

# Map Types

# Geospatial Data Visualization

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# Agenda

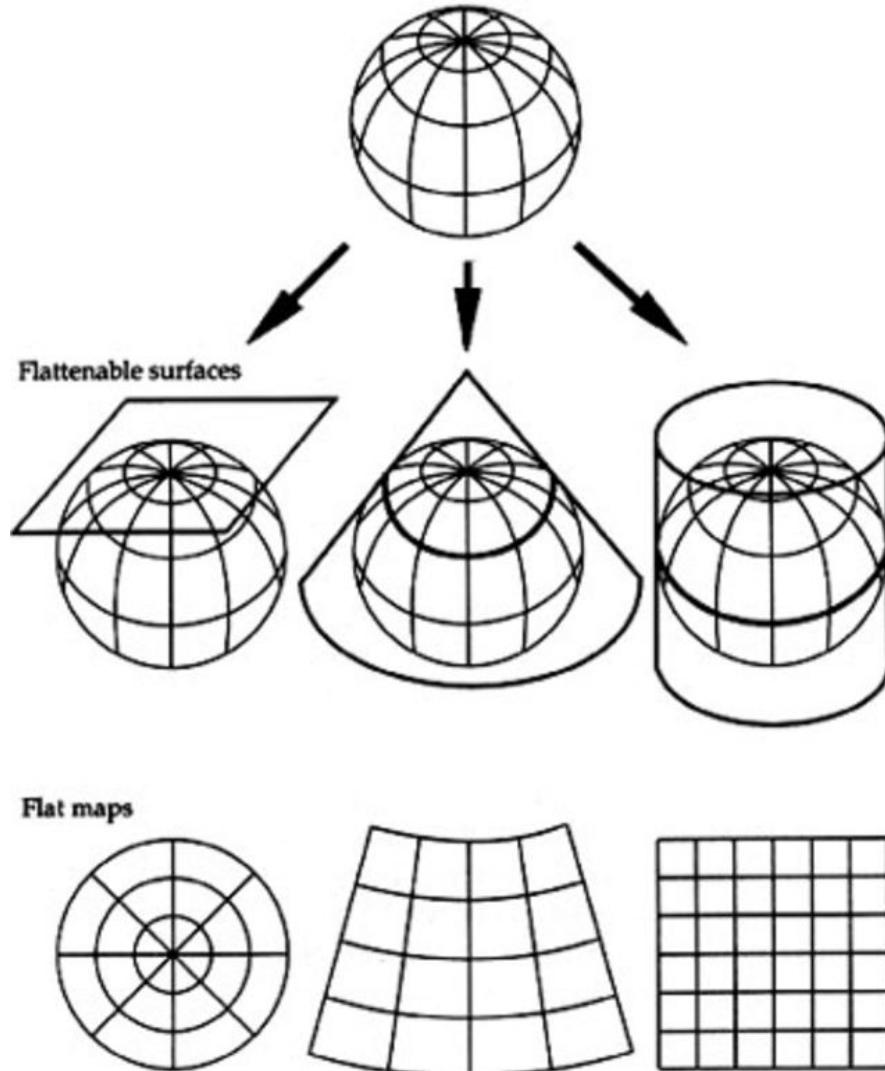
- Map Projections
- Geospatial Data Formats

# Map Design

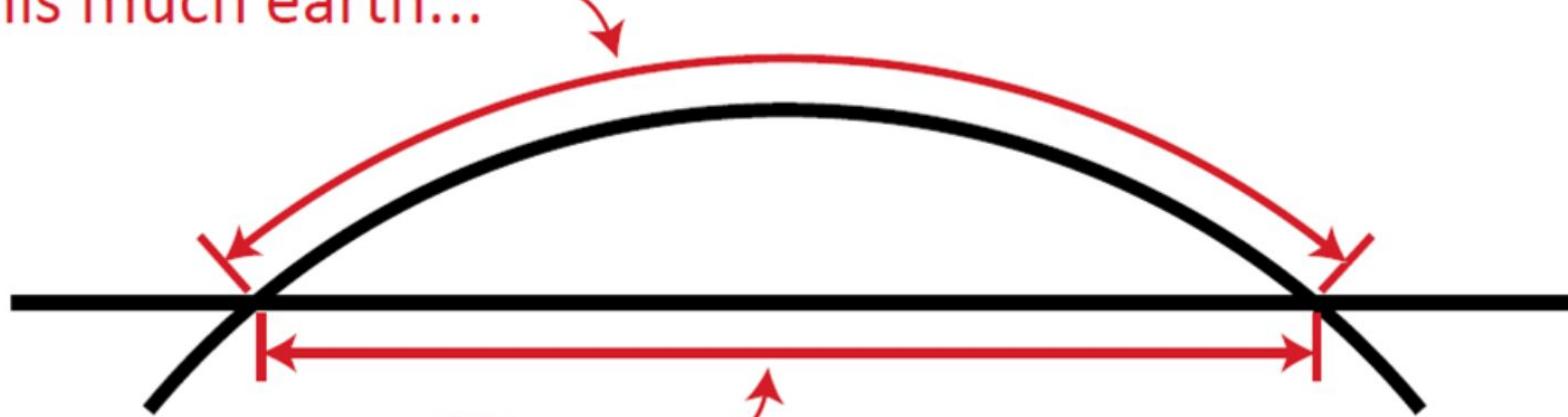
- Projection
- Scale
- **Symbolization**

# Map Projections

- World is 3D, maps are 2D
  - Earth is a ellipsoid(ish), not a perfect sphere
- Must project 3D coordinates onto 2D surface
  - Three basic “Flattenable surfaces”: plane, cylinder and cone
- All map projections result in distortion of angles, areas, shapes, distance and directions



This much earth...



...has to fit onto this much map surface.

# Projection Distortions

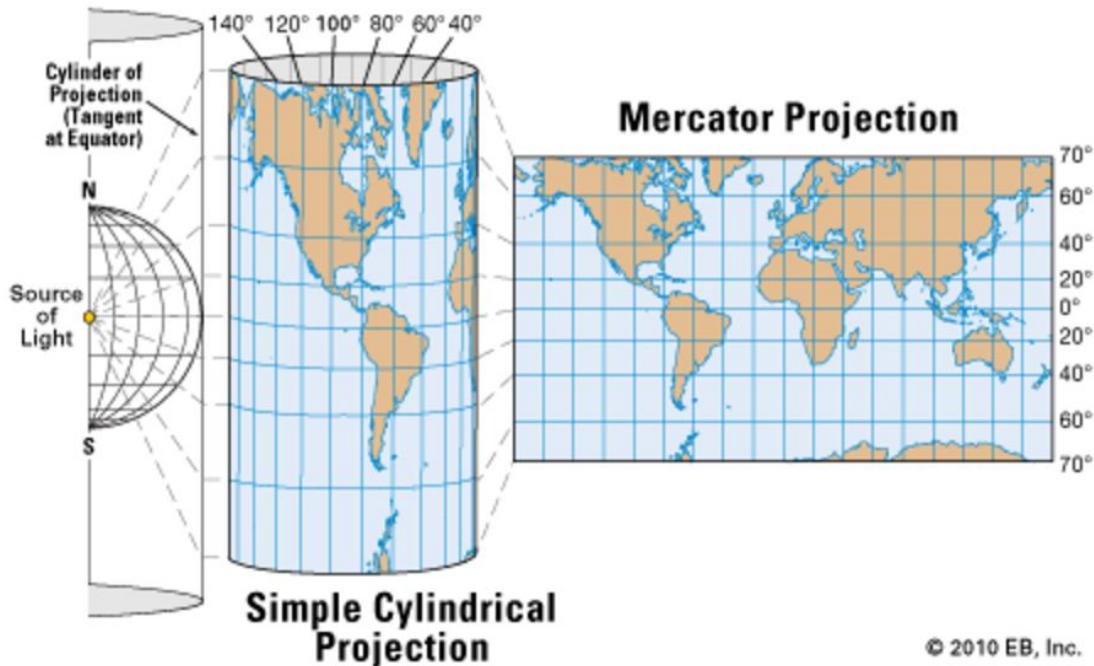
- **Distance** between two points
- **Direction** between two points
- **Shape** of regions
- **Area** of regions

# Types of Projections

- Azimuthal
  - Preserves the azimuth (direction) from center
- Conformal
  - Local angles are correct, preserving small shapes
- Equal-Area
  - All regions have correct area
- Equidistant
  - Distances from center (or along certain lines, like along meridians) are correct

# Mercator Projection

- Areas and shapes vary with latitude
- Greenland and Antarctica appear much larger than they actually are
- Preserves angles and the shapes of small objects (conformal)

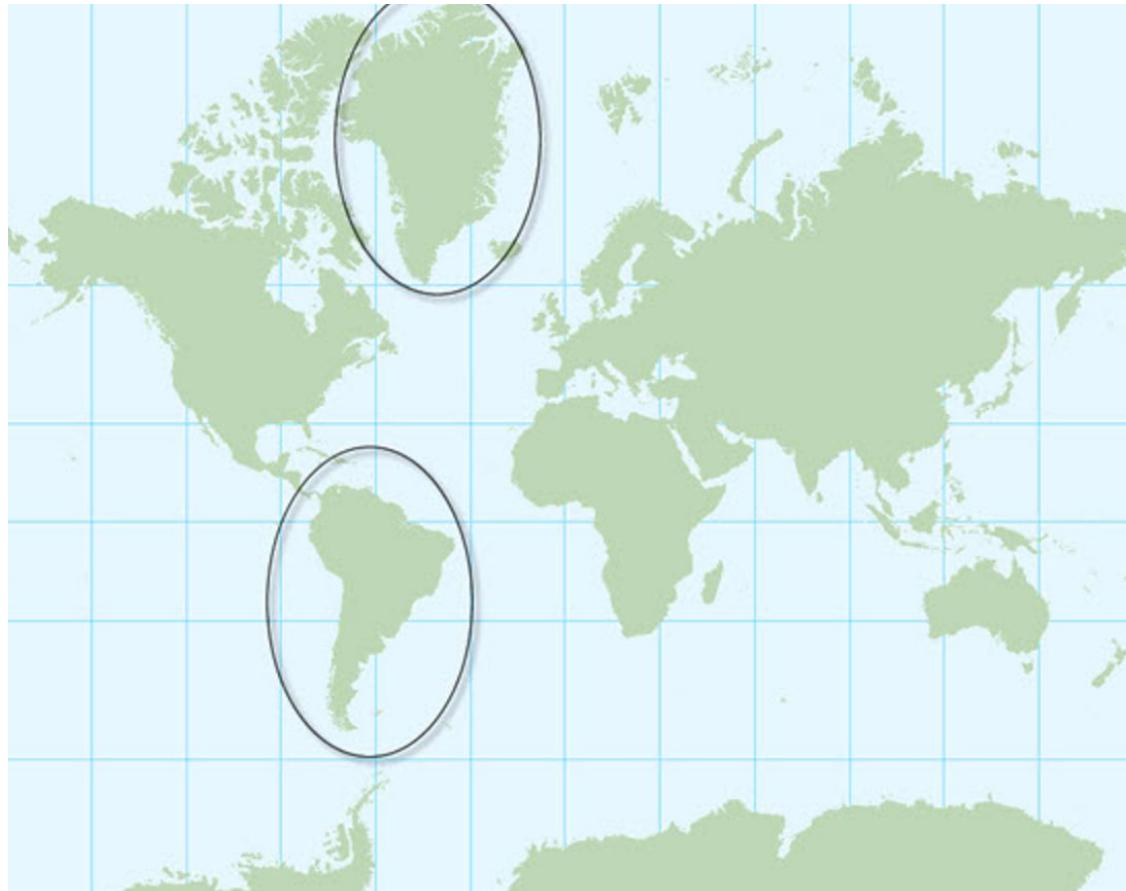


© 2010 EB, Inc.

