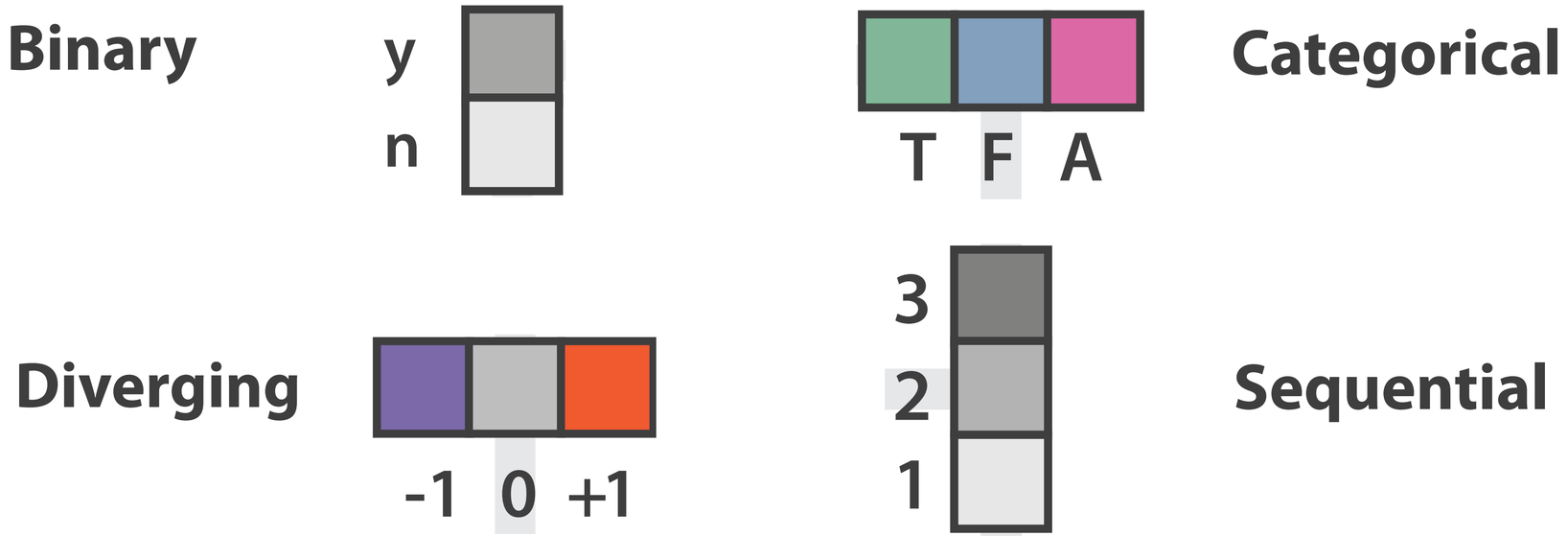
Data Visualization (CSCI 627/490)

Geospatial Data

Dr. David Koop

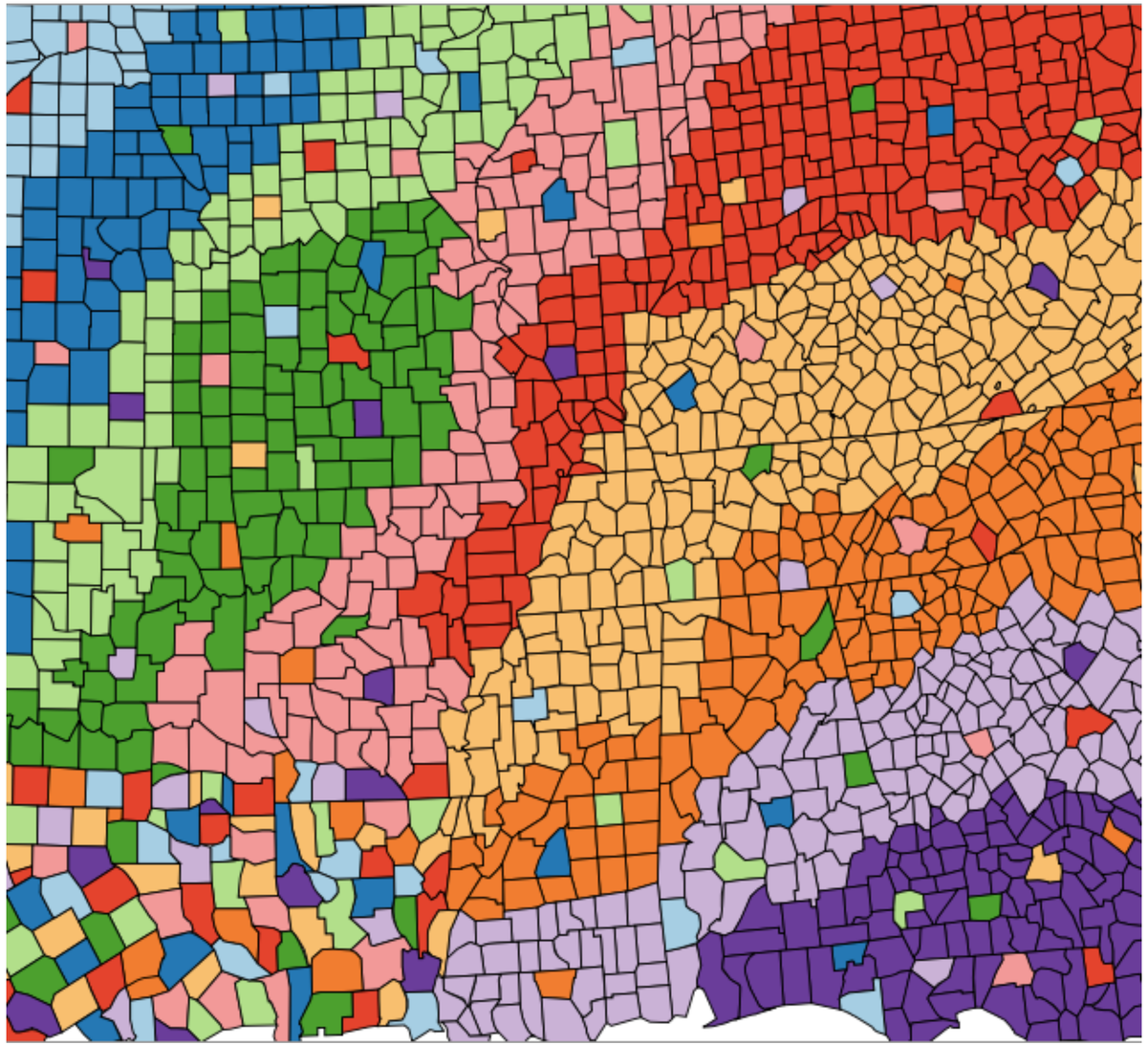
Colormap

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



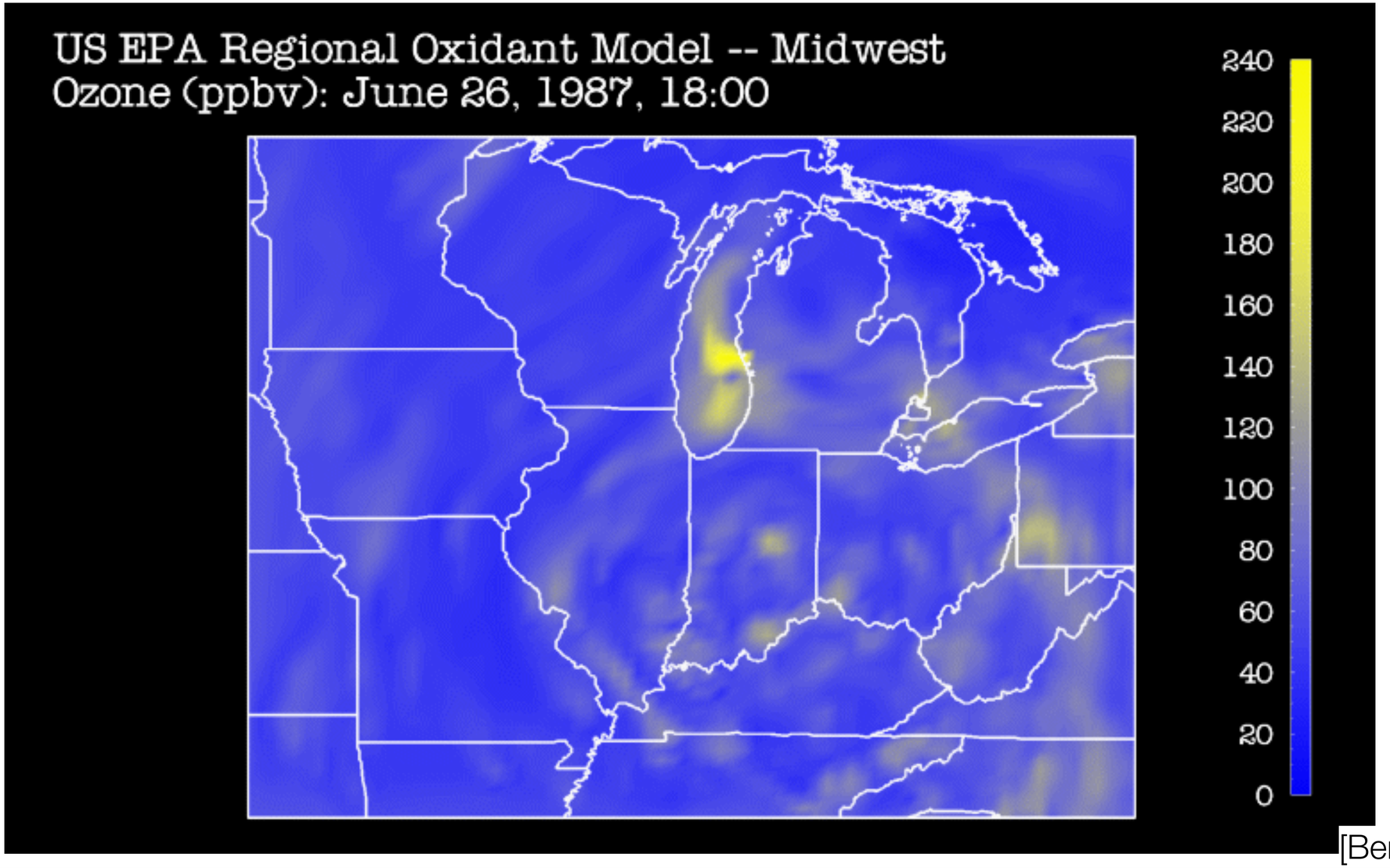
[Munzner (ill. Maguire), 2014]

Categorical Colormap Guidelines



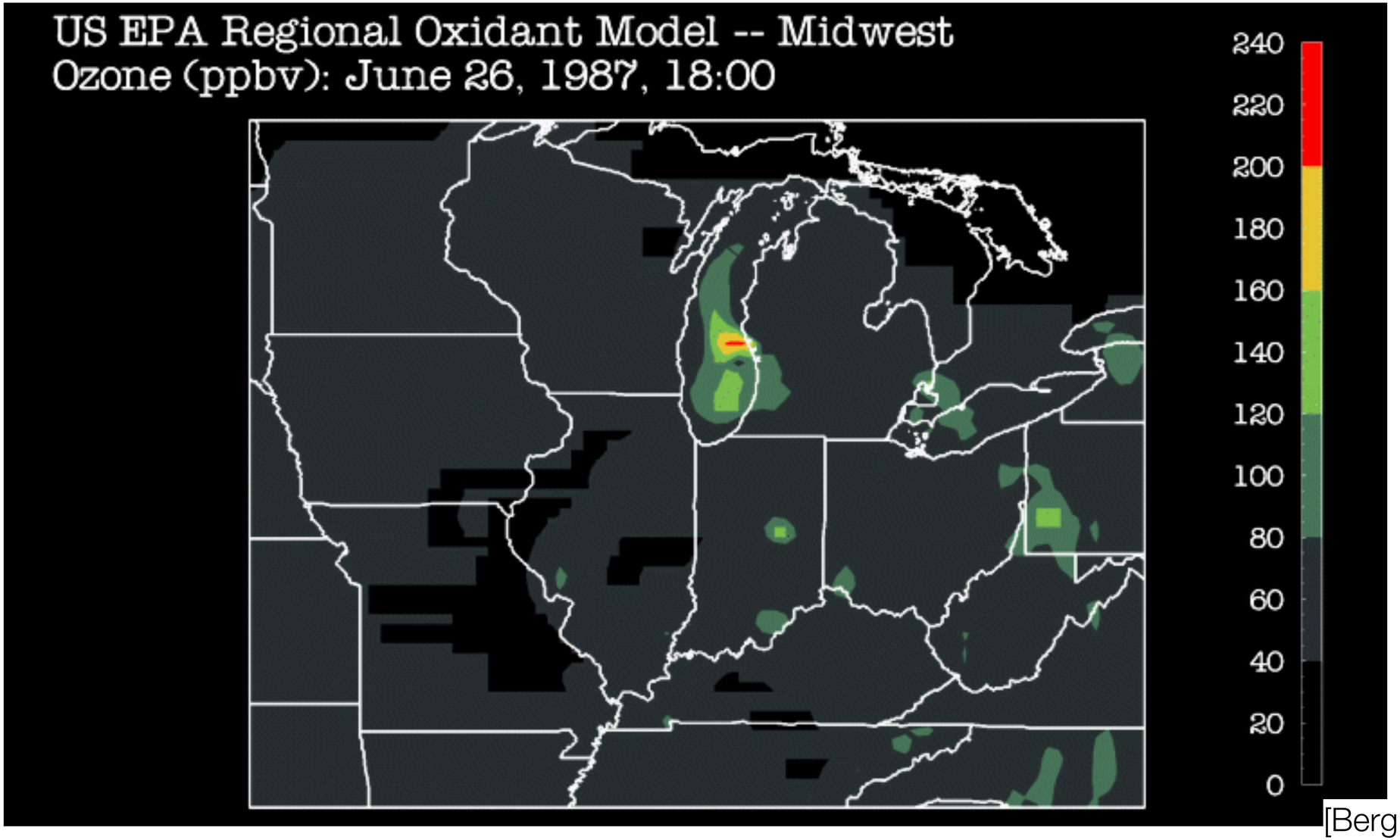
- Don't use too many colors (~12)
- Use other categories or create groups if you have too many values!
- Nameable colors help
- Be aware of luminance (e.g. difference between blue and yellow)
- Think about other marks you might wish to use in the visualization

Continuous Colormap for Ordered Data



[Bergman et al., 1995]

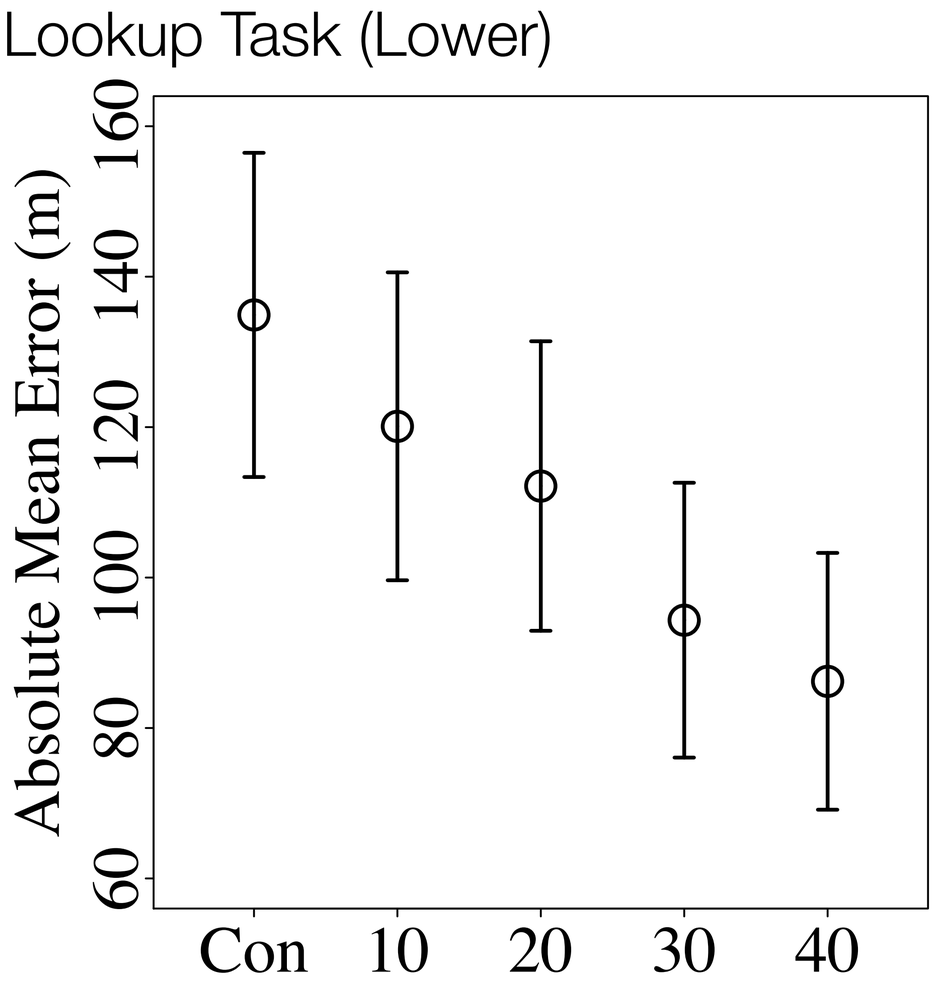
Segmented Colormap for Ordered Data



[Bergman et al., 1995]

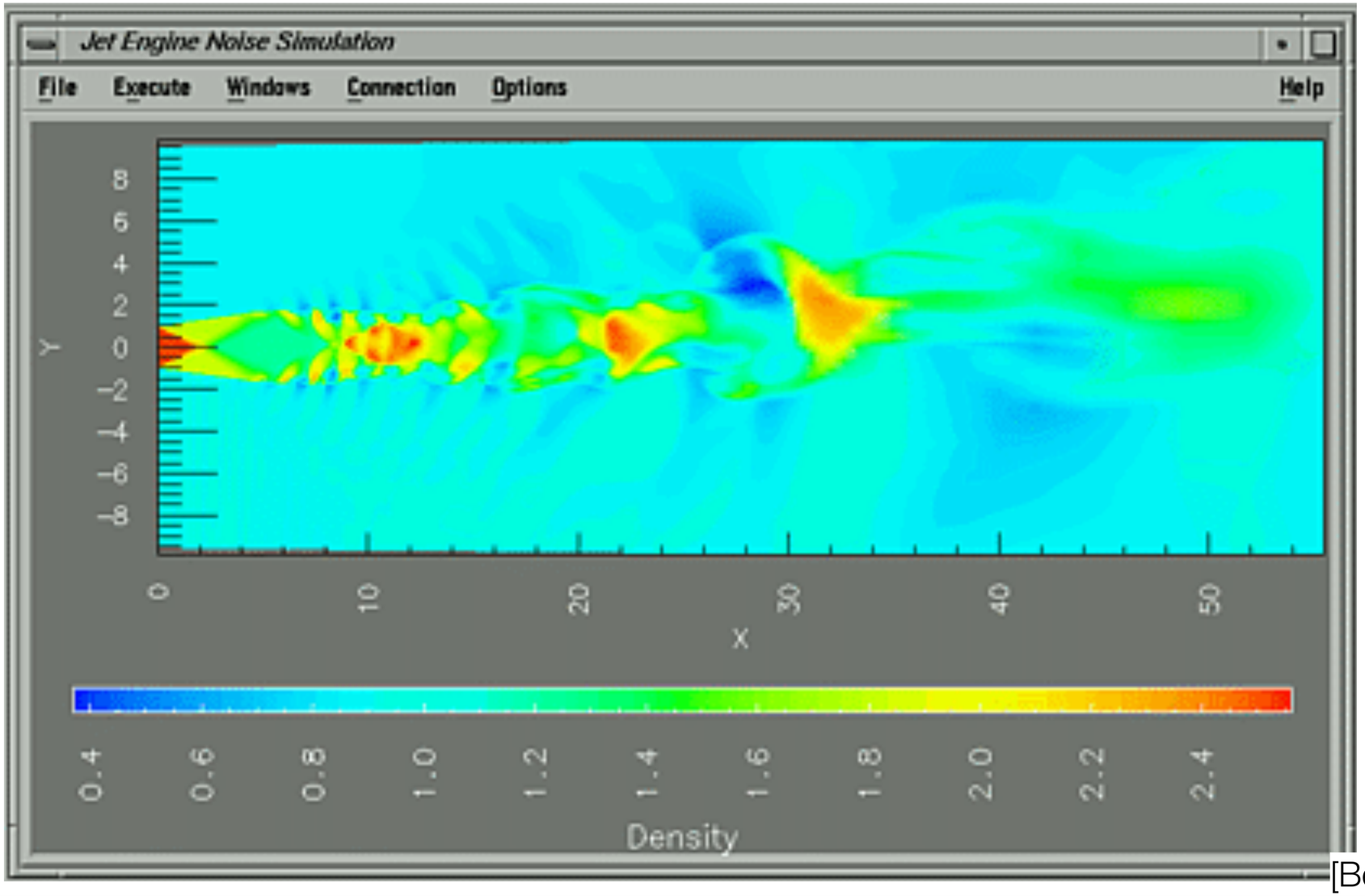
Continuous vs. Segmented Test Results

- "[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!



