Course Reminders

- Due Sunday (11:59 PM):
  - D8
  - Q9
  - Checkpoint #2: EDA
  - *weekly project survey (optional)*

Geospatial Analysis I

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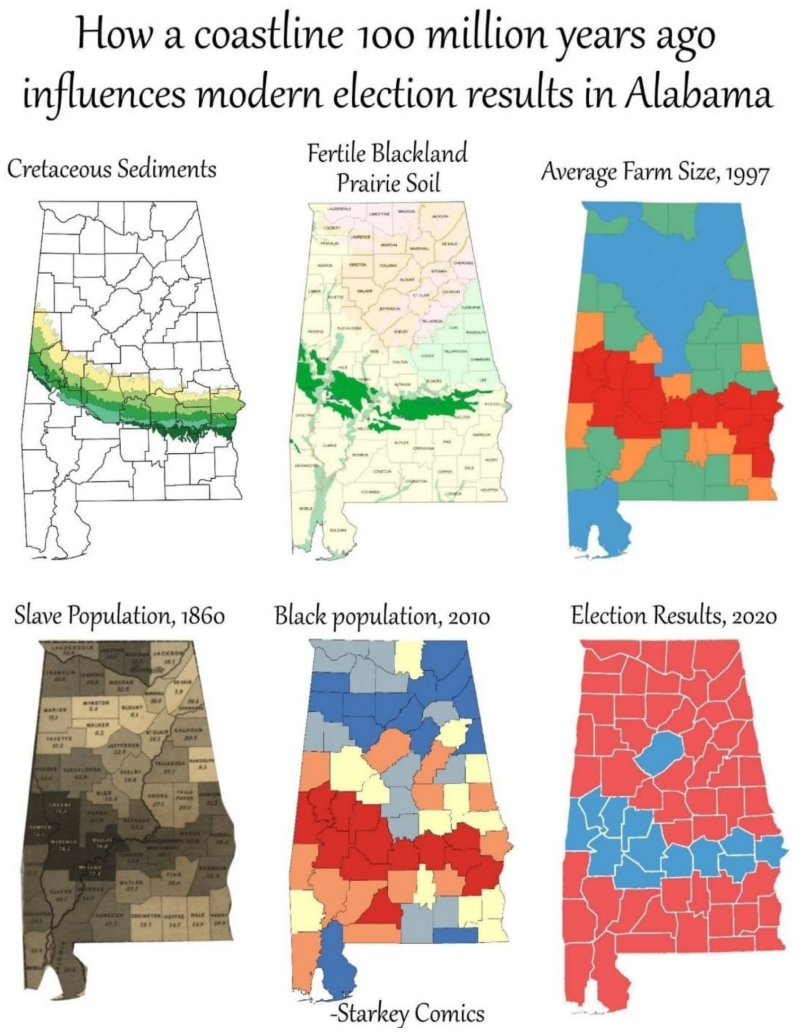


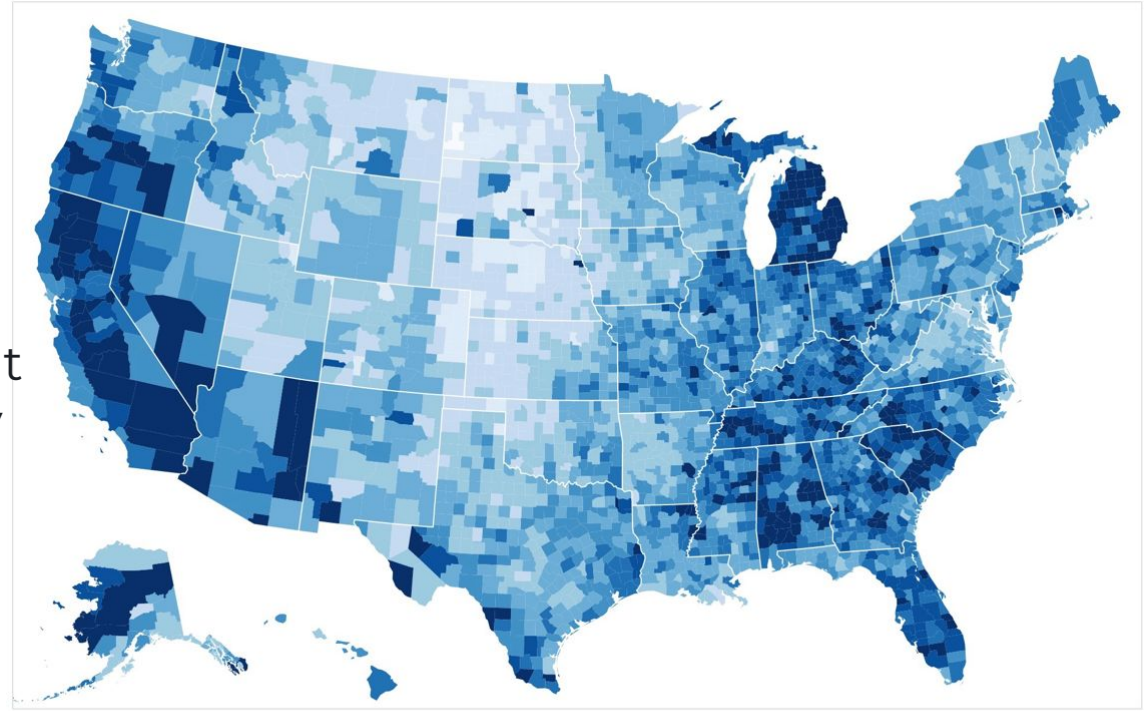
Why Geospatial Analysis?

"*Everything is related to everything else, but near things are more related than distant things.*" -Tobler 1979

"*...the purpose of geographic inquiry is to examine relationships between geographic features collectively and to use the relationships to describe the real-world phenomena that map features represent*" -Clarke 2001

Visualizing Geospatial Data

Unemployment rate by county (August 2016)



This choropleth encodes unemployment rates from 2008 with a quantize scale ranging from 0 to 15%. A threshold scale is a useful alternative for coloring arbitrary ranges.

Open in a new window.

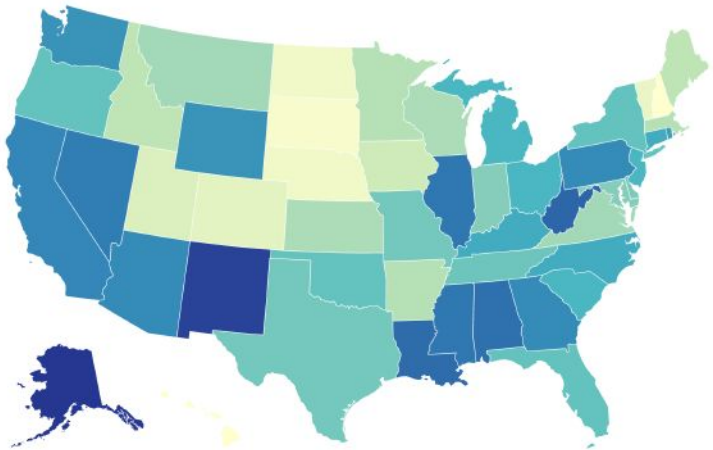
Choropleth maps are useful for visualizing *clear regional patterns* in the data

