Time Series, Storytelling, Geospatial

CS 4460 - Information Visualization

Spring 2019

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Today

- Timeseries
  - visualization of information that has an inherent temporal component (or explicit time attribute)
- Geospatial
  - how do we show information that has a geo coordinate?
- Storytelling
  - how do we show information in a storytelling manner (not for exploration/analysis)?

Timeseries

A Time Taxonomy

- Continuous, 2 types:
  - Non-periodic
  - Periodic
- Discrete
  - Non-periodic (non-recurring)
  - Periodic

- More on next pages……..

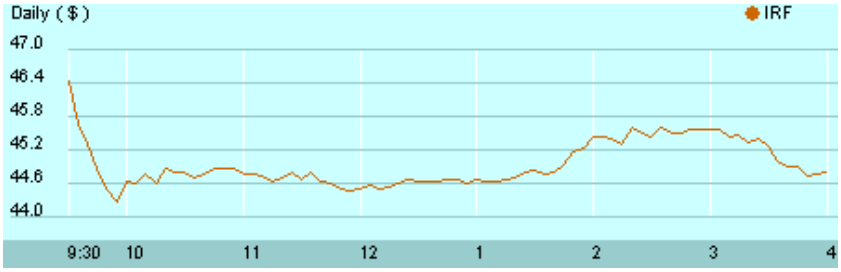
Continuous Time Data

- Examples
  - Stock market prices
  - My heart rate
  - Daily temperature in Atlanta
  - Height of ocean
- Periodic – repetitive
  - Temperature in Atlanta is periodic
    Daily highs and lows, seasonal highs and lows
  - Other examples?
- Non-periodic – many examples…

Discrete Time Data

- Birth/marriage/death
- Historical events
- Train leaves at 8:05 am
- Some discrete events have duration
  - Meeting or appointment
  - Hospital stay
  - Project phase
- Some discrete events are periodic
  - Presidential elections – every four years
  - Our class meetings (but not forever 😉)
- Recall that time data can be in multivariate, tree, network data organization

Continuous Time

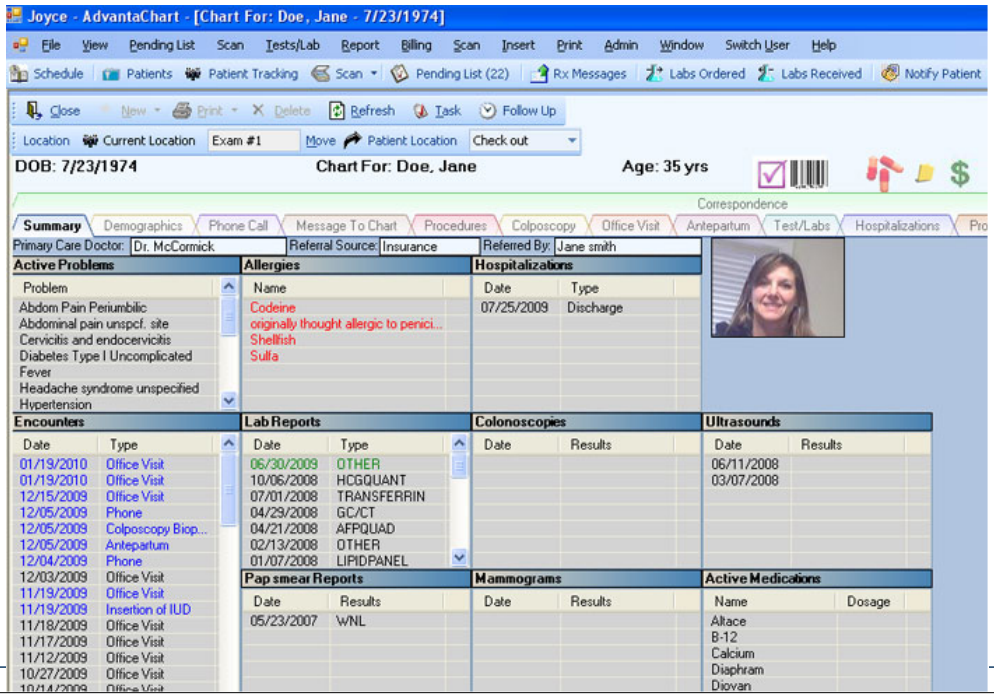


Two variables – price, time of day

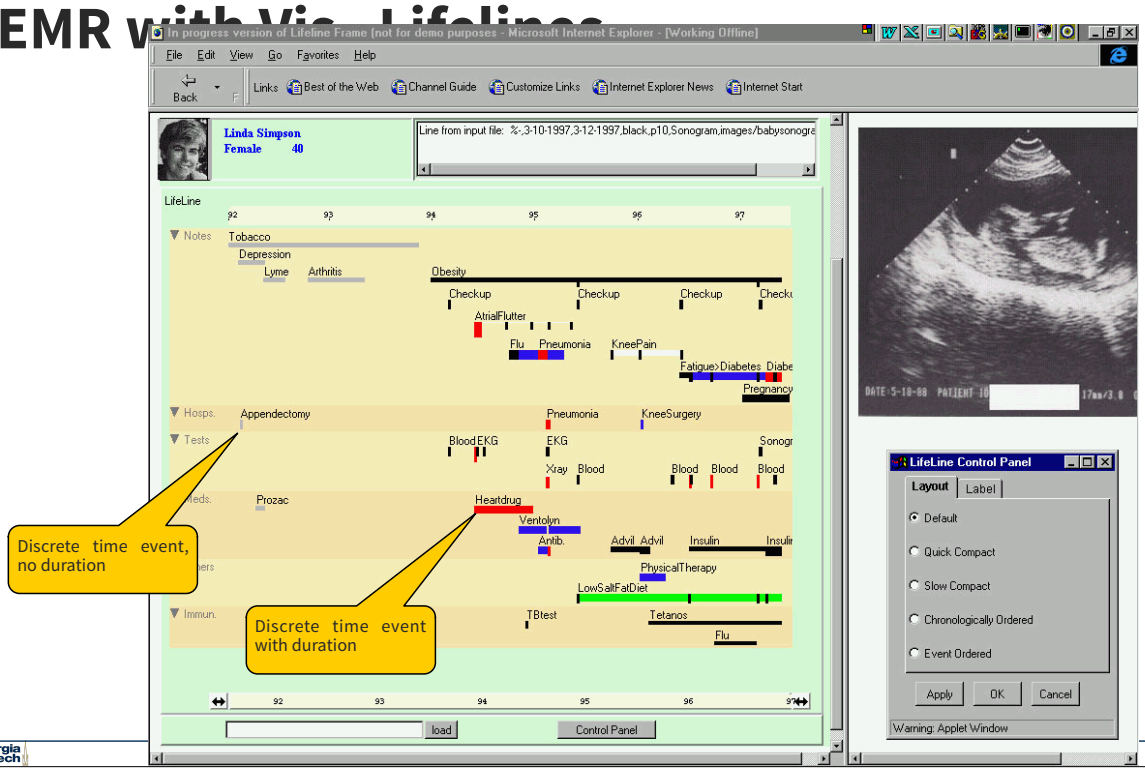
Example

- http://finance.yahoo.com/echarts?s=GOOG#symbol=goog;range=20120203,20130828;compare=;indicator=ud+volume;charttype=candlestick;crosshair=on;ohlcvalues=0;logscale=off;source=undefined;

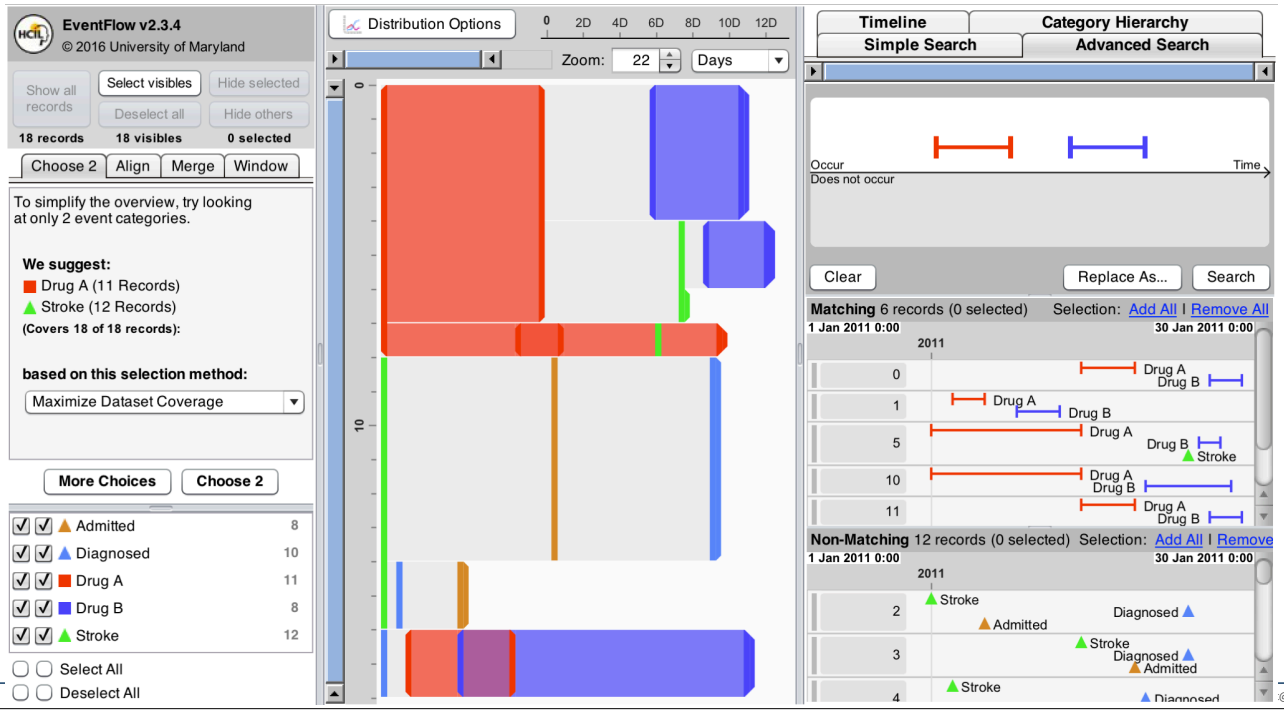
Electronic Medical Records (EMR) – no Vis



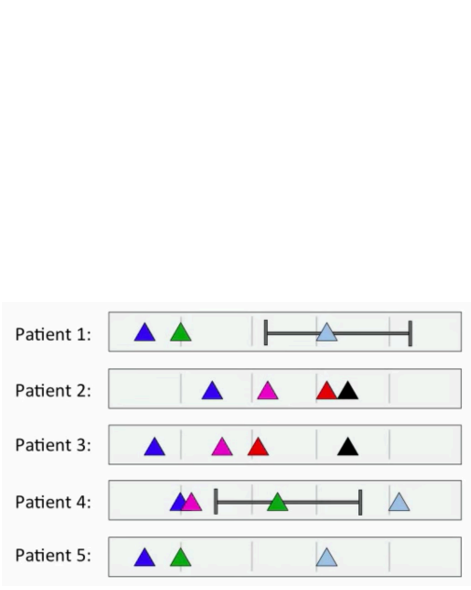
EMR with Vis – Lifelines



EventFlow

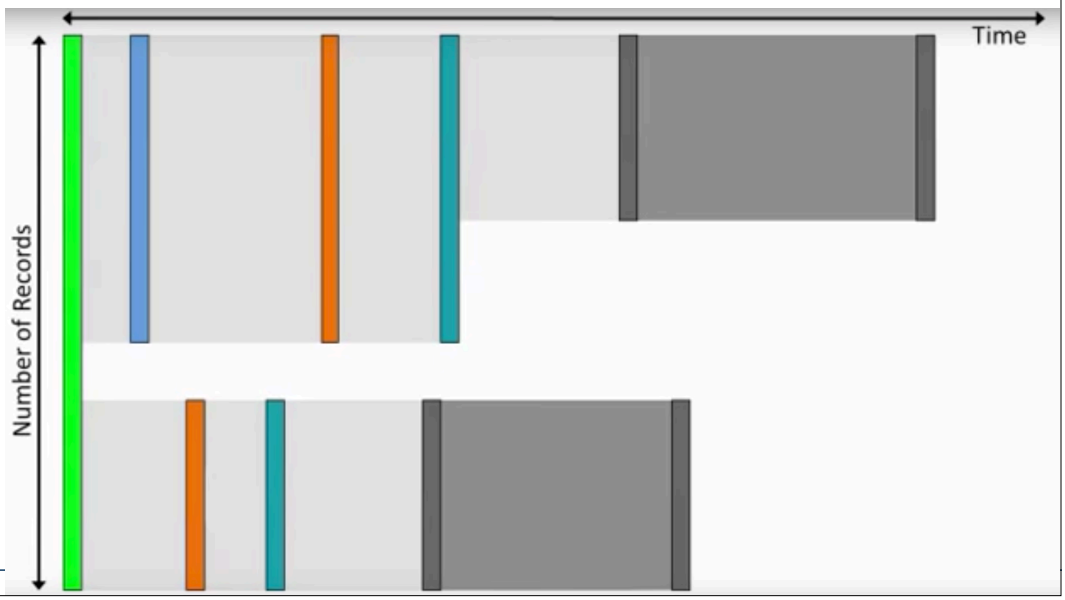


EventFlow



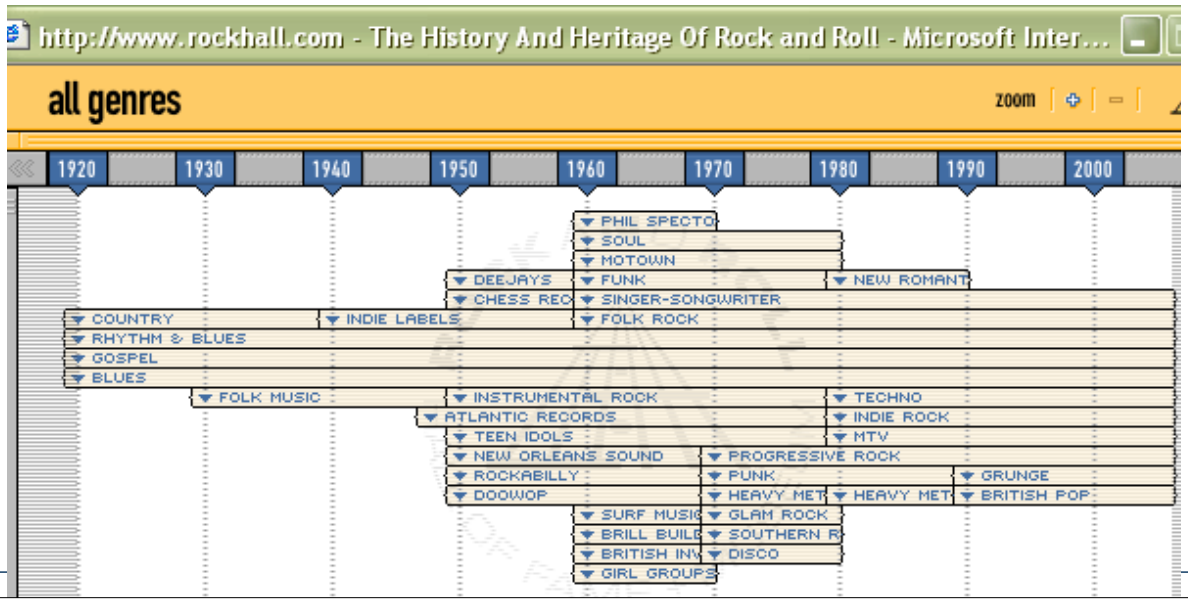
EventFlow

Video: http://hcil.umd.edu/eventflow/#video



Example: Music Over Time

History of Music Genres



endert@gatech.edu

Example: Project Management

- Project (write software, design/build plane, hire new person) involves
  - Multiple steps
  - Spread over time
  - Some steps depend on other steps
- How can we plan/manage project?

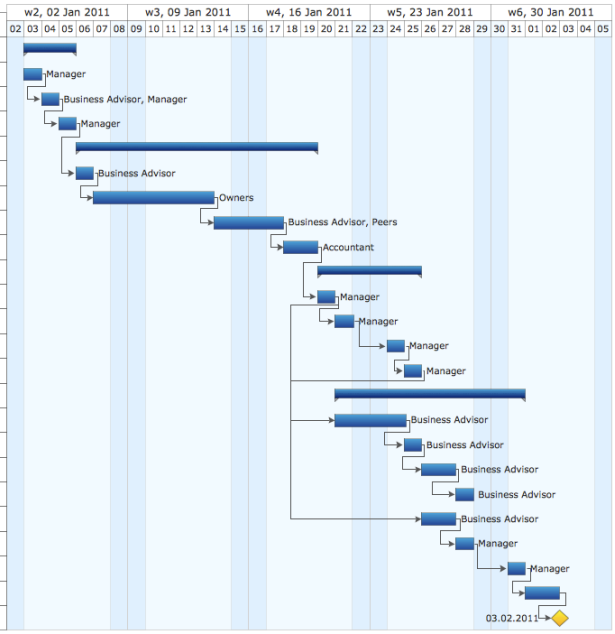
PERT/Gantt

- Project (write software, design/build plane, hire new person) involves
  - Multiple steps, each having a time interval (or range)
  - Some steps depend on other steps

Gantt Chart

Strategic Plan for New Business

#	Name	Duration	Start	Finish
1	Self-Assessment	23,0 d	03.01.2011	05.01.2011
2	Define business vision	1,0 d	03.01.2011	03.01.2011
3	Identify available skills, information and support	1,0 d	04.01.2011	04.01.2011
4	Decide whether to proceed	1,0 d	05.01.2011	05.01.2011
5	Define the Opportunity	10,0 d	06.01.2011	19.01.2011
6	Research the market & competition	1,0 d	06.01.2011	06.01.2011
7	Interview owners of similar businesses	5,0 d	07.01.2011	13.01.2011
8	Identify needed resources	2,0 d	14.01.2011	17.01.2011
9	Identify operating cost elements	2,0 d	18.01.2011	19.01.2011
10	Evaluate Business Approach	4,0 d	20.01.2011	25.01.2011
11	Define new entity requirements	1,0 d	20.01.2011	20.01.2011
12	Identify on-going business purchase opportunities	1,0 d	21.01.2011	21.01.2011
13	Research franchise possibilities	1,0 d	24.01.2011	24.01.2011
14	Summarize business approach	1,0 d	25.01.2011	25.01.2011
15	Evaluate Potential Risks and Rewards	7,0 d	21.01.2011	31.01.2011
16	Assess market size and stability	2,0 d	21.01.2011	24.01.2011
17	Estimate the competition	1,0 d	25.01.2011	25.01.2011
18	Assess needed resource availability	2,0 d	26.01.2011	27.01.2011
19	Evaluate realistic initial market share	1,0 d	28.01.2011	28.01.2011
20	Determine financial requirements	2,0 d	26.01.2011	27.01.2011
21	Review personal suitability	1,0 d	28.01.2011	28.01.2011
22	Evaluate initial profitability	1,0 d	31.01.2011	31.01.2011
23	Review and modify the strategic plan	2,0 d	01.02.2011	02.02.2011
24	Confirm decision to proceed		03.02.2011	