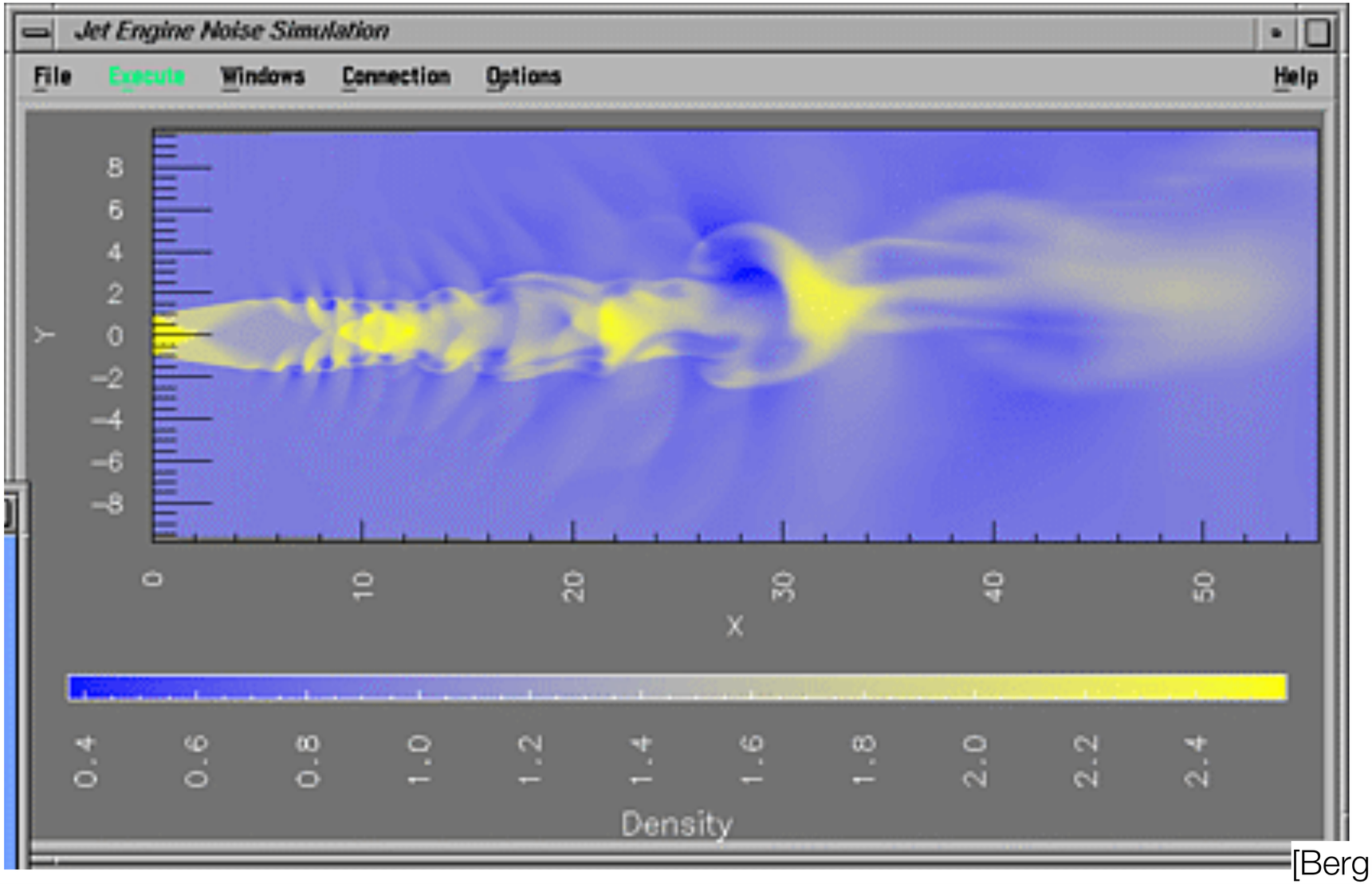
[Padilla et al., 2017]

Rainbow Colormap



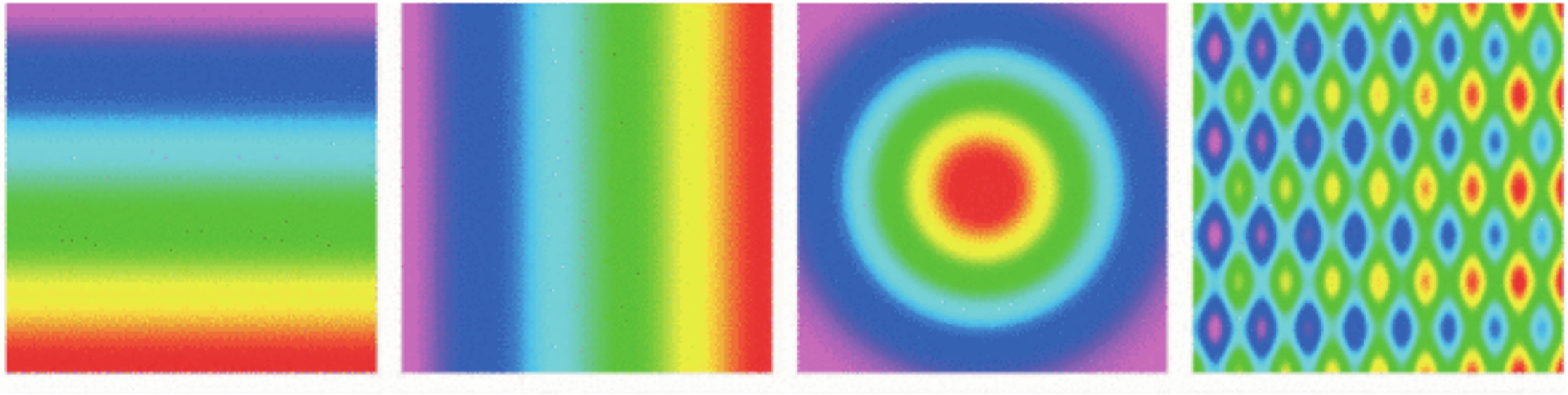
[Bergman et al., 1995]

Two-Hue Colormap



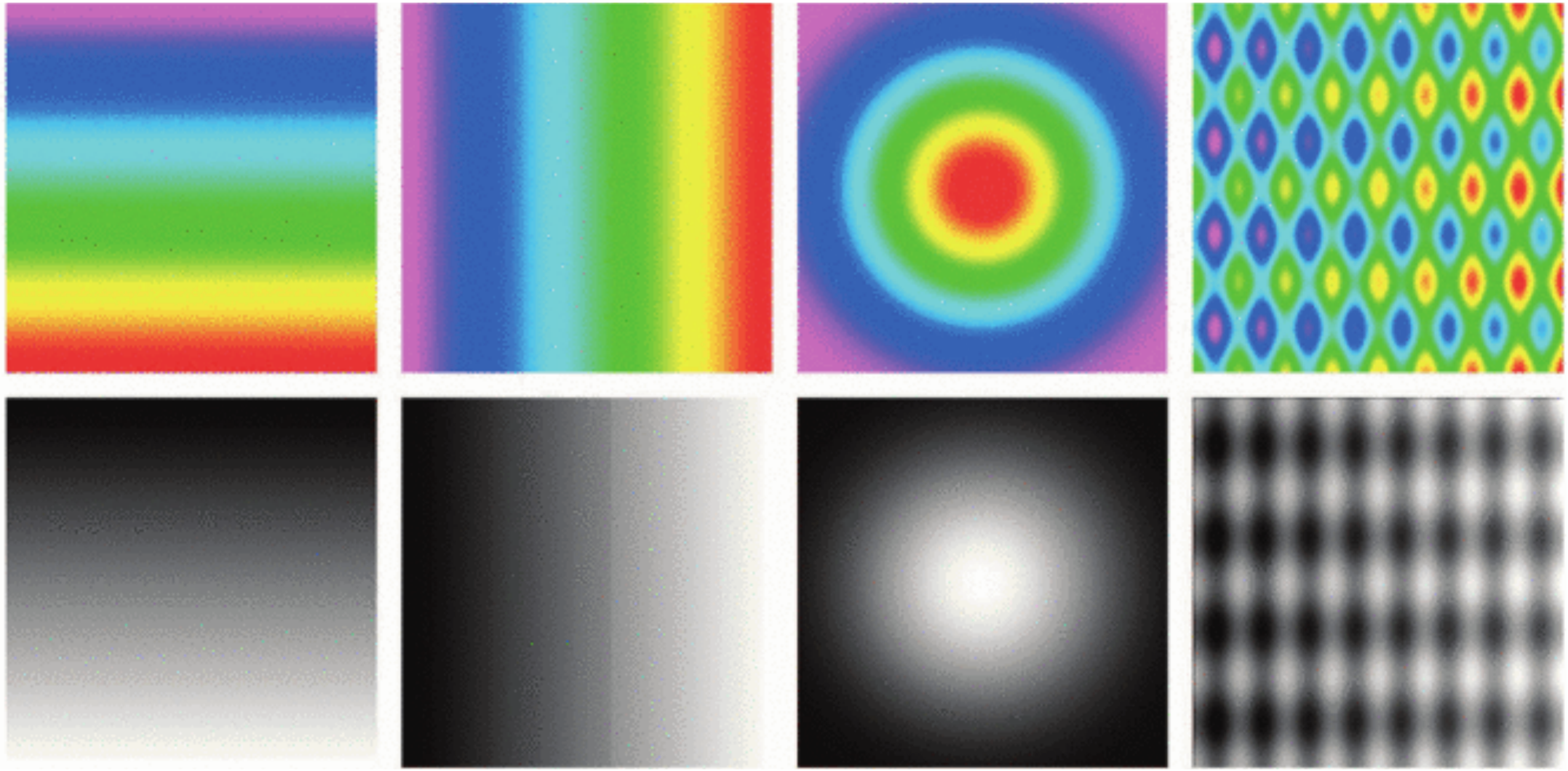
[Bergman et al., 1995]

Artifacts from Rainbow Colormaps



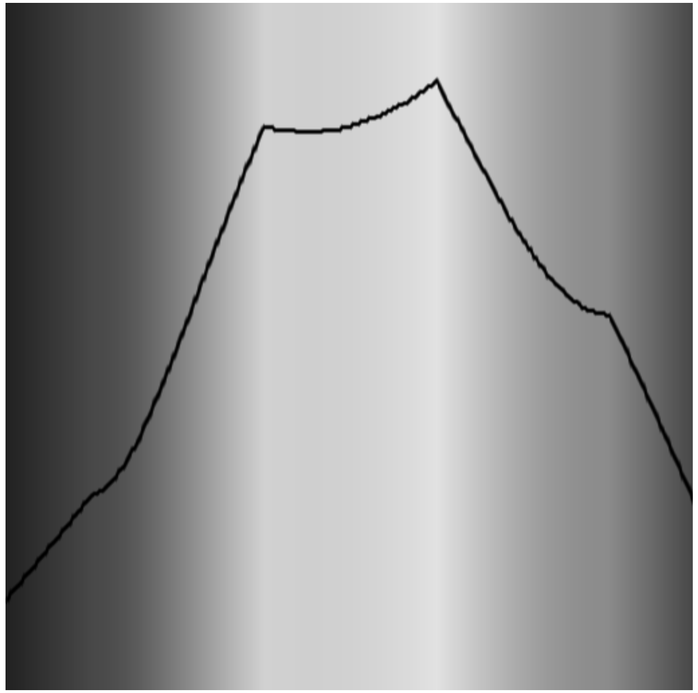
[Borland & Taylor, 2007]

Artifacts from Rainbow Colormaps

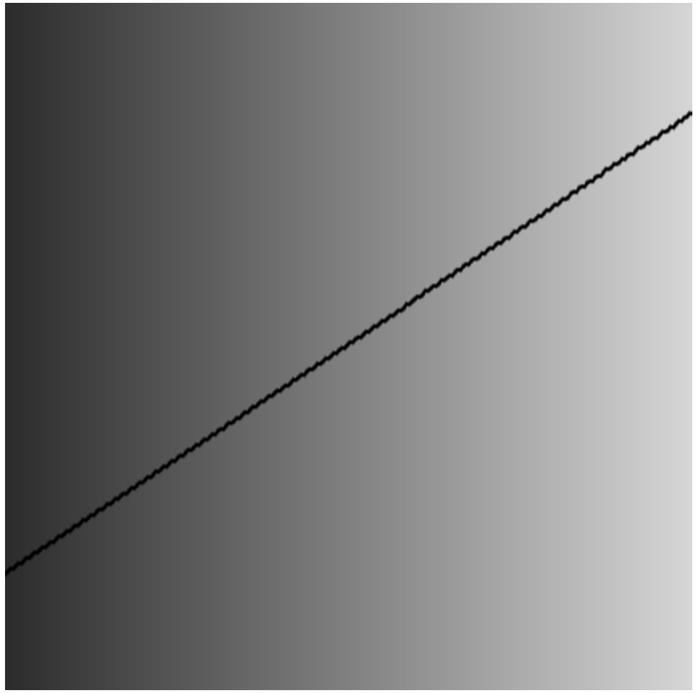


[Borland & Taylor, 2007]

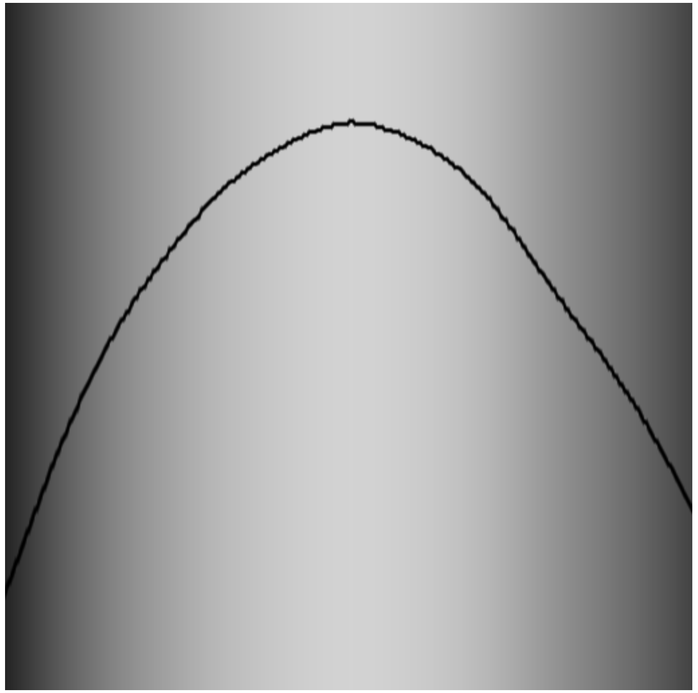
Turbo: Improving Rainbow Colormaps



Jet



Viridis



Turbo

[A. Mikhailov]

Midterm

- Thursday, October 13
- 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
  - NFL Data
  - Colorado River Data
  - Prescription Drug Cost Data
  - Others?
- Work on Proposal

Don't Dance Around the Color Wheel

NOT IDEAL

BETTER

[L. C. Rost]

Use Warm Colors & Blue

NOT IDEAL

BETTER

[L. C. Rost]

Avoid Too Little Contrast to Background

NOT IDEAL

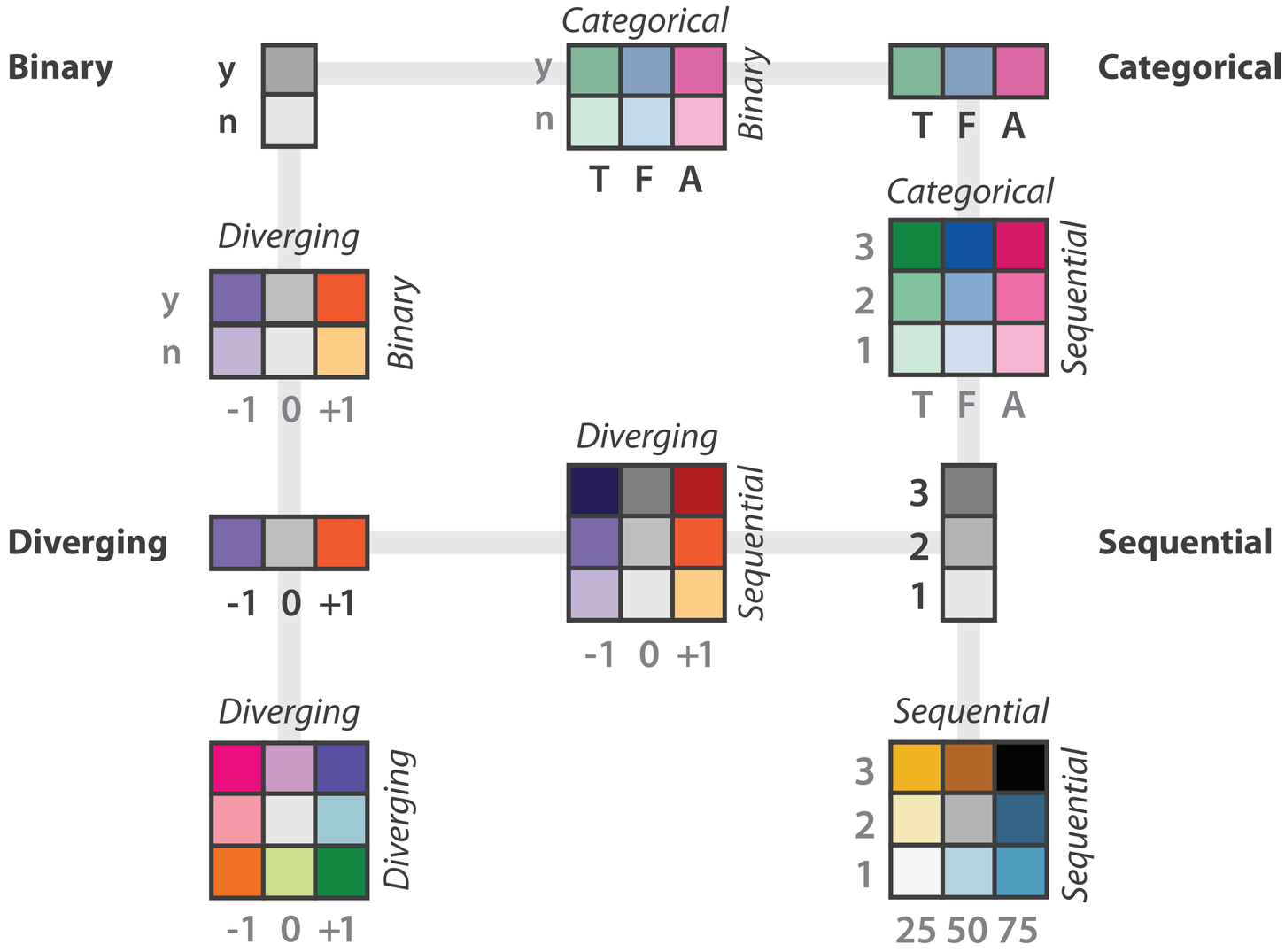
BETTER

[L. C. Rost]

D3's color scales

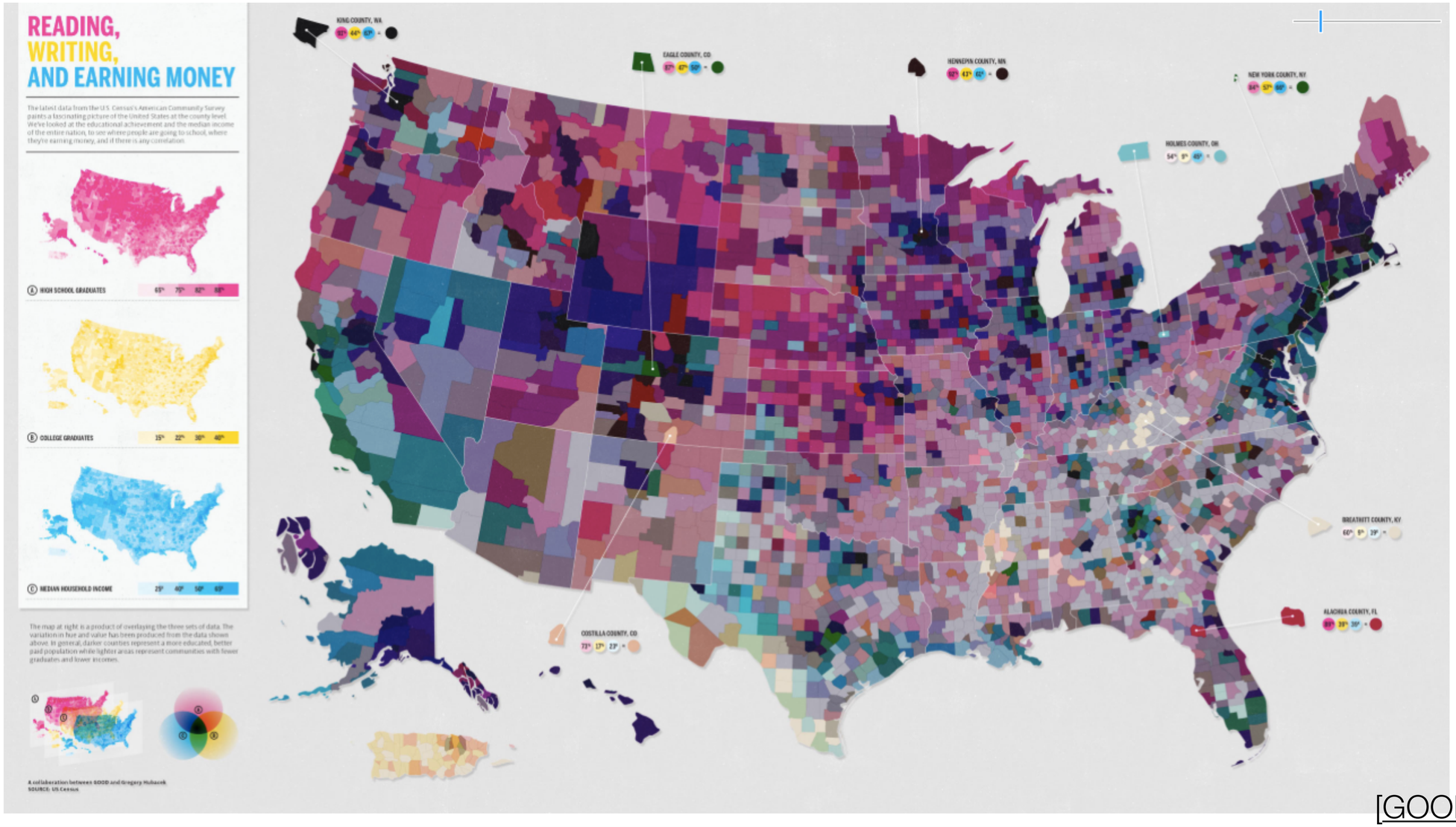
- https://github.com/d3/d3-scale-chromatic
- In v7, included in default bundle (no separate import)
- D3's built-in color scales
- Derived from ColorBrewer
- Sequential and diverging scales created using interpolation
- Hue **can** change, but be careful
- Color ramp [M. Bostock]

Bivariate Colormaps



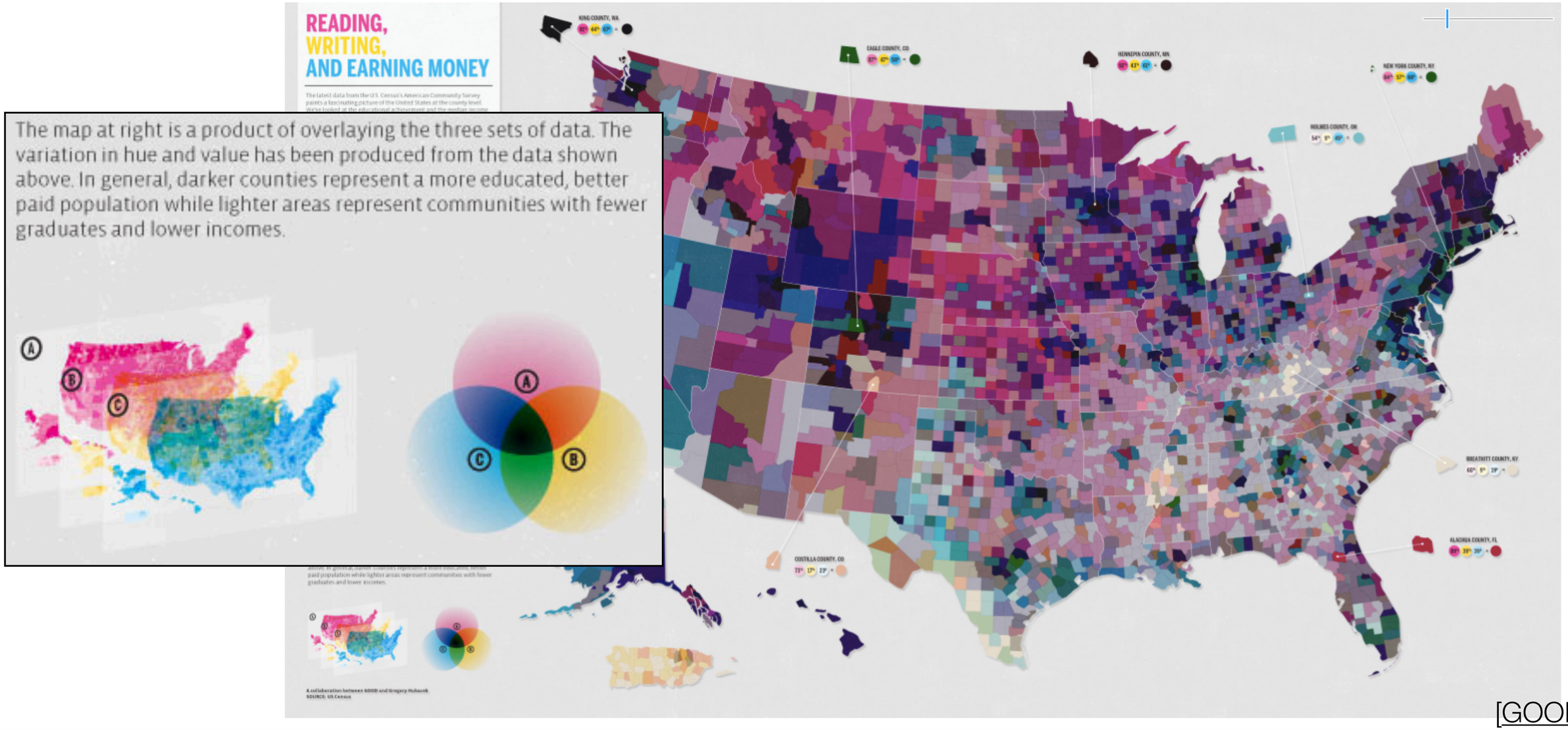
[Munzner (ill. Maguire), 2014]

Remember Separable vs. Integral



[GOOD]

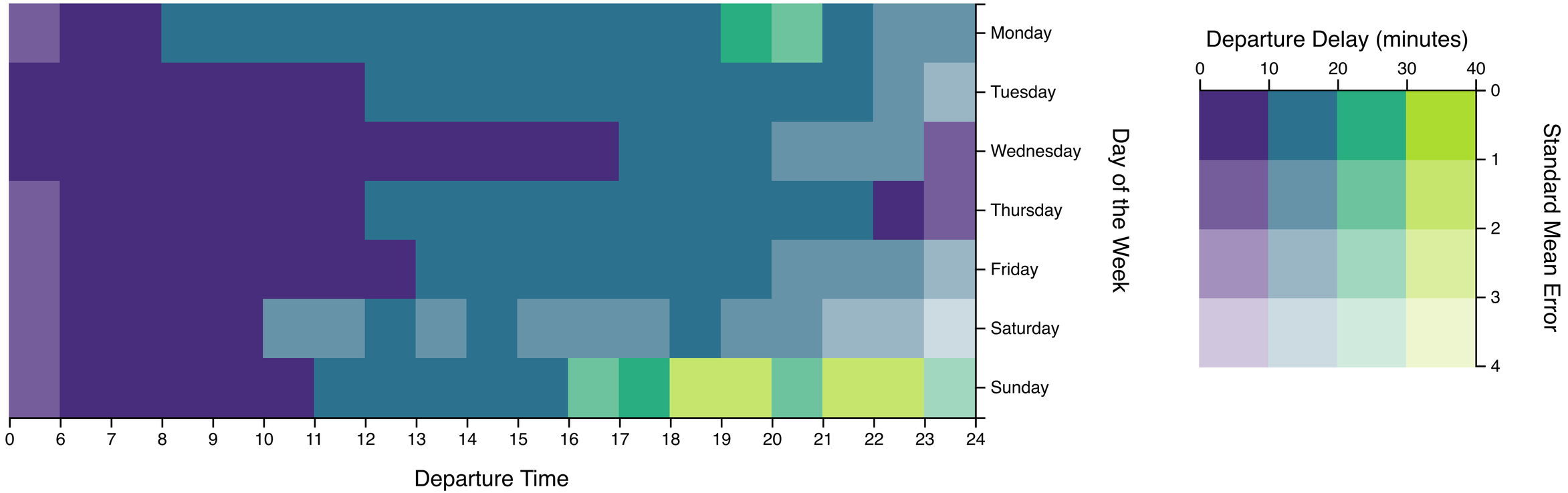
Remember Separable vs. Integral



[GOOD]

What about uncertain data?