Source: http://bl.ocks.org/mbostock/4060606

adapted from Brad Voytek

Cartograms should be considered when displaying how many people were affected

NOT IDEAL



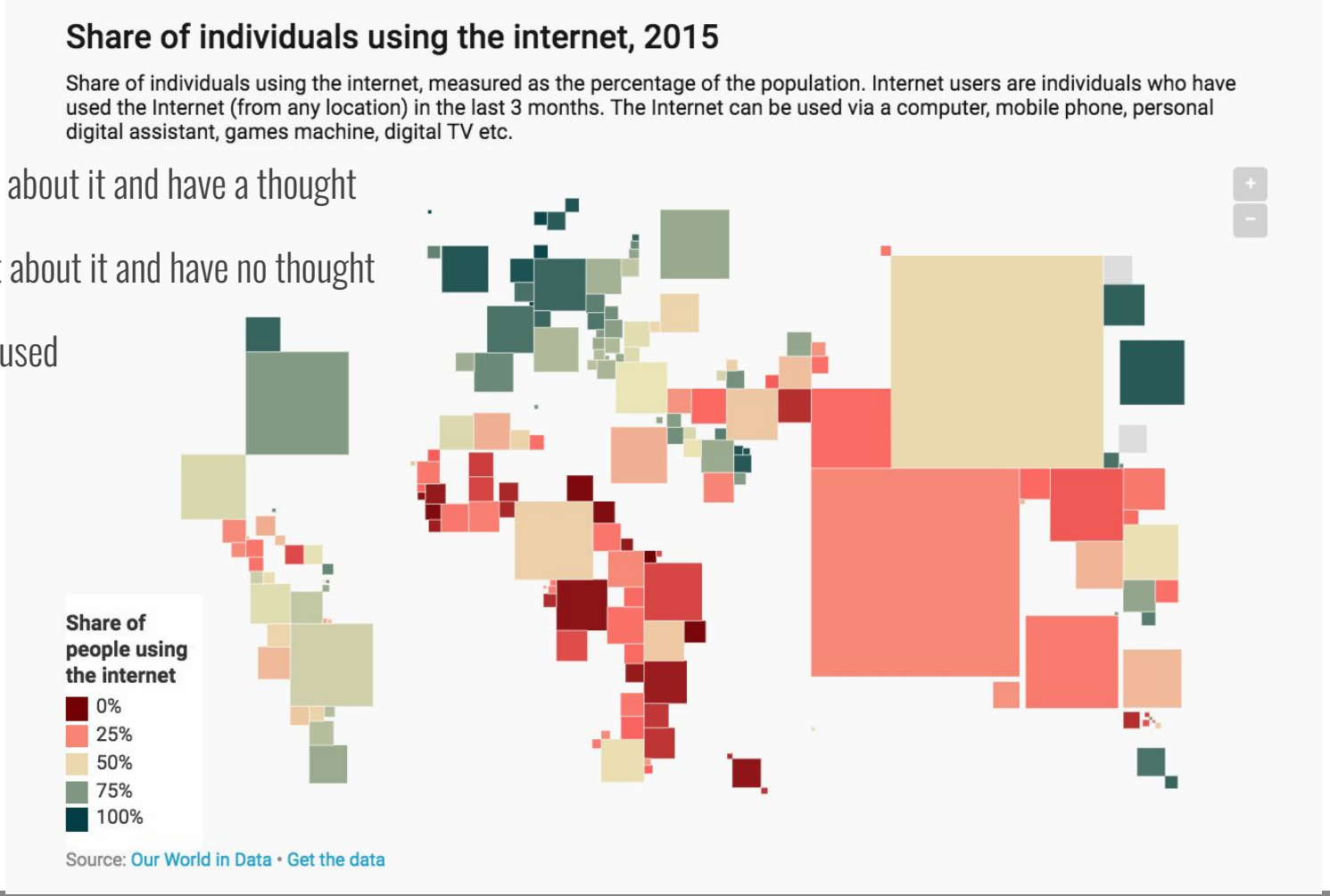
Choropleths answer “How much area was affected?”

BETTER

Cartograms answer “How many people were affected?”

https://blog.datawrapper.de/choroplethmaps/

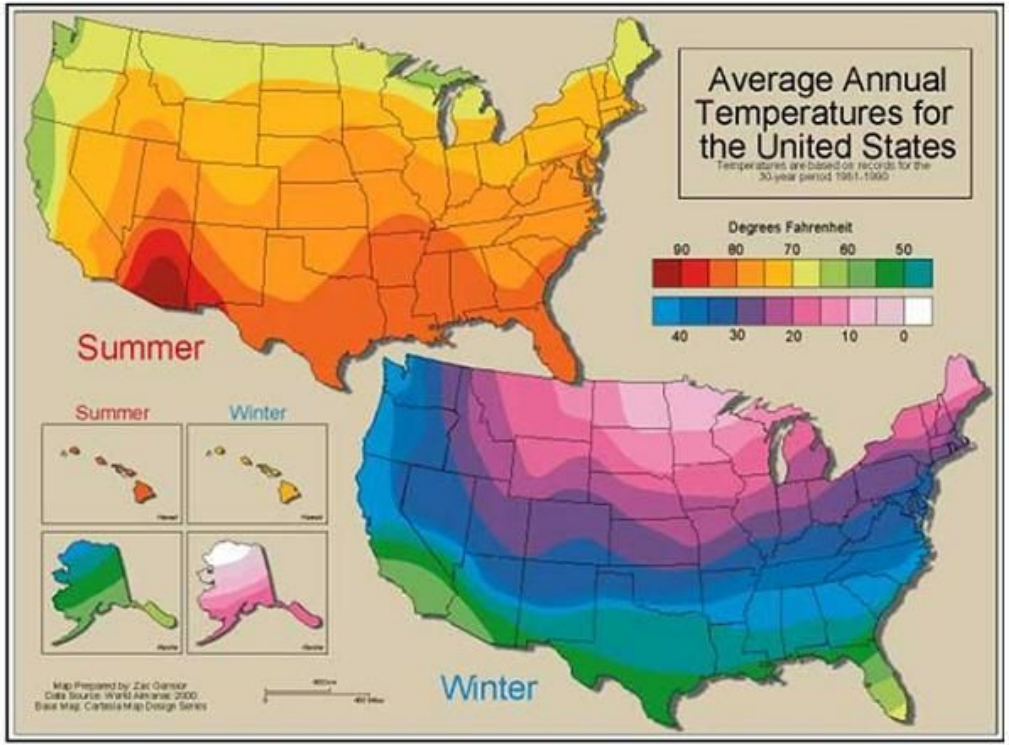
- **A** Thought about it and have a thought
- **B** Thought about it and have no thought
- **C** I'm confused



https://blog.datawrapper.de/cartograms/

Isarithmic maps demonstrate smooth, continuous phenomena

(temperature, elevation, rainfall, etc.)

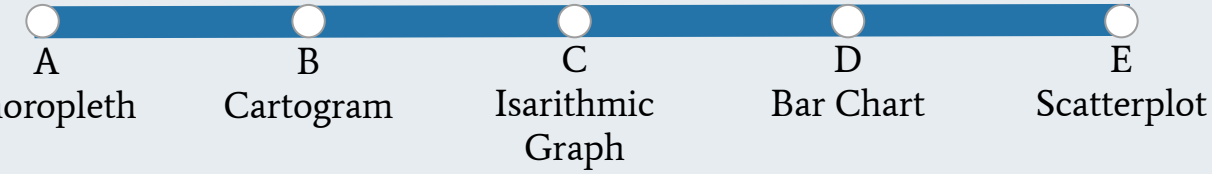


http://enb105-2012s-dem.blogspot.com/2012/03/isarithmic-map.html

Visualizing Geospatial Data

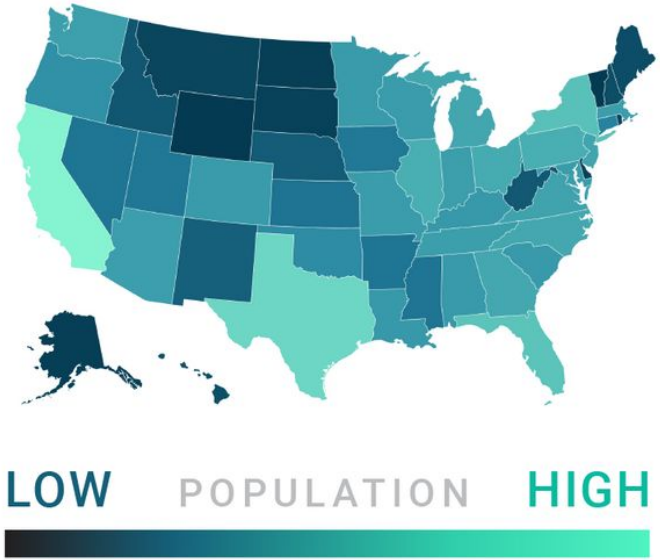
You want to visualize how many people have been affected by COVID19 worldwide.

