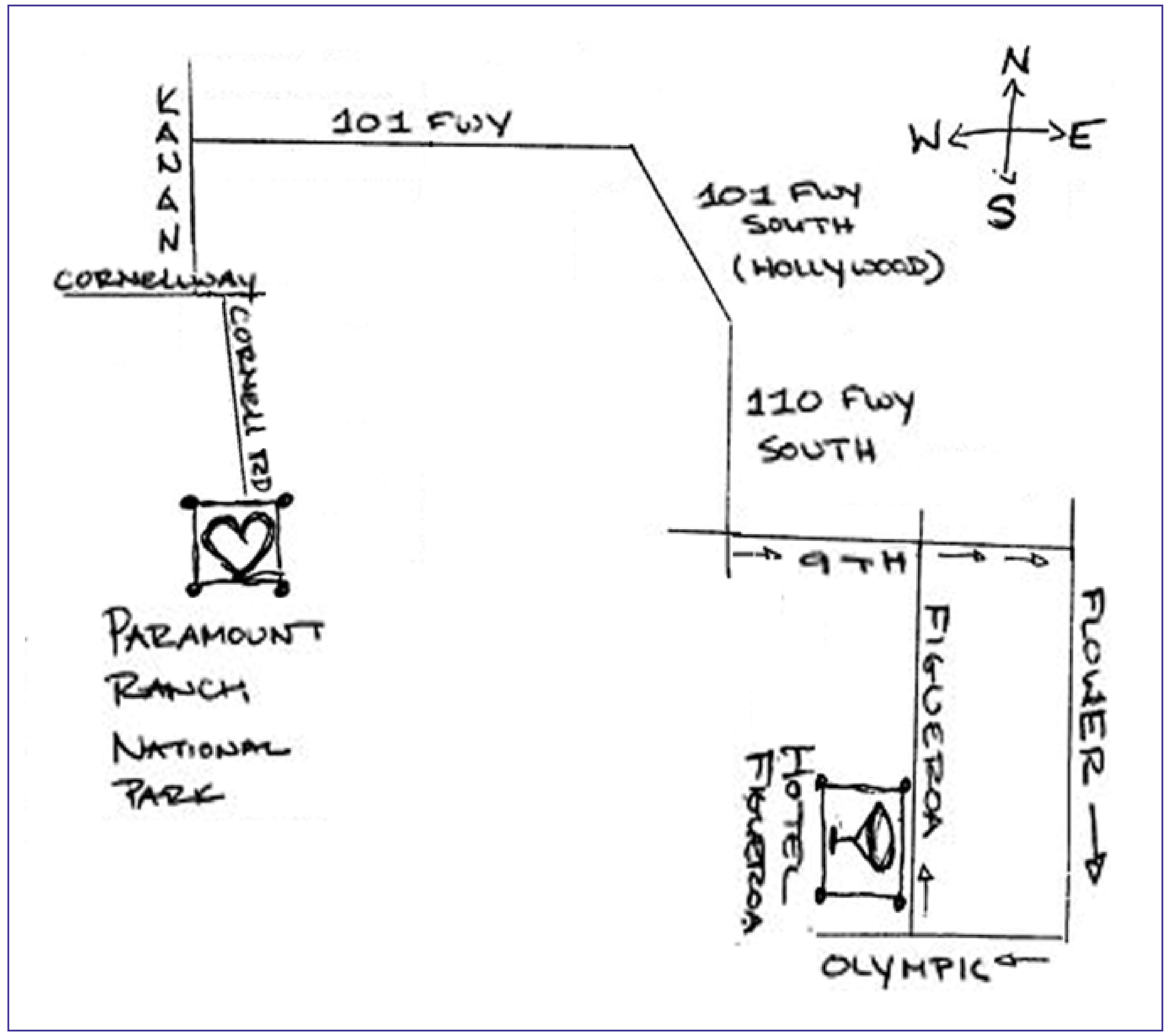
Lookup

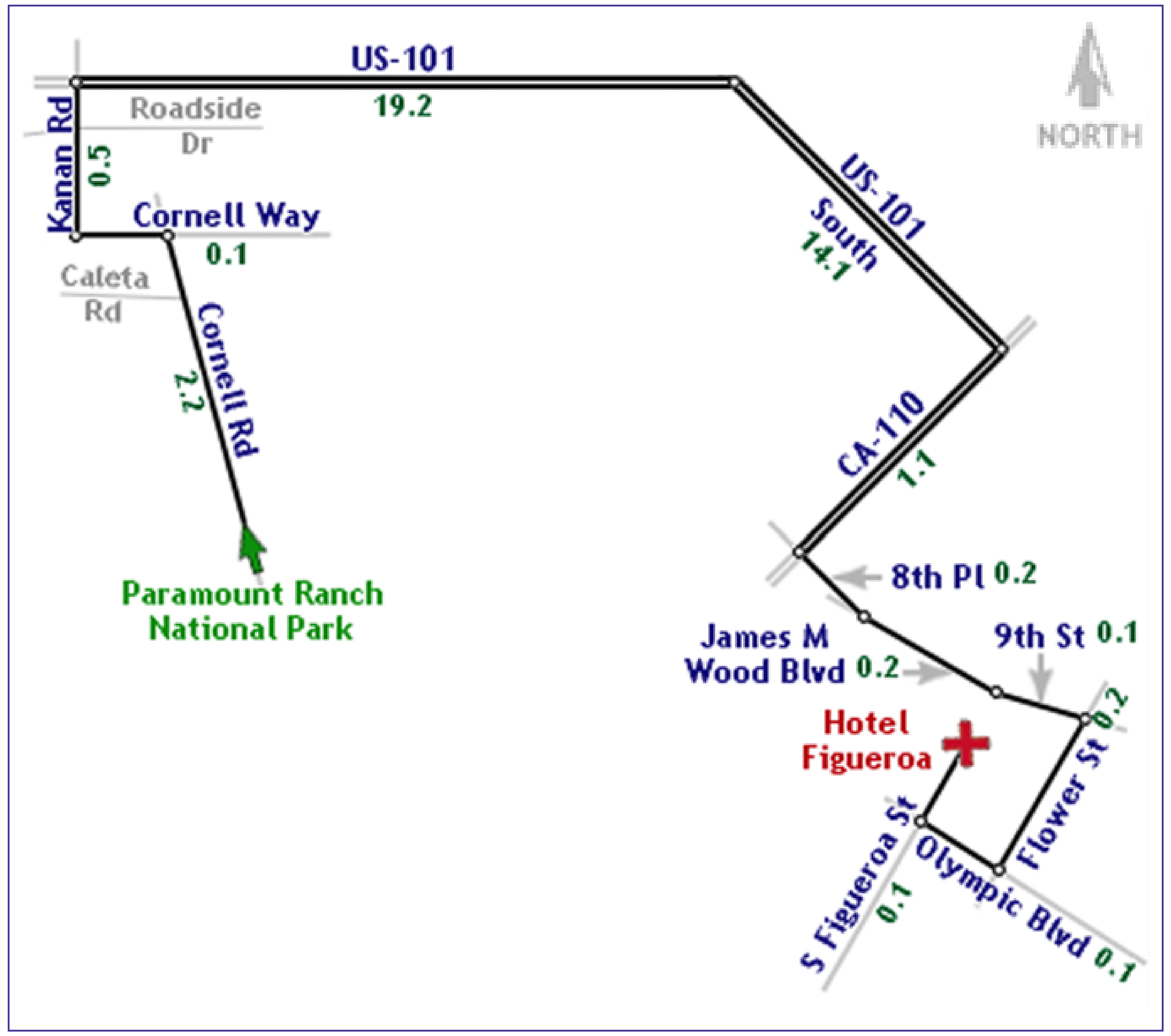


[Google Maps]

Route Maps

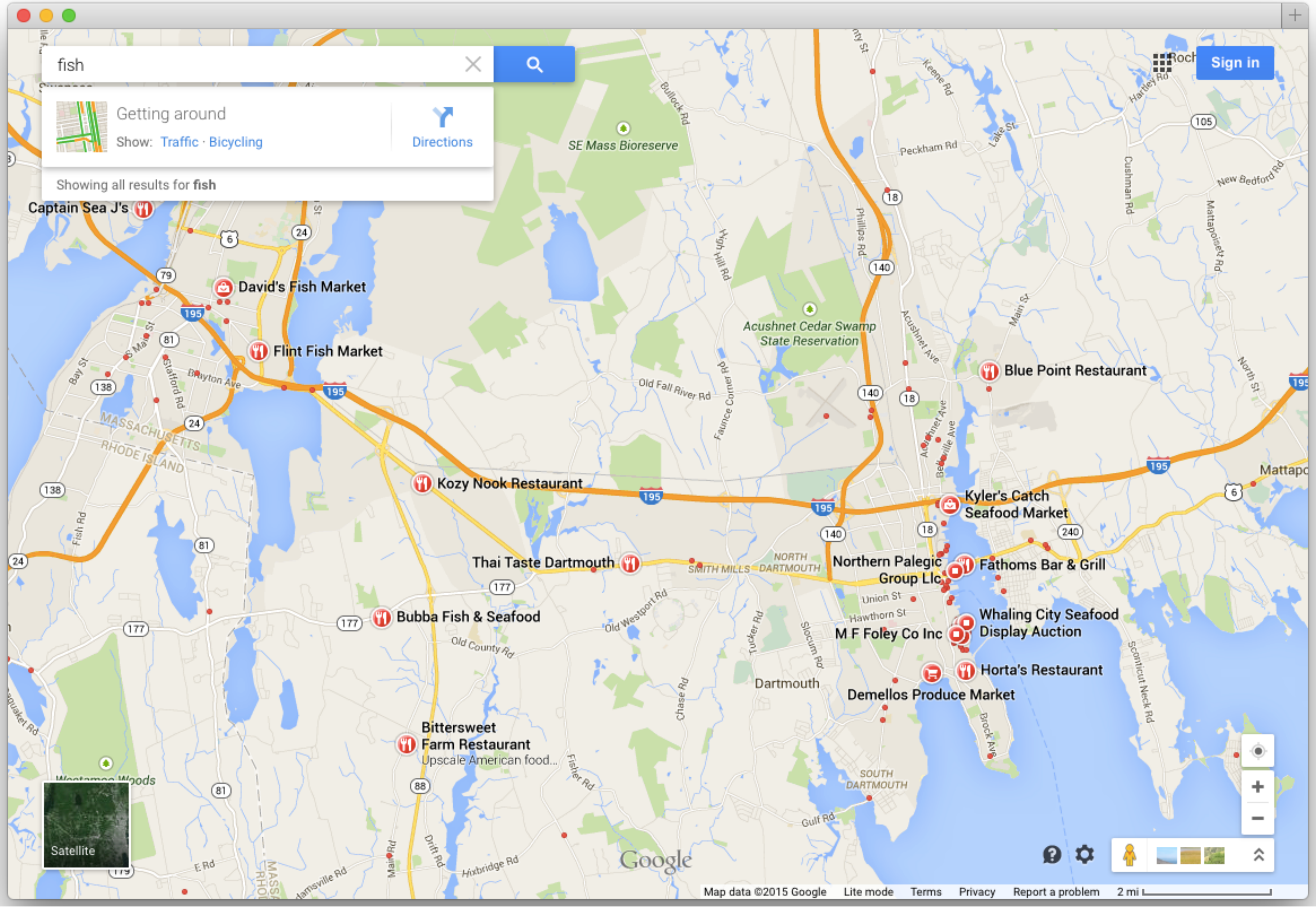






[Agrawala & Stolte, 2001]

Locate


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

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

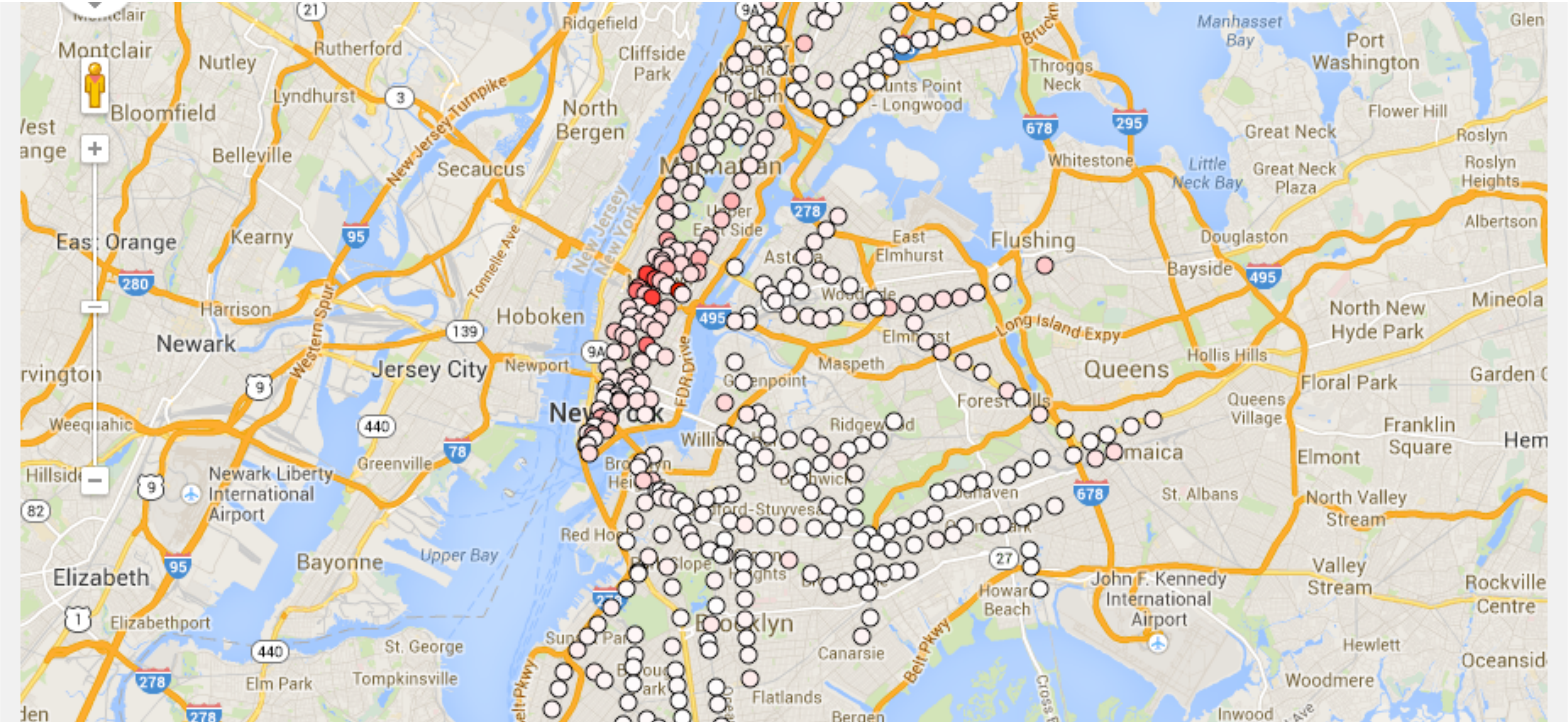
Discrete Categorical Attribute: Shape

[Acadia NP, National Park Service]