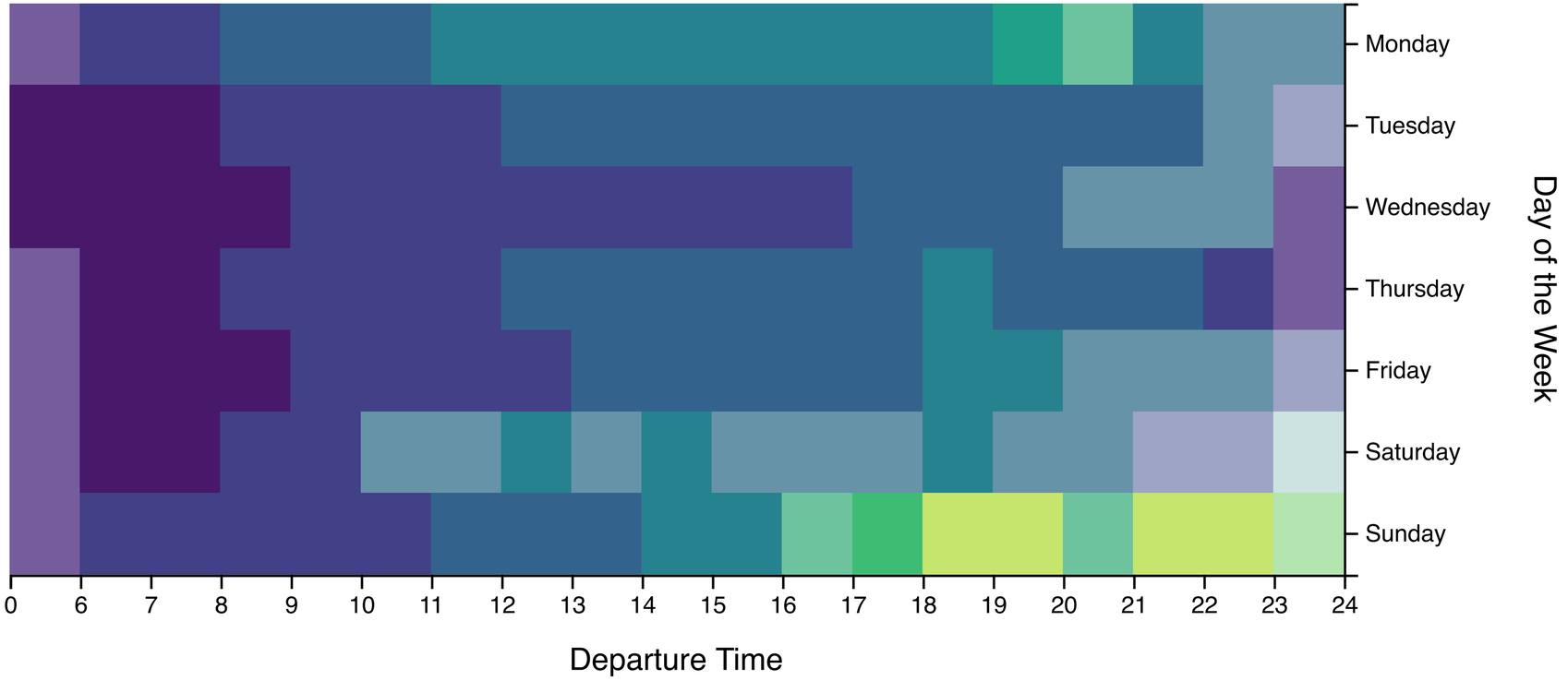
Bivariate Colormap (Uncertainty → Saturation)

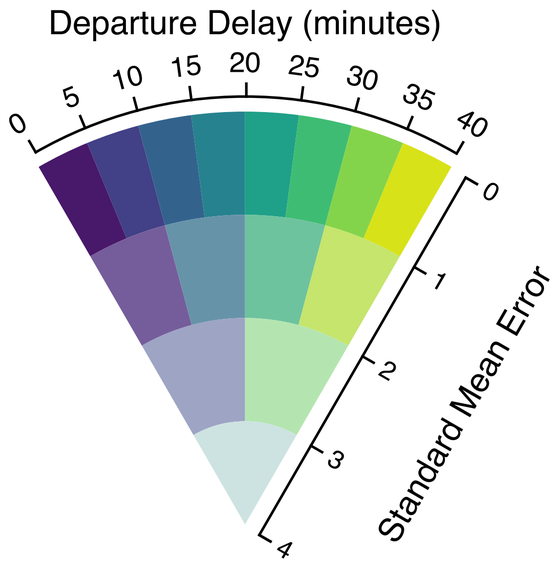


[Correll et al., 2018]

Value-Suppressing Uncertainty Palette (VSUP)

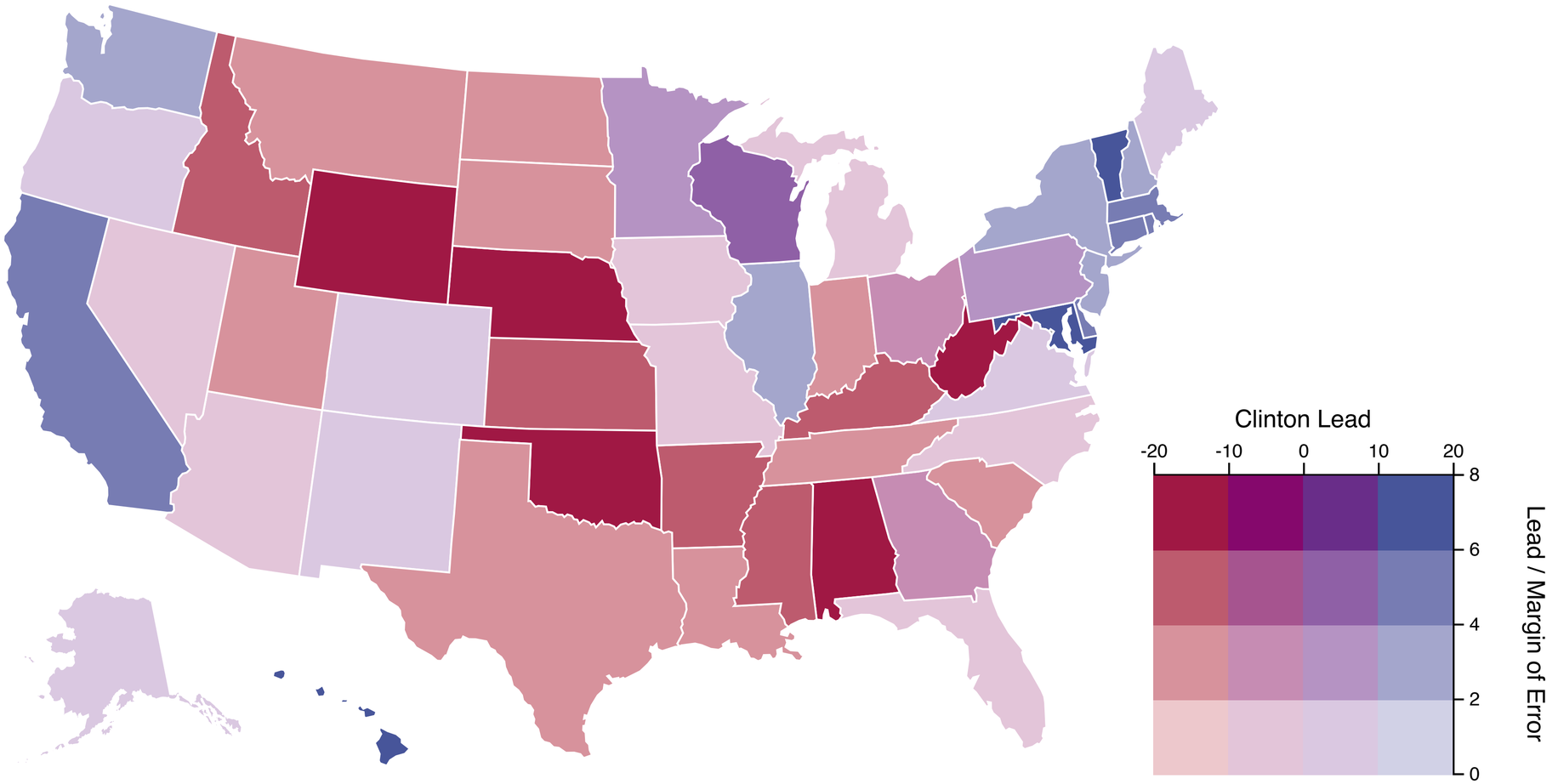
Same Channels, just binned differently





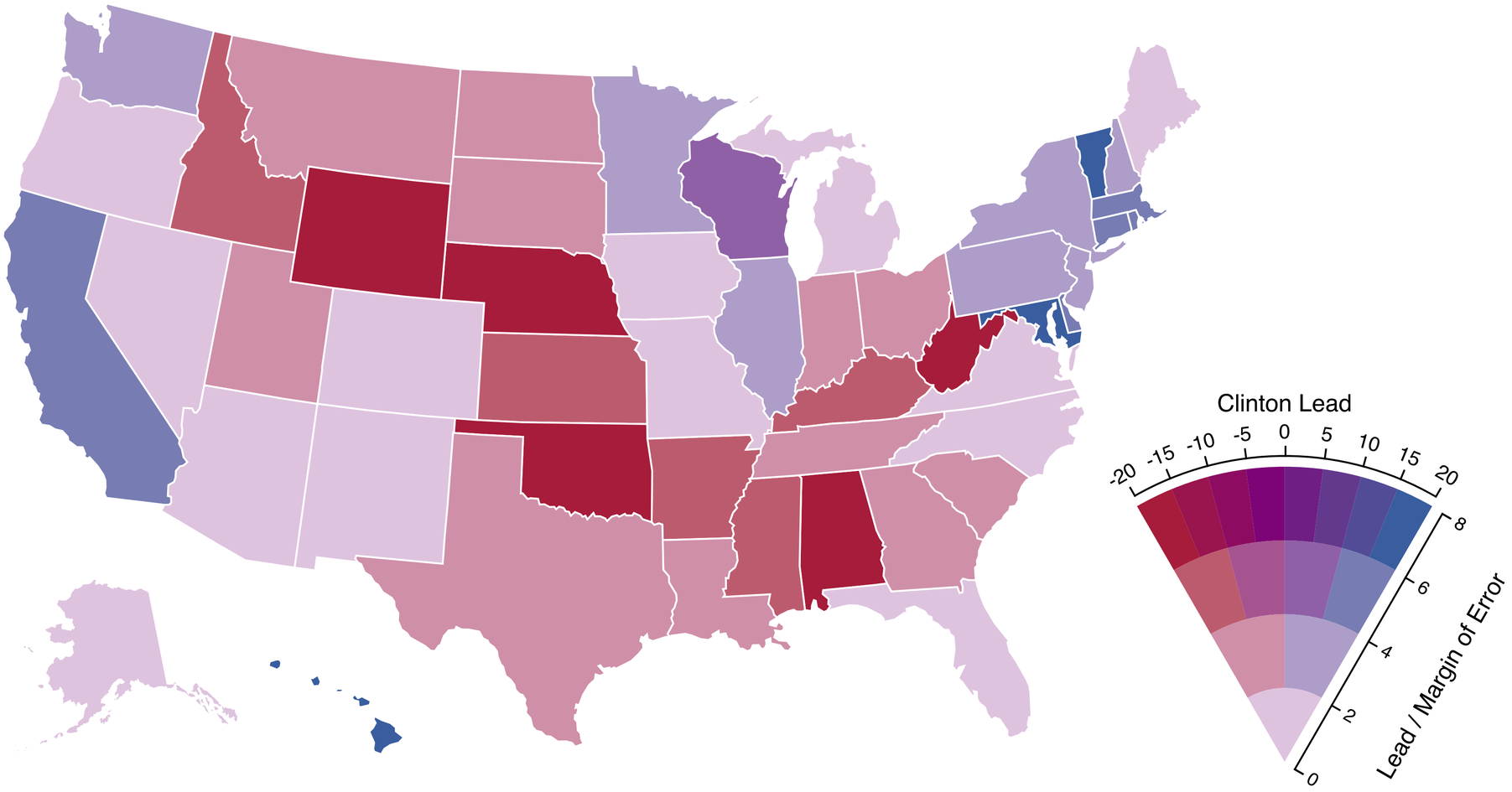
[Correll et al., 2018]

Bivariate Colormap (Uncertainty → Saturation)



[Correll et al., 2018]

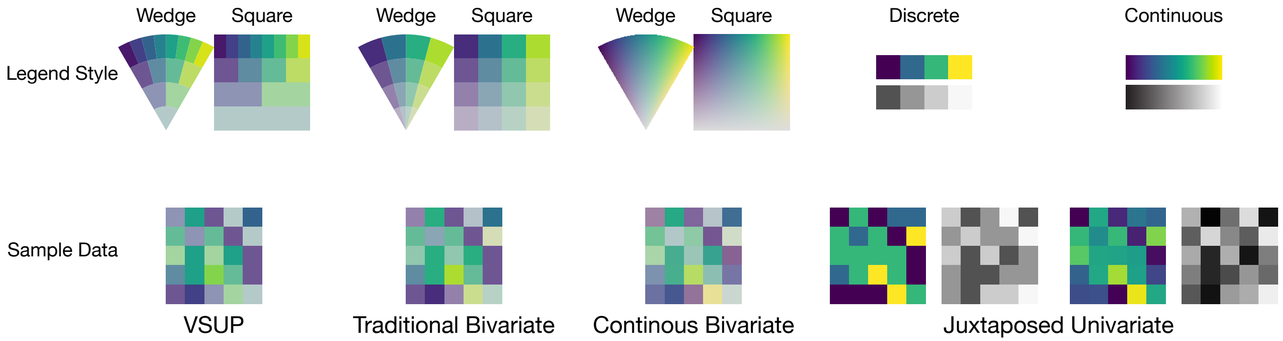
Value-Suppressing Uncertainty Palette



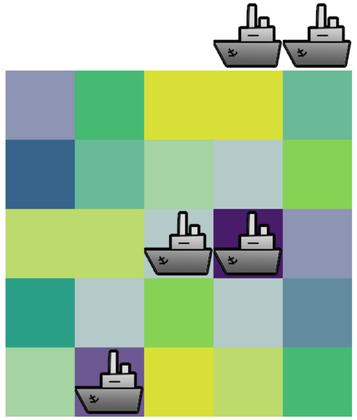
[Correll et al., 2018]

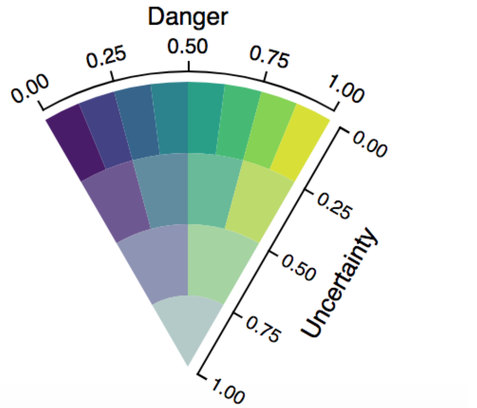
Evaluation

- Tasks:
  - Identification: locate spatial regions



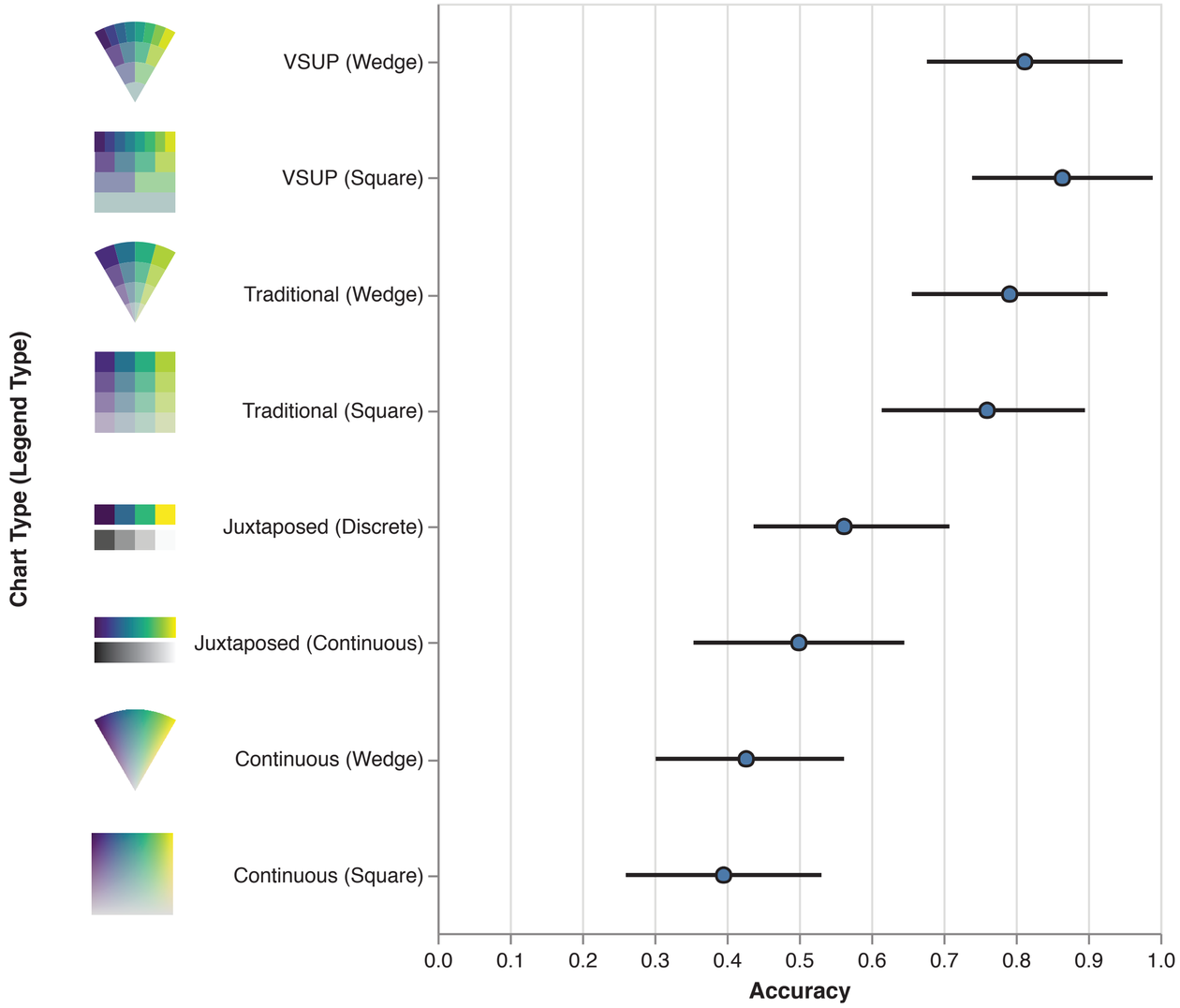
  - Prediction: place | "safest locations"





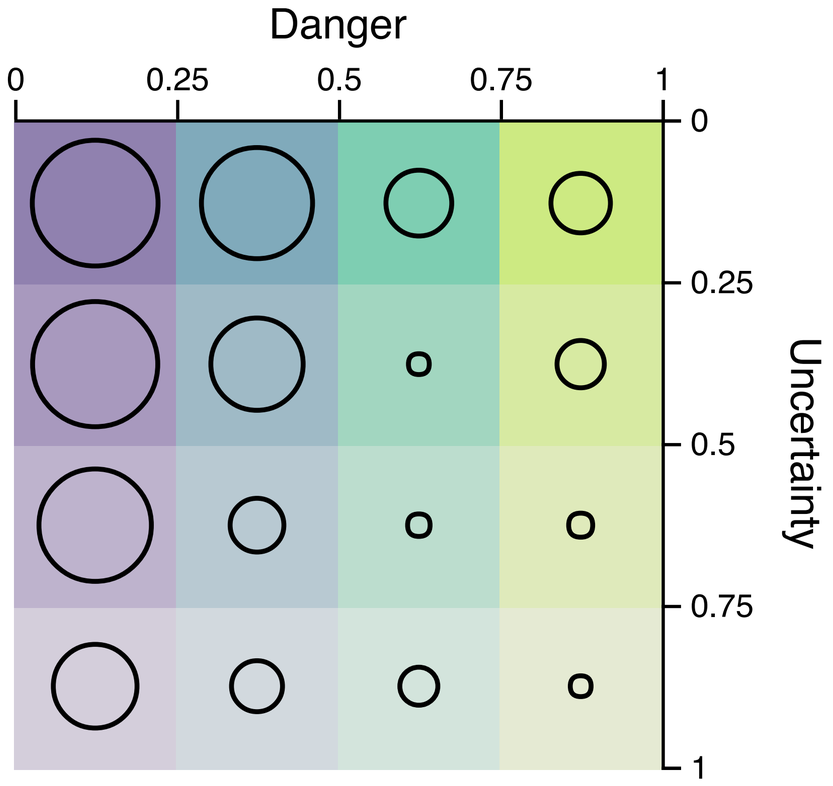
[Correll et al., 2018]

