

# Spatial

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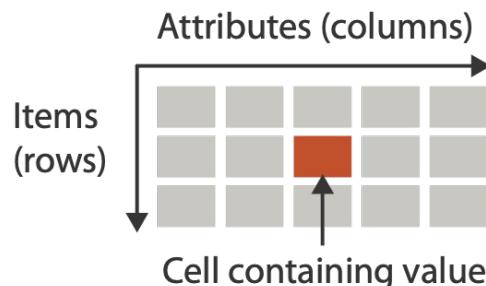
Spring 2024

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

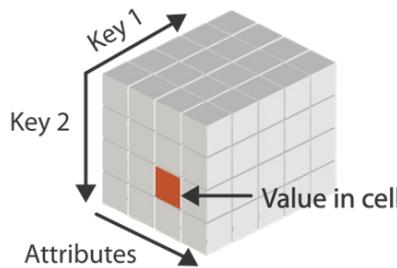
# Focus on spatial

## → Dataset Types

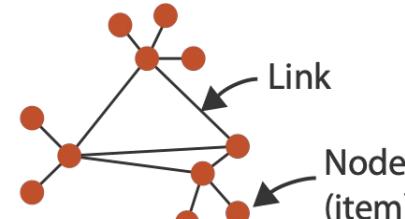
### → Tables



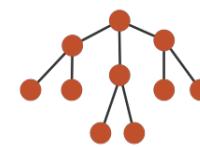
### → Multidimensional Table



### → Networks

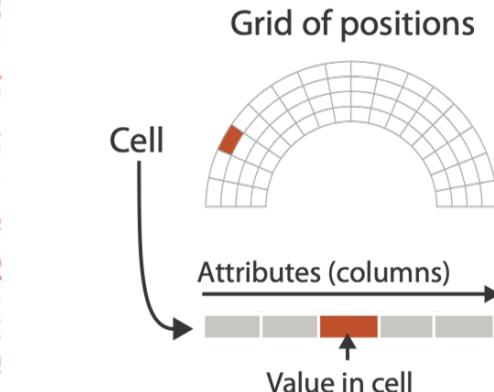


### → Trees

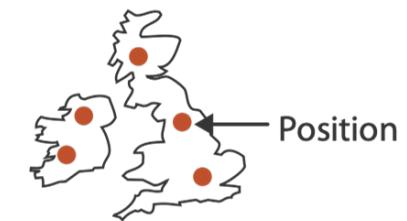


### → Spatial

### → Fields (Continuous)



### → Geometry (Spatial)



# How?

## Encode

- ④ **Arrange**
  - Express  

  - Separate  


- Order  

- Align  


- Use  


What?

Why?

How?

- ④ **Map**  
from **categorical** and **ordered** attributes
- Color
  - Hue
  - Saturation
  - Luminance
- Size, Angle, Curvature, ...  