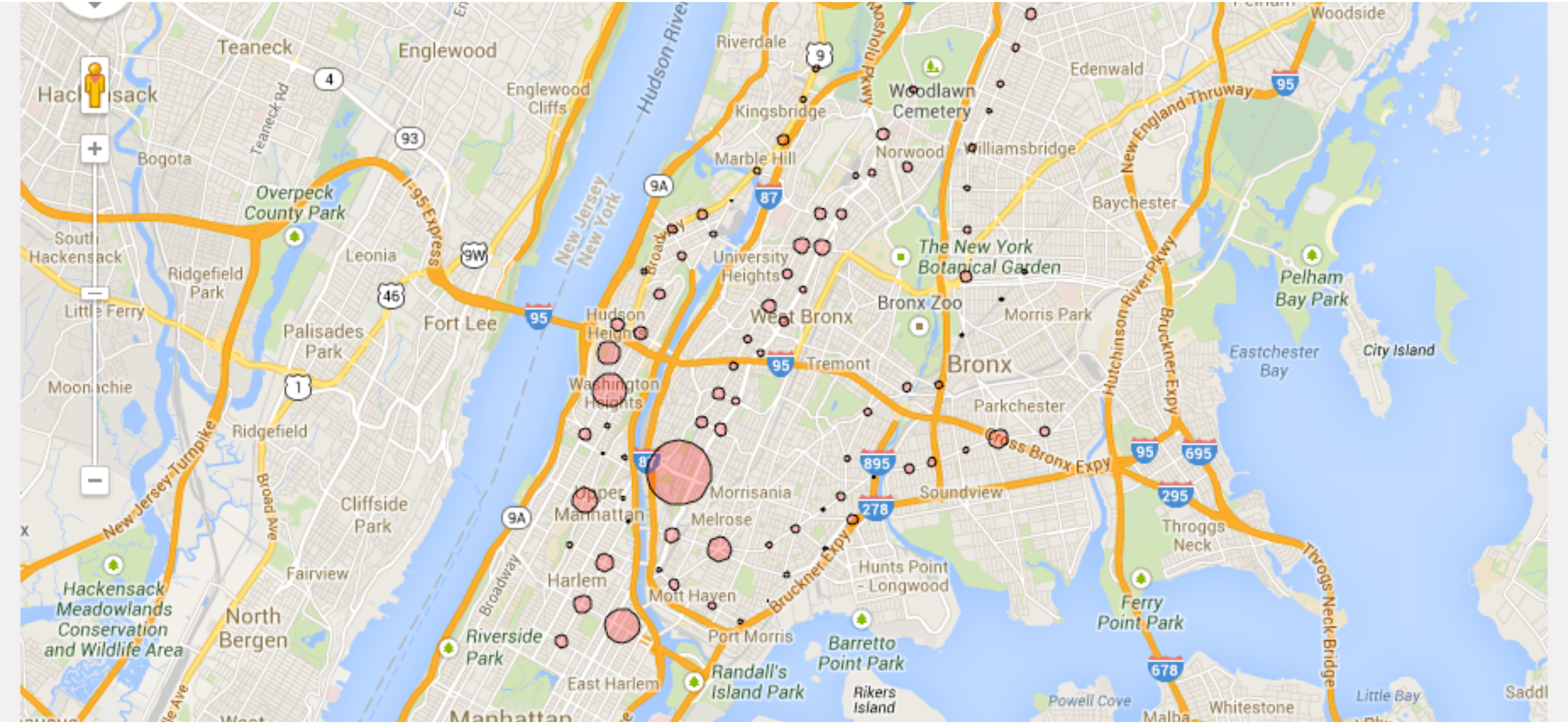
Discrete Categorical Attribute: Shape

[Acadia NP, National Park Service]

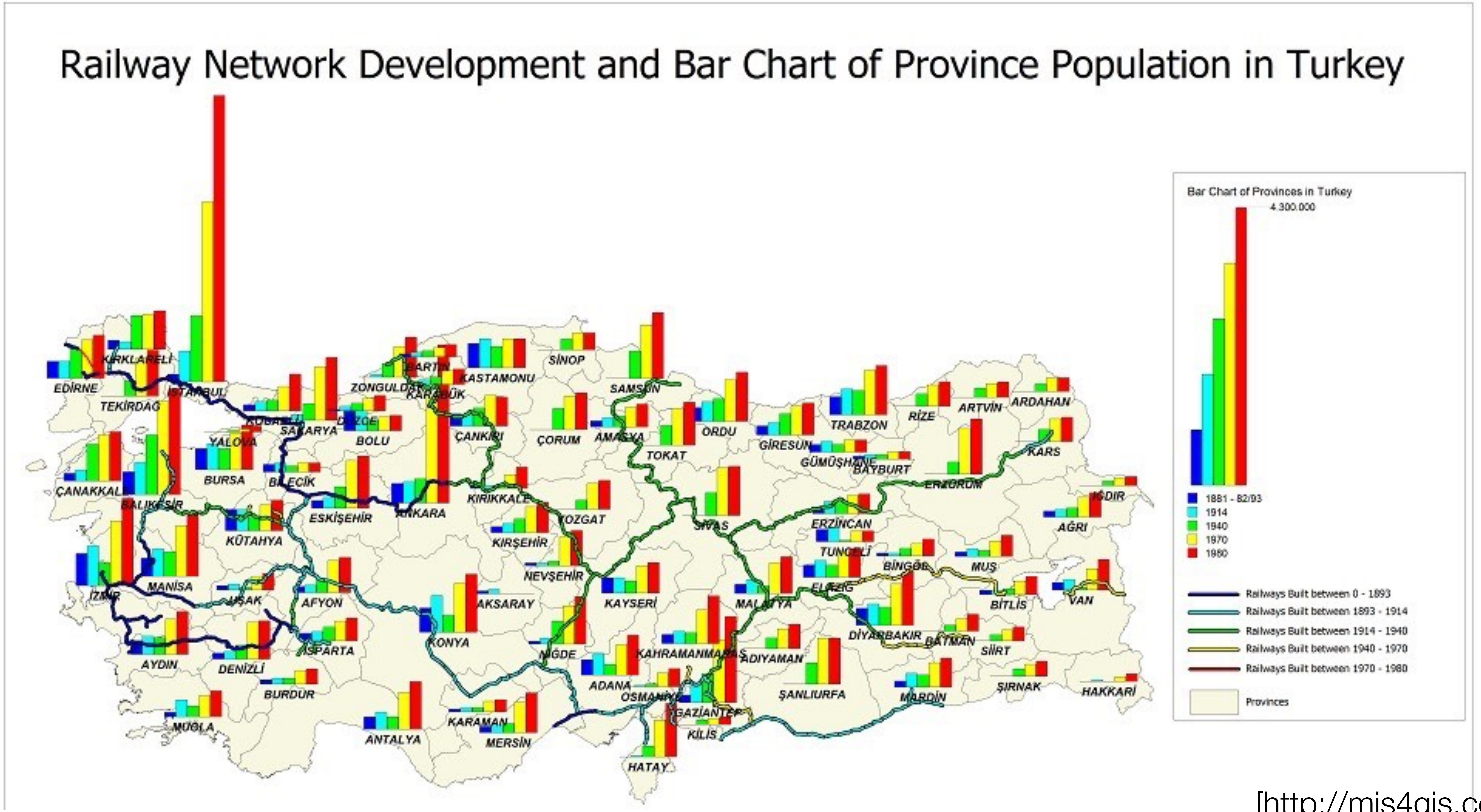
Discrete Quantitative Attribute: Color Saturation



Discrete Quantitative Attribute: Size

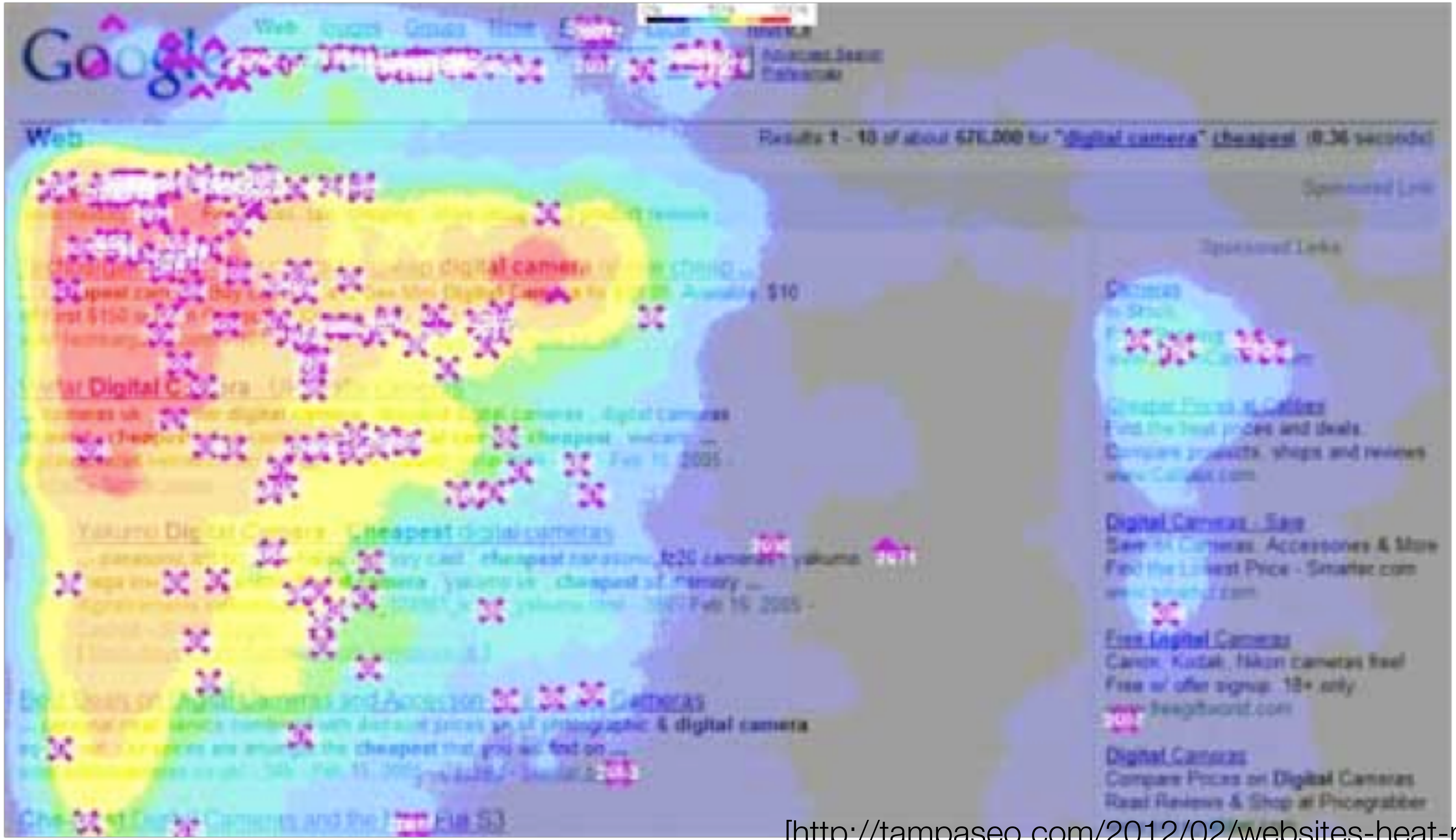


Discrete Quantitative Attributes: Bar Chart



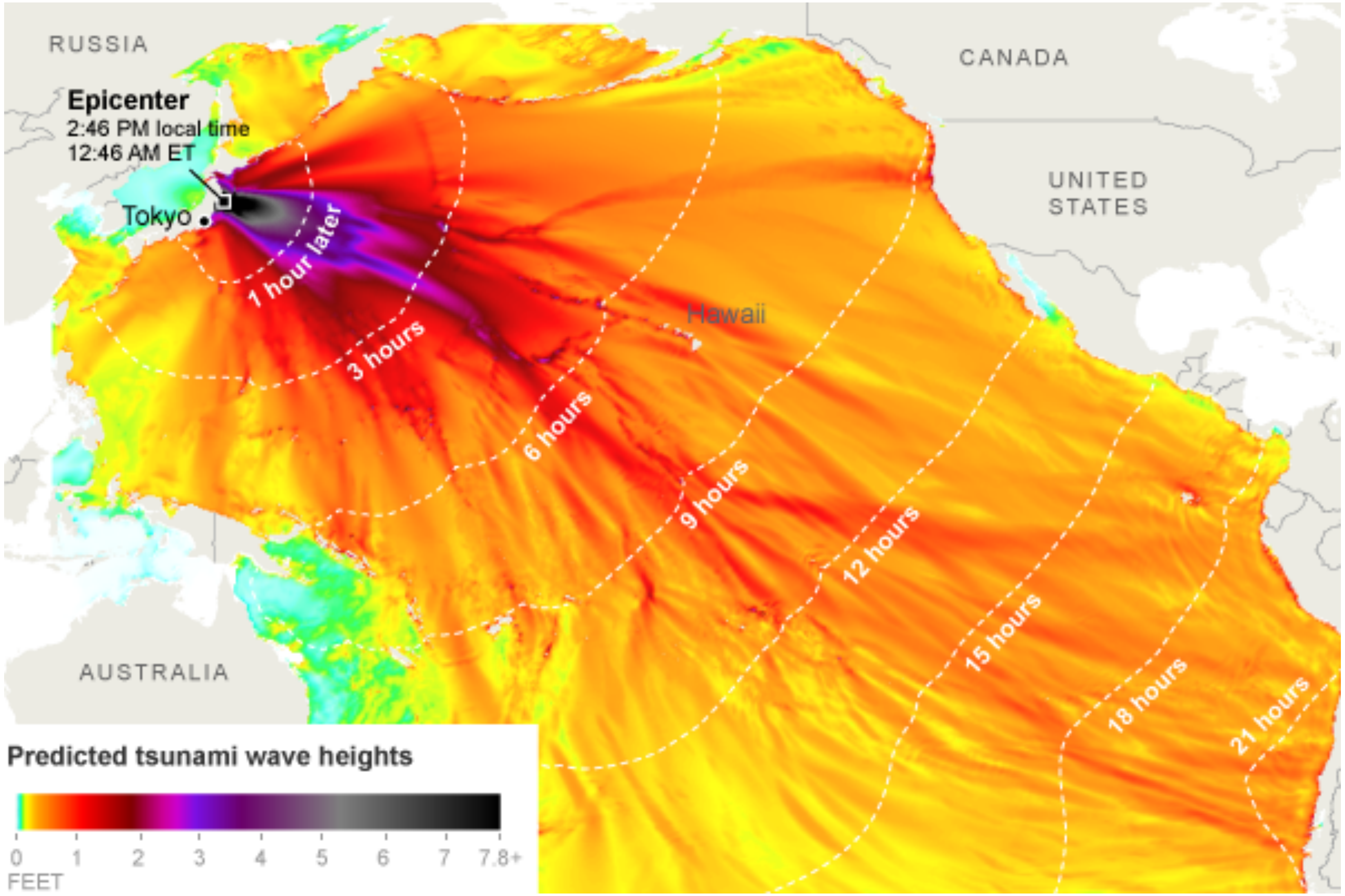
[http://mis4gis.com/hgistr.org/]

Continuous Quantitative Attribute: Color Hue



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

Time as the attribute



[NYTimes]

