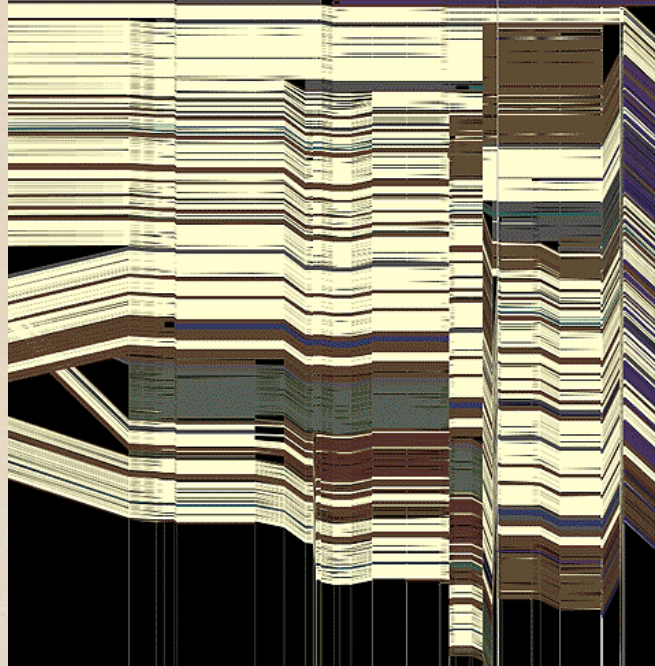
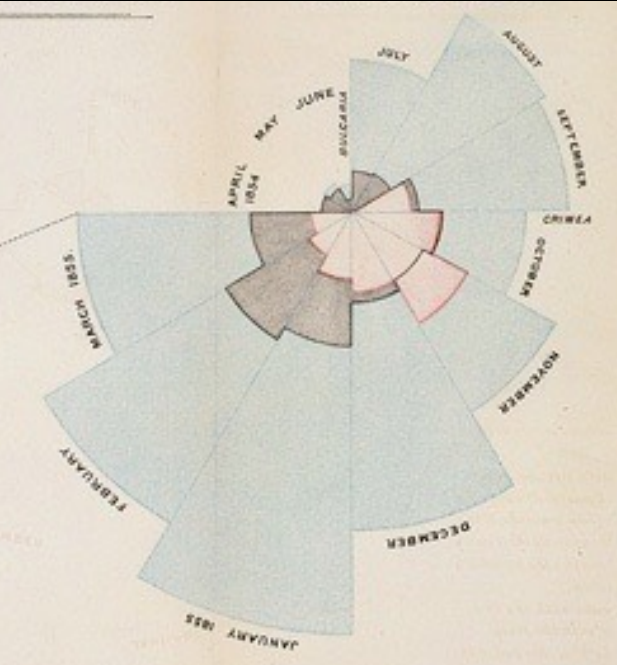


**CSE 442** - Data Visualization

# Mapping & Cartography



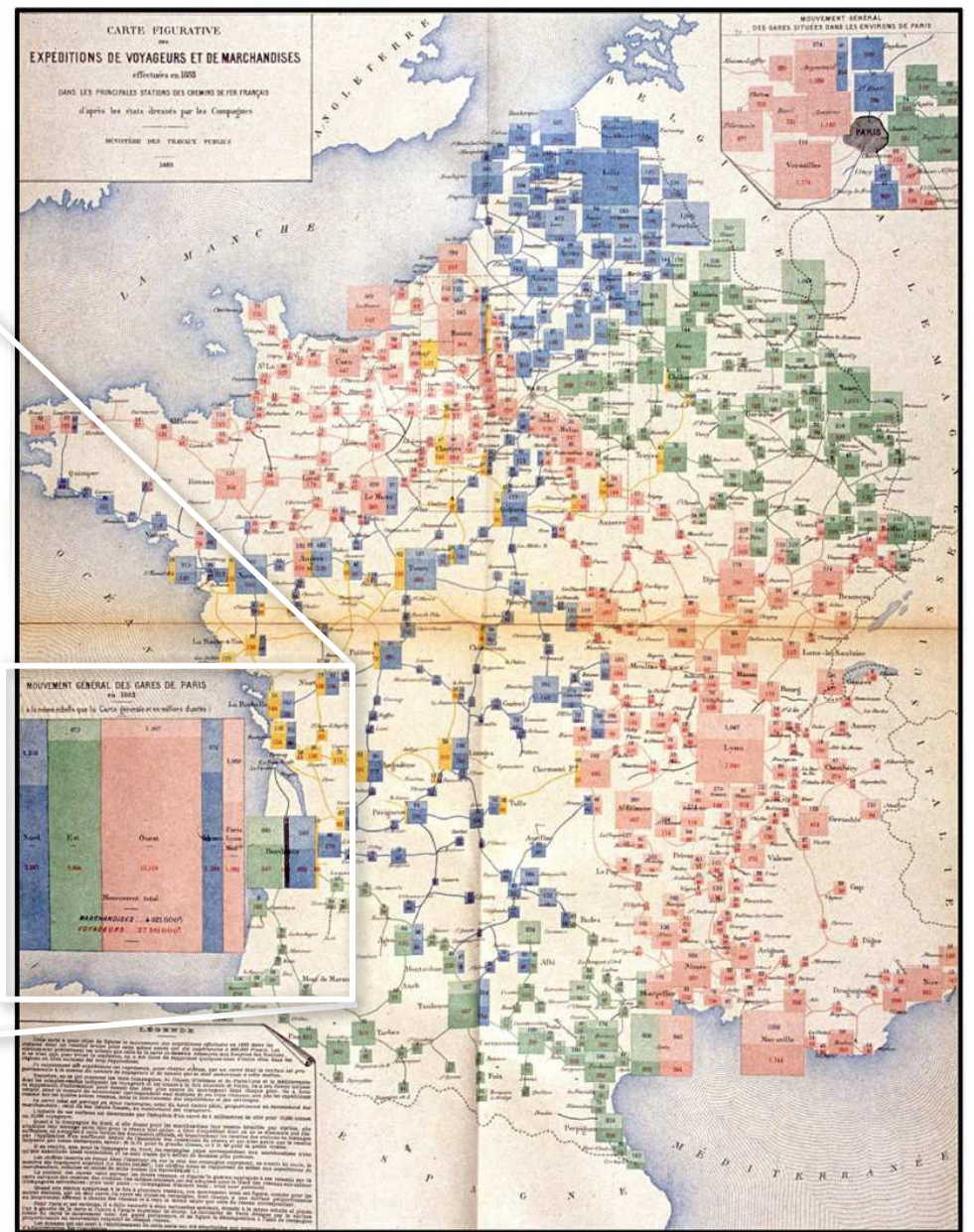
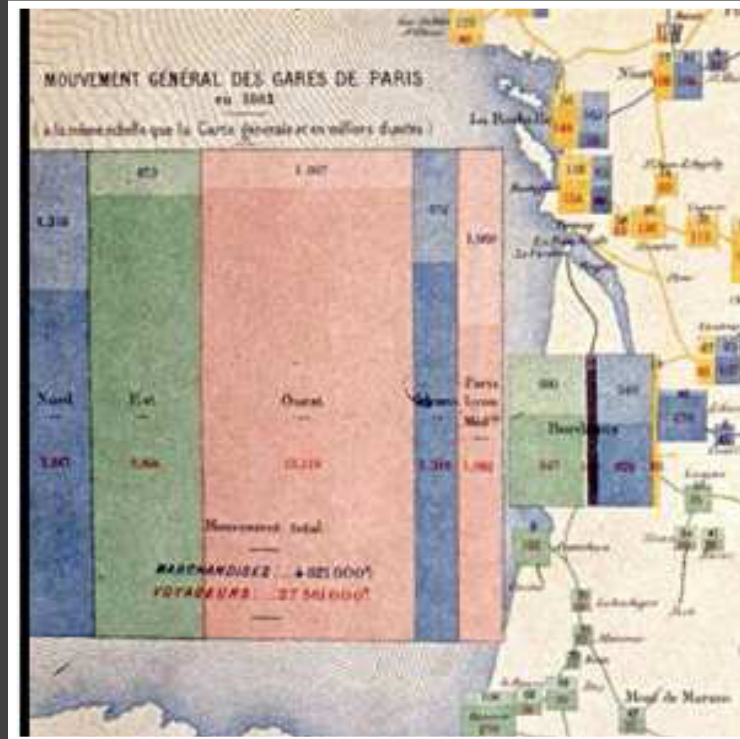
**Jeffrey Heer** University of Washington

(with significant material from Michal Migurski)



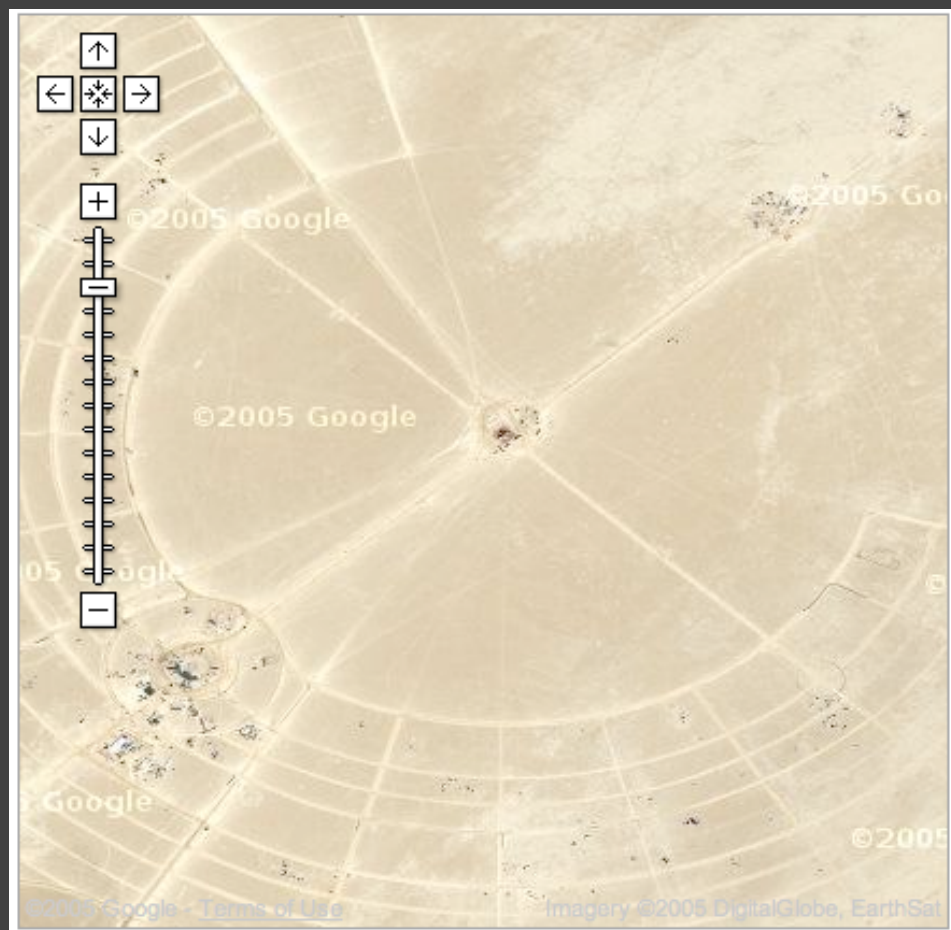
Ptolemy's Geographica  
Original ~150AD, This Map ~1300AD



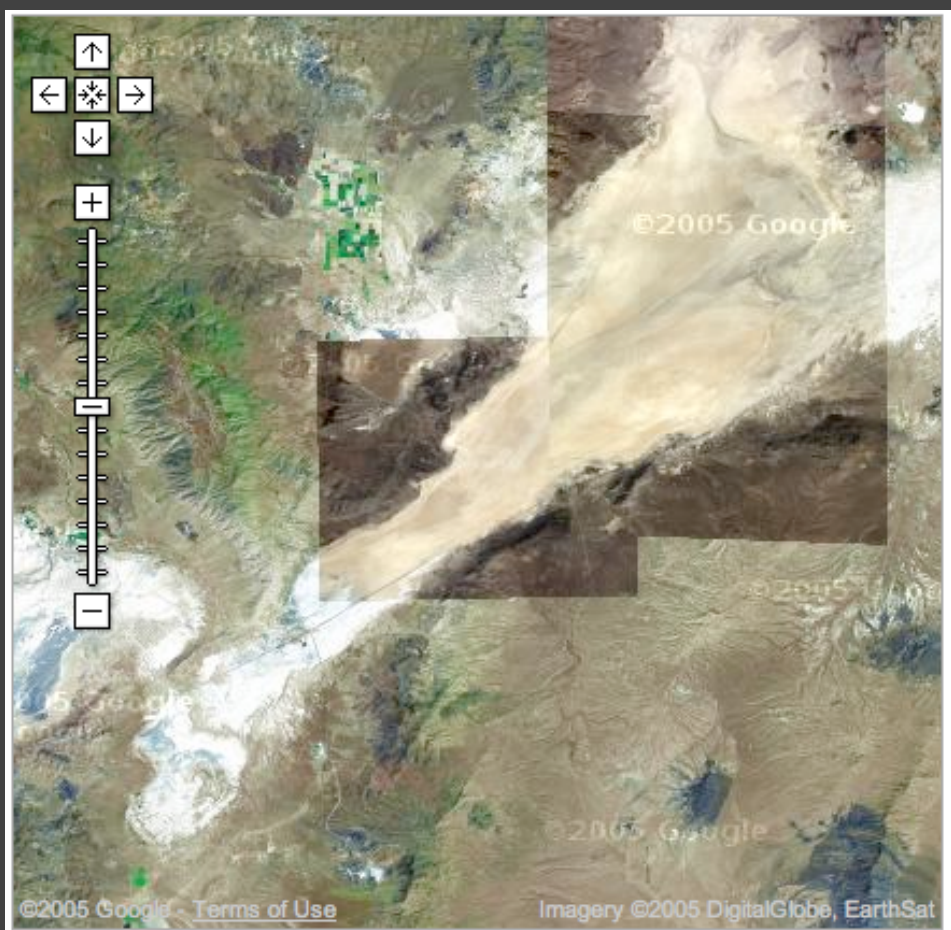


Rail Passengers and Freight from Paris 1884





# Black Rock City, Nevada (Burning Man)



# Google Maps 2005



[WORLD](#) [U.S.](#) [N.Y. / REGION](#) [BUSINESS](#) [TECHNOLOGY](#) [SCIENCE](#) [HEALTH](#) [SPORTS](#) [OPINION](#) [ARTS](#) [STYLE](#) [TRAVEL](#) [JOBS](#) [REAL ESTATE](#) [AUTOS](#)
[POLITICS](#) [WASHINGTON](#) [EDUCATION](#)

# Casualties of War

[FACES](#) [ANALYSIS](#) [THEIR STORIES](#)
[E-MAIL](#) [FEEDBACK](#)

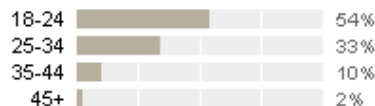
Use the slider below to investigate the demographics and military status of U.S. service members who died during the war in Iraq.

**MARCH 16, 2003 JULY 5, 2008** (277 WEEKS)

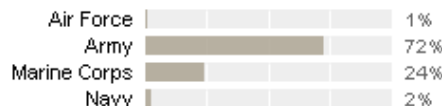
[Show all](#) | [Initial invasion](#) | [First invasion of Falluja](#) | [Second invasion of Falluja](#) | [Since troop buildup began](#)

4,097 deaths

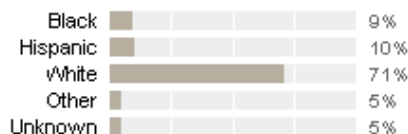
## Age



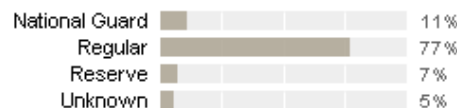
## Branch of Military



## Race



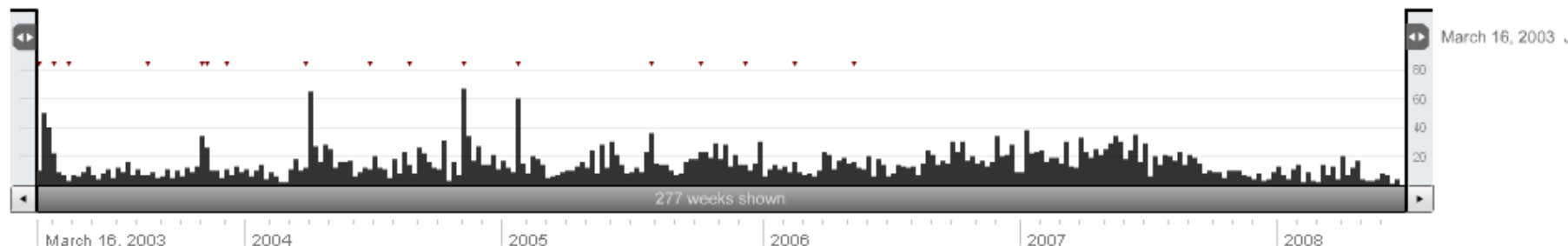
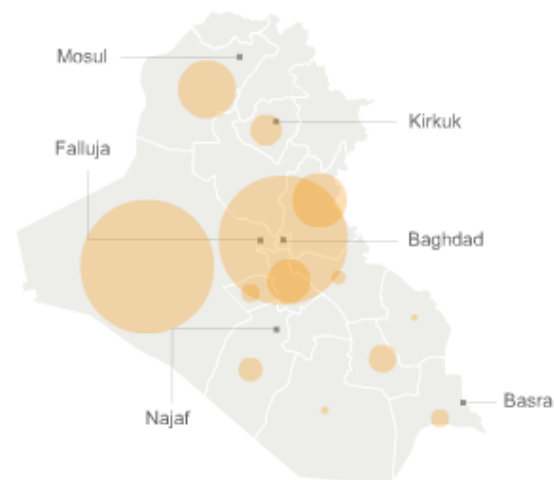
## Type of Duty



## Location of death

Circles sized according to percentage of deaths in each Iraqi province.

[Show home](#)



## Ramadi: The Government Provides an Opening for ISIS

ISIS Control

Tensions between this city's residents, who are mostly Sunni, and the central government had been brewing here for at least a year. Then in December, Iraq's prime minister, Nuri Kamal al-Maliki, **ordered security forces to dismantle a protest camp** — an outlet for disenchanted Sunnis angered at their treatment by the Shiite-dominated government. The action ignited days of violence and created the opening ISIS needed to seize parts of the city, the provincial capital.

Lake Tharthar

## Falluja: A Symbolic Fall

ISIS Control

Just days after the raid on the camp in Ramadi, **ISIS fighters destroyed the Police Headquarters and mayor's office here**, planted their flag on government buildings and decreed the city to be theirs. Ten years earlier, American forces had captured this city from Qaeda-style insurgents at a considerable cost of American lives.

Lake Habbaniya

Balad



17 MILES TO BAGHDAD



237

Joseph R. Biden Jr.

70,098,068 votes (50.2%)

87

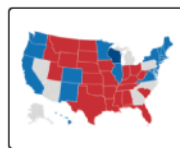
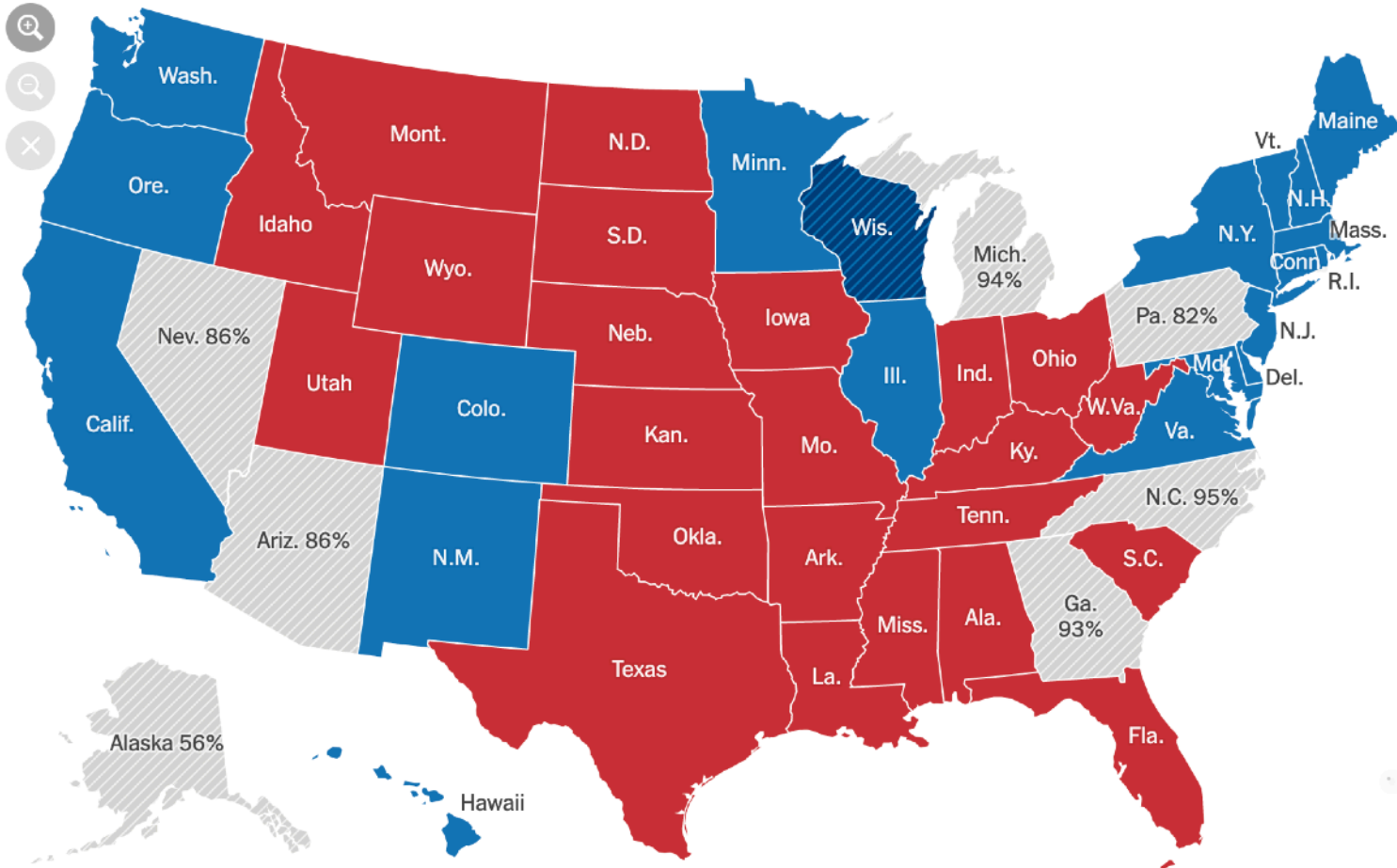
remaining

270  
TO WIN

214

Donald J. Trump

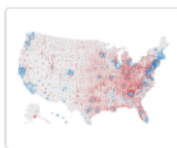
67,072,823 votes (48.1%)



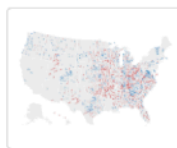
By winner



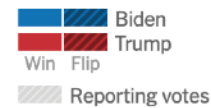
Electoral votes



Size of lead



Shift from 2016



Percentages are estimates of how much vote has been counted.

Choropleth Map  
[NY Times]

237

Joseph R. Biden Jr.

