Spatial Layout: Arrange Spatial Data (Map)

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?

When do we need geographic visualization?

◉ (1) The data contains geographical attributes
- City, location, altitude, longitude

◉ (2) Visualizing spatial relationships is an important task
- A dataset may contain geographical information and yet creating a geographical visualization may not be relevant.
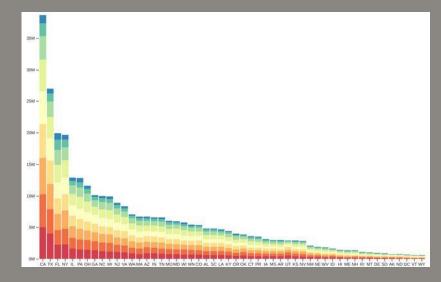
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When do we need geographic visualization?

◉ Key question?
   ○ Does the given spatial position matter for my task?
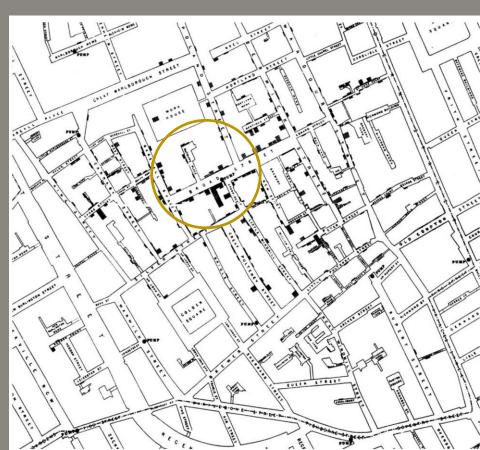   ■ A geo map is not always the best or only solution

When do we need geographic visualization?

◉ There is an advantage of maps over other representations
- Familiarity
- People know where something on a map is
- Map act as an index from spatial to semantic information and vice versa
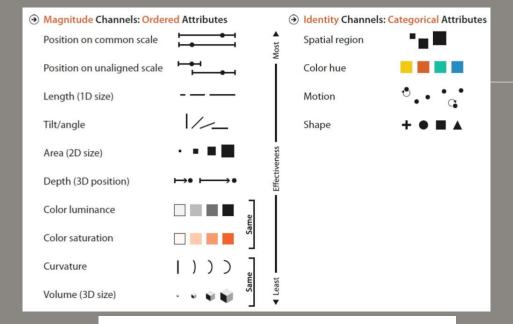- Visually encode given spatial geometry as marks using 2D position channel
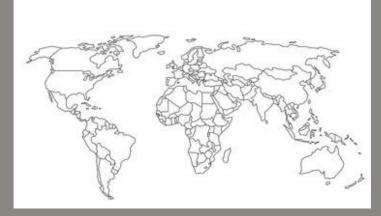
John Snow's Cholera Map

- London, 1854
  - Cholera outbreak was a mystery
- Snow mapped deaths as bars on a geo map
- Cases clustered around a water pump
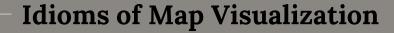- One part of a detailed statistical analysis

Geographic Map

◎ Interlocking marks
  ○ Shape
  ○ Area (size)
  ○ Position

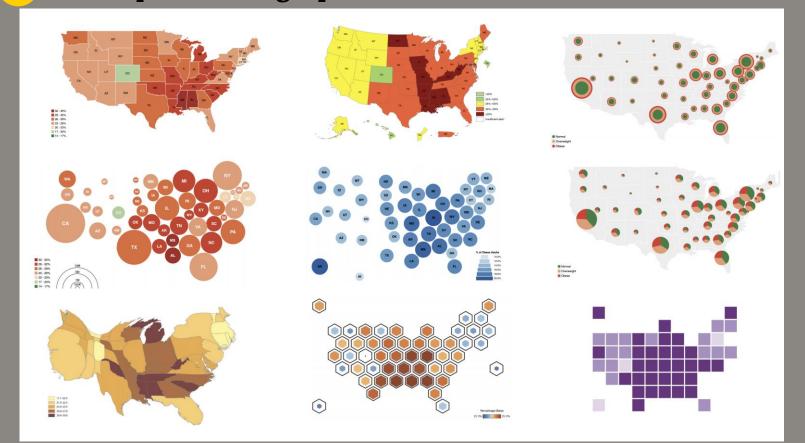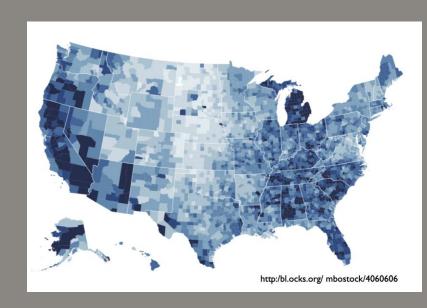◎ Cannot use to encode other attributes

Idioms of Map Visualization

◉ Show spatial variability of attribute
  ○ Combine map with tabular data
  ○ Data: attributes that associate with regions (province, countries, 2D lat/lon)