Identification Results

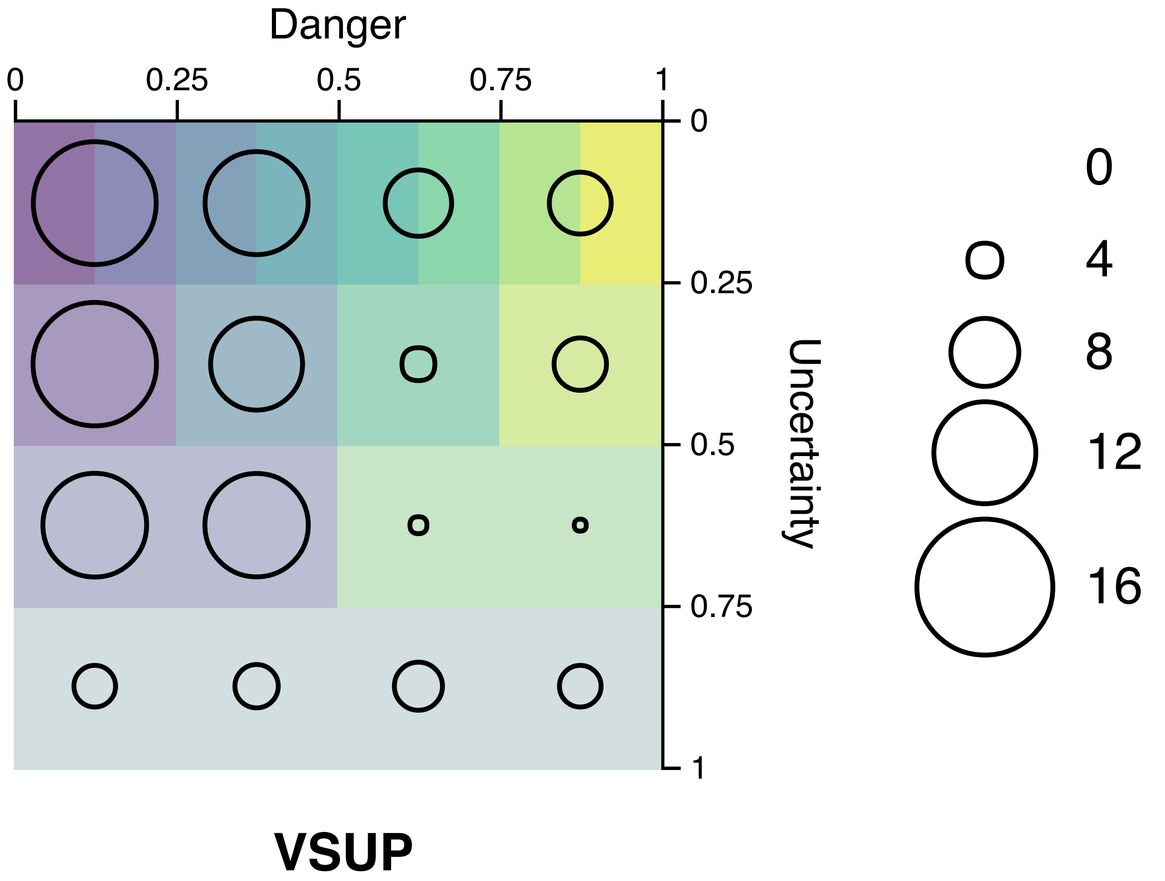


[Correll et al., 2018]

Prediction Results



Traditional Bivariate Map



VSUP

[Correll et al., 2018]

Results & Conclusions

- Legend shape has no significant effect
- Some indication that people avoid high uncertainty with VSUPs
- Tradeoff is that people do choose targets with higher danger when using a VSUP
- VSUPs present uncertainty information **simultaneously** (superimposed) instead of juxtaposed
- VSUPs encode value and uncertainty via **discrete, quantized bins** instead of continuously

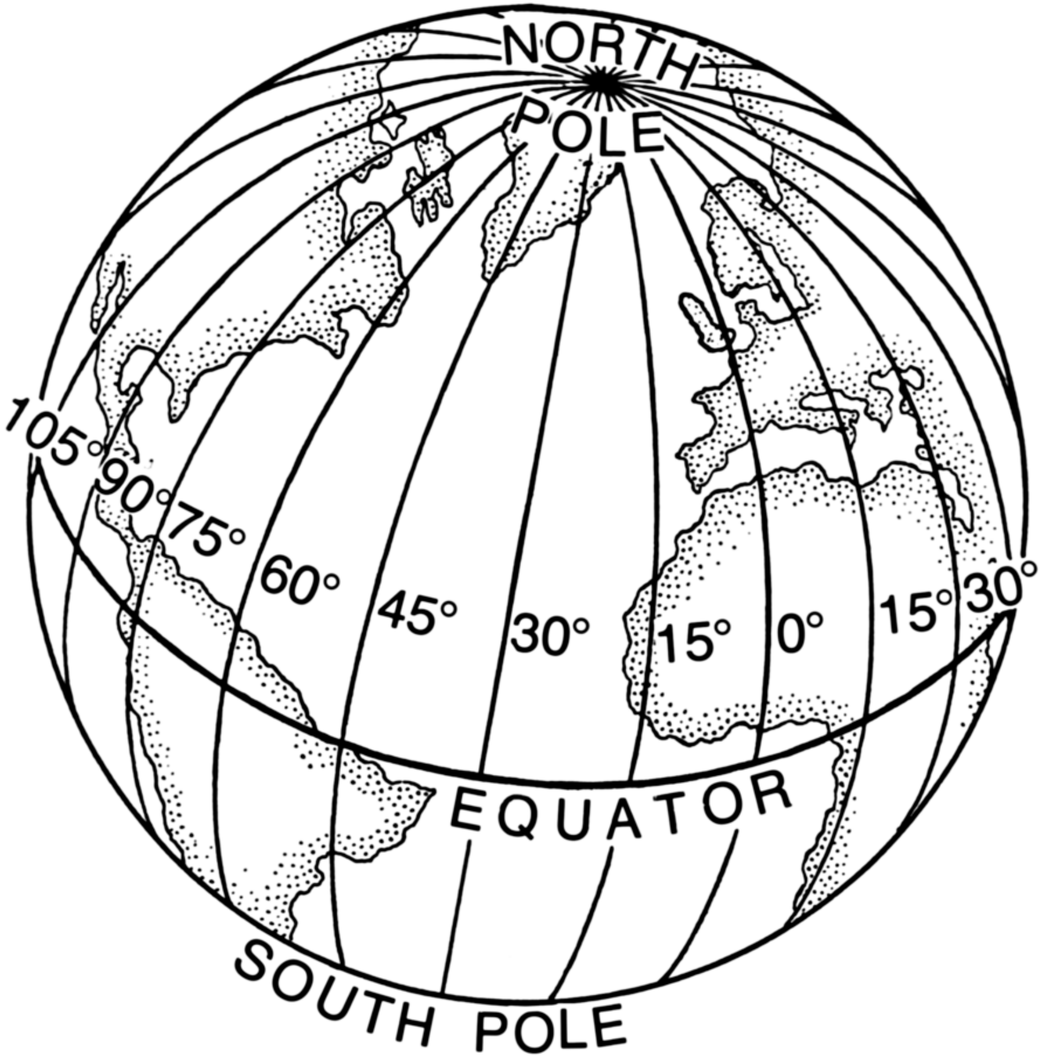
[Correll et al., 2018]

Geospatial Data

Geographic Data

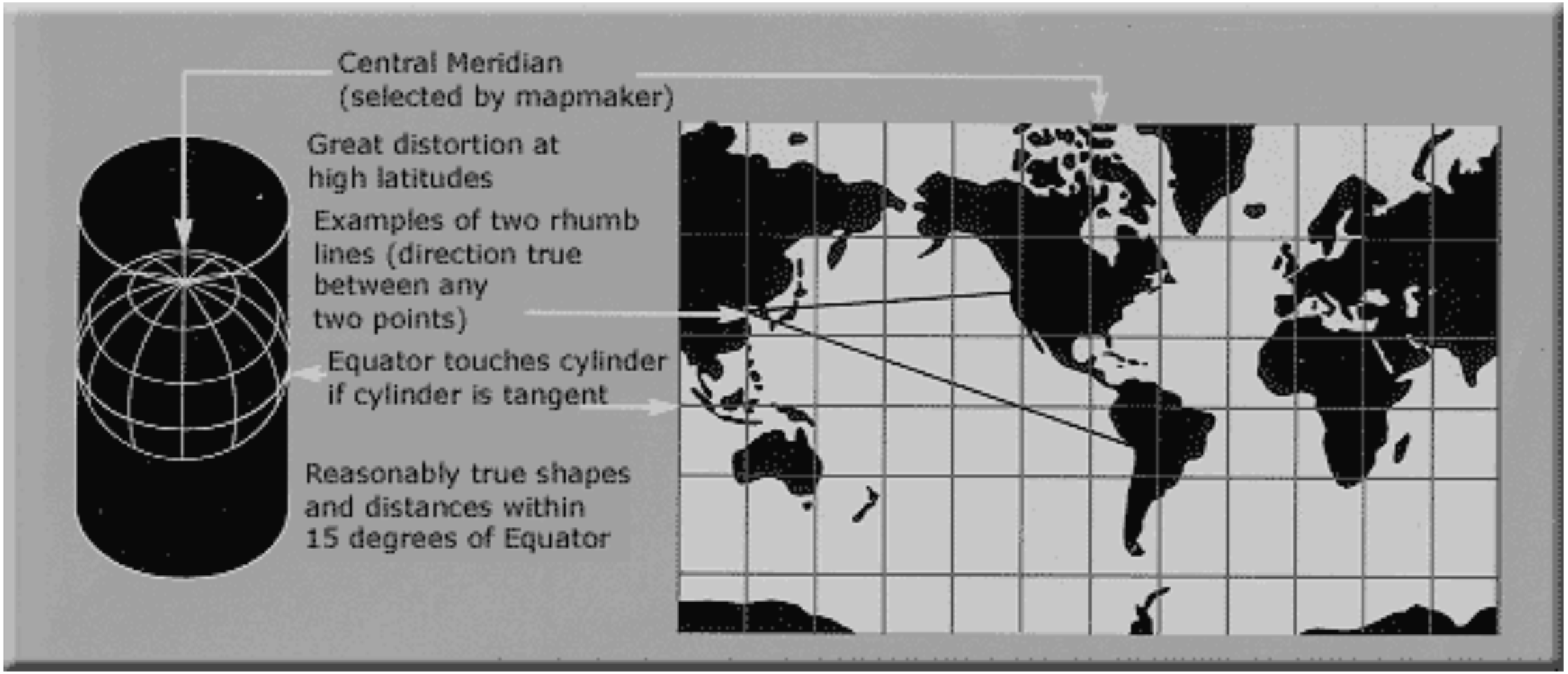
- Spatial data (have positions)
- Cartography: the science of drawing maps
  - Lots of history and well-established procedures
  - May also have non-spatial attributes associated with items
  - Thematic cartography: integrate these non-spatial attributes (e.g. population, life expectancy, etc.)
- Goals: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

Map Projection



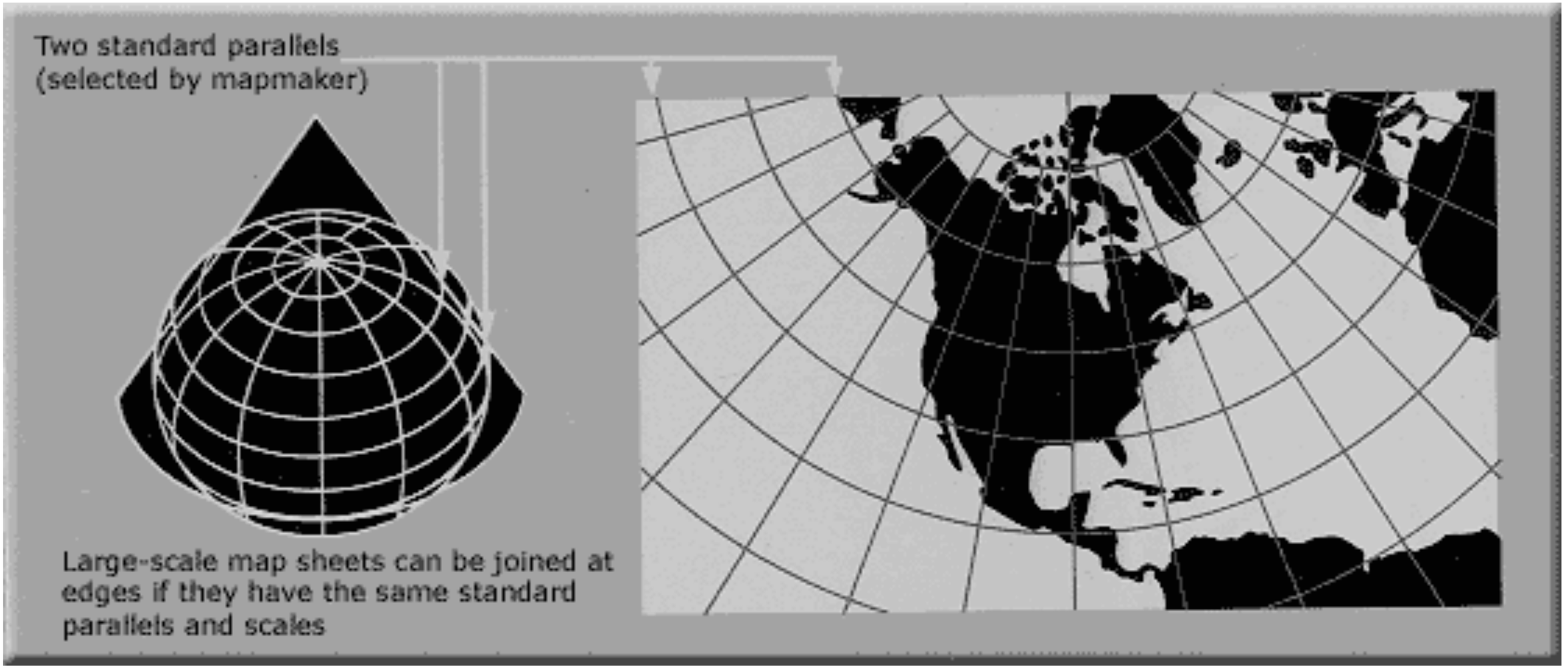
[P. Foresman, Wikimedia]

Flattening the Sphere?



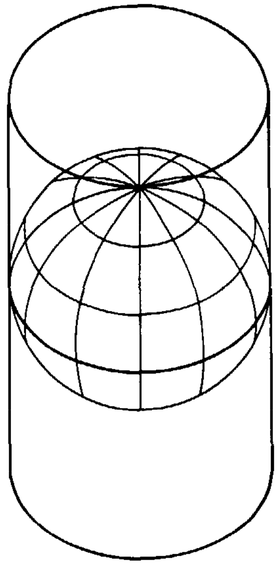
[USGS Map Projections]

Lambert Conformal Conic Projection

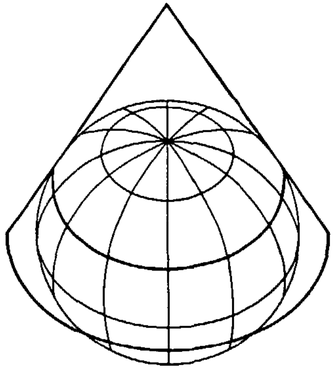


[USGS Map Projections]

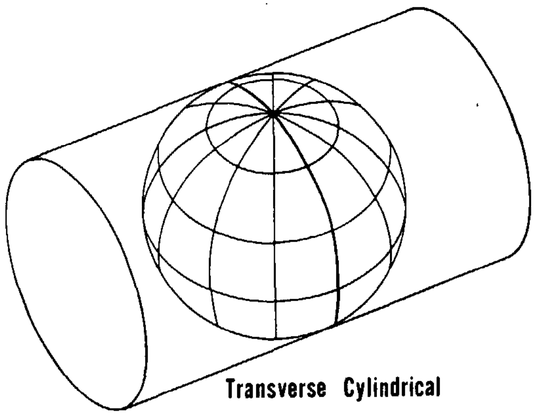
Standard Projections



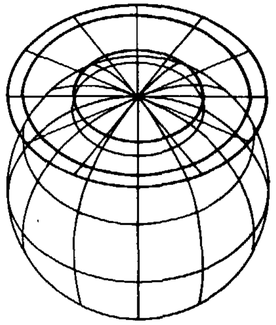
Regular Cylindrical



Regular Conic



Transverse Cylindrical



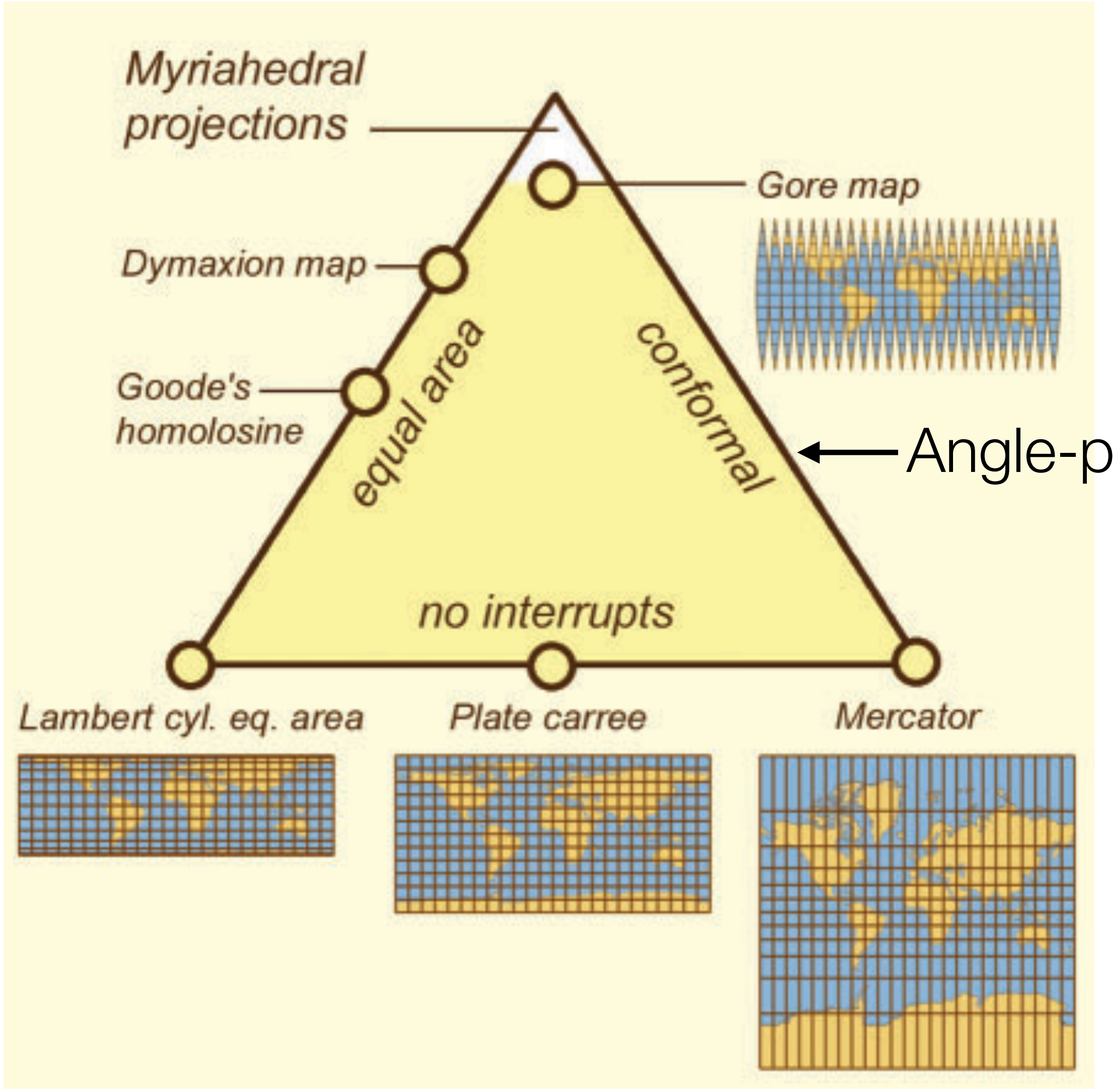
Polar Azimuthal (plane)

[J. P. Snyder, USGS]

Map Projections

[xkcd]

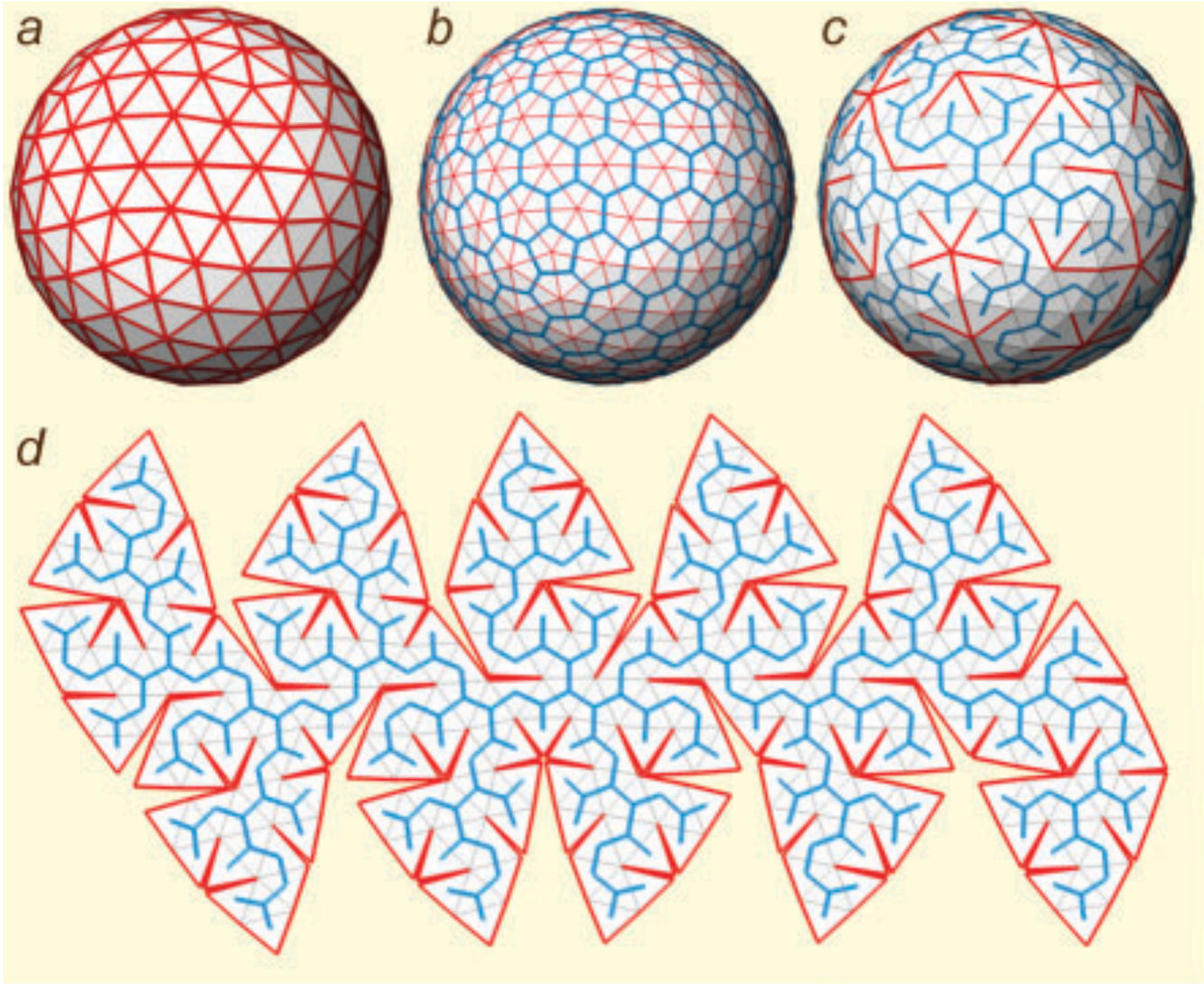
Projection Classification



← Angle-preserving

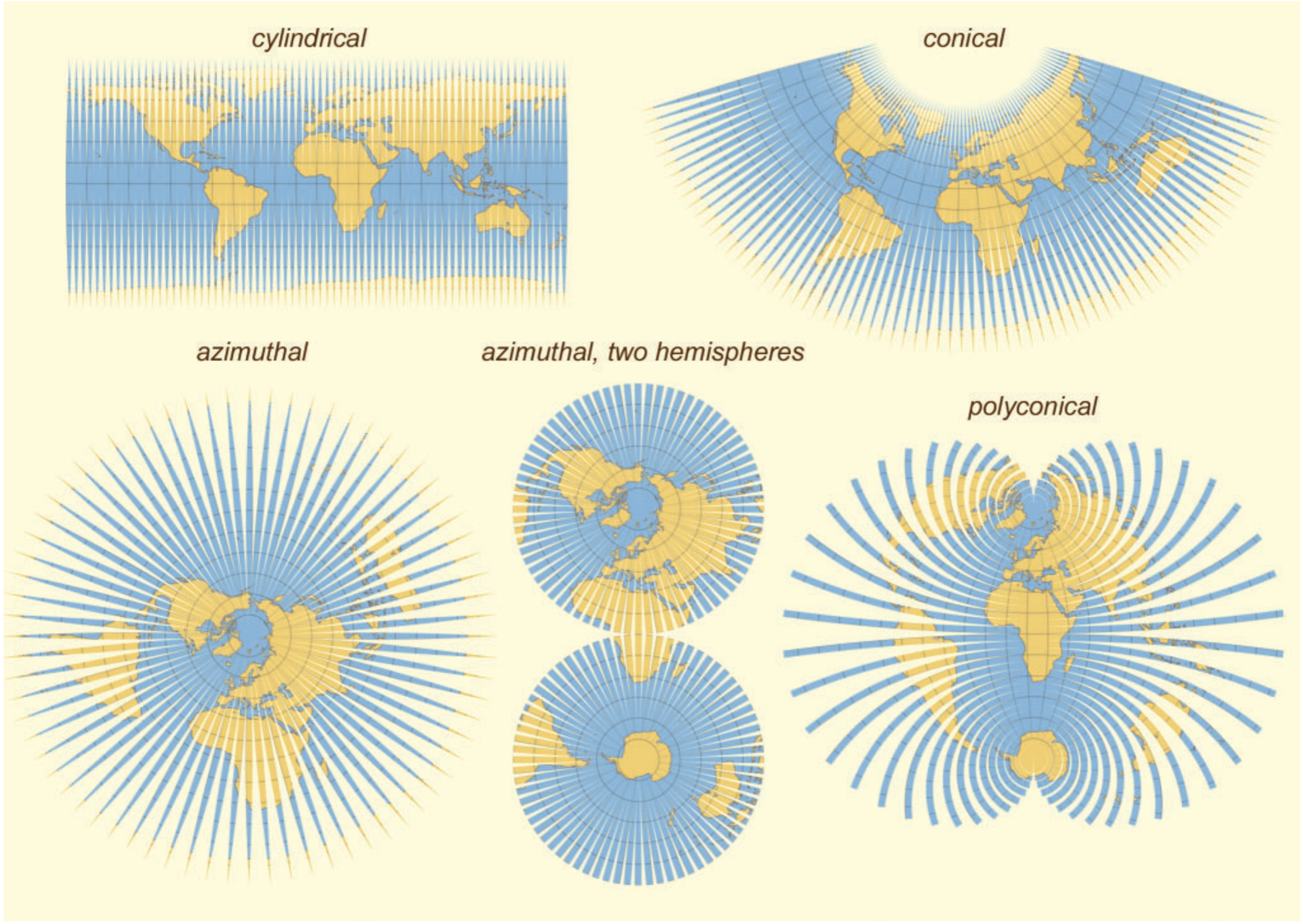
[J. van Wijk, 2008]