70,122,063 votes (50.2%)

87

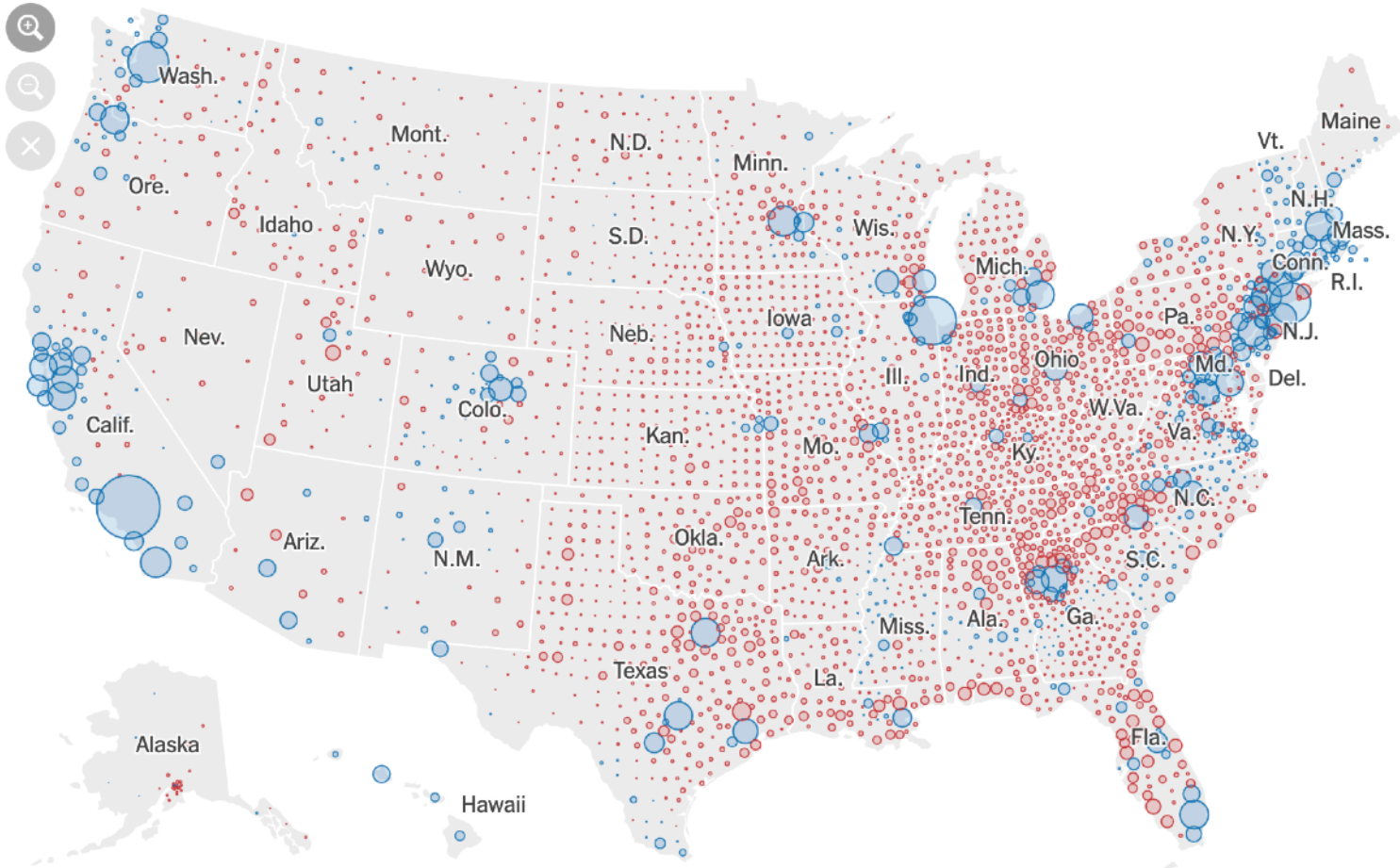
remaining

270  
TO WIN

214

Donald J. Trump

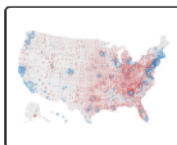
67,075,300 votes (48.0%)



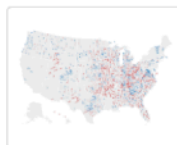
By winner



Electoral votes



Size of lead



Shift from 2016

**LEADER:** ● Biden ● Trump  
Circle size is proportional to the amount each county's leading candidate is ahead.

Symbol Map  
[NY Times]



237

Joseph R. Biden Jr.

70,122,064 votes (50.2%)

87

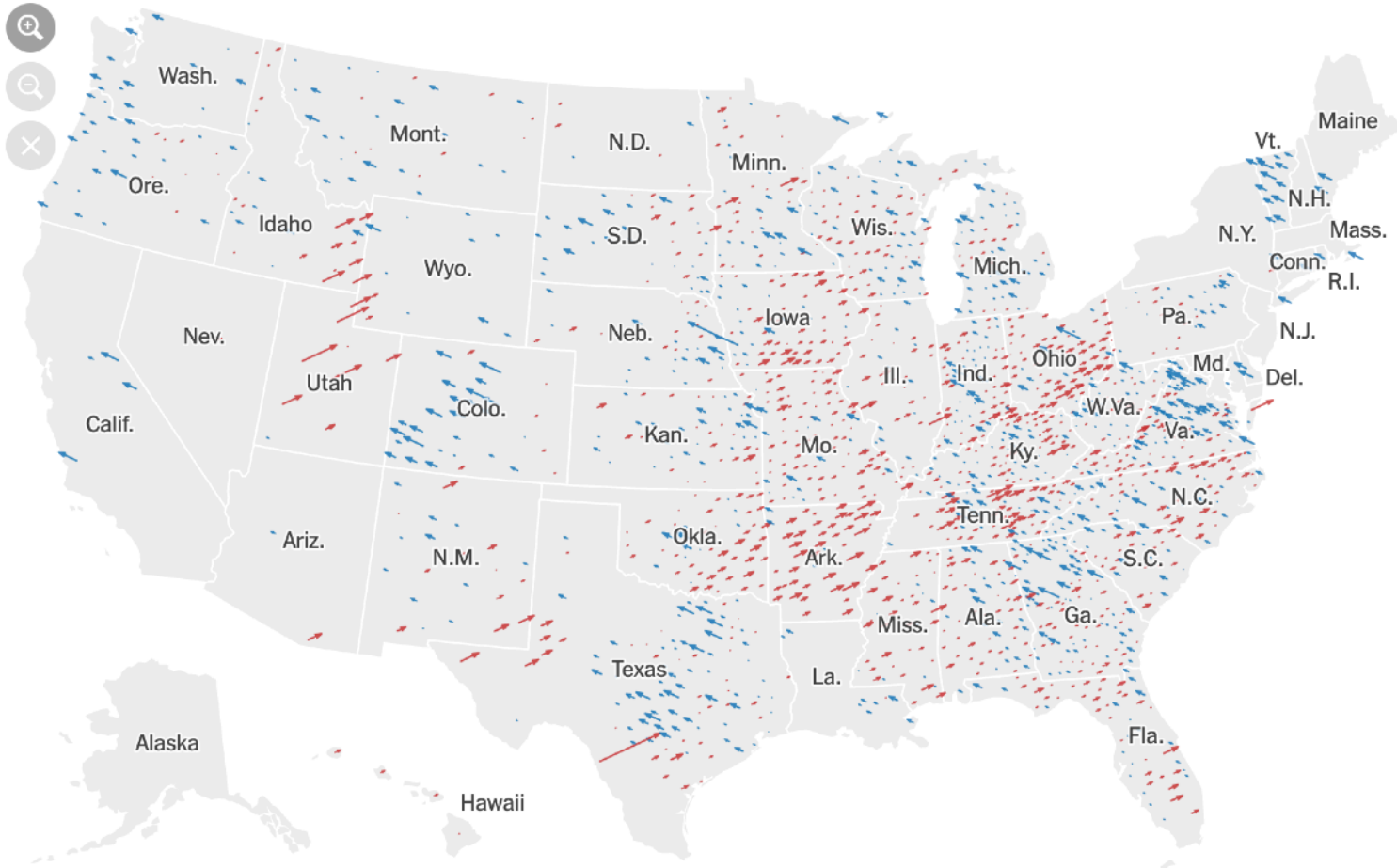
remaining

270  
TO WIN

214

Donald J. Trump

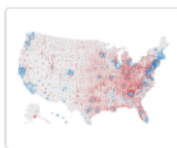
67,075,309 votes (48.0%)



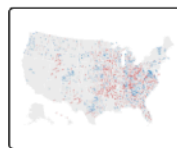
By winner



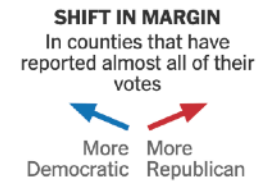
Electoral votes



Size of lead



Shift from 2016



Symbol Map  
[NY Times]

237

Joseph R. Biden Jr.

70,122,063 votes (50.2%)

87

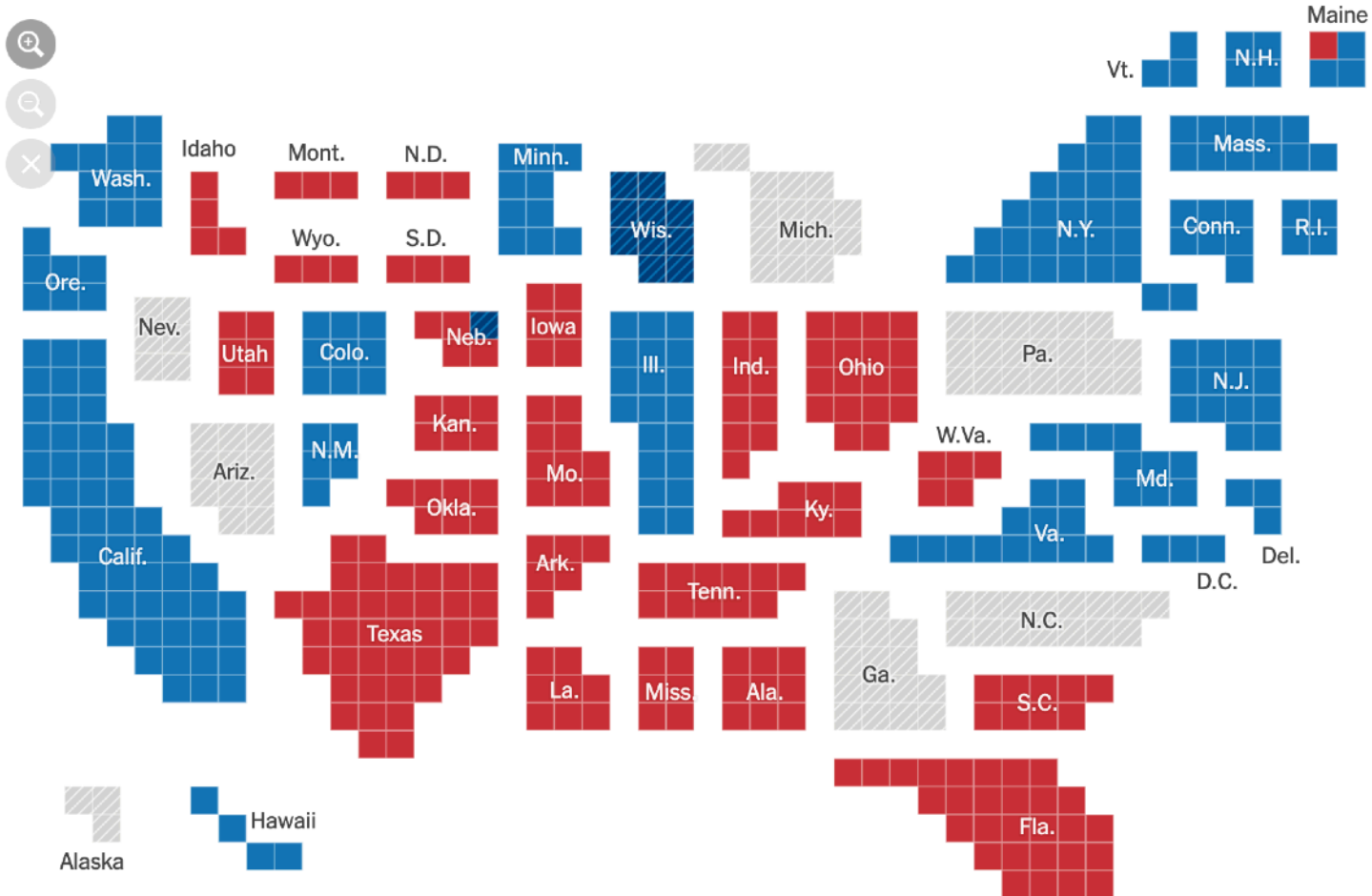
remaining

270  
TO WIN

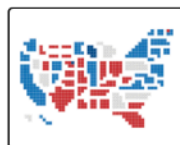
214

Donald J. Trump

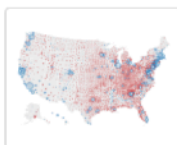
67,075,300 votes (48.0%)



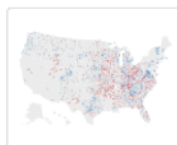
By winner



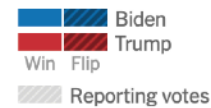
Electoral votes



Size of lead



Shift from 2016



Cartogram  
[NY Times]



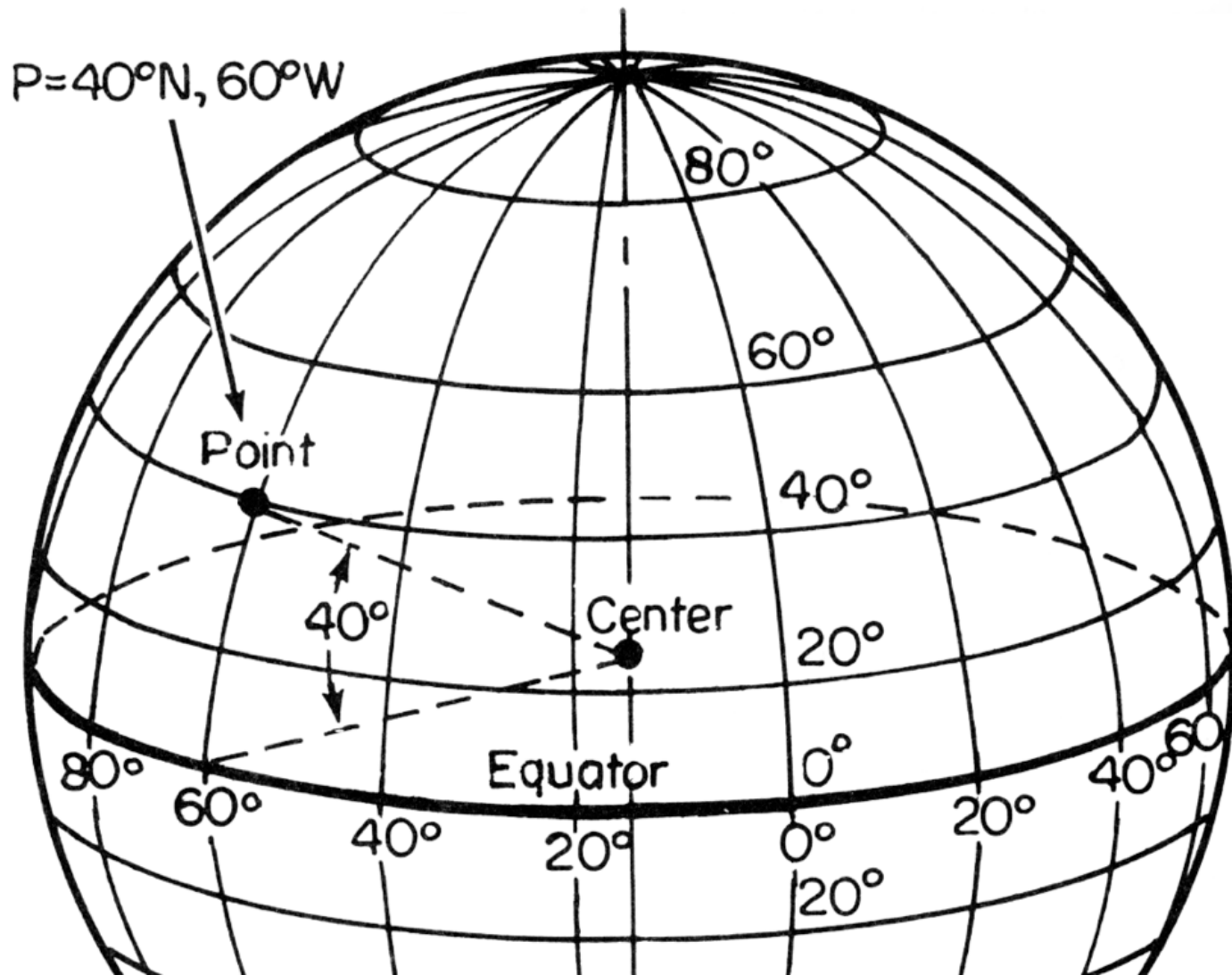
# Cartography

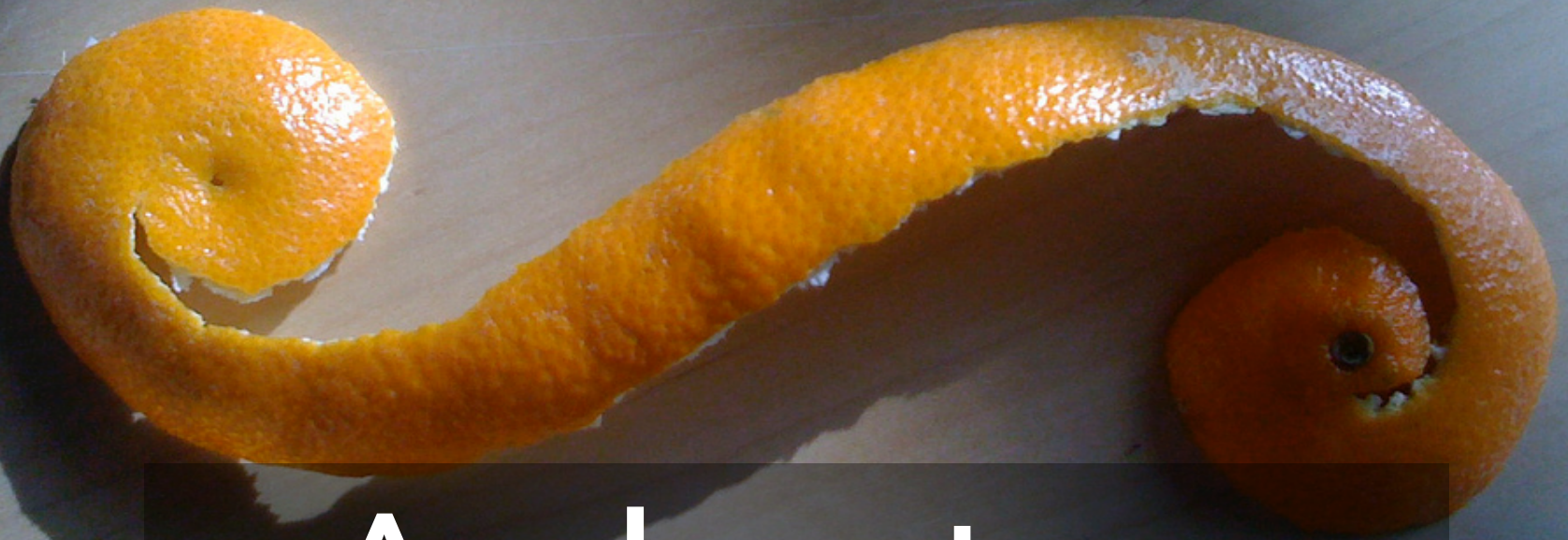
The Making of Maps

# Projections



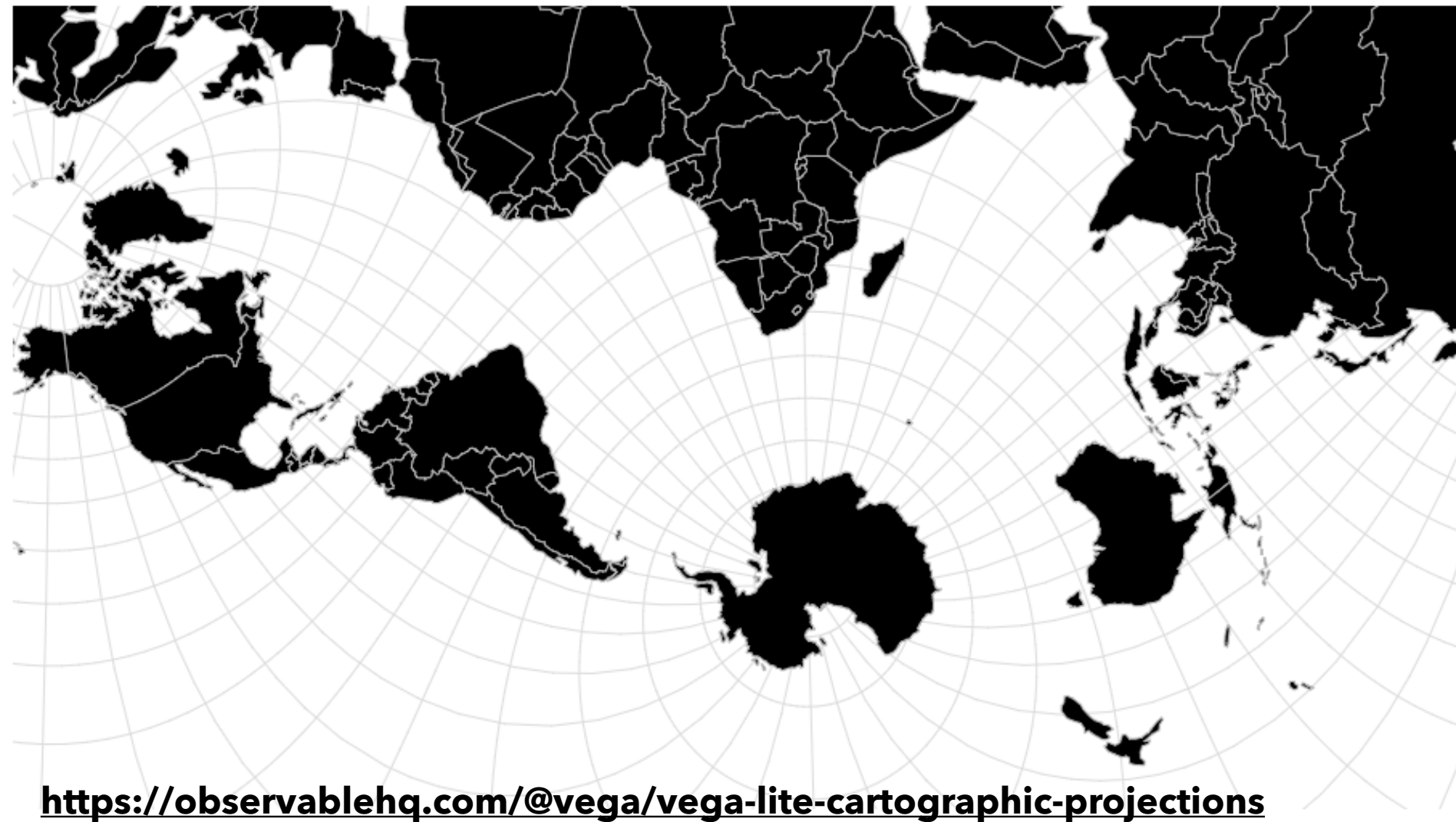
# Latitude, Longitude





A sphere tears  
when you flatten it

# Exploring Projections...



<https://observablehq.com/@vega/vega-lite-cartographic-projections>



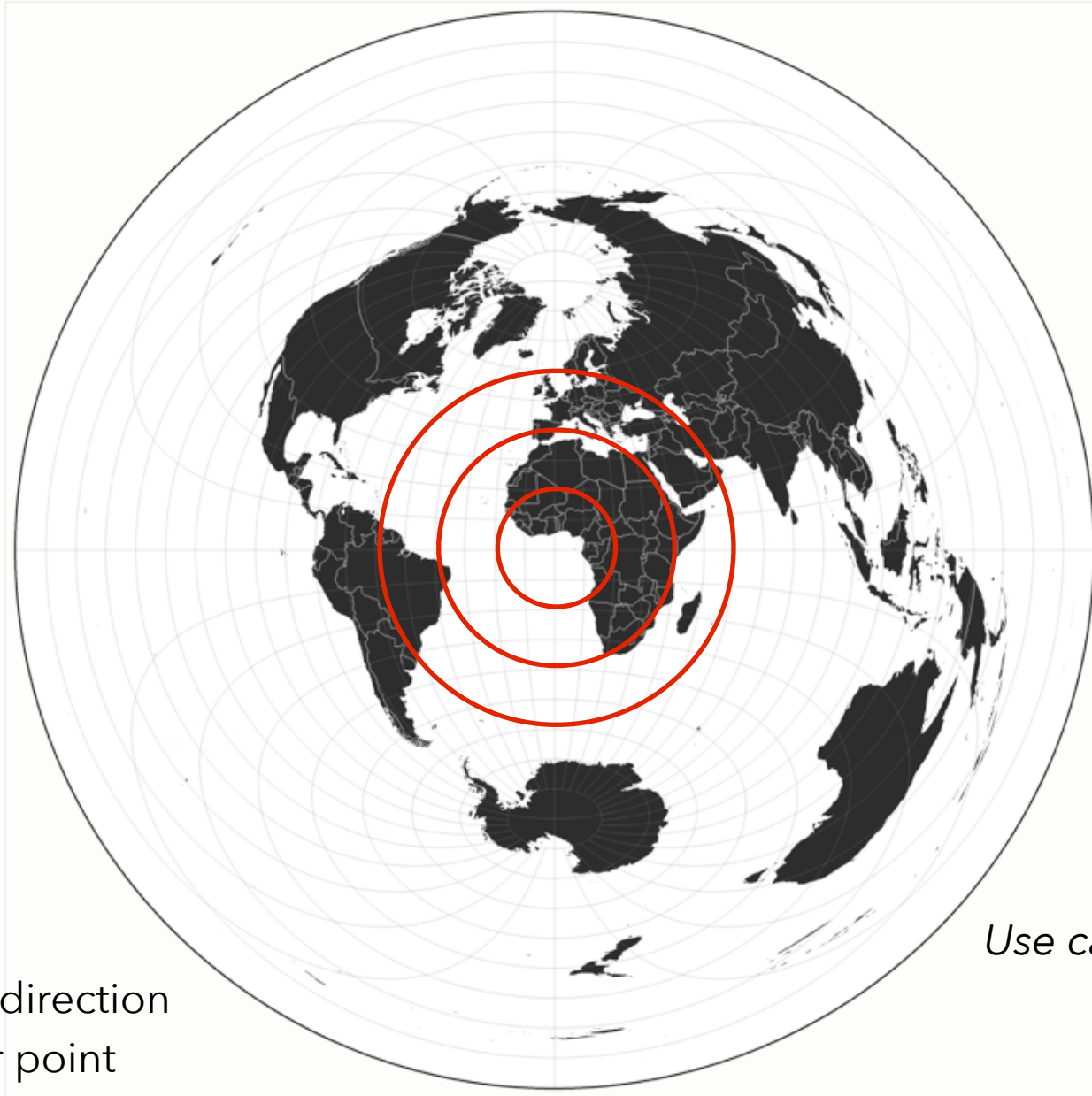
**We can categorize  
projections by what  
they preserve...**