◉ Major idioms
  ○ Choropleth map
  ○ Symbol map
  ○ Cartograms map
  ○ Dot density map

Examples of Geographic Vis

Choropleth Map

◉ Proposed by Charles Dupin in 1826

◉ Use when the central task is understanding spatial relationships

◉ Data
  ○ Geographic geometry
  ○ 1 quantitative attribute per "region"

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

◉ Encoding
  ○ Region: boundary (shape/size/position)
  ○ Color: sequential color map

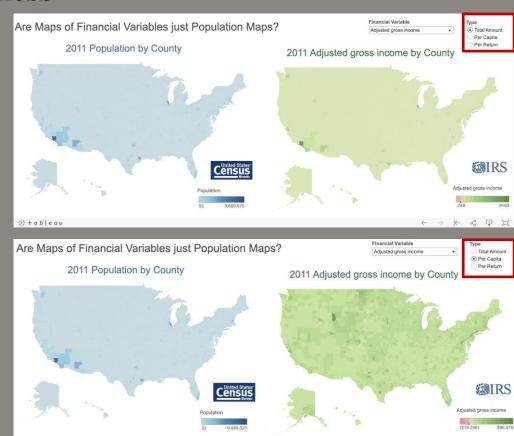D3: https://www.d3-graph-gallery.com/graph/choropleth_basic.html

Choropleth Map: Pros and Cons

◉ Procs:
  ○ Easy to understand (no learning curve)
  ○ Much of the geo data is reported by enumeration unit

◉ Cons:
  ○ The most effective visual channel (location) used for geographic location (shape, area and position)
    ■ Not easy to show multiple attributes
  ○ Large area is easier to attract people's attention
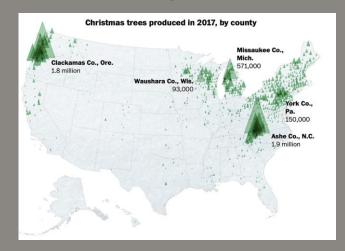 ○ Choropleths are often not suitable for showing total values.

Population Map Trickiness

- If you directly map absolute value of an attribute to color, the result is often the same as the population map
  - https://public.tableau.com/profile/ben.jones#!/vizhome/PopVsFin/PopVsFin

- Example: google (website) visitor, milk consumption, New York times subscriber
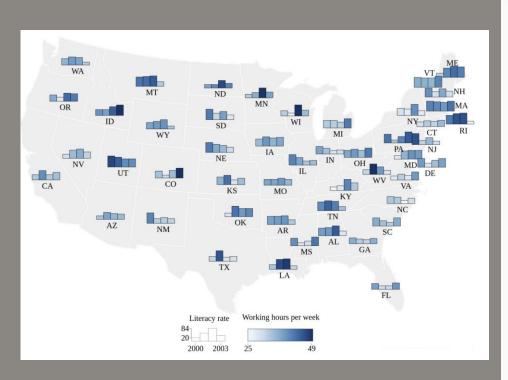
Symbol Map

- A symbol (ex: circle) is used to represent data
- Keep original spatial map in the background
- Use "size channel" to represent the attribute
- Encode multiple attributes of a region
- Often a good alternative to choropleth map

Christmas trees produced in 2017, by county

Clackamas Co., Ore.
1.8 million

Missaukee Co., Mich.
571,000

Waushara Co., Wis.
93,000

York Co., Pa.
150,000

Ashe Co., N.C.
1.9 million

Sustainable Development Goal: Poverty

Poverty (total)
1,000,000
100,000
1,000

Proportion of employed population below the international poverty line of US$1.90 per day
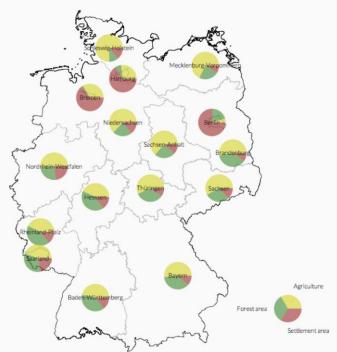Source: UNTSAT https://unstats.un.org/sdgs/ 2016

Symbol Map with Glyphs

Shares of agricultural, forest and settlement area

Source: Statistisches Bundesamt Fachserie 3 Reihe 5.1

Symbol Map: Pros and Cons

- ◉ Procs:
  - ○ 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
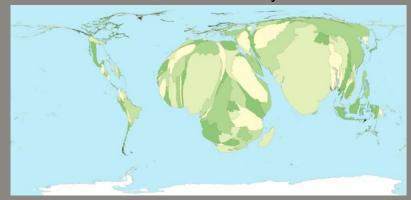 - ○ If a complex glyph is used, it may require explanation/training

(Contiguous) Cartograms

◉ Cartograms distort the shape of geographic region so that the area directly encodes a data variable
- D3: https://www.d3-graph-gallery.com/cartogram

◉ Goal of the algorithm
- Target size (your data value)
- Shape as close to the original as possible
- Maintaining the constraints of relative position and contiguous boundaries with their neighbors