- Shape
  - +
  - 
  - 
  - ▲
- Motion  
*Direction, Rate, Frequency, ...*  


## Manipulate

- ④ **Change**  

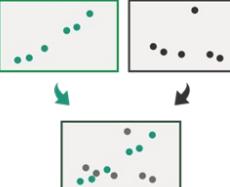

- ④ **Select**  


- ④ **Navigate**  


## Facet

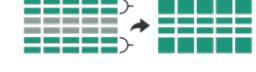
- ④ **Juxtapose**  


- ④ **Partition**  


- ④ **Superimpose**  


## Reduce

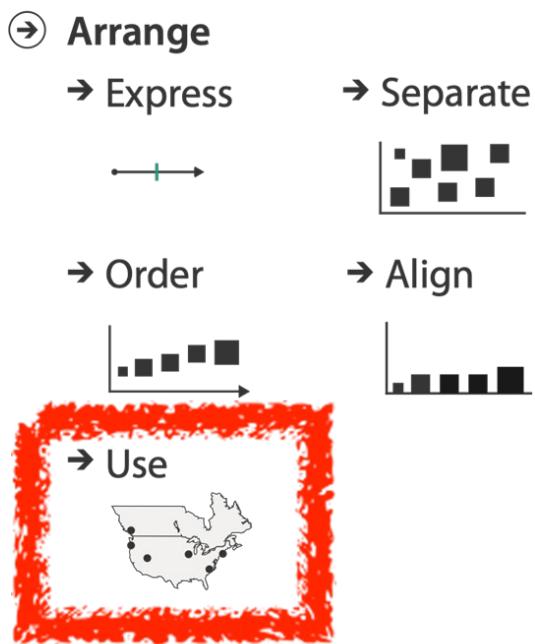
- ④ **Filter**  


- ④ **Aggregate**  


- ④ **Embed**  


# How?

## Encode



- Ⓑ Map  
from **categorical** and **ordered** attributes
- Color  
→ Hue → Saturation → Luminance  

- Size, Angle, Curvature, ...  

- Shape  
+ ● ■ ▲
- Motion  
*Direction, Rate, Frequency, ...*  


## Manipulate

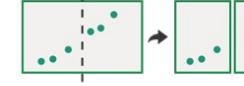
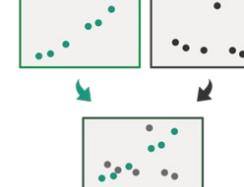
- Ⓐ Change  

- Ⓑ Select  

- Ⓑ Navigate  

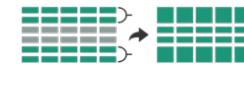

## Facet

- Ⓐ Juxtapose  

- Ⓐ Partition  

- Ⓐ Superimpose  


## Reduce

- Ⓐ Filter  

- Ⓐ Aggregate  

- Ⓐ Embed  


What?

Why?

How?

# 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



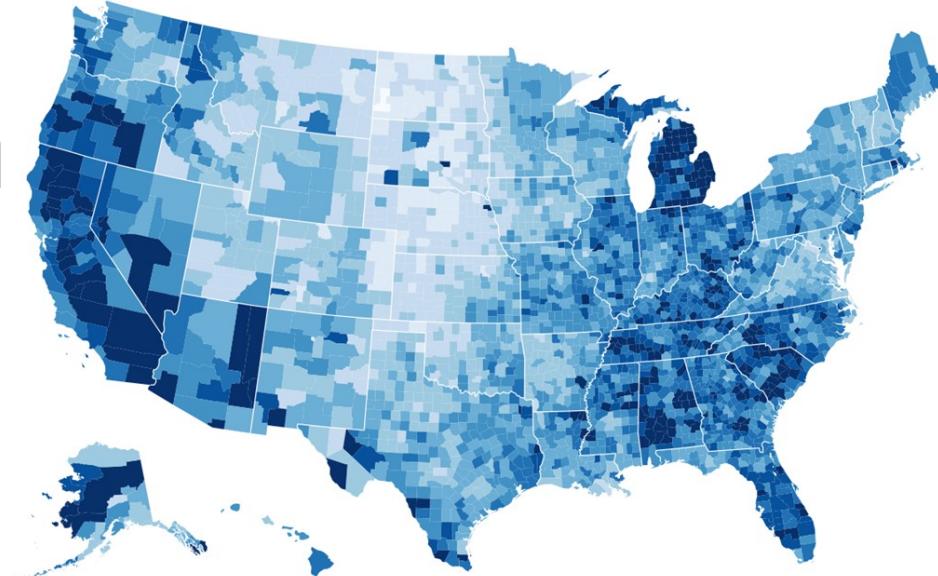
- Interlocking marks
  - Shape coded
  - Area coded
  - Position coded
- It cannot encode another attribute with these channels. They are taken.