# Distance

Preserve distance / direction from center

# Azimuthal Equidistant

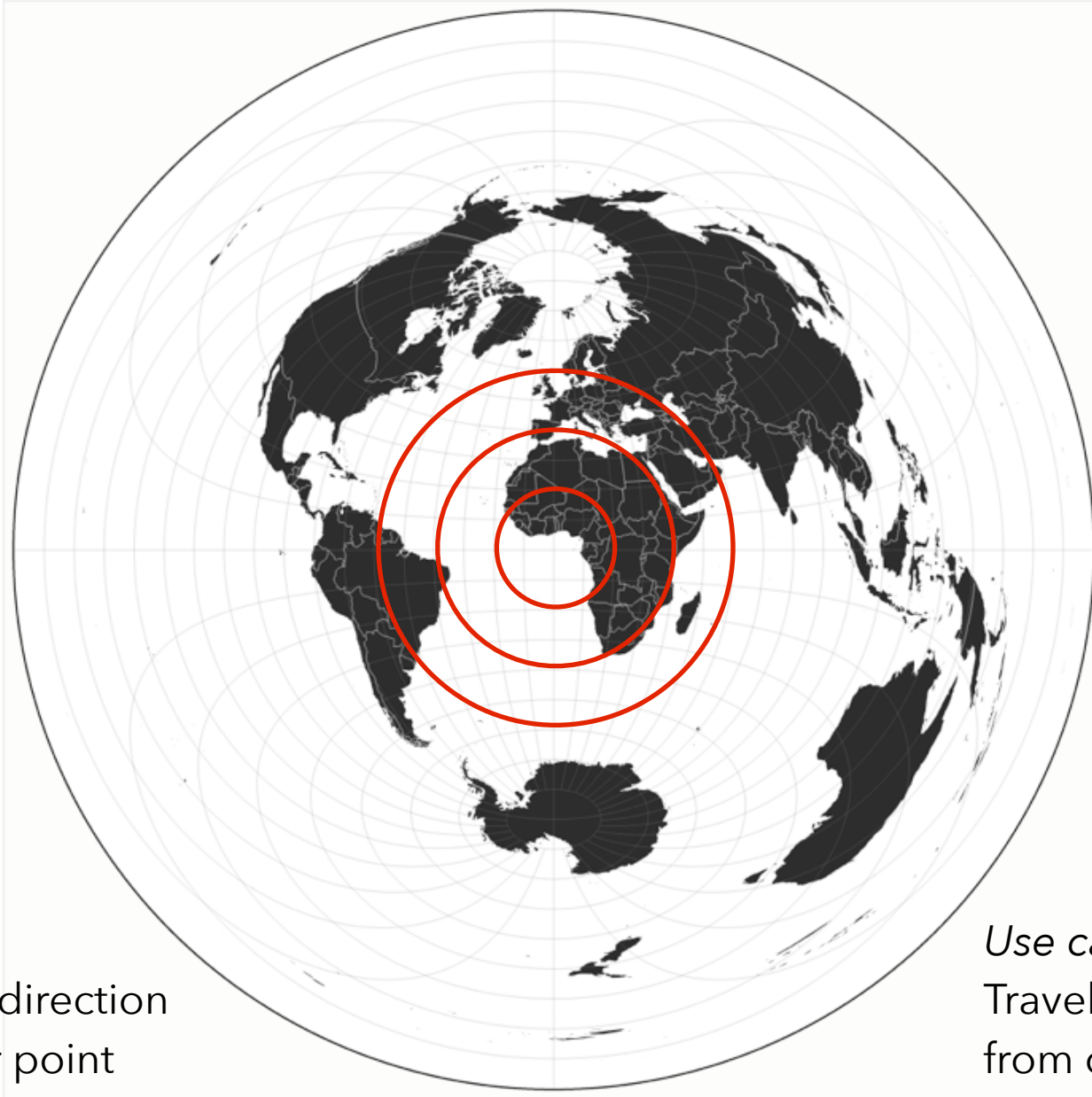


*Preserves:*  
Distance & direction  
from center point

*Use cases?*

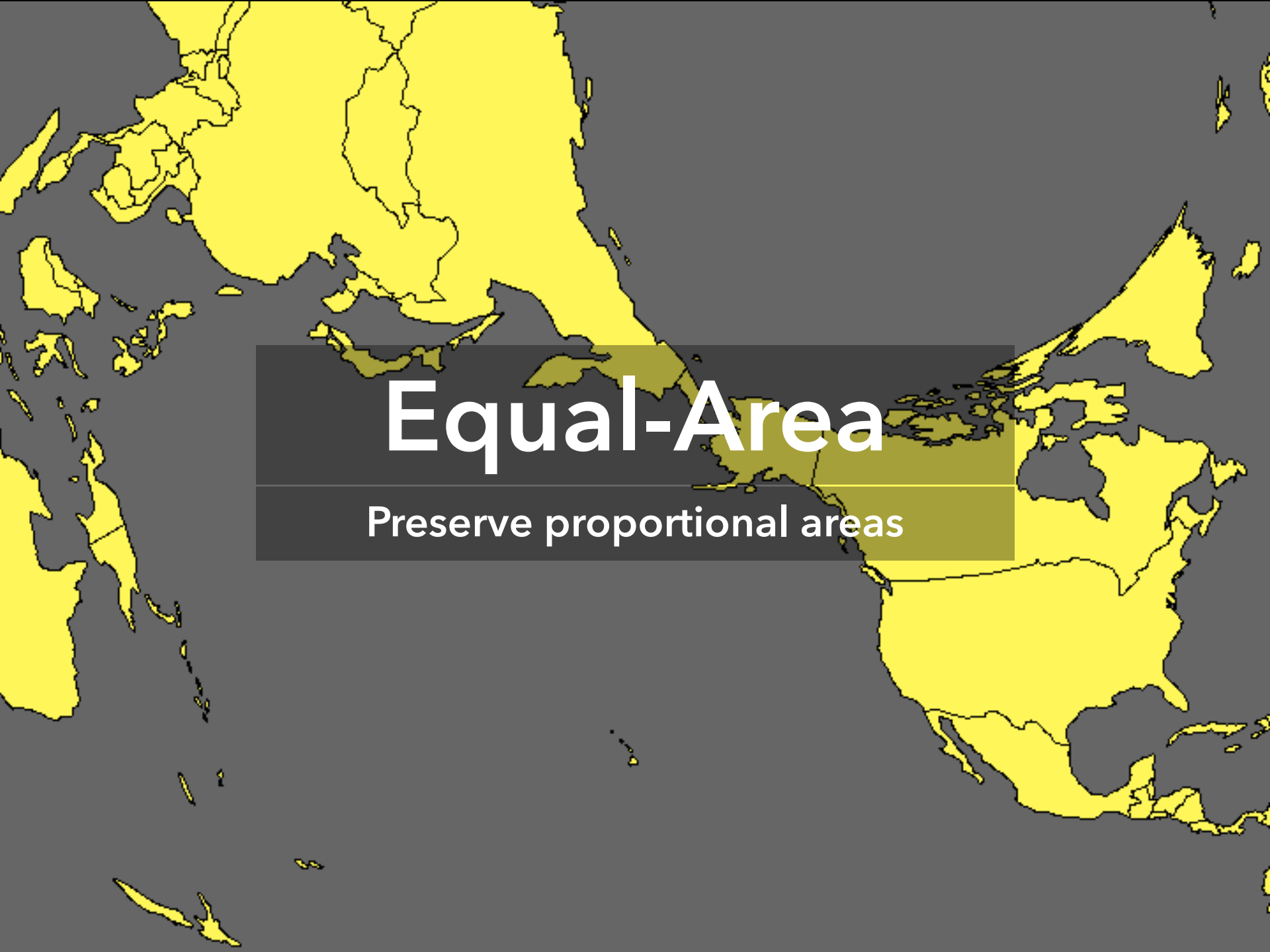


# Azimuthal Equidistant



*Preserves:*  
Distance & direction  
from center point

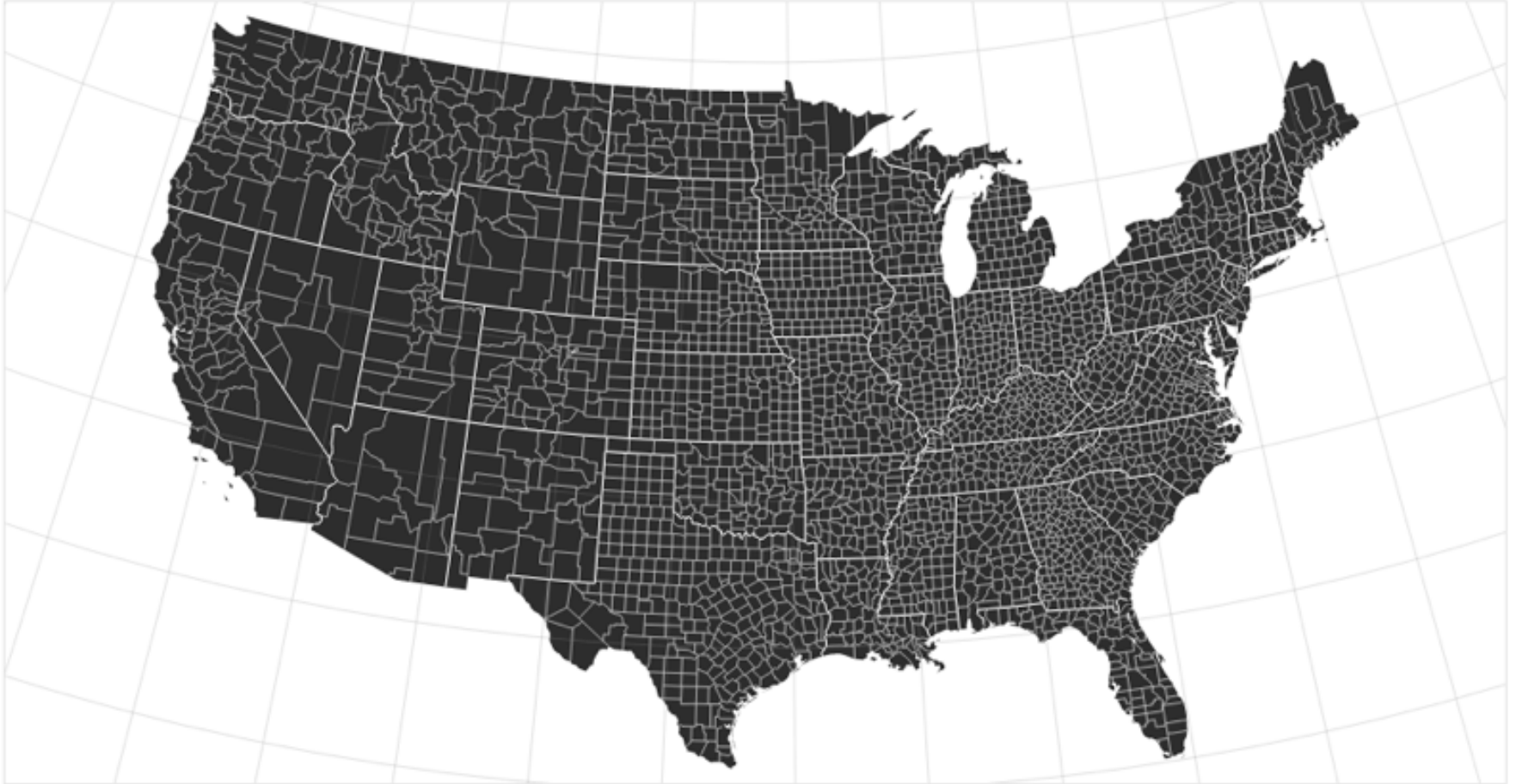
*Use cases:*  
Travel / propagation  
from center point



# Equal-Area

Preserve proportional areas

# Albers Equal-Area Conic

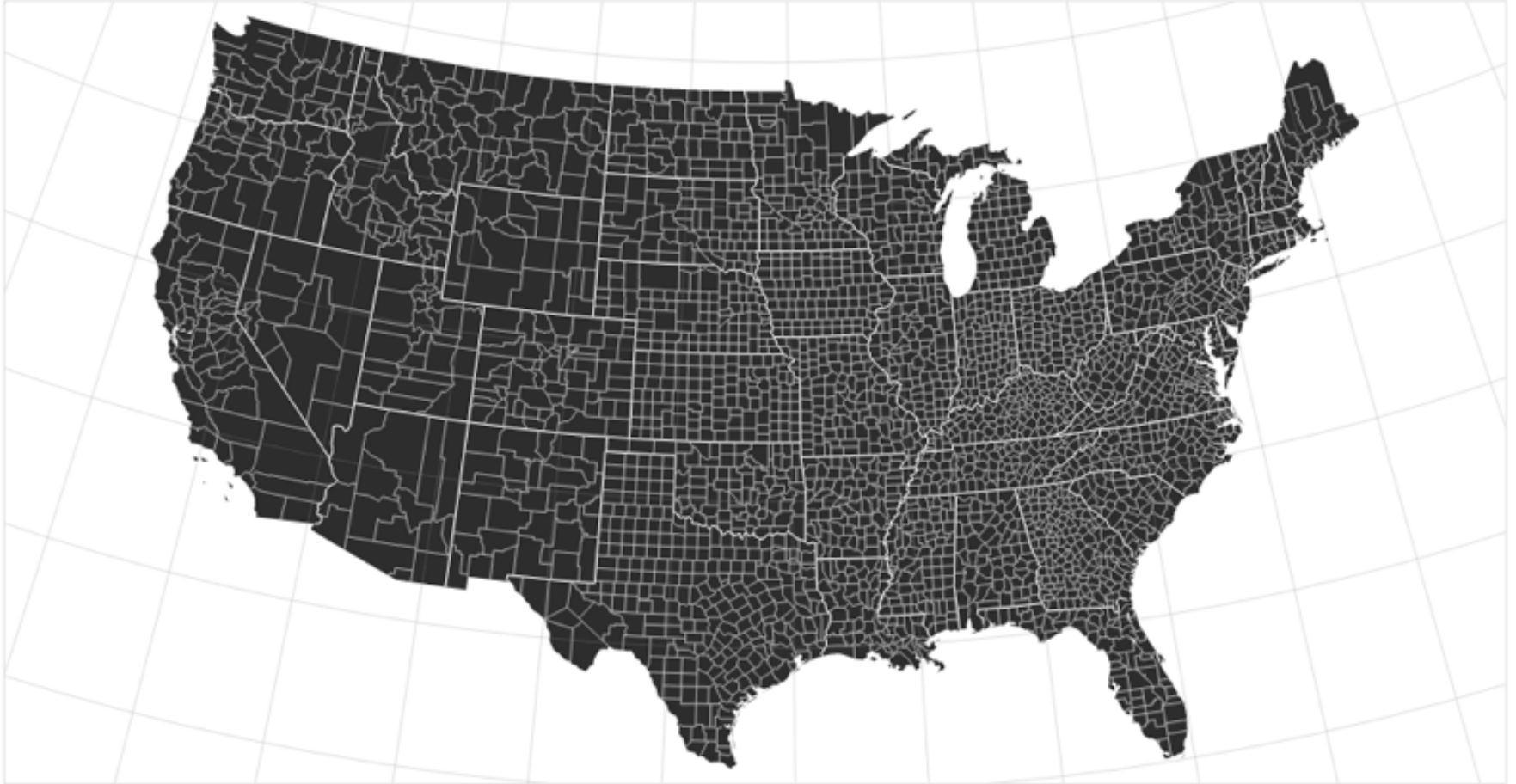


*Preserves:* Proportional area of geographic regions

*Use cases?*



# Albers Equal-Area Conic



*Preserves:* Proportional area of geographic regions

*Use cases:* Land surveys, choropleth (shaded) maps

A world map with yellow landmasses and dark grey oceans. A semi-transparent grey rectangular box is centered over the Atlantic Ocean and Western Europe. Inside this box, the word "Conformal" is written in large white letters, and below it, the text "Preserve local angles ('shape')" is written in smaller white letters.

# Conformal

Preserve local angles ("shape")

# Spherical Mercator



*Preserves:*  
Compass bearing  
as a straight line

*Use cases?*

# Spherical Mercator

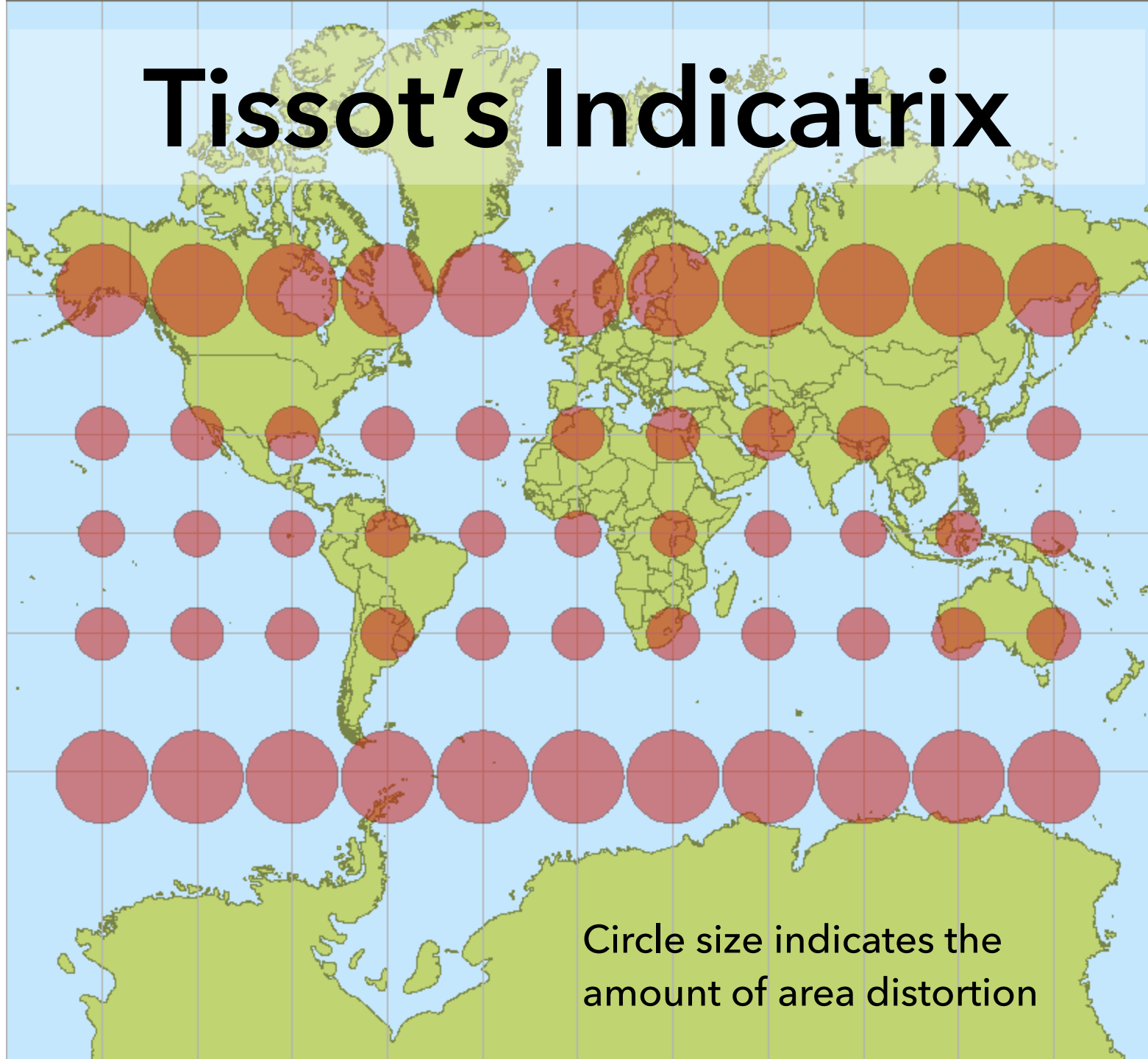


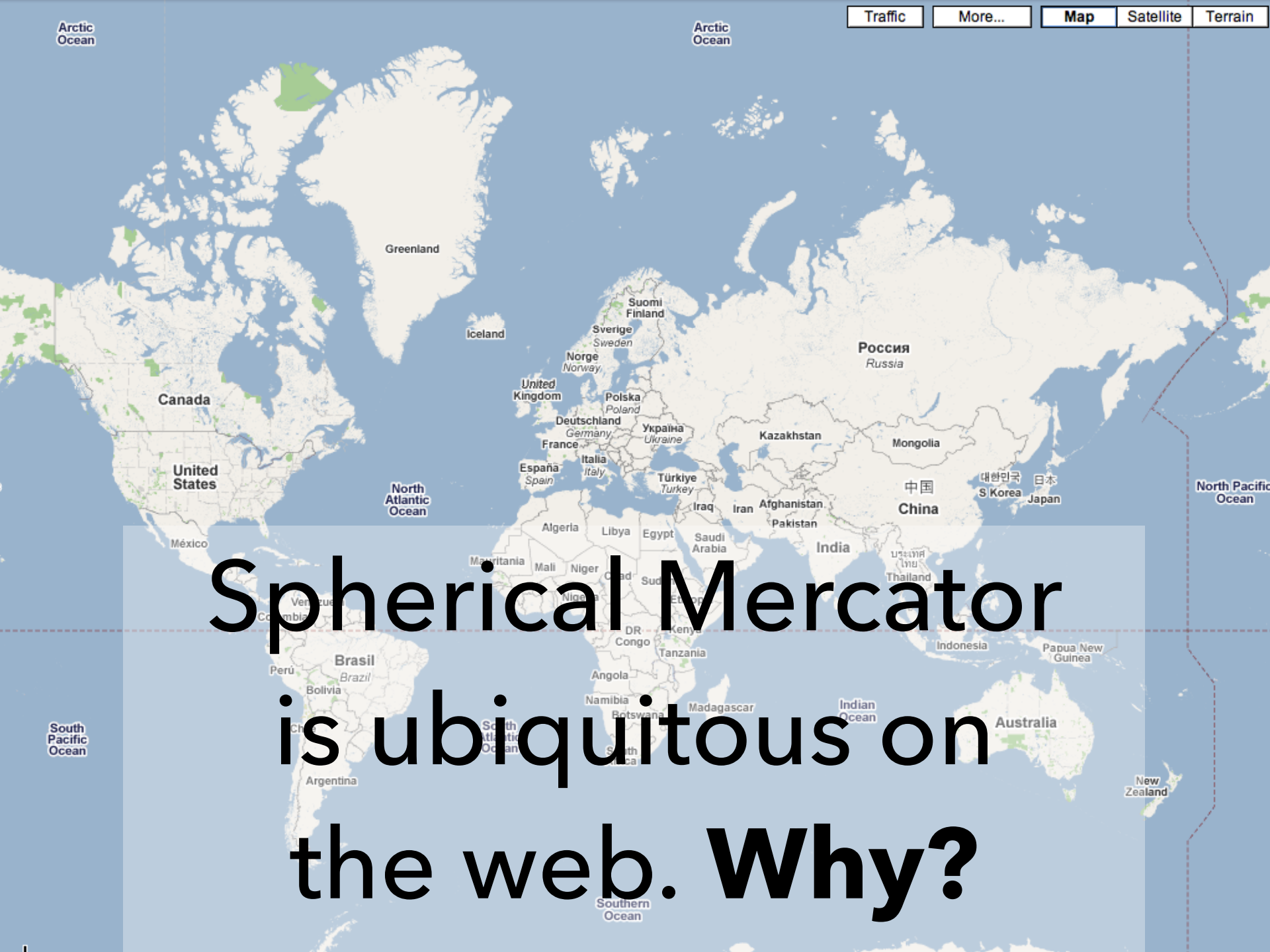
*Preserves:*  
Compass bearing  
as a straight line

*Use cases:*  
Navigation



# Tissot's Indicatrix





Spherical Mercator  
is ubiquitous on  
the web. Why?