Myriahedral Projections



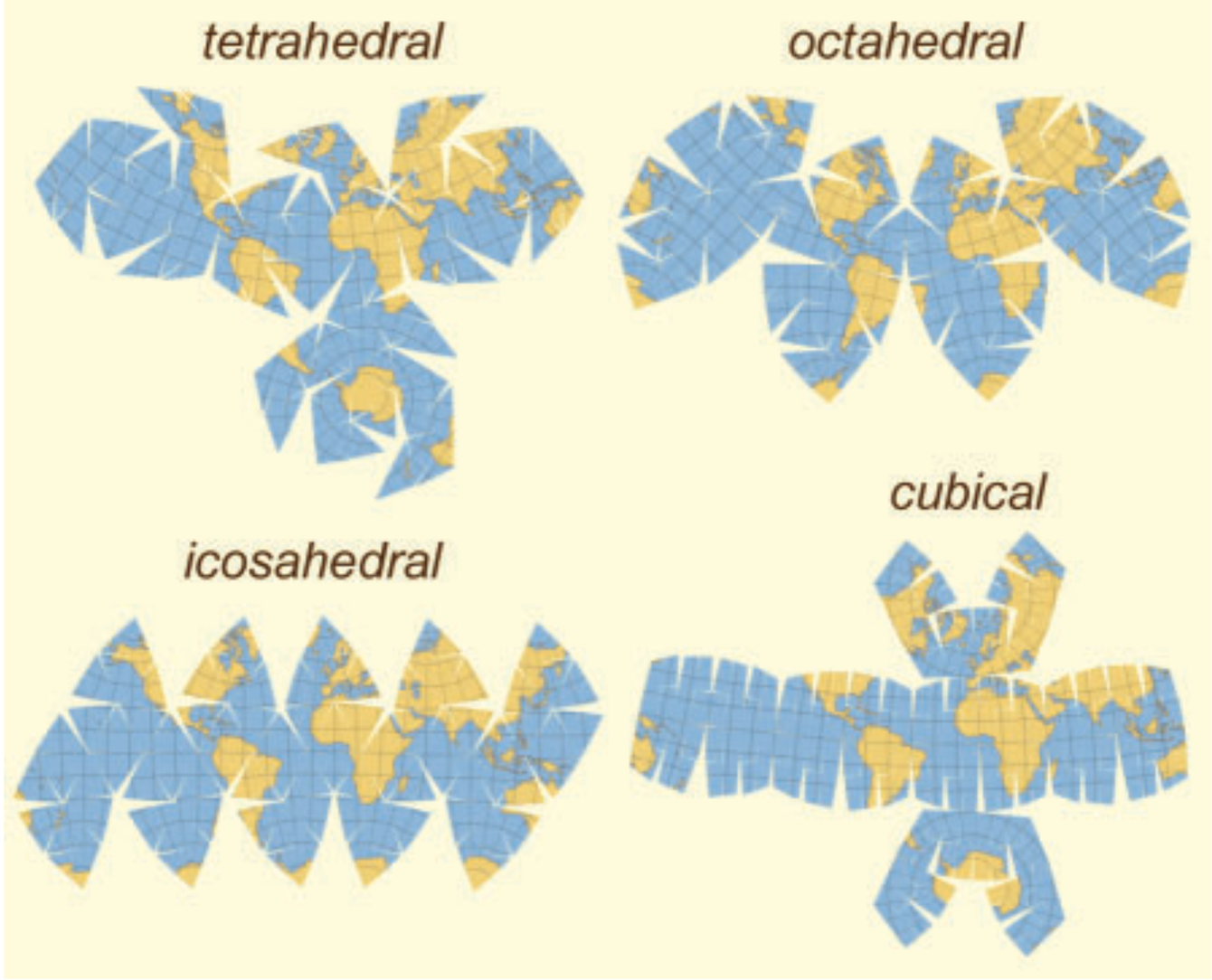
[J. van Wijk, 2008]

Cut along parallels or meridians (graticules)



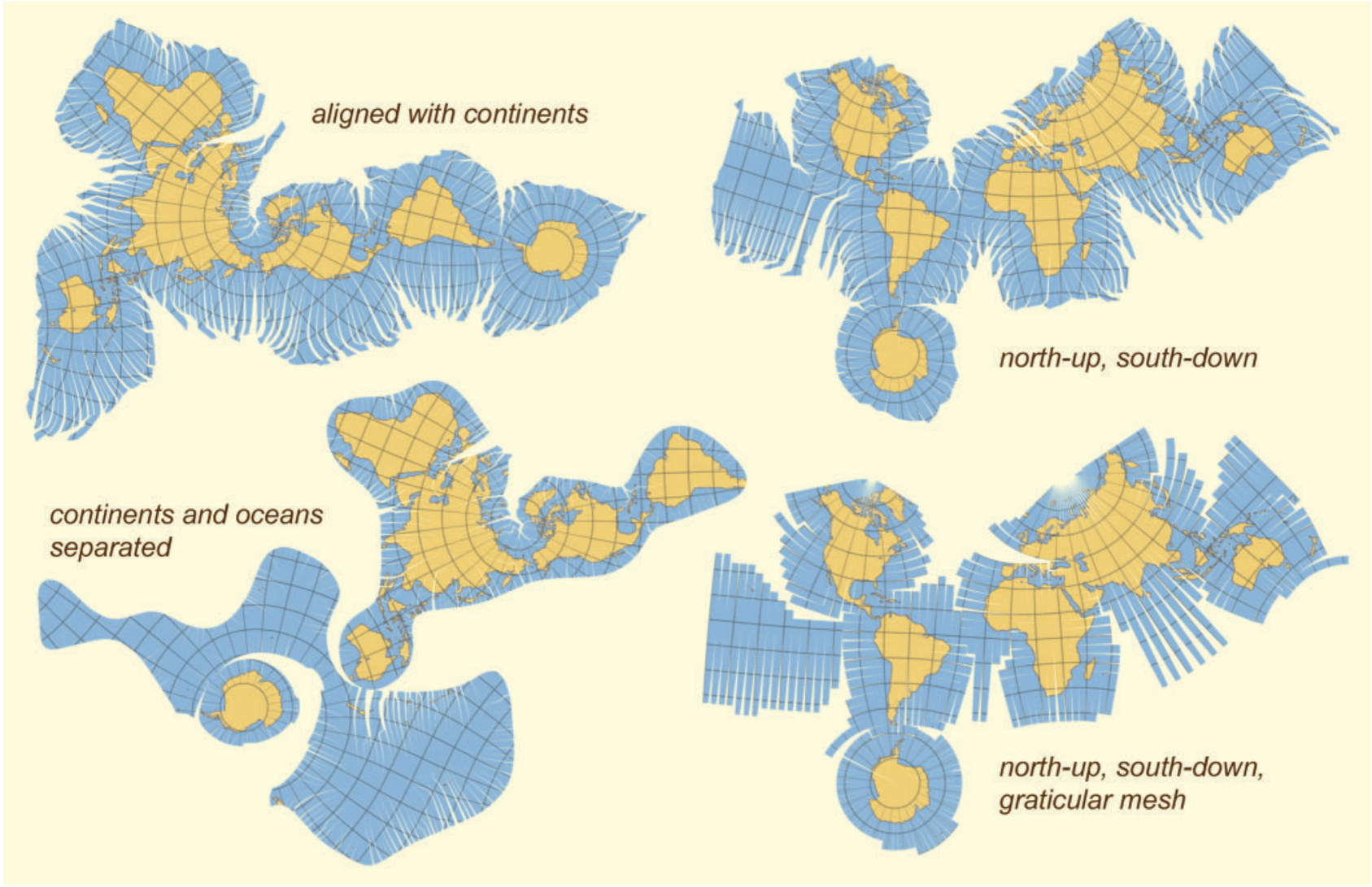
[J. van Wijk, 2008]

Subdividing regular polyhedra



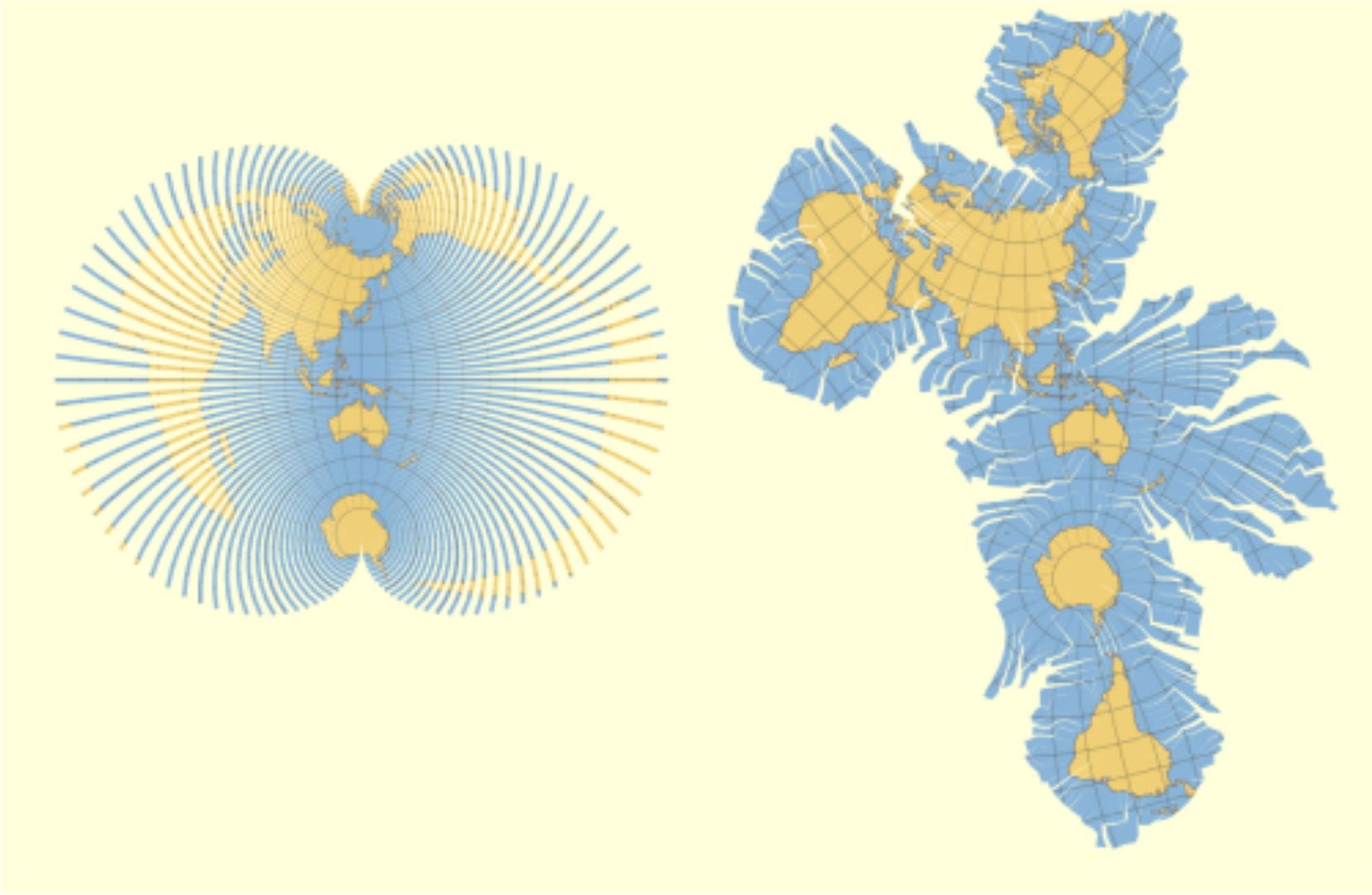
[J. van Wijk, 2008]

Geographically-aligned



[J. van Wijk, 2008]

Australia-centric



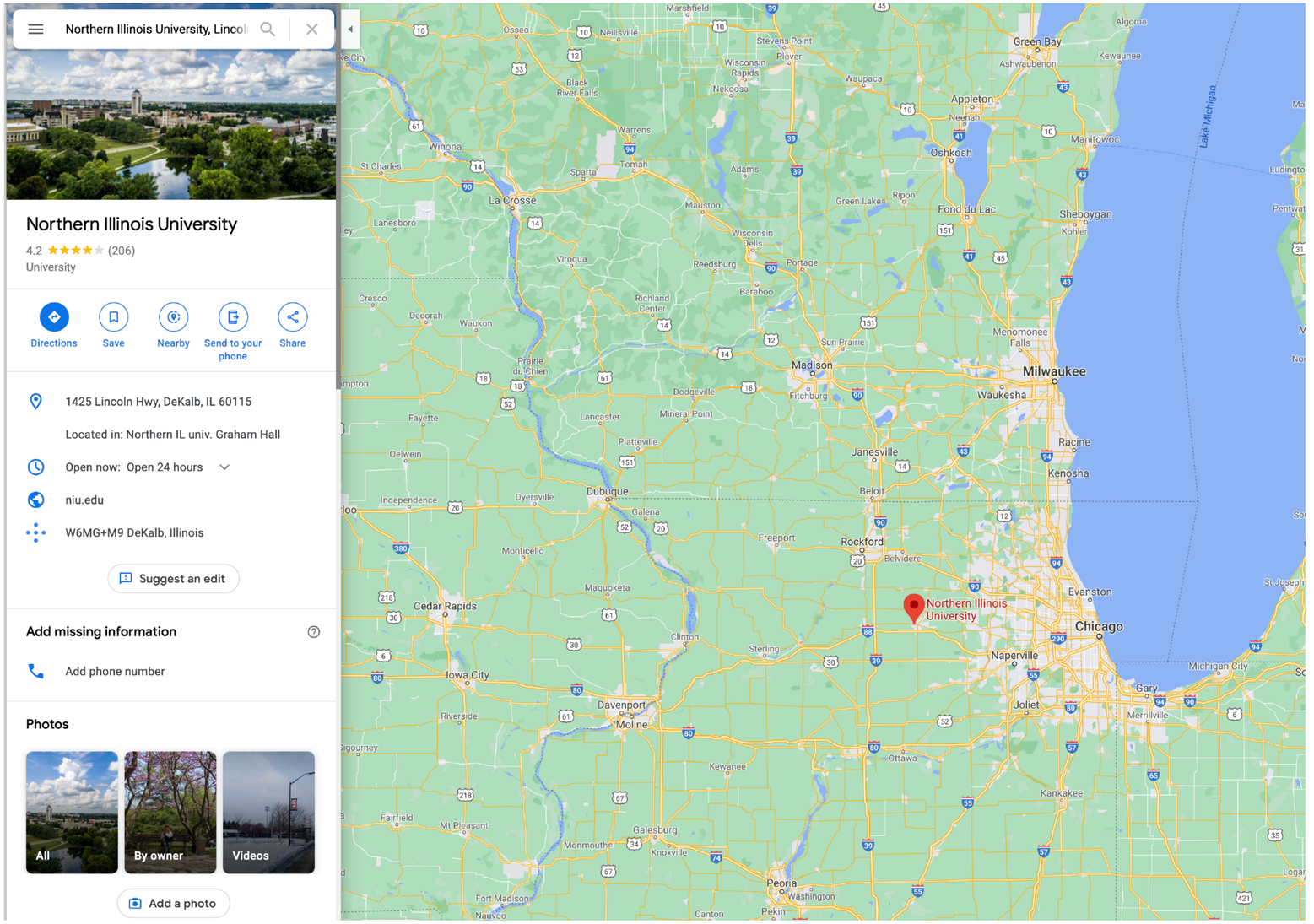
[J. van Wijk, 2008]

Search Tasks

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

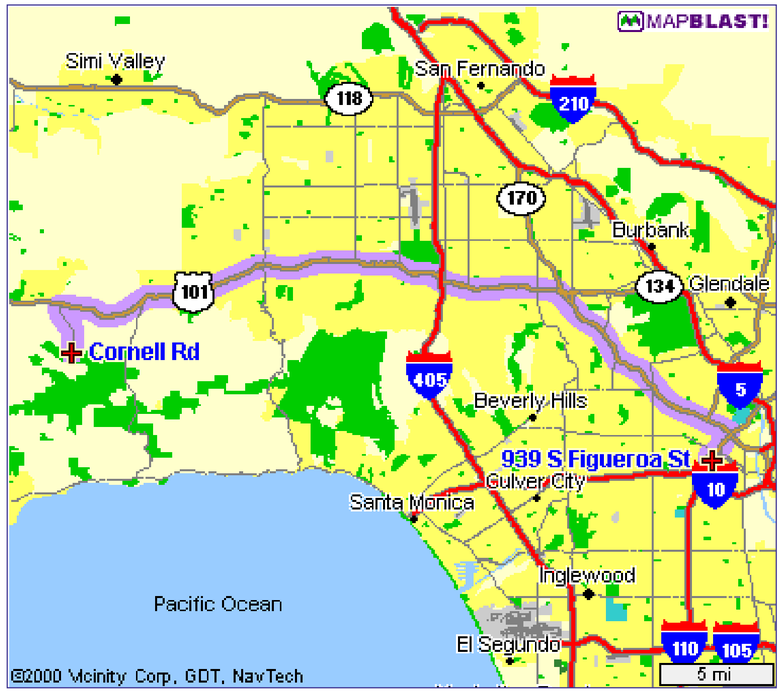
[Munzner (ill. Maguire), 2014]

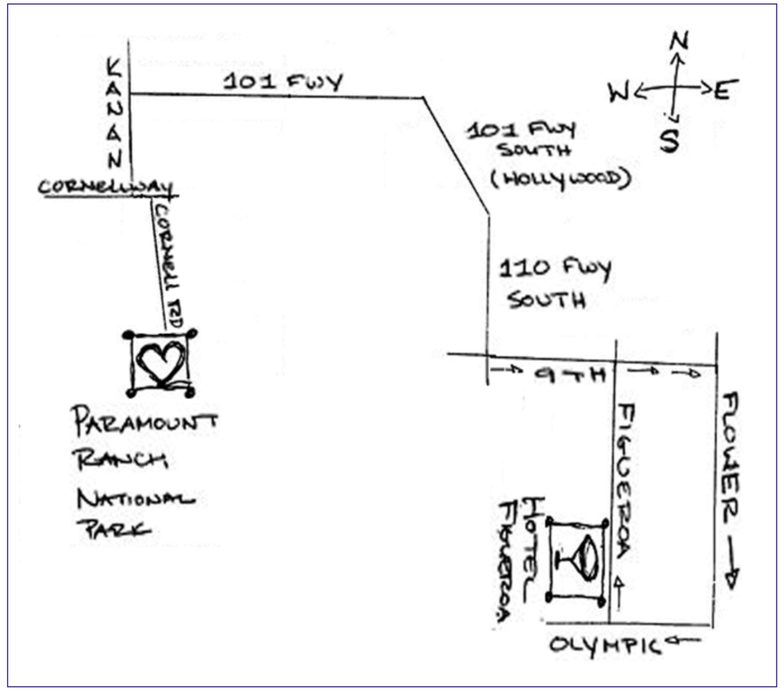
Lookup

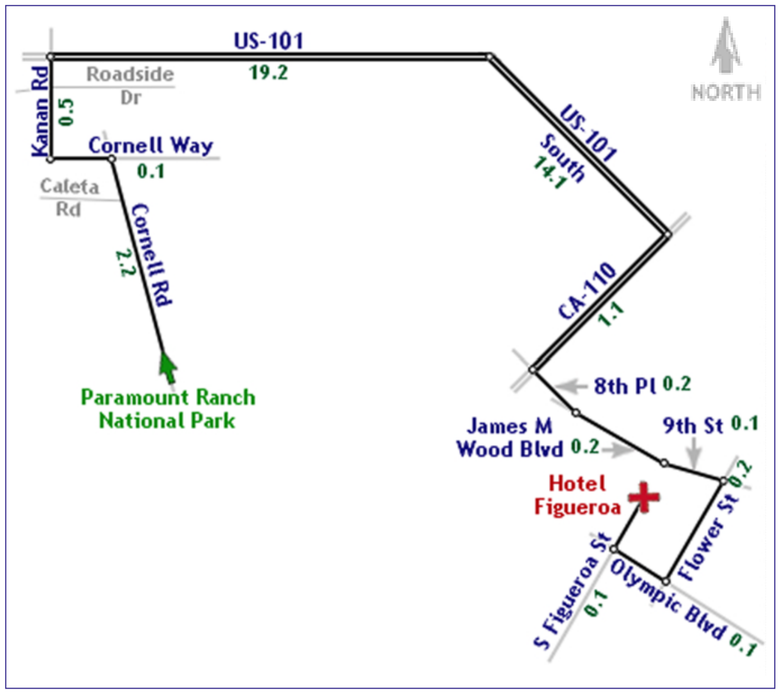


[Google Maps]