# 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

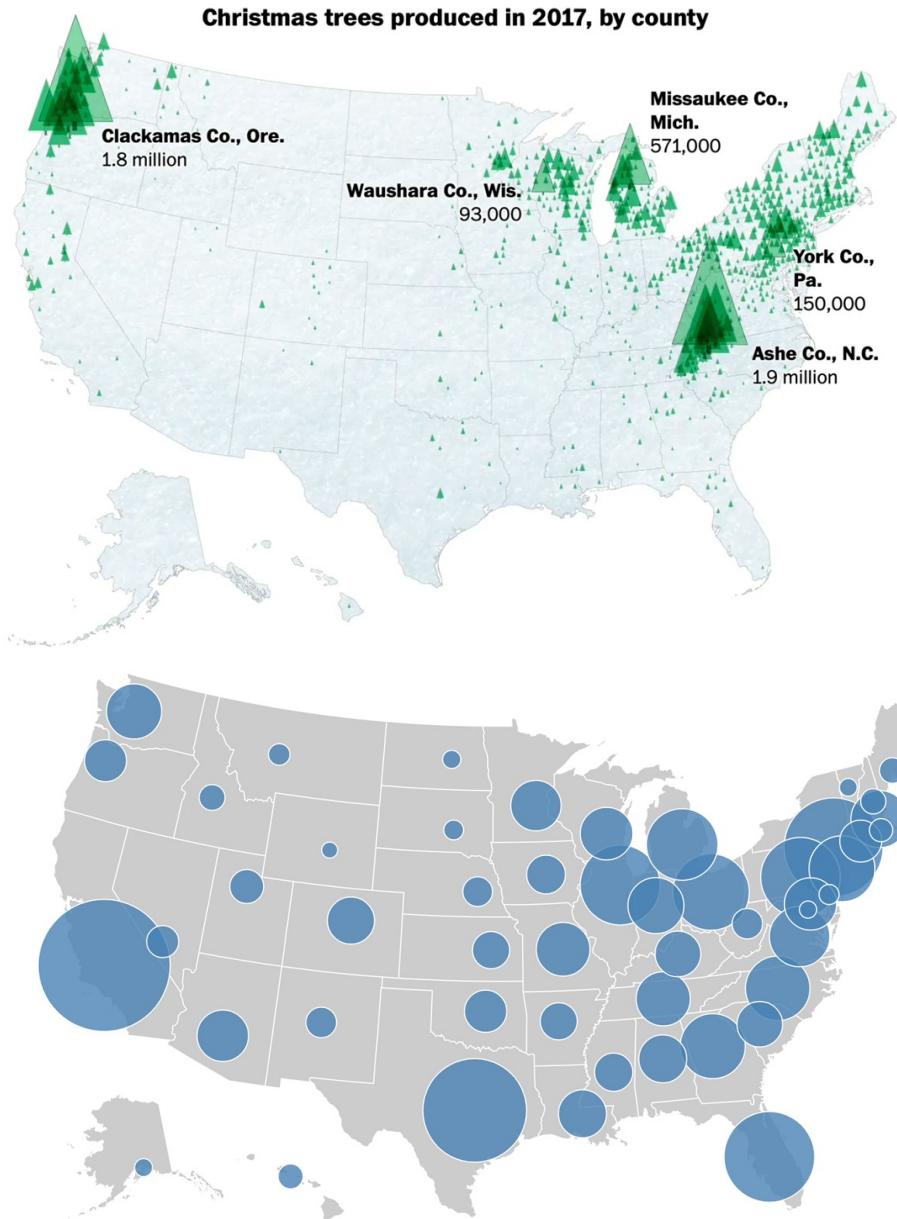
- Only use when the central task is understanding spatial relationships
- Show only one variable at a time
- Normalize when appropriate
- Be careful when choosing colors and bins
- Best case: regions are roughly equal sized