# The Earth as a Square



# Web Mercator

$$x = \frac{128}{\pi} 2^{\text{zoom level}} (\lambda + \pi) \text{ pixels}$$

$$y = \frac{128}{\pi} 2^{\text{zoom level}} \left( \pi - \ln \left[ \tan \left( \frac{\pi}{4} + \frac{\varphi}{2} \right) \right] \right) \text{ pixels}$$

World coordinates adjusted to map to 256 x 256 pixels.

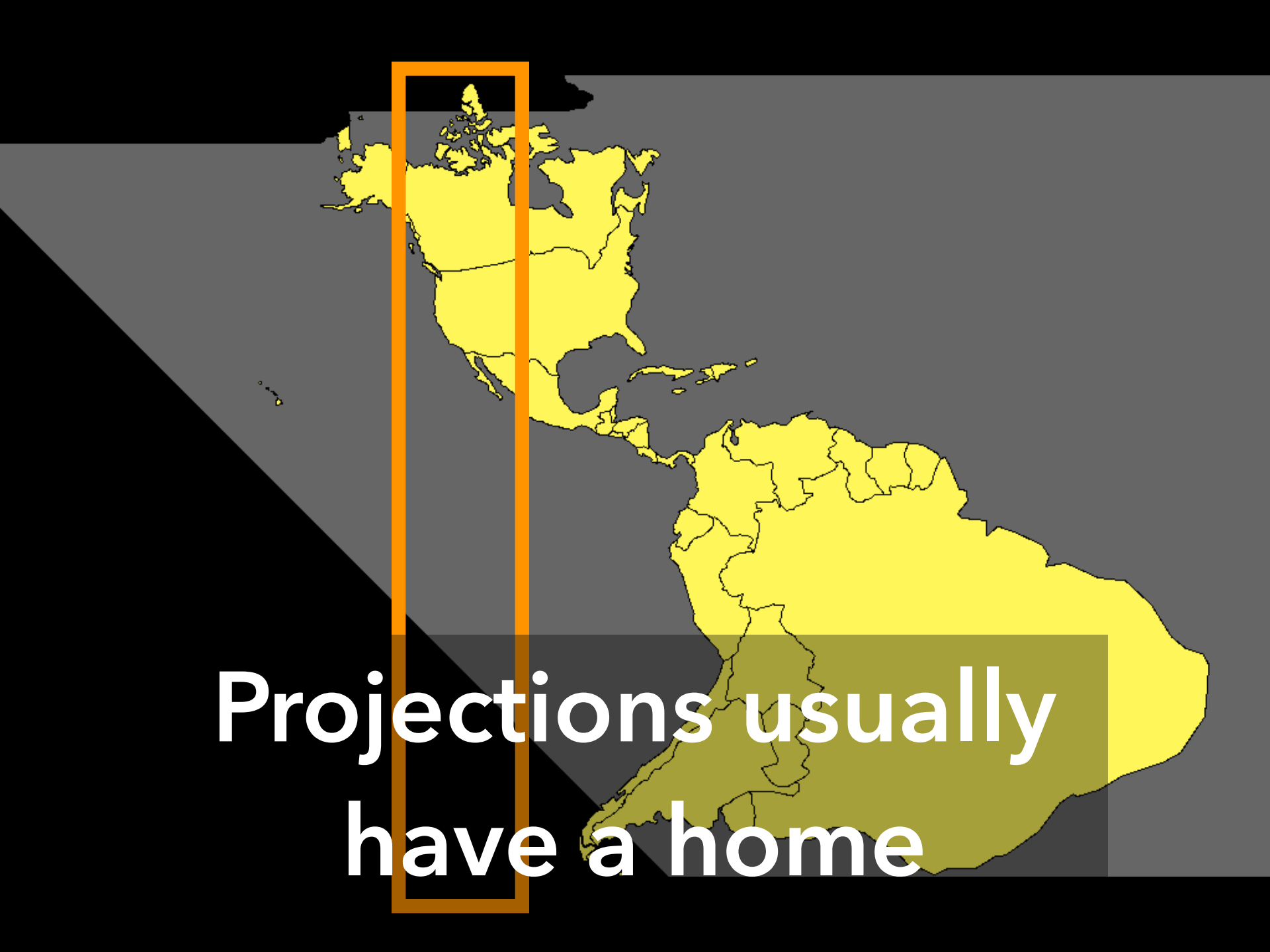
**Latitude cut-offs** at 85.051129 degrees: the exact point at which the projection frames the world in a square.



# Peirce Quincuncial



But there are other  
ways to fit the Earth  
into a square...

A map of the Americas, including North and South America, is shown in yellow against a dark gray background. A vertical orange line runs through the center of the continent. A semi-transparent gray box is overlaid on the lower right portion of the map, containing the text "Projections usually have a home".

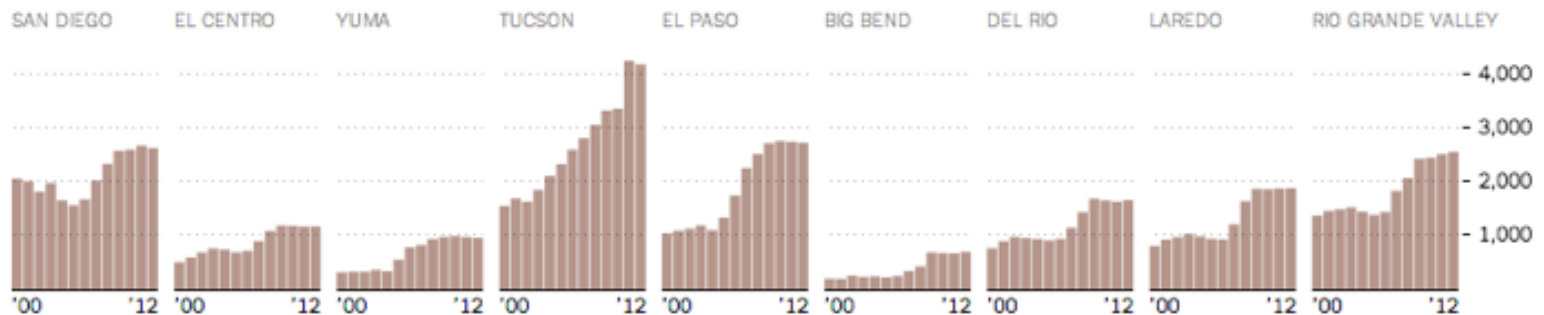
Projections usually  
have a home

# Increased Border Enforcement, With Varying Results



**There are now more agents along the 1,954 mile-long border than ever before...**

Border agents per sector.



Satellite Projection, NY Times

Not appropriate for the whole Earth,  
but fits the chosen focus region!

WHAT YOUR FAVORITE  
**MAP PROJECTION**  
SAYS ABOUT YOU

MERCATOR



YOU'RE NOT REALLY INTO MAPS.

VAN DER GRINTEN



YOU'RE NOT A COMPLICATED PERSON. YOU LOVE THE MERCATOR PROJECTION; YOU JUST WISH IT WEREN'T SQUARE. THE EARTH'S NOT A SQUARE, IT'S A CIRCLE. YOU LIKE CIRCLES. TODAY IS GONNA BE A GOOD DAY!



## PEIRCE QUINCUNCIAL



YOU THINK THAT WHEN WE LOOK AT A MAP, WHAT WE REALLY SEE IS OURSELVES. AFTER YOU FIRST SAW *INCEPTION*, YOU SAT SILENT IN THE THEATER FOR SIX HOURS. IT FREAKS YOU OUT TO REALIZE THAT EVERYONE AROUND YOU HAS A SKELETON INSIDE THEM. YOU *HAVE* REALLY LOOKED AT YOUR HANDS.

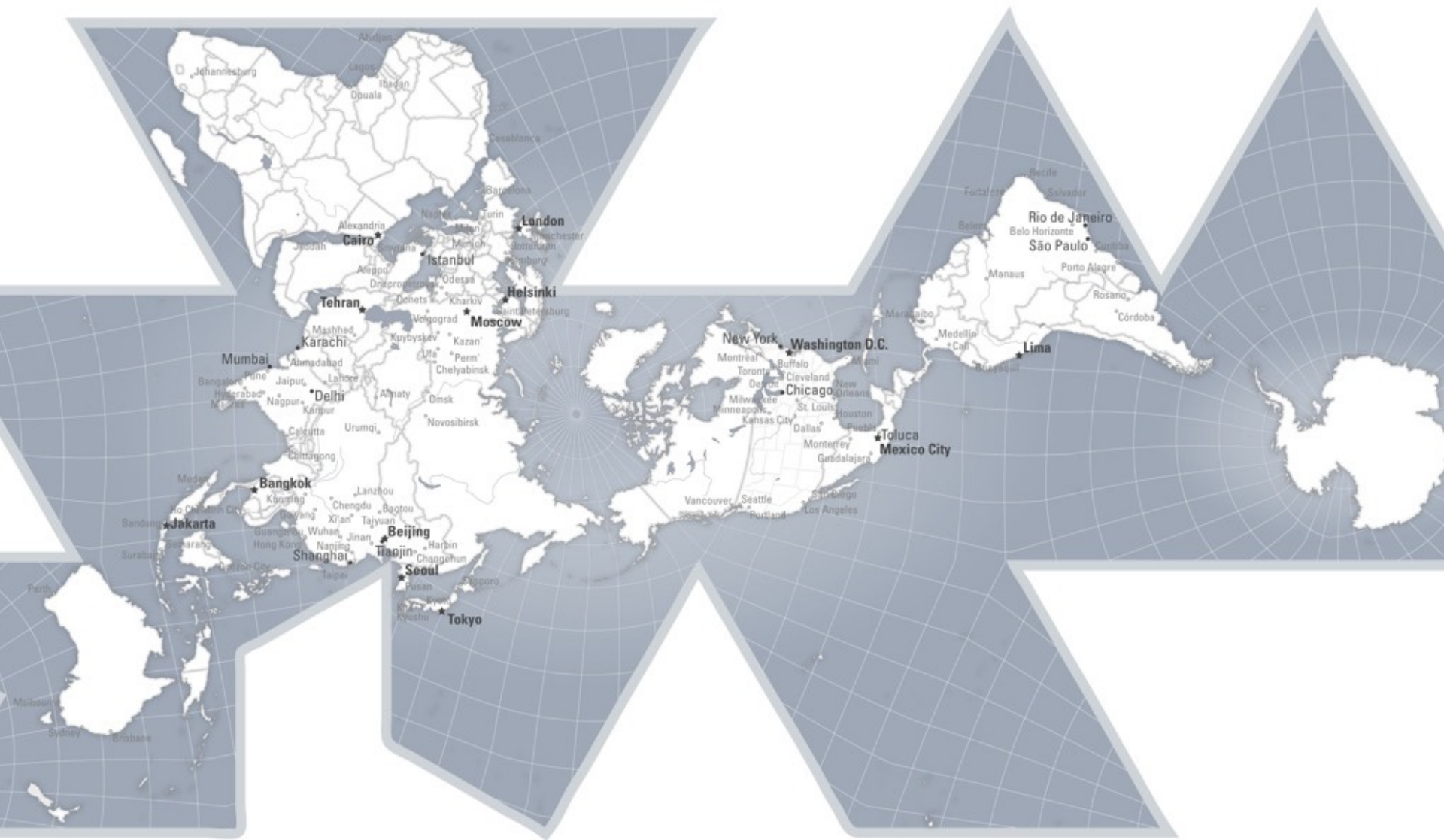


**There are interesting  
ways to tear spheres**



One notable interesting  
way to tear a sphere

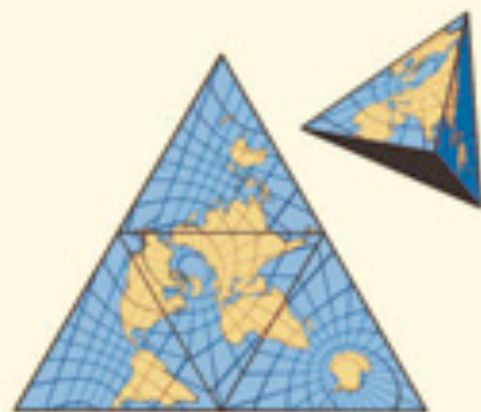




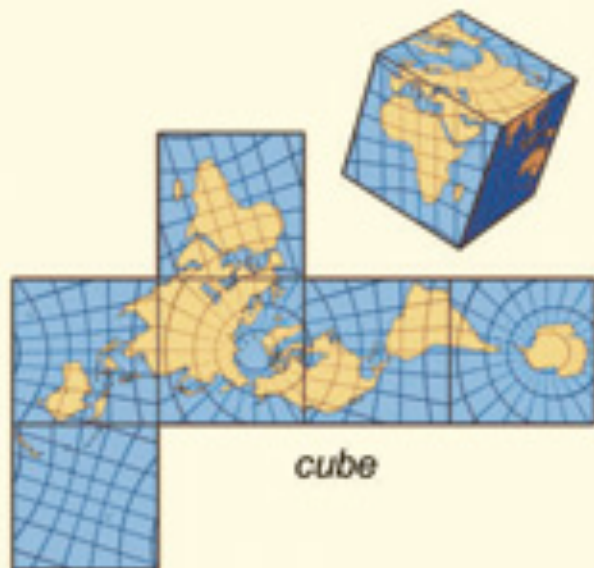
Balances preservation of area and shape.

*Provides different ways of thinking about the world!*

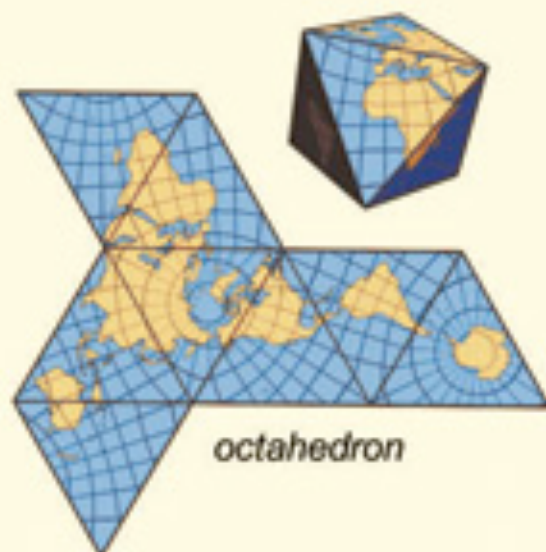




*tetrahedron*



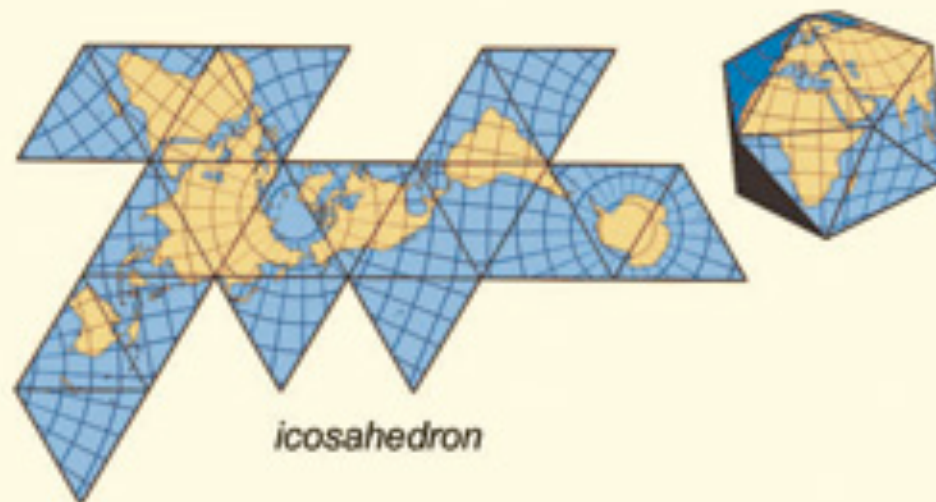
*cube*



*octahedron*



*dodecahedron*



*icosahedron*





## ADAPTIVE COMPOSITE MAP PROJECTIONS

---

Idea: switch *between* projections by location and zoom level

Scale



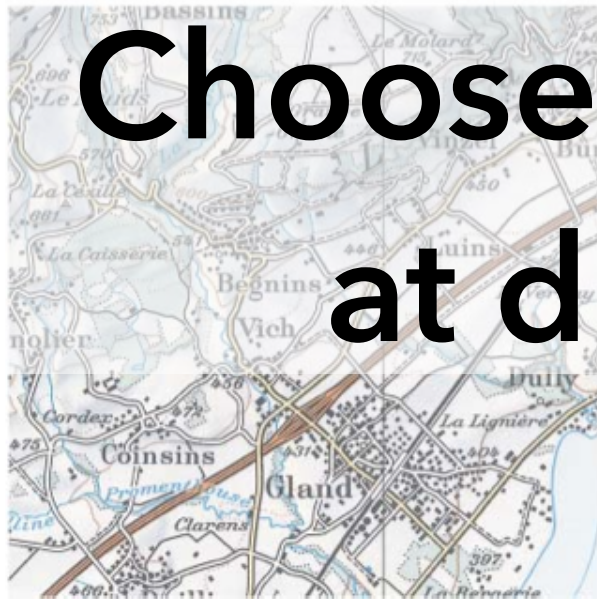
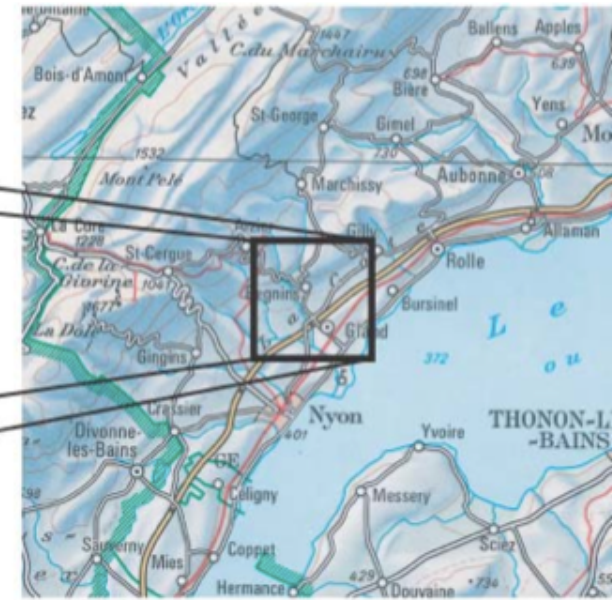
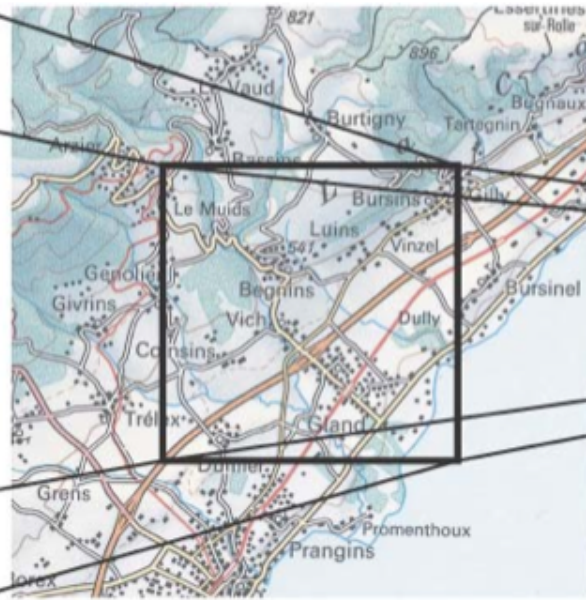
This is not "scale"

Texas-Europe Size Comparison

# Scale is an idea imported from print







**Choose the right content  
at different scales**



our maps, same ar

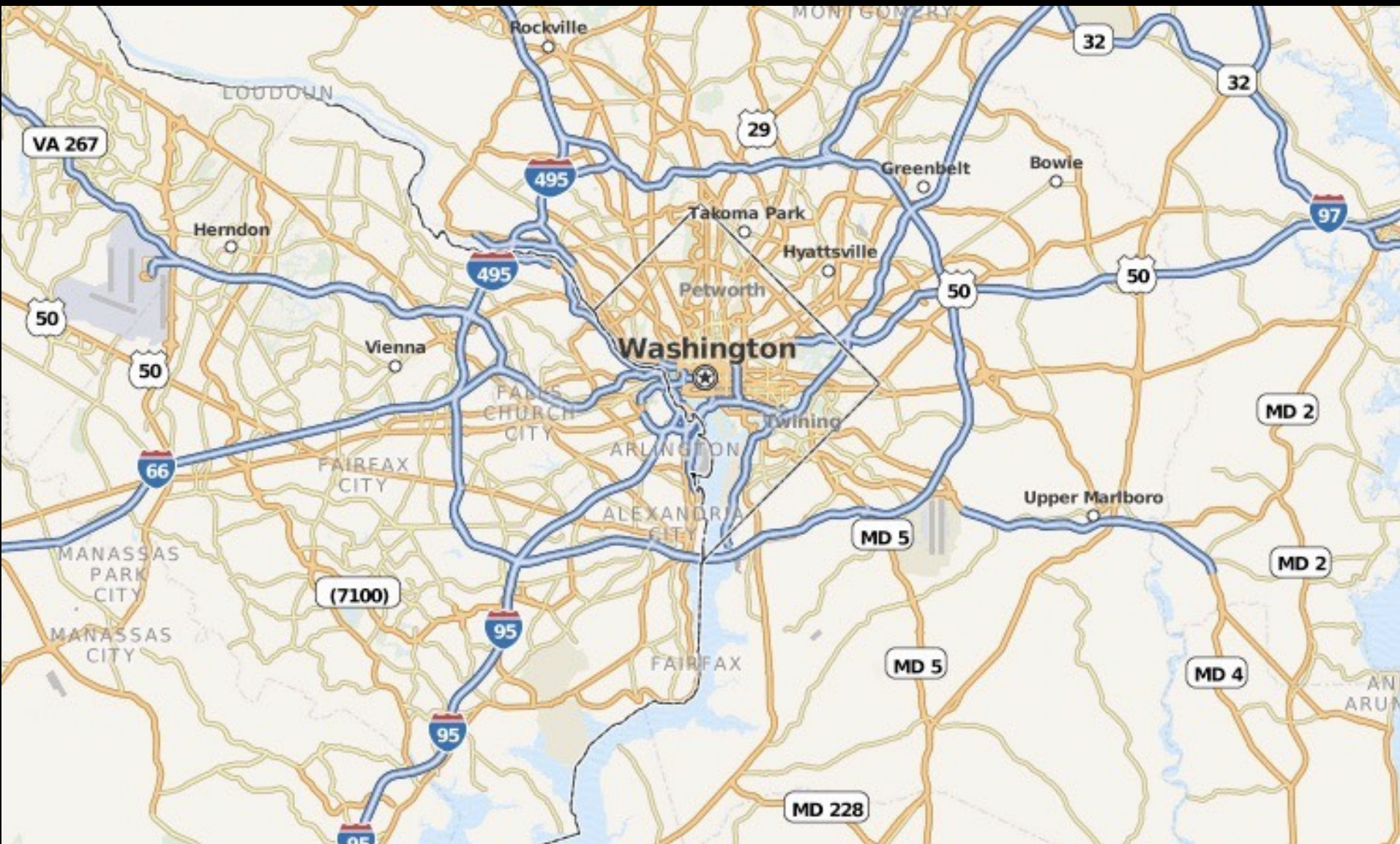
# What shows at different scales?