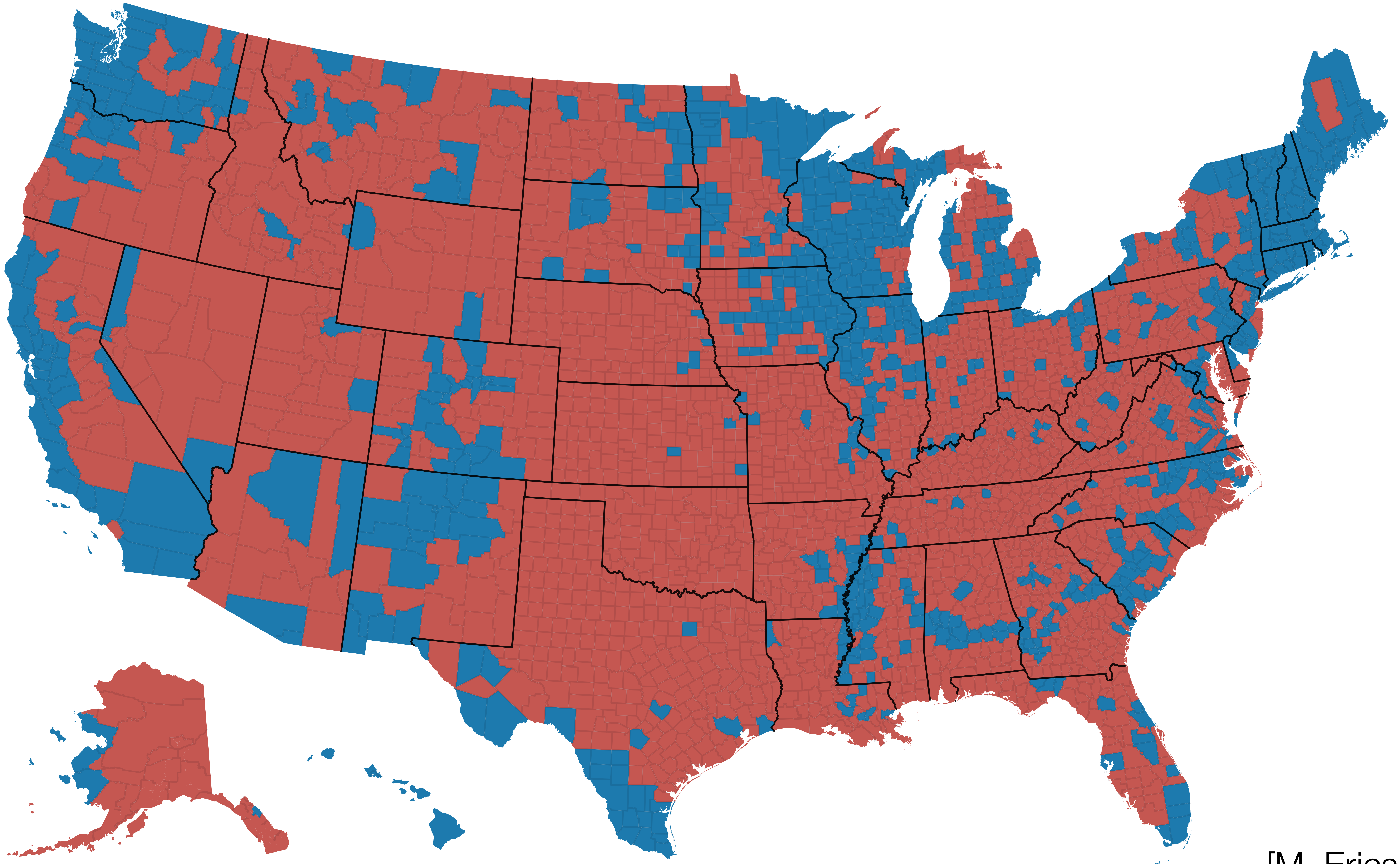
Isolines

[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)



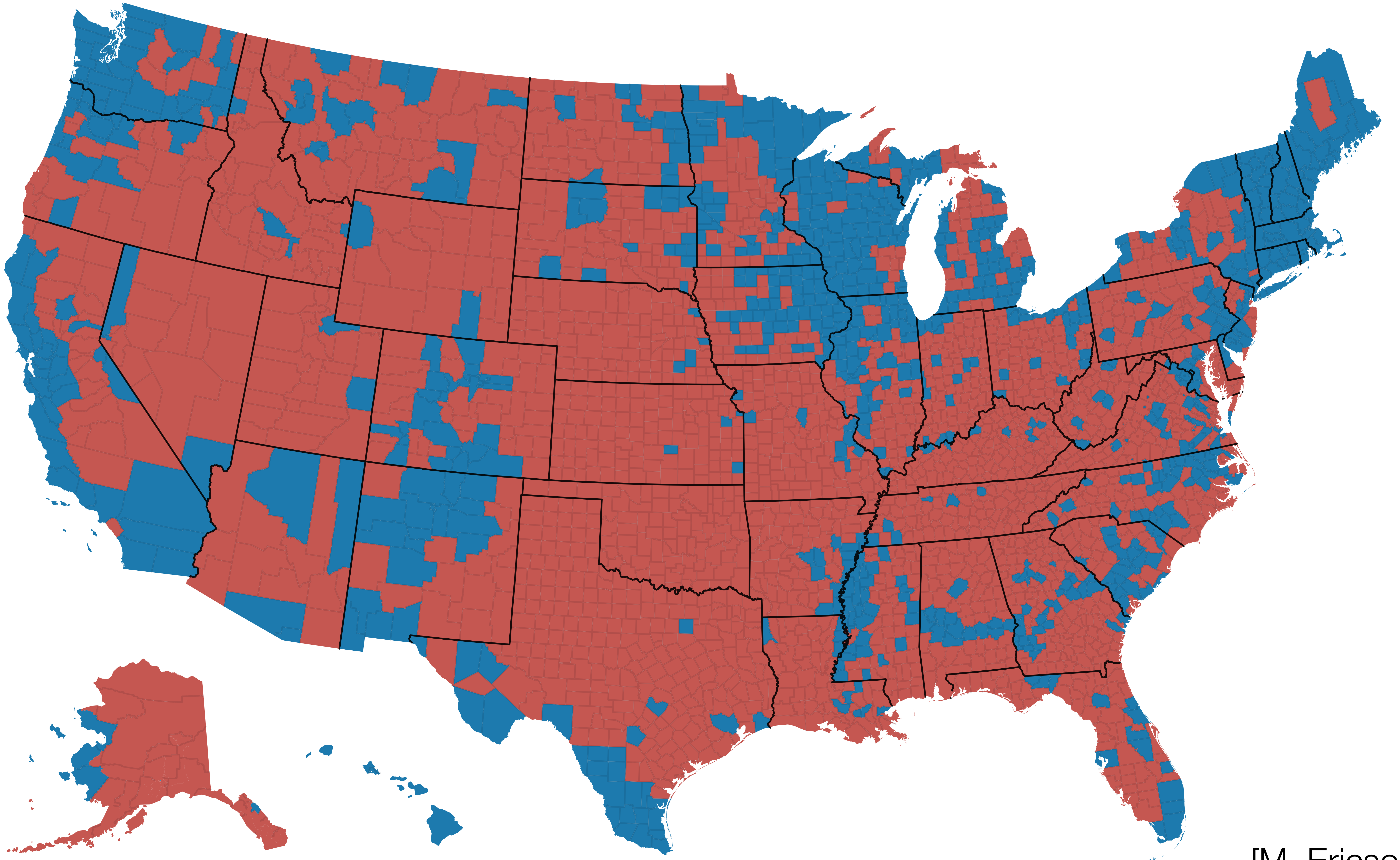
[M. Ericson, New York Times]

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

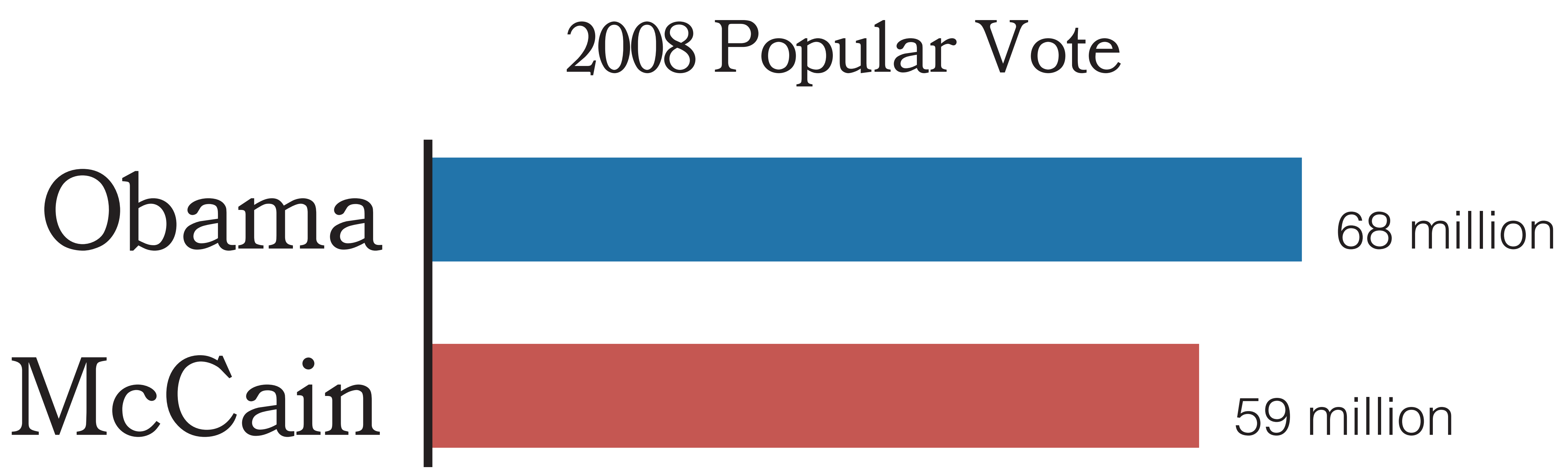
- Design choices:
  - Colormap
  - Region boundaries (level of summarization)

Choropleth (Two Hues)



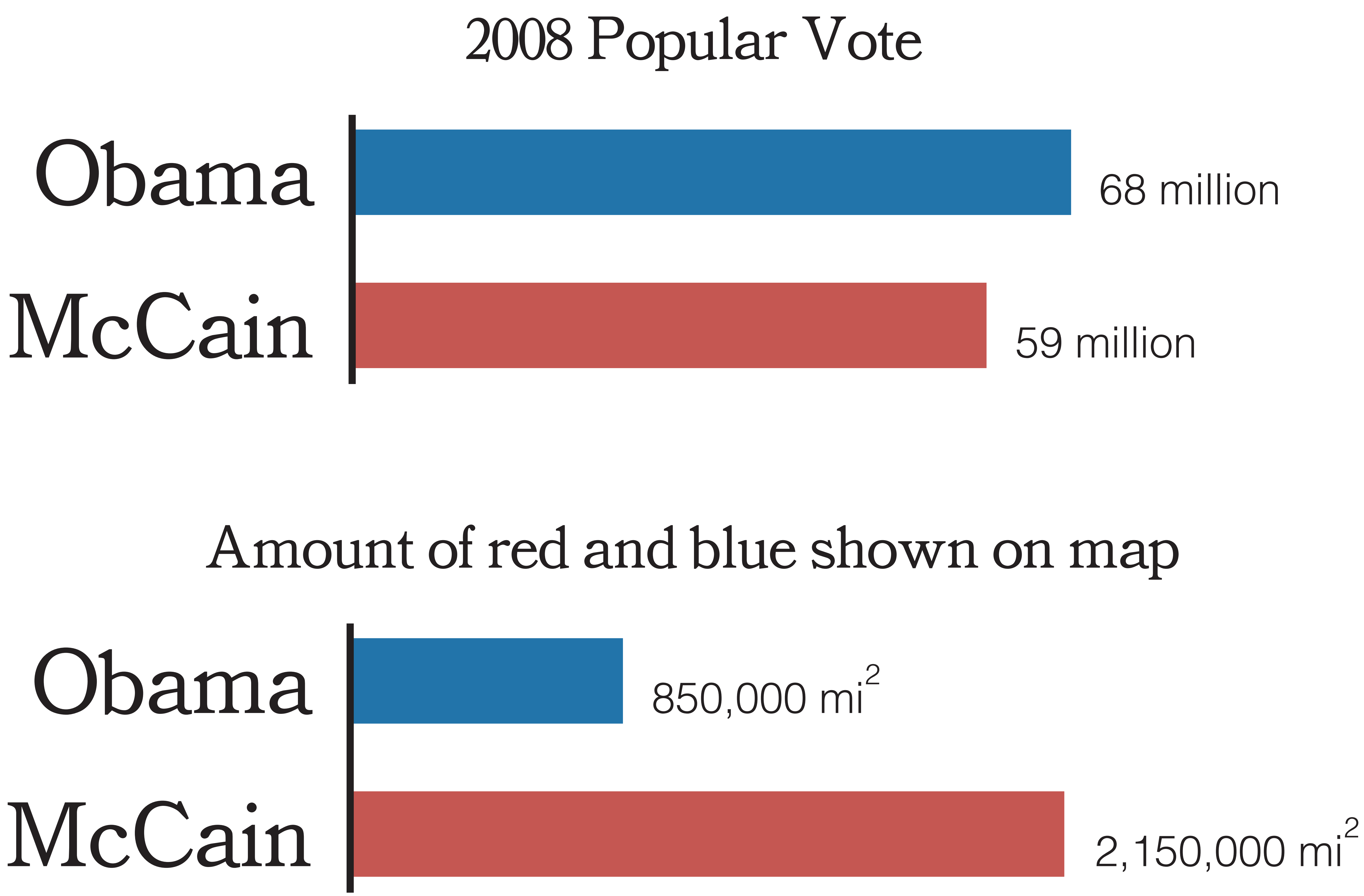
[M. Ericson, New York Times]

Problem?