Best approach to visualize these data?

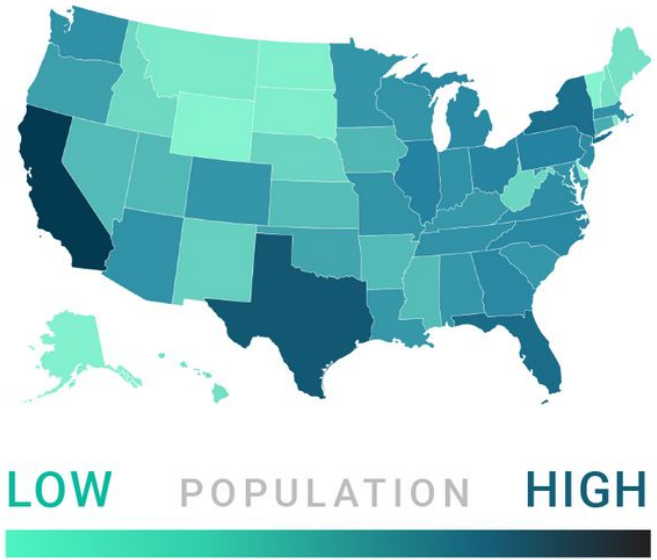


Use light colors for low values. Dark colors for high values.

NOT IDEAL



BETTER

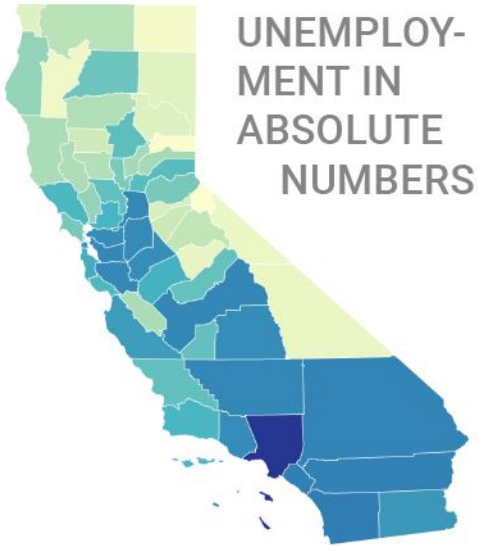


Choropleth maps are useful for visualizing *clear regional patterns* in the data

https://blog.datawrapper.de/colors/

Choropleth should display relative differences, *not* absolute numbers

NOT IDEAL



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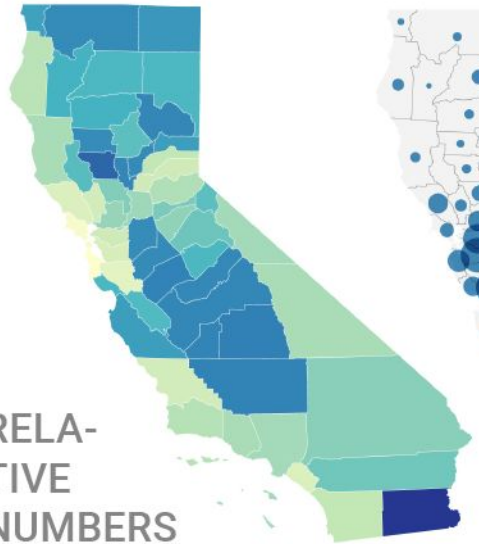
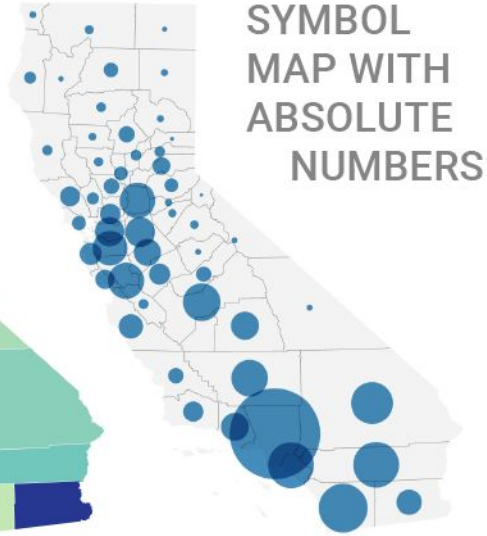
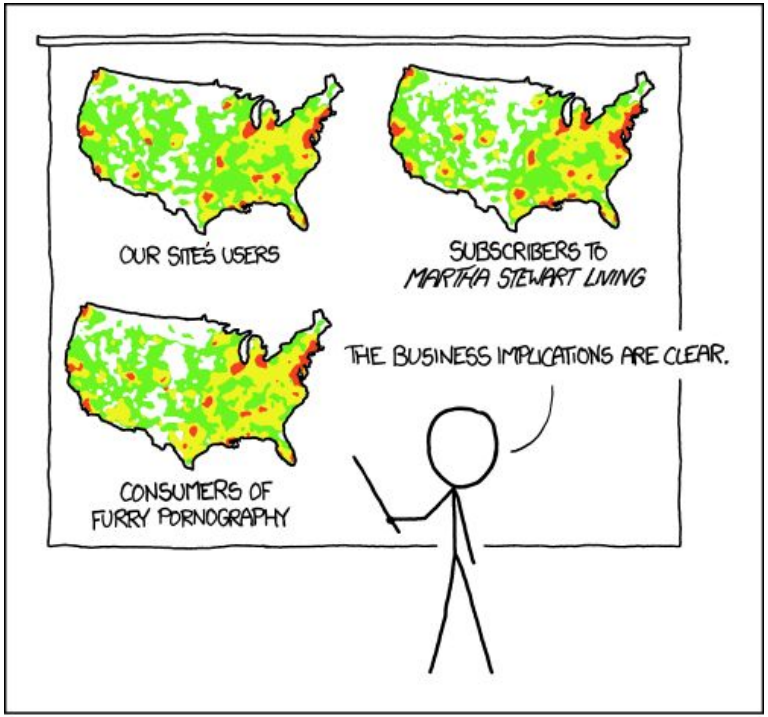




https://blog.datawrapper.de/choroplethmaps/



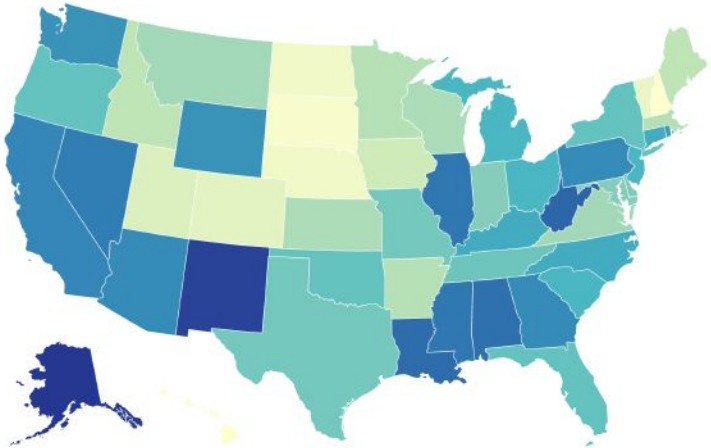
PET PEEVE #208:
GEOGRAPHIC PROFILE MAPS WHICH ARE BASICALLY JUST POPULATION MAPS

Choropleth maps can be **misleading**

https://xkcd.com/1138/

Consider using the smallest unit possible
(but there are exceptions!)