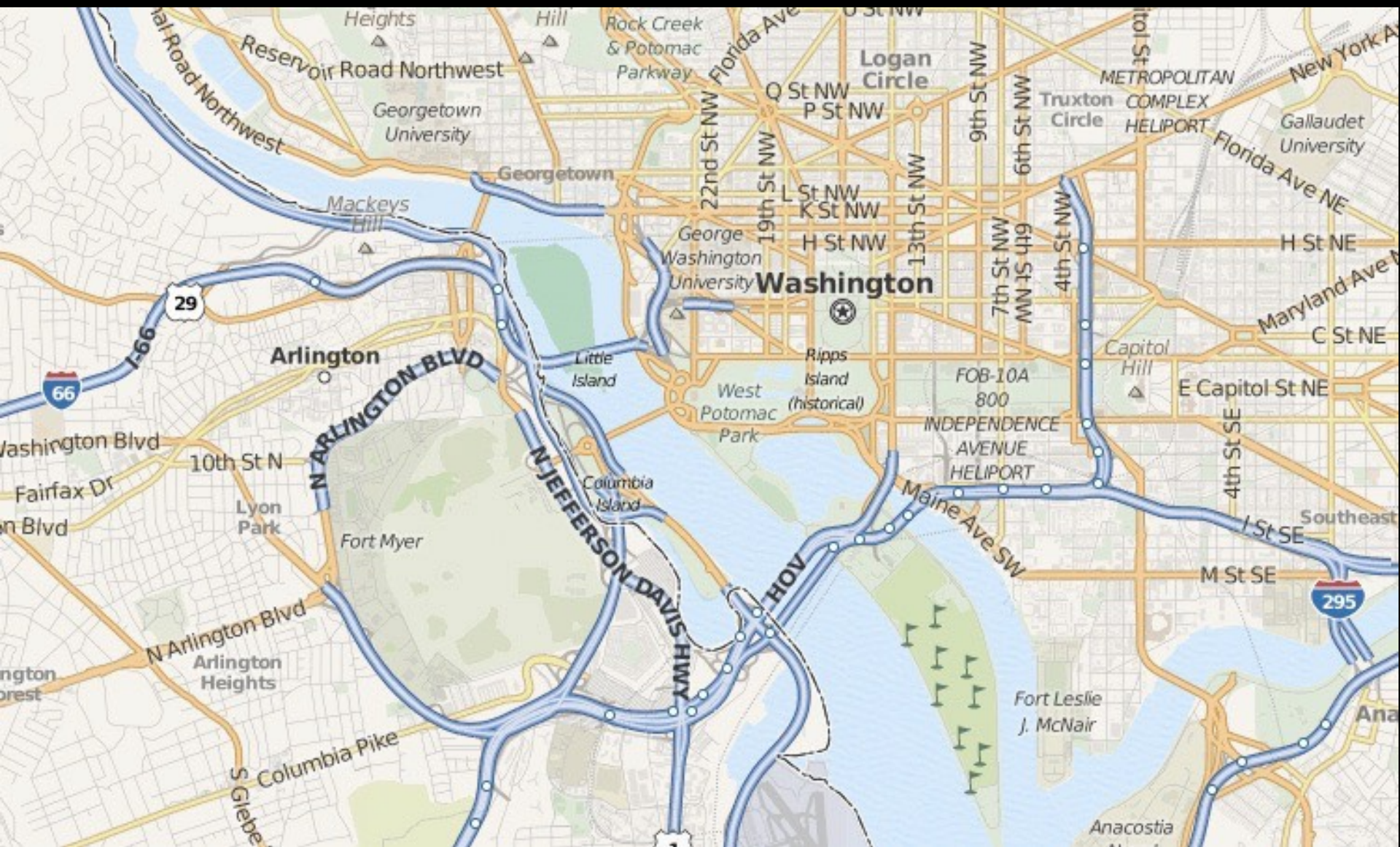




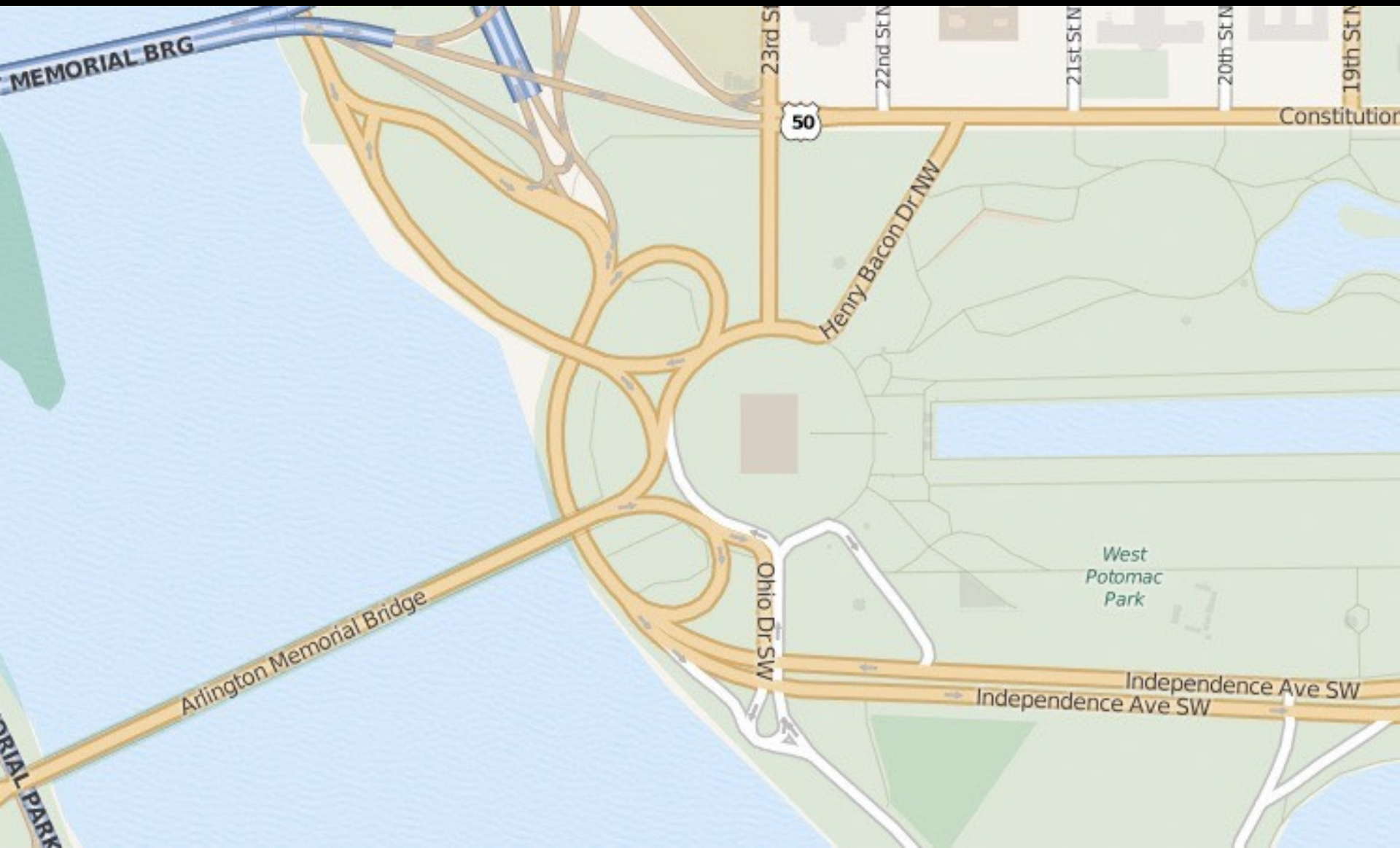












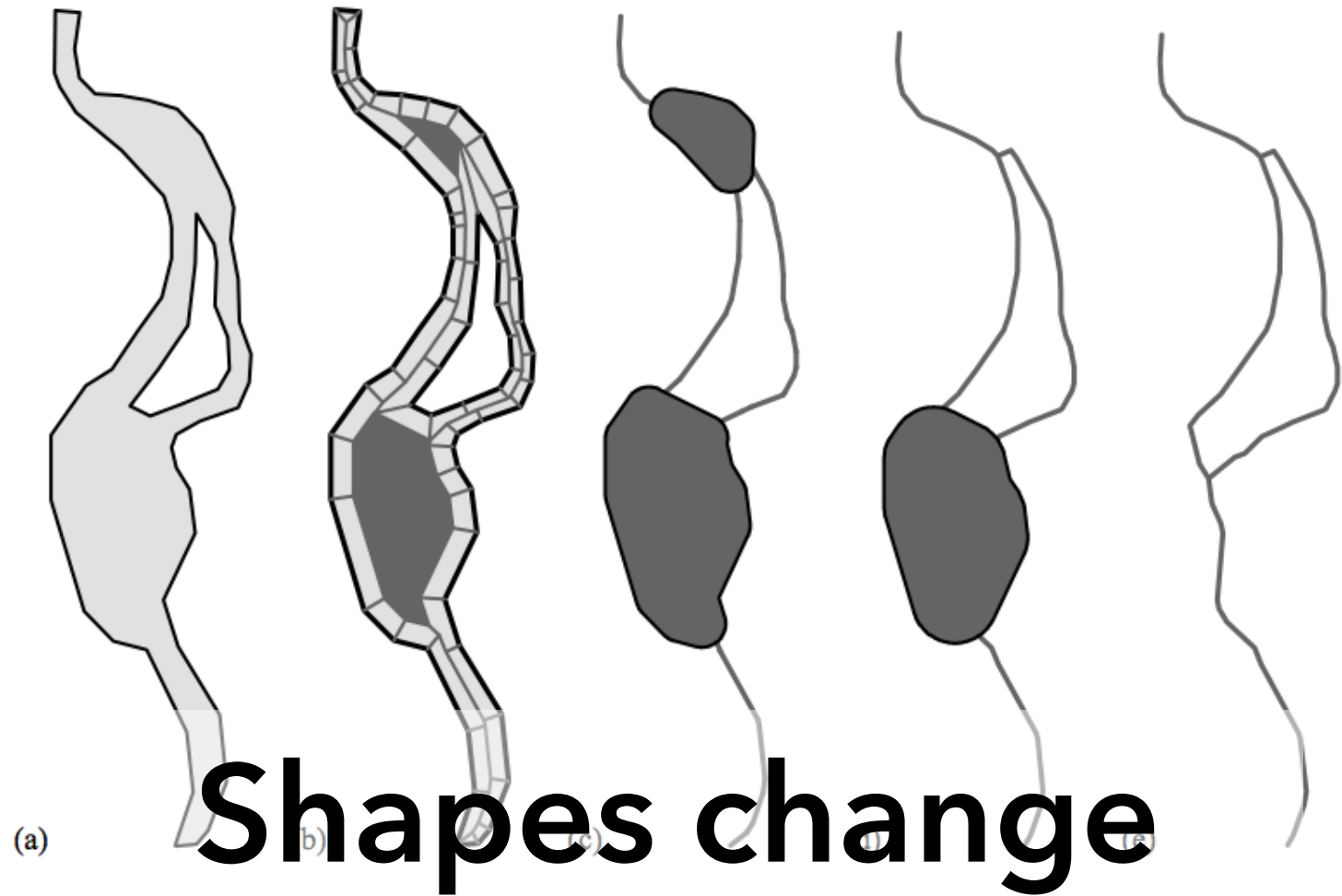


Figure 11. Fragmentation of a river into polygons and lines with different thresholds leading to different results (c, d, e).

# Shapes change at different scales



**Questions?**

# Administrivia

# A2: Deceptive Visualization

Design **two** static visualizations for a dataset:

1. An *earnest* visualization that faithfully conveys the data
2. A *deceptive* visualization that tries to mislead viewers

Your two visualizations may address different questions.

Try to design a deceptive visualization that appears to be earnest: *can you trick your classmates and course staff?*

You are free to choose your own dataset, but we have also provided some preselected datasets for you.

Submit two images and a brief write-up on Canvas.

Due by **Wed 1/26 11:59pm**.



# A2 Peer Reviews

On Thursday 1/27 you will be assigned two peer A2 submissions to review. For each:

- Try to determine which is earnest and which is deceptive
- Share a rationale for how you made this determination
- Share feedback using the “I Like / I Wish / What If” rubric

Assigned reviews will be posted on the A2 Peer Review page on Canvas, along with a link to a Google Form. You should submit two forms: one for each A2 peer review.

Due by **Mon 1/31 11:59pm**.

# I Like... / I Wish... / What If?

## I LIKE...

Praise for design ideas and/or well-executed implementation details. *Example: "I like the navigation through time via the slider; the patterns observed as one moves forward are compelling!"*

## I WISH...

Constructive statements on how the design might be improved or further refined. *Example: "I wish moving the slider caused the visualization to update immediately, rather than the current lag."*

## WHAT IF?

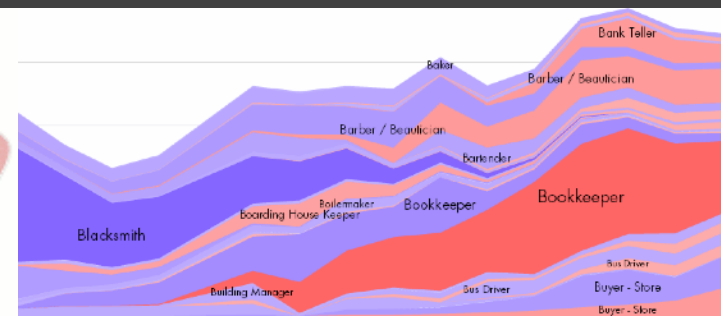
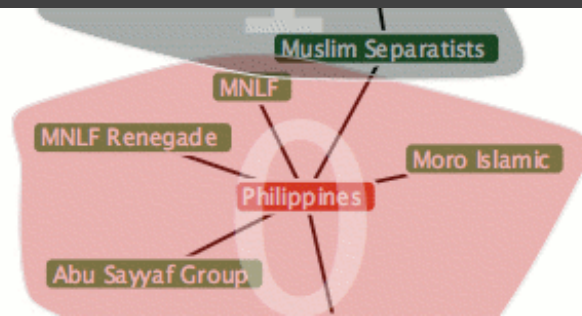
Suggest alternative design directions, or even wacky half-baked ideas. *Example: "What if we got rid of the slider and enabled direct manipulation navigation by dragging data points directly?"*

# A3: Interactive Prototype

Create an interactive visualization. Choose a driving question for a dataset and develop an appropriate visualization + interaction techniques, then deploy your visualization on the web.

Due by *11:59pm* on **Monday, February 14.**

Work in project teams of 3-4 people.



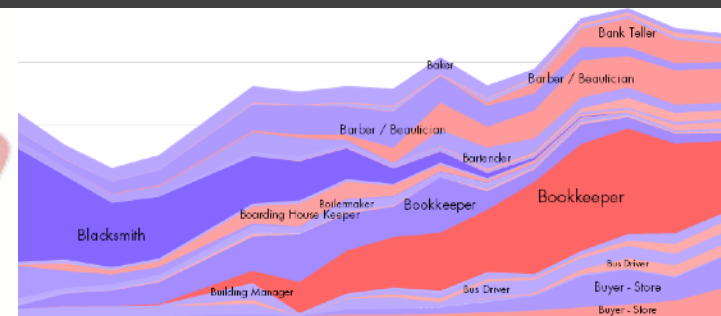
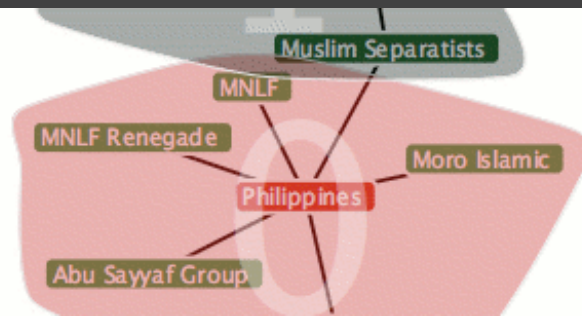
# Form A3 + Final Project Team

Form a **team of 3-4** for A3 and the Final Project.

Submit signup form by **Friday 2/4, 11:59pm**.

**If you do not have team mates**, post on Ed about your interests/skills/project ideas!

We will send out a reminder early next week.



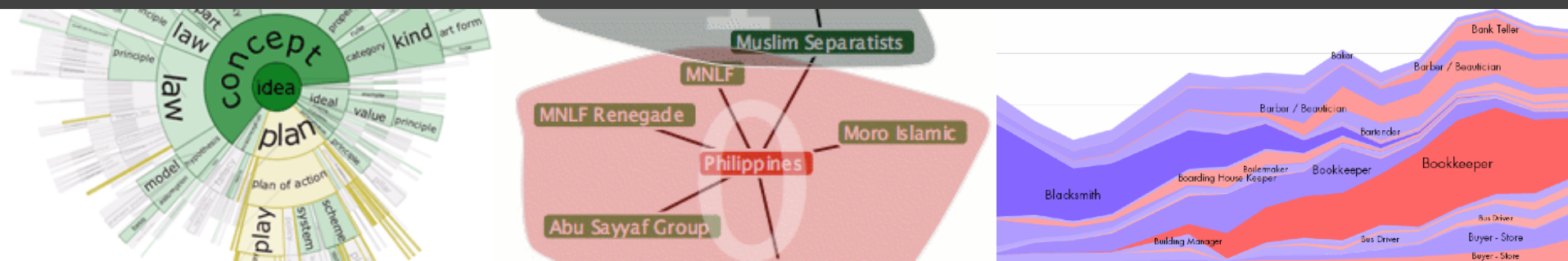


# Requirements

**Interactive.** You must implement interaction methods! However, this is not only selection / filtering / tooltips. Also consider annotations or other narrative features to draw attention and provide additional context

**Web-based.** D3/Vega-Lite are encouraged, but not required. Deploy to web using GitHub pages.

**Write-up.** Provide design rationale.

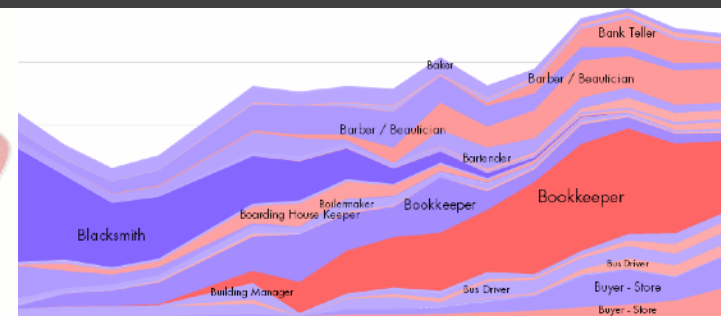
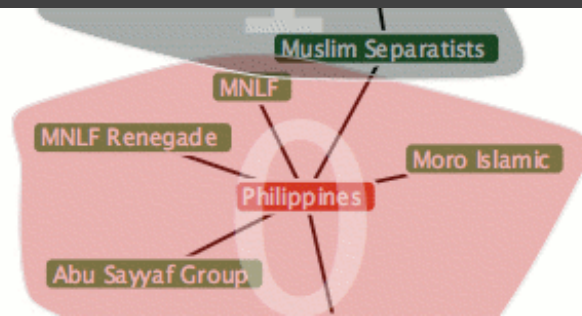


# Interactive Prototype Tips

**Start now.** It will take longer than you think.

**Keep it simple.** Choose a *minimal* set of interactions that enables users to explore and generate interesting insights. Do not feel obligated to convey *everything* about the data: focus on a compelling subset.