# Mercator Projection

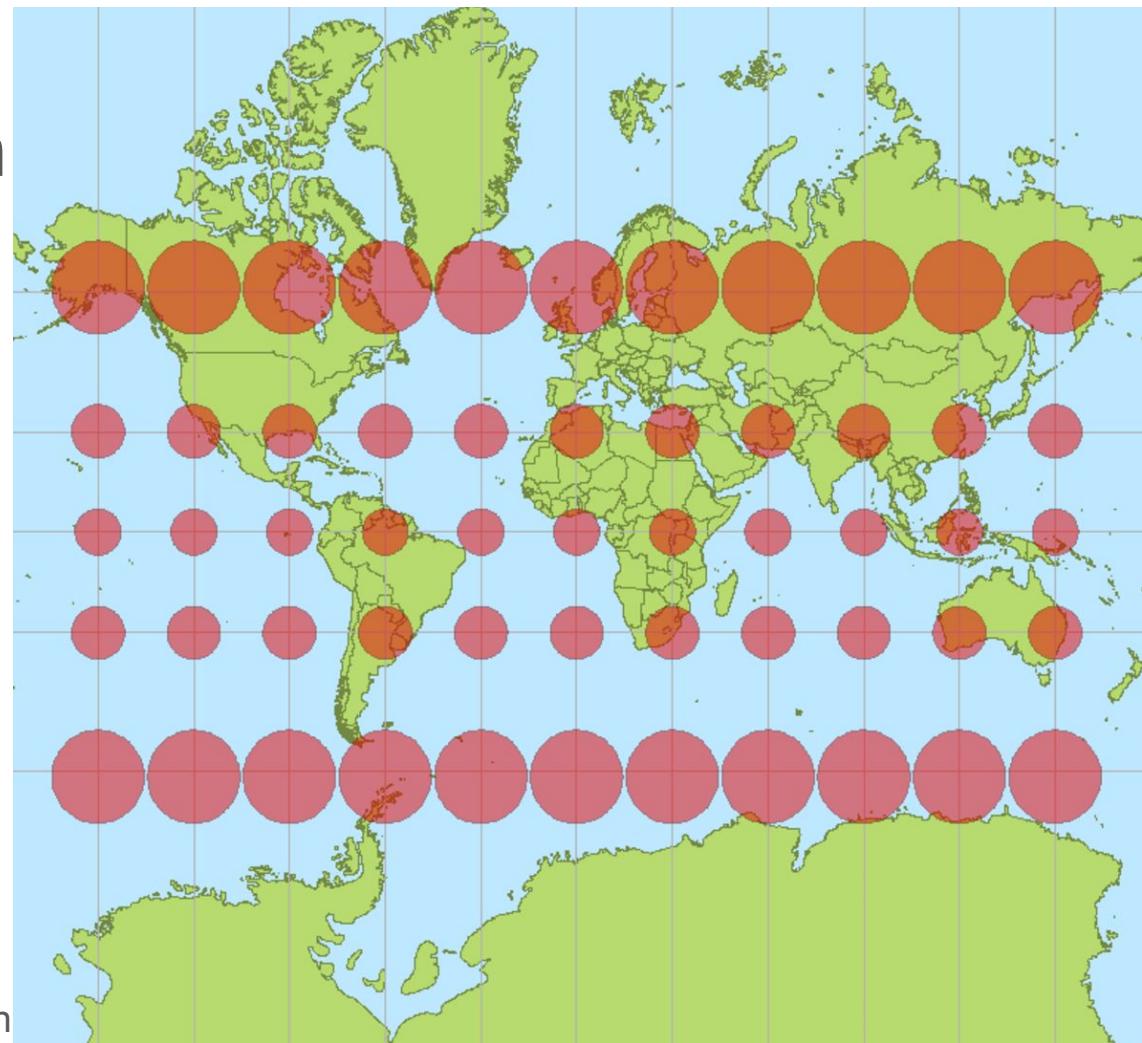
Greenland appears larger than South America in size when in reality it represents only a fraction of South America's landmass.

Greenland: 836,300 square miles, South America's 6.9 million square miles



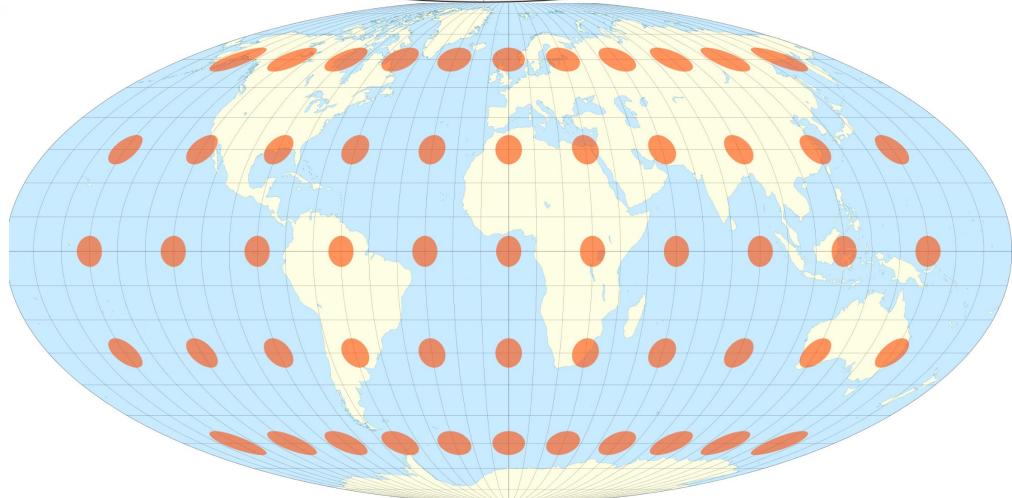
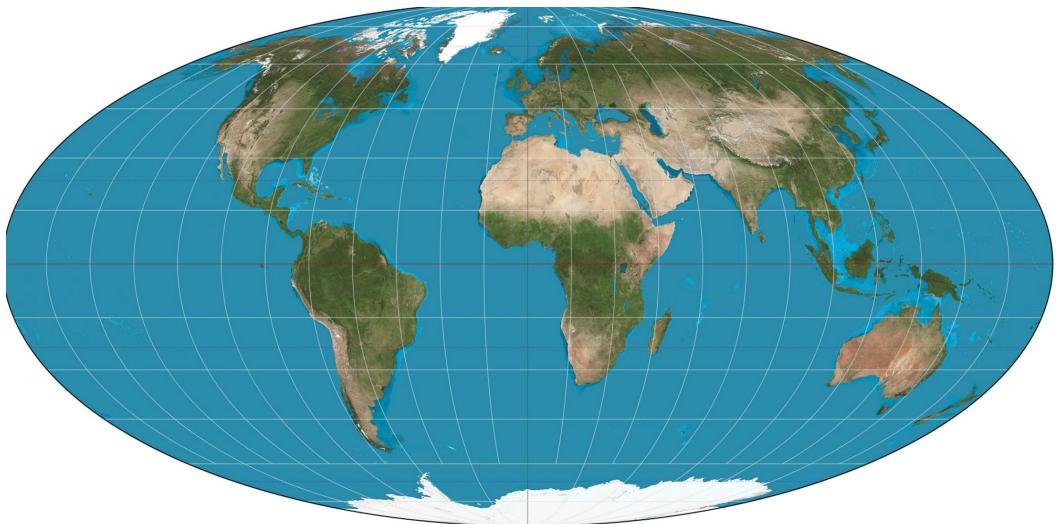
# Mercator Projection

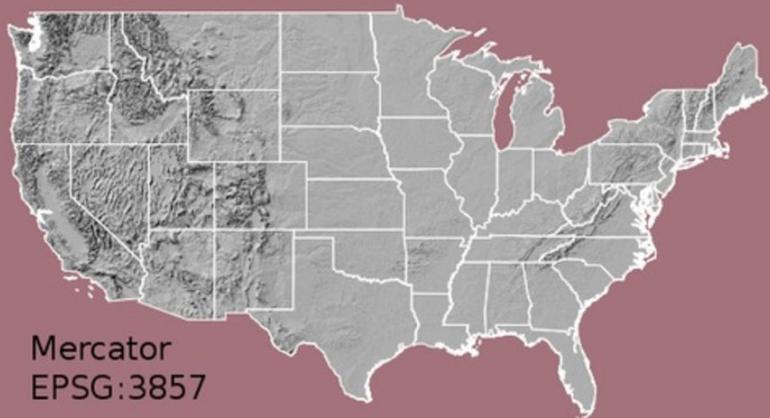
Tissot's indicatrix  
shows how distortion  
varies across the  
map



# Mollweide projection

- Preserves areas, distorts shapes
- Equal-area
- Equator is represented as a straight horizontal line perpendicular
- The other parallels compress near the poles





Mercator  
EPSG:3857

UTM Zone 11N  
EPSG:2955



U.S. National Atlas  
Equal Area  
EPSG:2163



WGS 84  
EPSG:4326

# Map Scale

Degree of resolution of the map.

The goal of the visualization should suggest the geographical scope of the map

# Visual Encoding

Visual encoding is the process of matching the phenomena to be visualized, which is provided by the dataset.

