

Spatial

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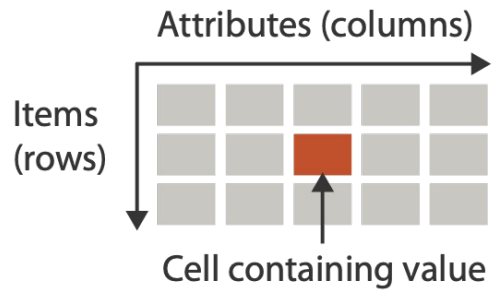
Spring 2024

Slides taken, reformatted, and used from Tamara Munzner (UBC,
Canada)

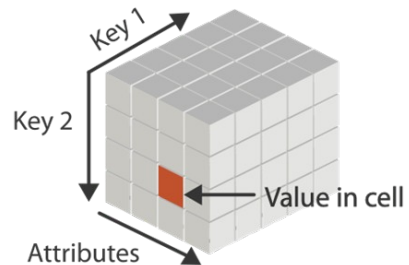
Focus on spatial

→ Dataset Types

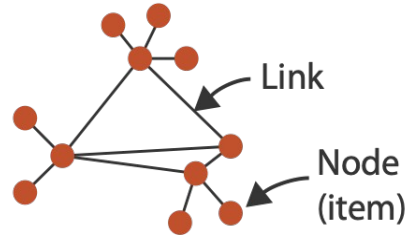
→ Tables



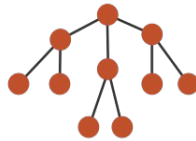
→ *Multidimensional Table*



→ Networks

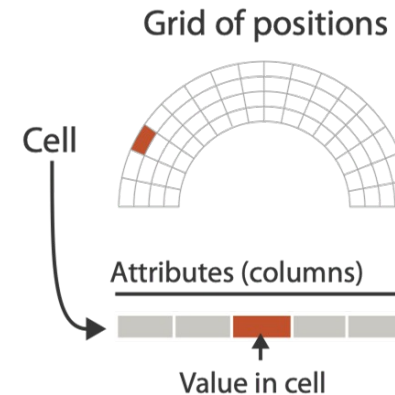


→ *Trees*



→ Spatial

→ Fields (Continuous)



→ Geometry (Spatial)



How?

Encode

➔ Arrange

➔ Express



➔ Separate



➔ Order



➔ Align



➔ Use



➔ Map

from **categorical** and **ordered** attributes

➔ Color

➔ Hue



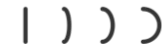
➔ Saturation



➔ Luminance



➔ Size, Angle, Curvature, ...



➔ Shape



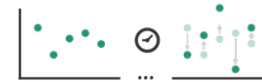
➔ Motion

Direction, Rate, Frequency, ...



Manipulate

➔ Change



➔ Select



➔ Navigate



Facet

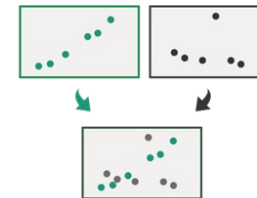
➔ Juxtapose



➔ Partition



➔ Superimpose



Reduce

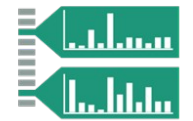
➔ Filter



➔ Aggregate



➔ Embed



What?

Why?

How?

How?