NOT IDEAL



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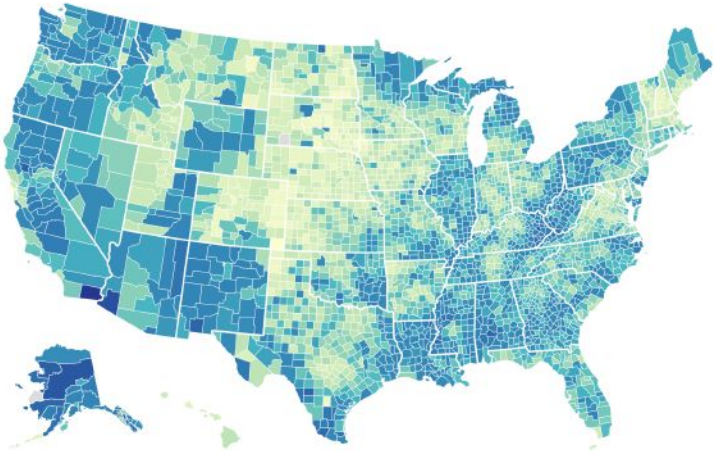
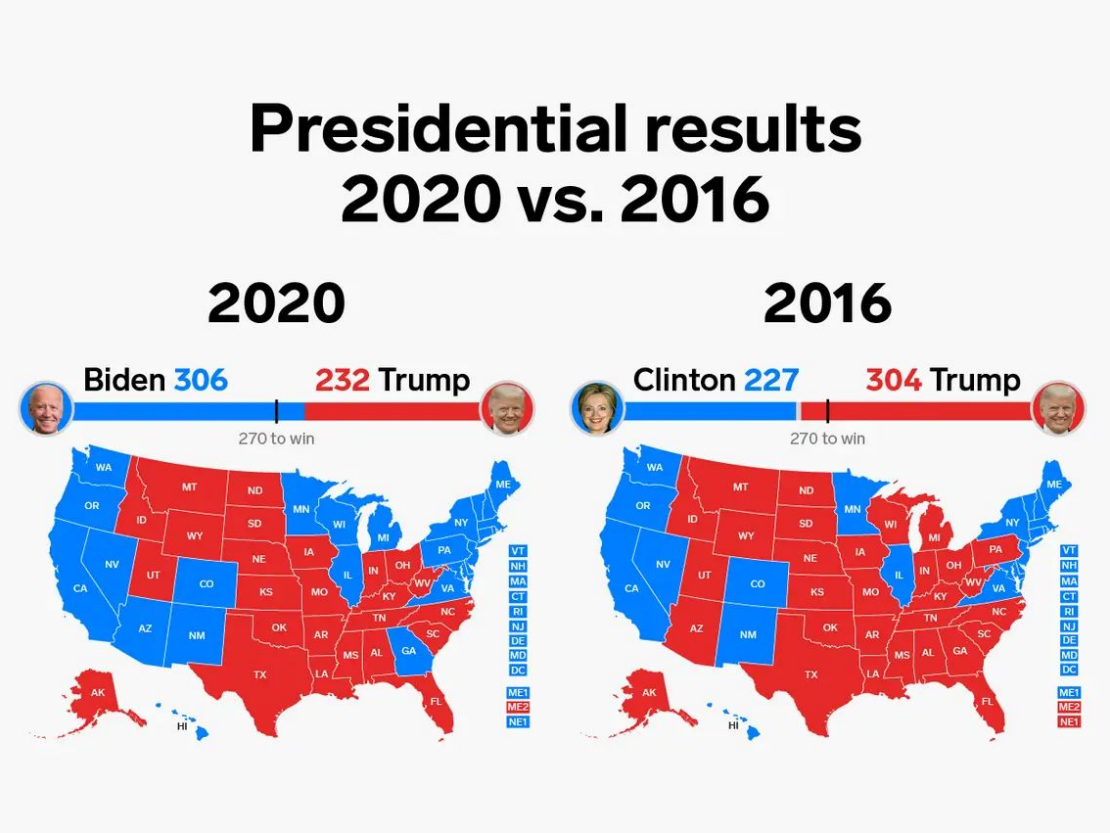


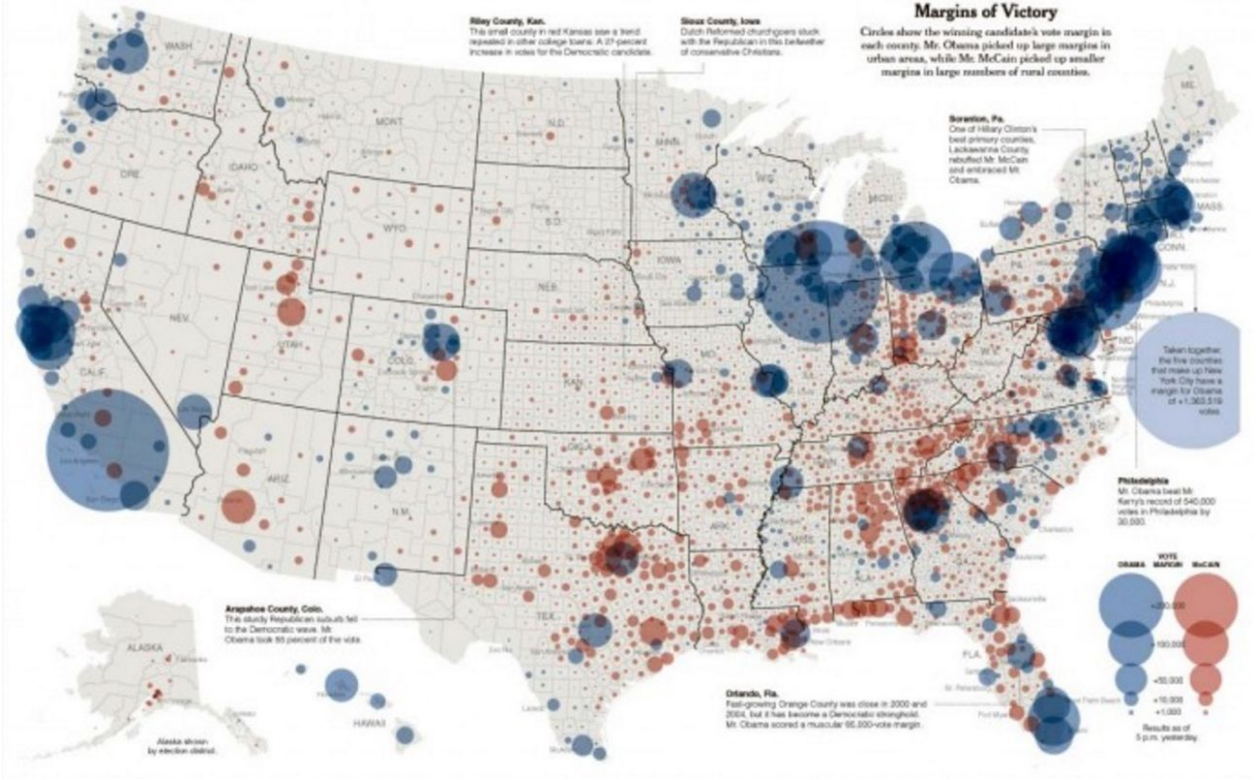
https://blog.datawrapper.de/choroplethmaps/



Sometimes summarizing at the state level is ok...

https://www.businessinsider.com/2020-vs-2016-electoral-college-maps-trump-biden-clinton-president-2020-11

adapted from Brad Voytek



This **bubble graph** more accurately tells the full story, since the size of the bubbles is reflective of the population

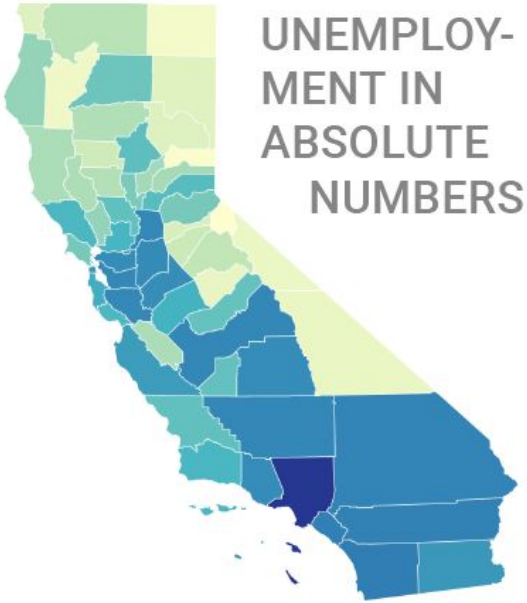
...but similar data *can* be displayed more effectively and informatively.