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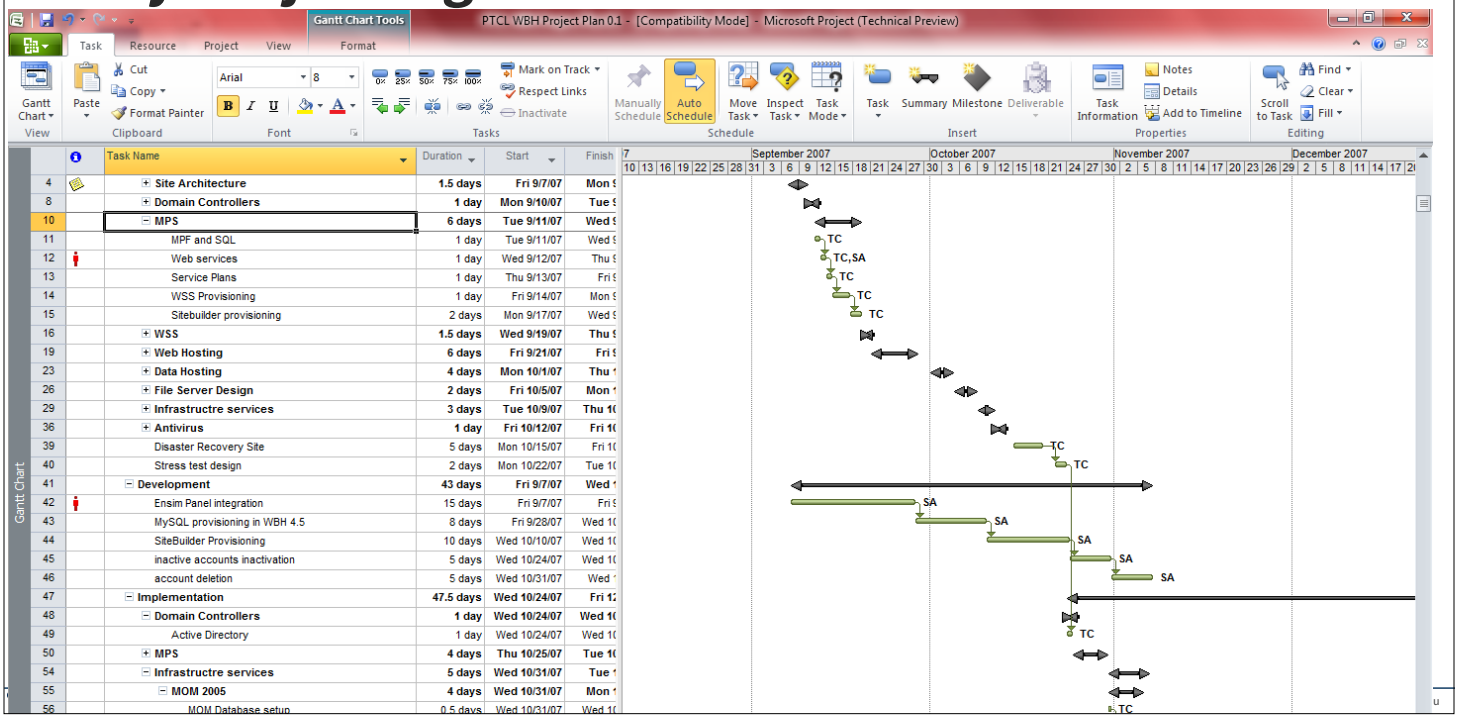
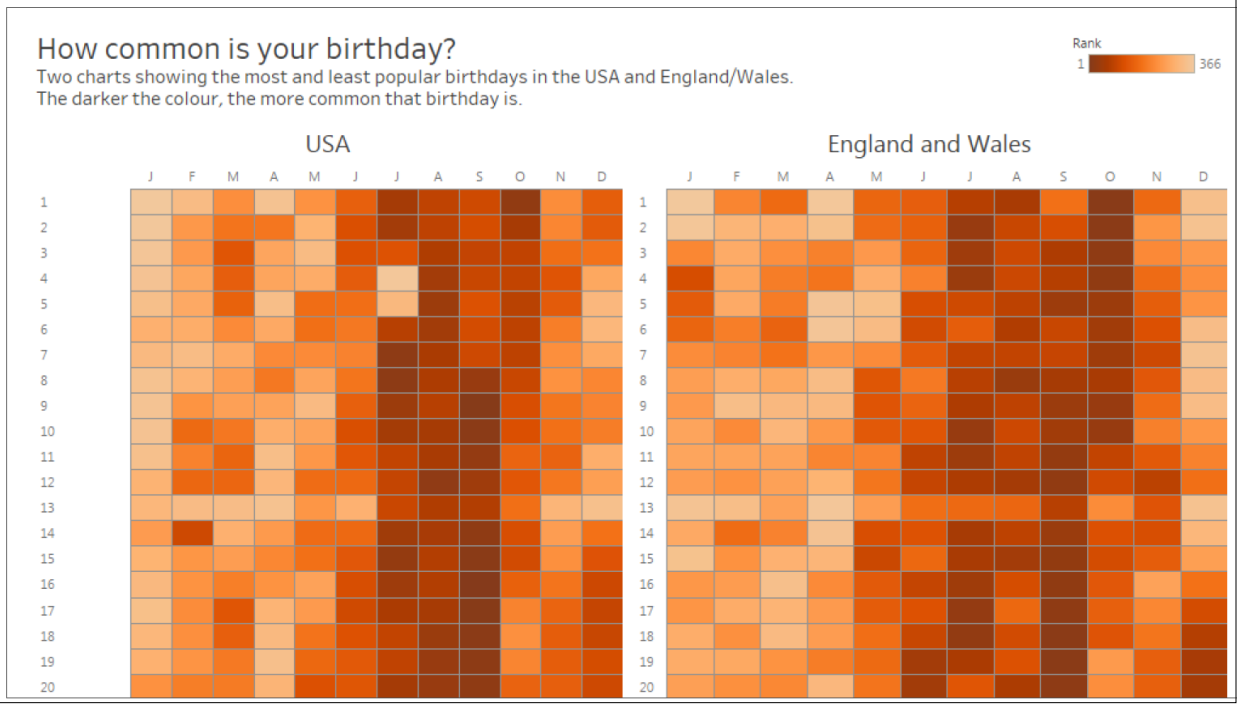
Many Project Mg't Products!

Microsoft Project

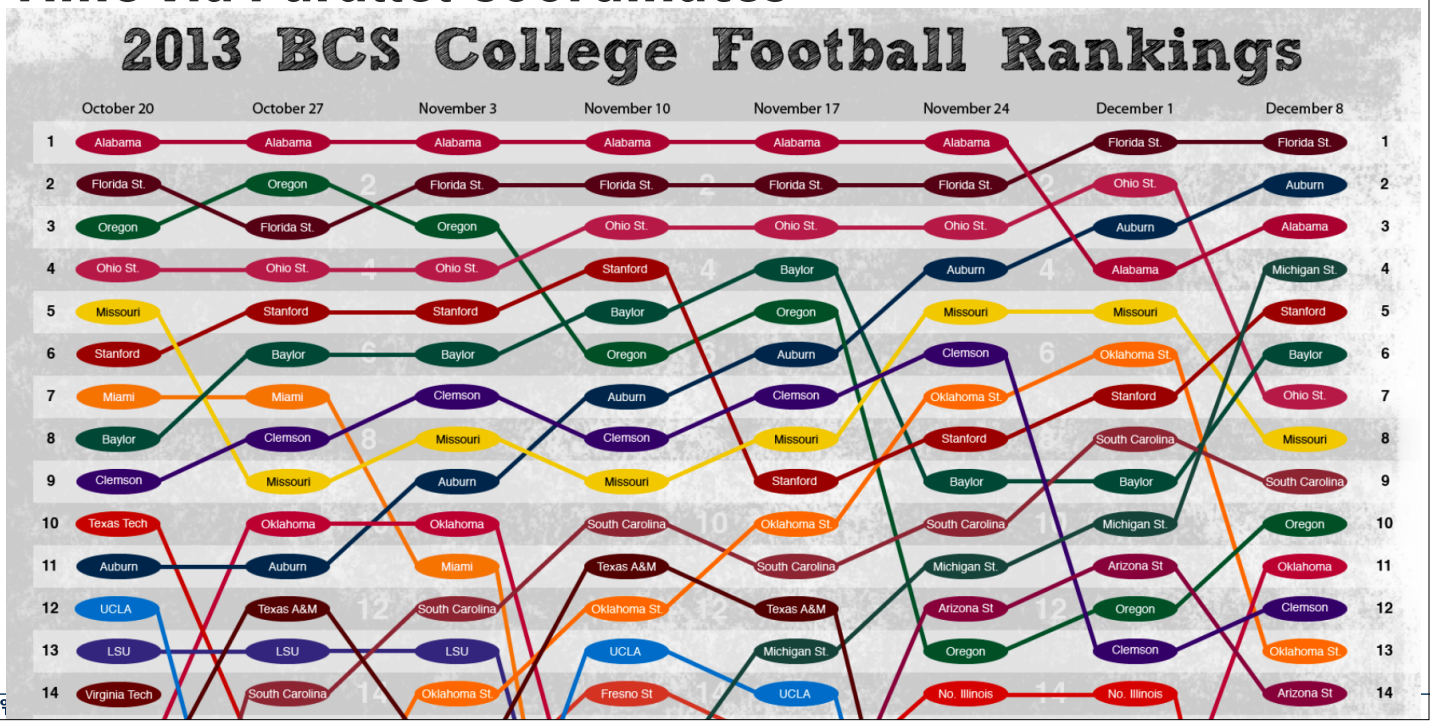


Time in 2D

another variation: http://thedailyviz.com/2016/09/17/how-common-is-your-birthday-dailyviz/



Time via Parallel Coordinates



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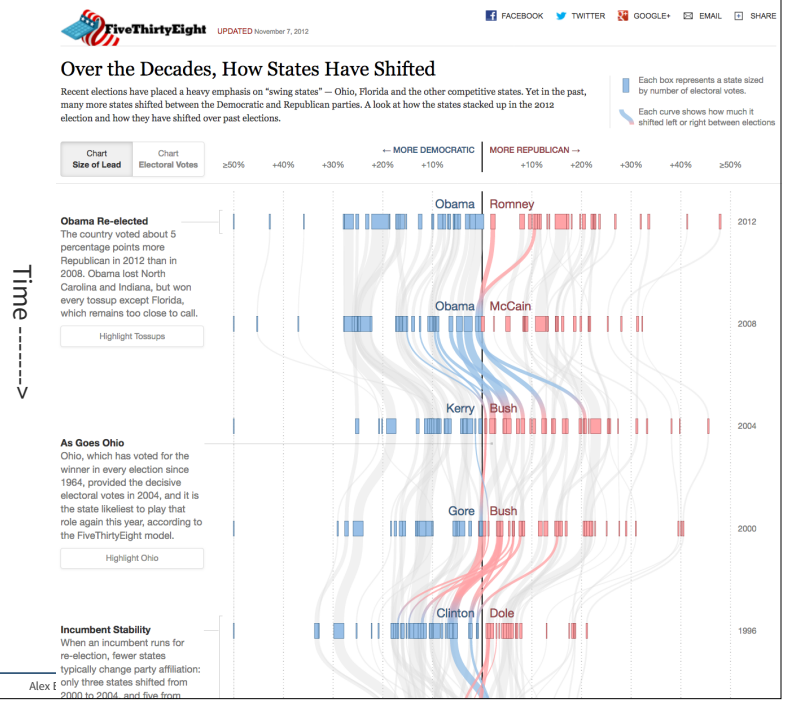


Time ----->

http://www.nytimes.com/interactive/2012/10/15/us/politics/swing-history.html?_r=1&

personal experience with cyber security

- [story time!]
- in my previous job, I worked with cyber security analysts to help them do their job
- I spent lots of time with them, helped build visualizations for them, and observed the effect this had

Cyber Security Analysts: what do they do?

Analysts filter out the "normal"
line-by-line

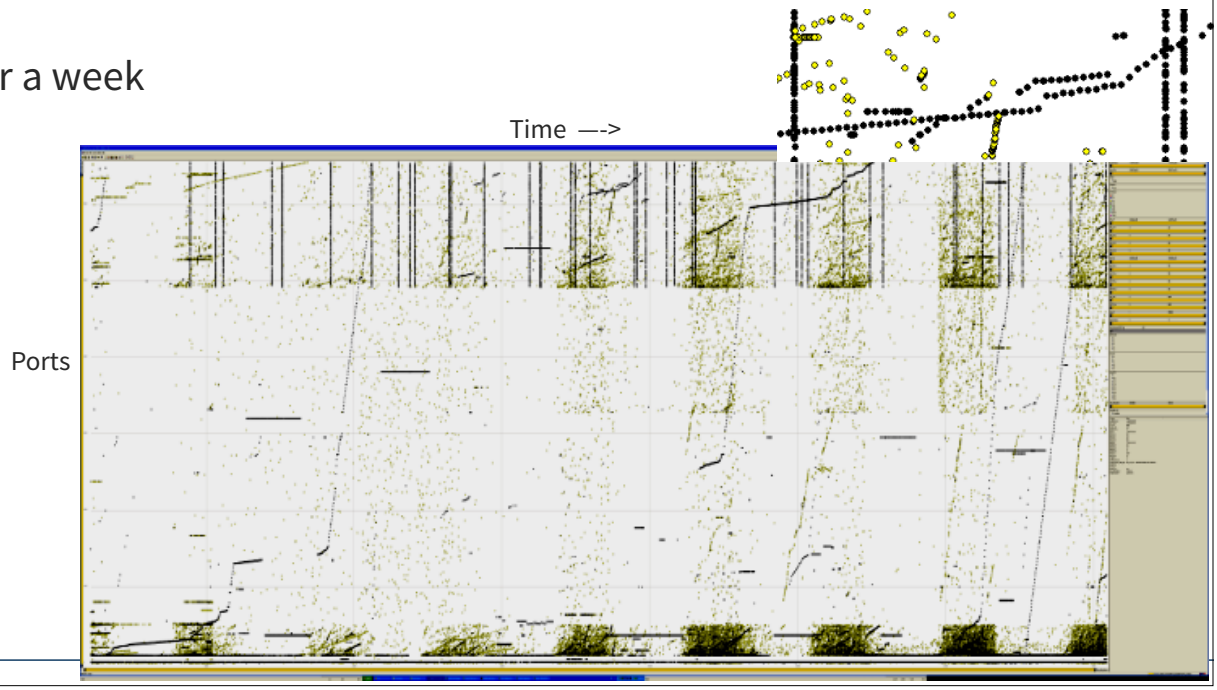
Seek patterns of familiar abnormalities
Previous experience creates personal "hit list"

Analysts observe data individually, not in connection with whole dataset

Lots of SQL, grep, cmd queries

a success story

- Packets for a week

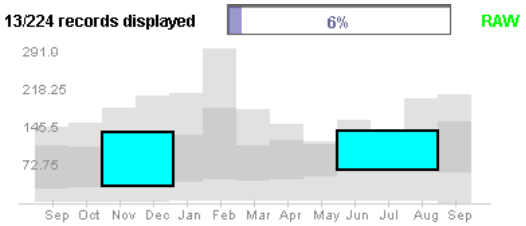


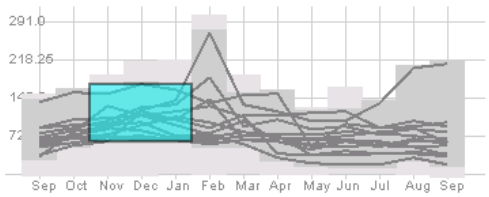
How to query?

- Most systems focus on visualizing and navigating time-series data.
- What about querying?

TimeSearcher

Can create rectangles that function as matching regions





Light gray is all data's extent

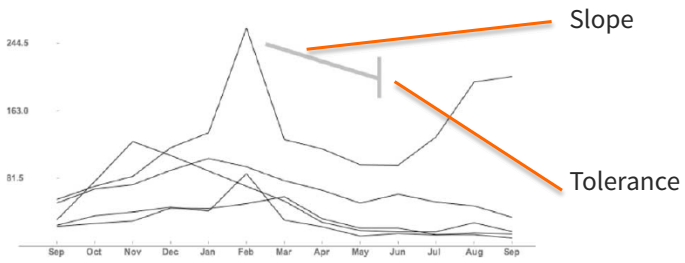
Darker grayed region is data envelope that shows extreme values of queries matching criteria

Multiple boxes are "anded"

Hochheiser & Shneiderman
Proc. Discovery Science '01
Info Vis '04

TimeFinder – Other Capabilities

- Search for matches based on angle (slope) ± tolerance



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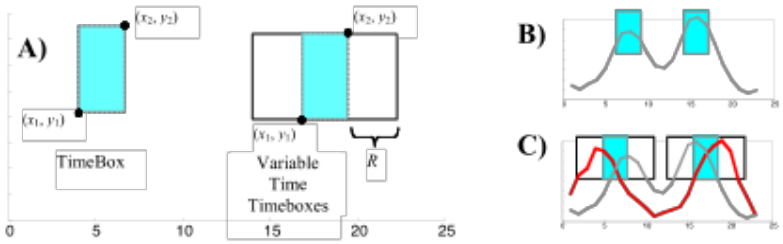
Example:TimeSearcher

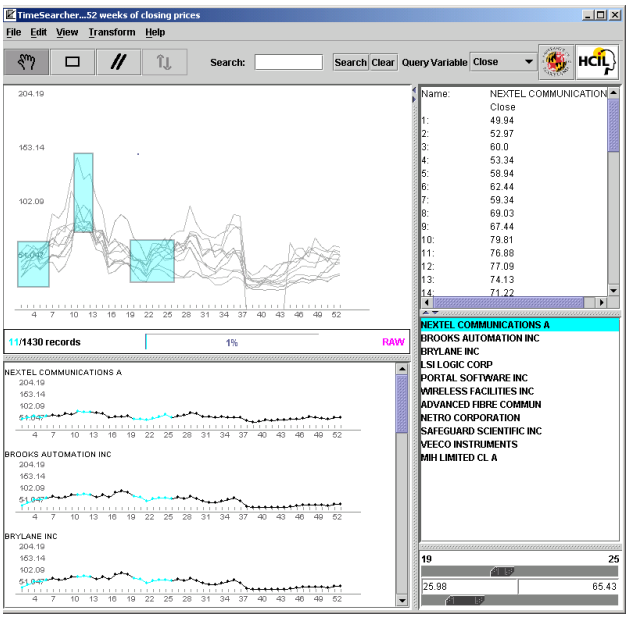
- Overcomes TimeFinder limitation
- Allow time boxes with deltas on each side
  - Video: https://www.youtube.com/watch?v=VWx1TMcrb74



Buono, Plaisant, Simeone, Aris, Shneiderman, et.al, Similarity-Based Forecasting with Simultaneous Previews: A River Plot Interface for Time Series Forecasting, 11th International Conference on Information Visualization, 2007

TimeSearcher

http://www.cs.umd.edu/hcil/timesearcher/videos/TimeSearcherDemo.mp4

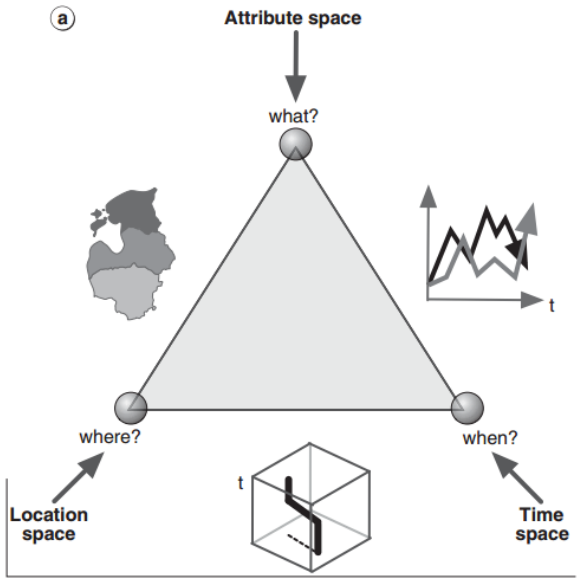


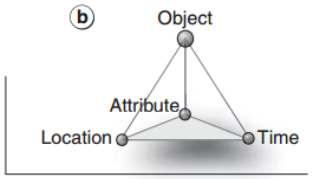
Geospatial

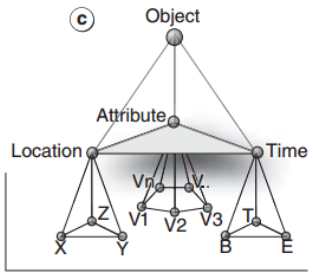
Geospatial visualization

- Important new factors that we have to visualize
  - **Where** is the data located?
  - **When** did the data happen (or get captured)?
  - **What** is it we're visualizing?