Encode

➔ Arrange

➔ Express



➔ Separate



➔ Order



➔ Align



➔ Use



➔ Map

from **categorical** and **ordered** attributes

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Facet

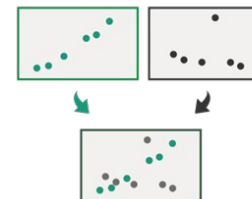
➔ Juxtapose



➔ Partition



➔ Superimpose



Reduce

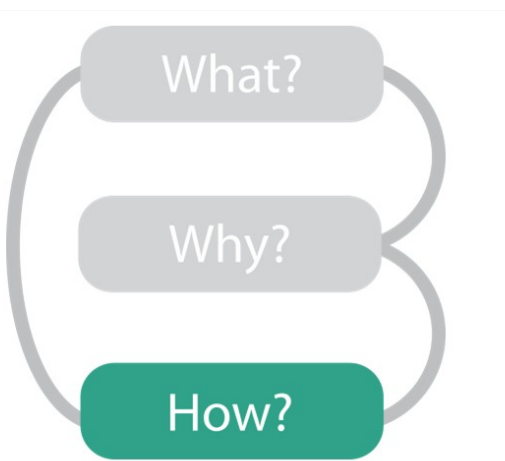
➔ Filter



➔ Aggregate



➔ Embed



Spatial data

- Use the given spatial position
- When?
 - Dataset contains spatial attributes, and they have primary importance
 - Central tasks revolve around understanding spatial relationships
- Examples
 - Geographical/cartographical data
 - Sensor/simulation data

Geographical maps

Geographic map



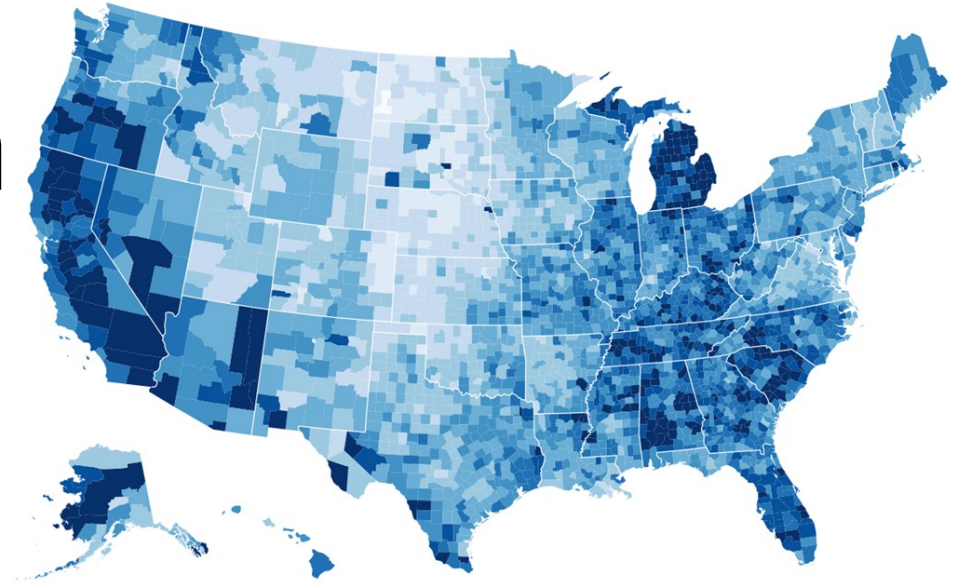
- Interlocking marks
 - Shape coded
 - Area coded
 - Position coded
- It cannot encode another attribute with these channels. They are taken.

Thematic maps

- Show spatial variability of attribute (“theme”)
 - Combine geographic/reference map with (simple, flat) tabular data
 - Join together
 - Region: interlocking area marks (provinces, countries with outline shapes)
 - Also could have point marks (cities, locations with 2D lat/lon cords)
 - Region: categorical key attribute in table
 - Use to look up value attributes
- Major idioms
 - Choropleth
 - Symbol maps
 - Cartograms
 - Dot density maps

Idiom: choropleth map

- Use the given spatial data
 - When the central task is understanding spatial relationships
- Data
 - Geographic geometry
 - Table with 1 quantitative attribute per region
- Encoding
 - Position: use the given geometry for area mark boundaries
 - Color: sequential segmented color map



<http://bl.ocks.org/mbostock/4060606>

Beware: population maps trickiness!

- Spurious correlations: most attributes show where they live
- Consider when to normalize by population density
 - Encode raw data values
 - Tied to the underlying population
 - But should use normalized values
 - Unemployed people per 100 citizens, mean family income
- General issue
 - Absolute counts vs relative/normalized data
 - Failure to normalize is common error