Route Maps

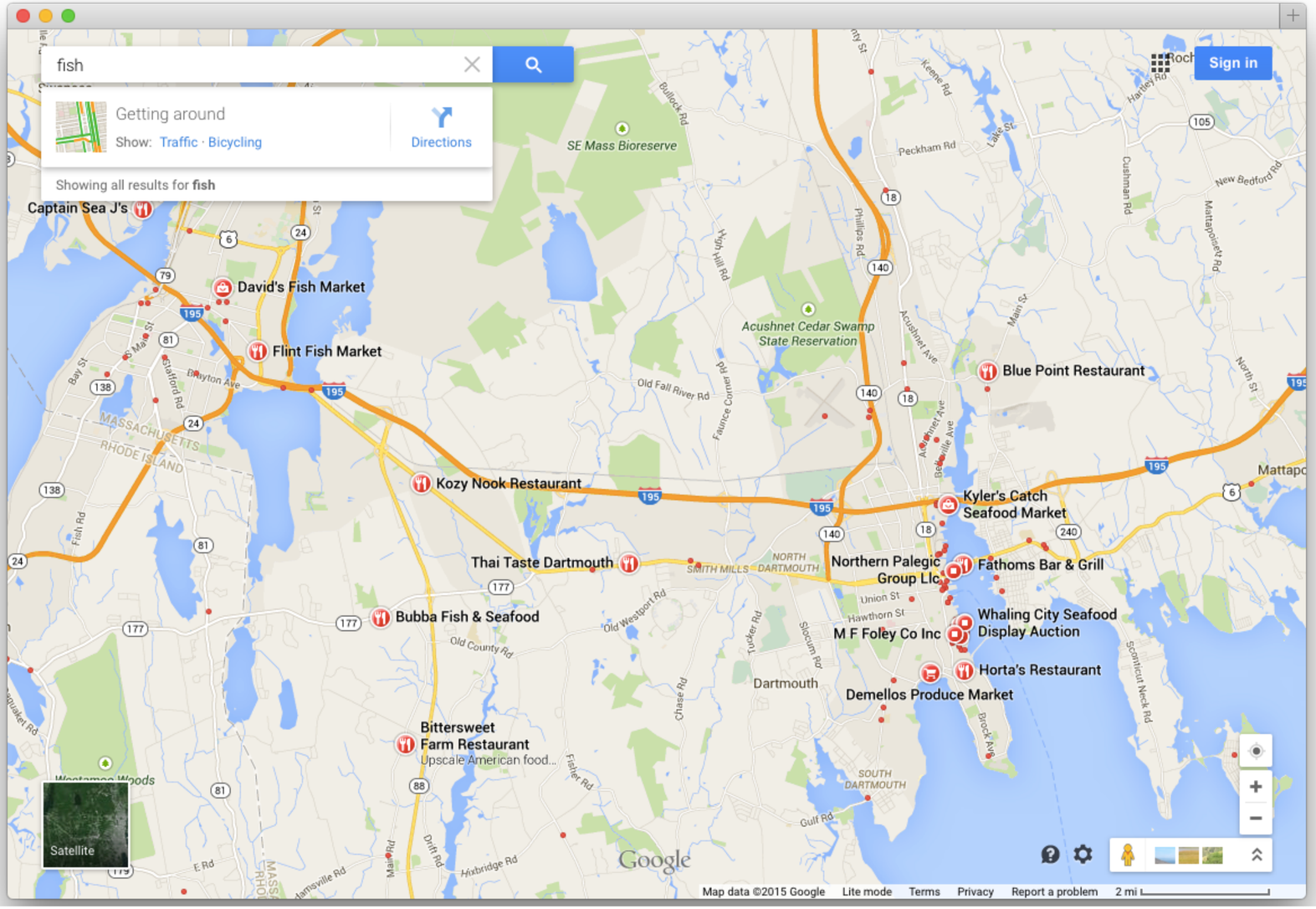






[Agrawala & Stolte, 2001]

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
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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

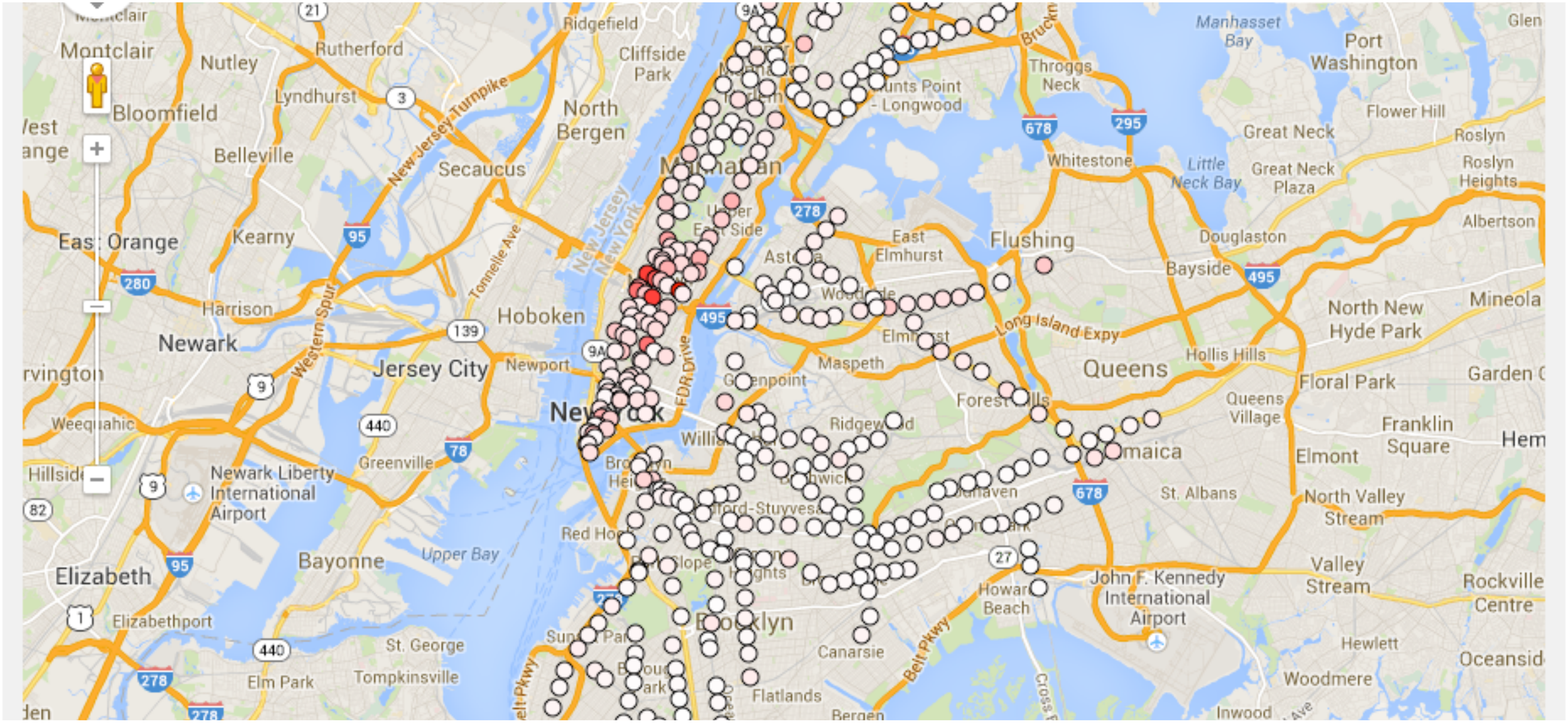
Discrete Categorical Attribute: Shape

[Acadia NP, National Park Service]

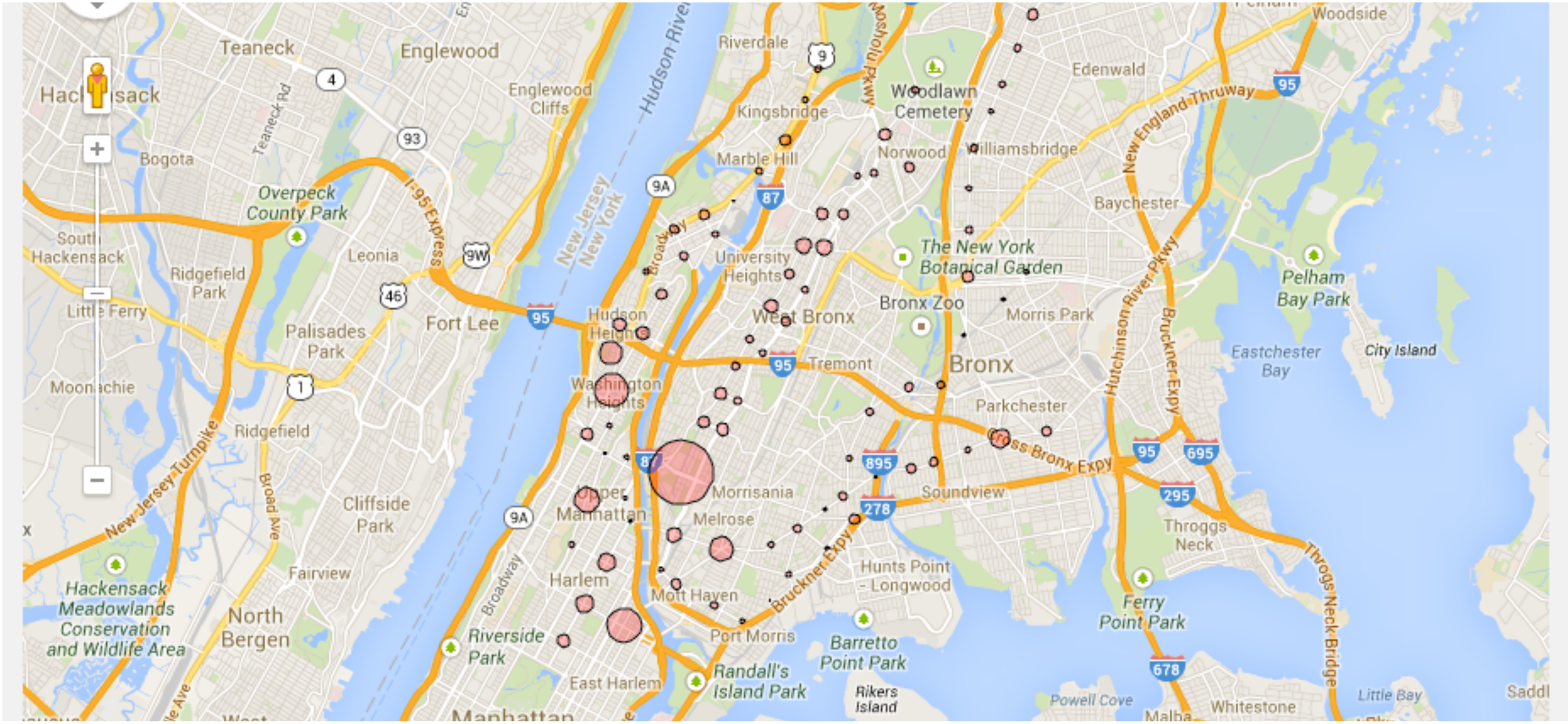
Discrete Categorical Attribute: Shape

[Acadia NP, National Park Service]

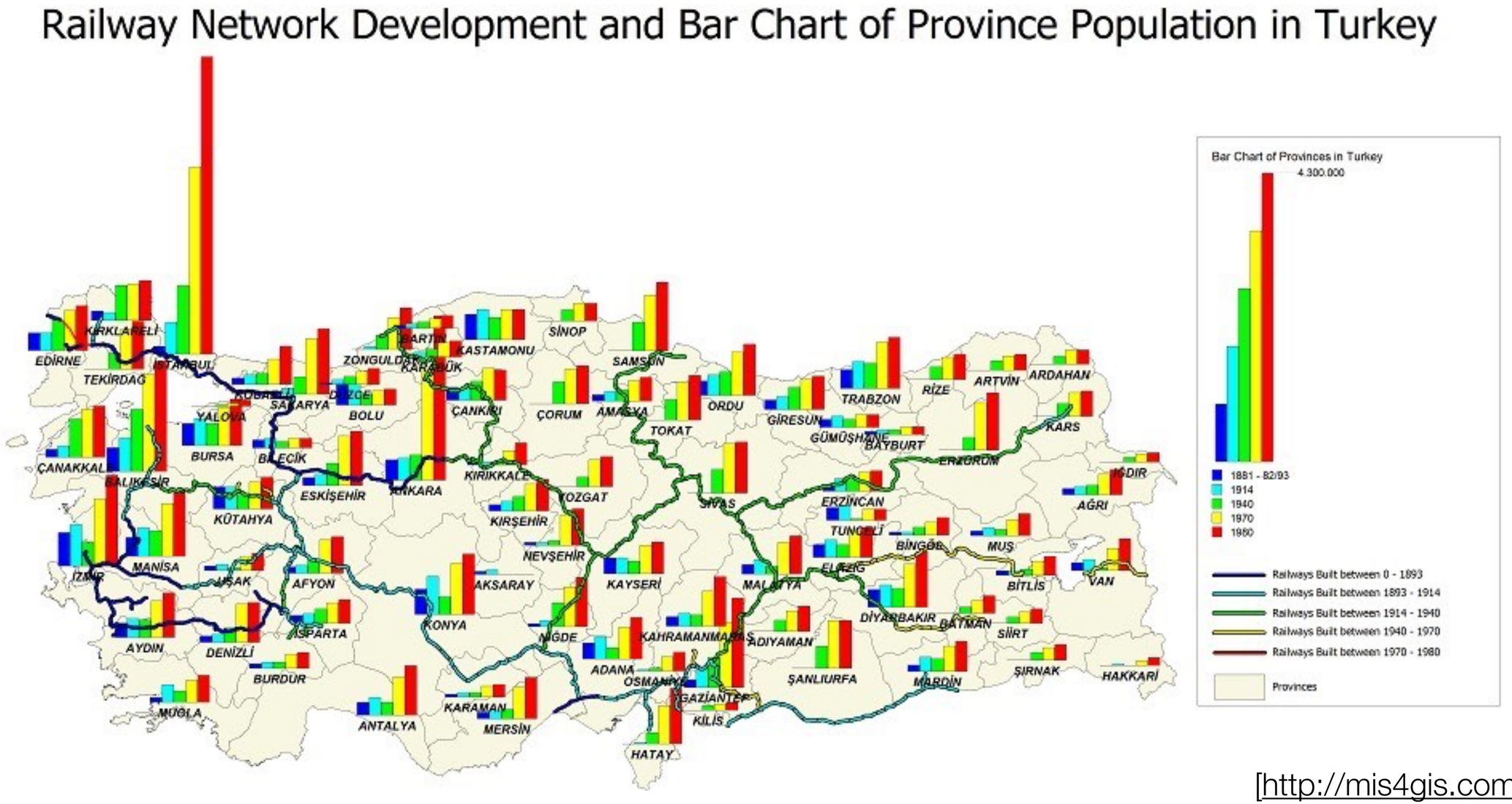
Discrete Quantitative Attribute: Color Saturation



Discrete Quantitative Attribute: Size

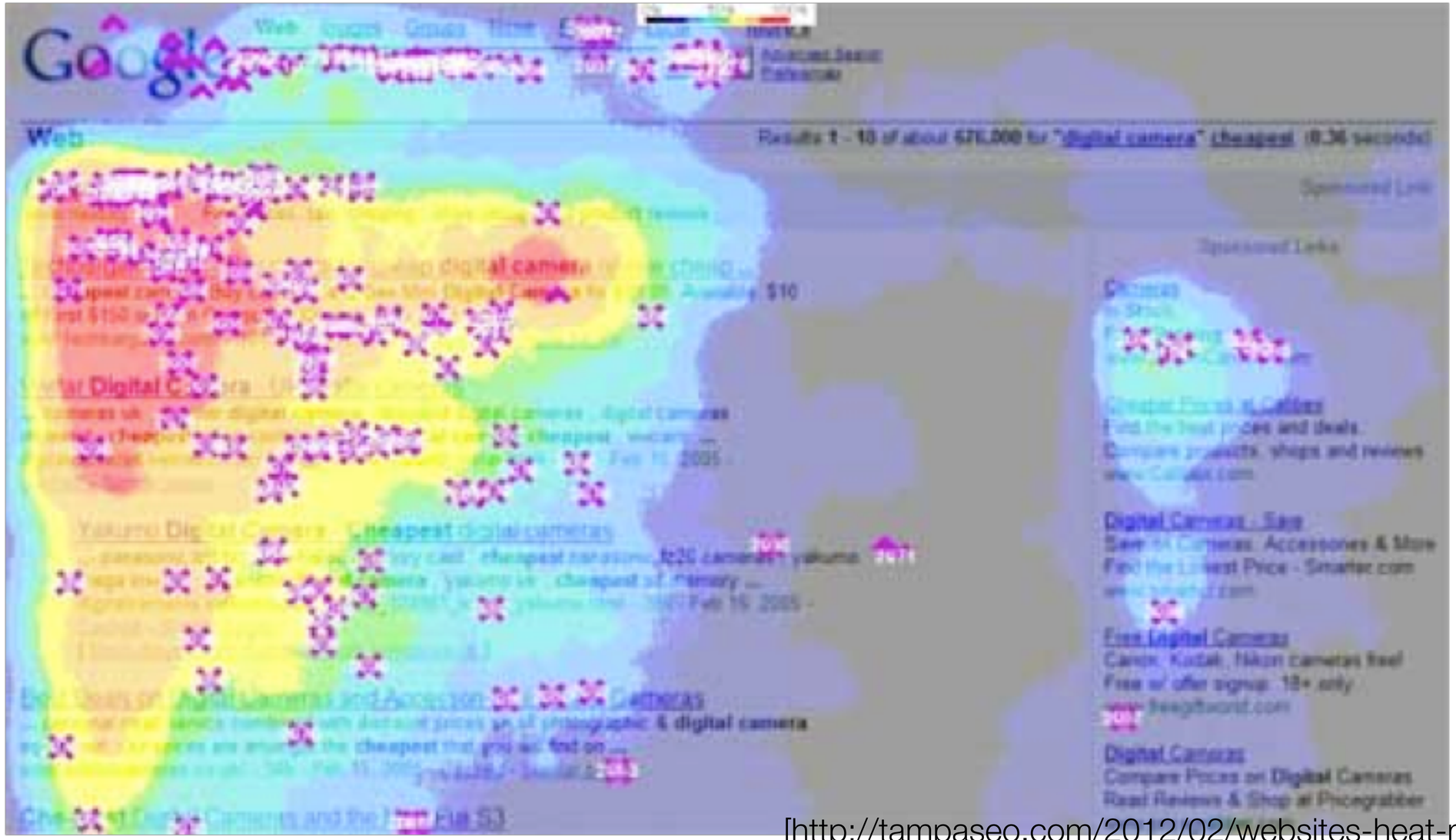


Discrete Quantitative Attributes: Bar Chart



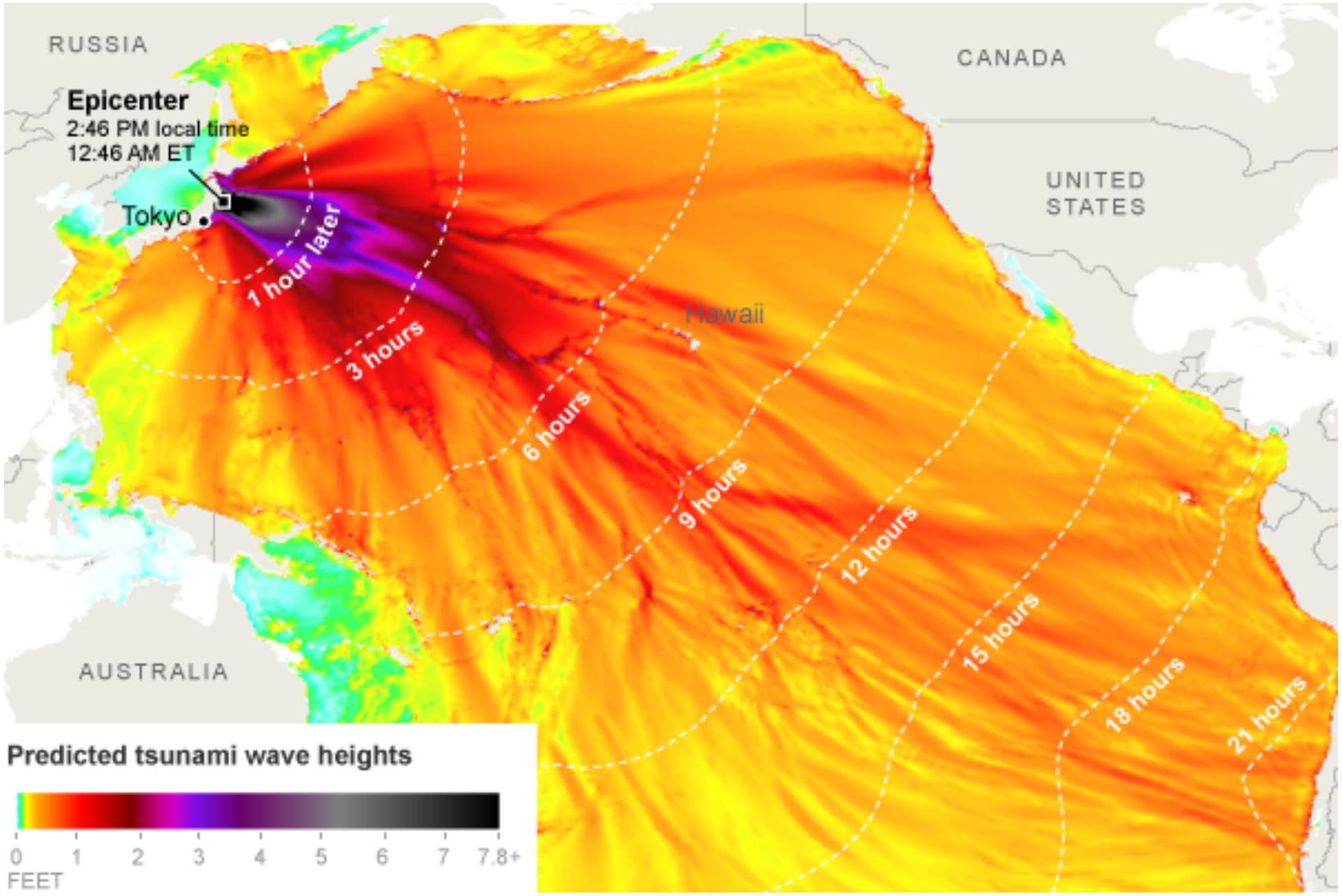
[http://mis4gis.com/hgistr.org/]

Continuous Quantitative Attribute: Color Hue



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

Time as the attribute



[NYTimes]

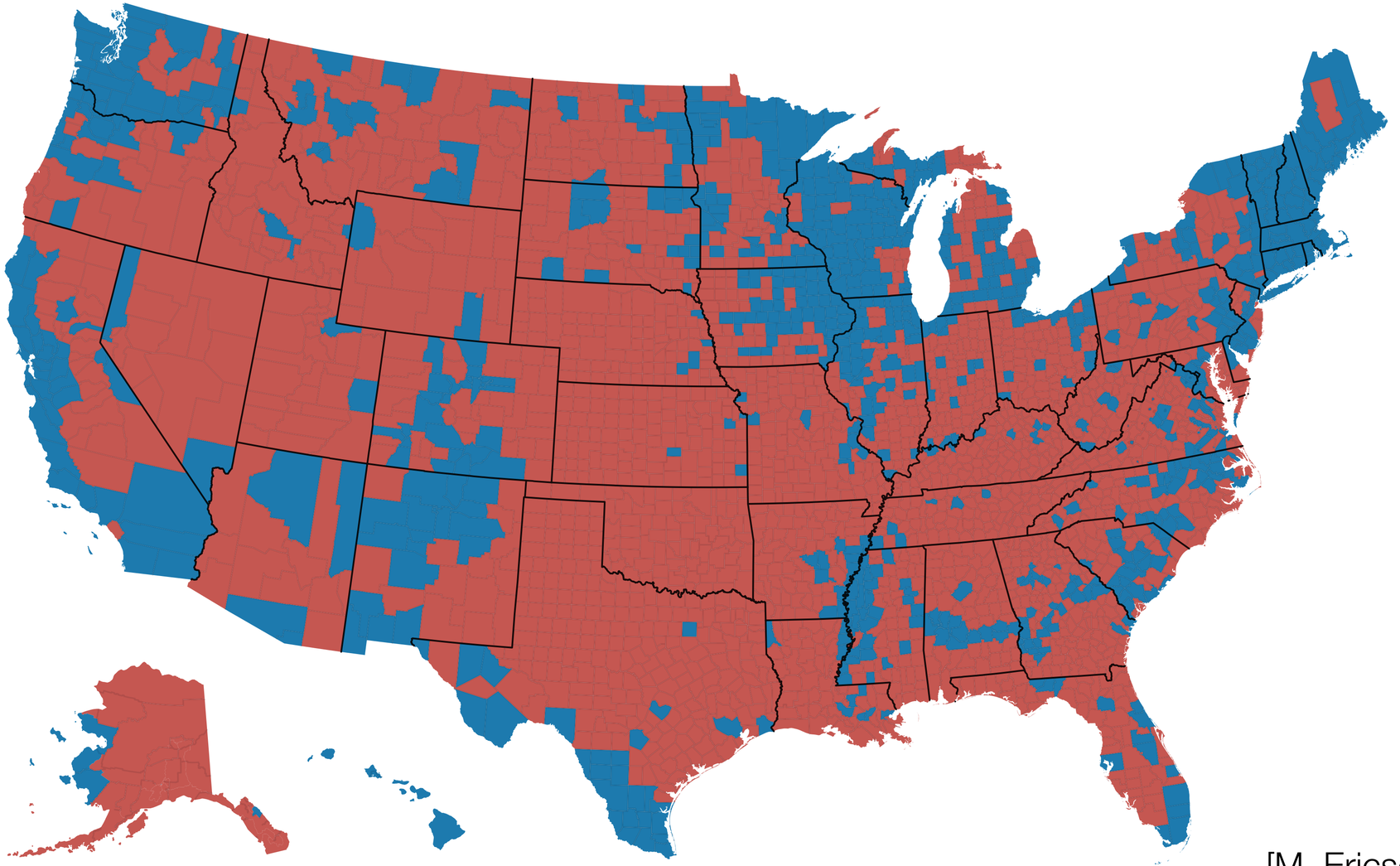
Isolines

[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)