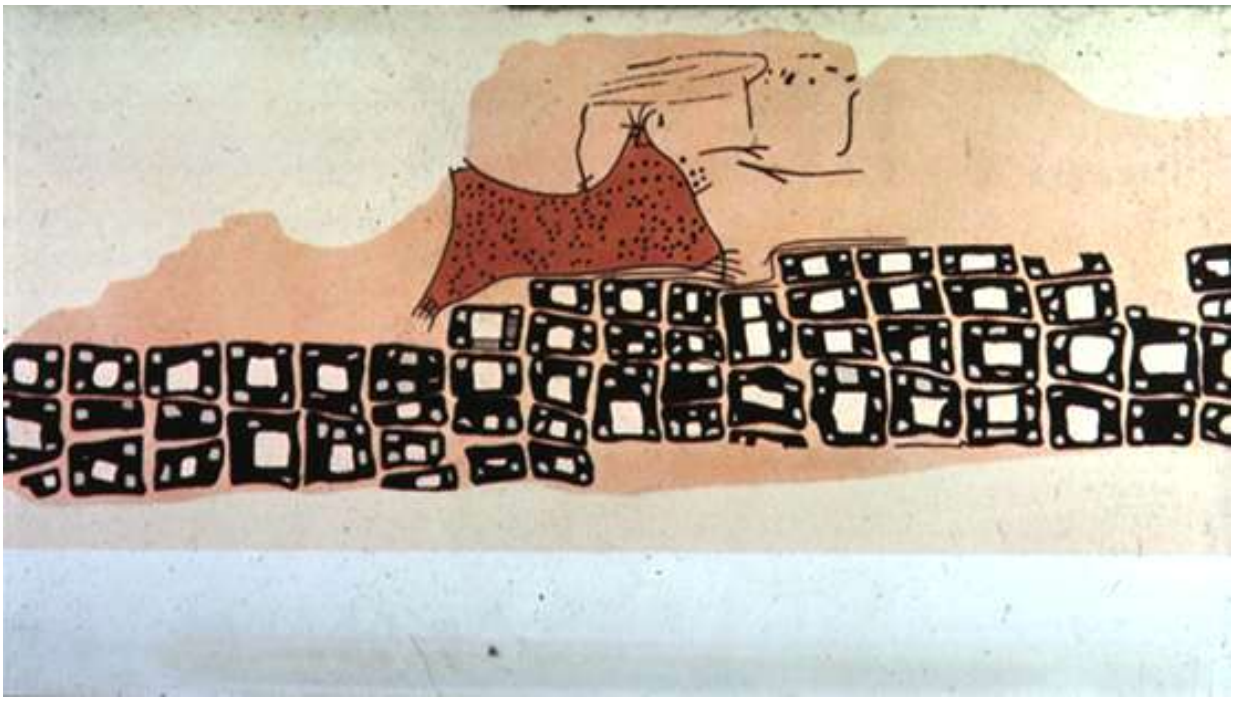
Data considerations



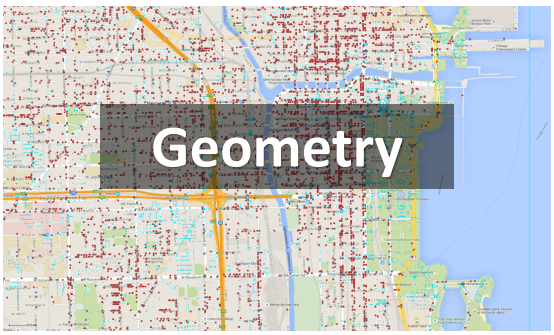


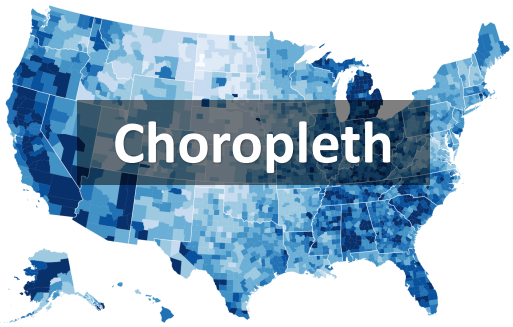


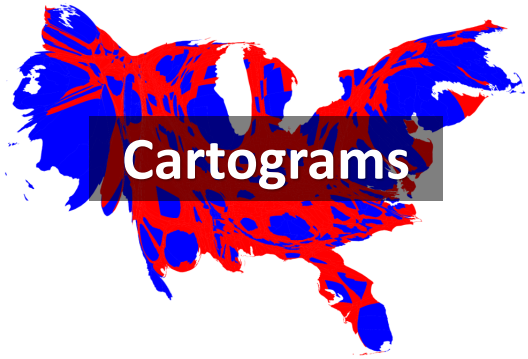
Kraak, Menno-Jan, and Ferjan Ormeling. Cartography: visualization of spatial data. Guilford Press, 2011.

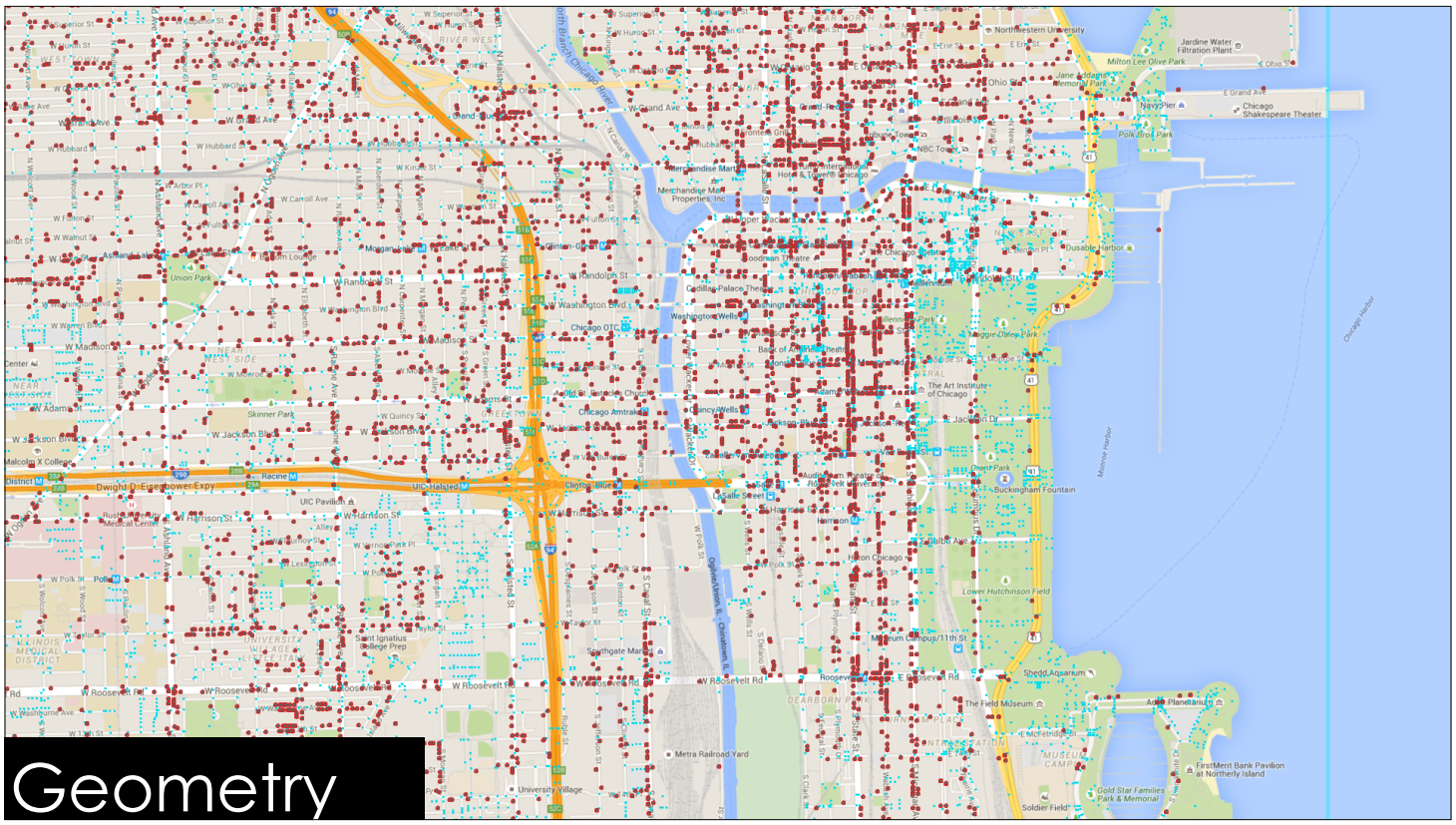


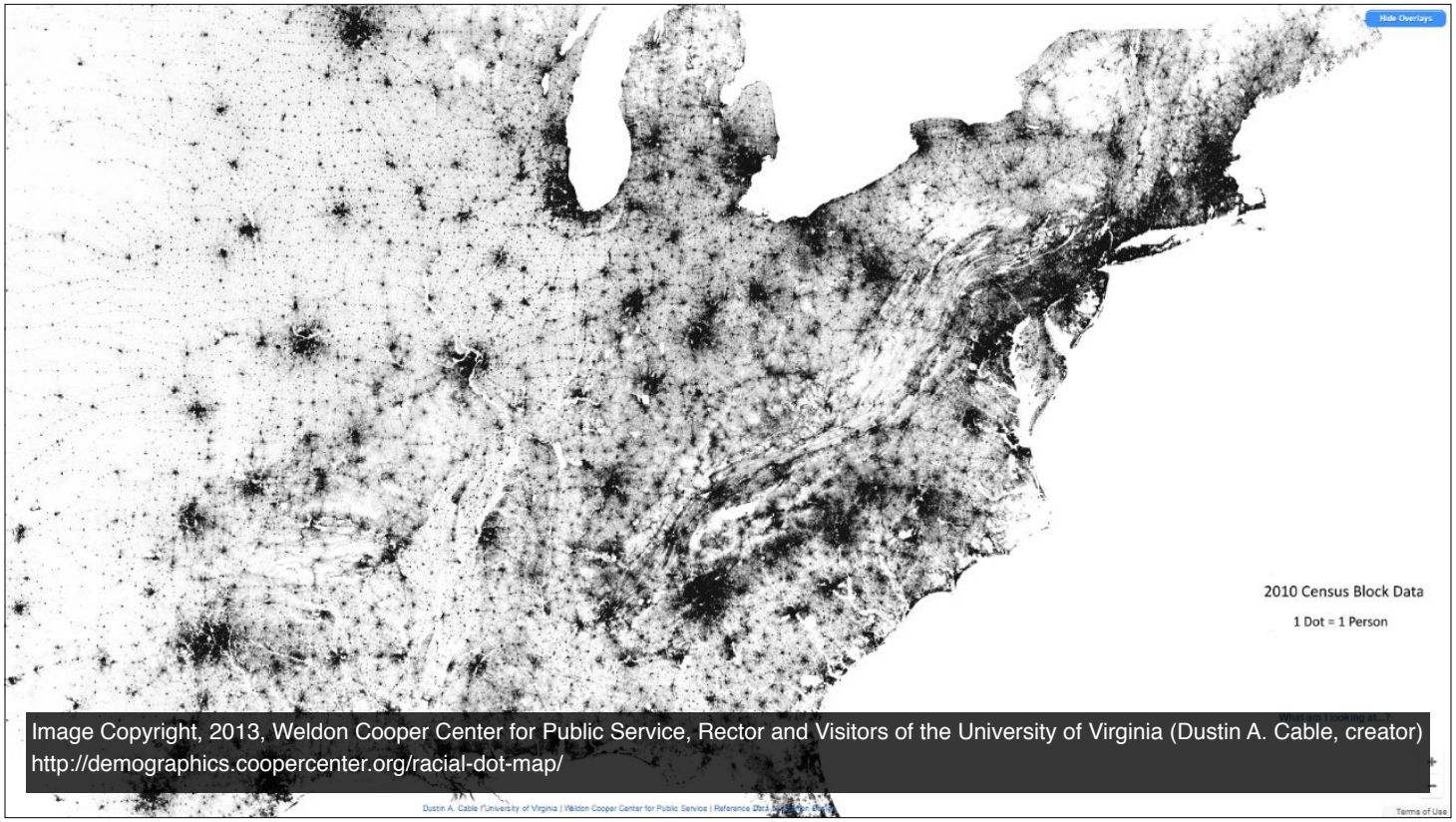
Oldest Known Map. Konya Town Map, 6200 BC Turkey

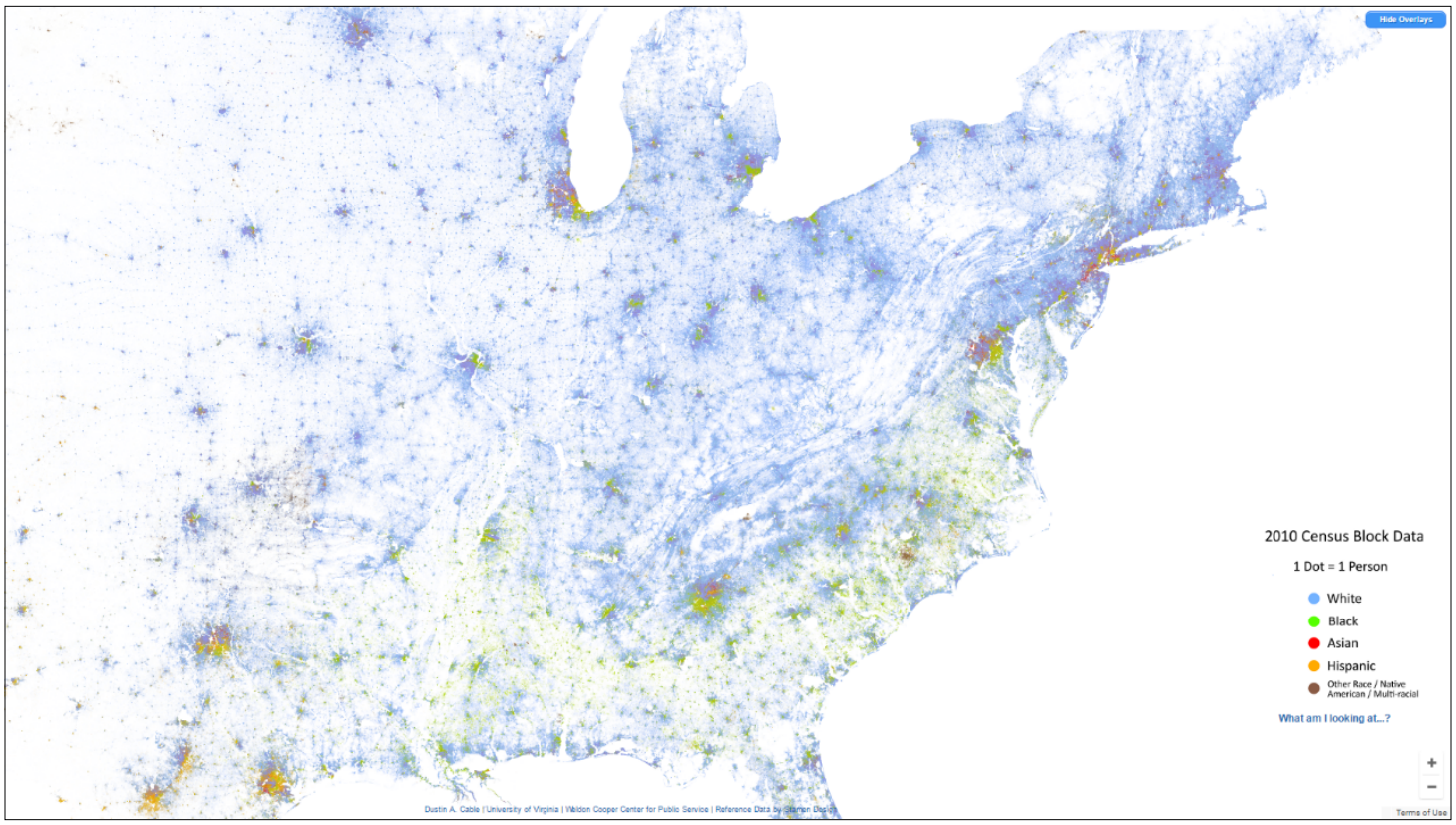


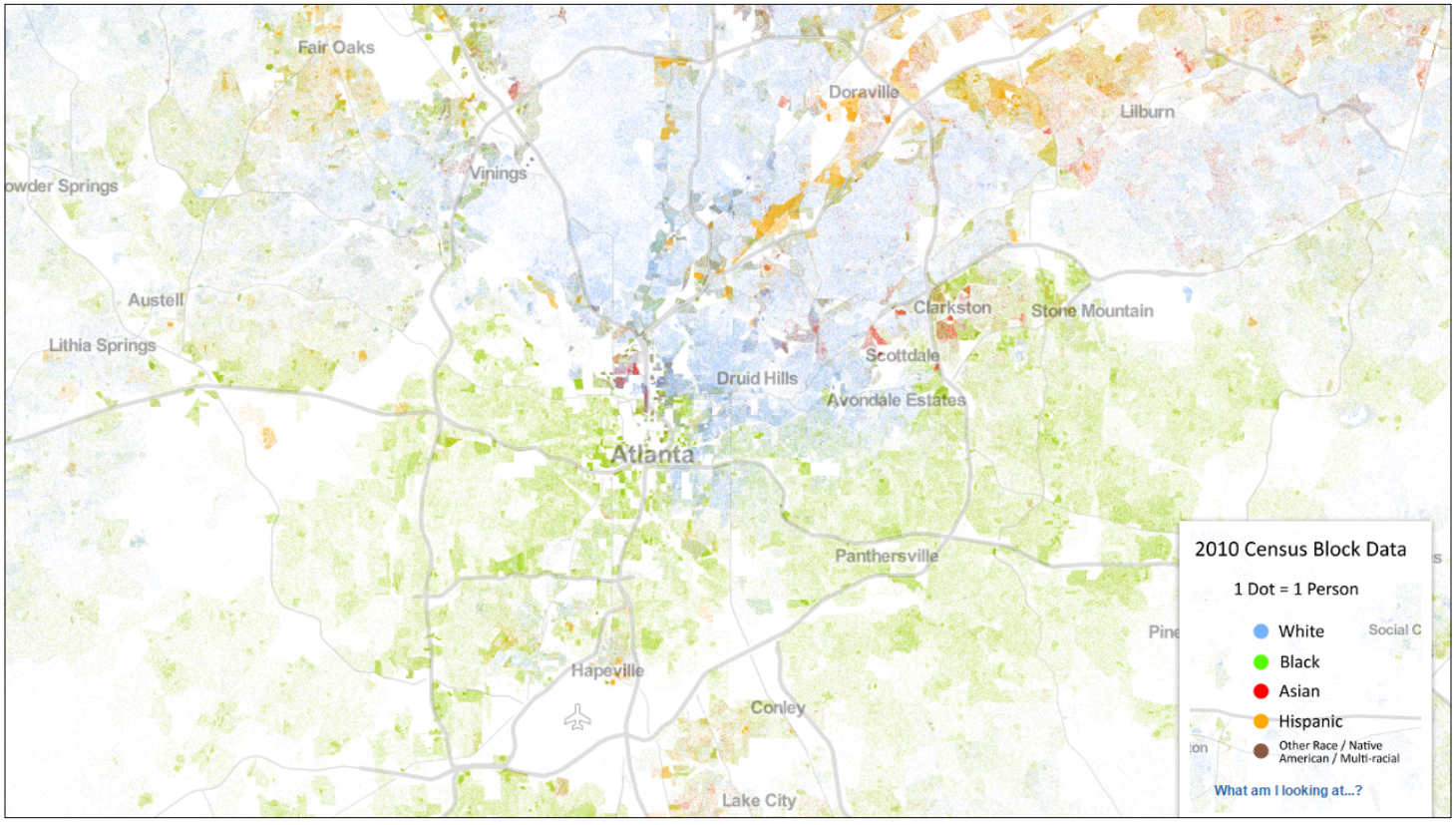





Geometry


Hide Overlays
2010 Census Block Data
1 Dot = 1 Person
Image Copyright, 2013, Weldon Cooper Center for Public Service, Rector and Visitors of the University of Virginia (Dustin A. Cable, creator)
http://demographics.coopercenter.org/racial-dot-map/


Hide Overlays
2010 Census Block Data
1 Dot = 1 Person
White
Black
Asian
Hispanic
Other Race / Native American / Multi-racial
What am I looking at...?
Dustin A. Cable | University of Virginia | Weldon Cooper Center for Public Service | Reference Data by Stamen Design
Terms of Use