Choropleth maps : recommendations

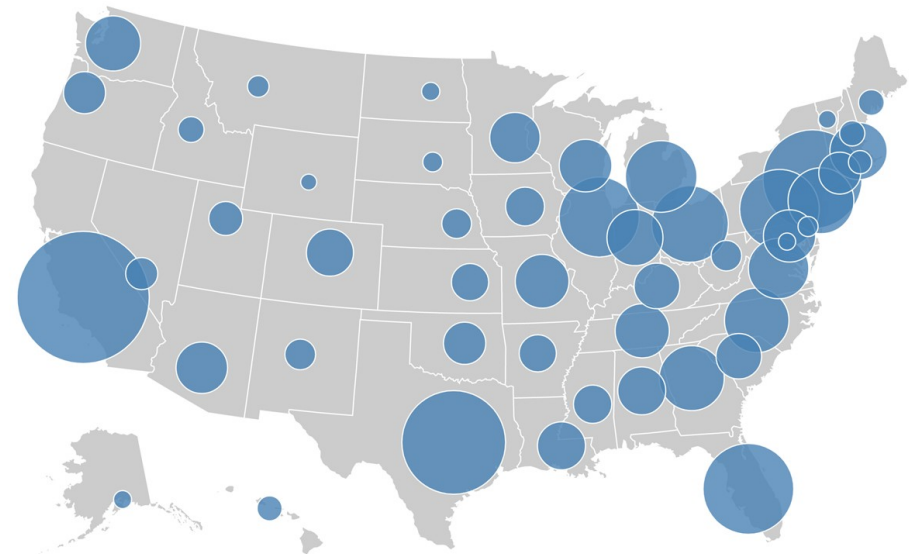
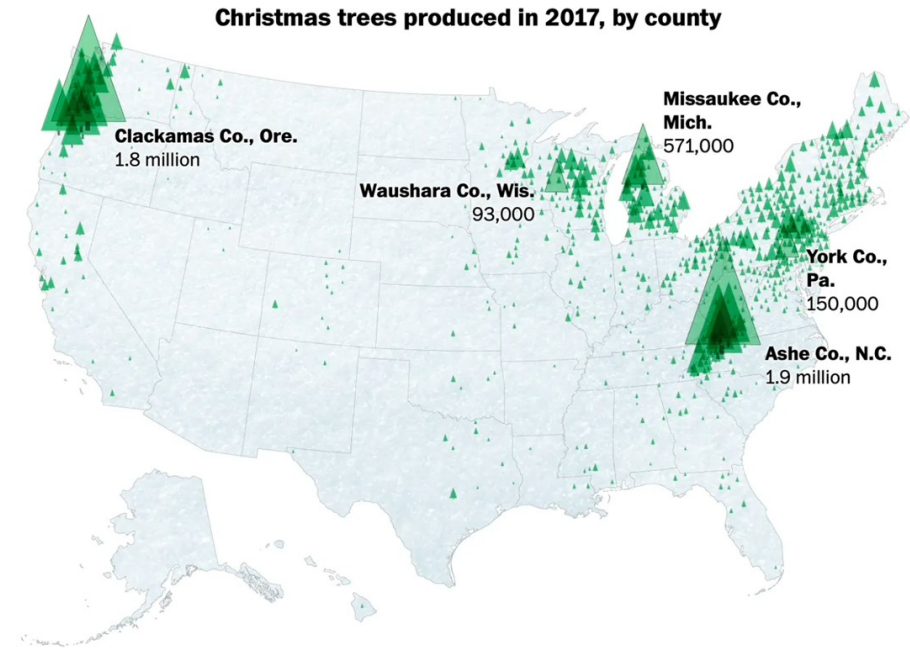
- Only use when the central task is understanding spatial relationships
- Show only one variable at a time
- Normalize when appropriate
- Be careful when choosing colors and bins
- Best case: regions are roughly equal sized