# Choropleth map: pros & cons

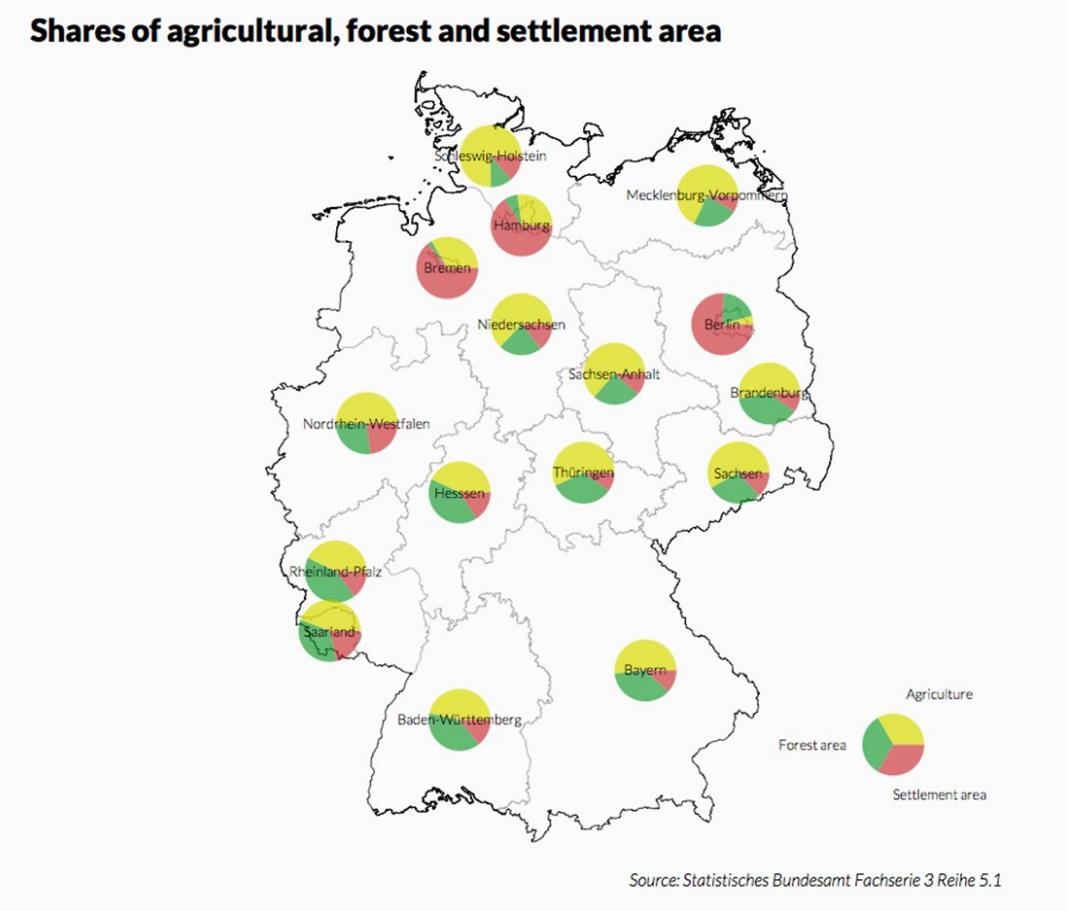
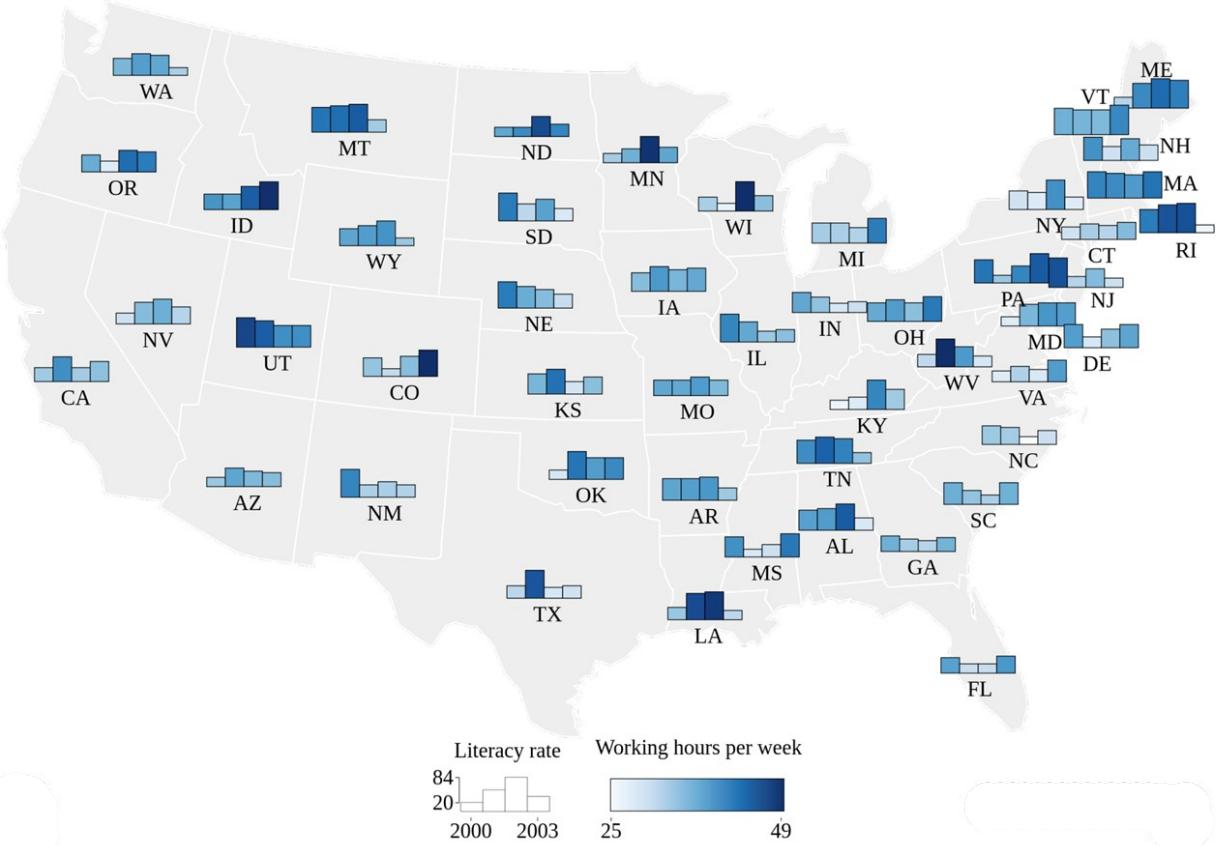
- Pros
  - Easy to read and understand
  - Well-established visualisation (no learning curve)
  - Data is often collected and aggregated by geographic regions
- Cons
  - Most effective visual variable used for geographic location
  - Visual salience depends on region size, not true importance wrt attribute 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