Fair Oaks
Doraville
Lilburn
Vinings
owder Springs
Austell
Clarkston
Stone Mountain
Lithia Springs
Scottdale
Druid Hills
Avondale Estates
Atlanta
Panthersville
Hapeville
Conley
Lake City
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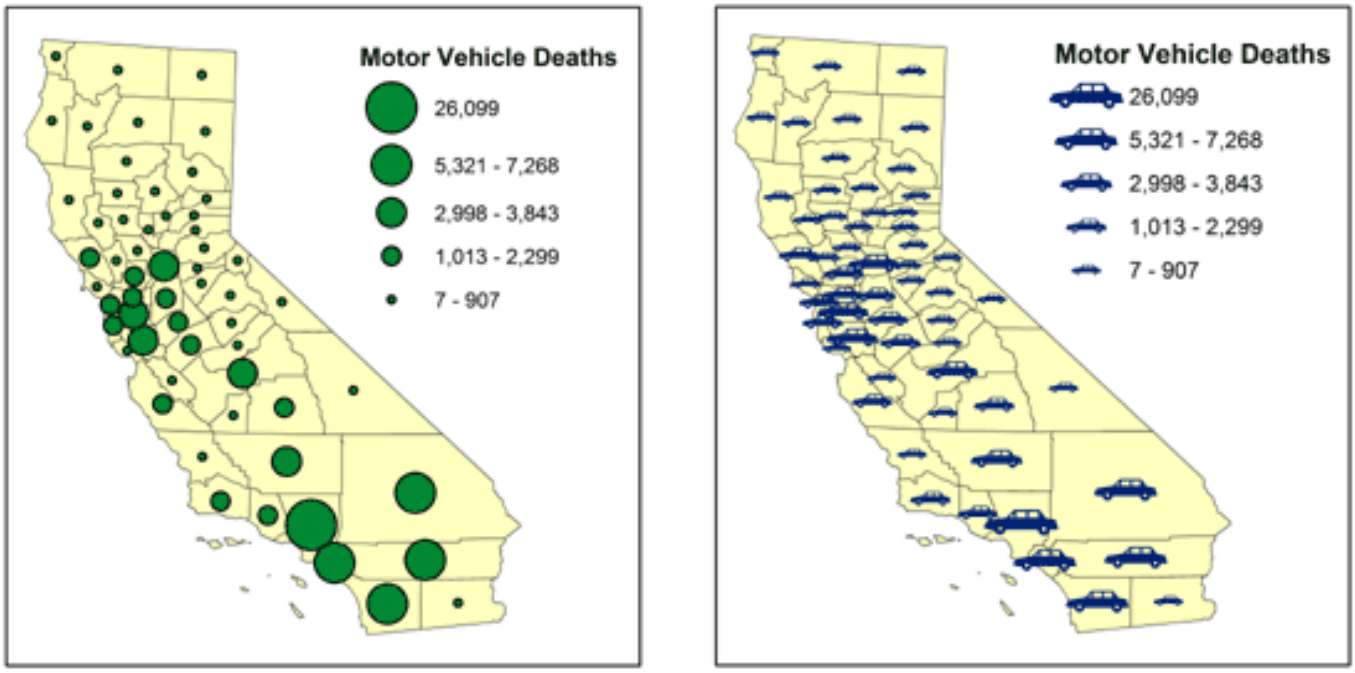
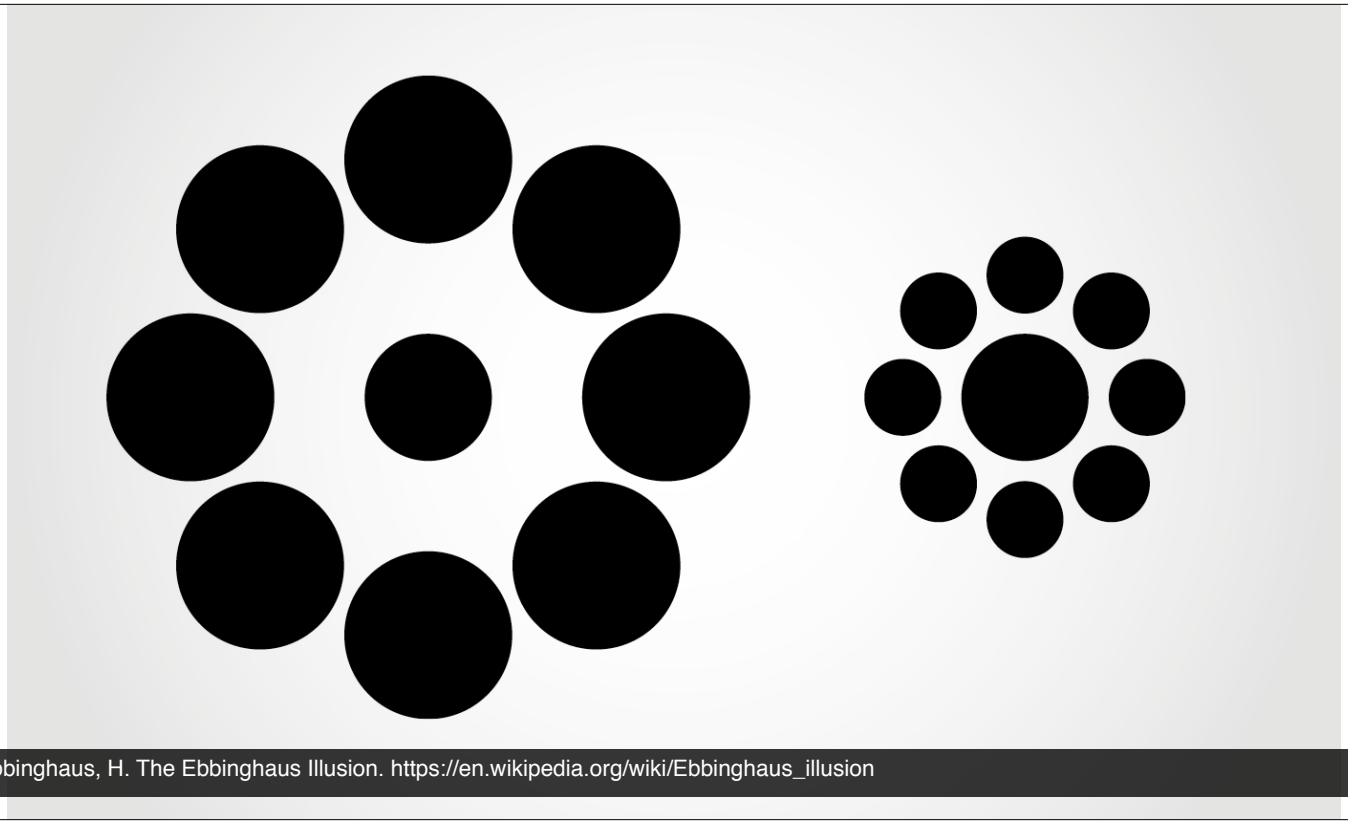
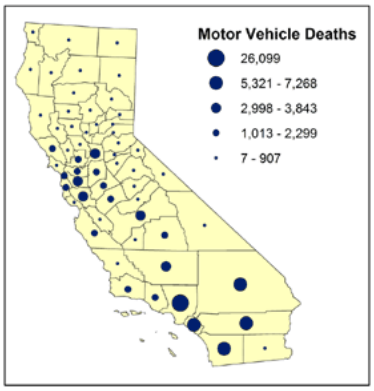
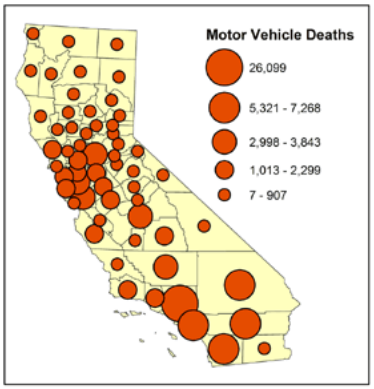


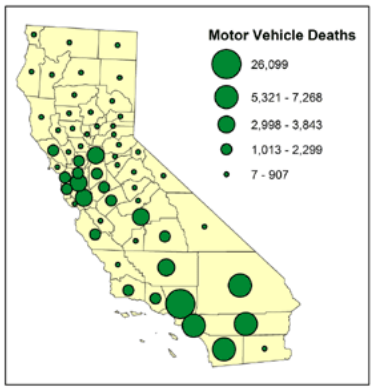
Gruver, A. Graduated and Proportional Symbol Maps. https://www.e-education.psu.edu/geog486/node/1869



Ebbinghaus, H. The Ebbinghaus Illusion. https://en.wikipedia.org/wiki/Ebbinghaus_illusion

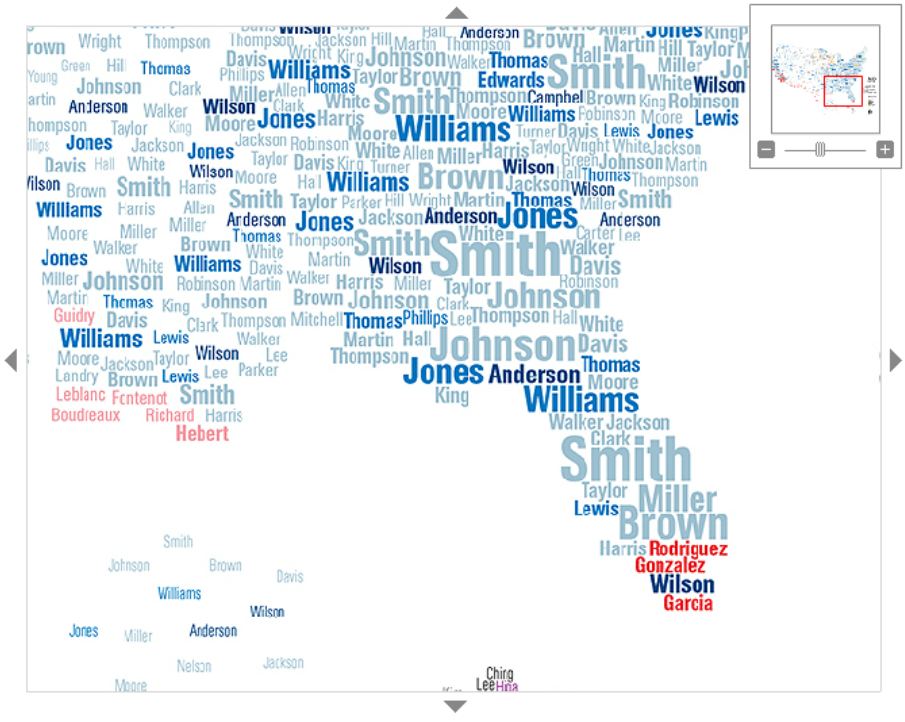




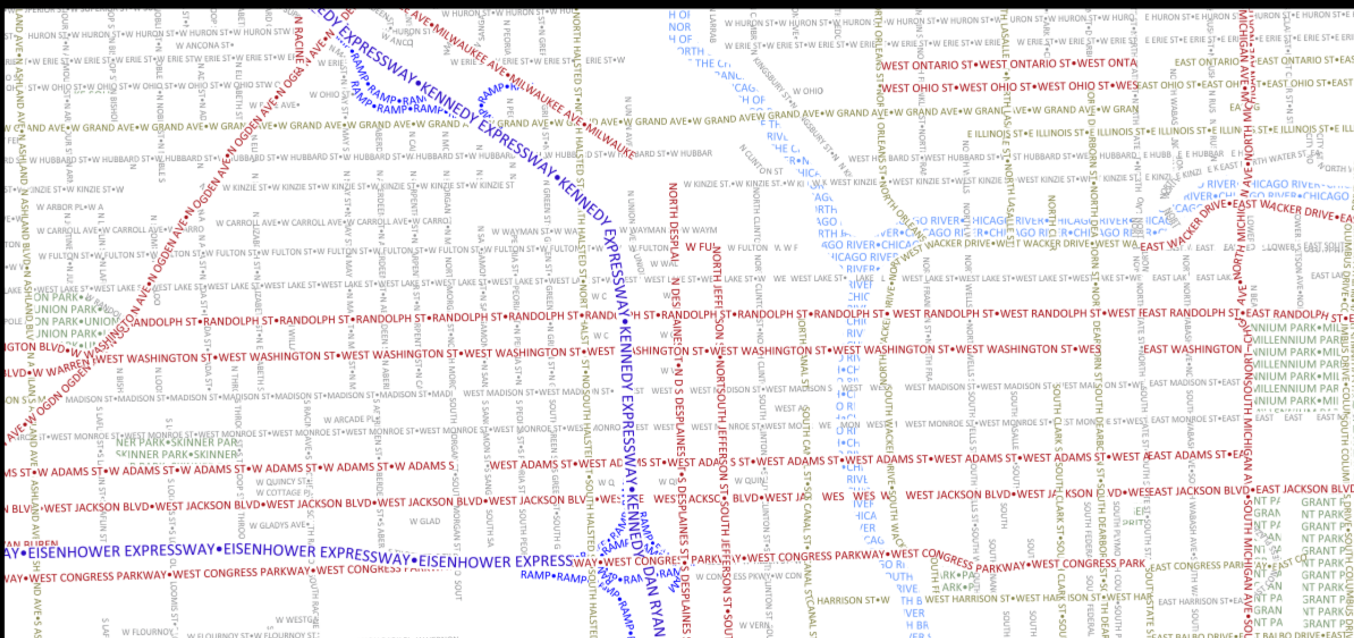


choice of **scaling factor** is important

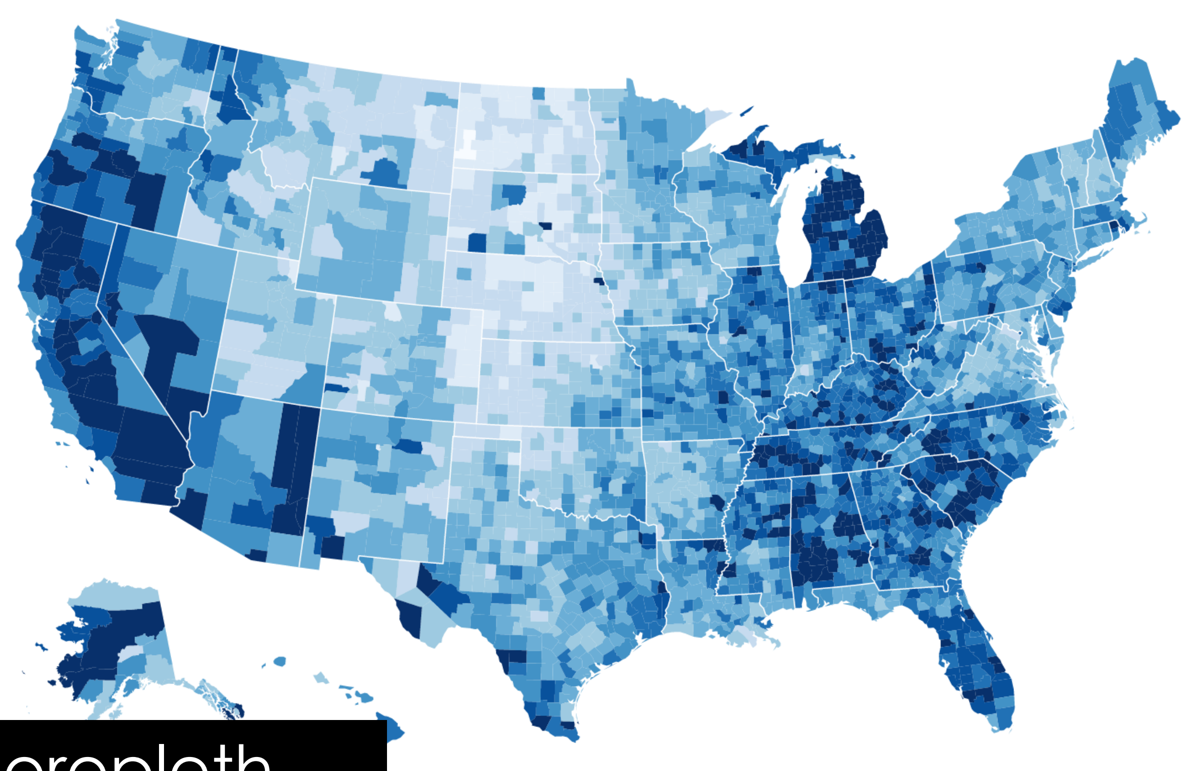
too small or too large means hard to see difference between points



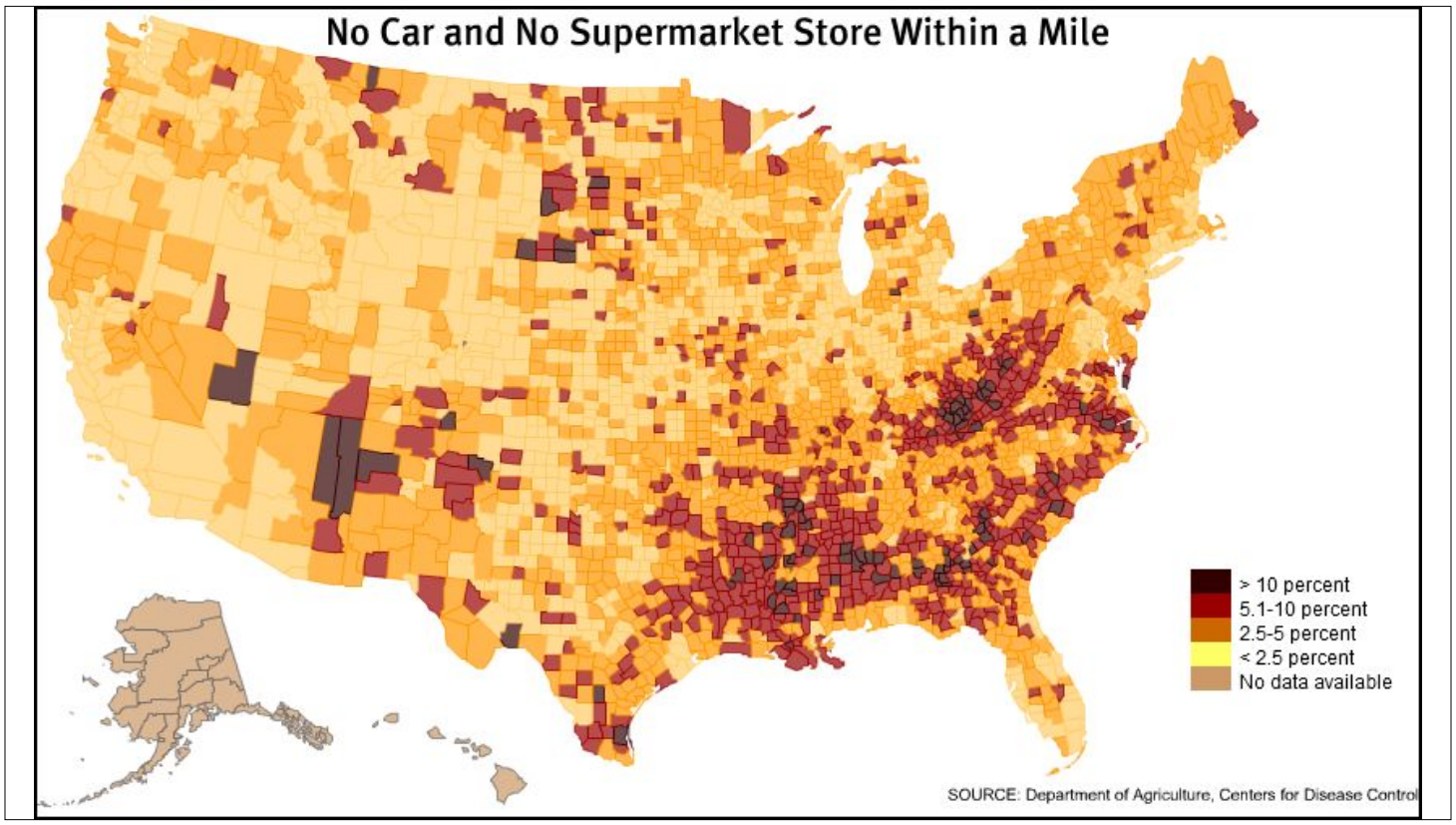
2011. “What’s in a Surname?”, National Geographic. http://ngm.nationalgeographic.com/2011/02/geography/usa-surnames-interactive

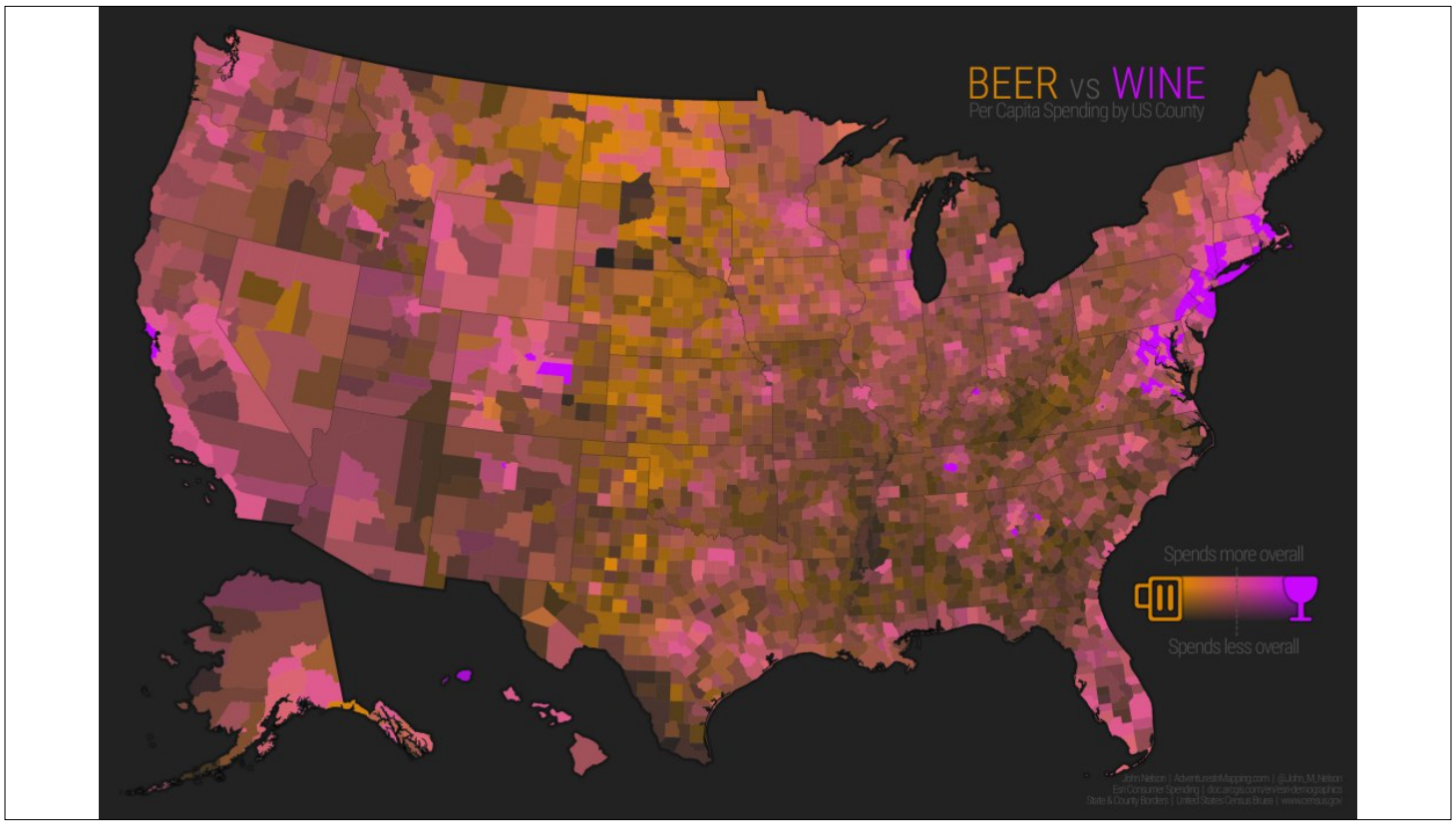


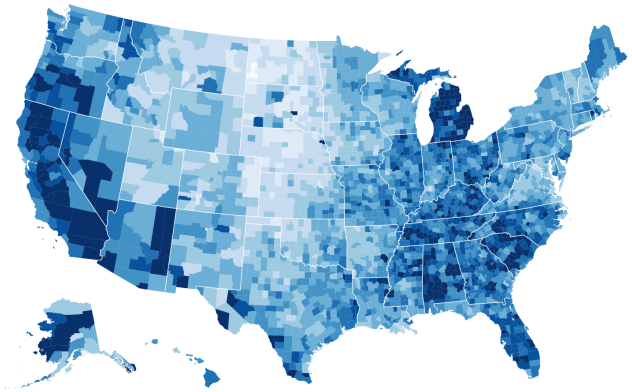
Afzal, S., Maciejewski, R., Jang, Y., Elmqvist, N., & Ebert, D. S. (2012). Spatial text visualization using automatic typographic maps. IEEE Transactions on Visualization and Computer Graphics, 18(12), 2556-2564.