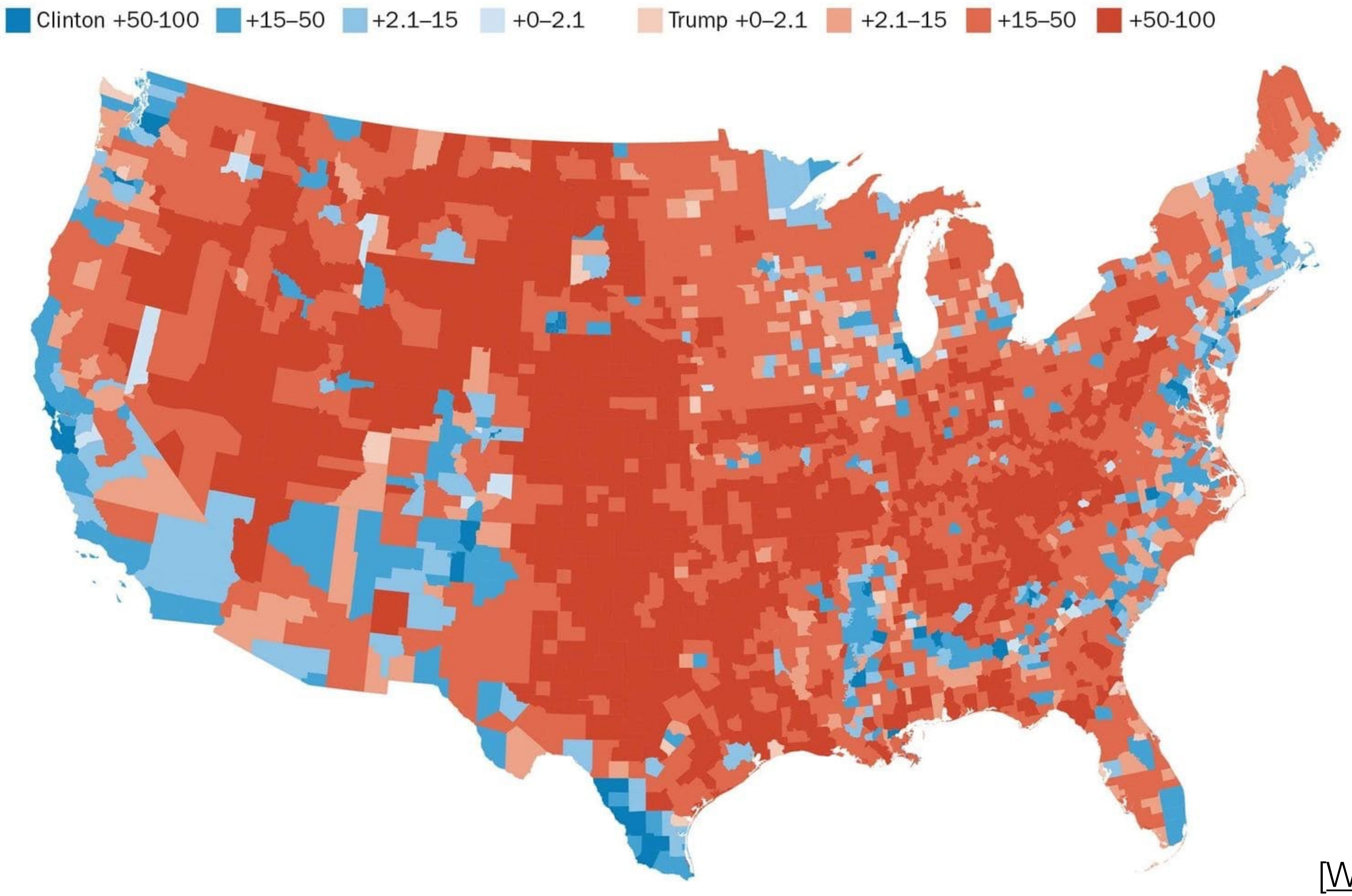
[M. Ericson, New York Times]

Problem?



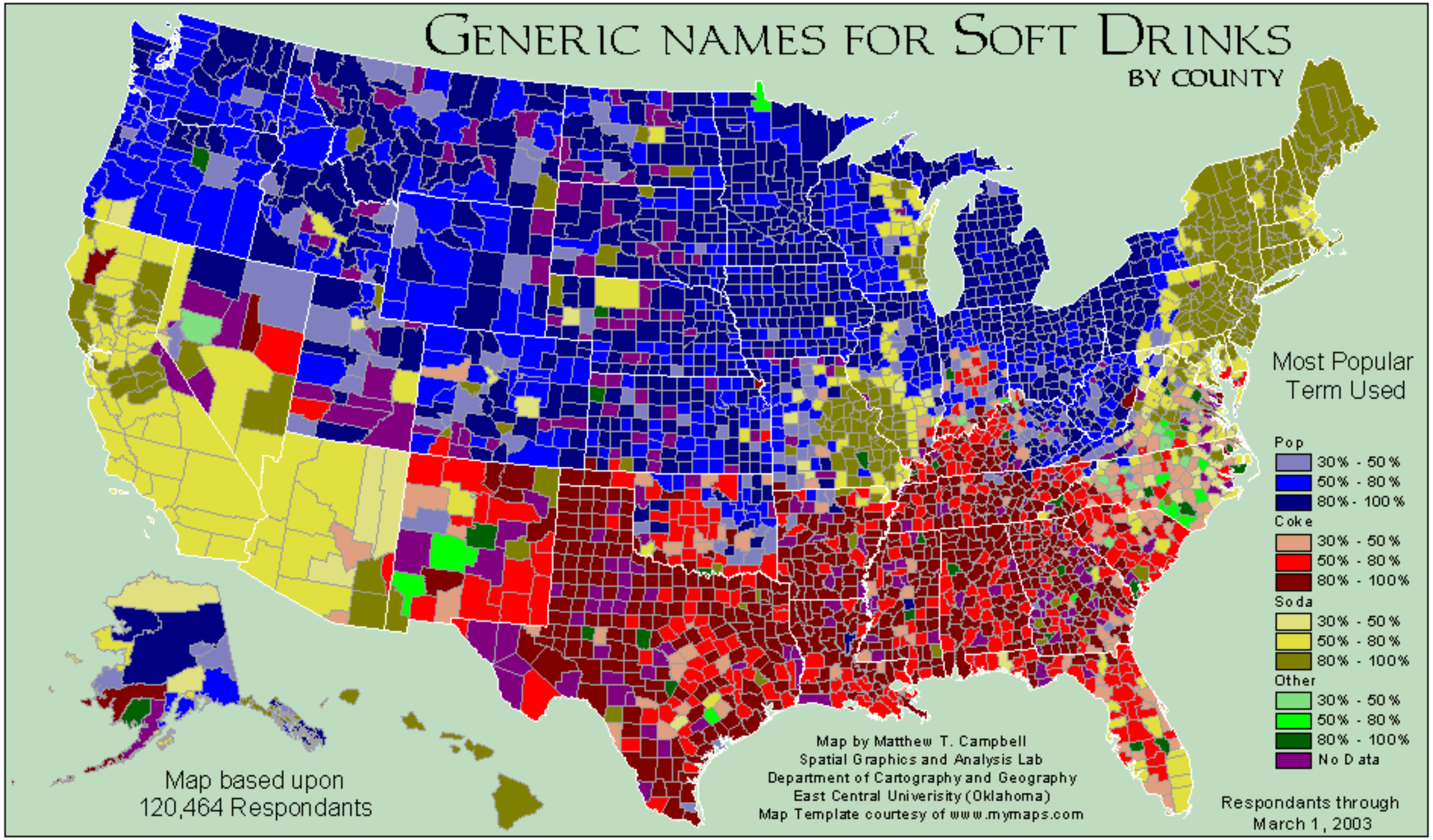
[M. Ericson, New York Times]

Adding Saturation



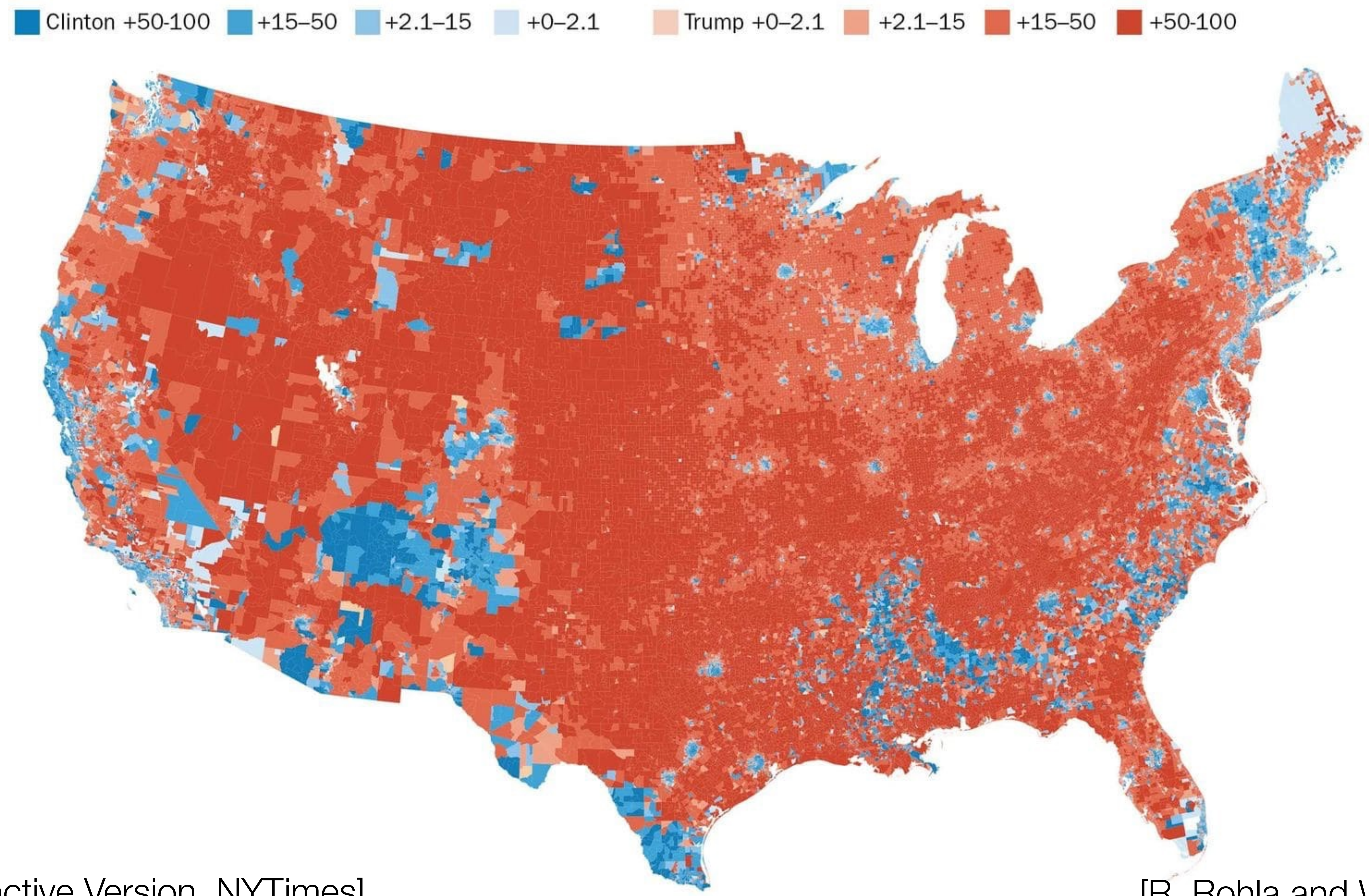
[Washington Post, 2018]

Area Marks and Color Hue & Saturation



[popvssoda.com]

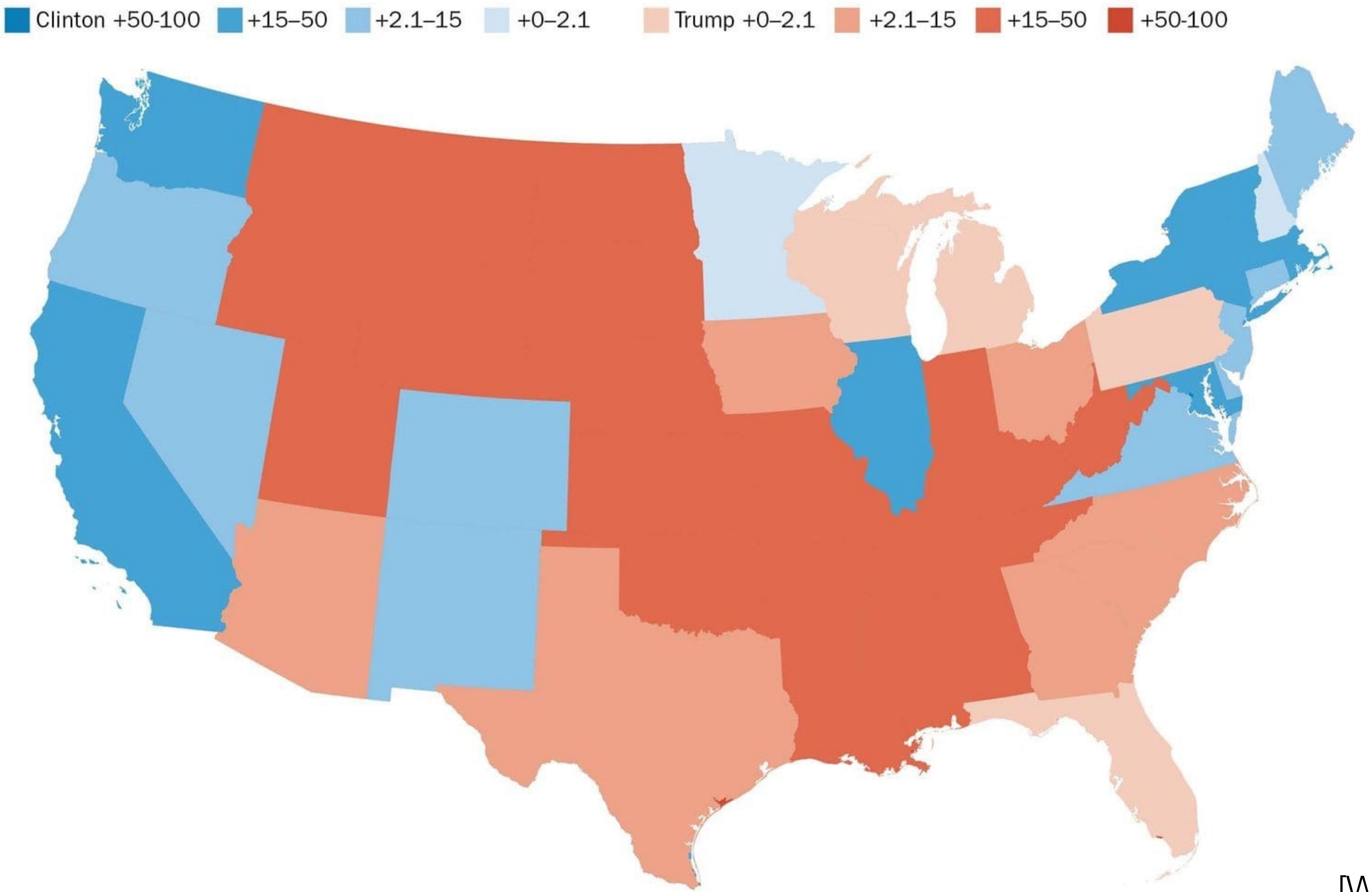
Aggregation: 2016 Election by Precinct



[Interactive Version, NYTimes]