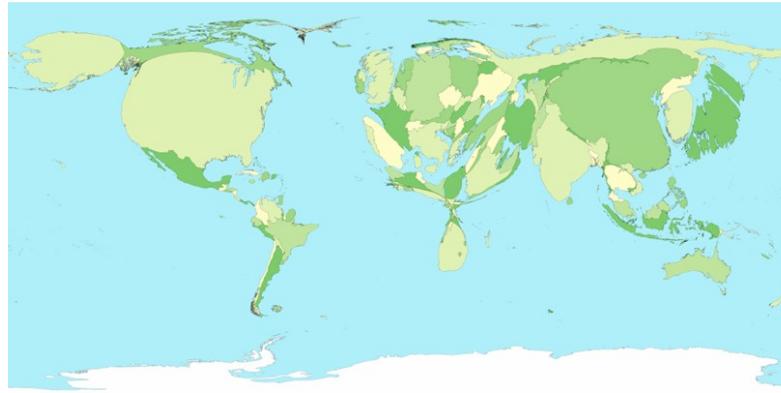


# Symbol map: Pros & Cons

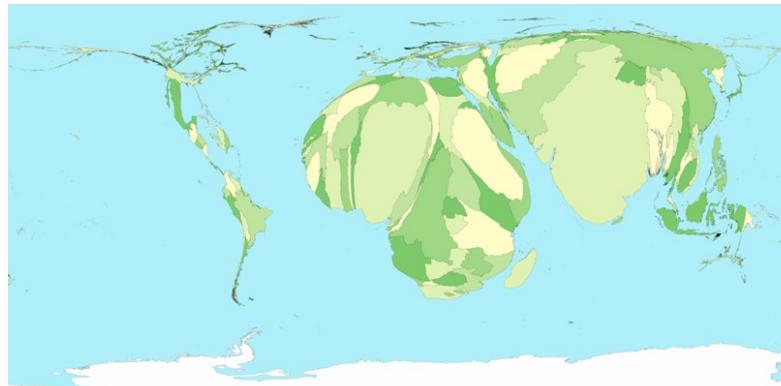
- Pros
  - Somewhat intuitive to read and understand
  - Mitigate problems with region size vs data salience
    - Marks: symbol size follows attribute value
    - Glyphs: symbol size can be uniform
- Cons
  - Possible occlusion/overlap
    - Symbols could overlap each other
    - Symbols could occlude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