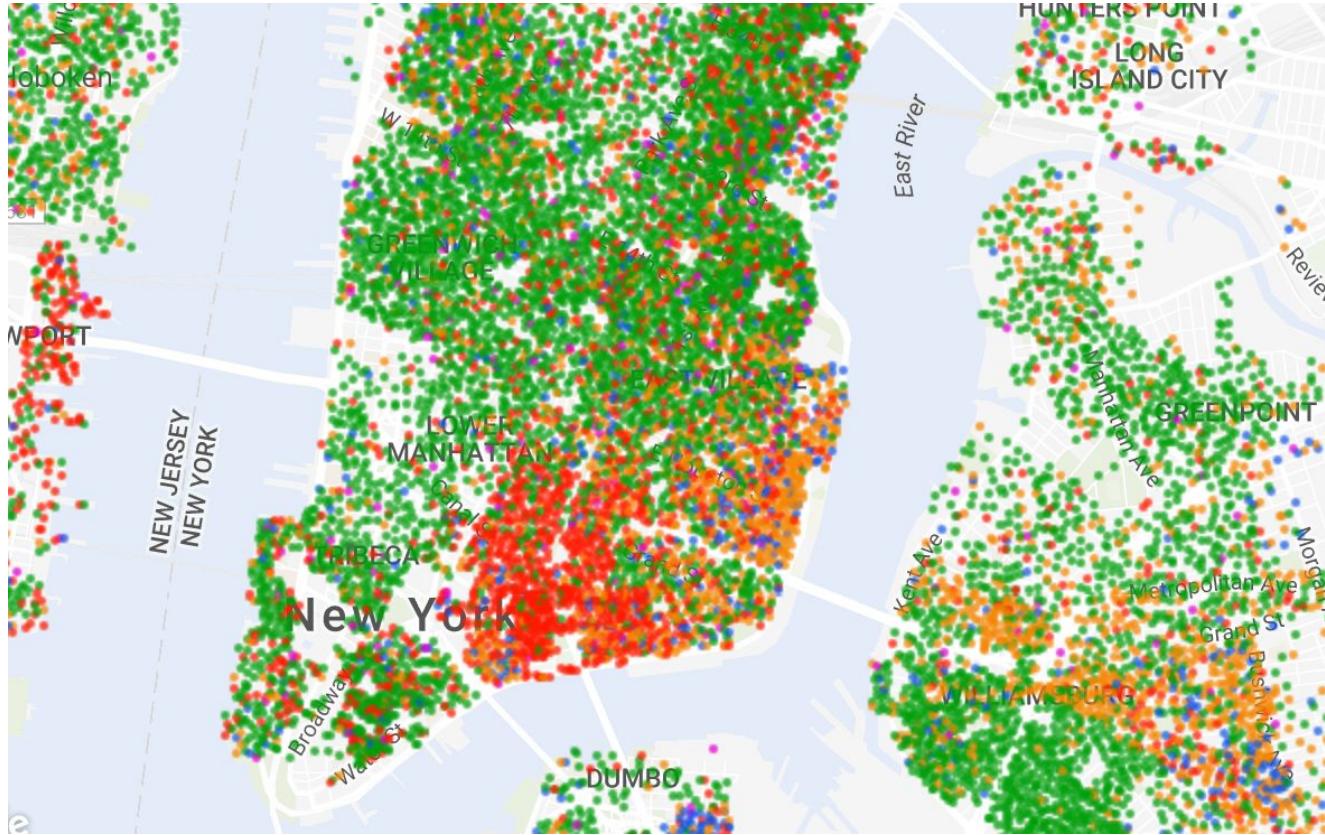
# Thematic maps

A thematic map is a map that emphasizes a particular theme or special topic (data) such as the average distribution of rainfall in an area. They are different from general reference maps because they do not just show natural features like rivers, cities, political subdivisions and highways.

# Main Graphical Methods in Thematic maps

1. Dot distribution maps
2. Graduated symbol maps
3. Choropleth maps
4. Isometric and isopleth maps
5. Flows and Network maps
6. Area and distance cartograms

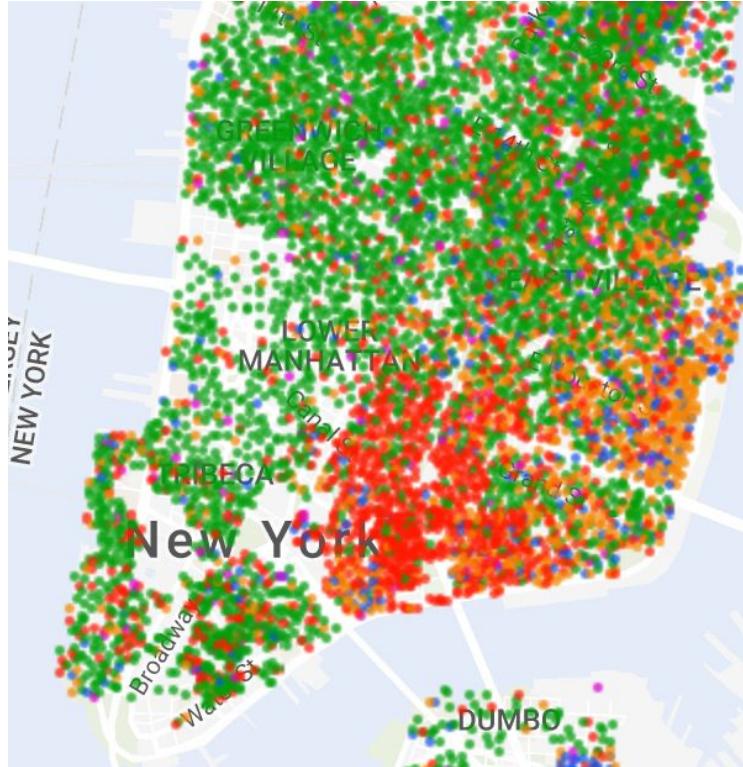
# Dot distribution maps: Mapping Segregation



[https://www.nytimes.com/interactive/2015/07/08/us/census-race-map.html?\\_r=0](https://www.nytimes.com/interactive/2015/07/08/us/census-race-map.html?_r=0)

# Dot distribution maps

- Distribution of racial ethnic groups
- One dot = 25 people
- Dots are evenly distributed across each county
- Dots have same size



[https://www.nytimes.com/interactive/2015/07/08/us/census-race-map.html?\\_r=0](https://www.nytimes.com/interactive/2015/07/08/us/census-race-map.html?_r=0)

# Dot distribution maps

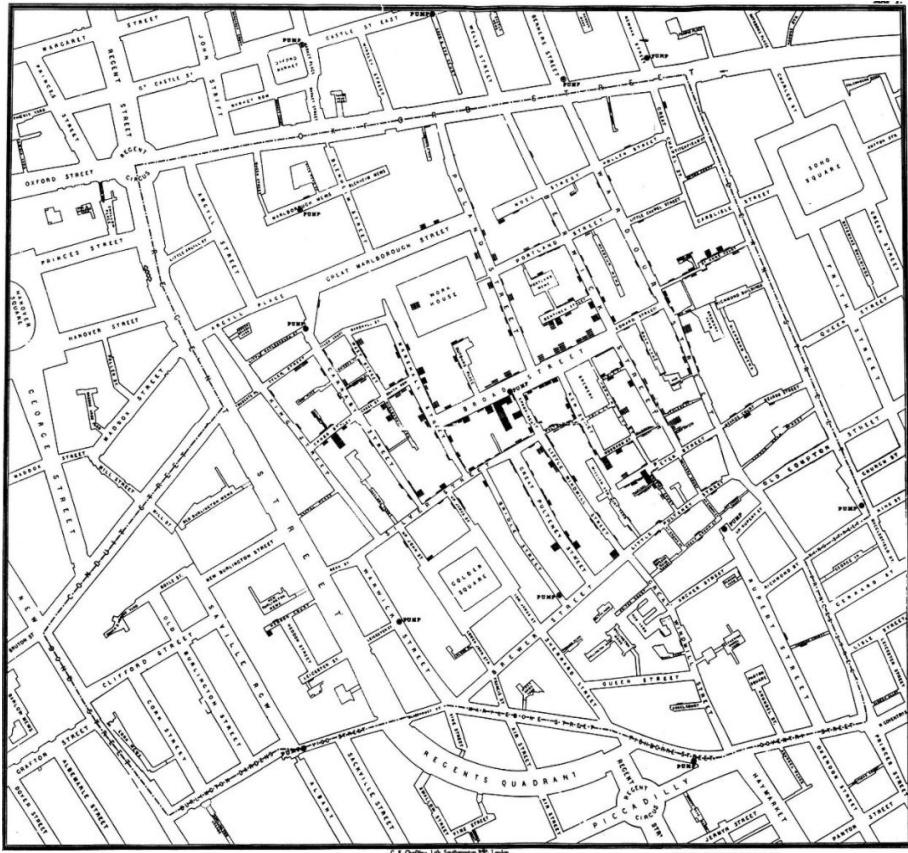
- Distribution of racial ethnic groups
- One dot = 60 people
  - The number of people per dot changes with resolution
- Dots are evenly distributed across each county
- Two variables are represented population density and race



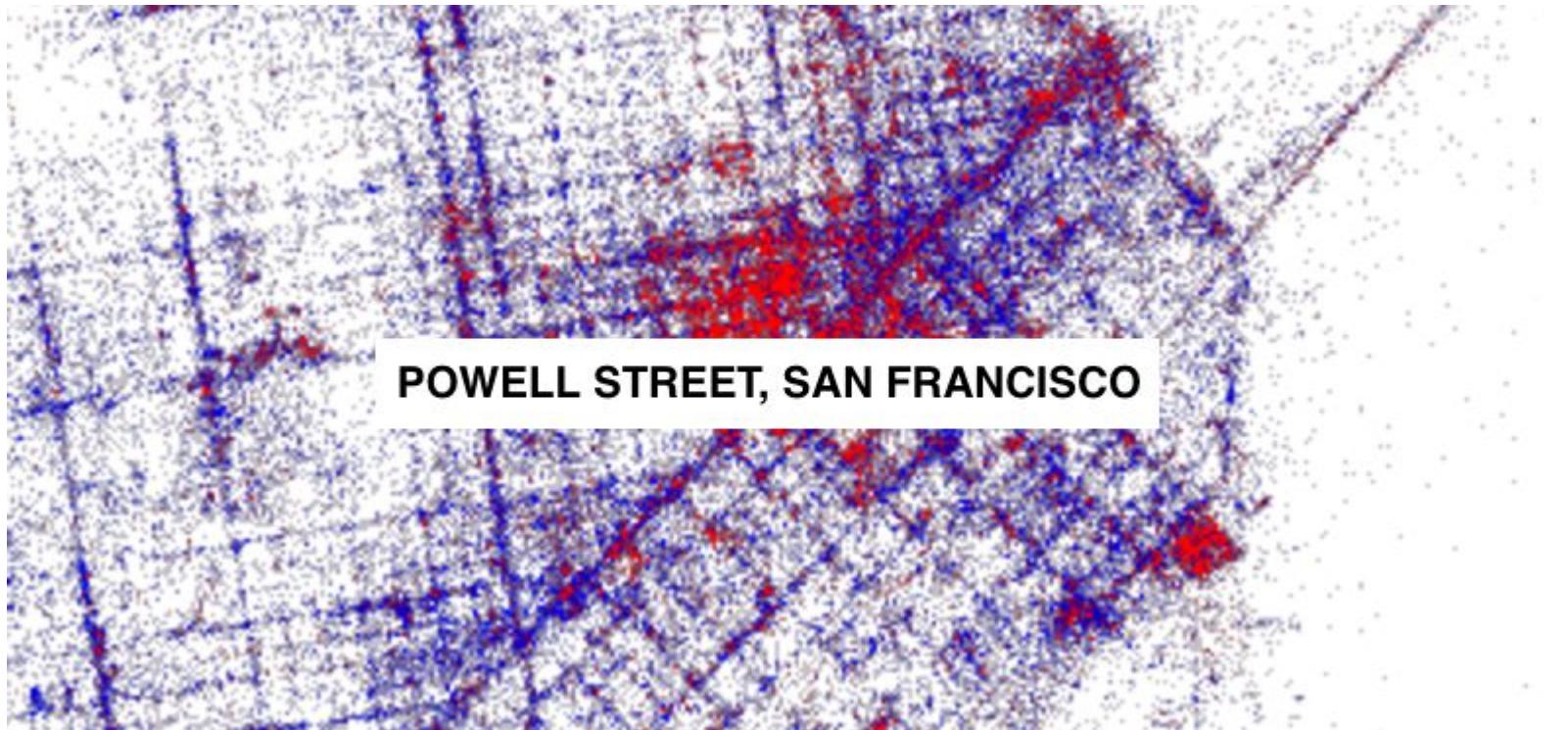
[https://www.nytimes.com/interactive/2015/07/08/us/census-race-map.html?\\_r=0](https://www.nytimes.com/interactive/2015/07/08/us/census-race-map.html?_r=0)

# Dot maps

- Dot map are effective in portraying relative densities
- Bad at displaying absolute quantities