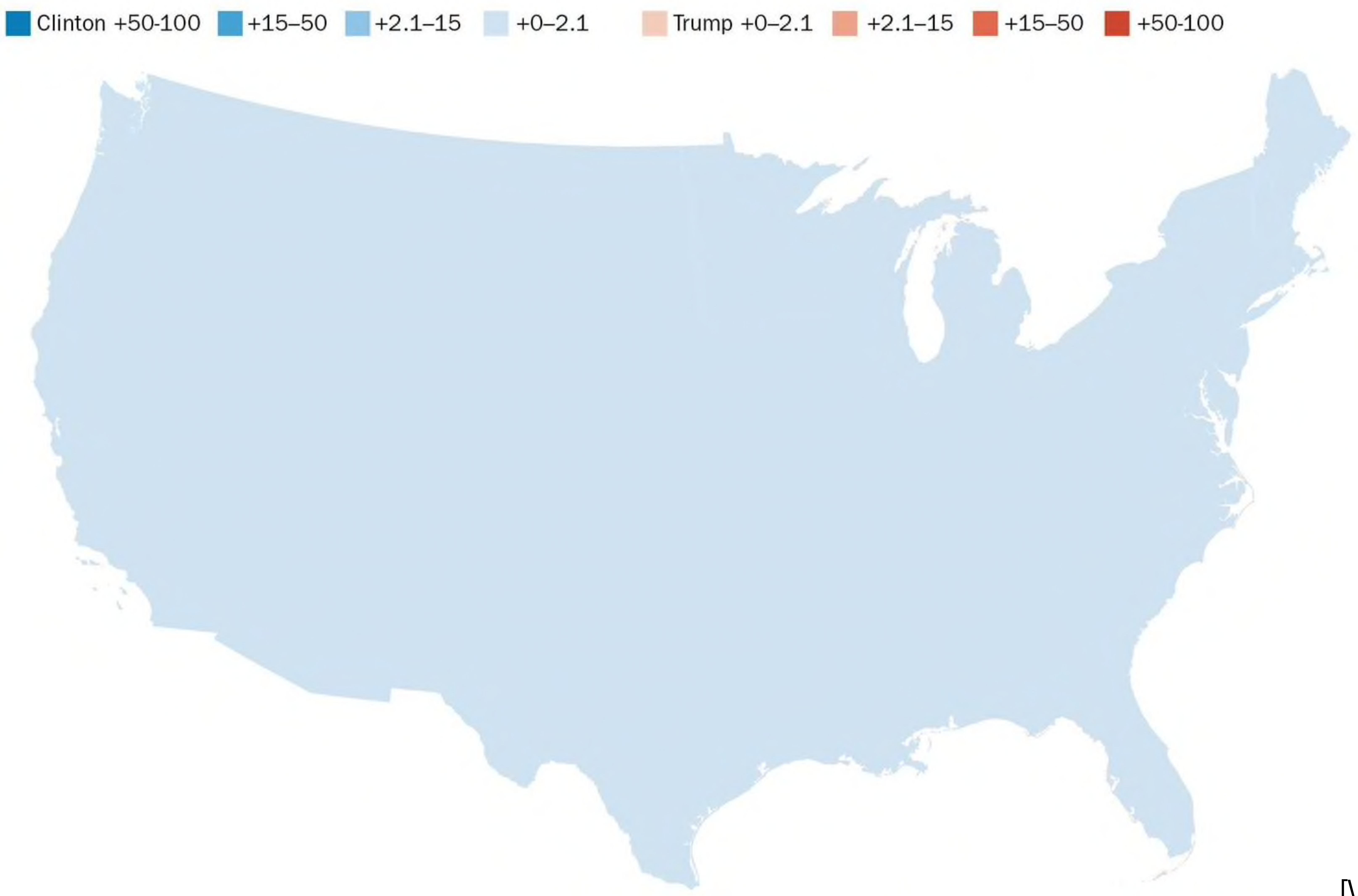
[R. Rohla and Washington Post, 2018]

Aggregation: 2016 Election by State



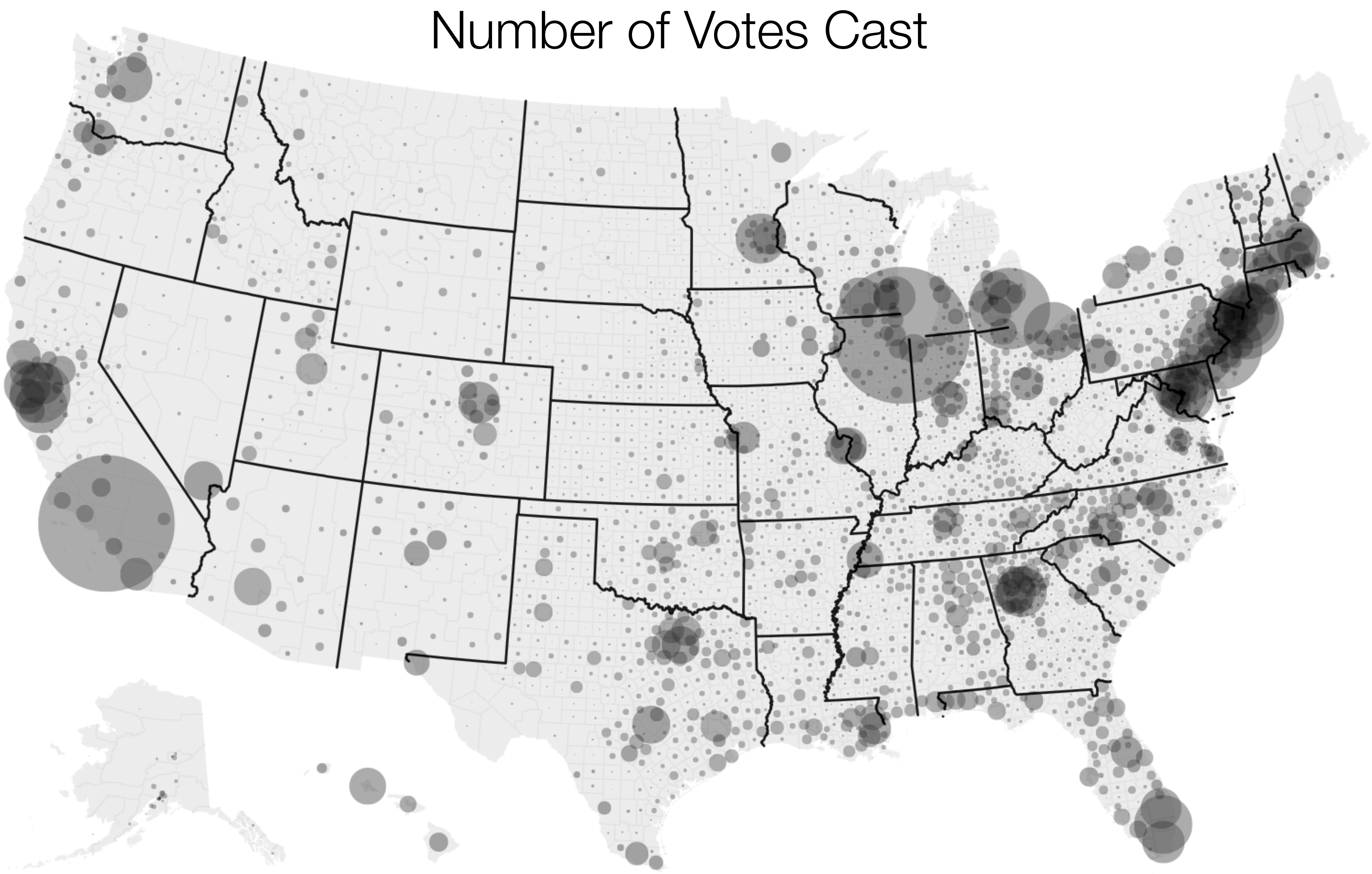
[Washington Post, 2018]

Aggregation: 2016 Election by Country



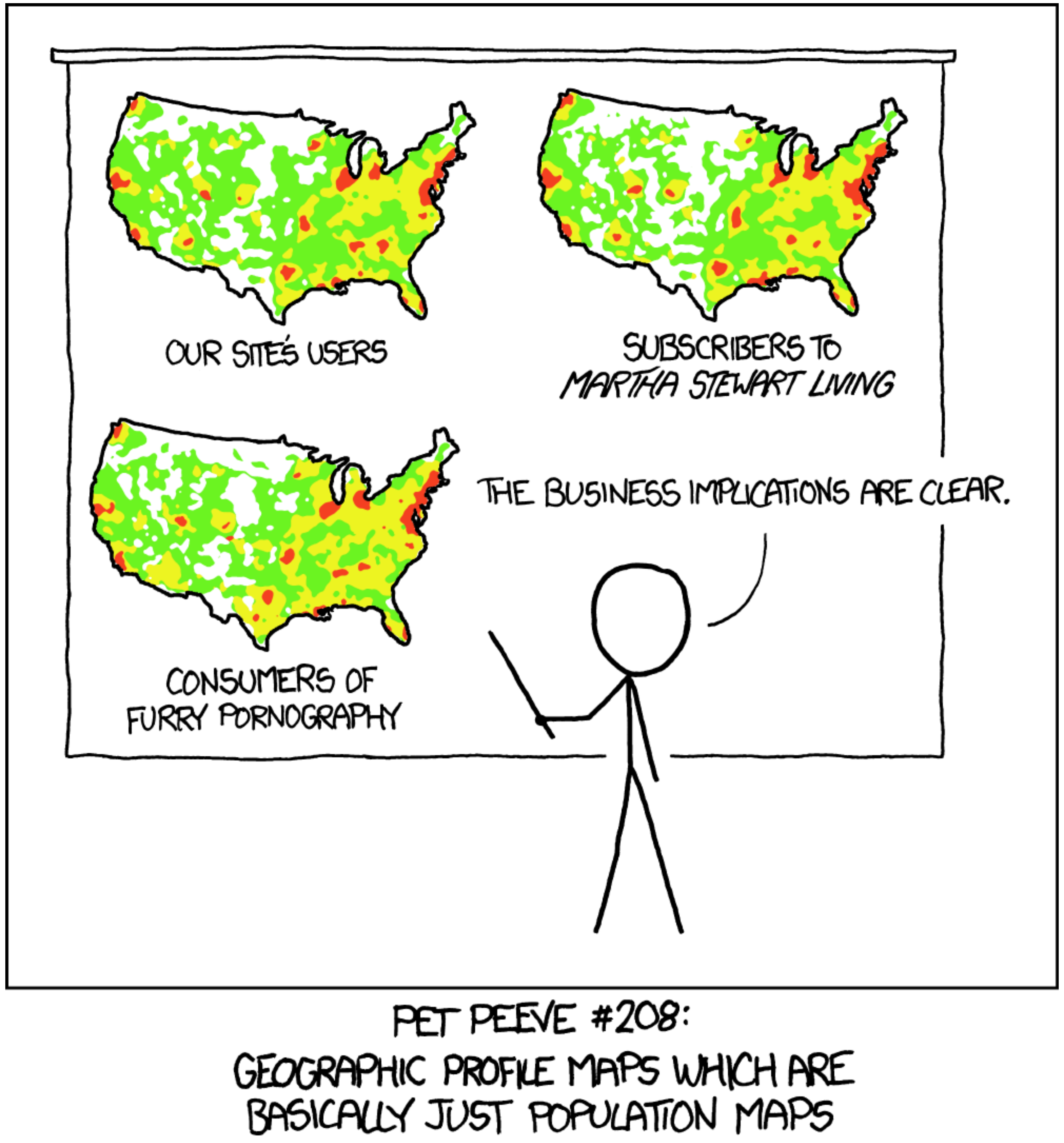
[Washington Post, 2018]

Maps: What trends do you see?



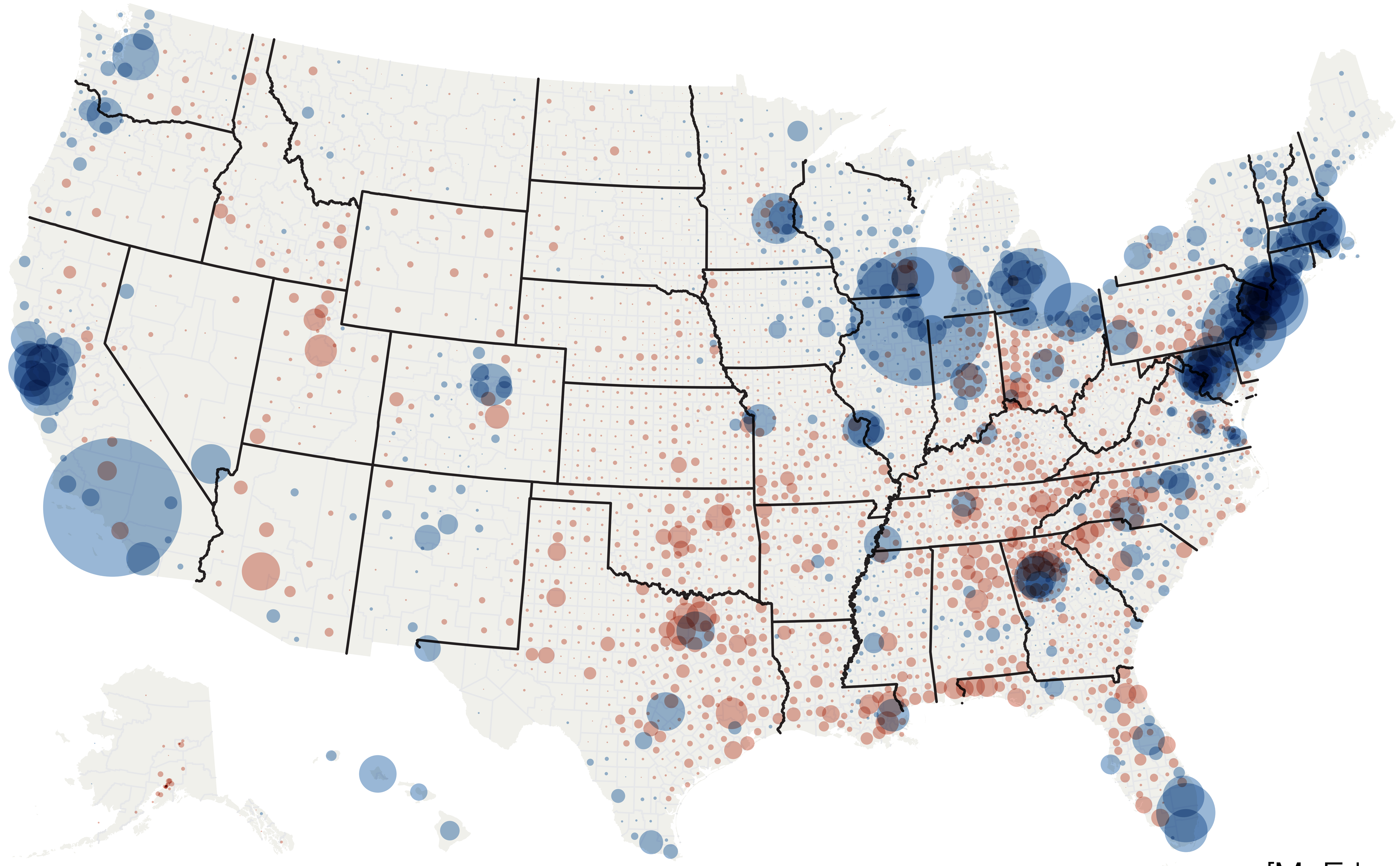
[Desaturated by D. Koop, M. Ericson, New York Times]

Don't Just Create Population Maps!