# Idiom: contiguous cartogram

- Interlocking marks: shape, area, and position coded
- Derive new interlocking marks
  - Based on 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

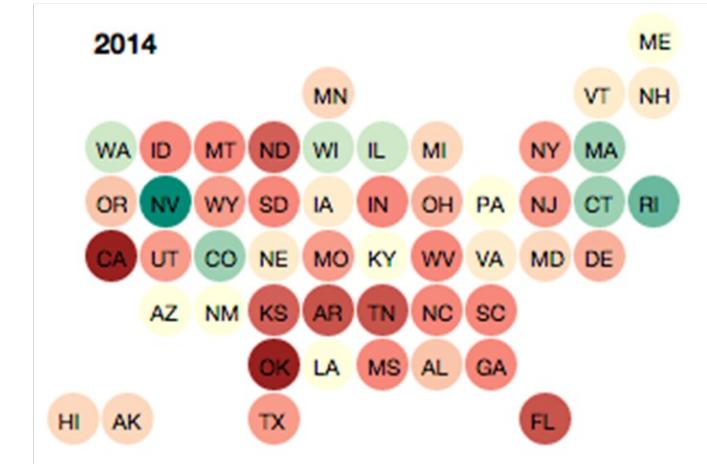
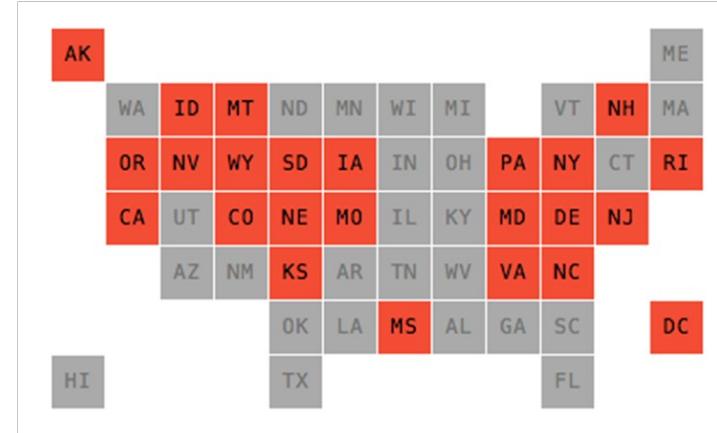
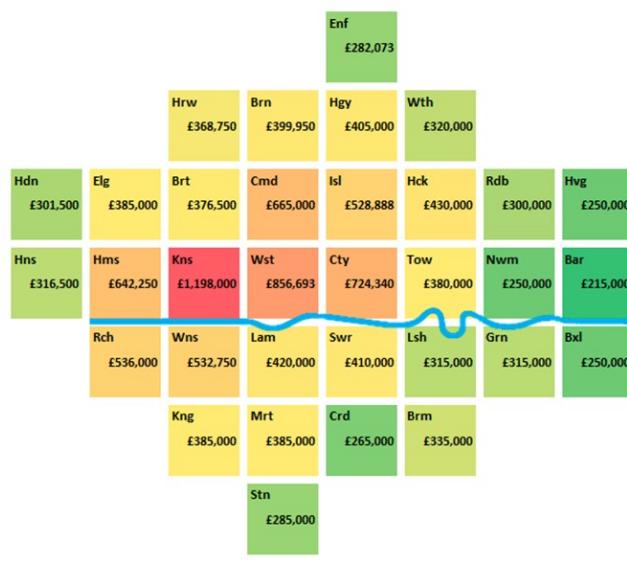