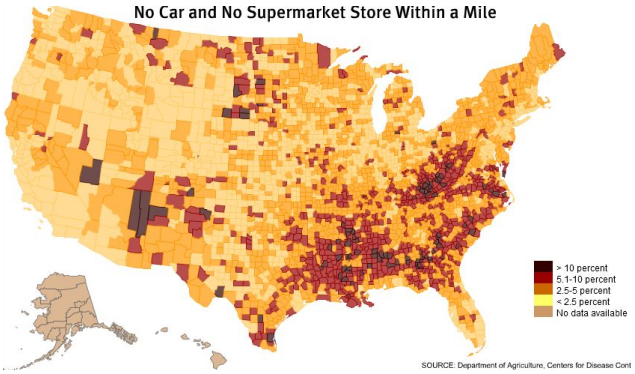


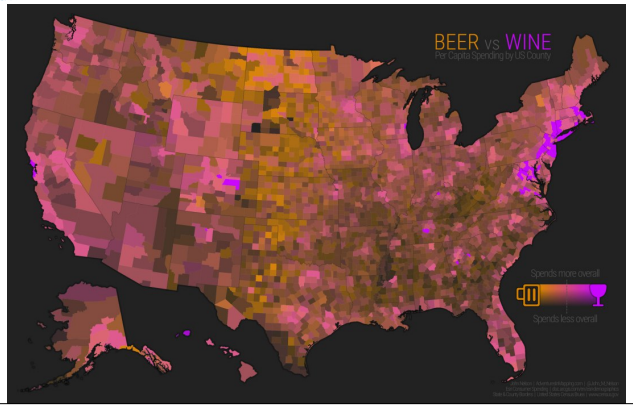
Choropleth

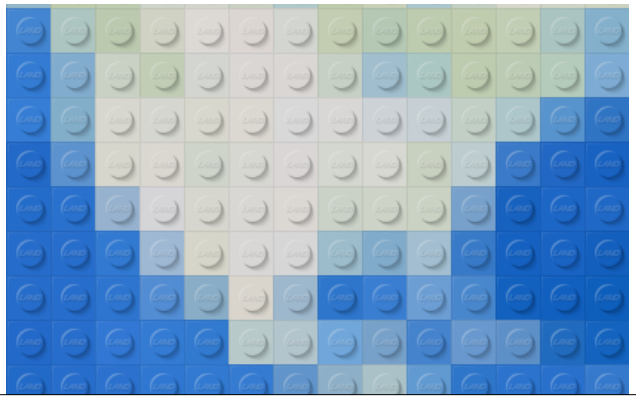

No Car and No Supermarket Store Within a Mile
> 10 percent
5.1-10 percent
2.5-5 percent
< 2.5 percent
No data available
SOURCE: Department of Agriculture, Centers for Disease Control

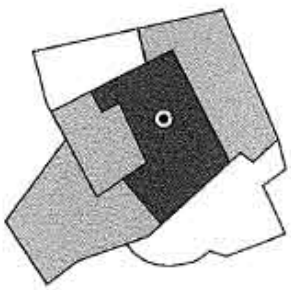

BEER vs WINE
Per Capita Spending by US County
Spends more overall
Spends less overall

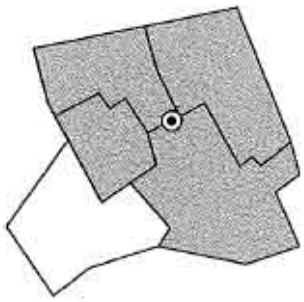


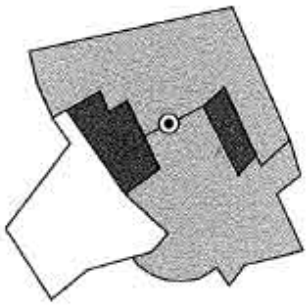




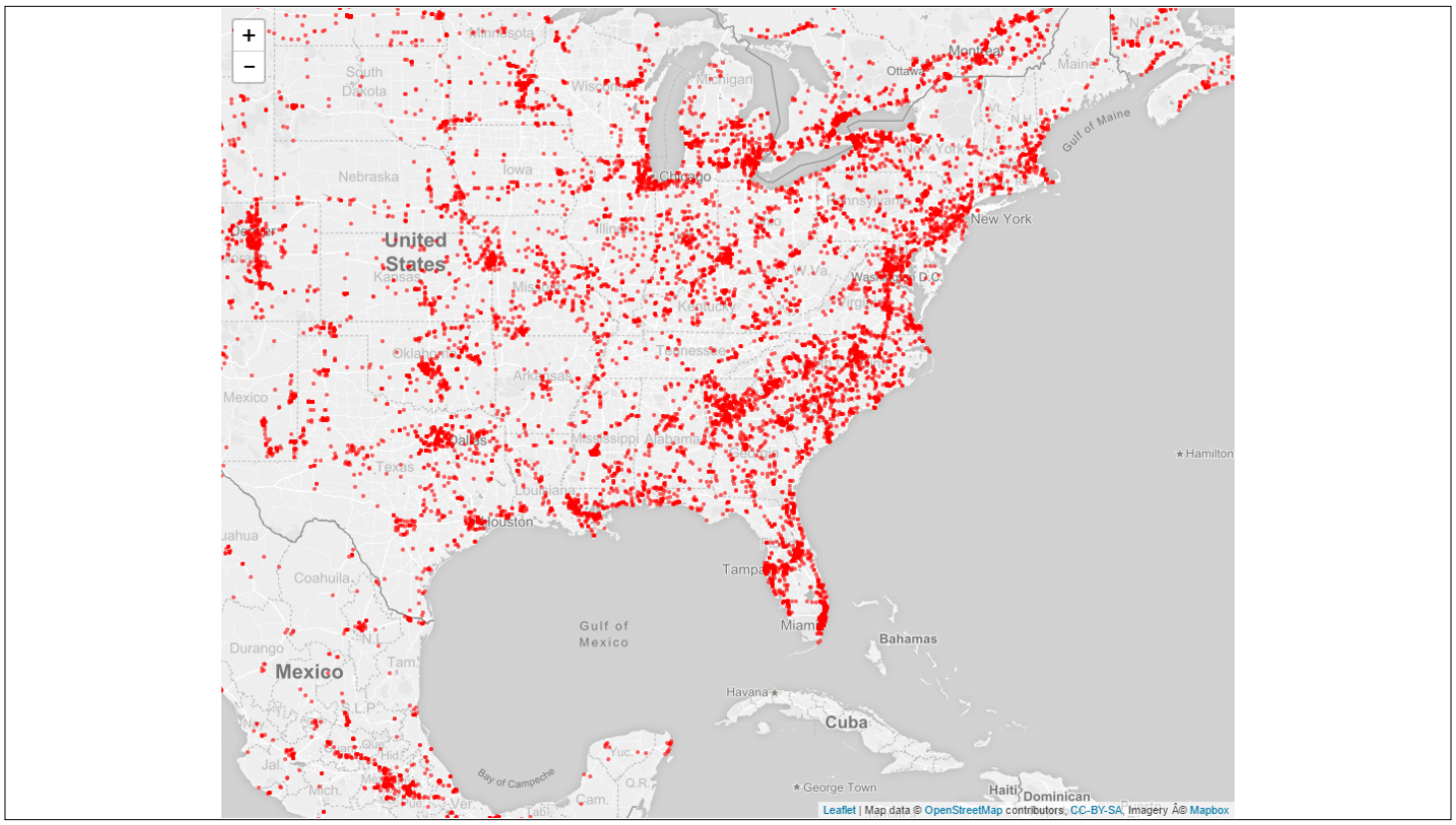








Modifiable Areal Unit Problem (MAUP)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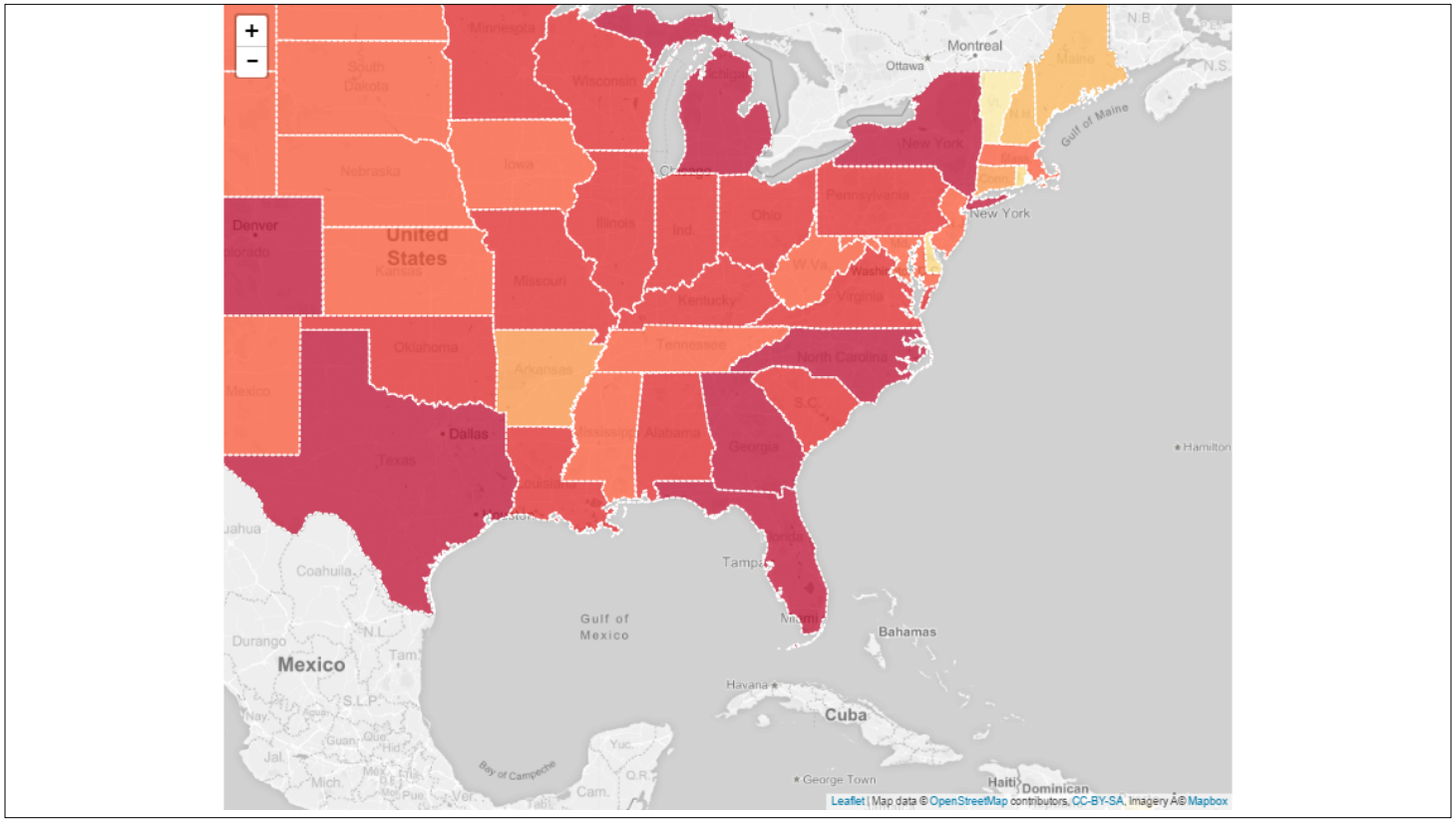
Gulf of Mexico
Cuba
Bahamas
Montreal
Ottawa
New York
Gulf of Maine
Hamilton
Havana
George Town
Haiti
Dominican
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery Â© Mapbox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Cuba
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Montreal
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New York
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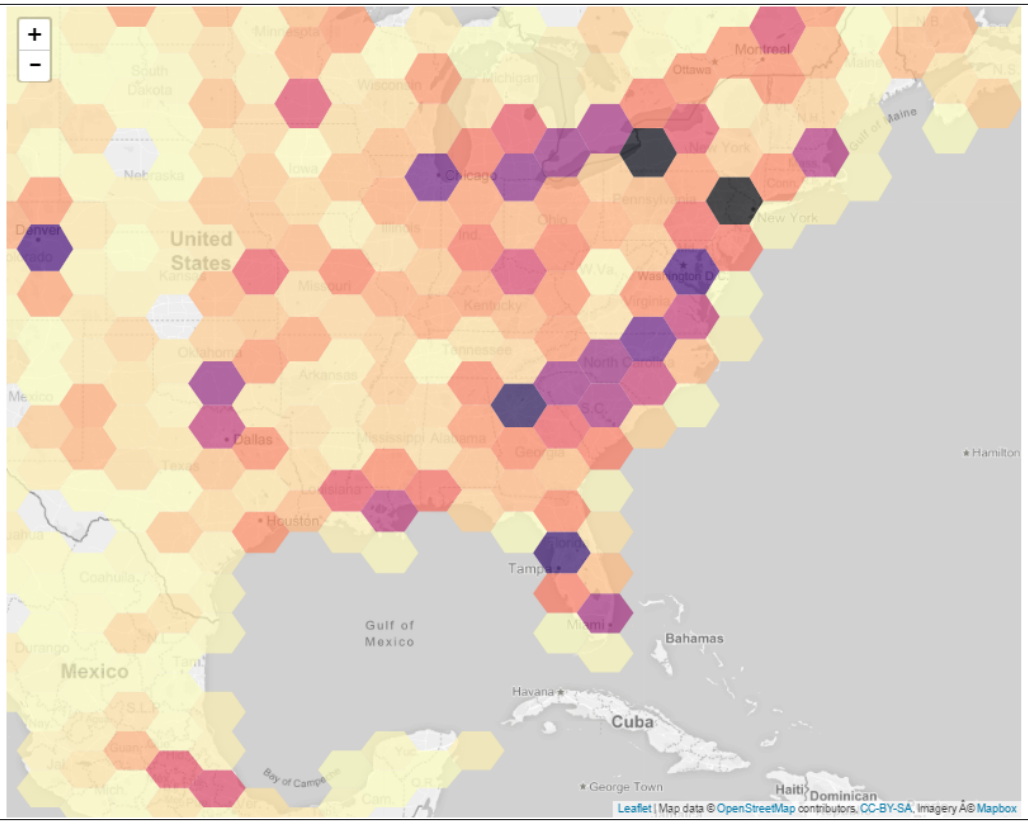
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Mexico
Gulf of Mexico
Cuba
Bahamas
Havana
Dallas
Houston
Tampa
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Ottawa
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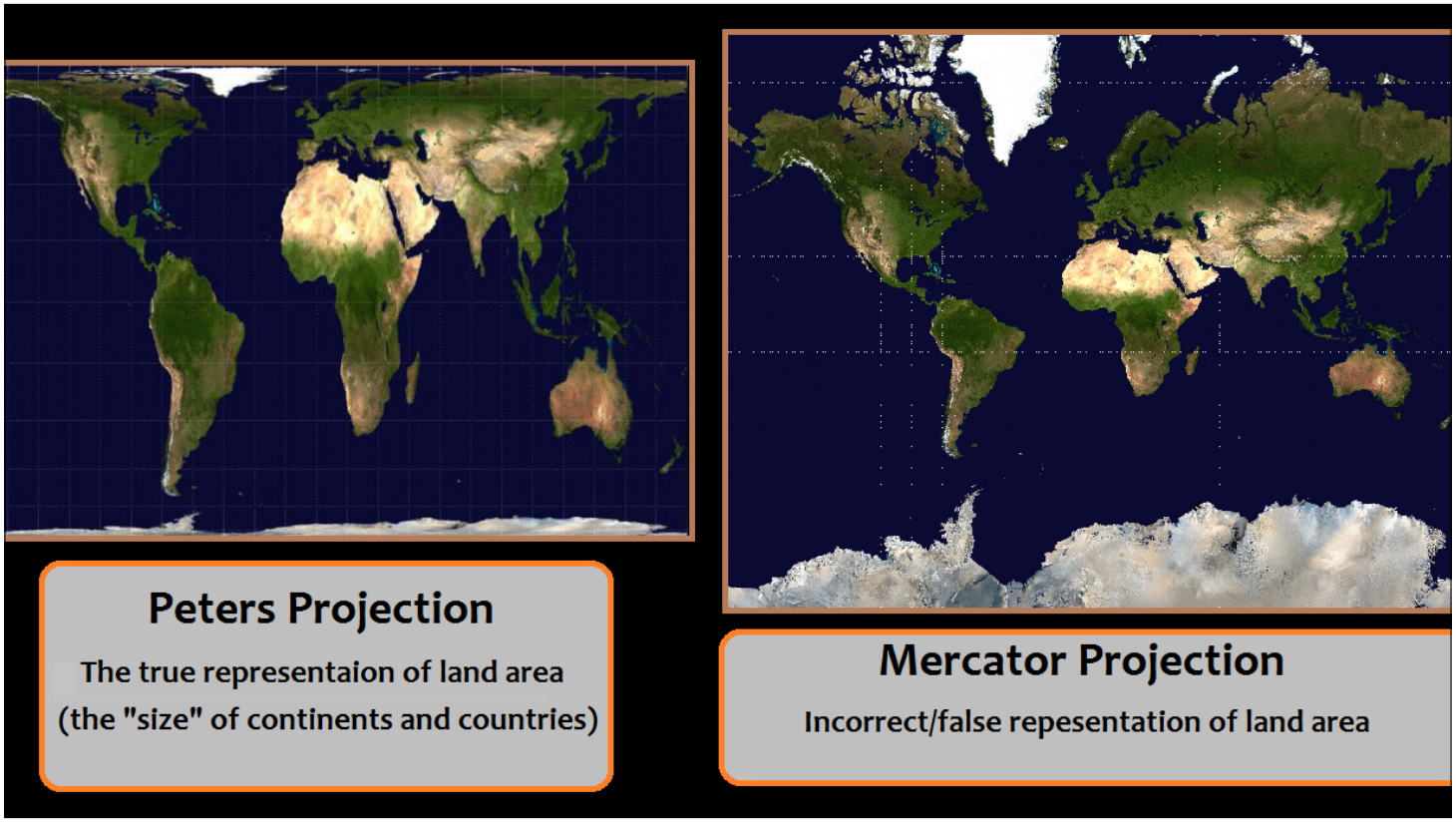
Cartograms