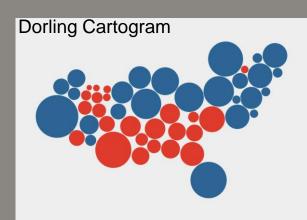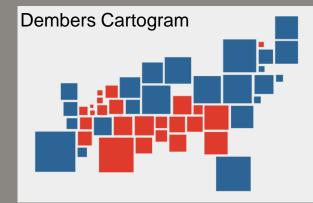Greenhouse Emission

Child Mortality

Dorling/Dembers of Cartogram

- Sized circles/rects represent quantity of interest per geographic region
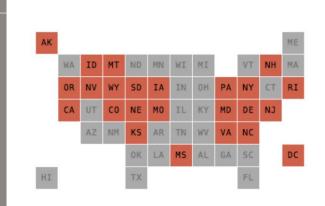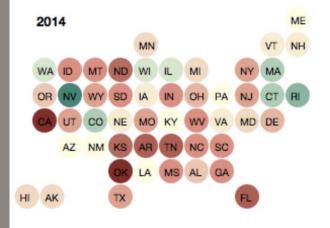
- Geometric shapes in place of geographic area

Dorling Cartogram

Dembers Cartogram

(Grid) Cartogram

◉ Grid cartogram
- ○ Uniform-sized shapes arranged in grid
- ○ Maintain approximate spatial position and arrangement
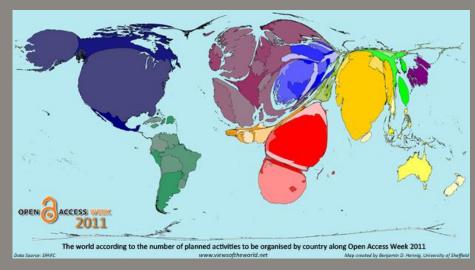
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Problem of Cartogram

◉ **Most of visualization based on map**
   ○ **"Lock shape, area and position channels"**

◉ Cartogram unlocks some of the above visual channels however, we usually use position and shape to recognize a country/region

The world according to the number of planned activities to be organised by country along Open Access Week 2011
Data Source: SPARC   www.viewsoftheworld.net   Map created by Benjamin D. Hennig, University of Sheffield

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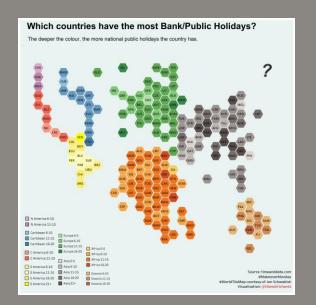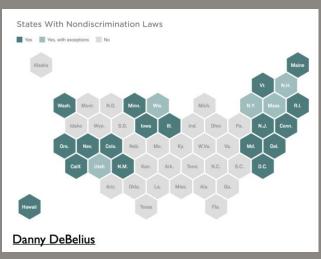

Which countries have the most Bank/Public Holidays?
The deeper the colour, the more national public holidays the country has.

States With Nondiscrimination Laws

Danny DeBelius

Grid Cartogram:

Resolution matters:
It is important to find a "proper" resolution and users still can recognize regions

Summary of Cartograms

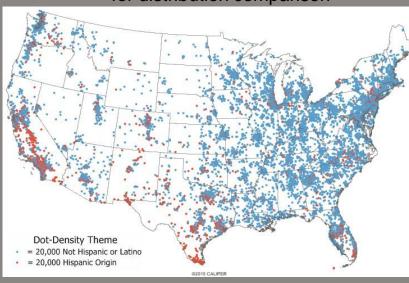|	Continuous cartogram	Dorling cartogram	Grid cartogram	Geographic al map
Easy to recognize by **position**?	●●	●	●	●●●
Easy to recognize by **size**?	✕	✕	✕	●●●
Easy to recognize by **shape**?	●	✕	✕	●●●
Easy to compare shape size?	●●	●●●	✕	✕

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

Dot Density Map

◉ Visualize "distribution" over the map

◉ One symbol represents
   ○ one object or a constant number of objects
   ○ Allows use of color channel

◉ Goal: see spatial patterns, clusters

Two distributions on this map
for distribution comparison

Dot-Density Theme
· = 20,000 Not Hispanic or Latino
· = 20,000 Hispanic Origin
©2015 CALIPER

Dot Density Map: Pros and Cons

◎ Pros
- Straightforward to understand
- Avoid choropleth non-uniform region size problem

◎ Cons
- Challenge: population map trickiness (same as choropleth map)
- Difficult to extract quantities
- Performance disadvantage: rendering a lot of points could be slow

Map Projection Problem

- Map global to 2D plane
  - No perfect projection
- Mercator Projection is popular, but it's not accurate
  - Direction is accurate. Area is not.
- We will discuss projection again in D3 tutorial

MERCATOR PROJECTION VS THE TRUE SIZE OF COUNTRIES

@neilrkaye