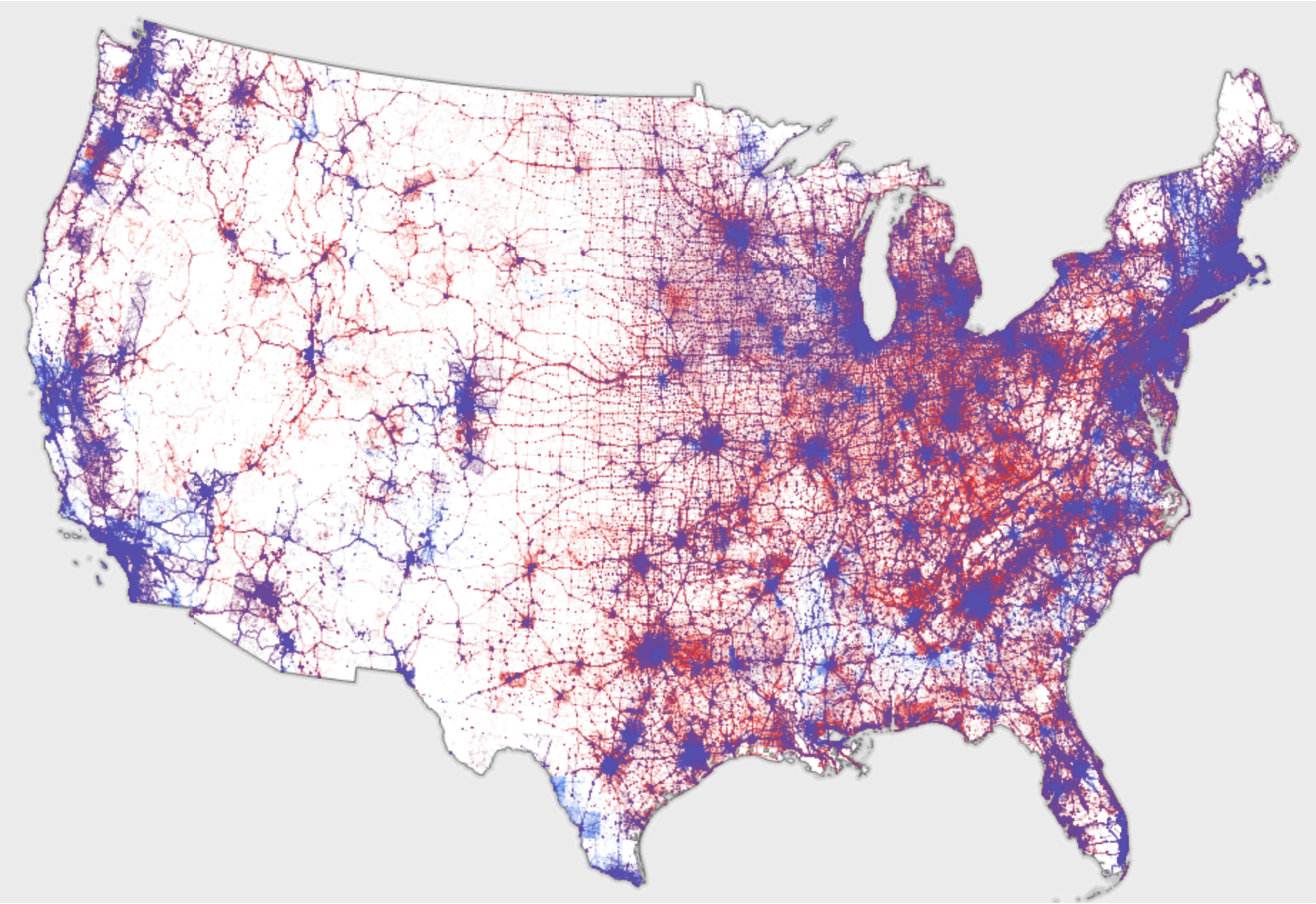
[xkcd]

Size Encoding



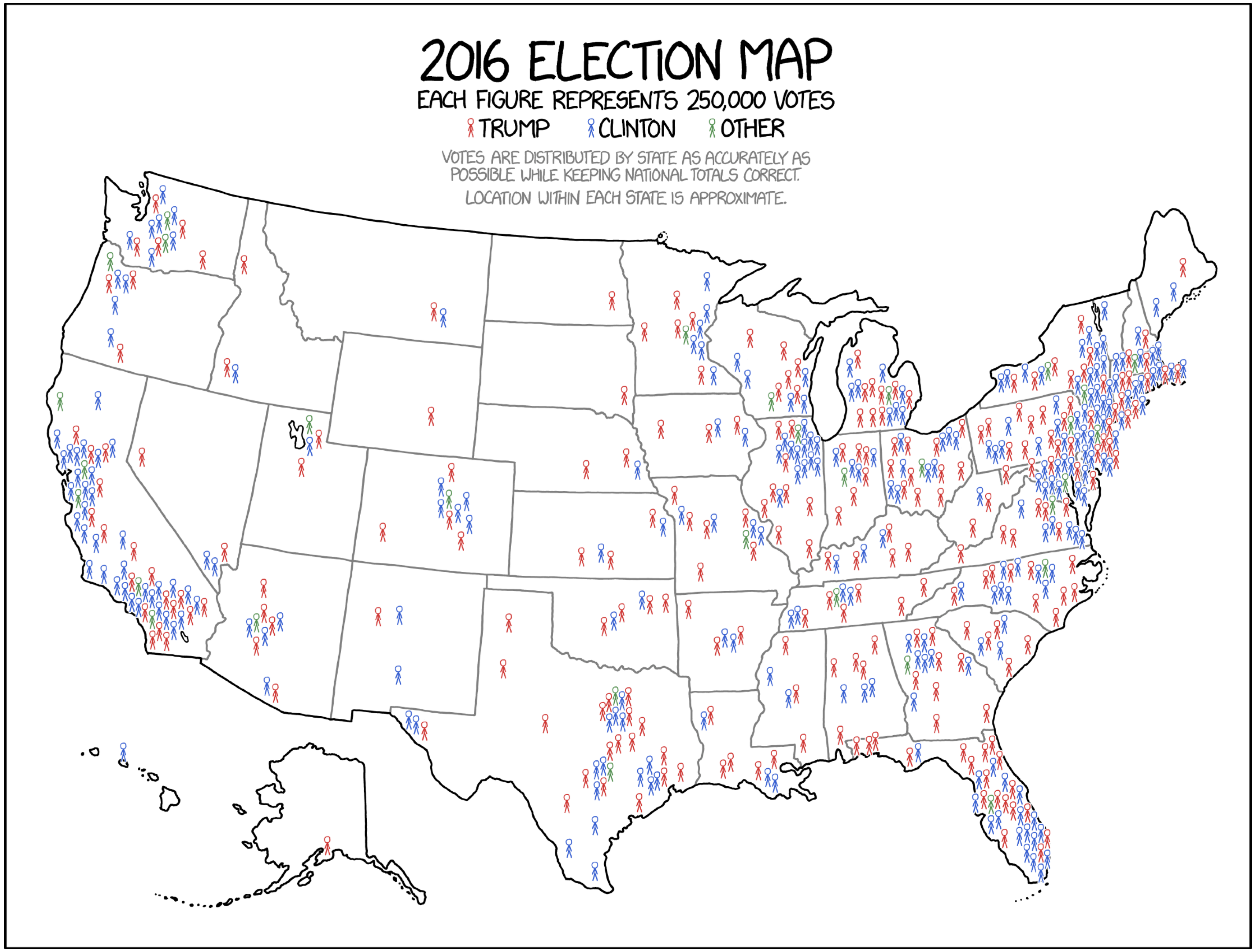
[M. Ericson, New York Times]

Dasymetric Dot Density



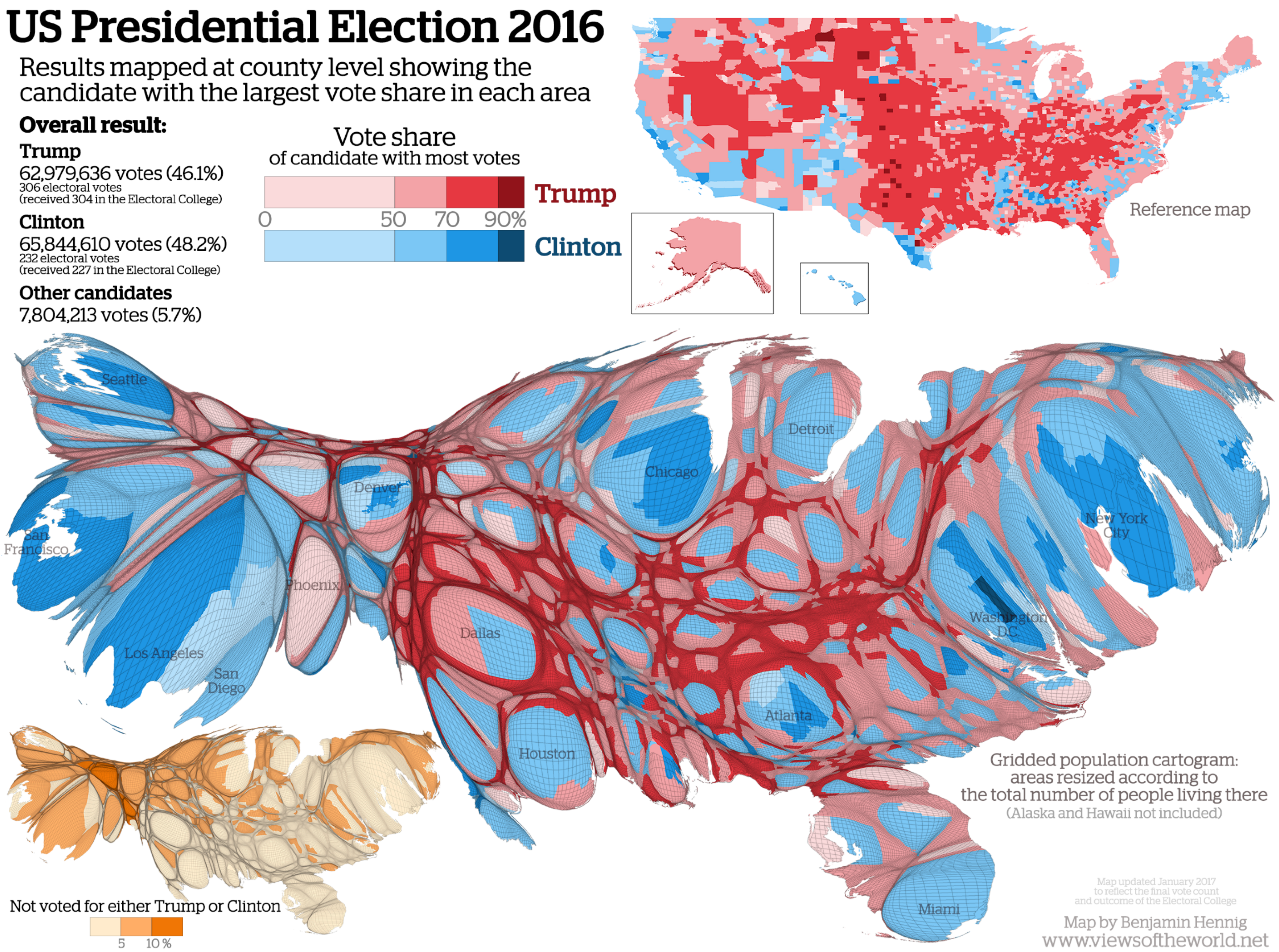
[K. Field]

Glyphs: xkcd's Map



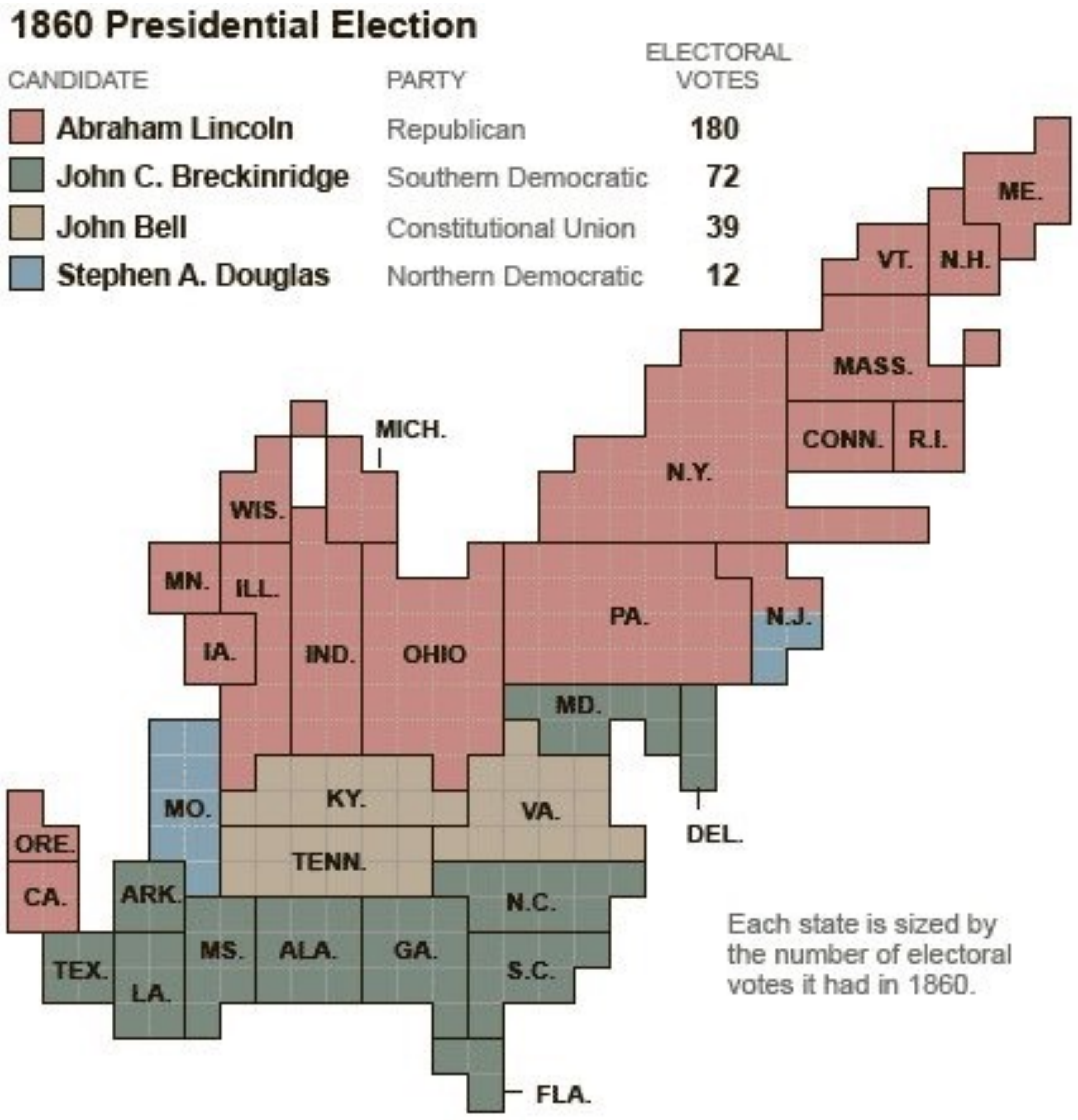
[xkcd]

Cartograms



[B. Hennig]