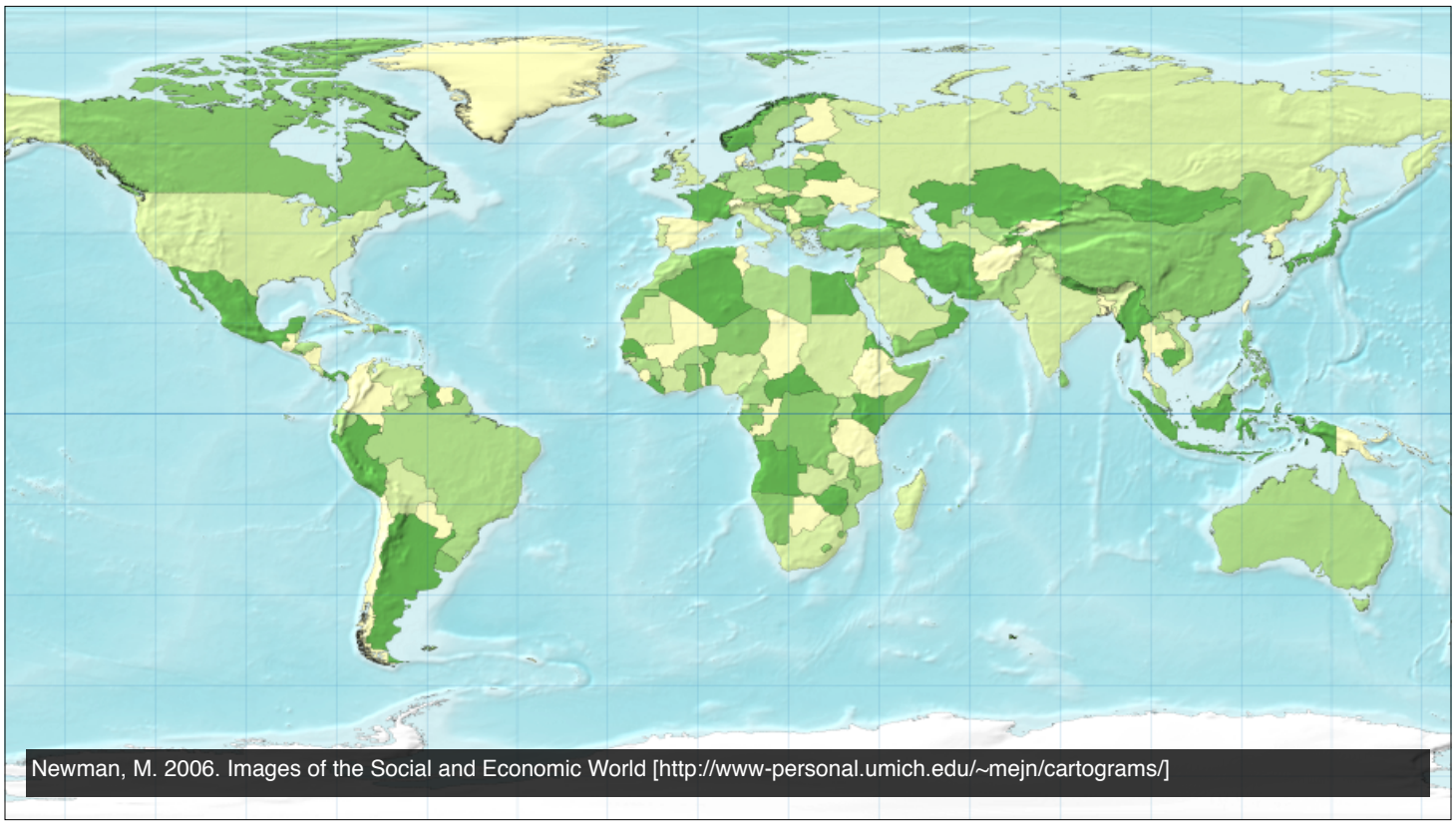


Peters Projection

The true representaion of land area
(the "size" of continents and countries)

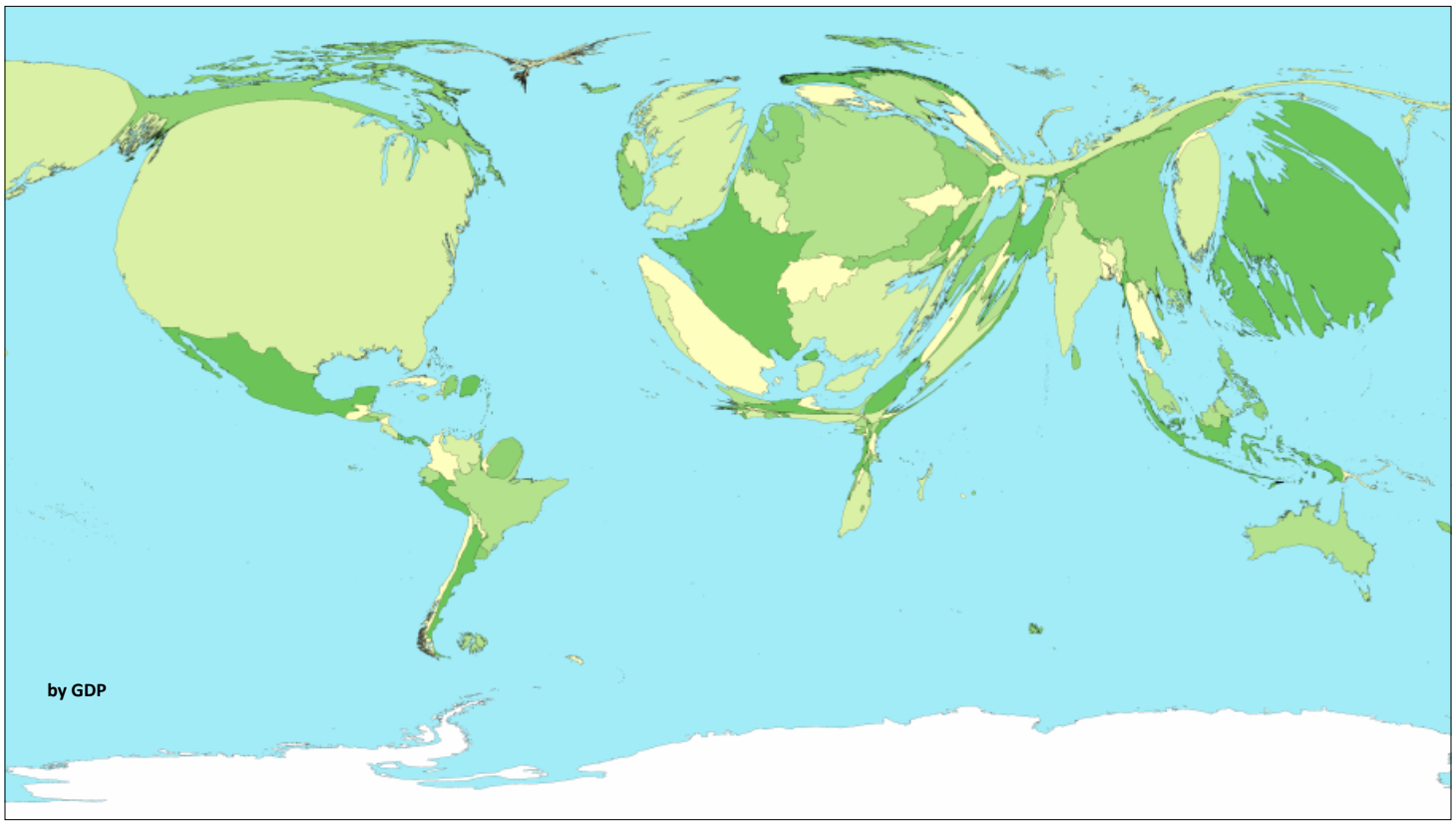
Mercator Projection

Incorrect/false repesentation of land area

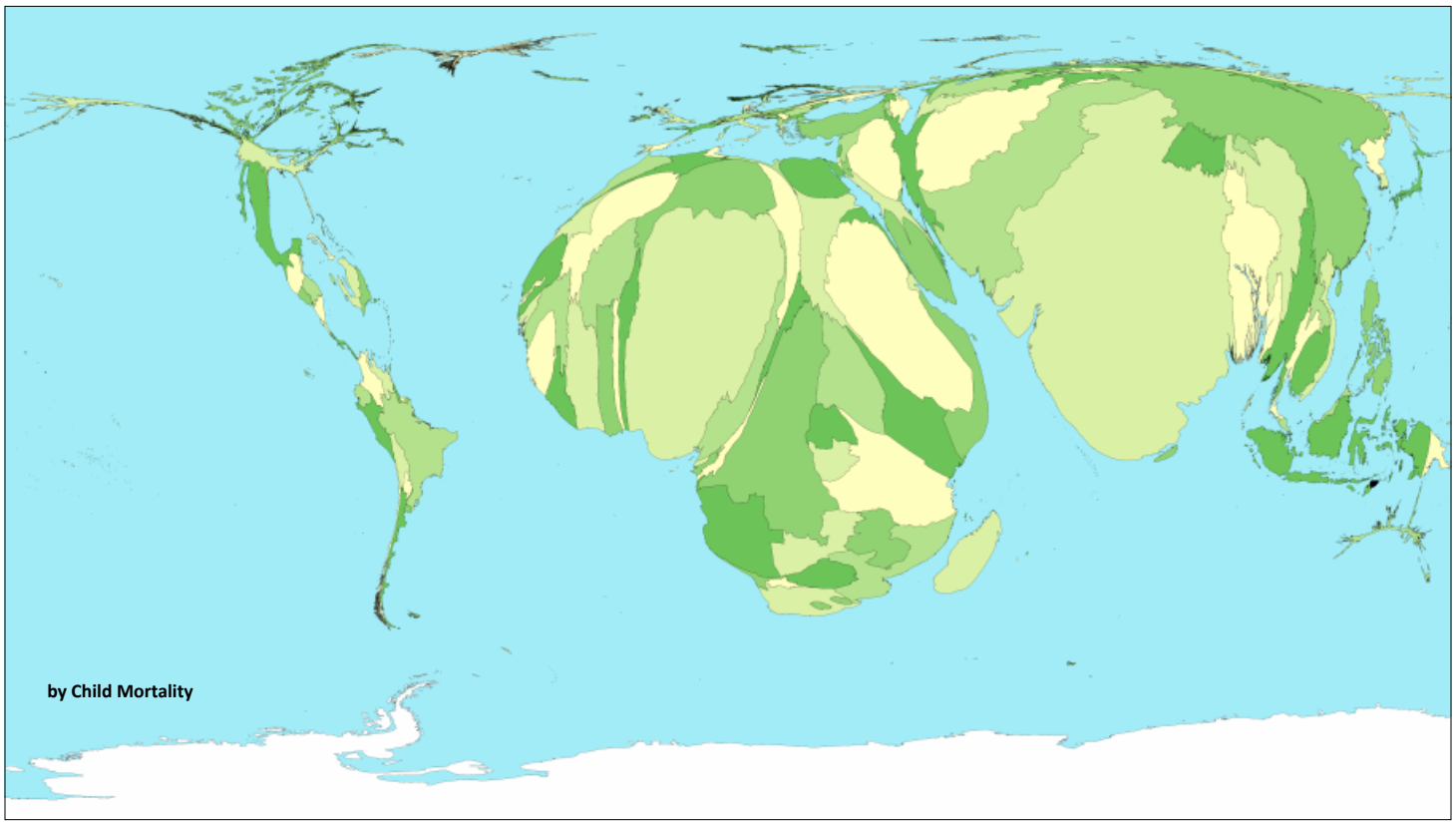


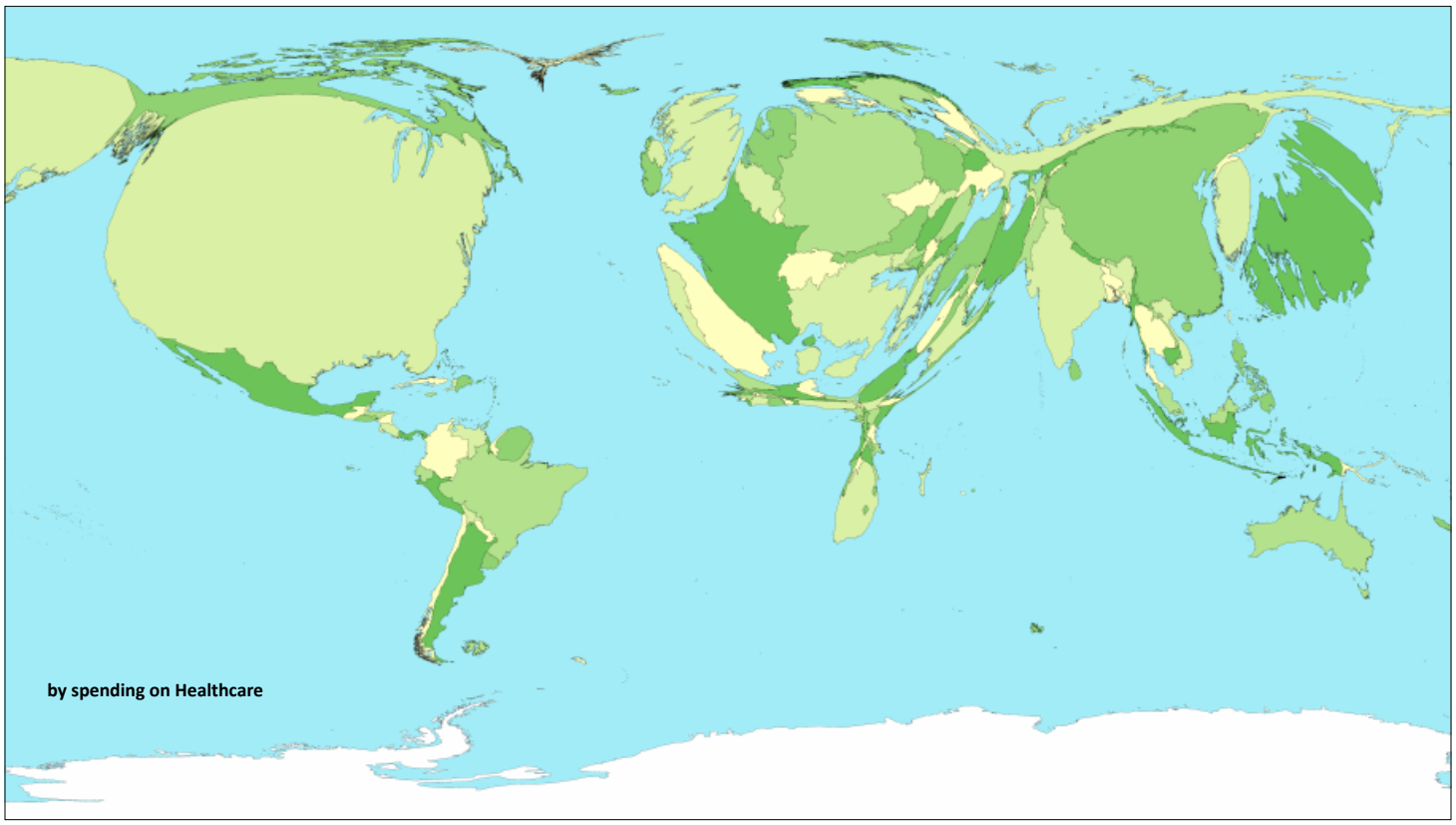
Newman, M. 2006. Images of the Social and Economic World [http://www-personal.umich.edu/~mejn/cartograms/]