# Dot Map: Locals and Tourists



<https://www.mapbox.com/labs/twitter-gnip/locals/#5/38.000/-95.000>

# Graduated symbol maps

**365**  Obama  
Electoral Votes  
Projected Winner

Popular vote: 66,862,039

**0**  
undecided

**173** McCain  
Electoral Votes

Popular vote: 58,319,442

270 needed to win

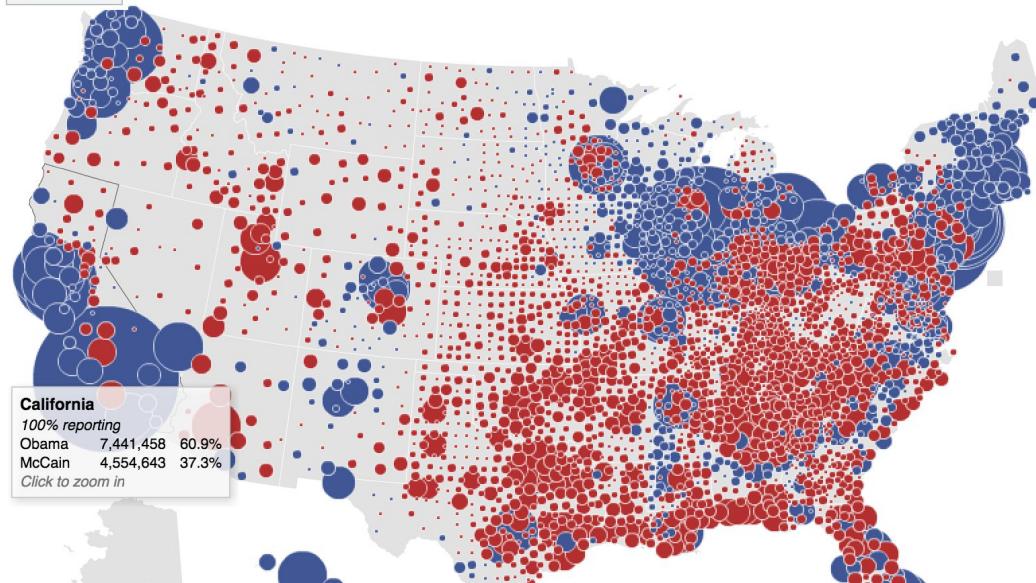
- State winners
- County bubbles
- County leaders
- Voting shifts

ZOOM IN

Year  
 '08 '04 '00 '96 '92

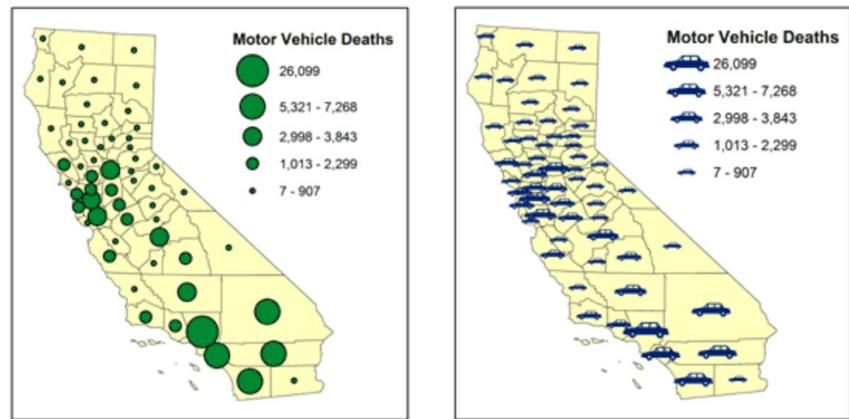
Map key  
Circle size is proportional to the amount each county's leading candidate is ahead.  
  
Larger      Smaller

**California**  
100% reporting  
Obama 7,441,458 60.9%  
McCain 4,554,643 37.3%  
Click to zoom in

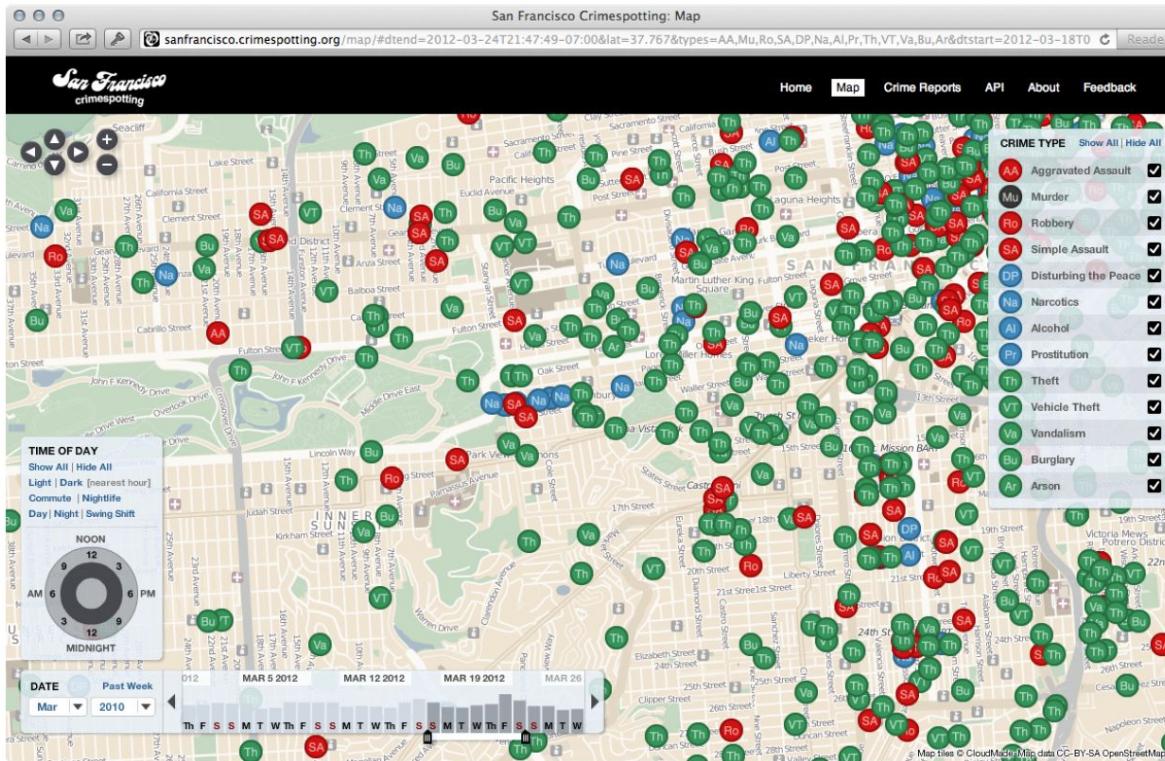


# Graduated symbol maps

Use the visual variable of size to represent differences in the magnitude of a discrete phenomenon, e.g. counts of people

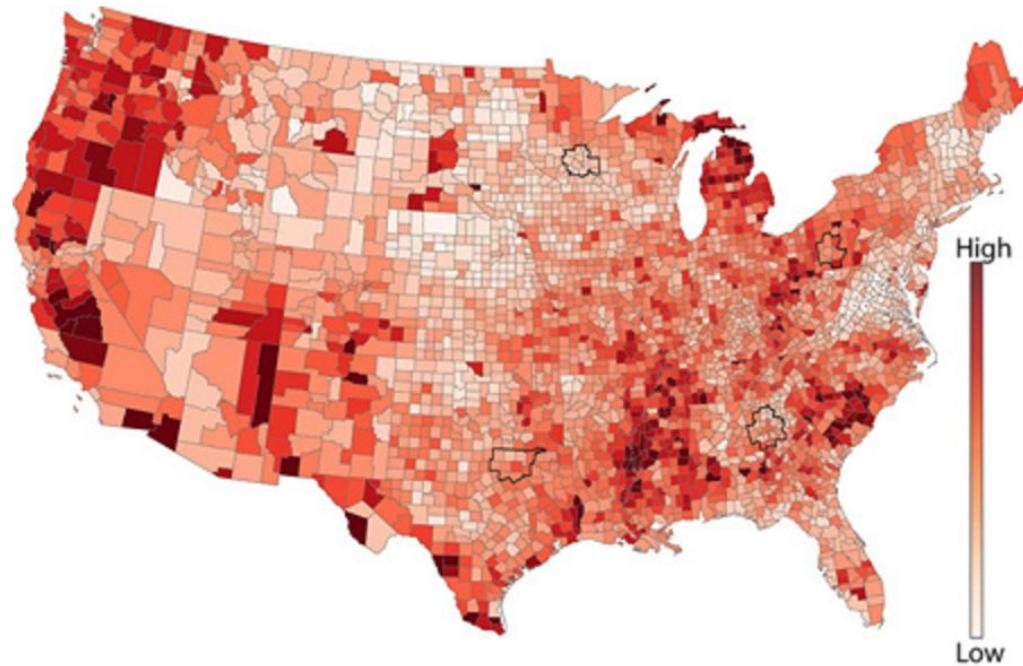


# Symbol Maps



<http://sanfrancisco.crimespotting.org>

# Choropleth Maps

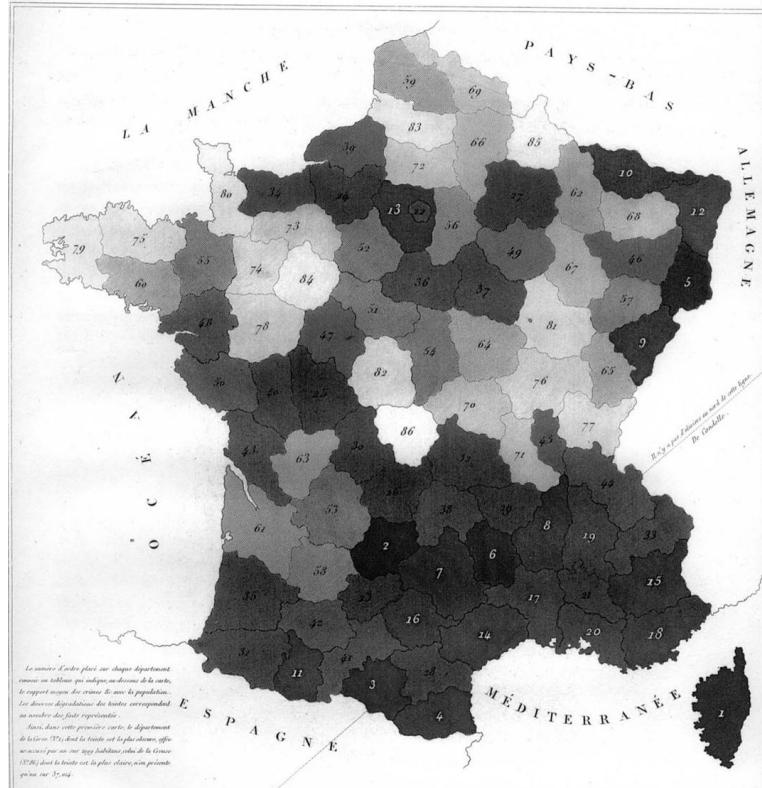


# Choropleth Maps: when to use

1. Data aggregated by administrative units
  - a. e.g., counties, provinces, countries
2. Standardized to show rates or ratios
  - a. never use choropleth with raw data/counts

Example:

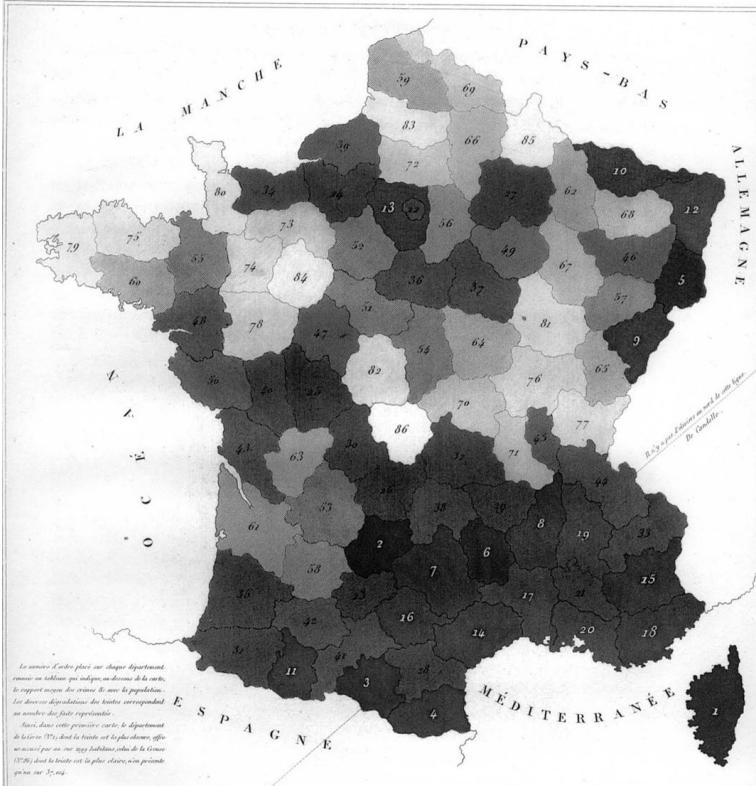
*number of people ×  
number of people per square mile ✓*



# Choropleth Maps

Visual variables used in choropleth to encode quantitative data include:

- Color
  - Value
  - Saturation
  - Texture



- Saturation is the purity of a color
  - High saturation colors look rich and full. Low saturation colors look dull and grayish
- Value is the lightness or darkness of a color
  - Light colors are sometimes called tints, and dark colors shades. Light and dark colors are achieved by mixing with white or black.

**Saturation:**  
(also called chroma)

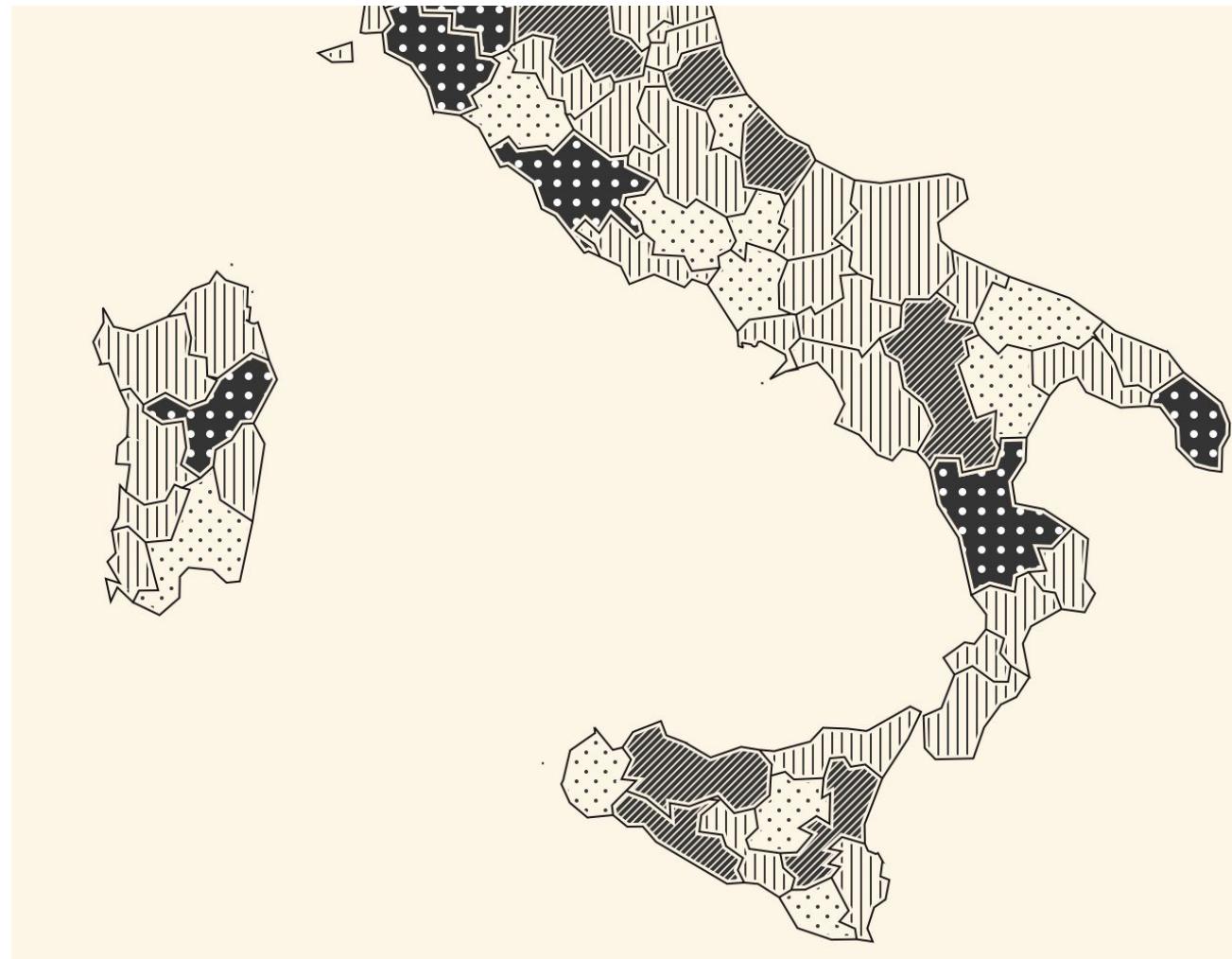


**Value:**  
(also called brightness or luminosity)

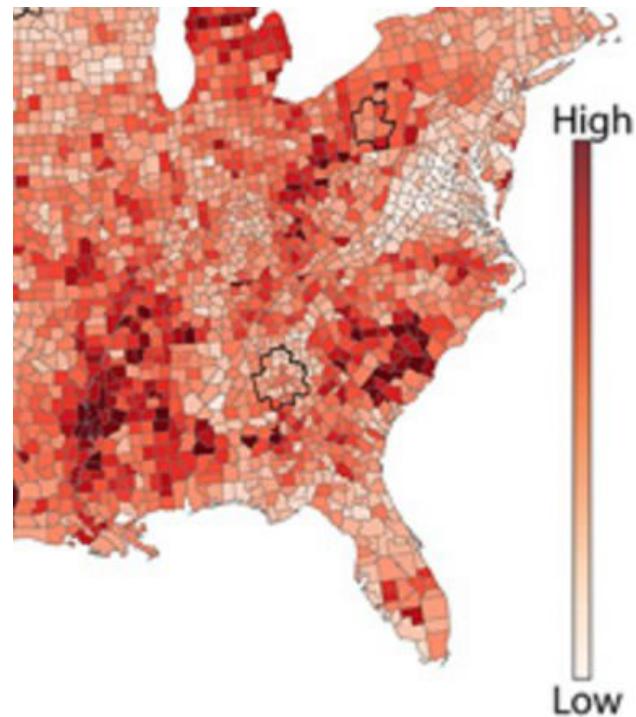
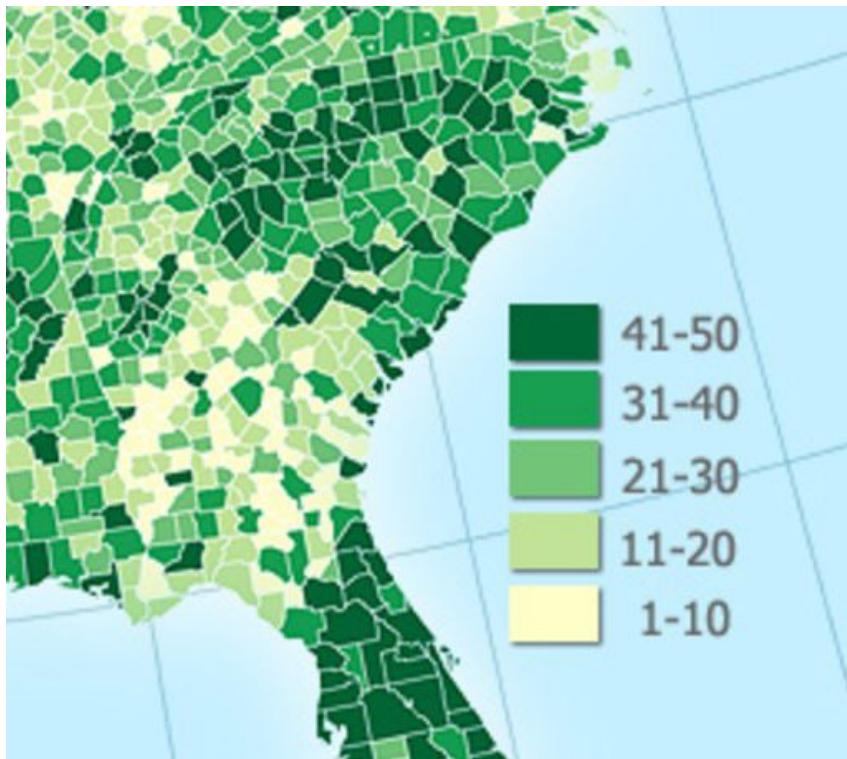


Texture is used  
with categorical  
data

Color hue is  
also used with  
categorical data



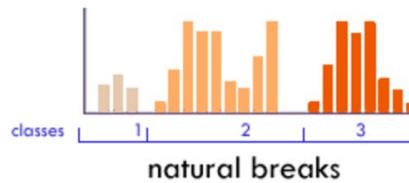
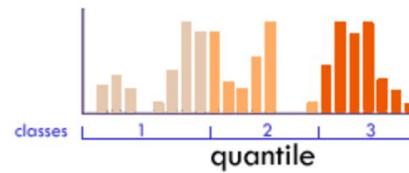
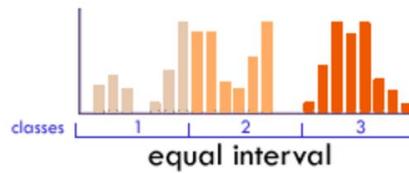
## Two types: classed and unclassed



# Unclassed versus classed Choropleth

- Use unclassed choropleth maps
  - Less filtered view of our data
  - Making the map specifically to highlight overall geographic patterns
- Use classed choropleth maps
  - Get numbers off the map
  - Compare one location to another
  - Use 3–7 data classes