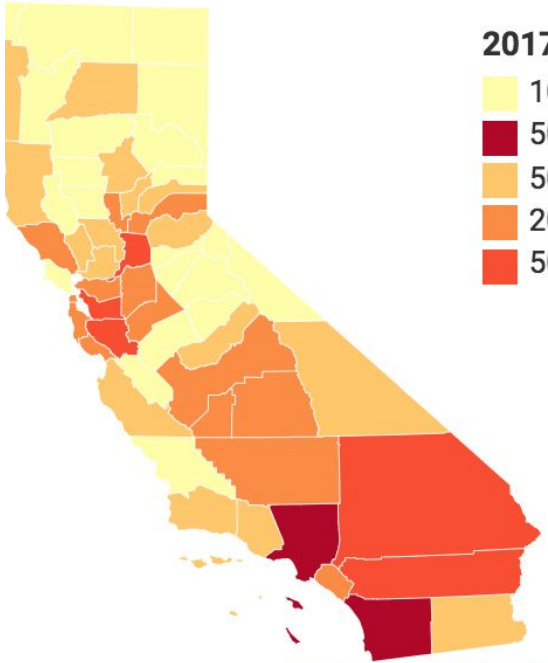
Source: http://www.thefunctionalart.com/2012/11/when-choropleth-maps-deceive.html

adapted from Brad Voytek

Map: Where Are Students Attending Charter Schools?

The majority of California's charter school student population is concentrated in Los Angeles, San Diego and Bay Area counties. Hover through the counties on each map for more information on their





2017-18 Charter Enrollment

- 1000-0
- 50001+
- 5000-1001
- 20000-5001
- 50000-20001

partment of Education • Get the data • Created with Datawrapper

- **A** Thought about it and have a thought
- **B** Thought about it and have no thought
- **C** I'm confused

https://calmatters.org/articles/california-charter-school-data-enrollment-cost-teachers-unions/

Spatial Statistics : The Why

Spatial Statistics

The statistical techniques we've discussed so far don't work well when considering spatial distributions...

Spatial Statistics

The statistical techniques we've discussed so far don't work well when considering spatial distributions...

...which means we have a chance to take a look at data and the relationship between the data in new and interesting ways
(distance, adjacency, interaction, and neighbor)

Spatial data violate conventional statistics:

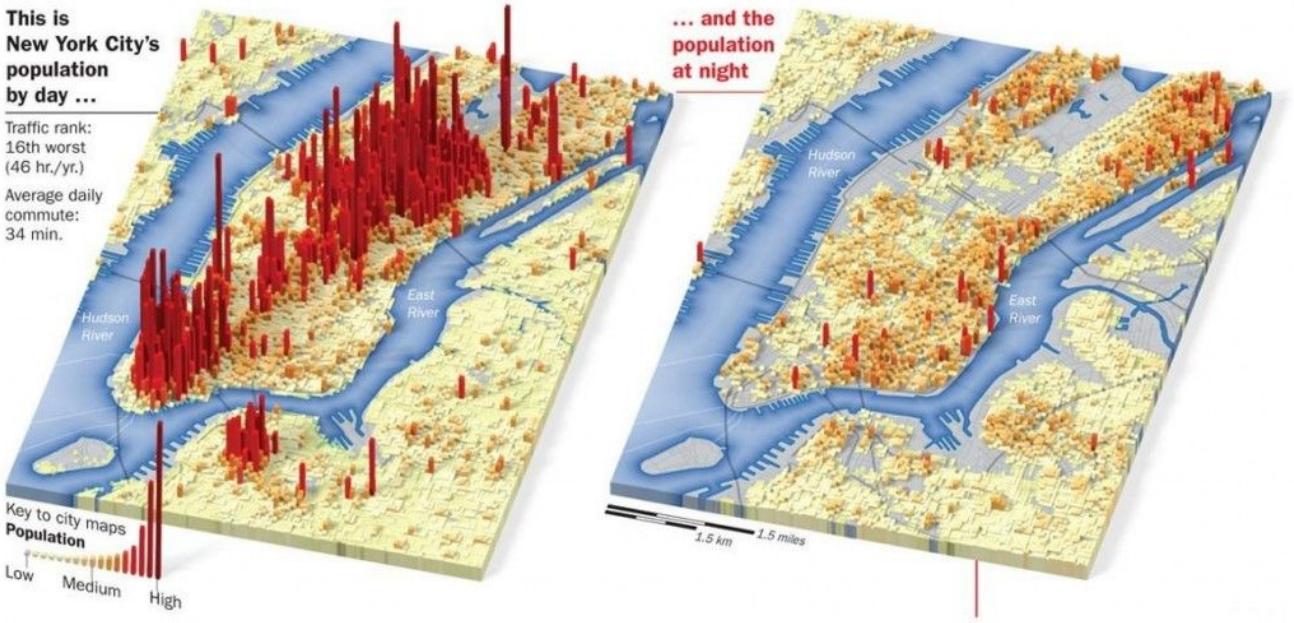
Violations of conventional statistics:

- Spatial autocorrelation
- Modifiable areal unit problem (MAUP)
- Edge effects (Boundary problem)
- Ecology fallacy
- Nonuniformity of space

Spatial Autocorrelation

Data from locations near one another in space are more likely to be similar than data from locations remote from one another:

- Housing market
- Elevation change
- Temperature



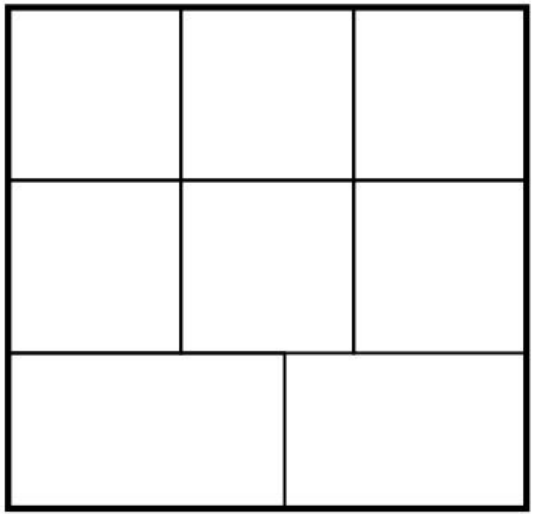
Modifiable Areal Unit Problem (MAUP)

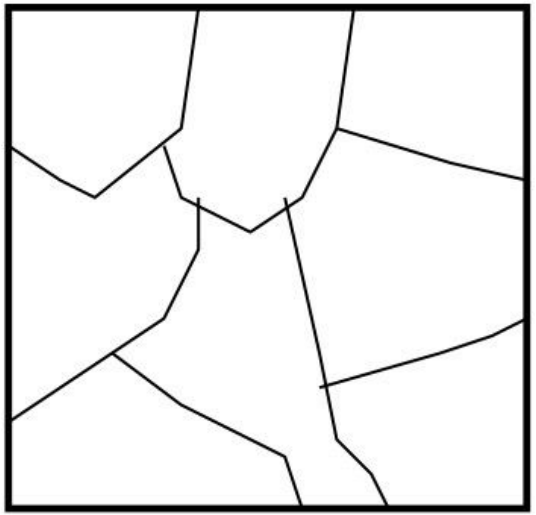
The aggregation units used are arbitrary with respect to the phenomena under investigation, yet the aggregation units used will affect statistics determined on the basis of data reported in this way.