**Promote engagement.** How do your chosen interactions reveal interesting observations?



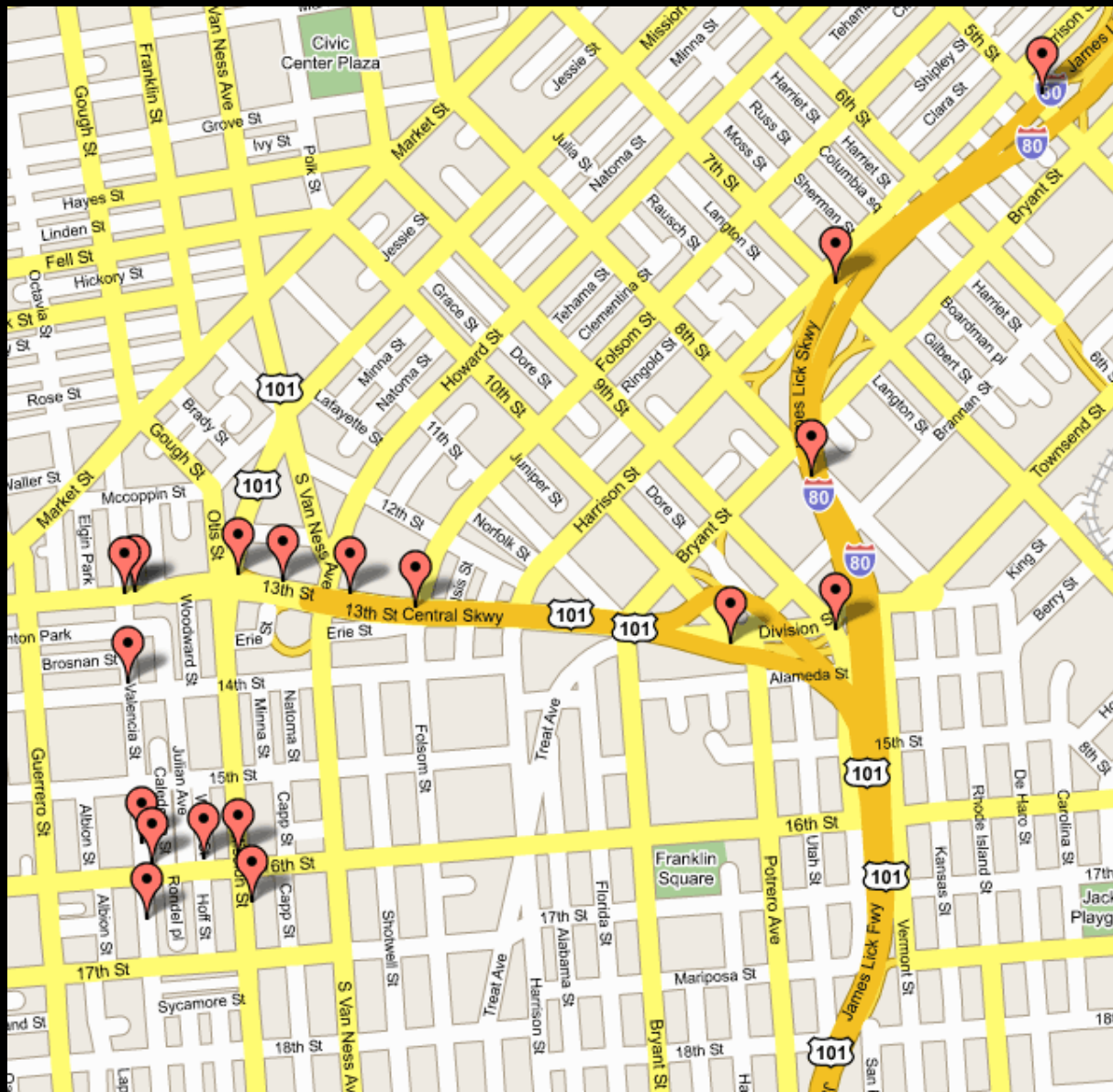
# Mapping

Visualizing Geospatial Data

# Symbol Maps

Convey Locations & Magnitudes



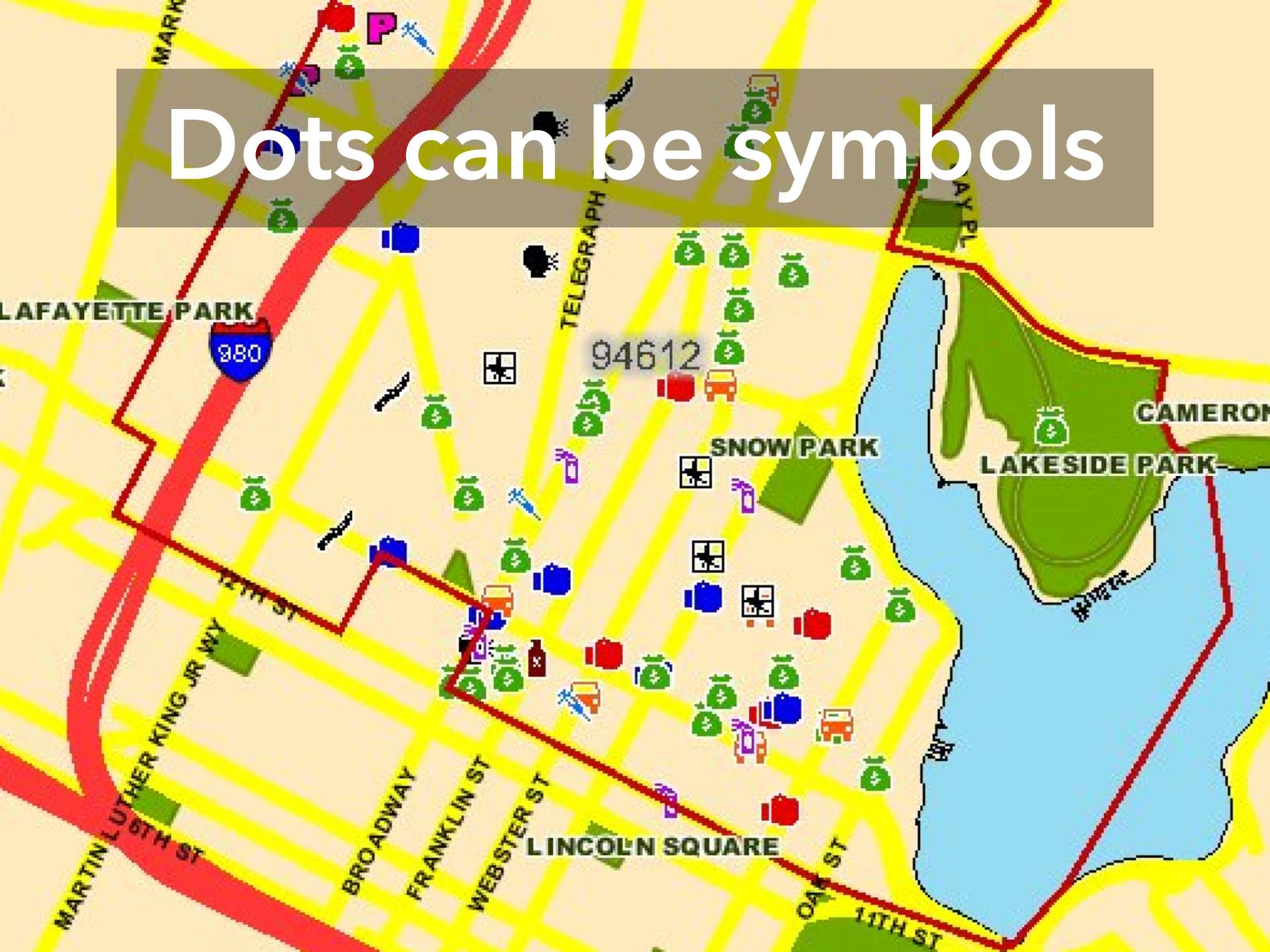


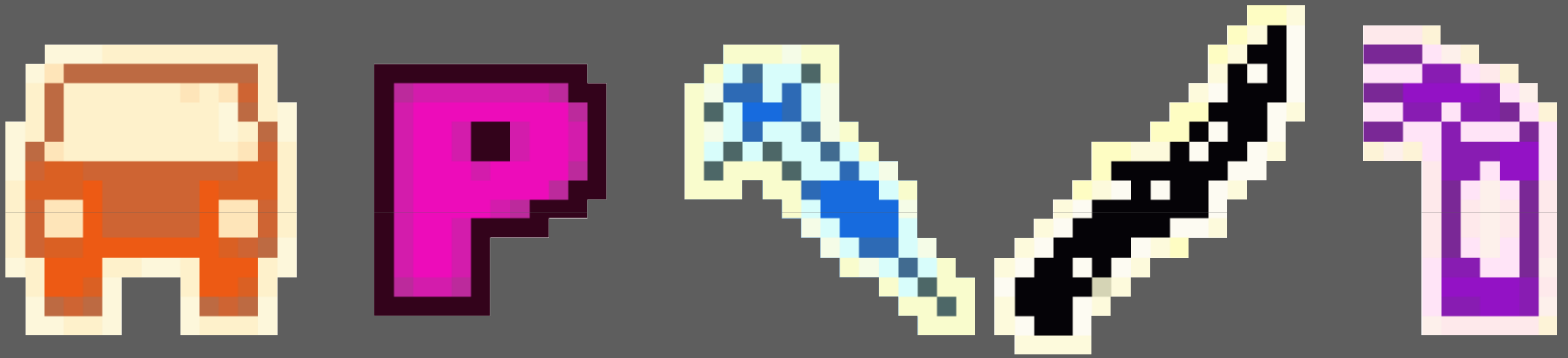
Dots are ubiquitous





# Dots can be symbols





Guess the crime



# Dots can can be good symbols

## TIME OF DAY

Show All | Hide All

Light | Dark [nearest hour]

Commute | Nightlife

Day | Night | Swing Shift



## DATE

Past Week

Sep 2009

AUG 17 2009 AUG 24 2009 AUG 31 2009 SEP 7 2009

T W Th F S S M T W Th F S S M T W Th F S S M

## CRIME TYPE [Show All](#) | [Hide All](#)

- AA Aggravated Assault
- Mu Murder
- Ro Robbery
- SA Simple Assault
- DP Disturbing the Peace
- Na Narcotics
- Al Alcohol
- Pr Prostitution
- Th Theft
- VT Vehicle Theft
- Va Vandalism
- Bu Burglary
- Ar Arson

237

Joseph R. Biden Jr.

70,122,063 votes (50.2%)

87

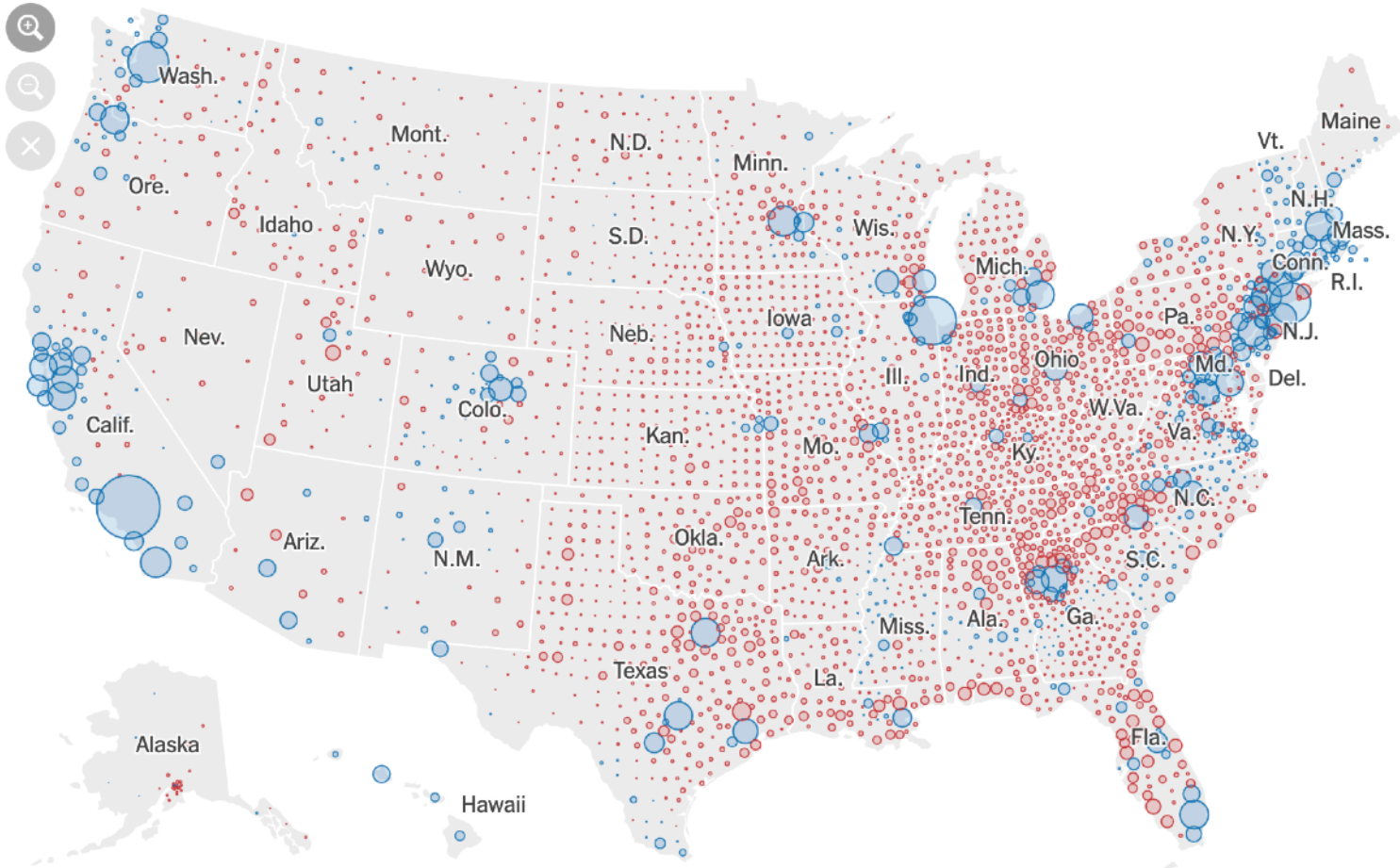
remaining

270  
TO WIN

214

Donald J. Trump

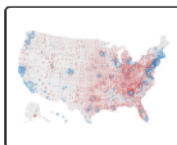
67,075,300 votes (48.0%)



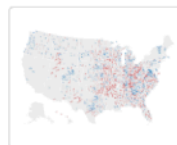
By winner



Electoral votes



Size of lead

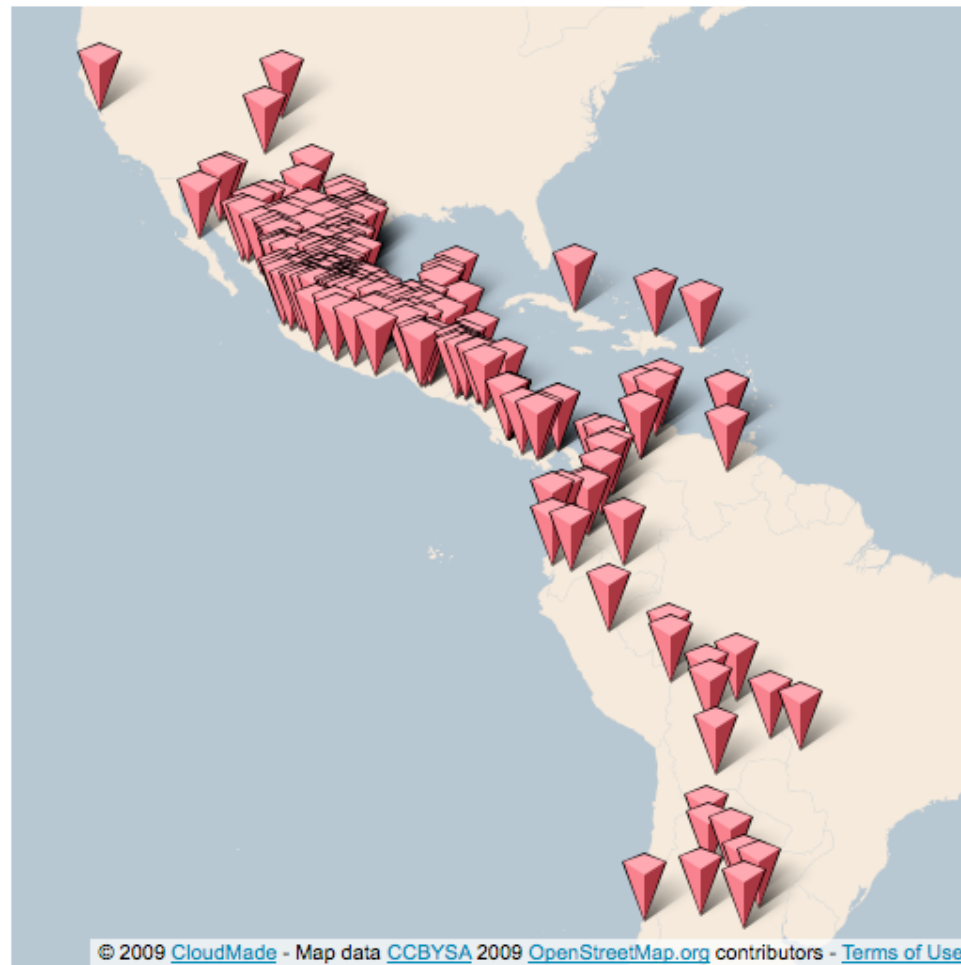


Shift from 2016

**LEADER:** ● Biden ● Trump  
Circle size is proportional to the amount each county's leading candidate is ahead.

Symbol Map  
[NY Times]

# "Red Dot Fever"





# Mapping America: Every City, Every Block

Find something interesting? Share this view on [Twitter](#) or [Facebook](#)

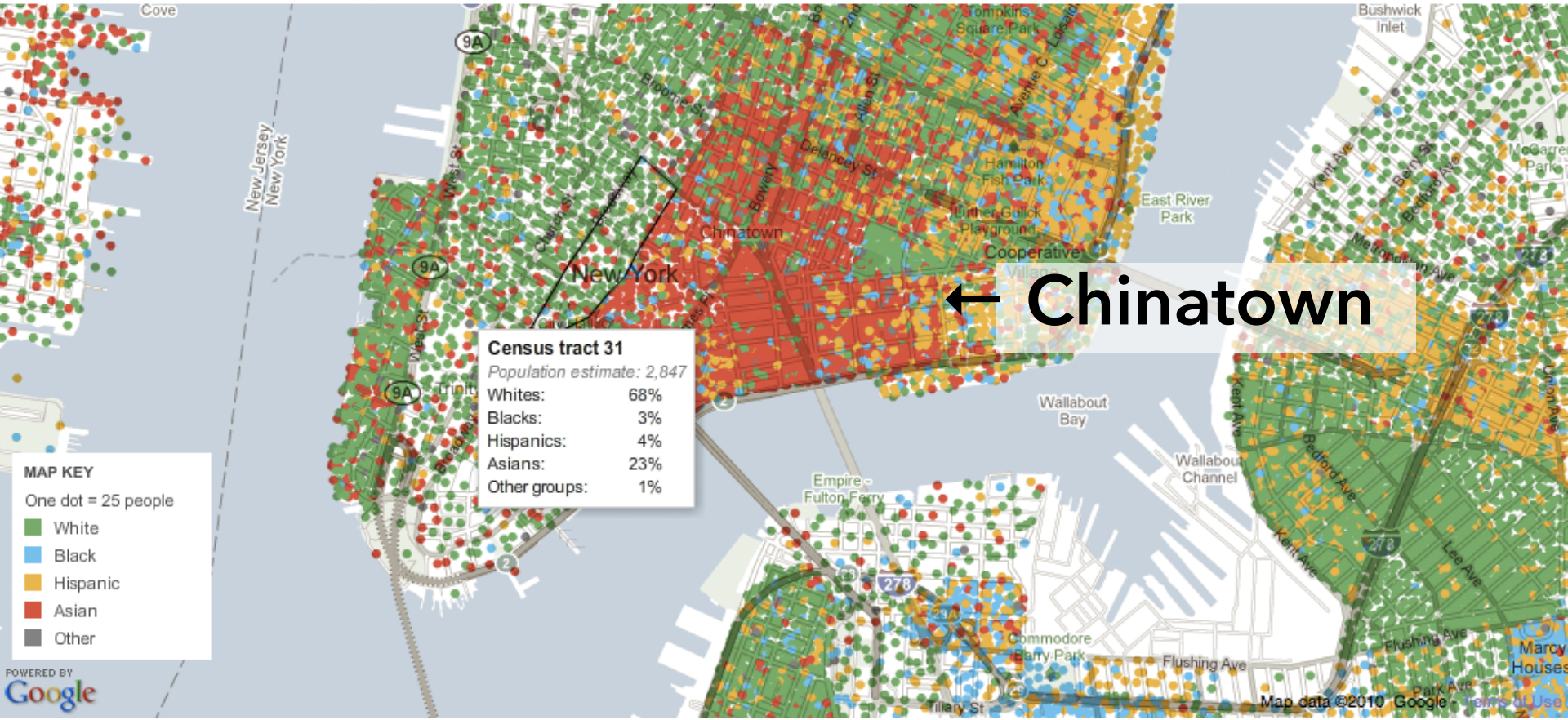
Browse local data from the Census Bureau's American Community Survey, based on samples from 2005 to 2009. Because these figures are based on [View Readers Maps \(49\)](#) samples, they are subject to a margin of error, particularly in places with a low population, and are best regarded as estimates.

## Distribution of racial and ethnic groups

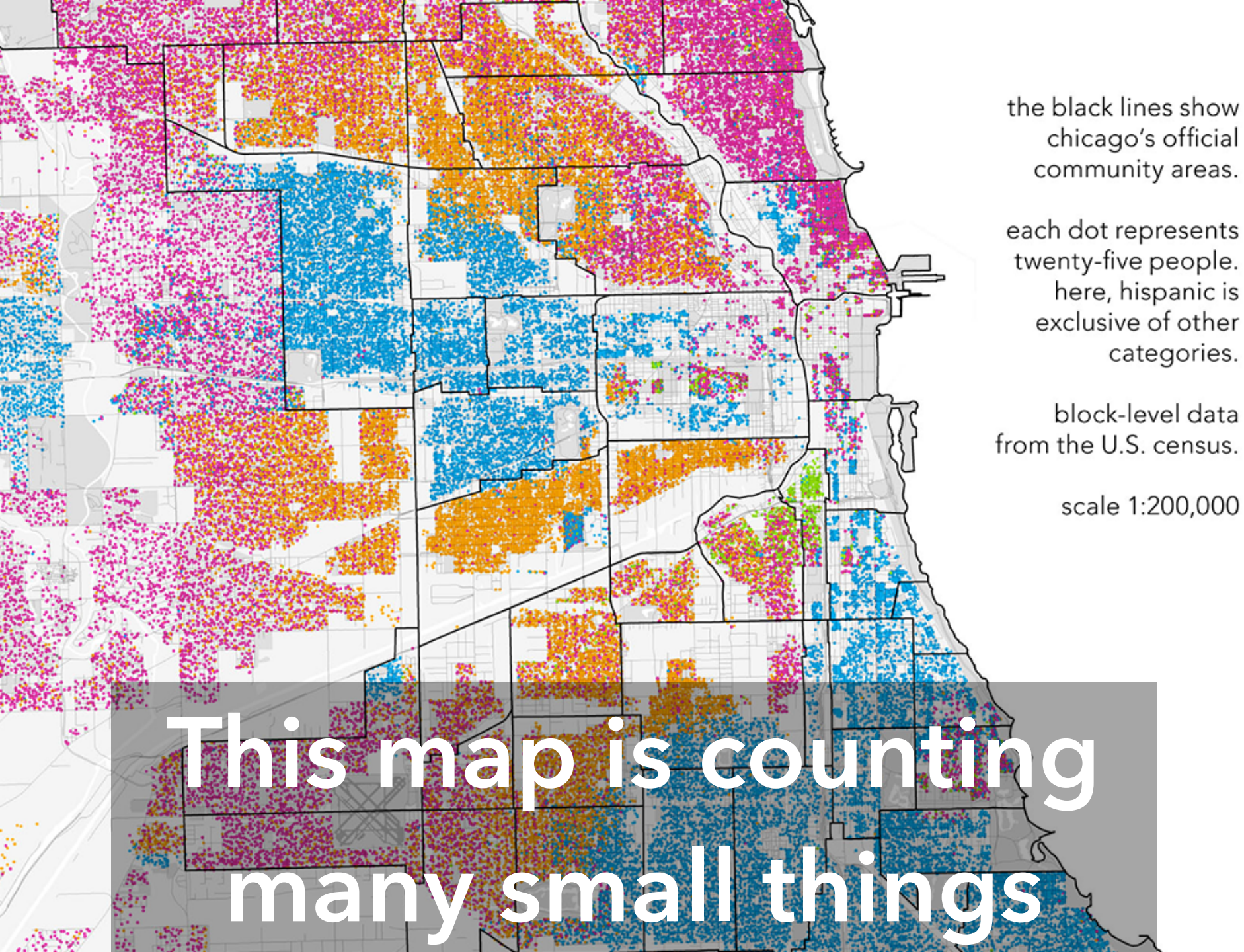
[View More Maps](#)

Address, ZIP code or city

Go







the black lines show  
chicago's official  
community areas.