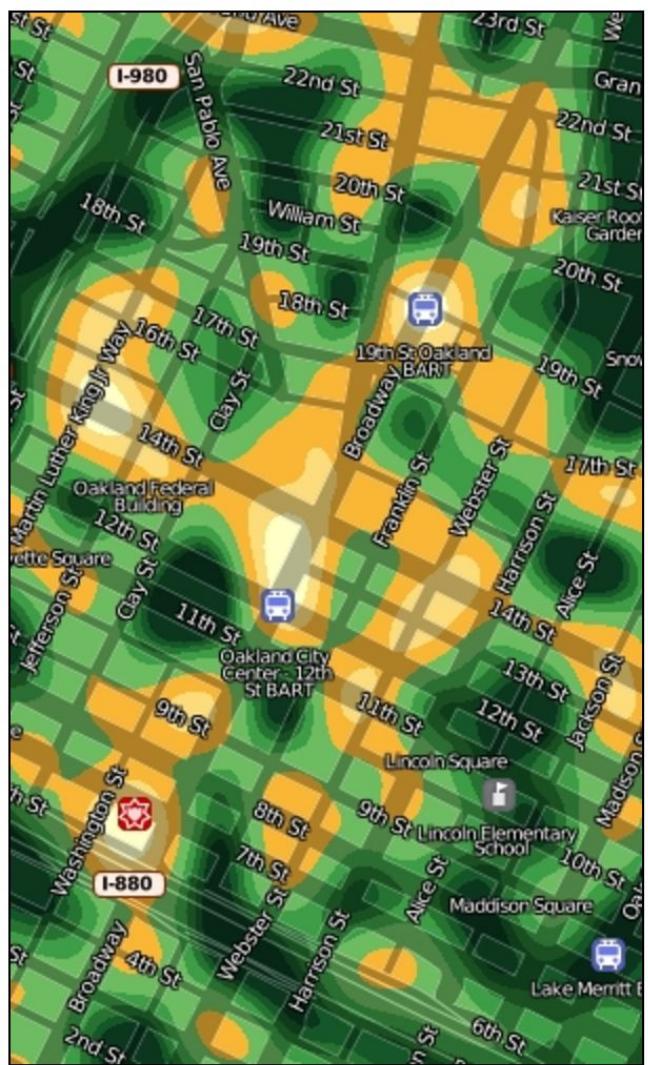
# How to make classes for numerical data



# Isopleth Maps

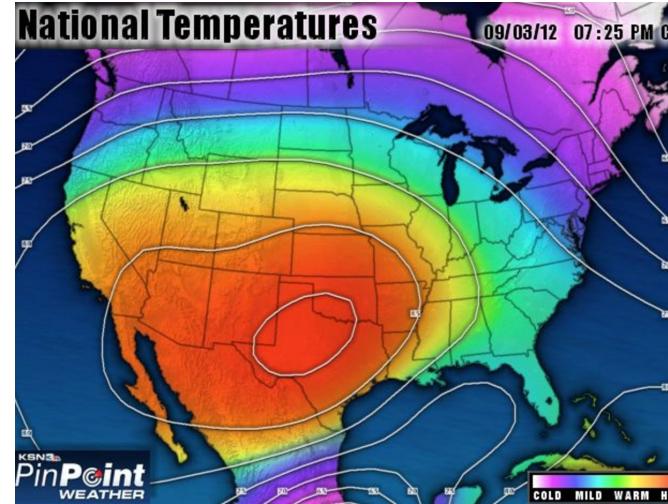
- Show a range of quantity.
- Data as a third dimension on a map
- Good for mapping surface elevations, weather data
- Radar maps, temperature maps and rainfall maps are all isopleth maps

<http://mike.teczno.com/notes/oakland-crime-maps/XI.html>



# Isopleth maps

- Isopleth maps differ from choropleth maps in that the data is not grouped to a predefined region like a state or country.
- Temperature works well as an isopleth map because temperature is continuous but does not change abruptly at any point



# Flow Maps

- Encoding
  - Edge between two locations indicates flow between those locations
  - Width of edge proportional to flow
  - Usually wider end of edge is source of flow
- Limitations
  - Can get difficult to compare flows
  - Best flow maps are done by hand

# Carte Figurative des pertes successives en hommes de l'Armée Française dans la Campagne de Russie 1812-1813.

Dessiné par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite

Paris, le 20 Novembre 1869.

Les nombres d'hommes perdus sont représentés par les largeurs des zones colorées à raison d'un millimètre pour six mille hommes; ils sont de plus écrits en lettres des zones. Le rouge désigne les hommes qui entrent en Russie, le noir ceux qui en sortent. — Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M. M. Chiers, de Léger, de Fezenac, de Chambray et le journal médical de Jacob, pharmacien de l'Armée depuis le 28 Octobre.

Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Iérome et du Maréchal Davout, qui avaient été détachés sur Minsk et Mohilow et se rejoignirent vers Orsza et Witebsk, avaient toujours marché avec l'armée.

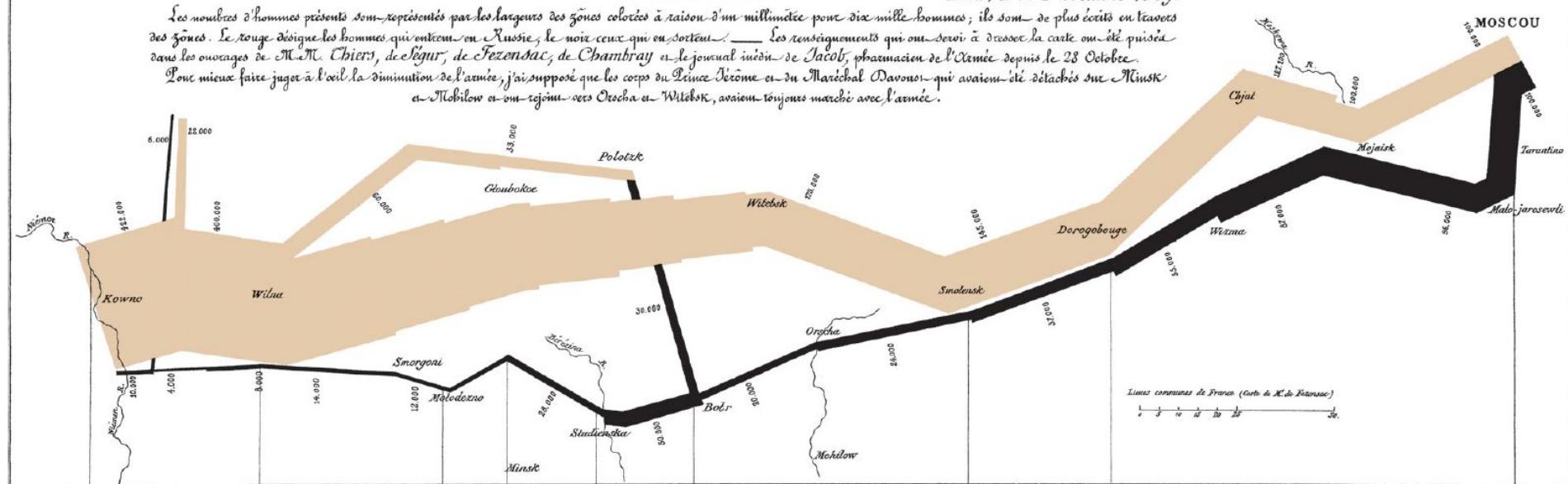


TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Réaumur au dessous de zéro.

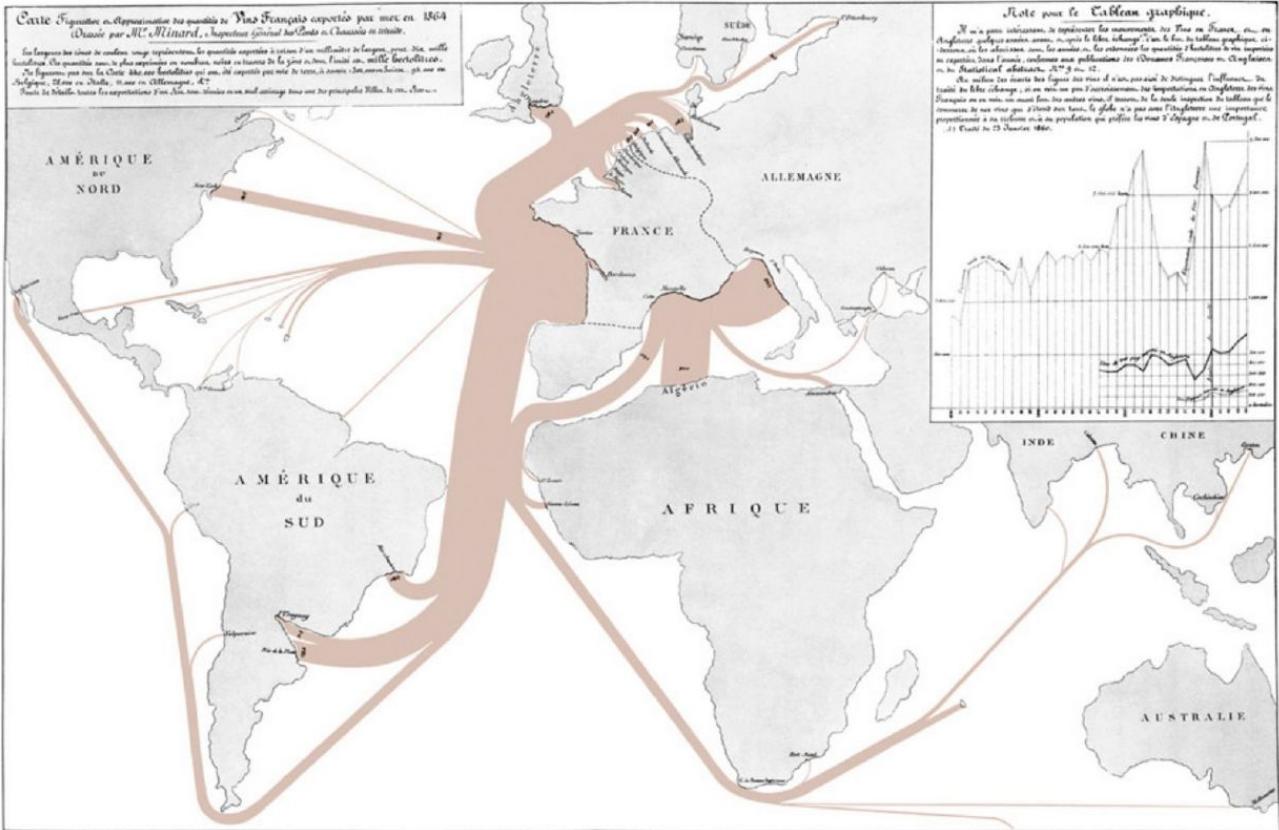
Les Cosaques passent au galop  
le Niemen gelé.

-26° le 7 X<sup>bre</sup>.  
-30° le 6 X<sup>bre</sup>.  
-24° le 1<sup>er</sup> X<sup>bre</sup>.  
-20° le 28 X<sup>bre</sup>.  
-11°.  
-9° le 9 X<sup>bre</sup>.  
-21° le 14 X<sup>bre</sup>.



Imp. Lith. Regnier et Drouard.