Choropleth map: pros & cons

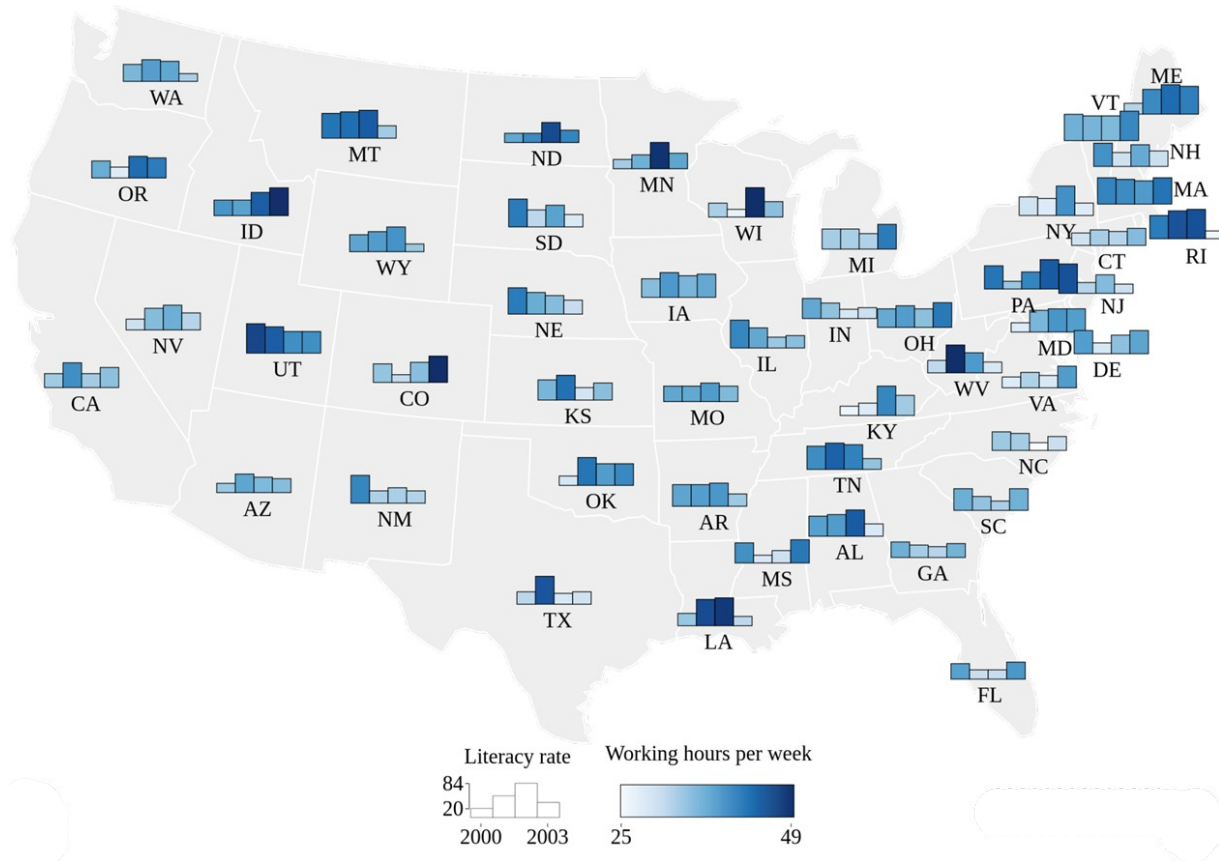
- Pros
 - Easy to read and understand
 - Well-established visualisation (no learning curve)
 - Data is often collected and aggregated by geographic regions
- Cons
 - Most effective visual variable used for geographic location
 - Visual salience depends on region size, not true importance wrt attribute value
 - Large regions appear more important than small ones
 - Color palette choice has a huge influence on the result