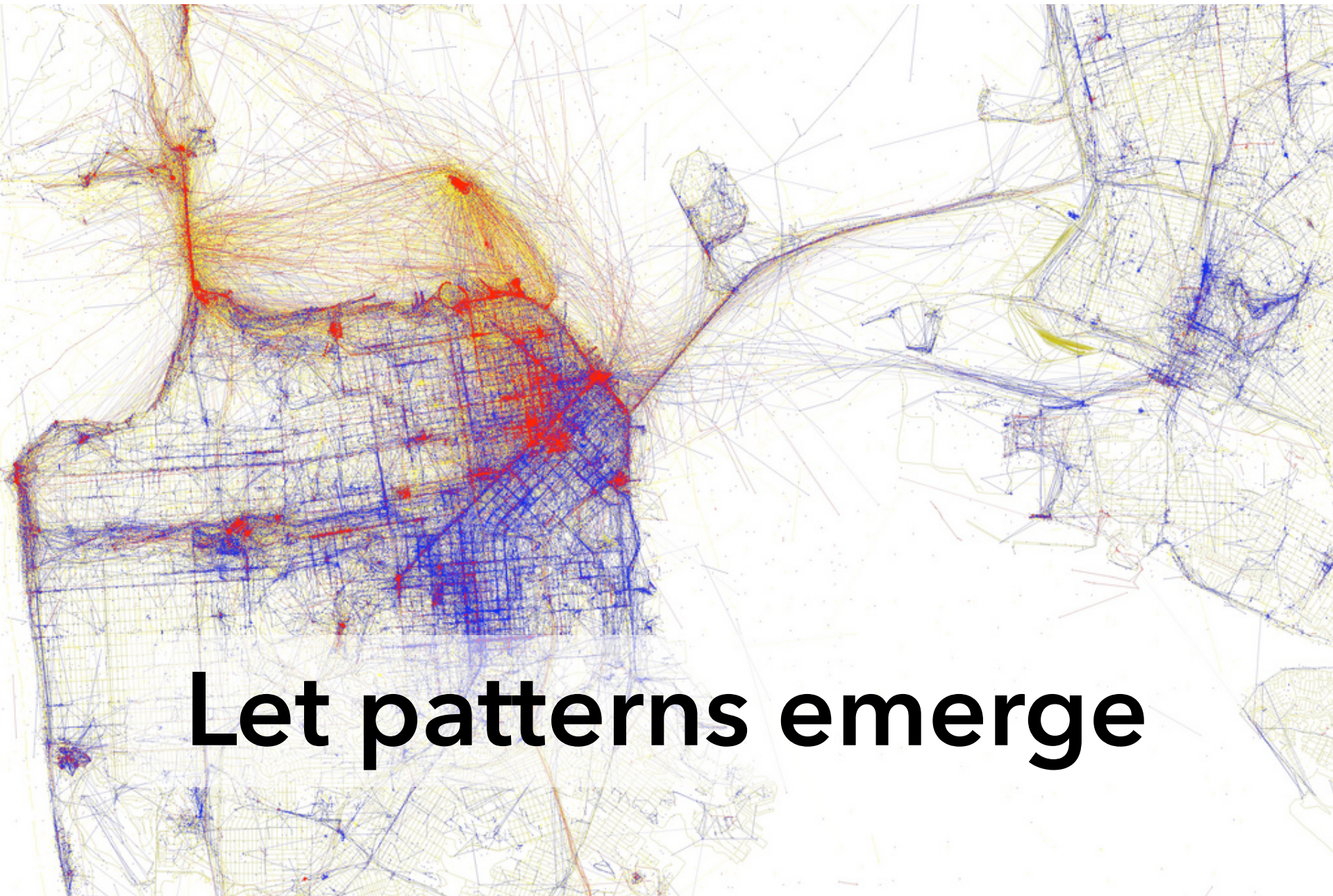
each dot represents  
twenty-five people.  
here, hispanic is  
exclusive of other  
categories.

block-level data  
from the U.S. census.

scale 1:200,000

This map is counting  
many small things

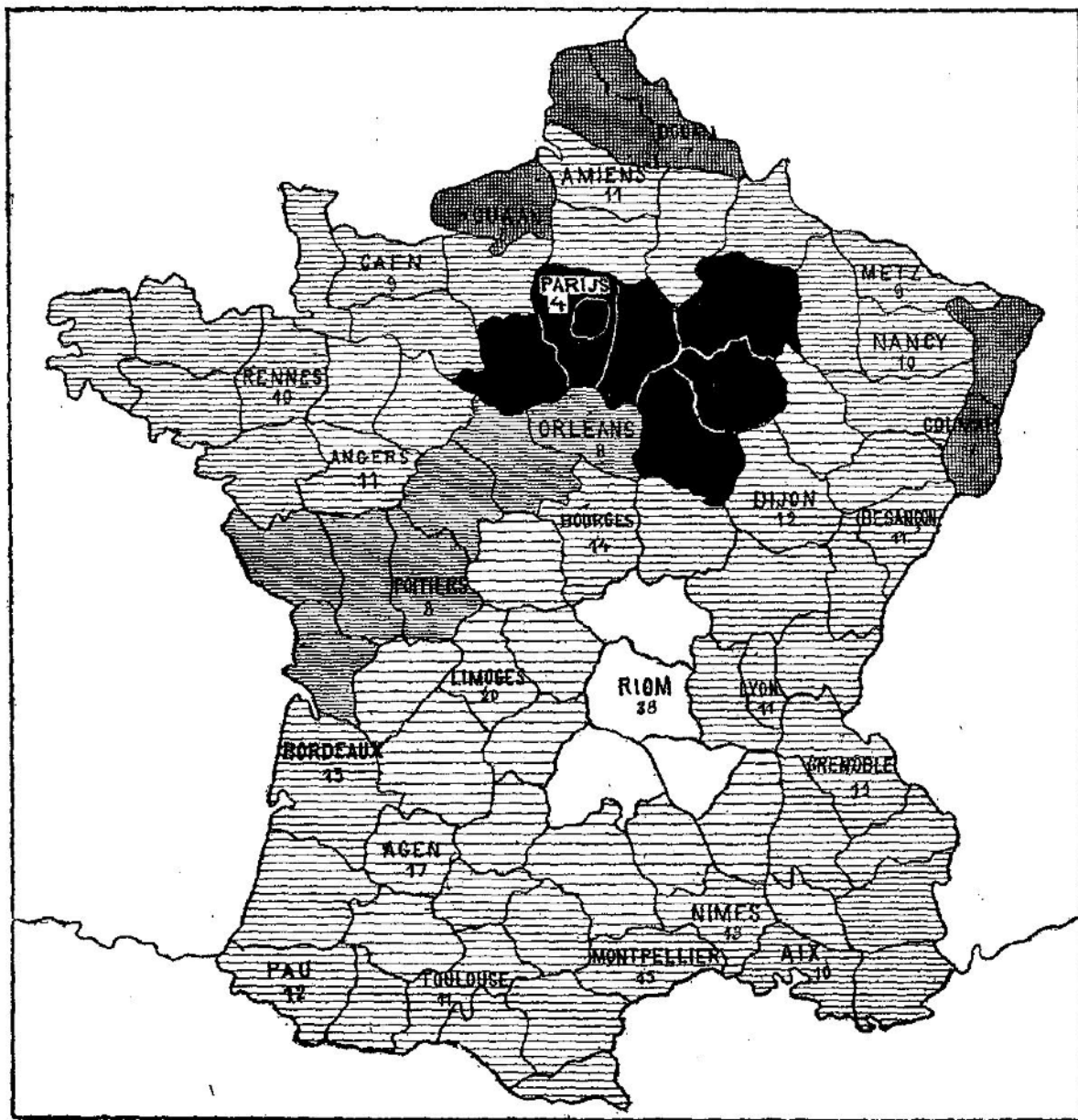




**Let patterns emerge**

# Choropleth Maps

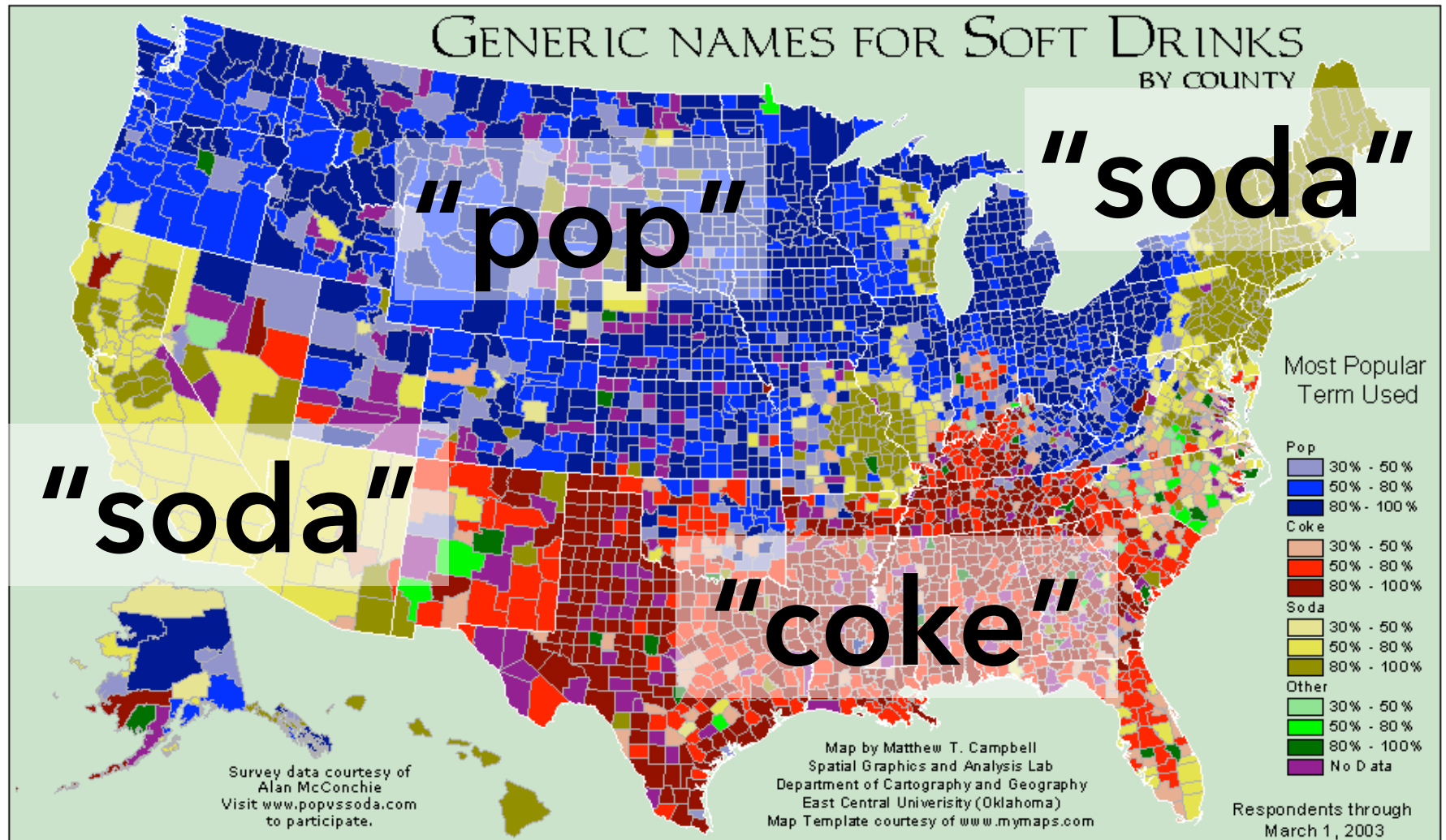
Convey Rates Across Regions



1826(?) Illiteracy in France, Pierre Charles Dupin

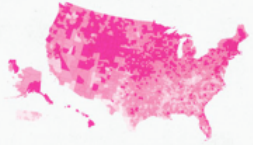


# GENERIC NAMES FOR SOFT DRINKS BY COUNTY



## READING, WRITING, AND EARNING MONEY

The latest data from the U.S. Census's American Community Survey paints a fascinating picture of the United States at the county level. We've looked at the educational achievement and the median income of the entire nation, to see where people are going to school, where they're earning money, and if there is any correlation.



A HIGH SCHOOL GRADUATES 65% 75% 82% 85%



B COLLEGE GRADUATES 15% 22% 30% 40%

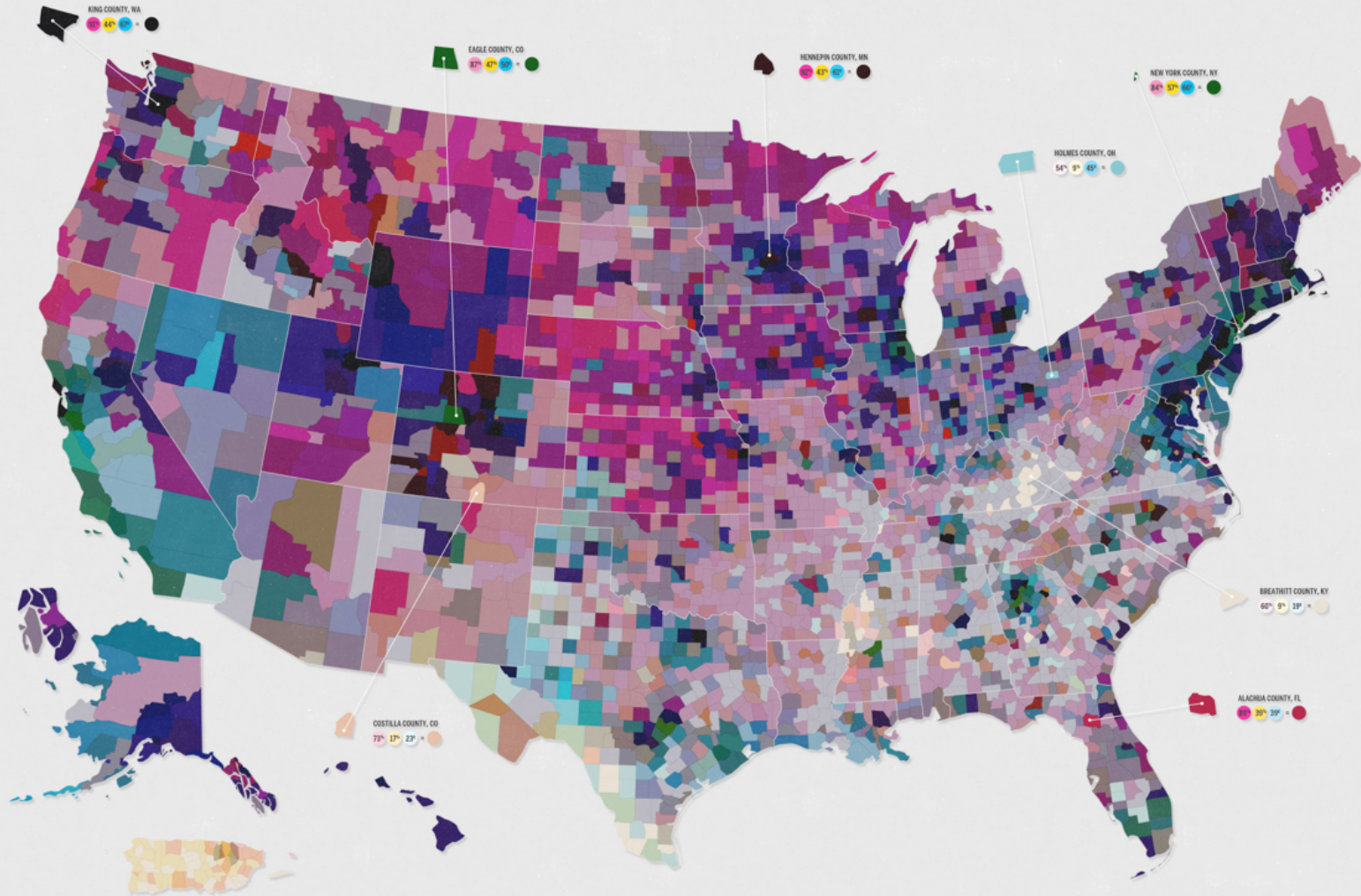


C MEDIAN HOUSEHOLD INCOME 25% 40% 50% 60%

The map at right is a product of overlaying the three sets of data. The variation in hue and value has been produced from the data shown above. In general, darker counties represent a more educated, better paid population while lighter areas represent communities with fewer graduates and lower incomes.



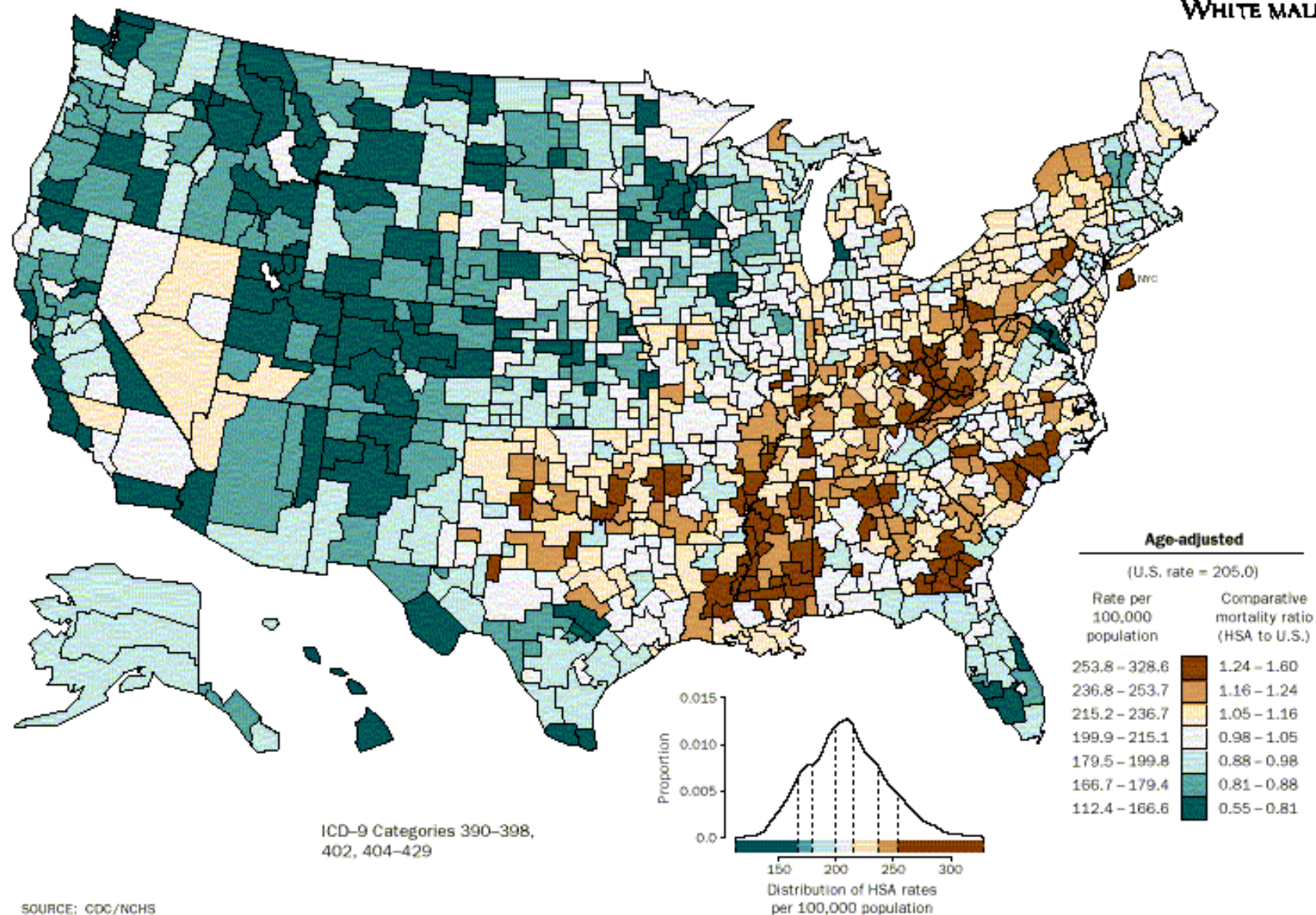
A collaboration between GOOD and Gregory Huback  
SOURCE: US Census