1864 exports  
of French  
wine globally



## GLOBAL TRAFFIC MAP 2010



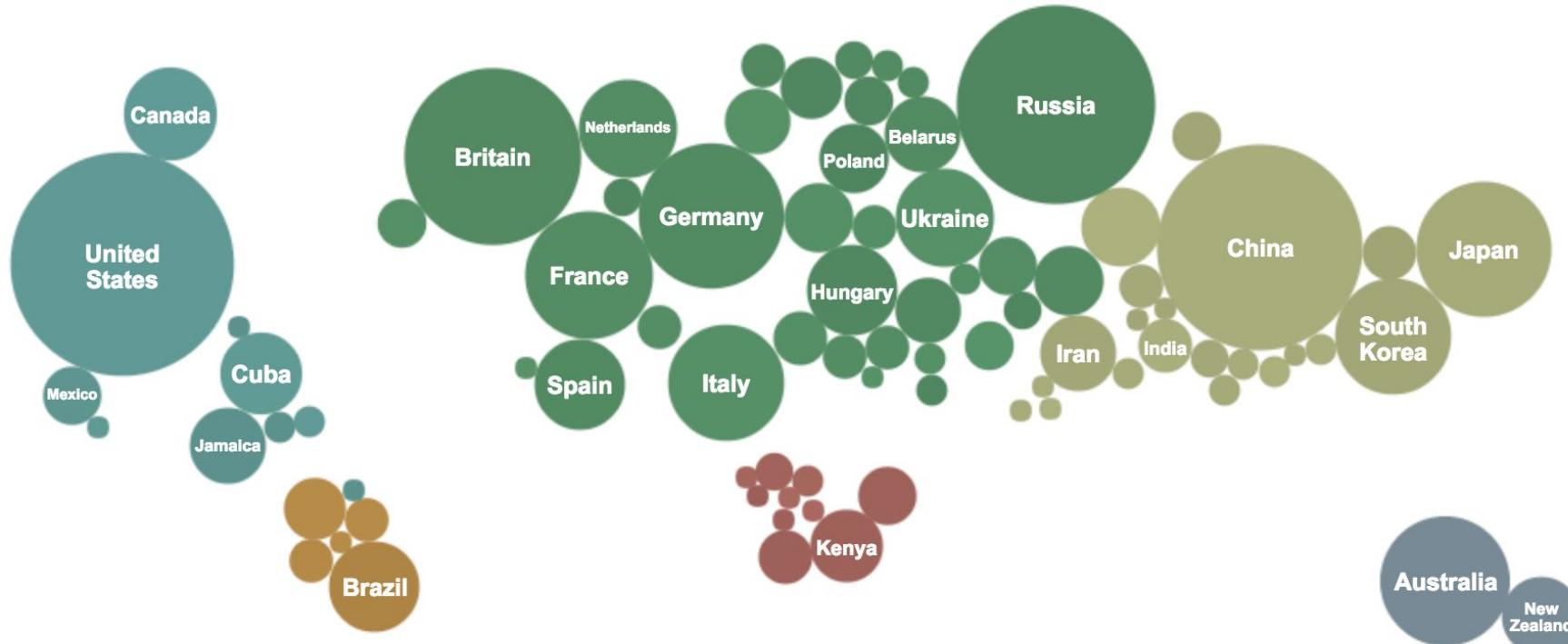
Global voice traffic

<https://www.telegeography.com/telecom-resources/map-gallery/global-voice-traffic-map-2010/>

# Area and Distance Cartograms

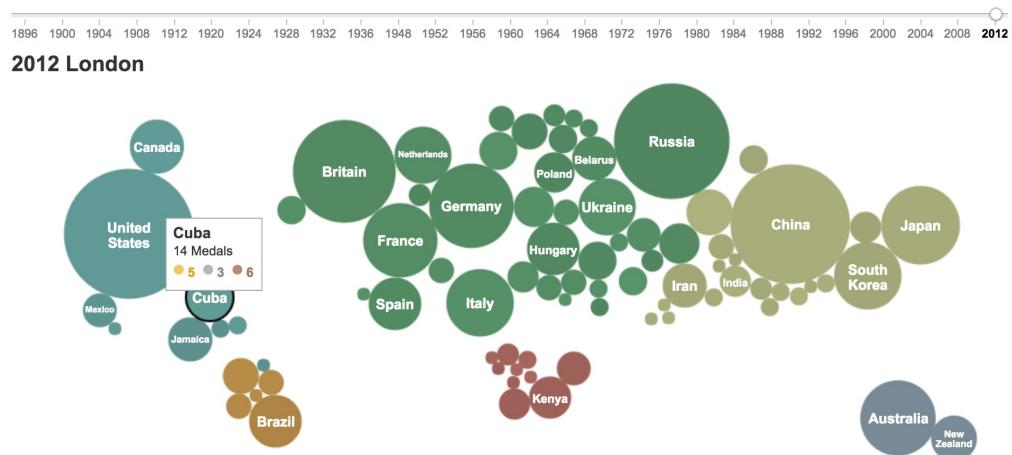


2012 London

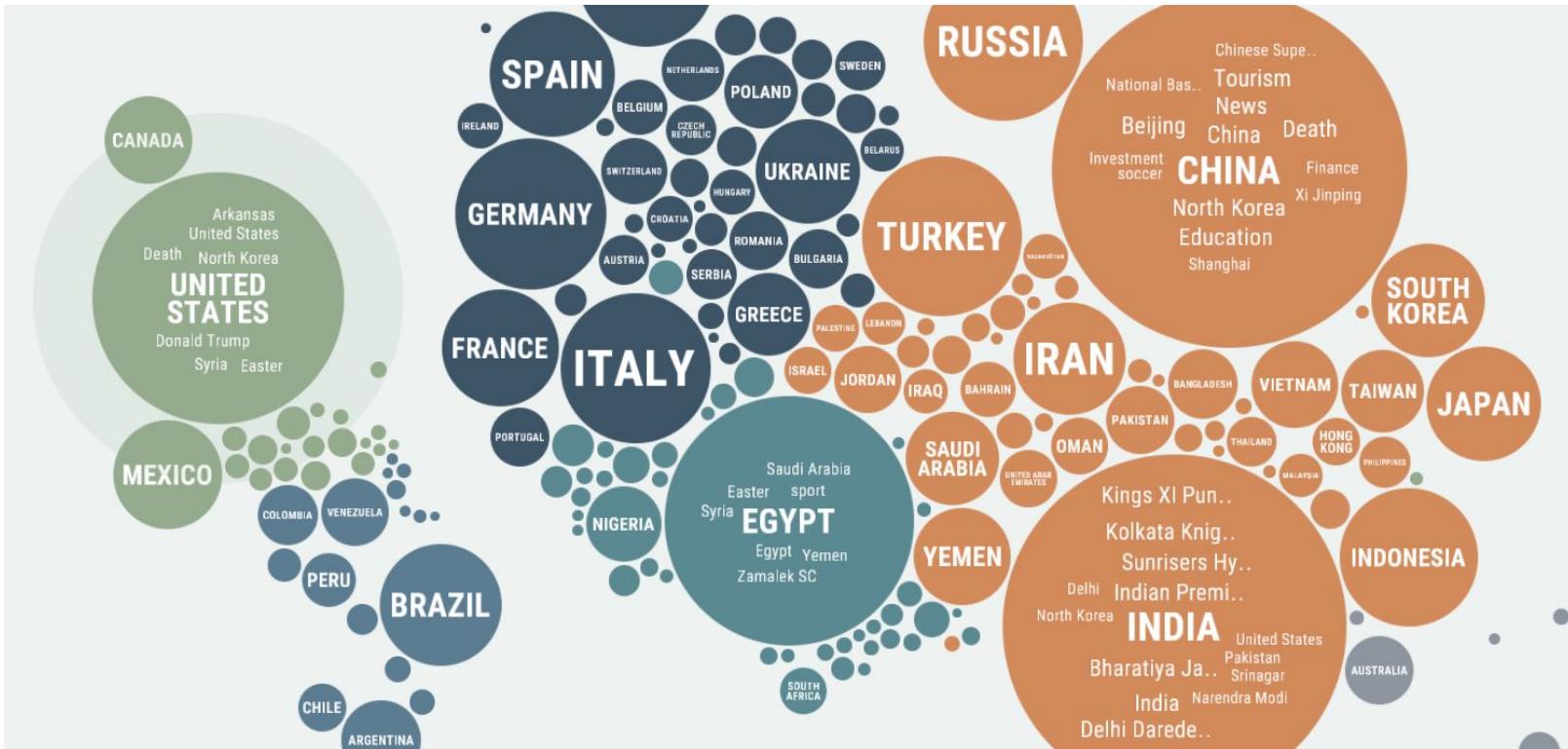


# Area and Distance Cartograms

Cartograms distort the shape of geographic regions to encode another variable into the spatial area