Idiom: symbol maps

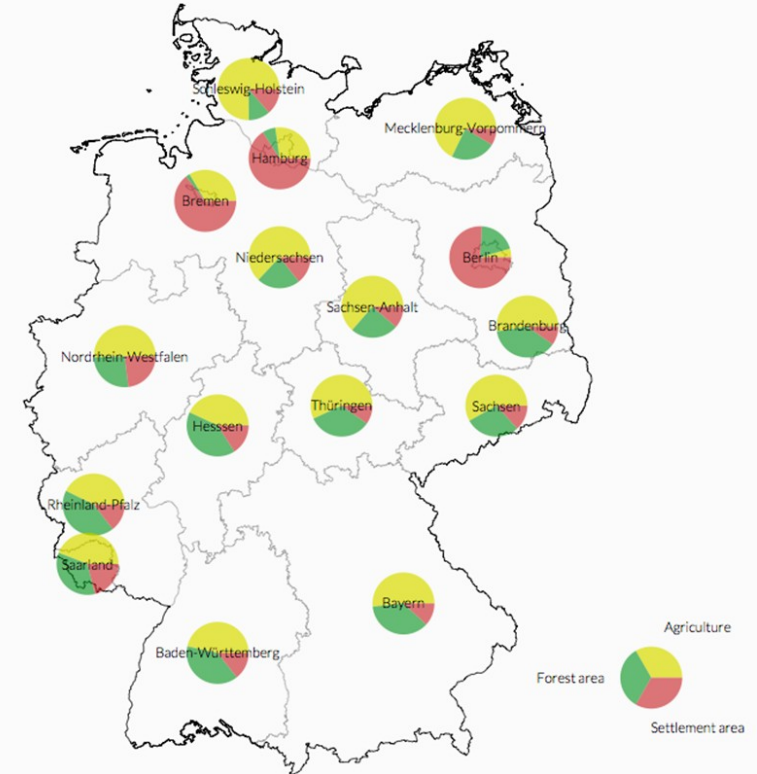
- Symbol is used to represent aggregated data (mark or glyph)
 - Allows use of size and shape and color channels
 - Aka proportional symbol maps, graduated symbol maps
- Keep original spatial geometry in the background
- Often a good alternative to choropleth maps



Symbol maps with glyphs



Shares of agricultural, forest and settlement area



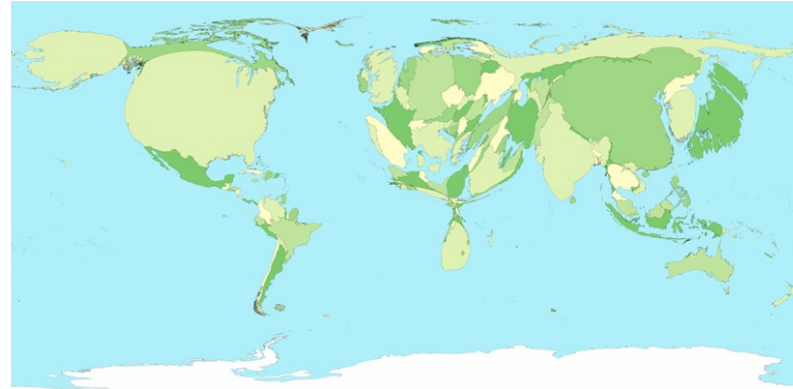
Source: Statistisches Bundesamt Fachserie 3 Reihe 5.1

Symbol map: Pros & Cons

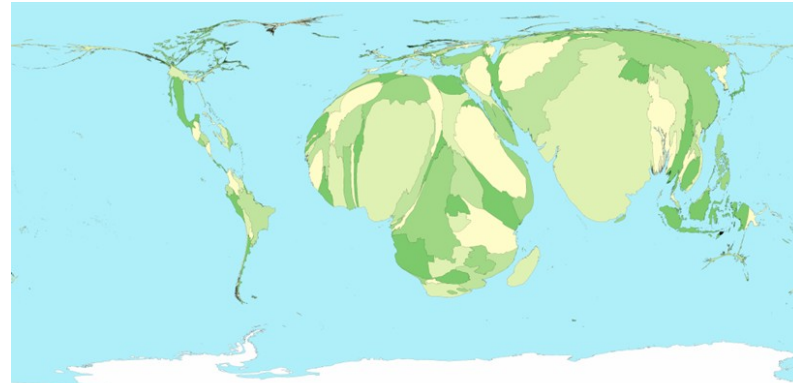
- Pros
 - Somewhat intuitive to read and understand
 - Mitigate problems with region size vs data salience
 - Marks: symbol size follows attribute value
 - Glyphs: symbol size can be uniform
- Cons
 - Possible occlusion/overlap
 - Symbols could overlap each other
 - Symbols could occlude region boundaries
 - Complex glyphs may require explanation/training

Idiom: contiguous cartogram

- Interlocking marks: shape, area, and position coded
- Derive new interlocking marks
 - Base don combination of original interlocking marks and new quantitative attribute
- Algorithm to create new marks
 - Input – target size
 - Goal – shape as close to the original as possible
 - Requirement: maintain constraints
 - Relative position
 - Contiguous boundaries with their neighbours