Greenhouse Emissions



Child Mortality

# Idiom: grid cartogram



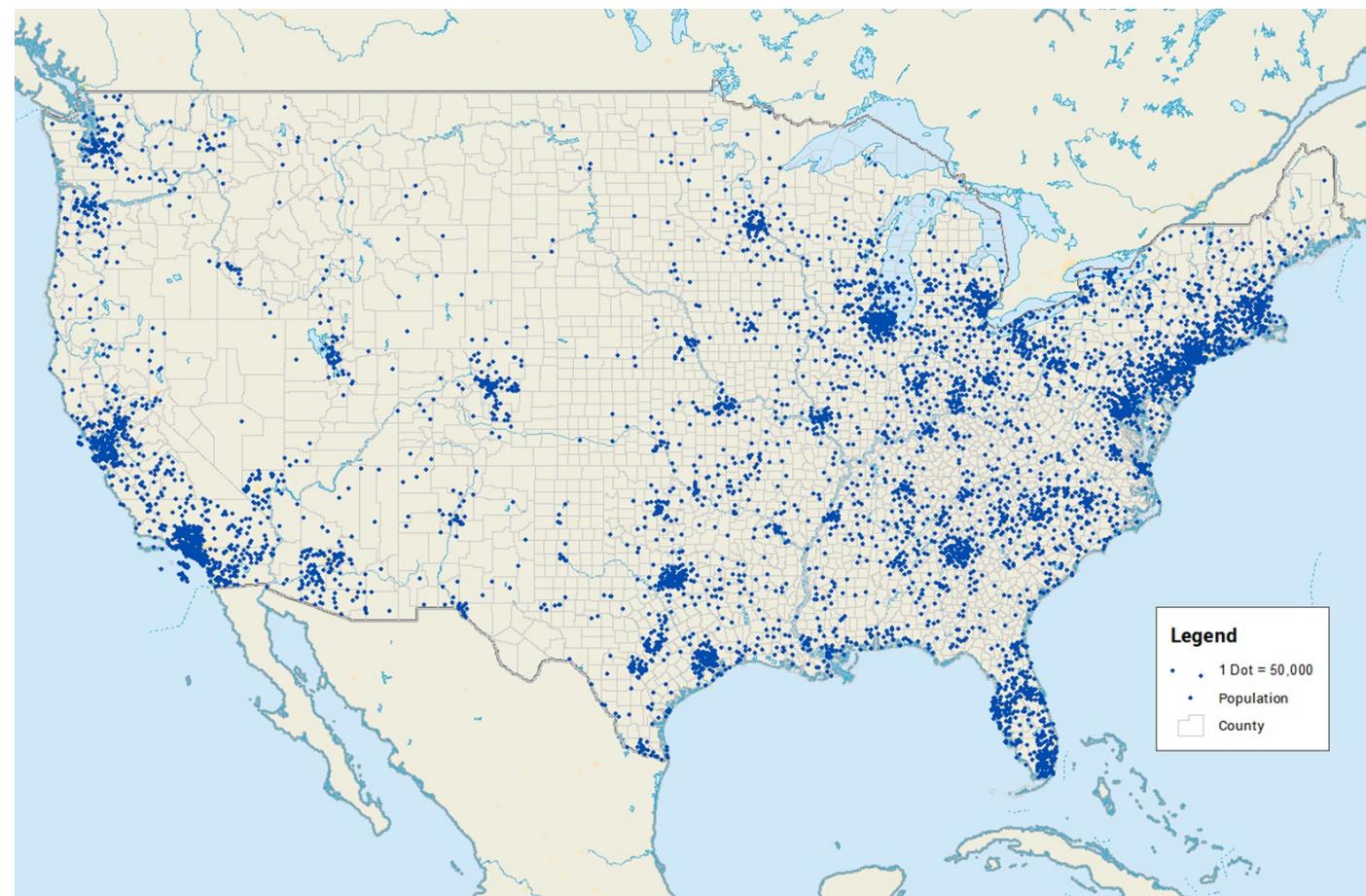
- Uniform-sized shapes arranged in a rectilinear grid
- Maintain approximate spatial position and arrangement

# 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.