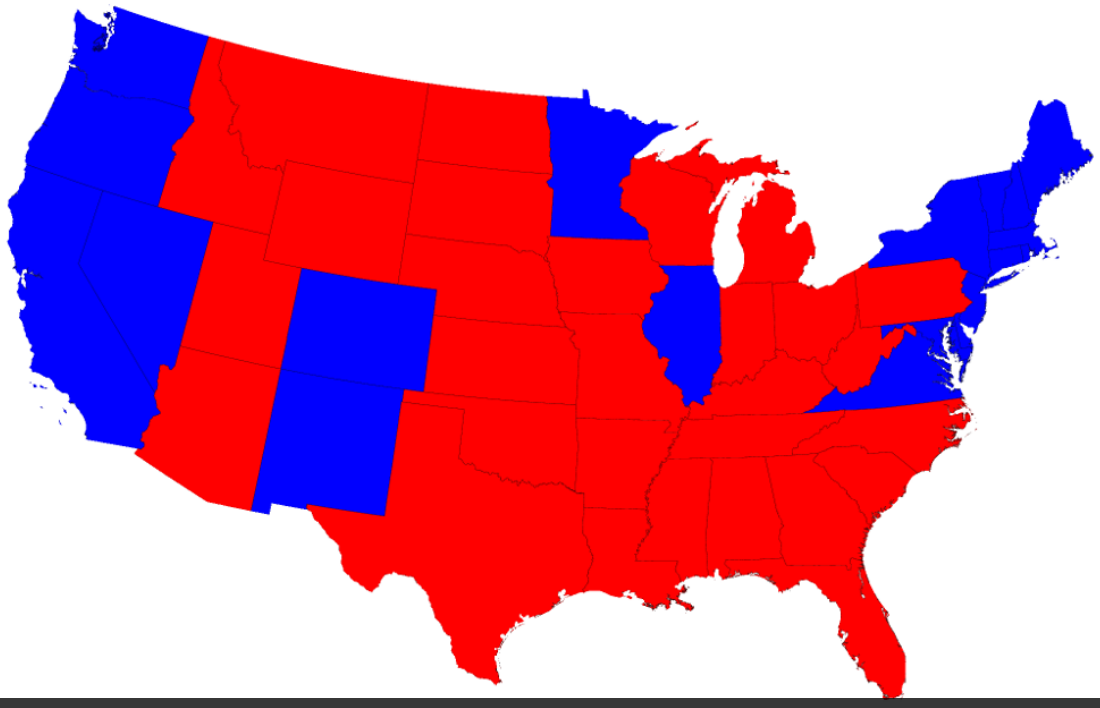
by population



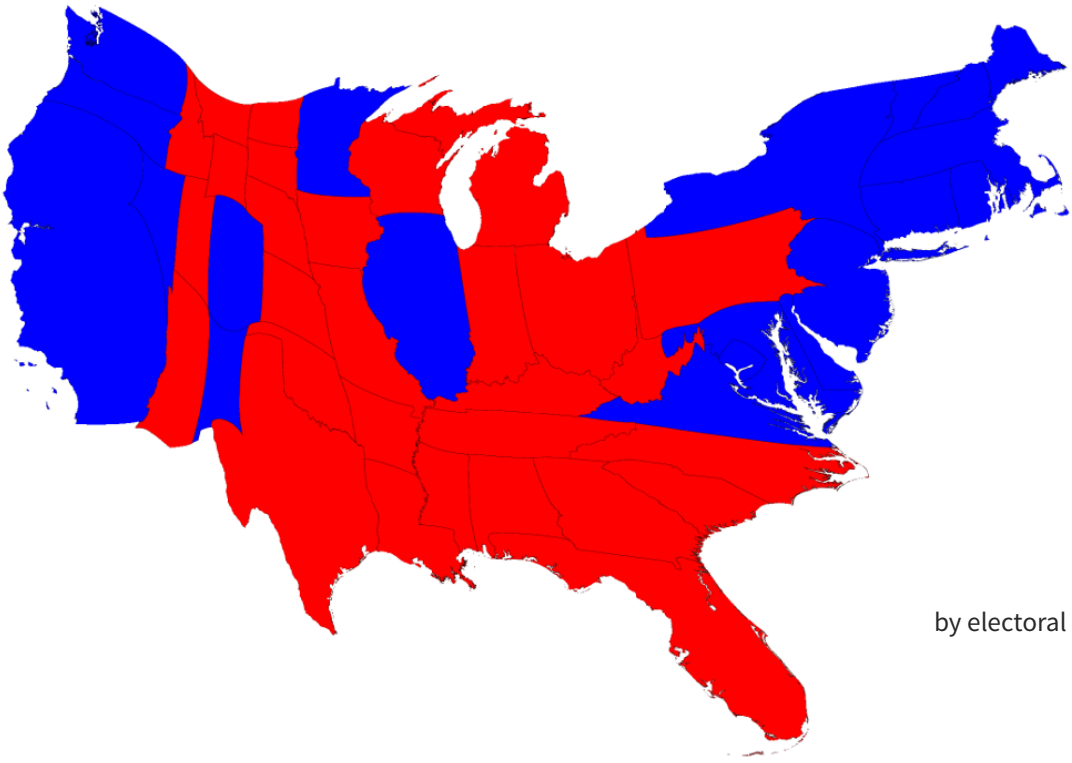
by GDP


by Child Mortality

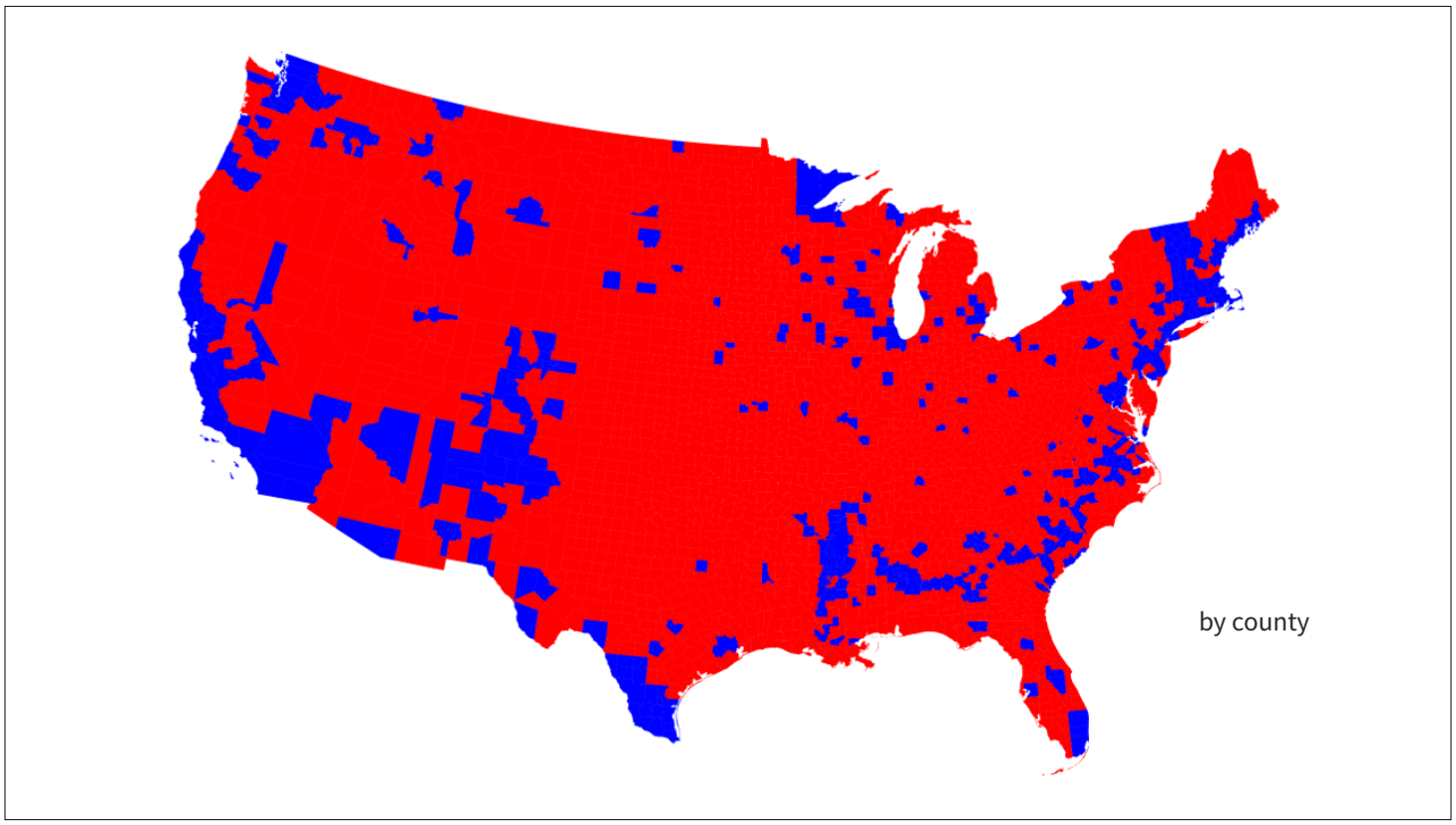

by spending on Healthcare



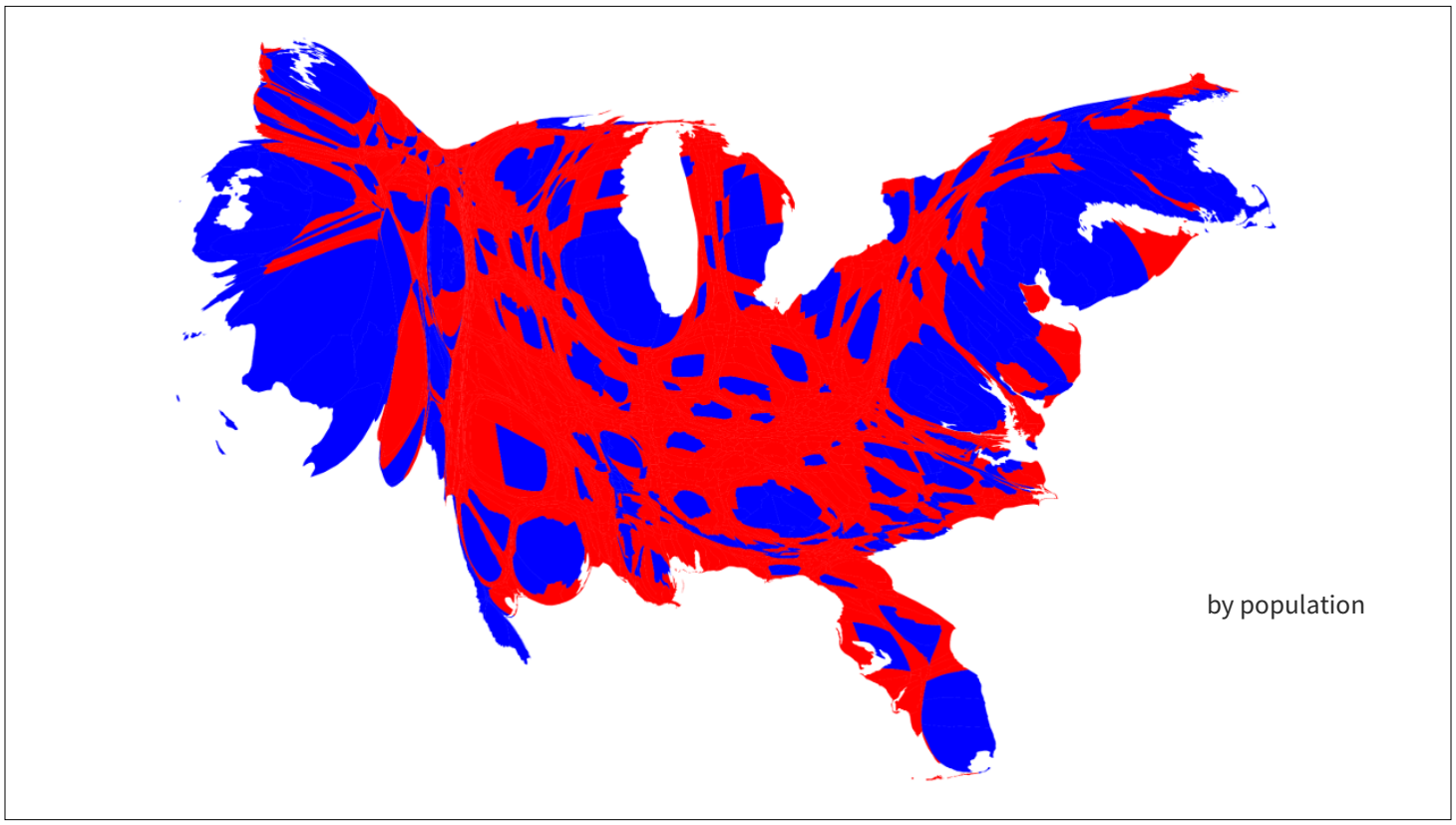
Newman, M. 2016. Maps of the 2016 US Presidential Election Results. http://www-personal.umich.edu/~mejn/election/2016/



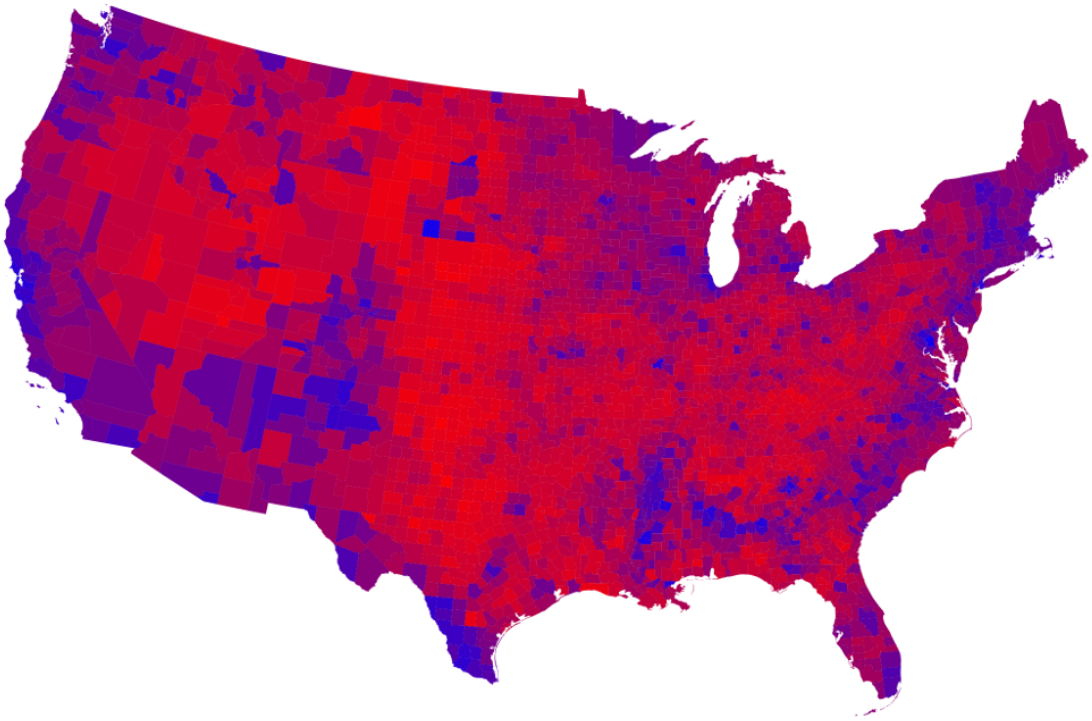
by electoral votes



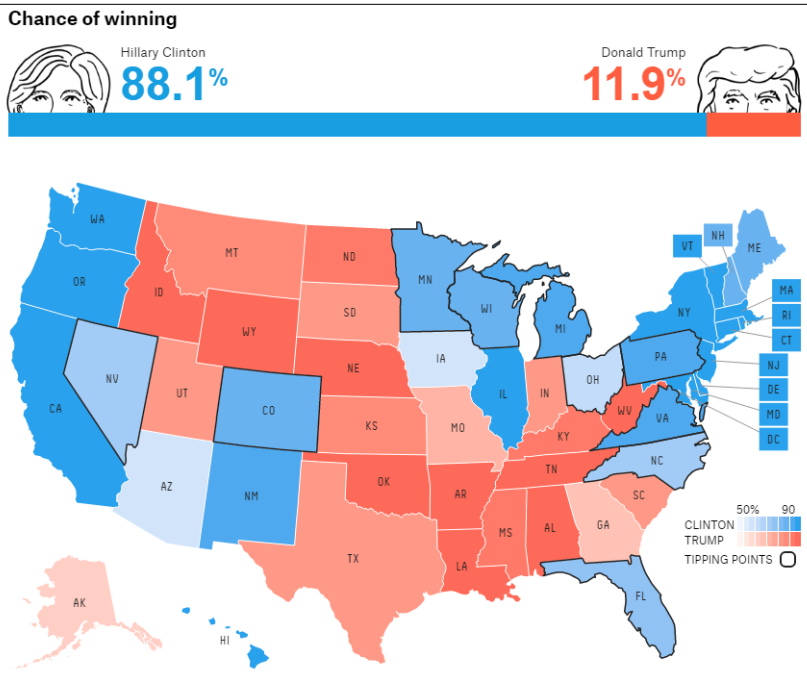
by county



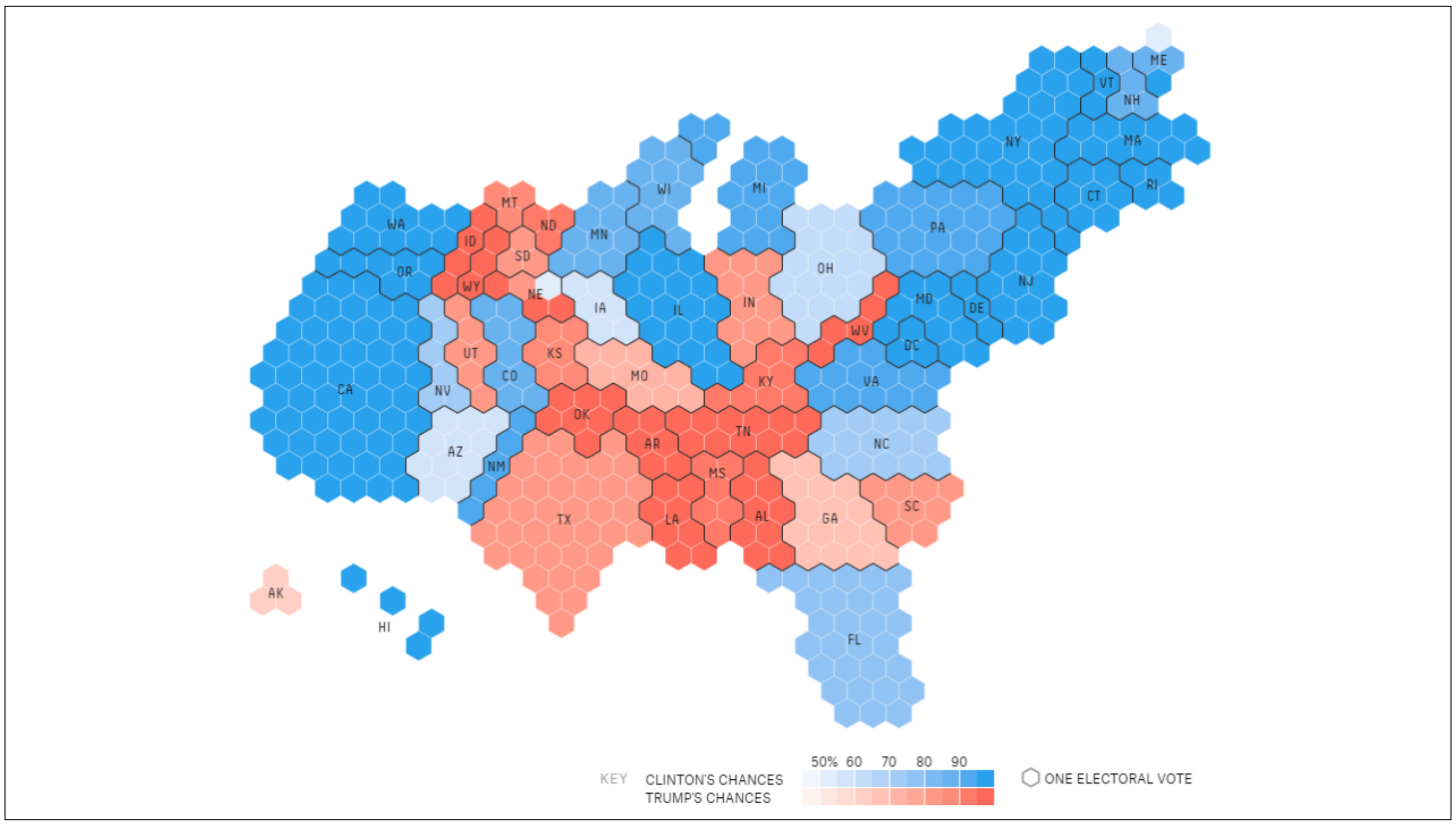
by population



blue-red gradient by voter percentage



Five Thirty Eight. 2016. https://projects.fivethirtyeight.com/2016-election-forecast/



Scalar Fields & Isolines

Isocontours (Terrain)

Desirability Map - California

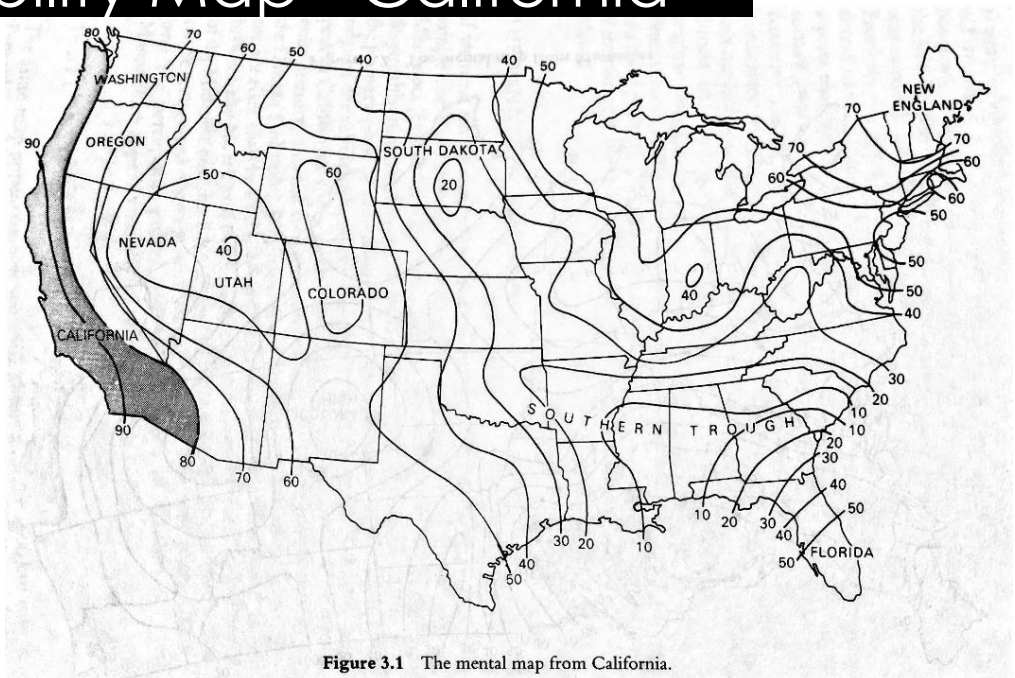
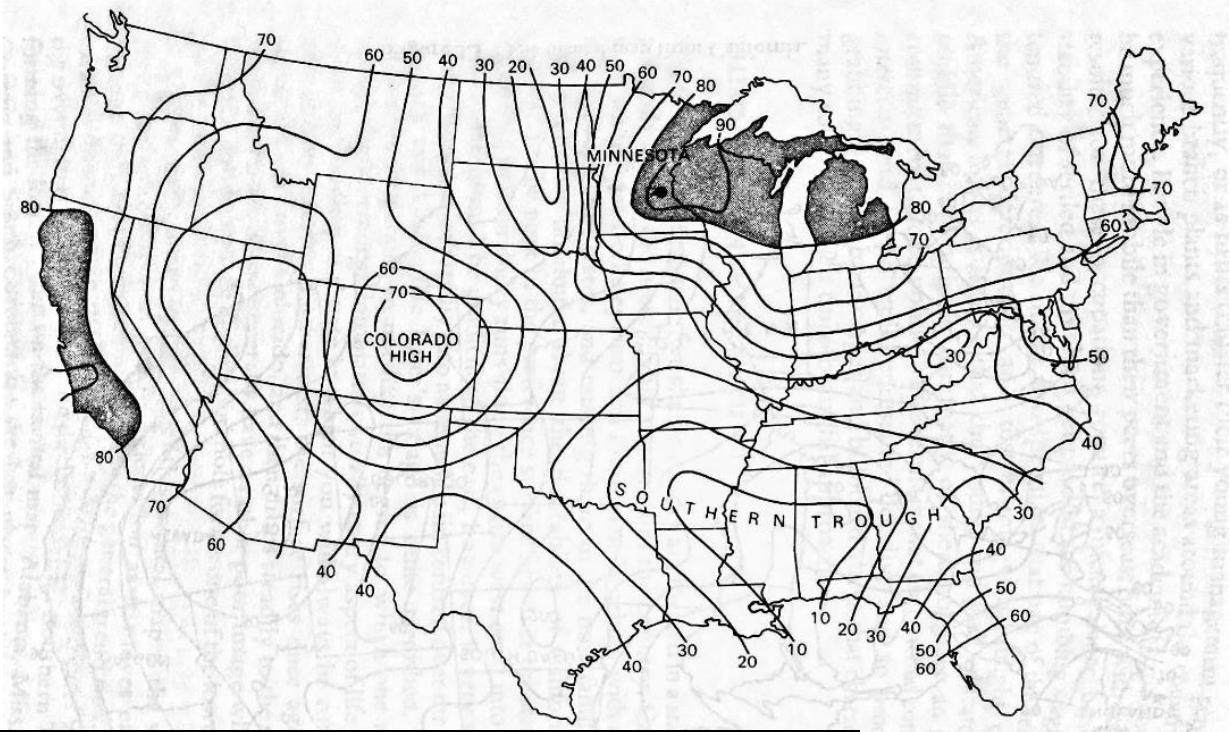
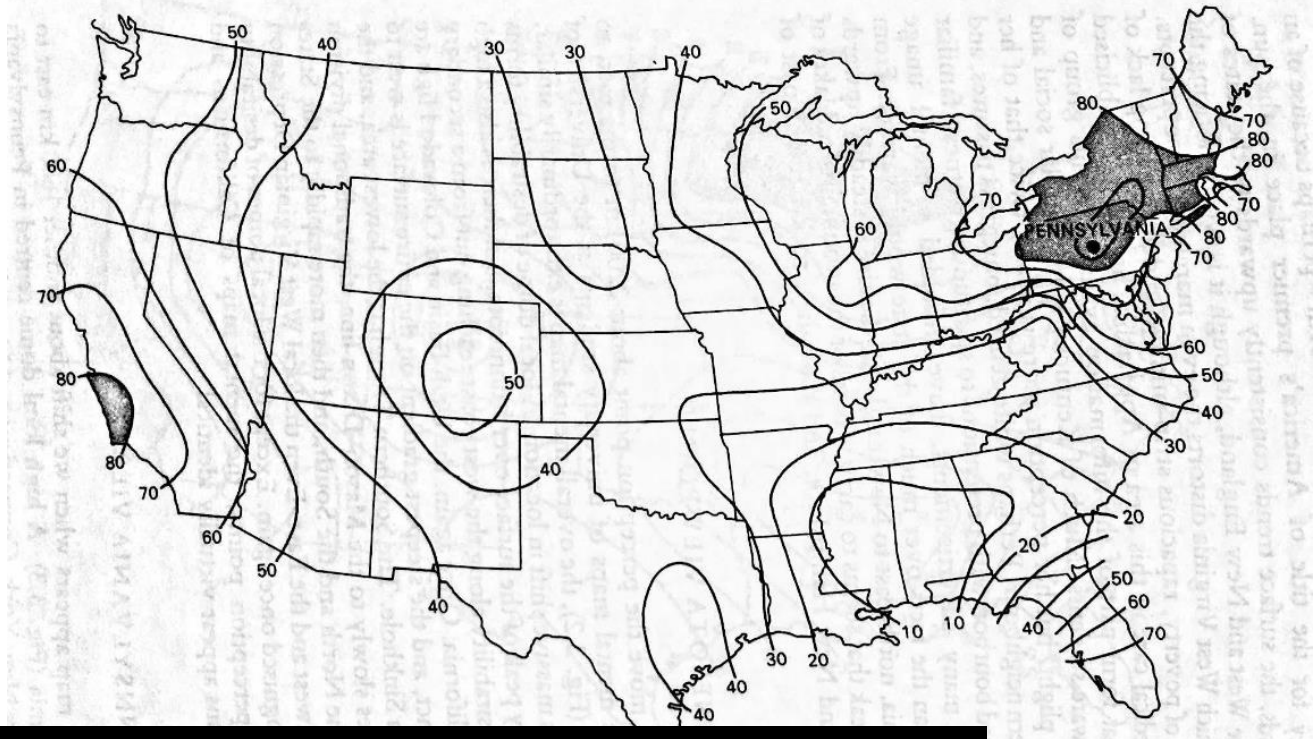


Figure 3.1 The mental map from California.