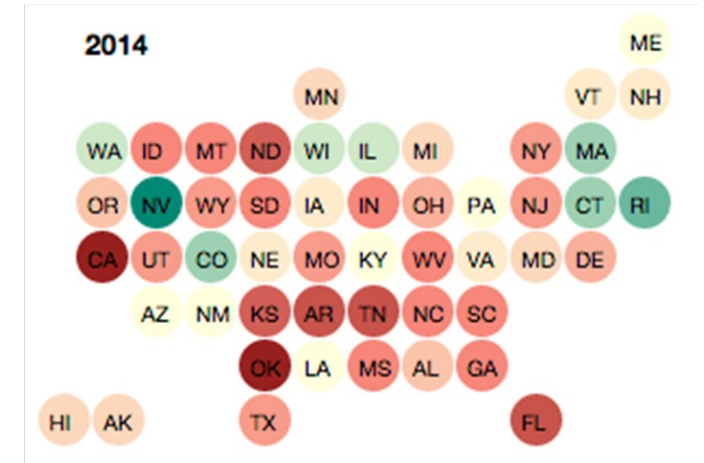
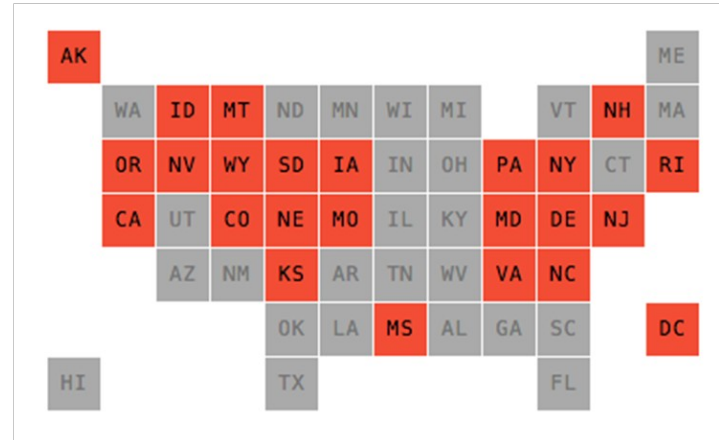
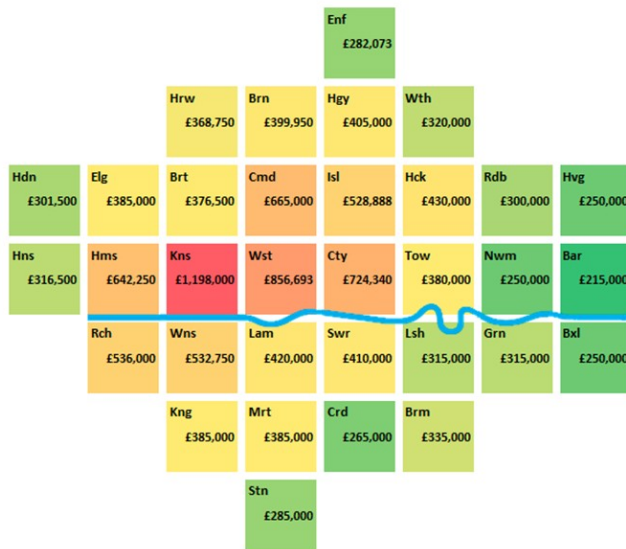