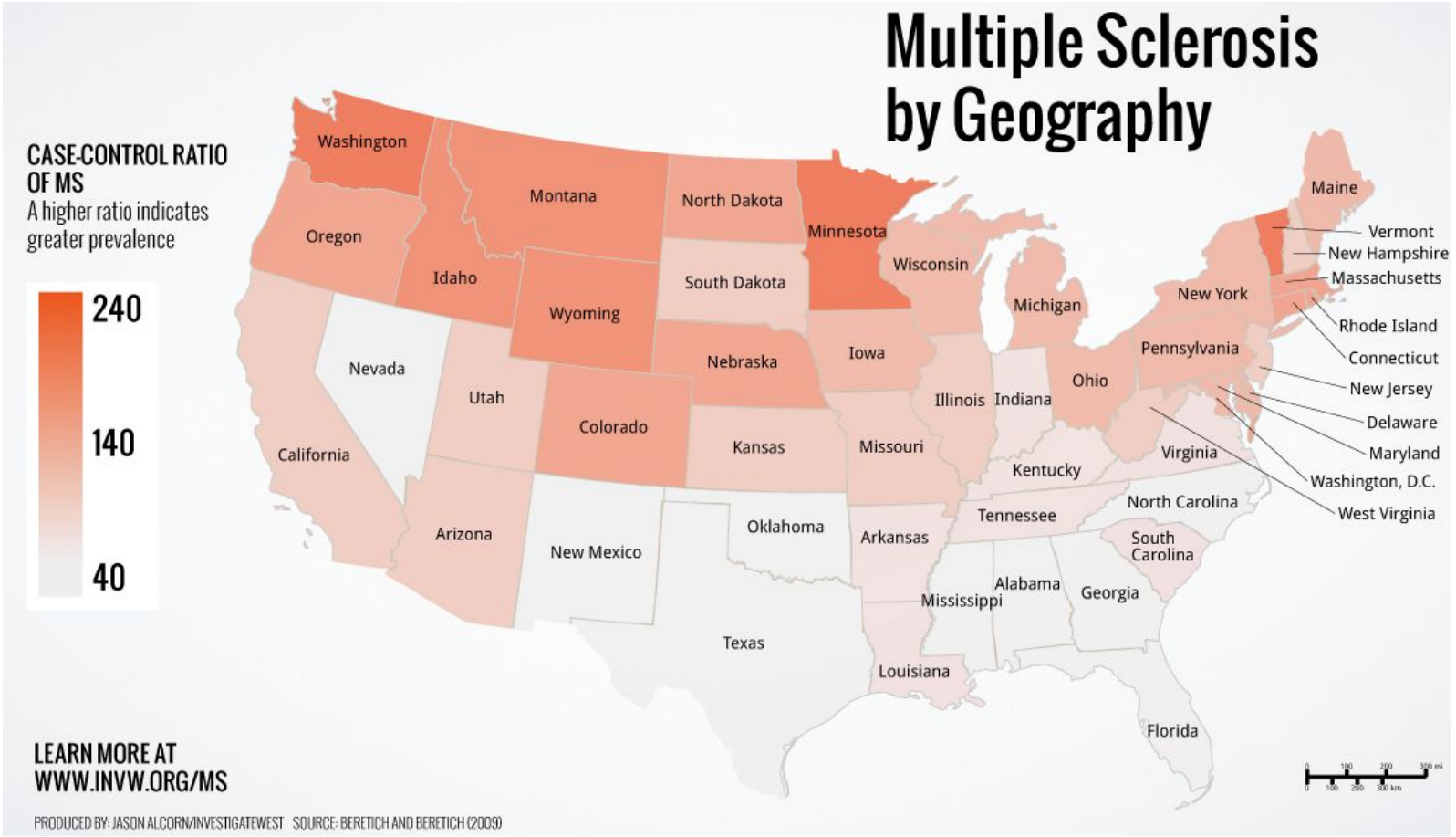
If the spatial units in a particular study were specified differently, we might observe very different patterns and relationships.

Modifiable Areal Unit Problem (MAUP)

modifiable area: Units are arbitrary defined and different organization of the units may create different analytical results.