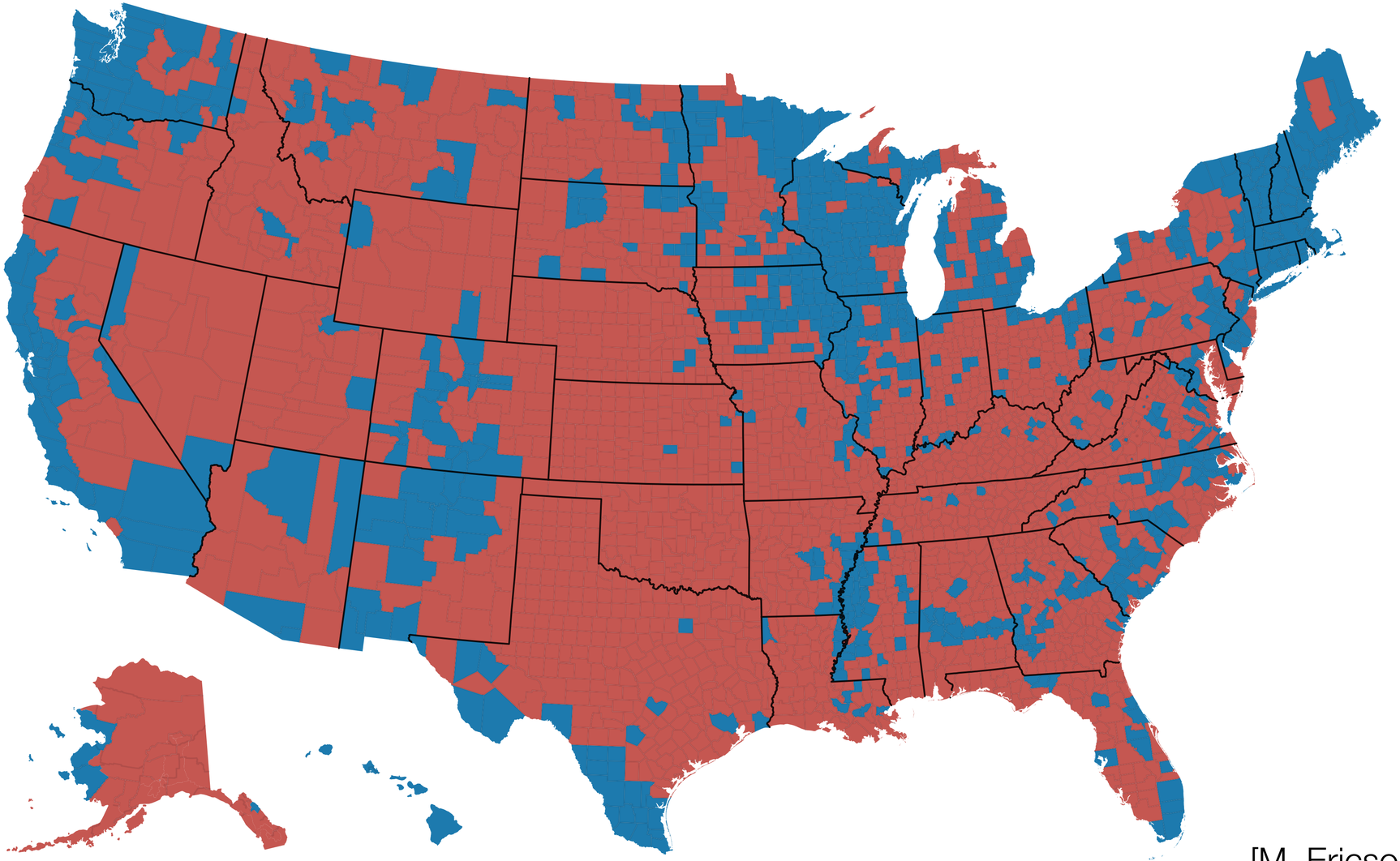
[M. Ericson, New York Times]

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

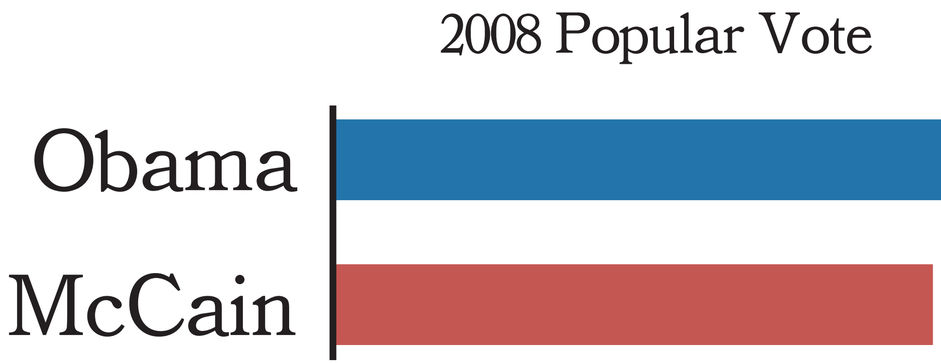
- Design choices:
  - Colormap
  - Region boundaries (level of summarization)

Choropleth (Two Hues)



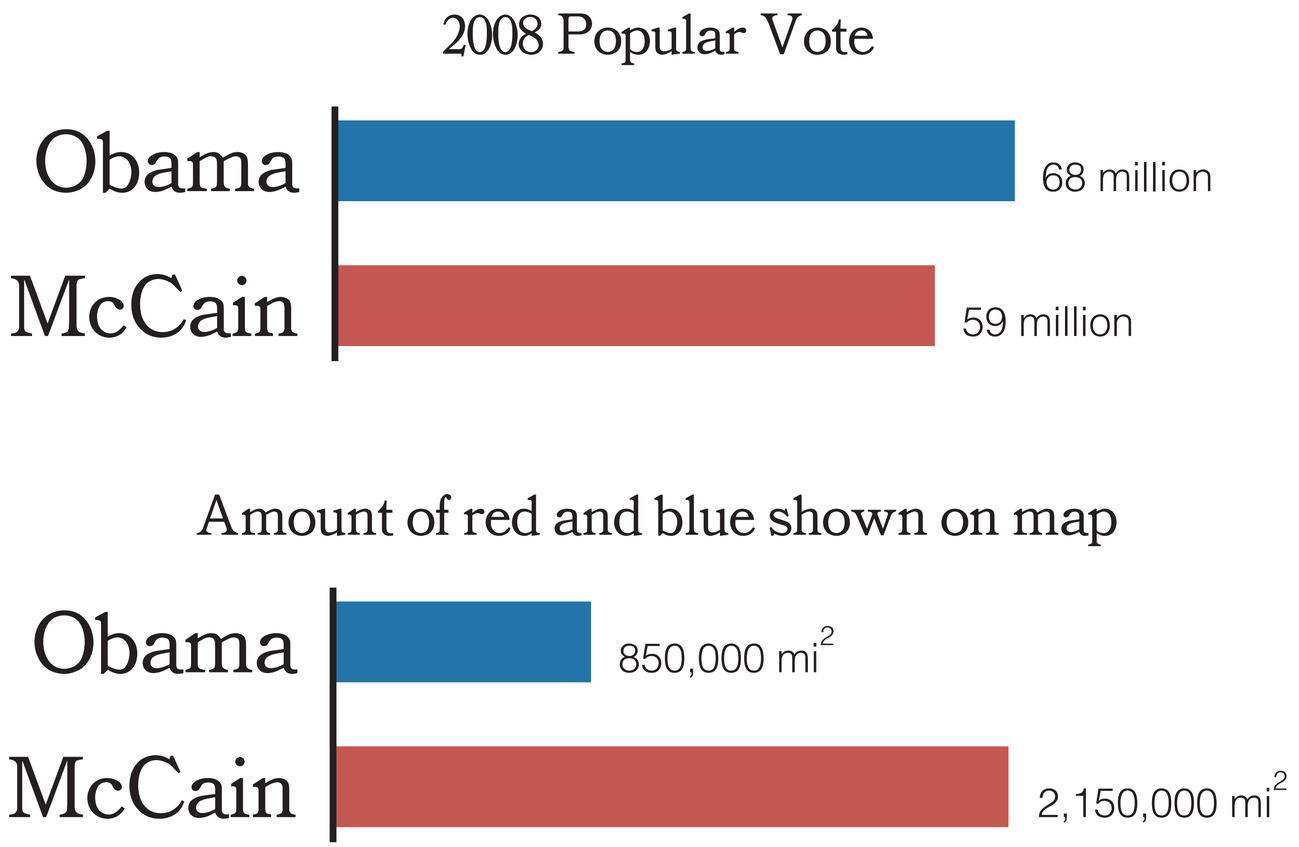
[M. Ericson, New York Times]

Problem?



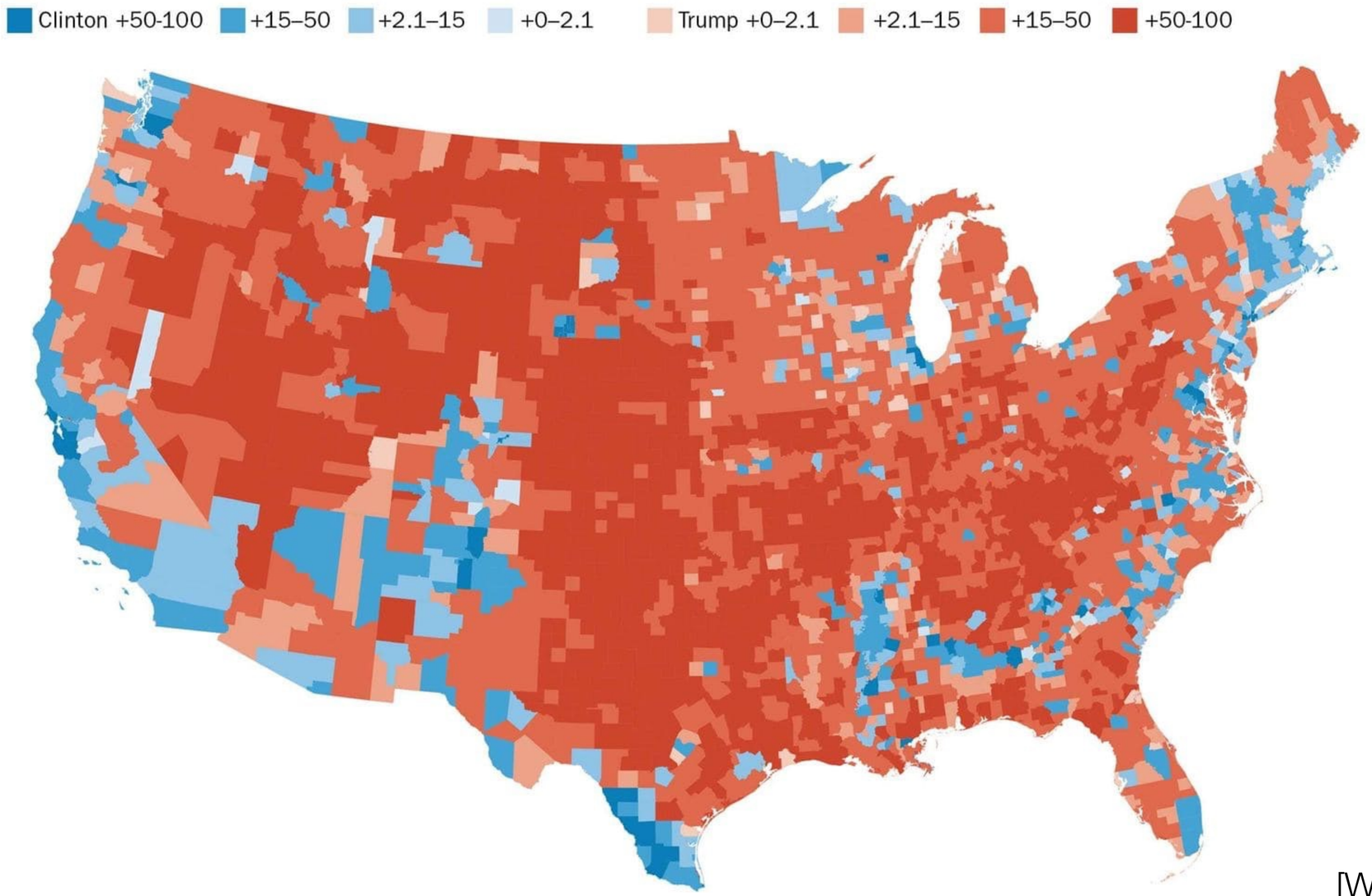
[M. Ericson, New York Times]

Problem?



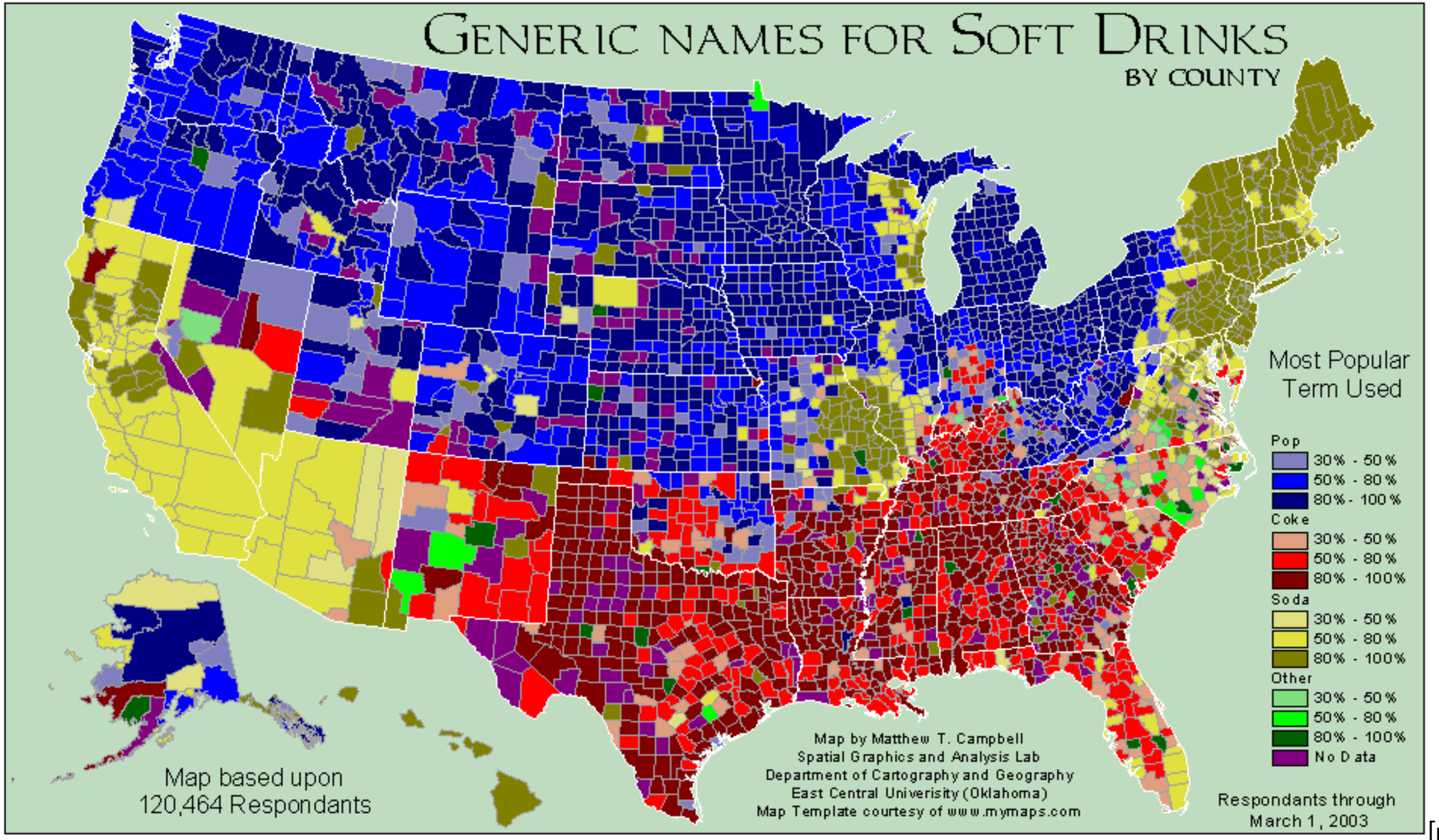
[M. Ericson, New York Times]

Adding Saturation



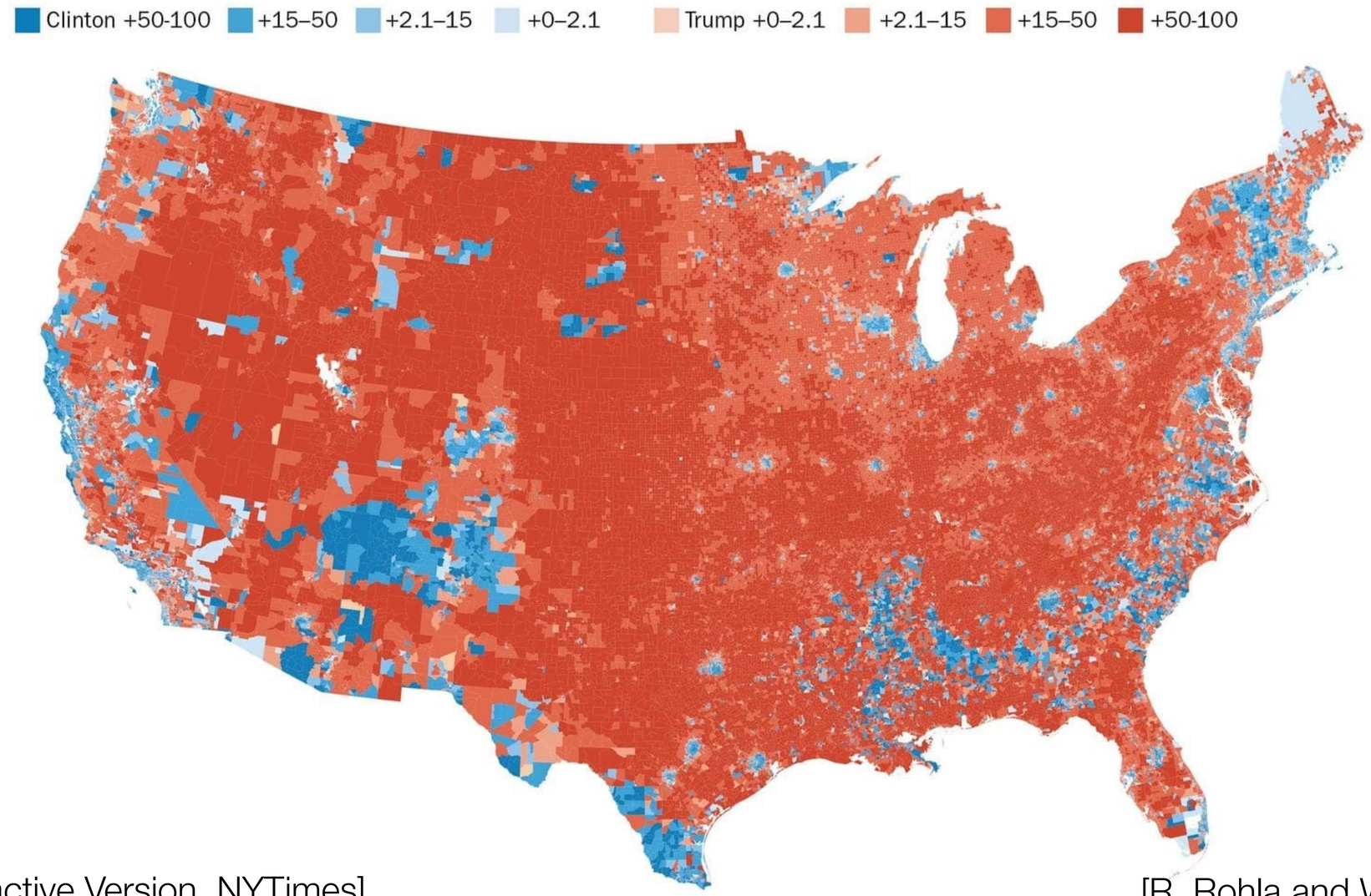
[Washington Post, 2018]

Area Marks and Color Hue & Saturation



[popvssoda.com]

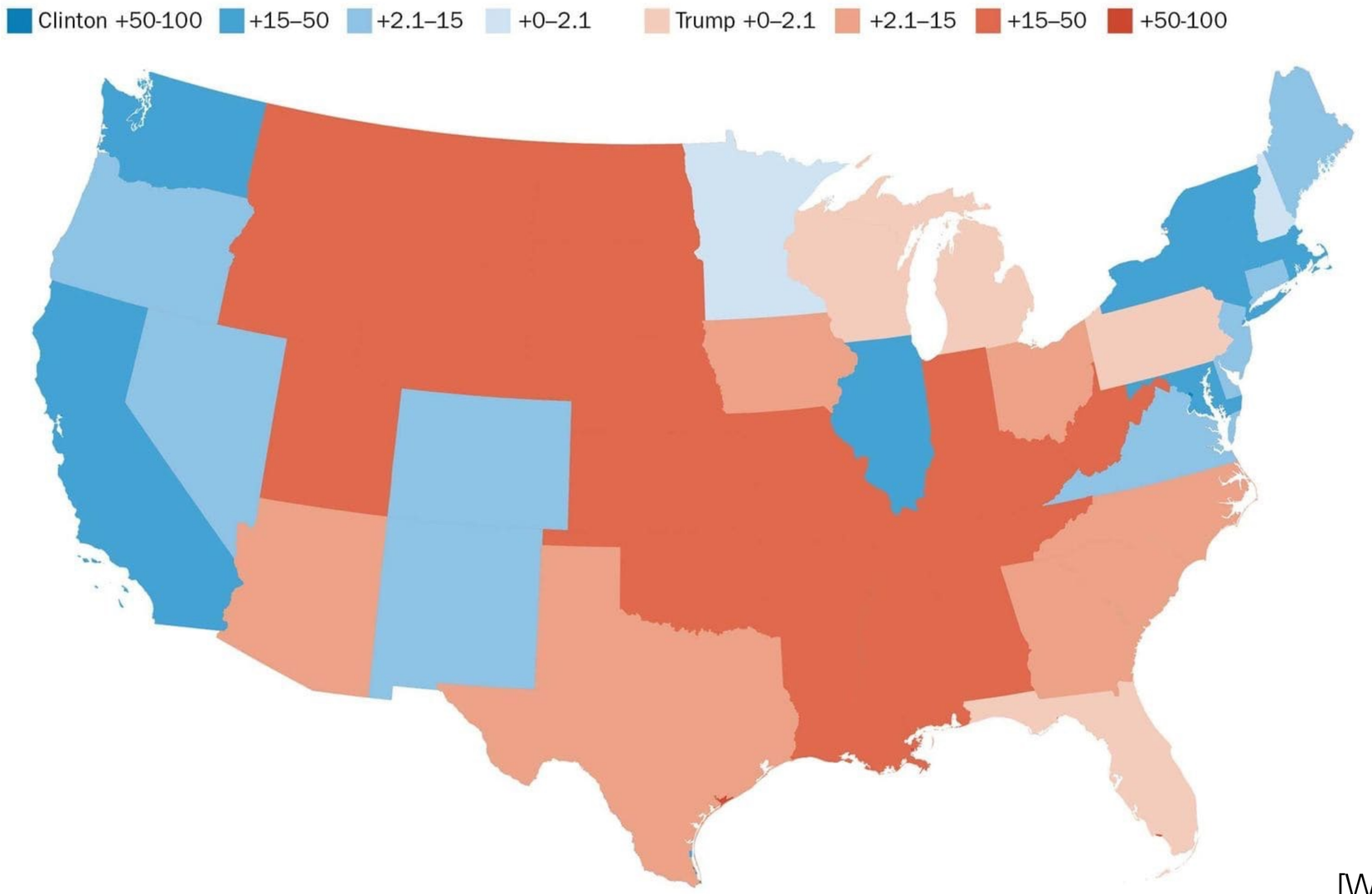
Aggregation: 2016 Election by Precinct



[Interactive Version, NYTimes]