# Area Cartogram: Unfiltered News

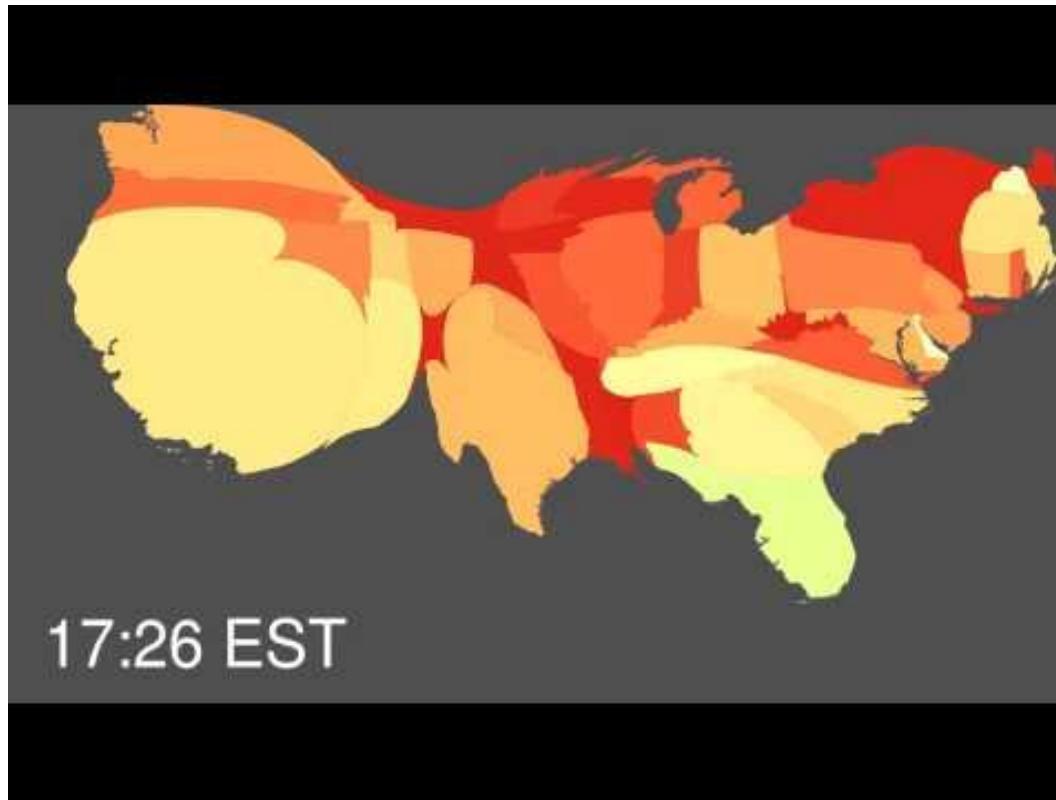


Demo: <https://unfiltered.news/#/2017/04/16/us>

# Cartogram: Pulse of the Nation

Demo

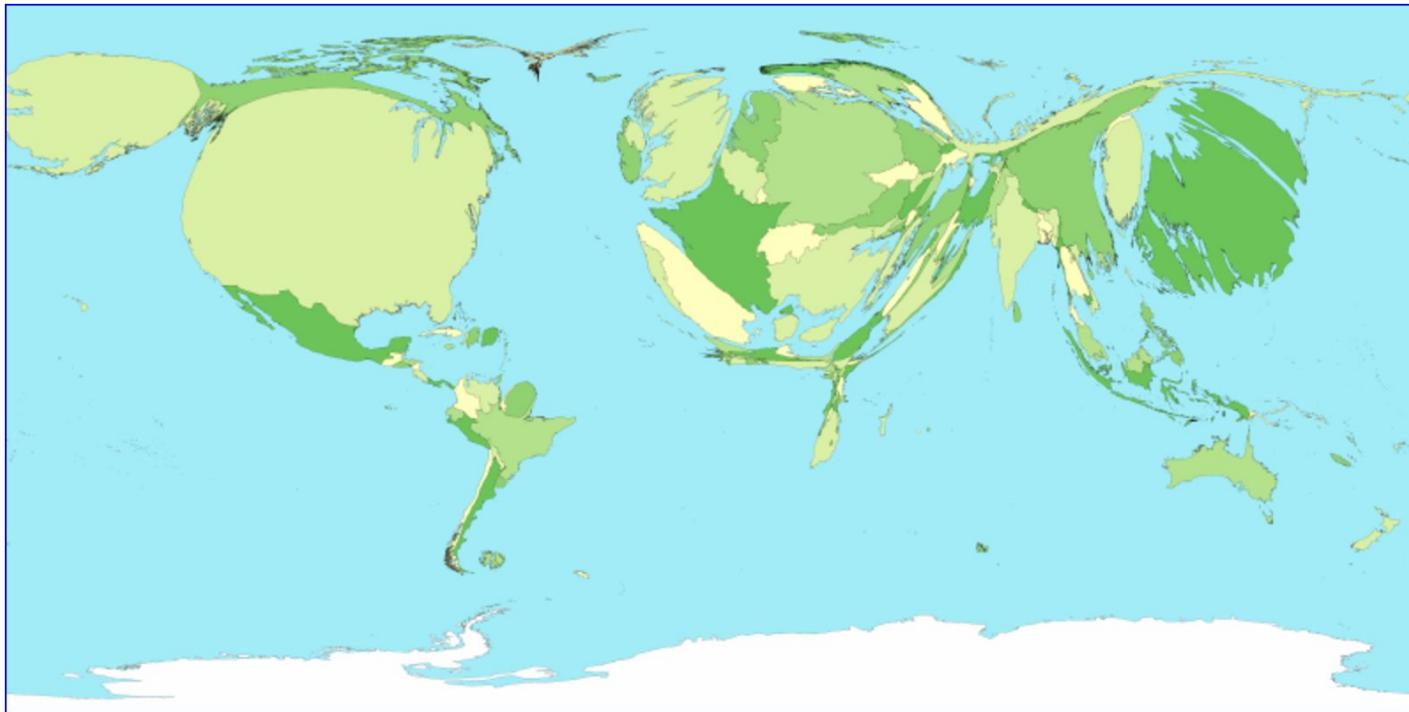
*Tracking the  
National Mood  
Through  
Twitter*



# Cartogram: Population



# Cartogram: Gross domestic product



**Obama**  
ELECTORAL VOTES  
**243**

Needs 27  
to win

Needs 64  
to win  
**206**  
ELECTORAL VOTES

185 Solid Obama

58 Leaning Oba...

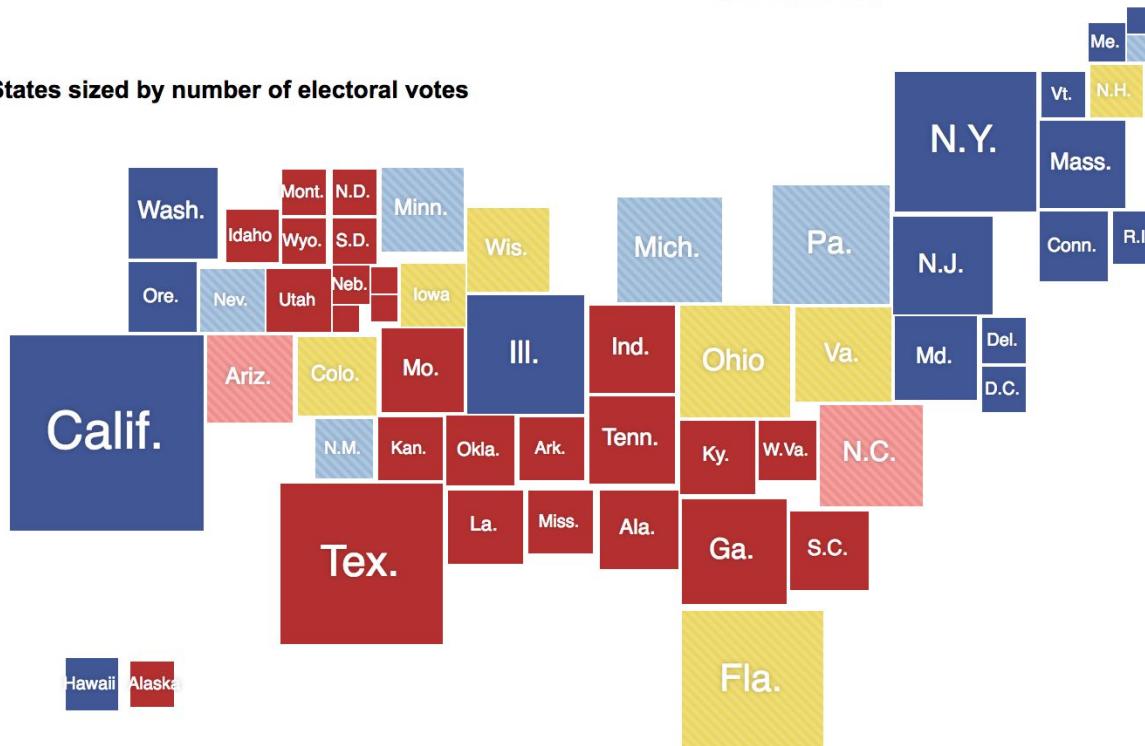
89 Tossup Votes

26 Le...

180 Solid Romney

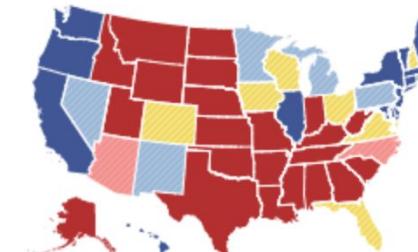
270 needed to win

### States sized by number of electoral votes



Maine and Nebraska give two electoral votes to the statewide winner and allocate the rest by congressional district.

### Geographic View

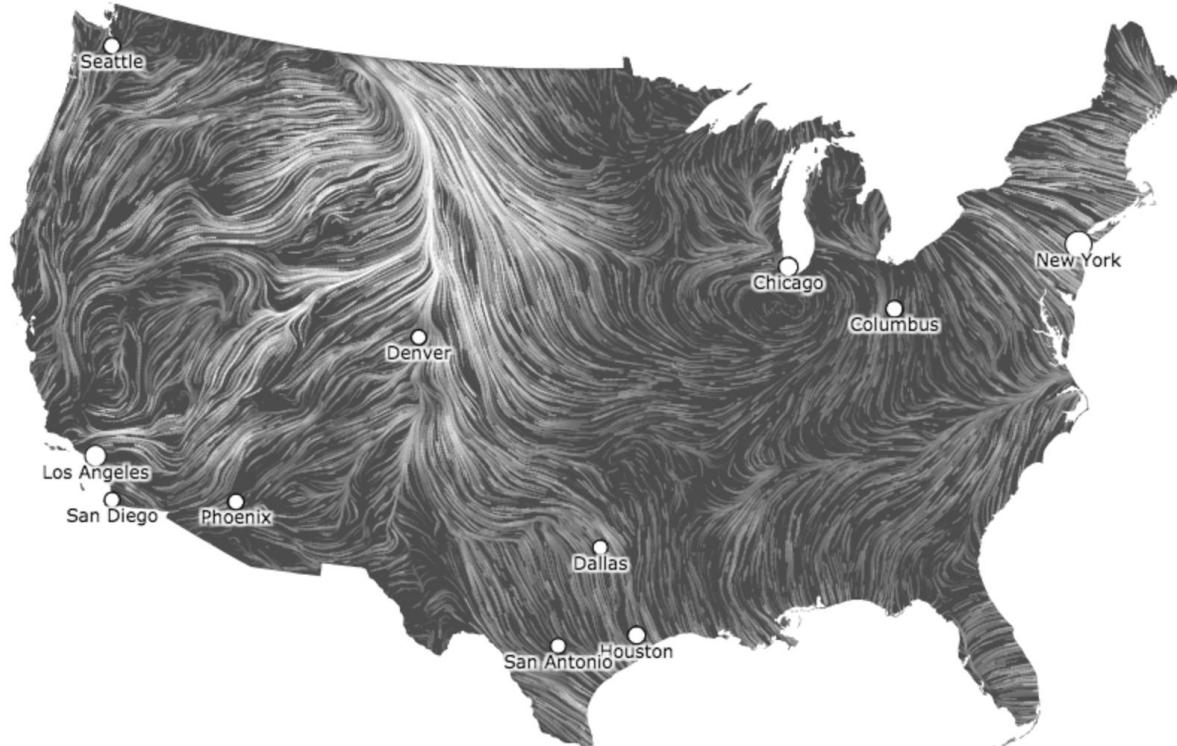


# Other types of Maps

# Wind Map Demo

Art project by  
Fernanda Viegas  
and Martin  
Wattenberg

*To visualize wind  
as a source of  
energy*



# Where Do Your State's Taxes Come From?

2014 state tax revenues

Income taxes make up more than 50% of tax revenue



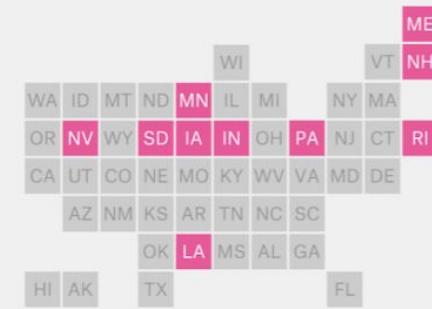
Sales taxes make up more than 50% of tax revenue



Property taxes make up more than 10% of tax revenue



Sin taxes make up more than 10% of tax revenue



Corporate taxes make up more than 10% of tax revenue



Severance taxes make up more than 10% of tax revenue



# GEOSPATIAL DATA FORMATS

# GeoJSON

- JSON-based standard for geospatial data on web
- May include a geometry, feature, or collection of features
- Geometry types
  - Point, LineString, Polygon, MultiPoint, MultiLineString, MultiPolygon, and GeometryCollection
- Can add additional data in JSON format

# GeoJSON example

```
{ "type": "FeatureCollection",
  "features": [
    { "type": "Feature",
      "geometry": { "type": "Point", "coordinates": [102.0, 0.5]},
      "properties": { "prop0": "value0" }
    },
    { "type": "Feature",
      "geometry": {
        "type": "LineString",
        "coordinates": [
          [102.0, 0.0], [103.0, 1.0], [104.0, 0.0], [105.0, 1.0]
        ]
      },
      "properties": {
        "prop0": "value0",
        "prop1": 0.0
      }
    },
    { "type": "Feature",
      "geometry": {
        "type": "Polygon",
        "coordinates": [
          [ [100.0, 0.0], [101.0, 0.0], [101.0, 1.0],
            [100.0, 1.0], [100.0, 0.0] ]
        ]
      },
      "properties": {
        "prop0": "value0",
        "prop1": { "this": "that" }
      }
    }
  ]
}
```

# Style your map style

<http://leaflet-extras.github.io/leaflet-providers/preview/index.html>

# References

- Design for information. Isabel Meirelles. Chapter 4