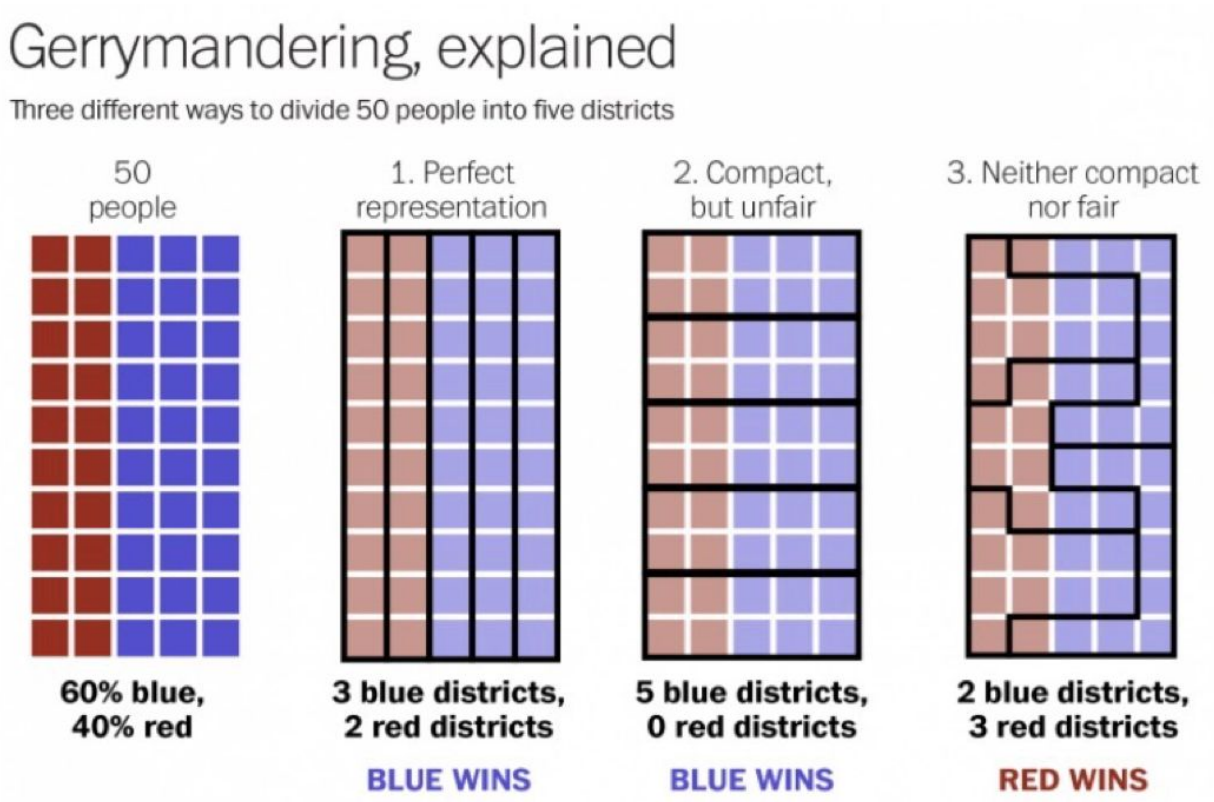






adapted from Brad Voytek

For example...gerrymandering

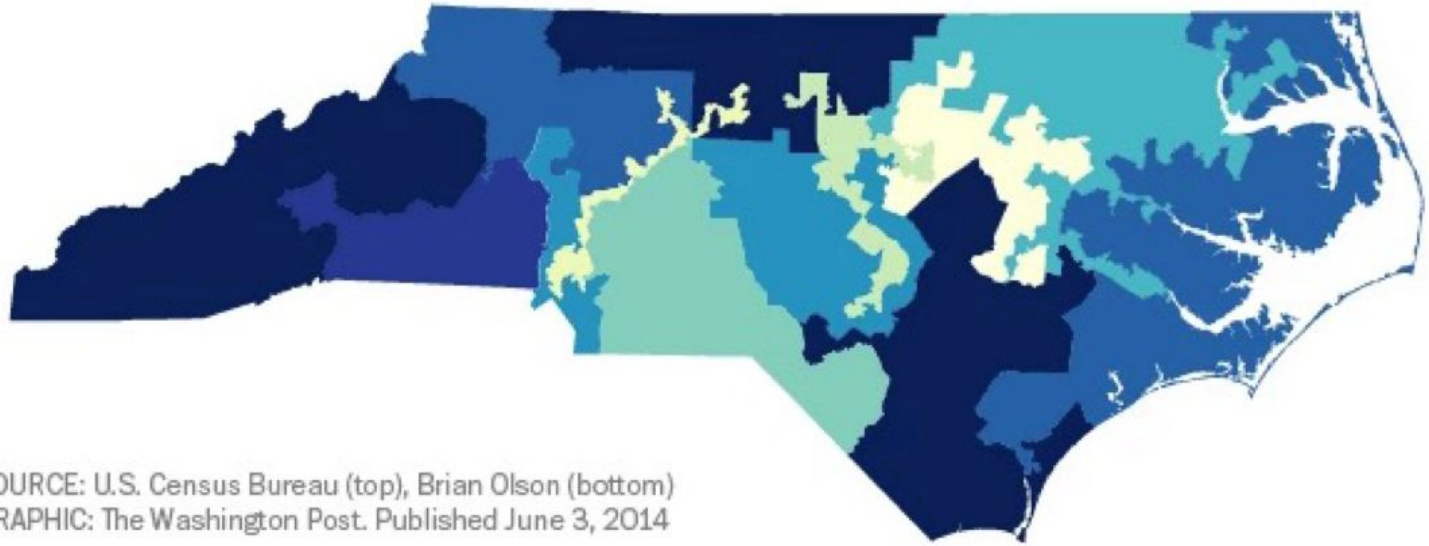


https://www.washingtonpost.com/news/wonk/wp/2015/03/01/this-is-the-best-explanation-of-gerrymandering-you-will-ever-see/ adapted from Brad Voytek

For example...gerrymandering

North Carolina

CURRENT CONGRESSIONAL DISTRICTS



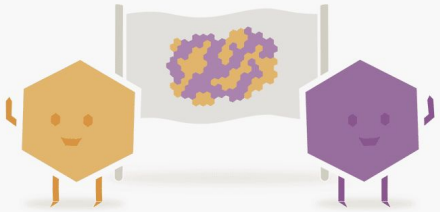
SOURCE: U.S. Census Bureau (top), Brian Olson (bottom)
GRAPHIC: The Washington Post. Published June 3, 2014

For example...gerrymandering

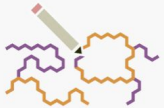
North Carolina

DISTRICTS REDRAWN TO OPTIMIZE COMPACTNESS

SOURCE: U.S. Census Bureau (top), Brian Olson (bottom)
GRAPHIC: The Washington Post. Published June 3, 2014



Welcome to Hexapolis



Every 10 years, Hexapolis redraws its congressional district lines — just like the United States does. But Hexapolis is a simpler place.

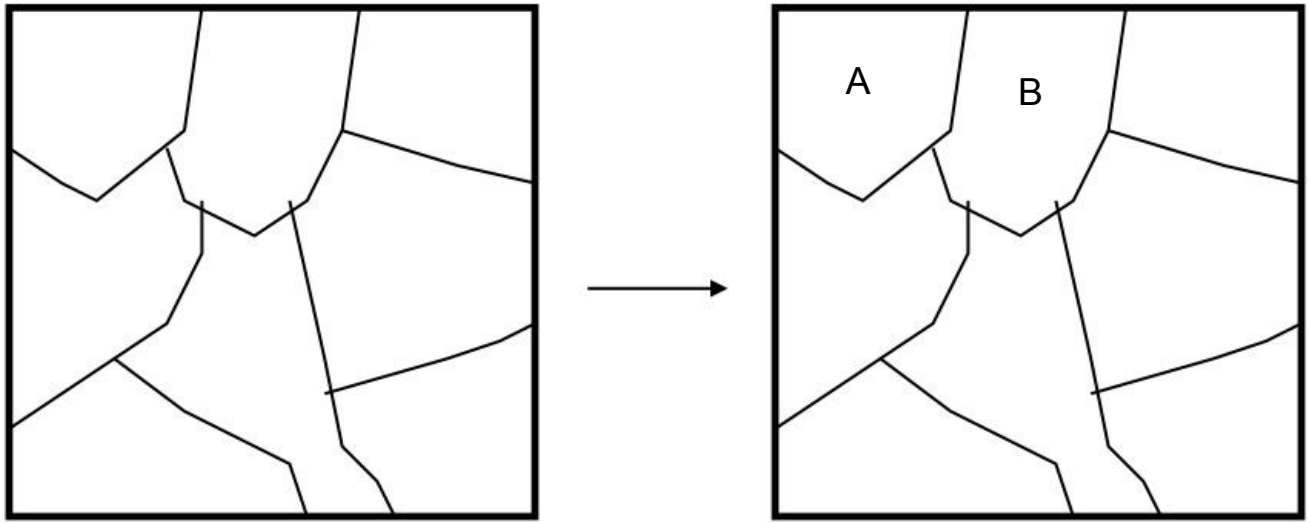
Lawmakers in either the **Purple Party** or **Yellow Party** control redistricting. To increase their advantage in upcoming elections, they have been known to gerrymander egregiously — even if it means leaving some voters disenfranchised.

Hexapolis has nine districts. Even though a majority of voters favor the Purple Party, that does not mean that the Yellow Party can't shift the state's partisan tilt.

Gerrymandering Redistricting Game: https://www.nytimes.com/interactive/2022/01/27/us/politics/congressional-gerrymandering-redistricting-game-2022.html

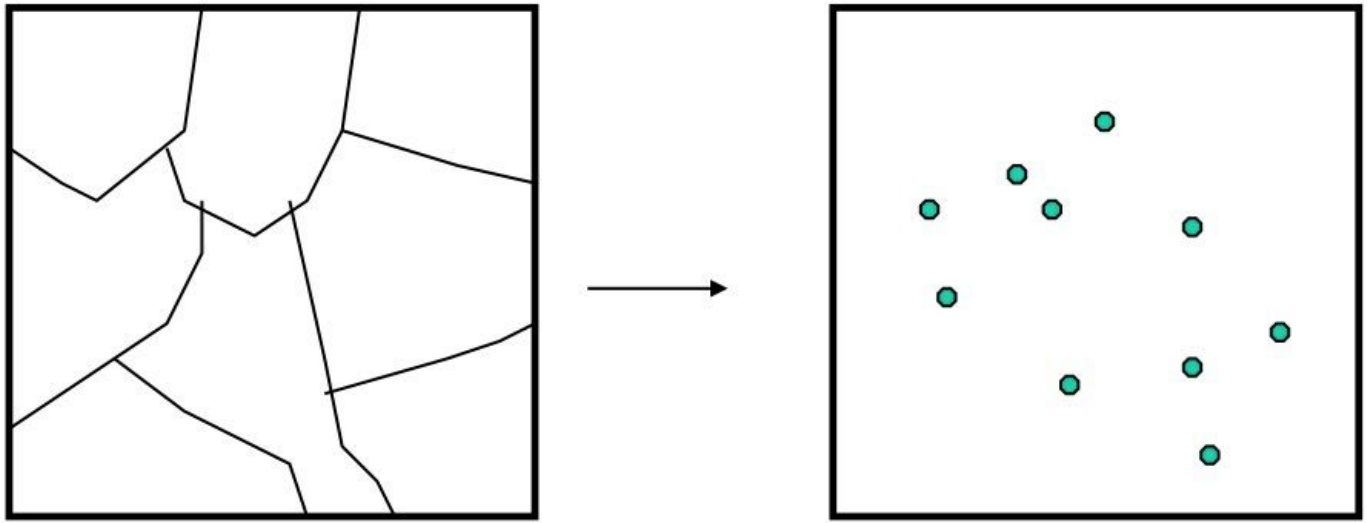
Edge Effects (The Boundary Problem)