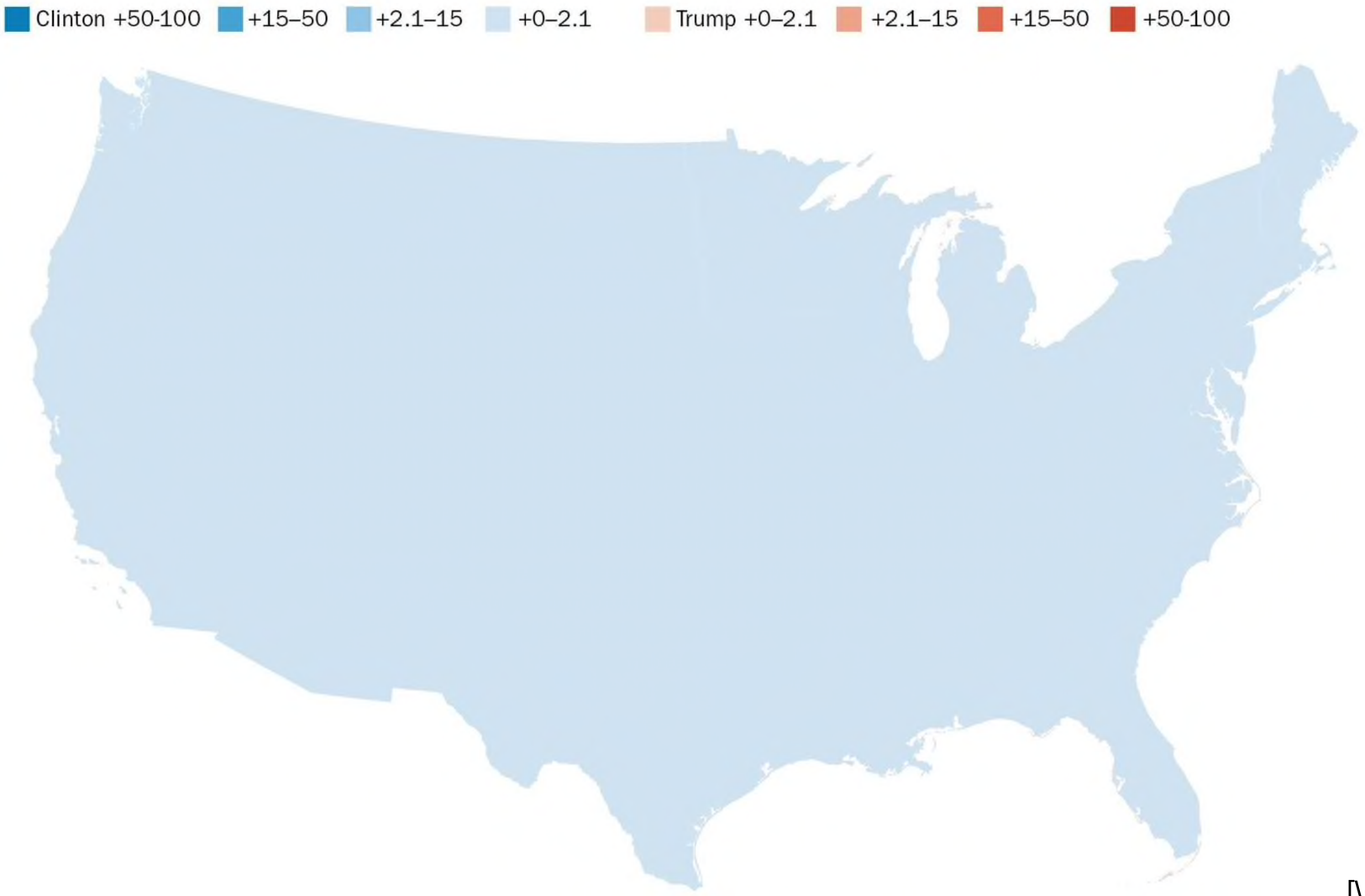
[R. Rohla and Washington Post, 2018]

Aggregation: 2016 Election by State



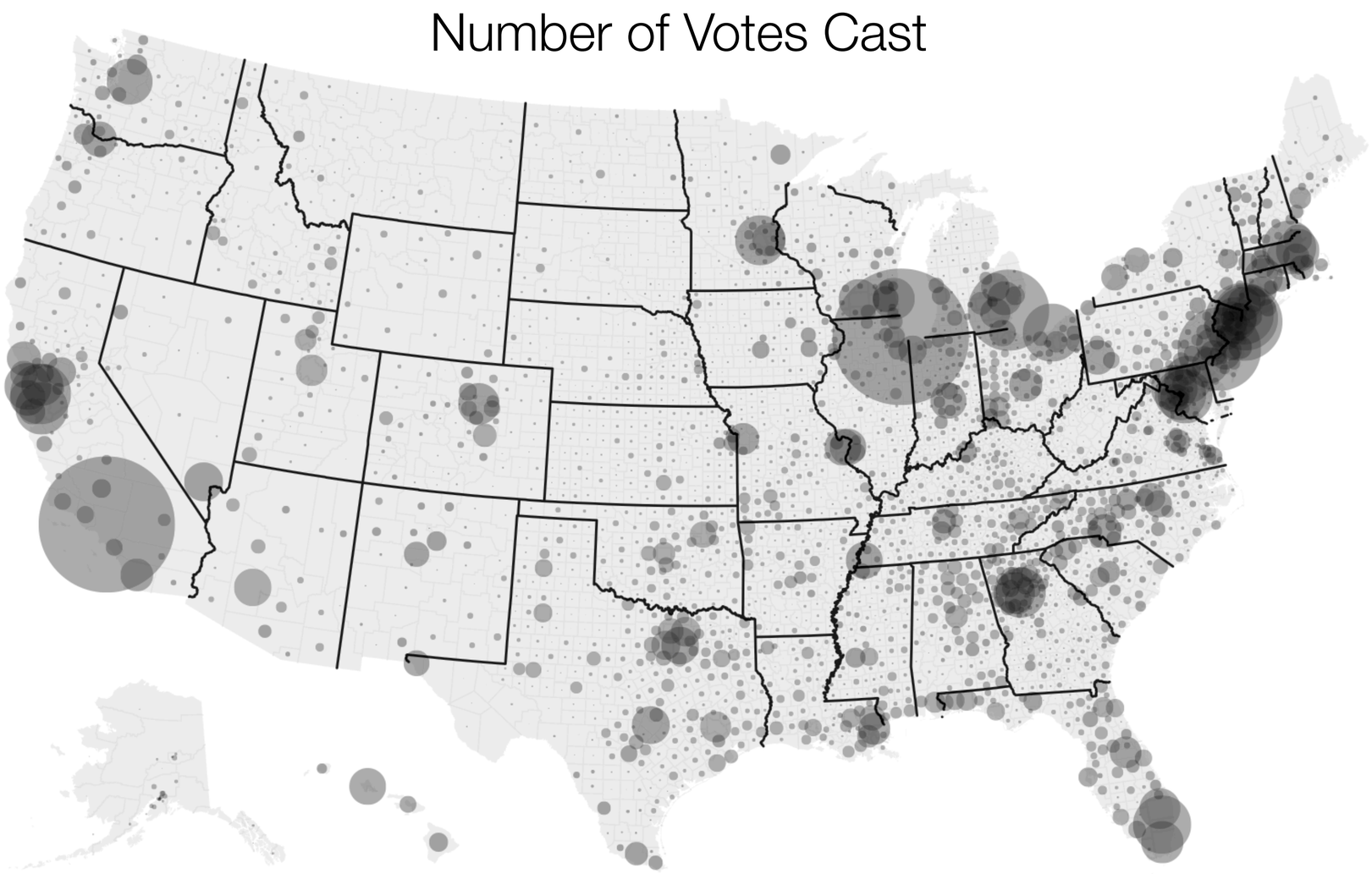
[Washington Post, 2018]

Aggregation: 2016 Election by Country



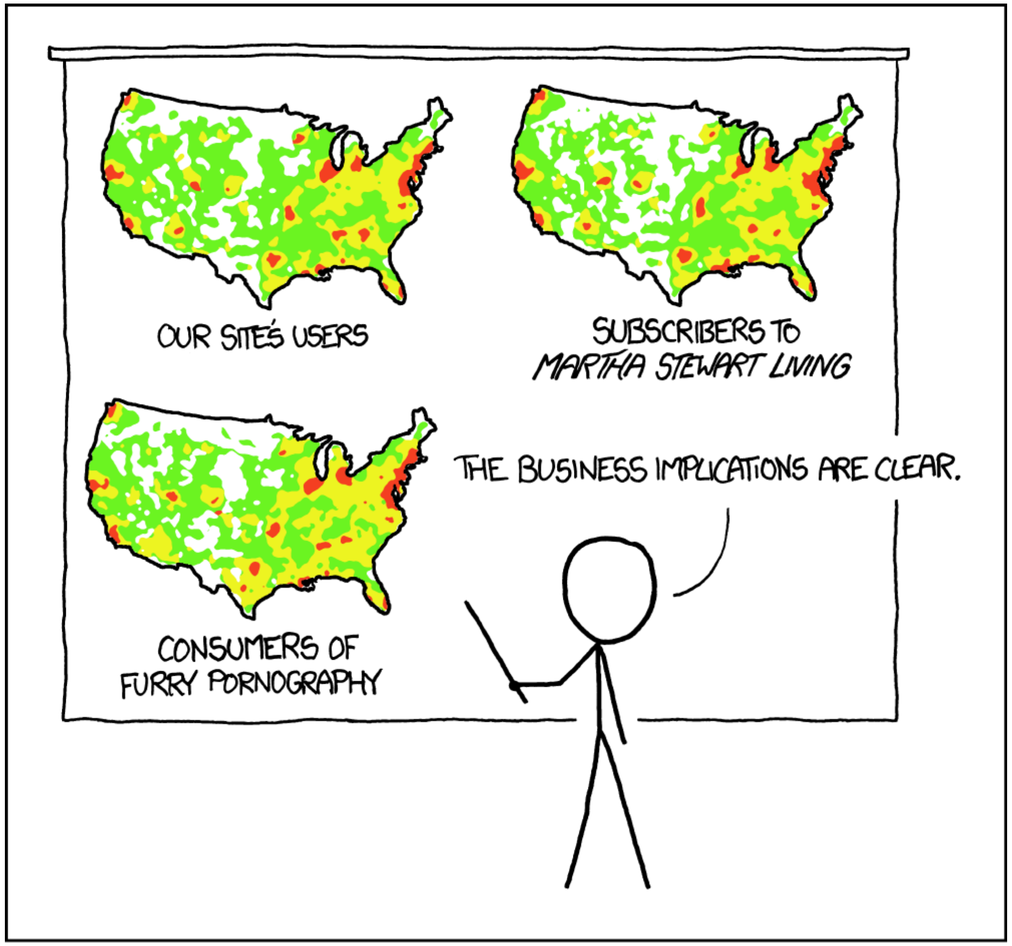
[Washington Post, 2018]

Maps: What trends do you see?



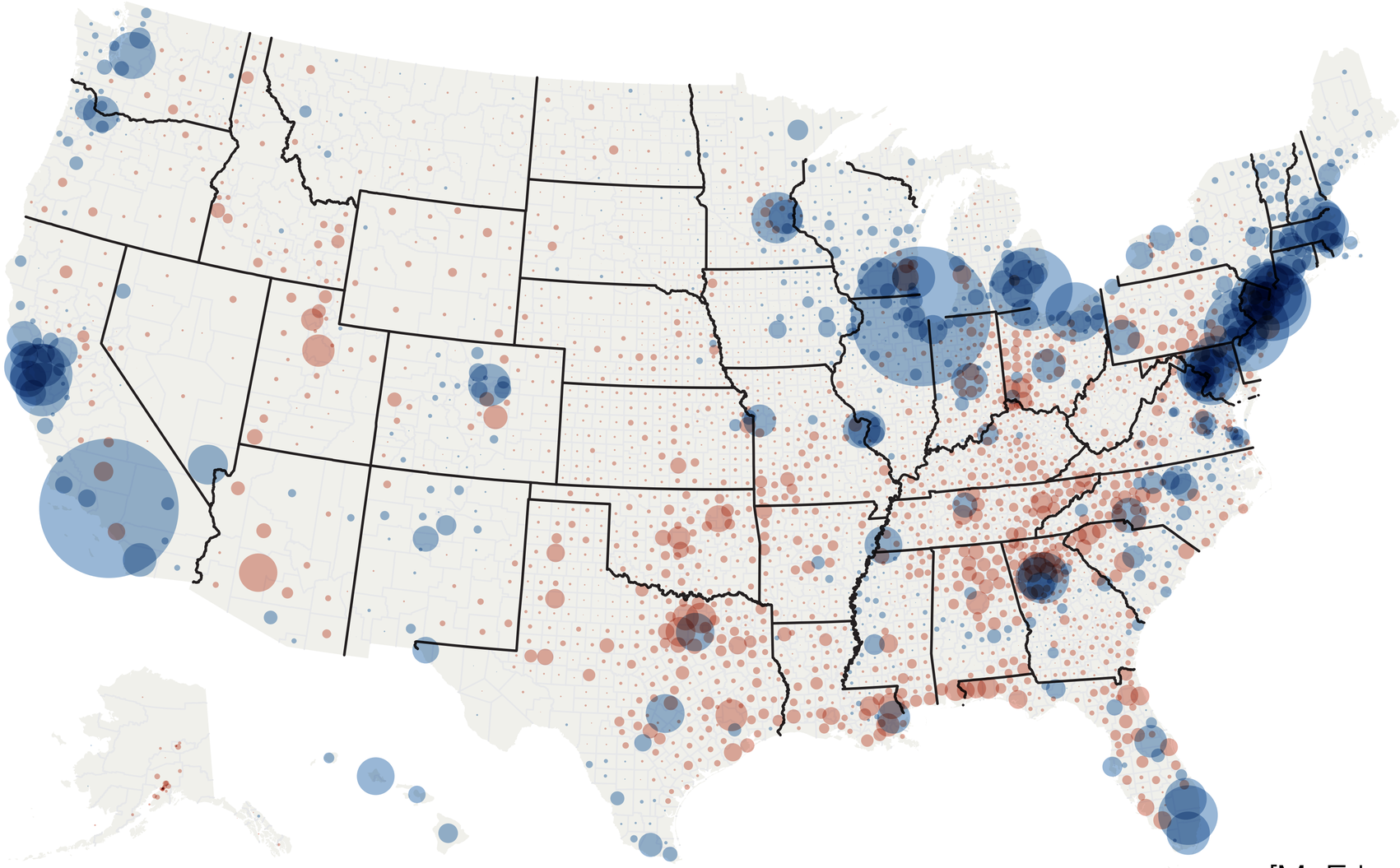
[Desaturated by D. Koop, M. Ericson, New York Times]

Don't Just Create Population Maps!



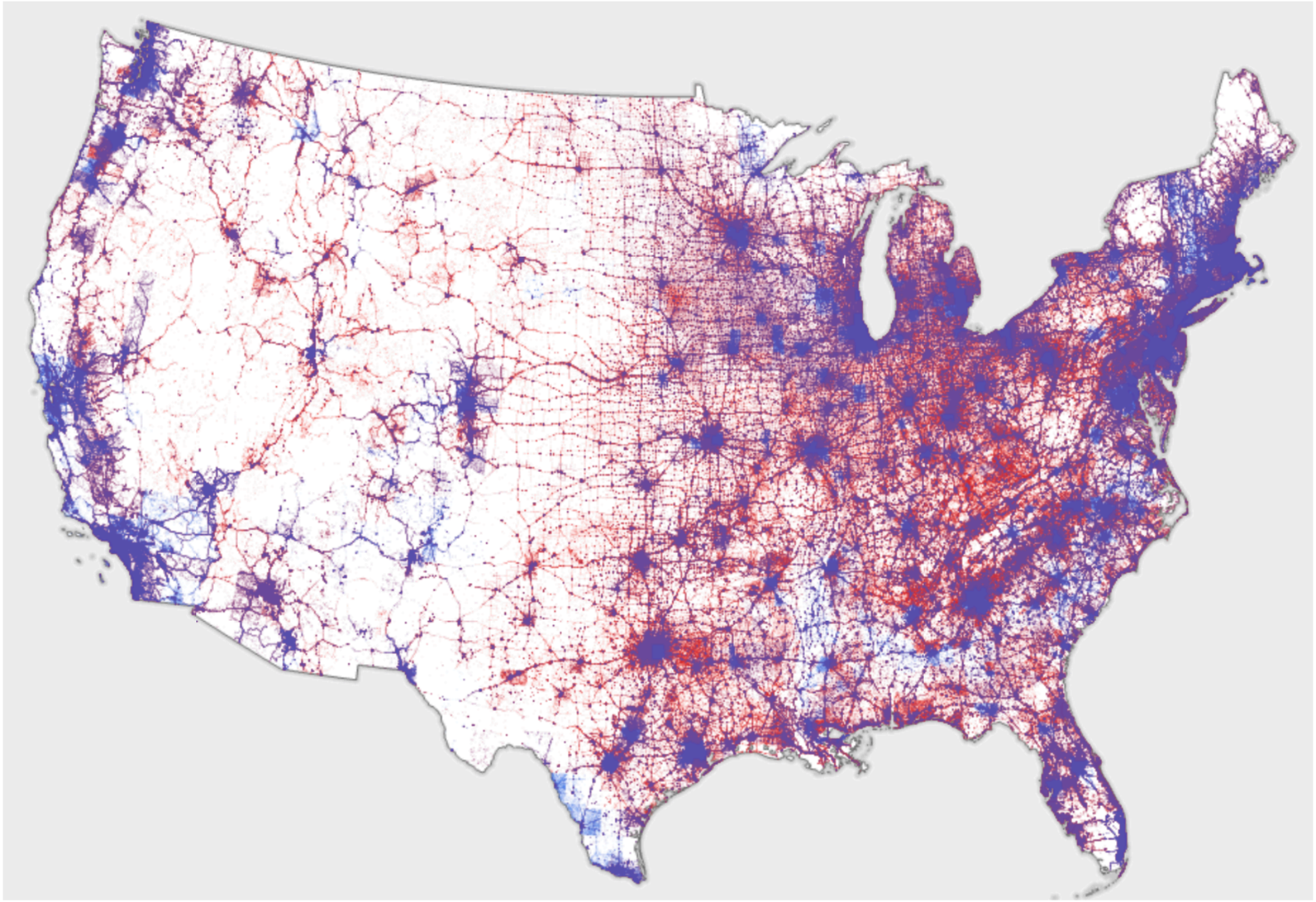
[xkcd]

Size Encoding



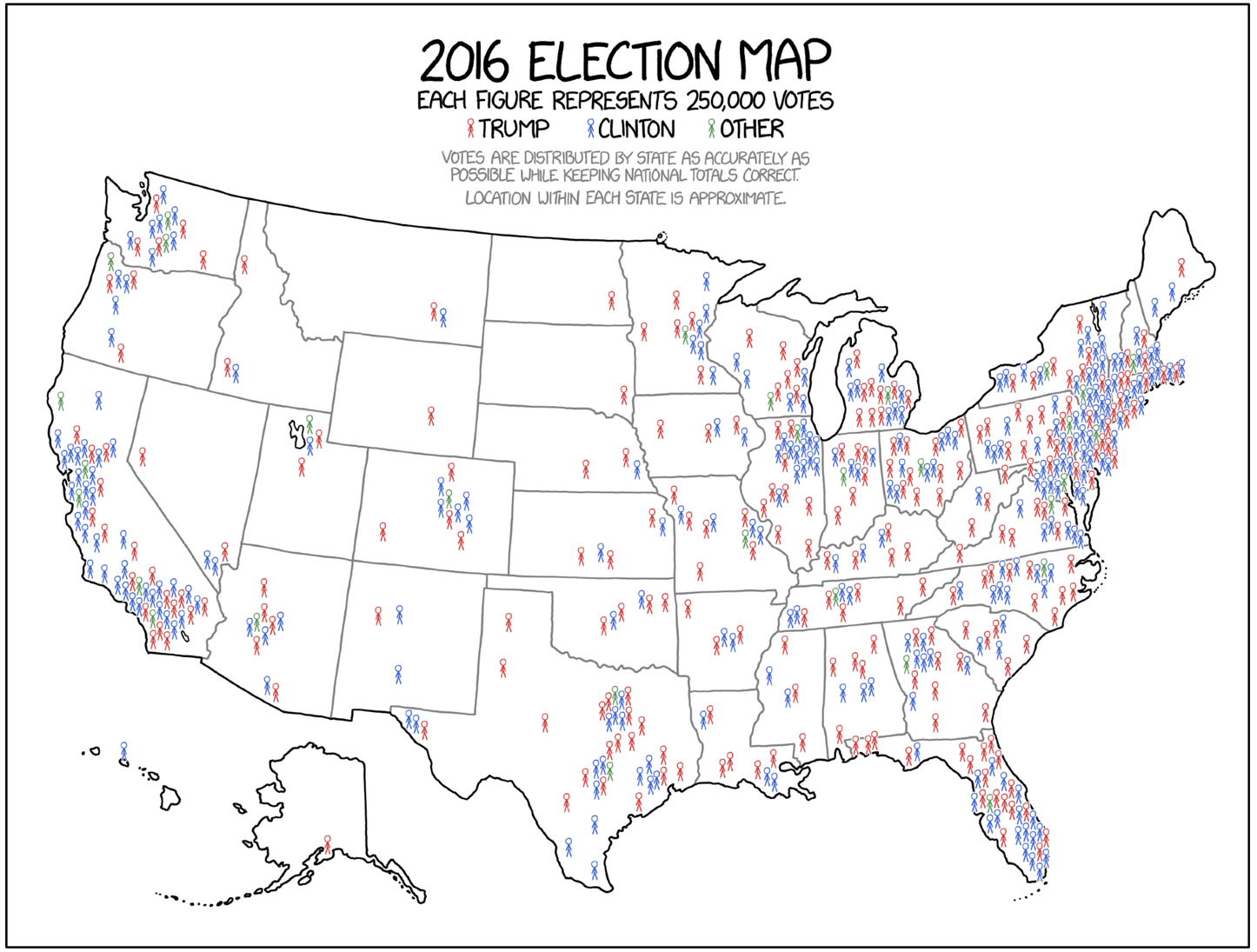
[M. Ericson, New York Times]

Dasymetric Dot Density



[K. Field]

Glyphs: xkcd's Map



[xkcd]