Greenhouse Emissions



Child Mortality

Idiom: grid cartogram



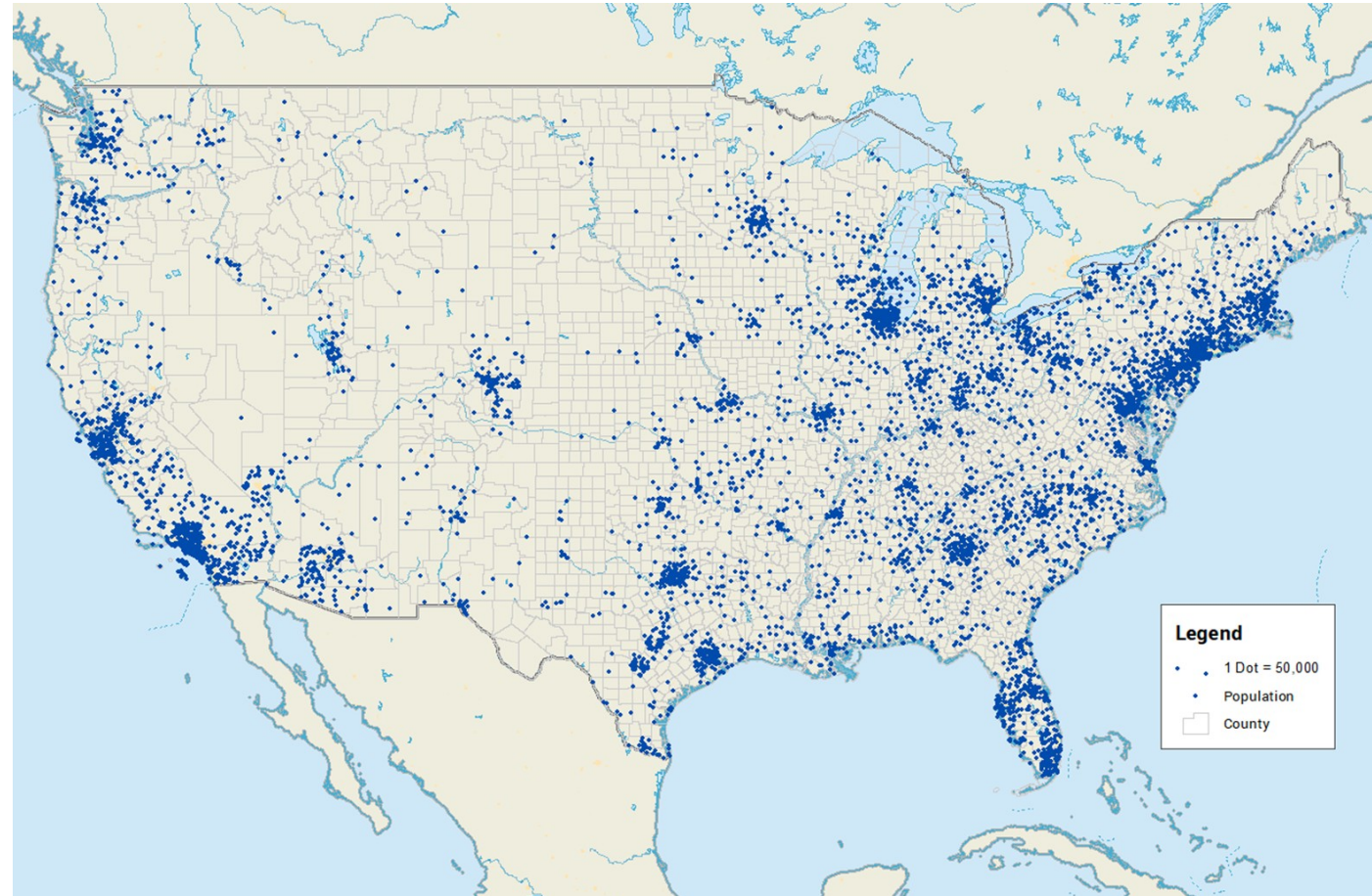
- Uniform-sized shapes arranged in a rectilinear grid
- Maintain approximate spatial position and arrangement

Cartogram pros & cons

- Pros
 - Can be intriguing and engaging
 - Best case: strong and surprising size disparities
 - Non-contiguous cartograms often easier to understand
- Cons
 - Require substantial familiarity with original dataset and use of memory
 - Compare distorted marks to memory of original marks
 - Mitigation strategies: transitions or side by side views
 - Major distortion is problematic
 - May be aesthetically displeasing
 - May result in unrecognizable marks
 - Difficult to extract quantities

Idiom: dot density maps

- Visualize the distribution of a phenomenon by placing dots
- One symbol represents a constant number of items
 - Dots have uniform size and shape
 - Allows use of color channel
- Task: show spatial patterns, clusters



Dot density maps: pros and cons

- Pros
 - Straightforward to understand
 - Avoids choropleth non-uniform region size problems
- Cons
 - Challenge: normalisation, just like choropleths
 - Show population density (correlated with attribute), not the effect of interest
 - Perceptual disadvantage: difficult to extract quantities
 - Performance disadvantage: rendering many dots can be slow.