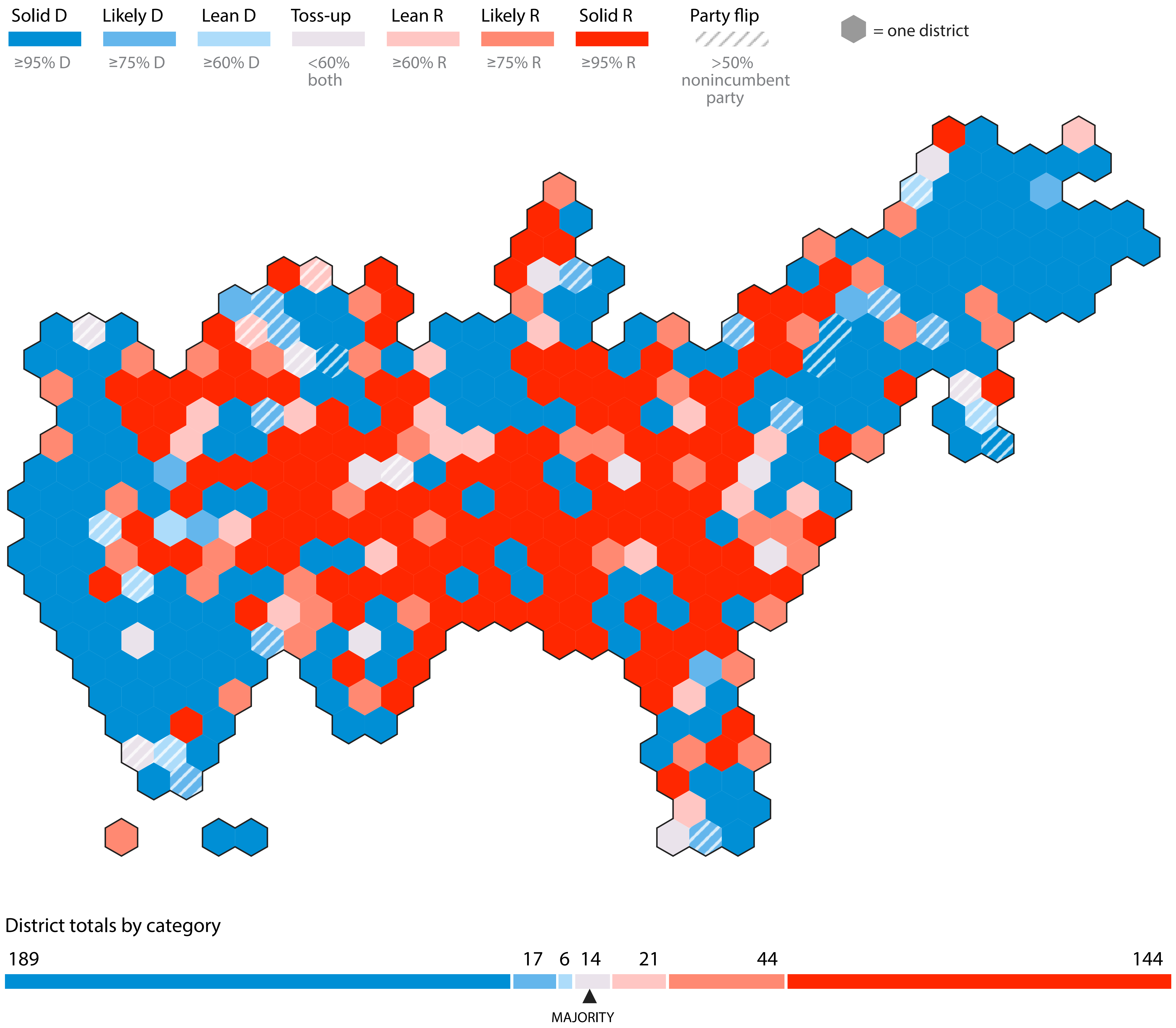
Cartograms



- 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

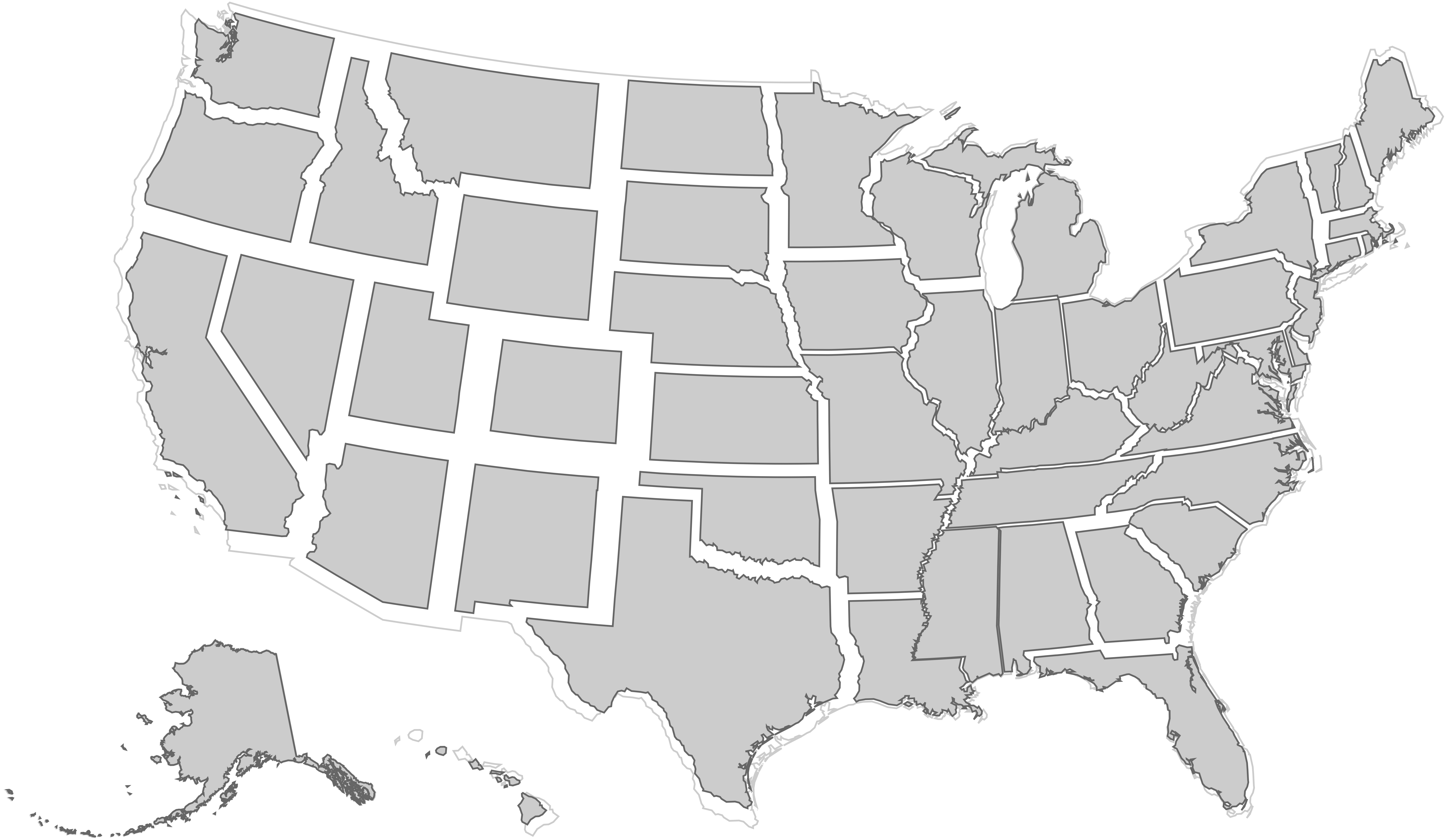
[New York Times]

Hexagonal Cartogram



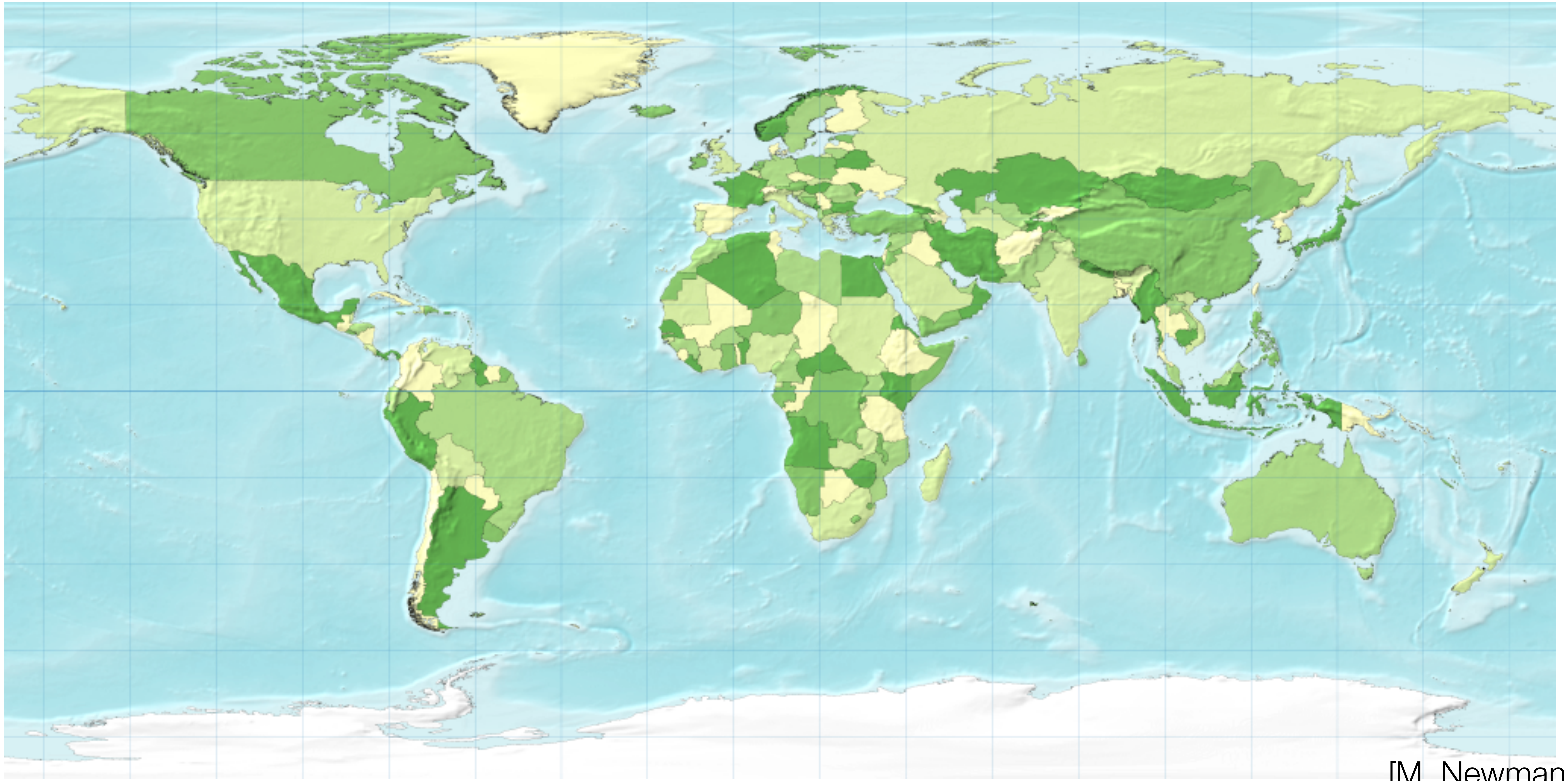
[FiveThirtyEight, 2018]

Non-Contiguous Cartogram



[M. Bostock, 2012]

World Cartograms

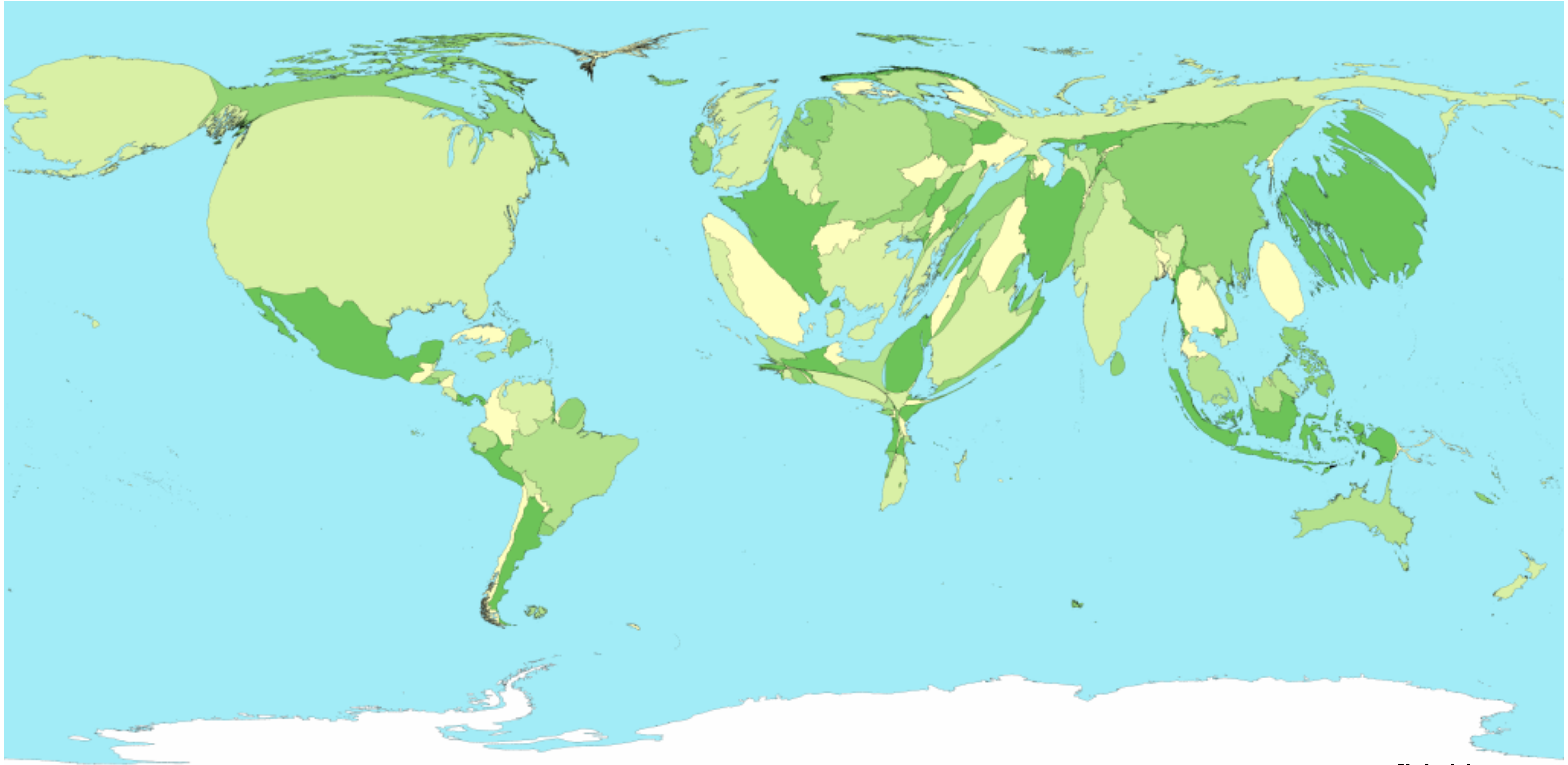


[M. Newman, 2009]