Analyzing A vs B ignores similarities between the two based on their shared boundary



Ecological Fallacy

The Ecological Fallacy is a situation that can occur when a researcher or analyst makes an inference about an individual based on aggregate data for a group.



Ecological Fallacy

Example: we might observe a *strong relationship between income and crime at the county level*, with lower-income areas being associated with higher crime rate.

Conclusion:

- Lower-income persons are more likely to commit crime
- Individuals from lower-income areas are more likely to commit crime
- Lower-income counties tend to experience higher crime rates The only valid conclusion!

Ecological Fallacy

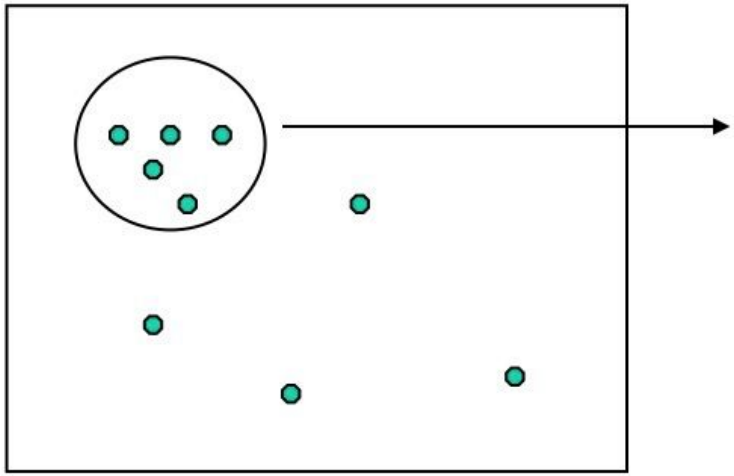
Issues:

Inferences drawn about associations between the characteristics of an aggregate population and the characteristics of sub-units within the population are wrong. That is: *results from aggregated data (e.g. counties) cannot be applied to individual people*

What should we do?

Be aware of the process of aggregating or disaggregating data may conceal the variations that are not visible at the larger aggregate level

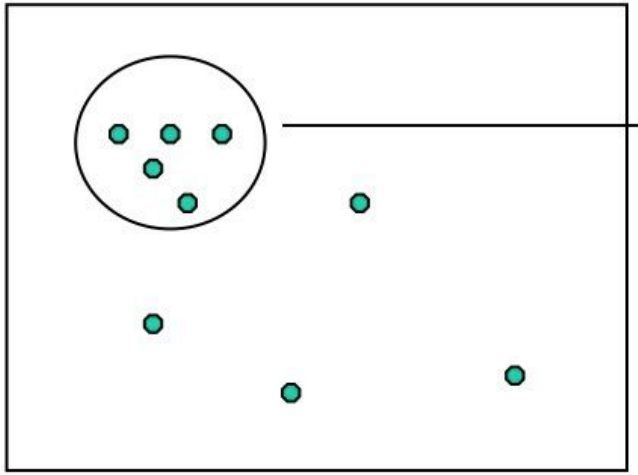
Nonuniformity



Area with high crime rates?

Crime locations

Nonuniformity

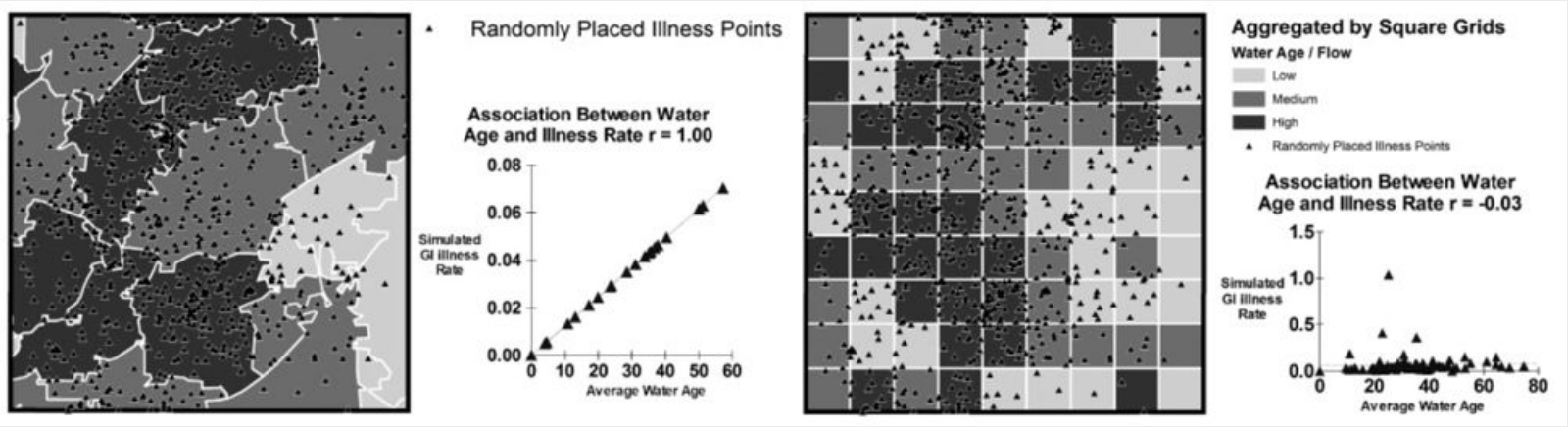


Crime locations

Area with high crime rates?

Conclusion: Bank robberies are clustered
....but only because banks are clustered!

Spatial Statistics



What explains what's going on here?

A
Spatial Autocorrelation

B
MAUP

C
Edge Effects

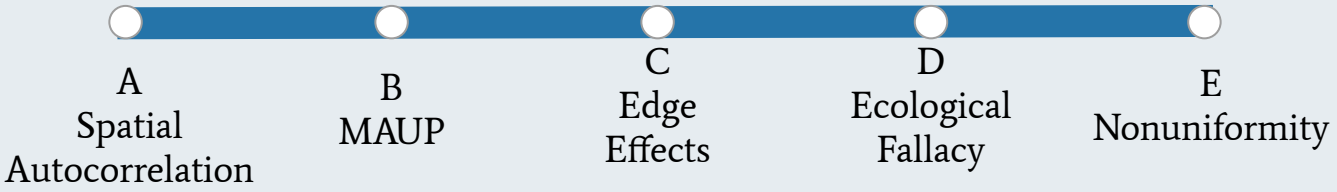
D
Ecological Fallacy

E
Nonuniformity

Spatial Statistics

In Baltimore City, police spend more time in a few neighborhoods. Crime rates are higher in those neighborhoods.

What explains what's going on here?



Spatial Statistics

A Trader Joe's just opened in a new neighborhood.
Nearby homes are now worth more money.

What explains what's going on here?