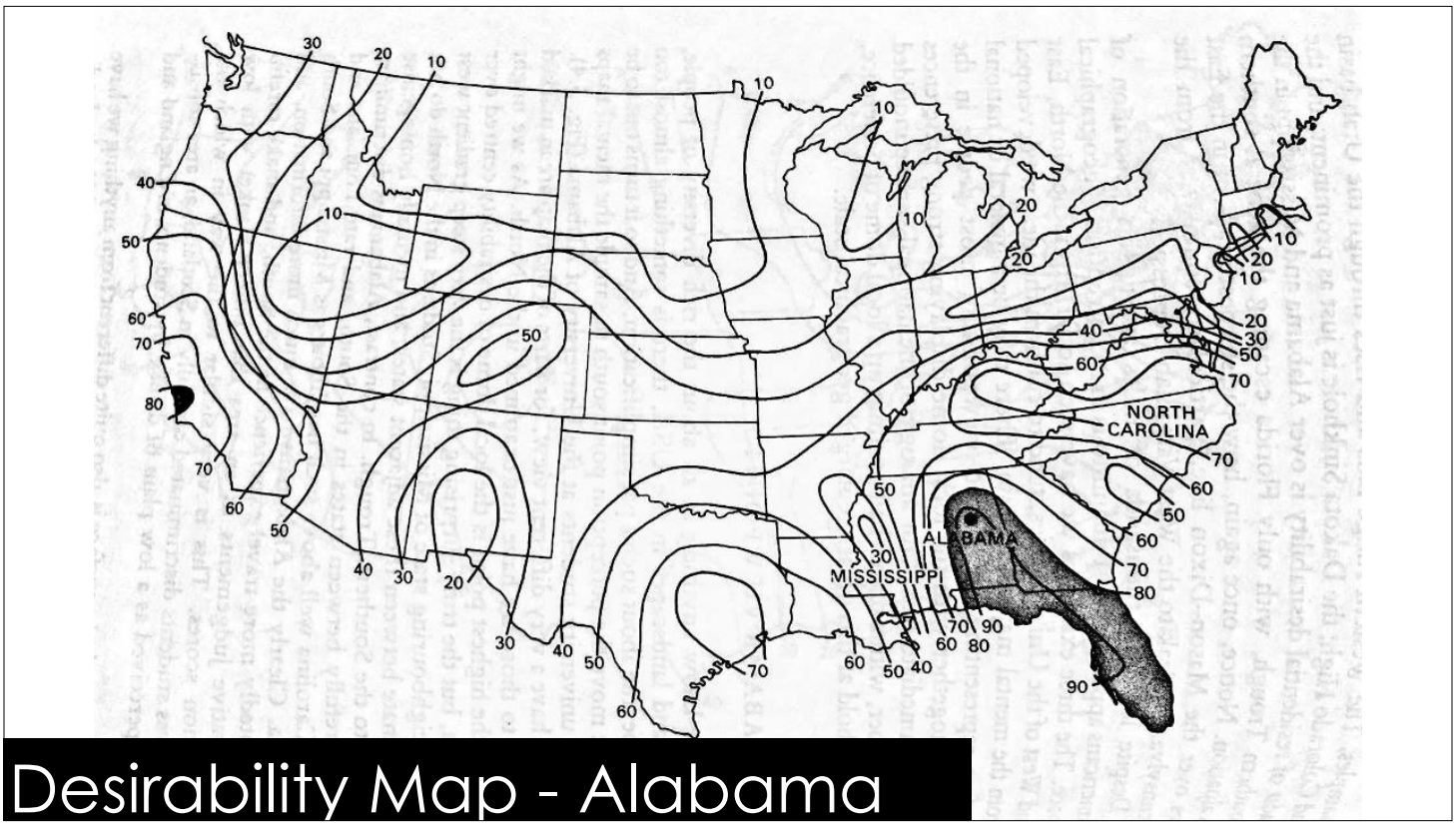
Gould, P., & White, R. (2012). Mental maps. Routledge.



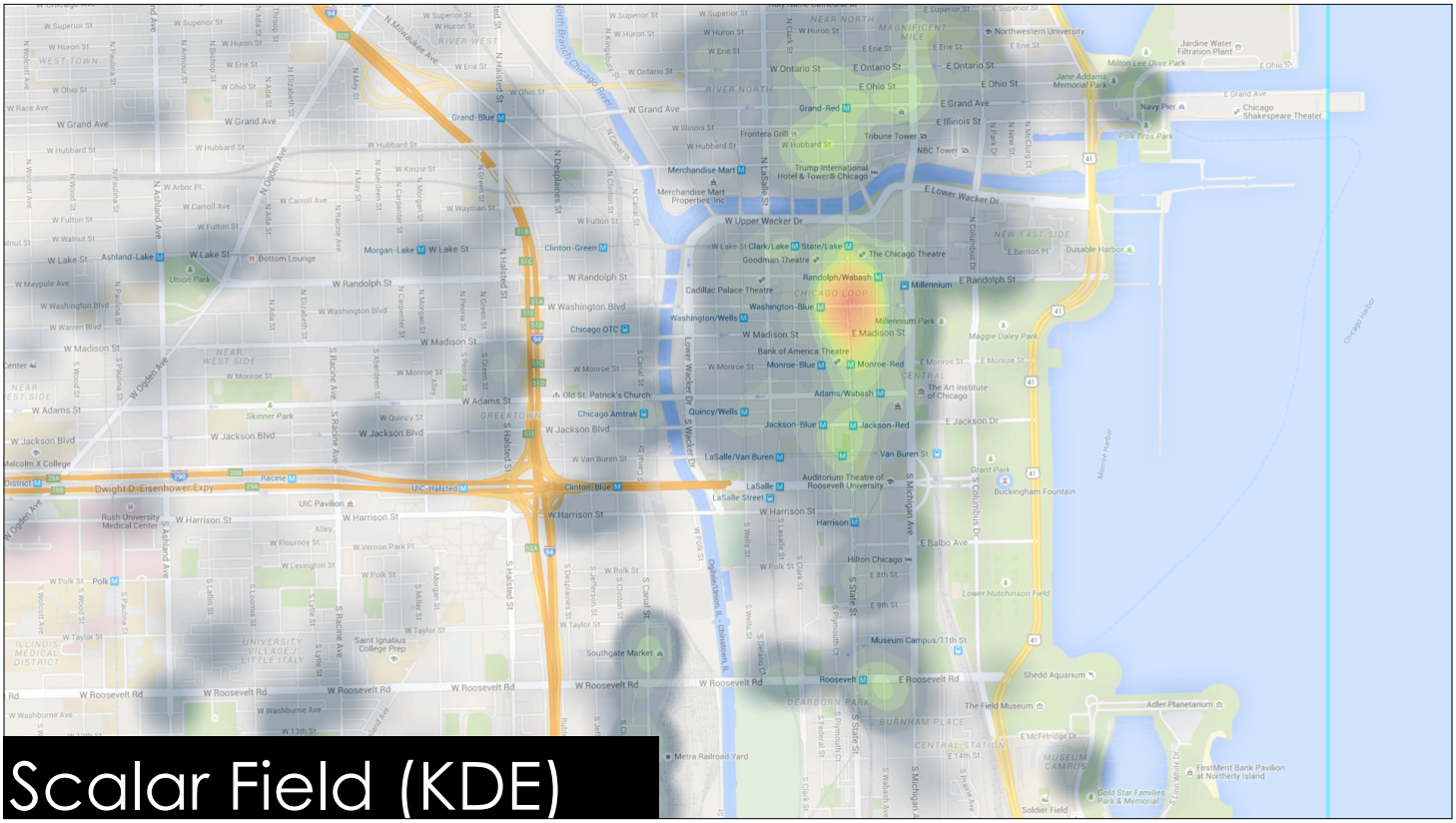
Desirability Map - Minnesota



Desirability Map - Pennsylvania

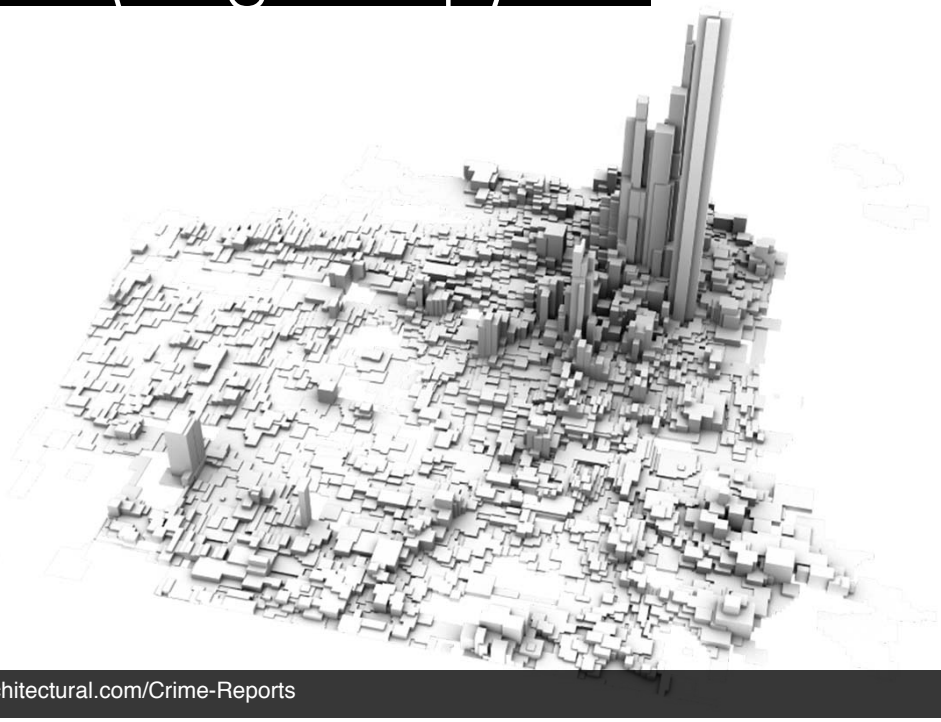


Desirability Map - Alabama



Scalar Field (KDE)

Scalar Field (heightmap)



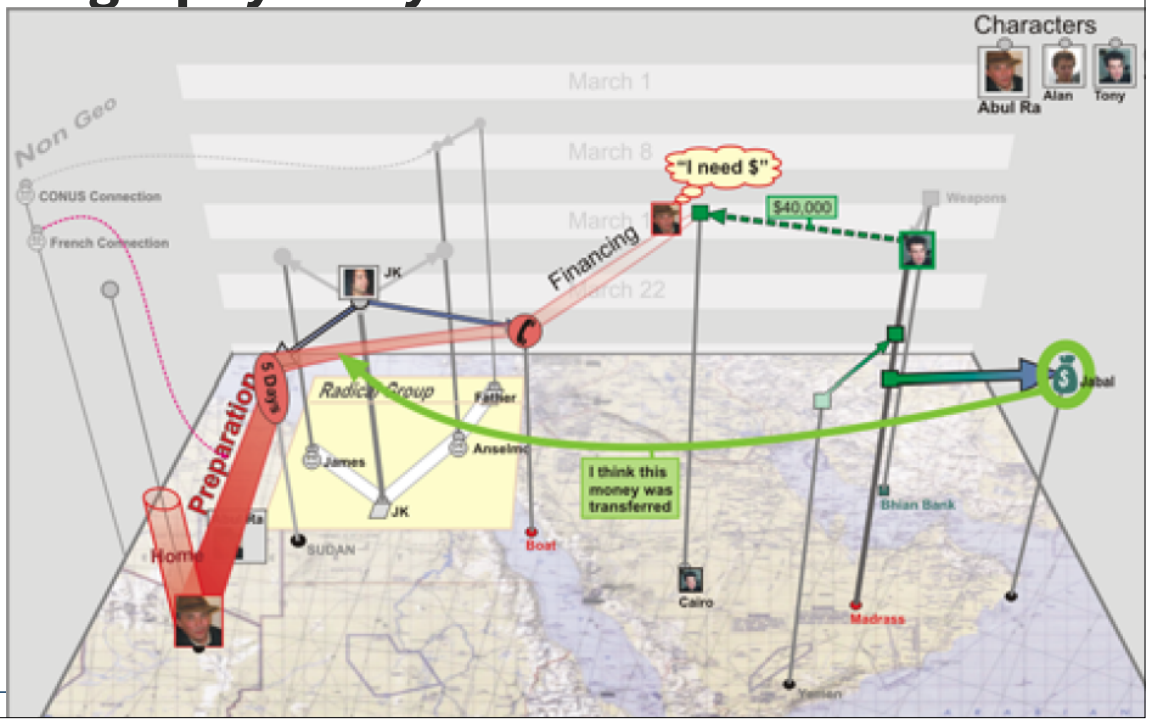
Sha Hwang. http://postarchitectural.com/Crime-Reports

Example: Time + Geography

- Typically superimpose temporal events on a map
  - Intelligence analysis
  - Literary plot analysis
  - Military planning
  - Maybe in future plan plots for interactive games
- Following figures from GeoTime, a product of Oculus www.oculusinfo.com/

Time and Geography Story

GeoTime



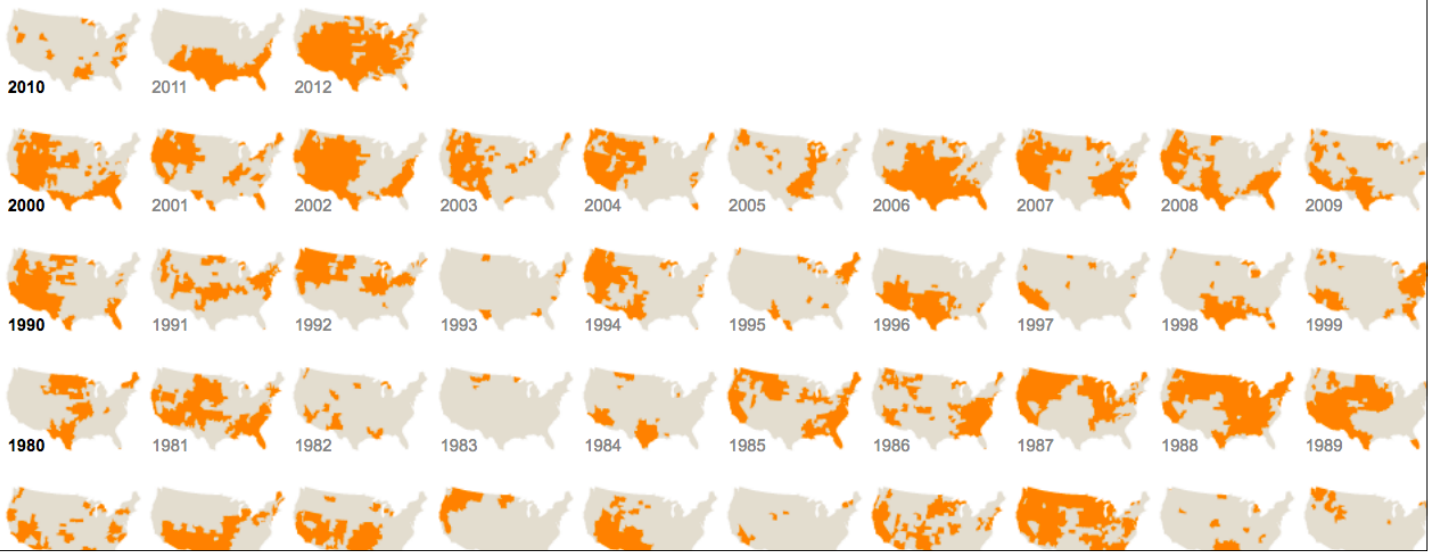
Time via Small Multiples

http://www.nytimes.com/interactive/2012/07/20/us/drought-footprint.html?_r=2&

Drought's Footprint

More than half of the country was under moderate to extreme drought in June, the largest area of the contiguous United States affected by such dryness in nearly 60 years. Nearly 1,300 counties across 29 states have been declared federal disaster areas. Areas under moderate to extreme drought in June of each year are shown in orange below.

Related Article »



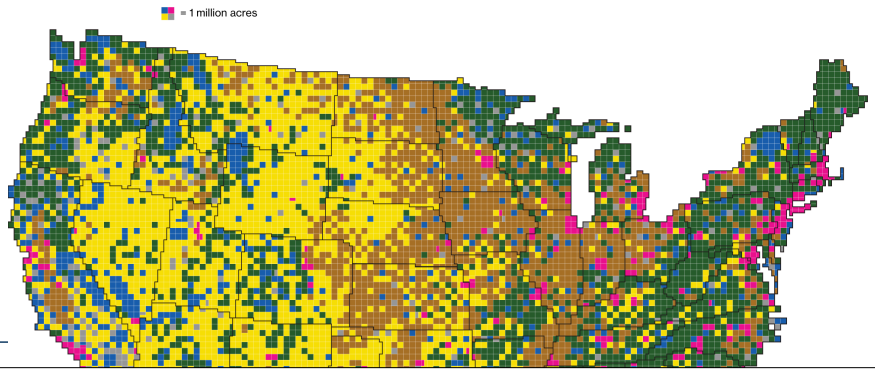
Storytelling

Goal

- Tell a narrative to your audience using data, visualizations, and story

American Land Usage

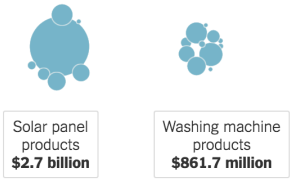
- https://www.bloomberg.com/graphics/2018-us-land-use/



US Trade Tariffs

How Trump's Trade War Went From 18 Products to 10,000

By KEITH COLLINS and JASMINE C. LEE JULY 11, 2018



https://www.nytimes.com/interactive/2018/07/11/business/trade-war.html

USA likes trucks

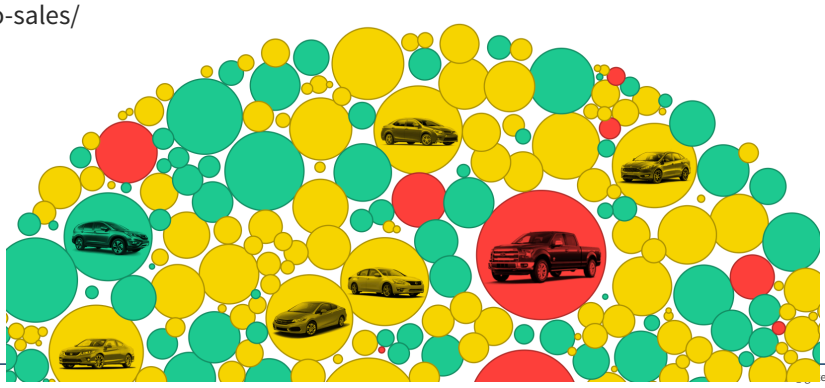
https://www.bloomberg.com/graphics/2015-auto-sales/

Scientific Proof that Americans are Completely Addicted to Trucks

By Adam Pearce Blacki Migliozzi and David Ingold | Jan. 15, 2015

Car geeks will be elbowing each other out of the way for a glimpse of Ford's gorgeous ne GT sports car when the Detroit auto show opens to the public this weekend. But when i comes to the new vehicles people actually buy, the story is all about light-trucks—the broad category that includes pickups, SUVs, crossovers, and minivans. As the economy gains strength and gas prices drop, Americans are turning away from cars and snappin up trucks of all sizes.

2014 new U.S. auto sales, by model



In Summary

- **Time** is a special attribute of data that we need to pay particular attention to when visualizing.
- **Geo** data has many alternatives that we need to consider depending on the user task
- **Storytelling** involves an author narrative in addition to visualizing data.