World Population

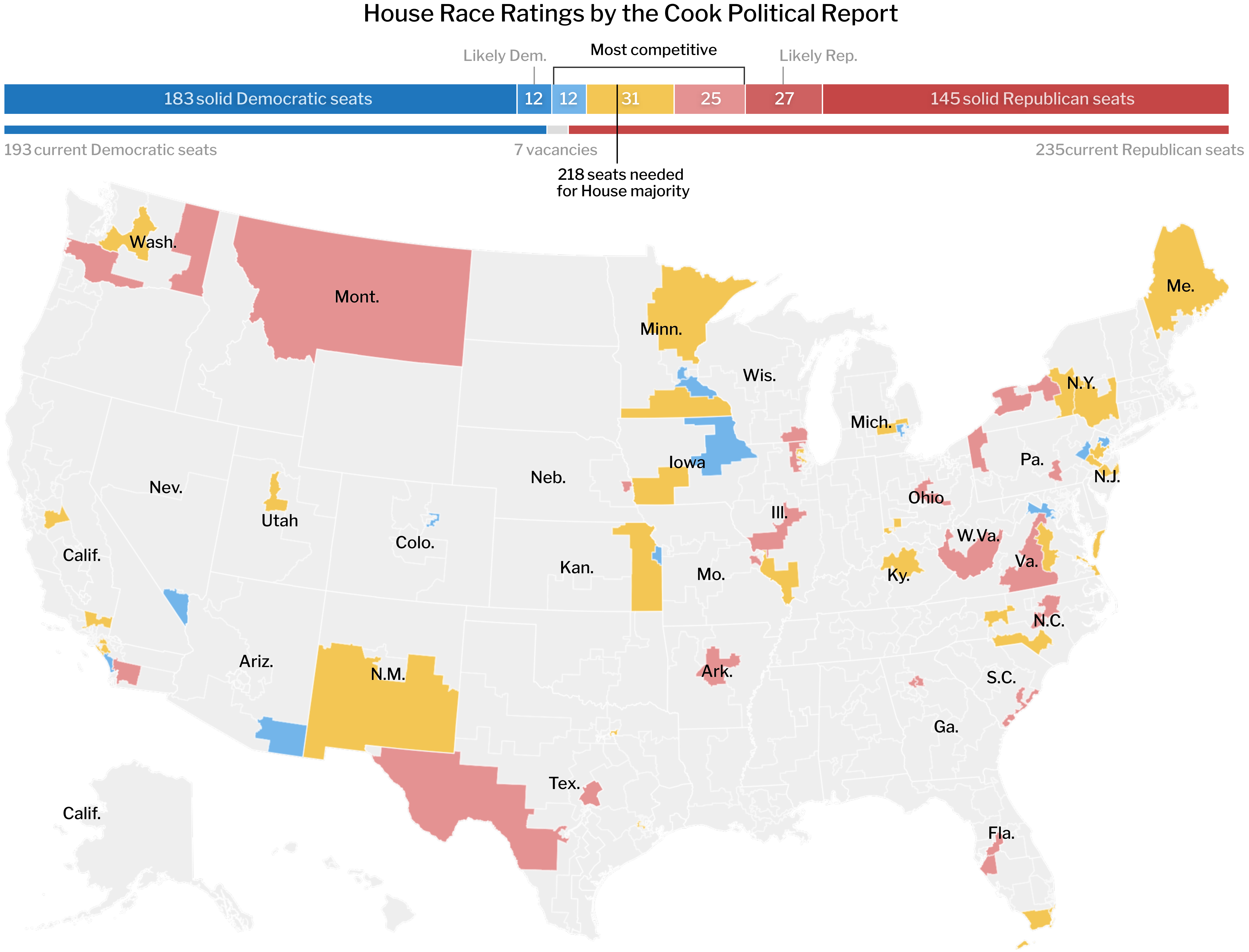
[M. Newman, 2009]

World Energy Consumption



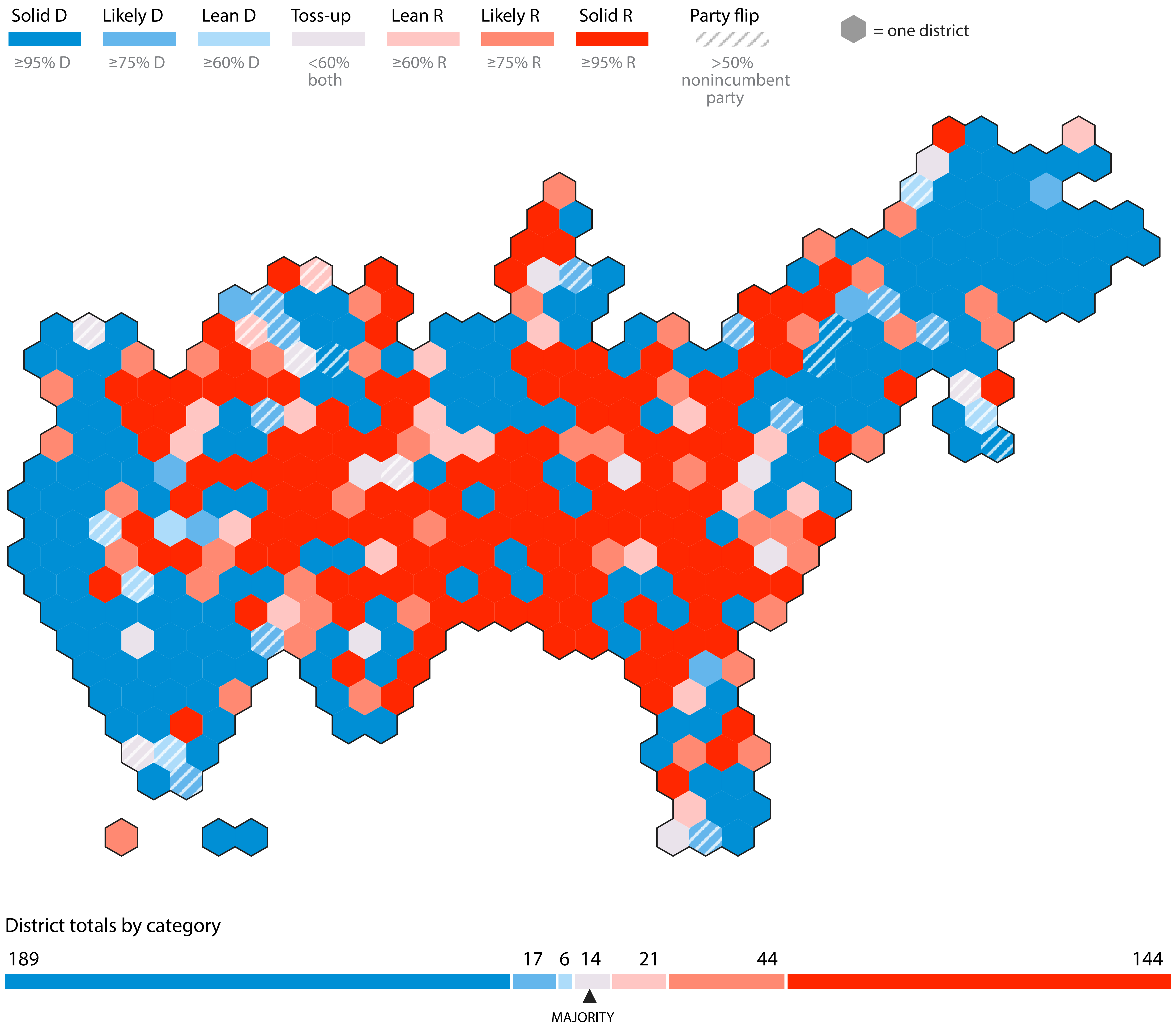
[M. Newman, 2009]

House Races: Map?



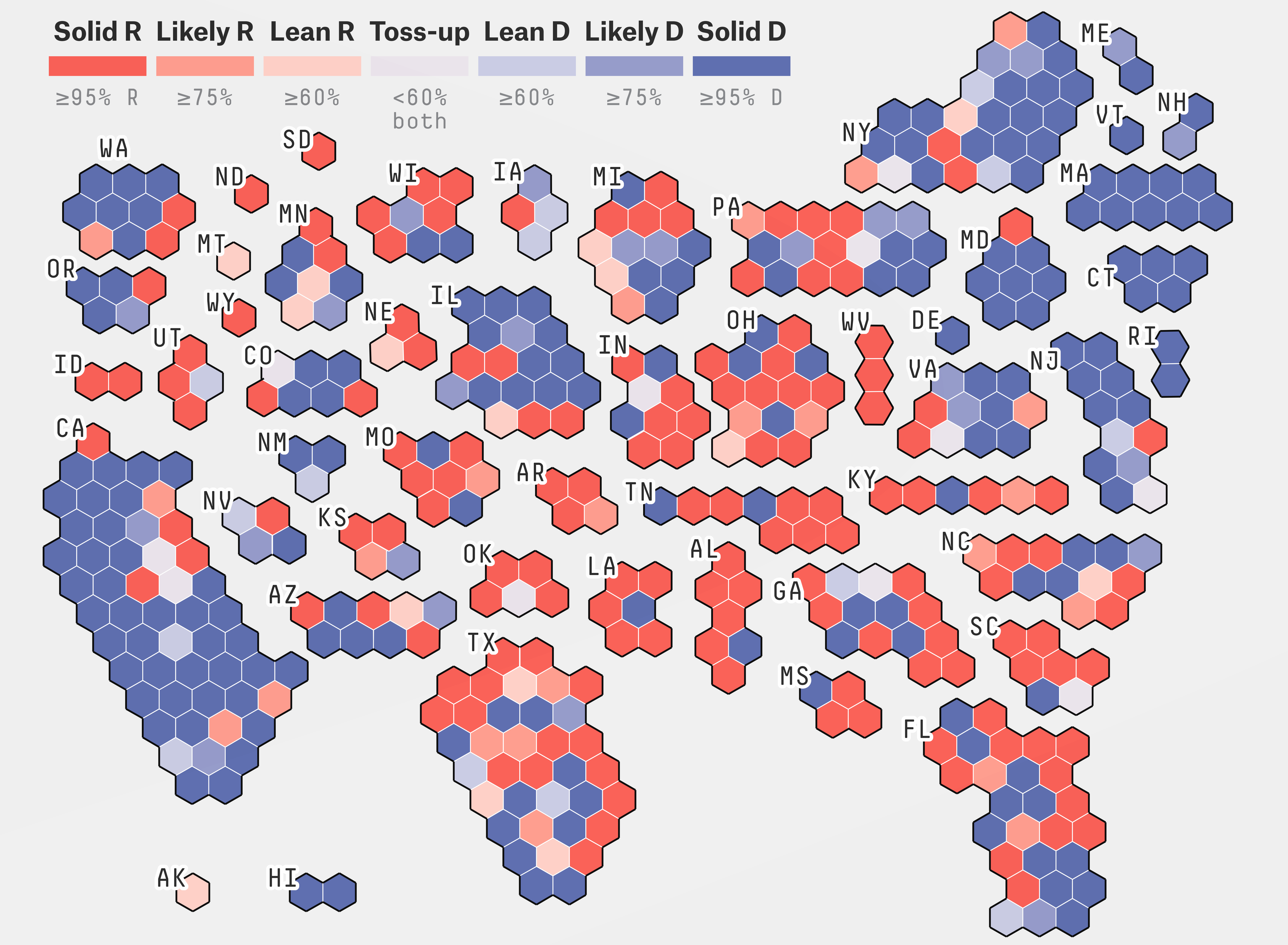
[New York Times, 2018]

House Races: Cartogram?



[FiveThirtyEight, 2018]

House Races: Non-Contiguous "Cartogram"



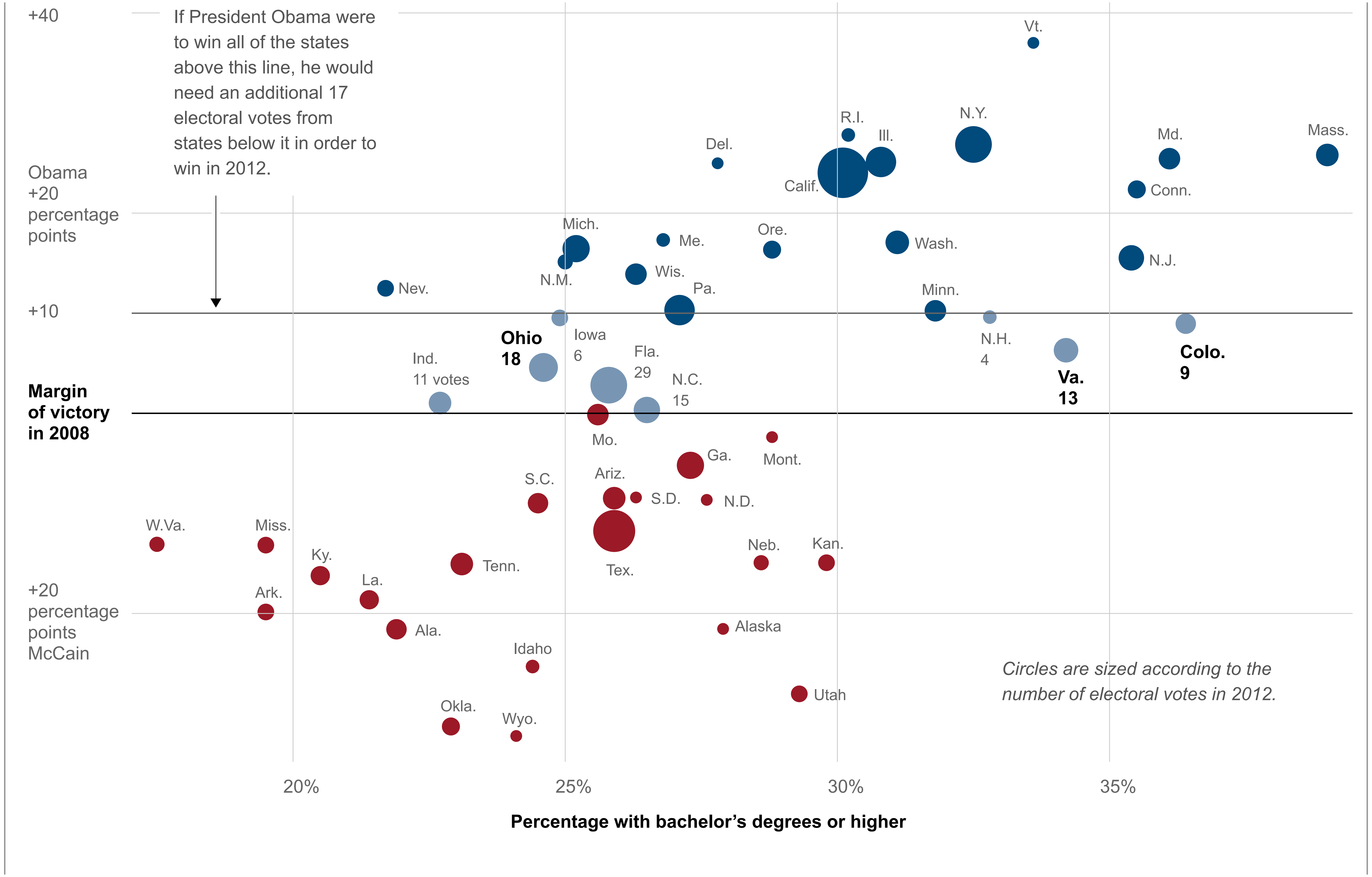
[FiveThirtyEight, 2020]

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]