# Choose colors with care

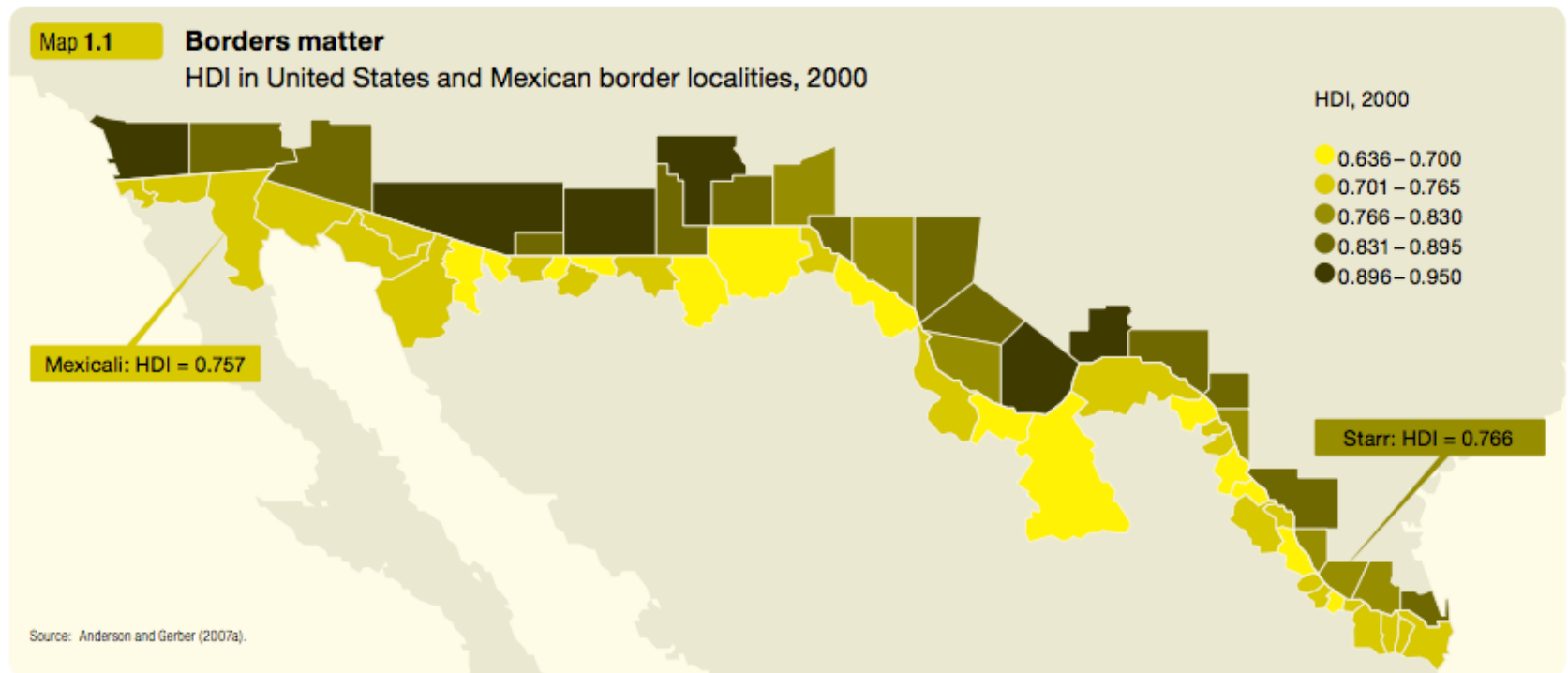


## AGE-ADJUSTED DEATH RATES BY HSA, 1988-92

HEART DISEASE  
WHITE MALE

SOURCE: CDC/NCHS

# Seven quantiles



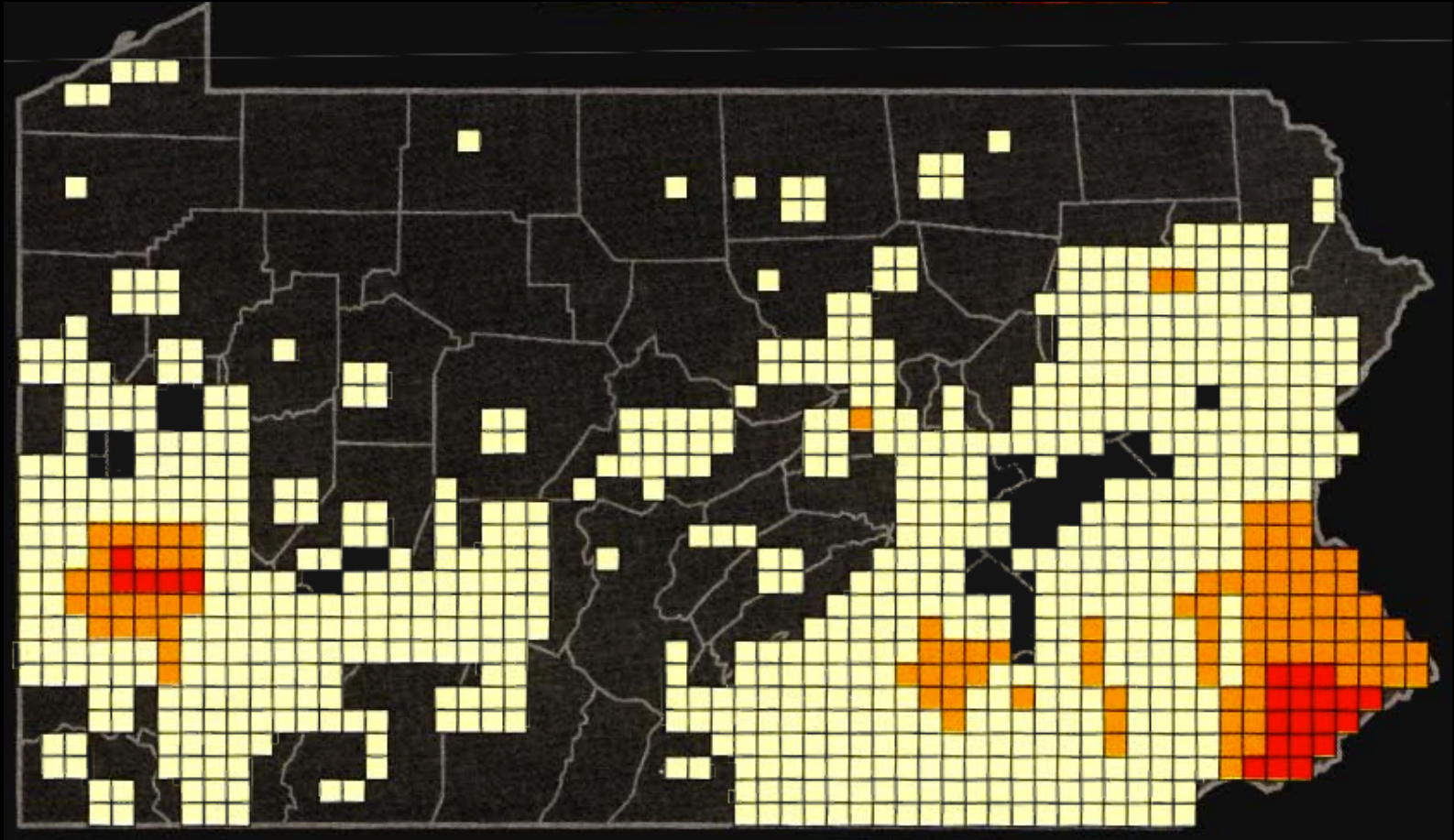
# Focus on the foreground



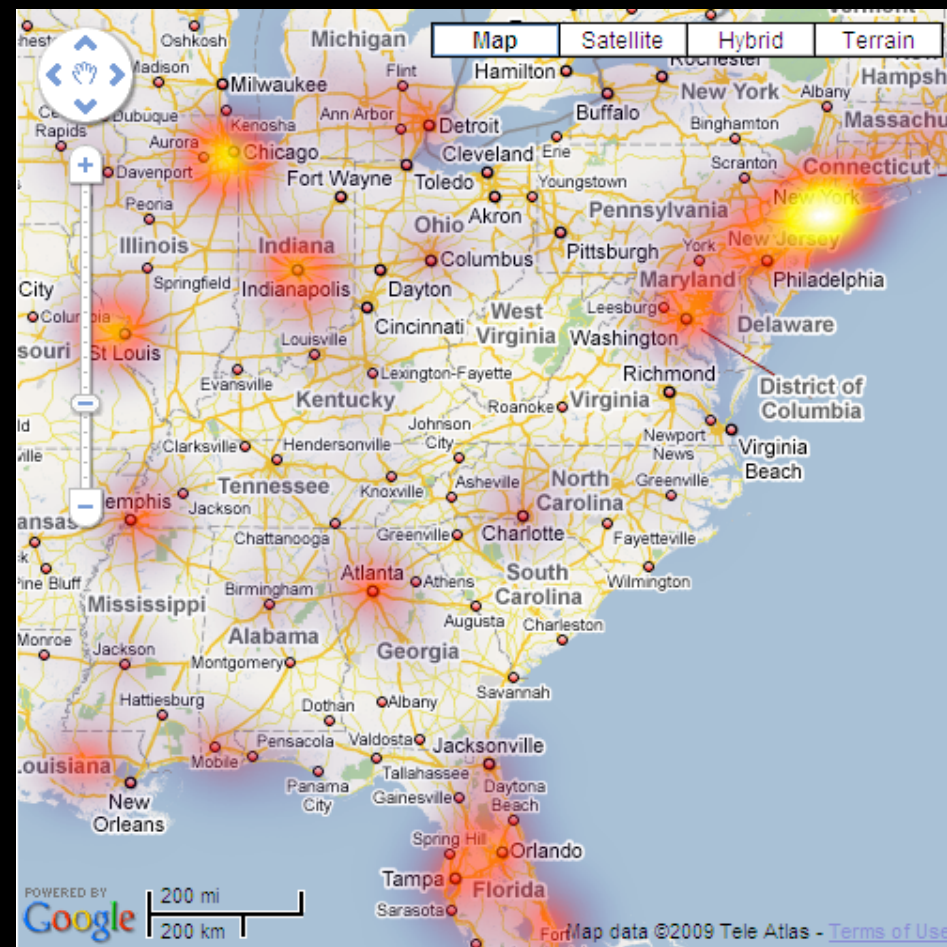
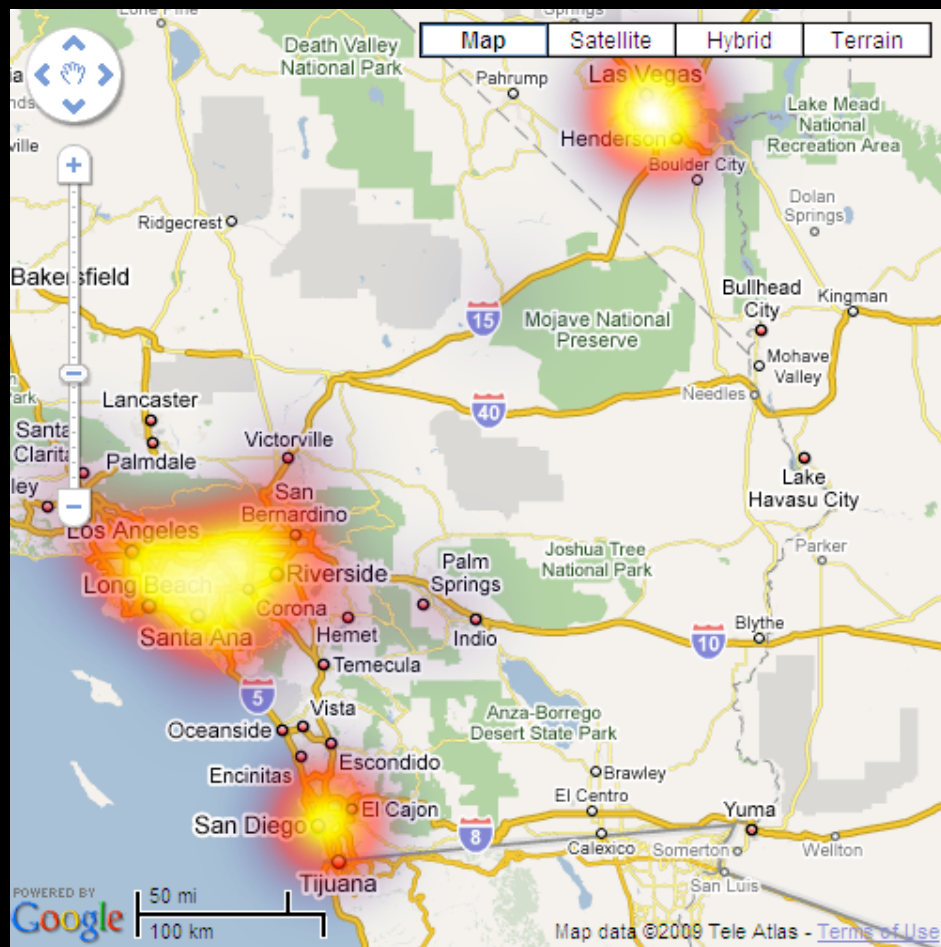
# Heatmaps / Contour Maps

Convey Continuous Data

# Binning



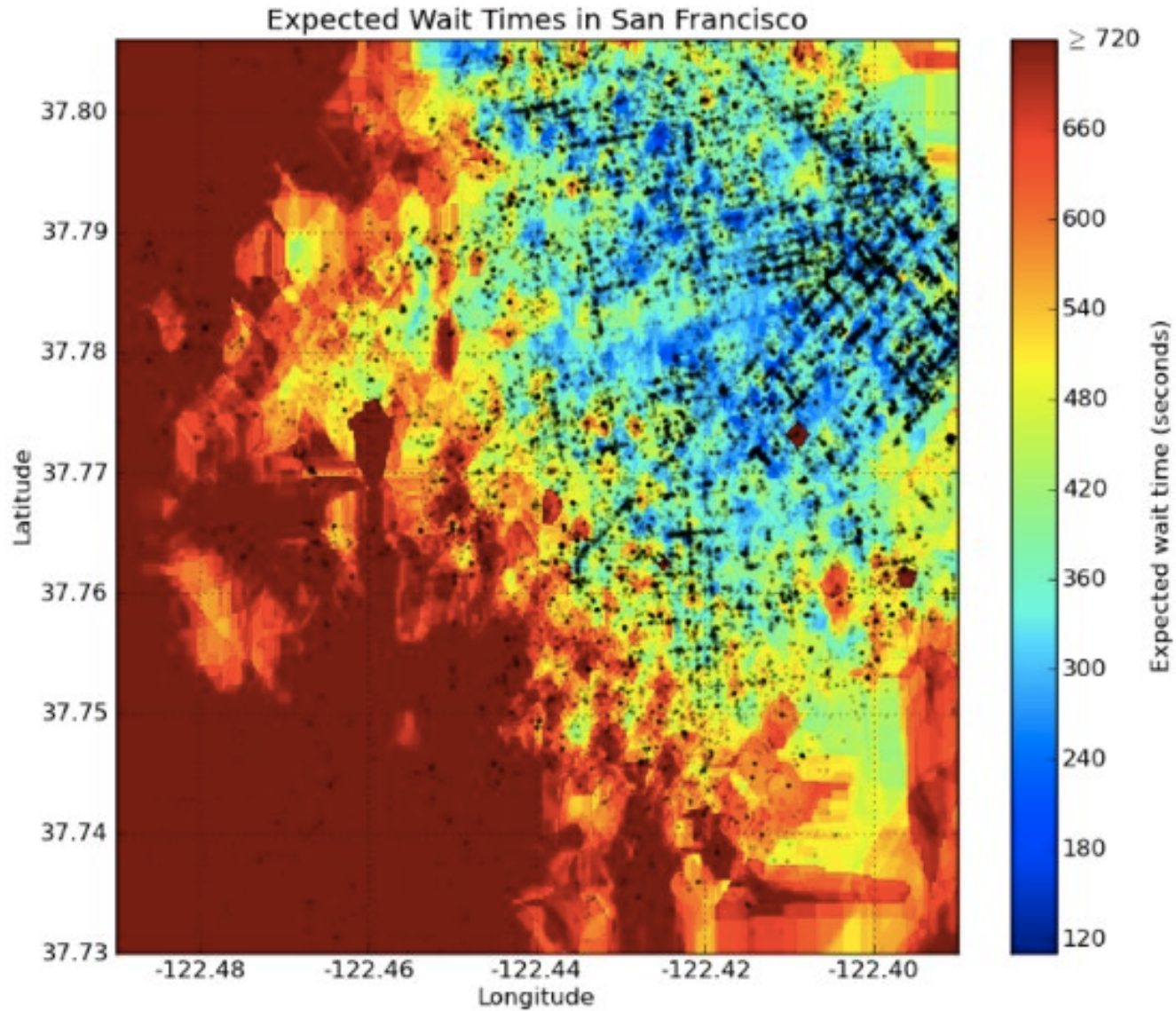
Chorodot Maps: Alan MacEachren and David DiBiase, 1991



# Don't hide the context



# Uber Wait Times, 2011





# Break data into buckets

## CRIMESPOTTING

The brazen 2007 murder of journalist Chauncey Bailey in Oakland, California, led Stamen partner Mike Migurski to

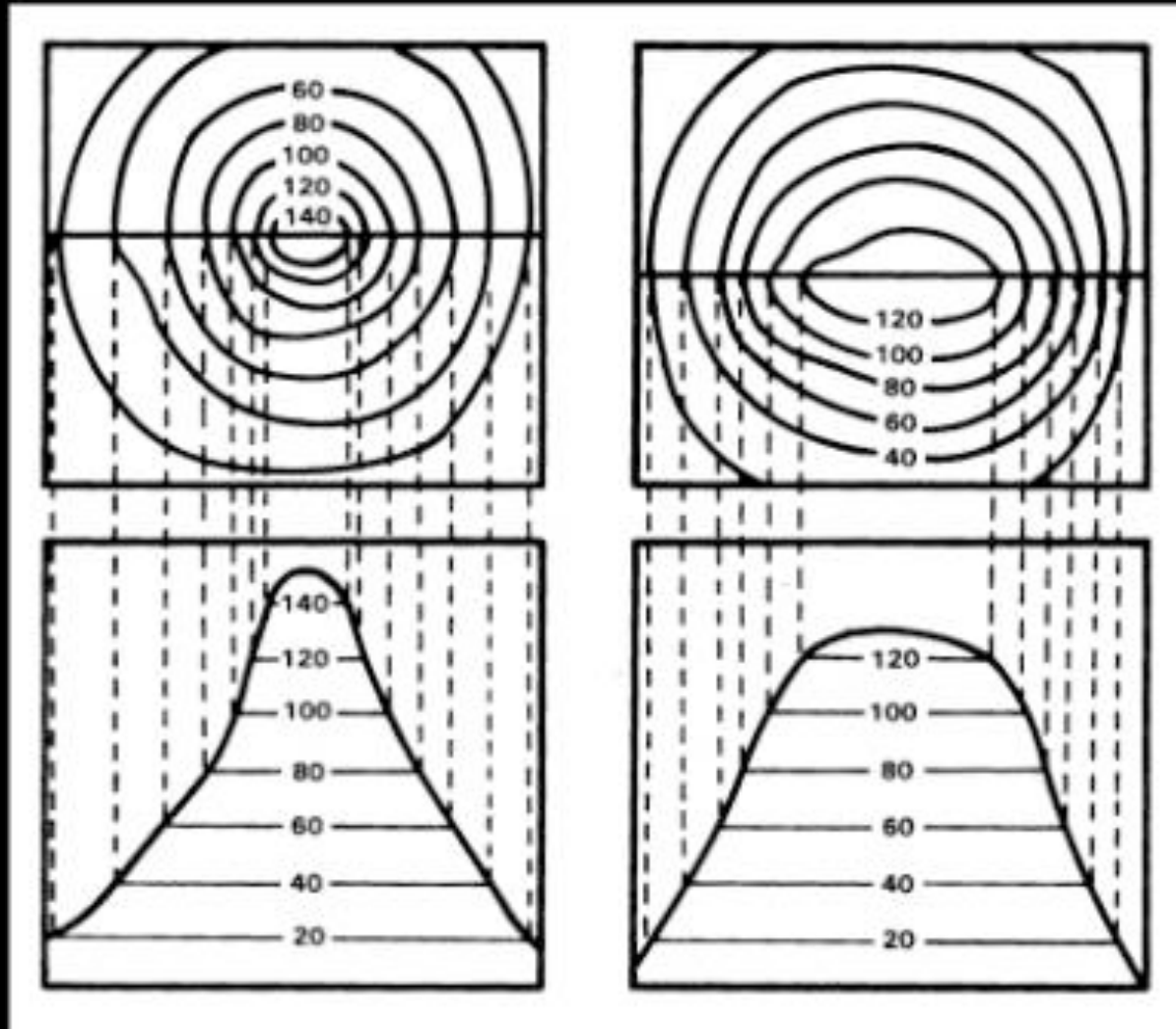
make the city's crime data more accessible. This heat map of downtown uses data from CrimeWatch, a community website,

to show the gaps between crimes at a given intersection: white is high-crime; darker areas are safe. [stamen.com](http://stamen.com)

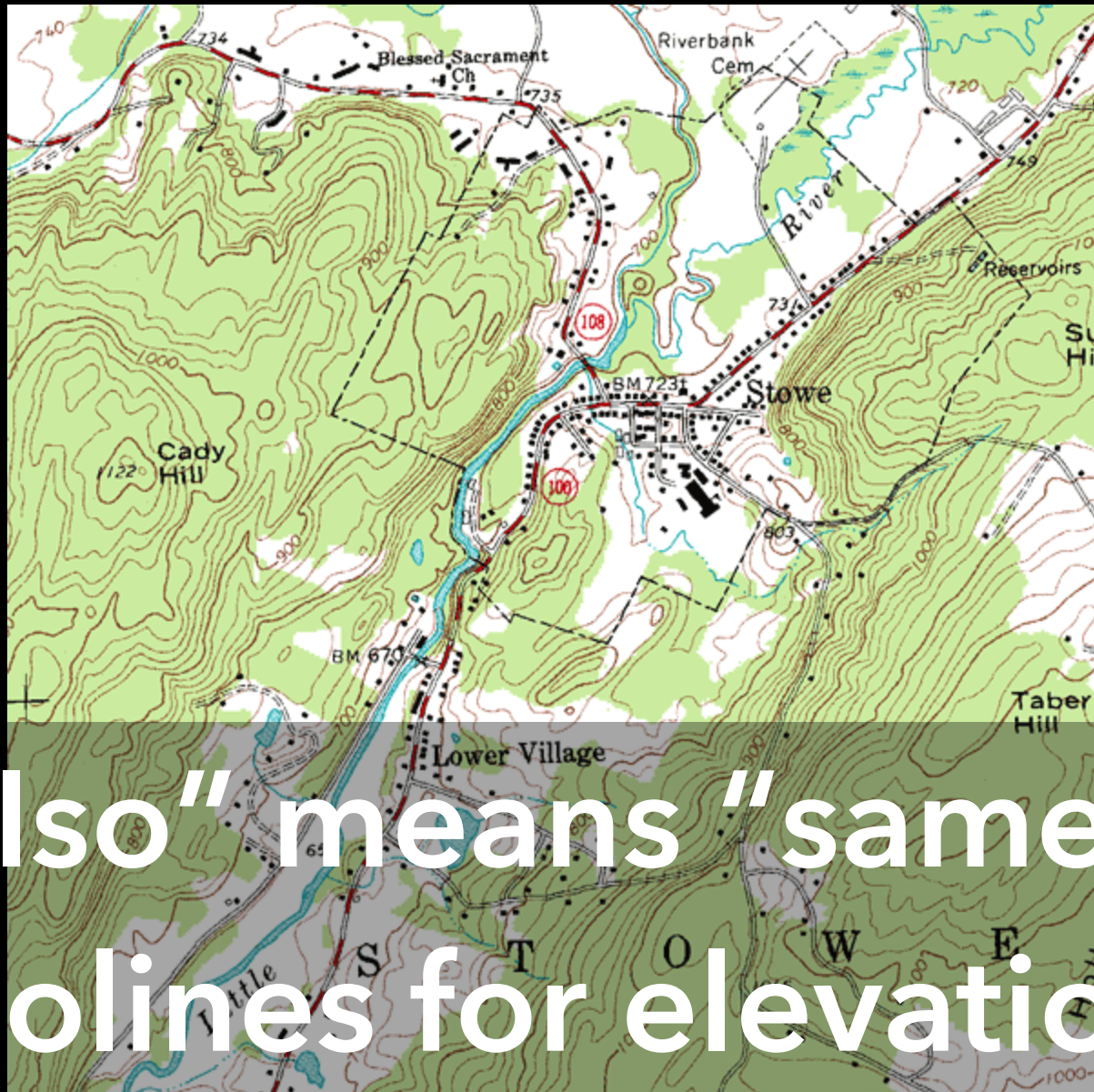
**KEY**  
Colours show how recently a crime was reported in a given part of Oakland

- A week ago
- Two weeks ago
- A month ago
- Two months ago
- Three months ago
- Four months ago
- Five months ago

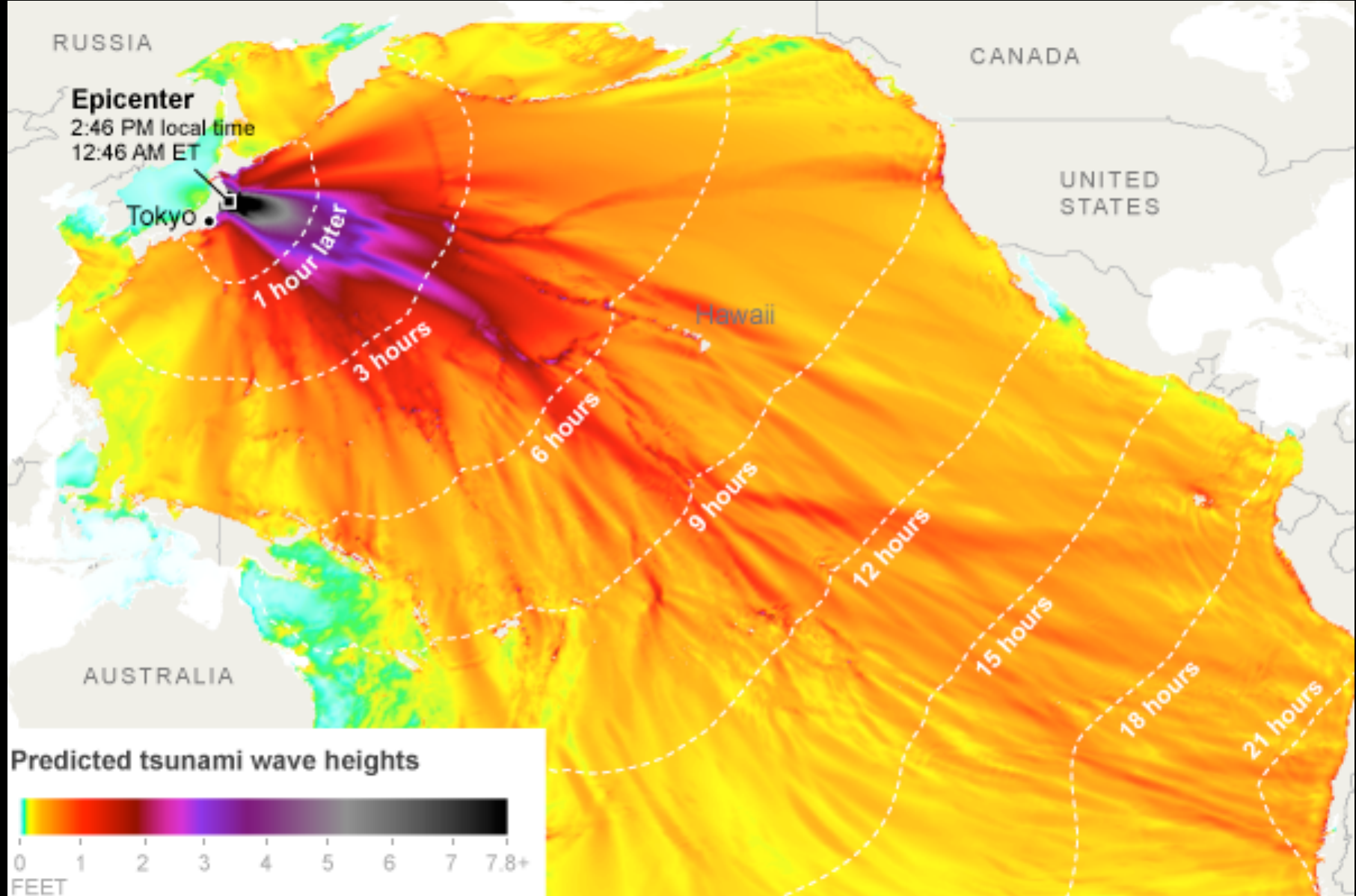
# Meaningful buckets, isolines







**“Iso” means “same”**  
**Isolines for elevation**



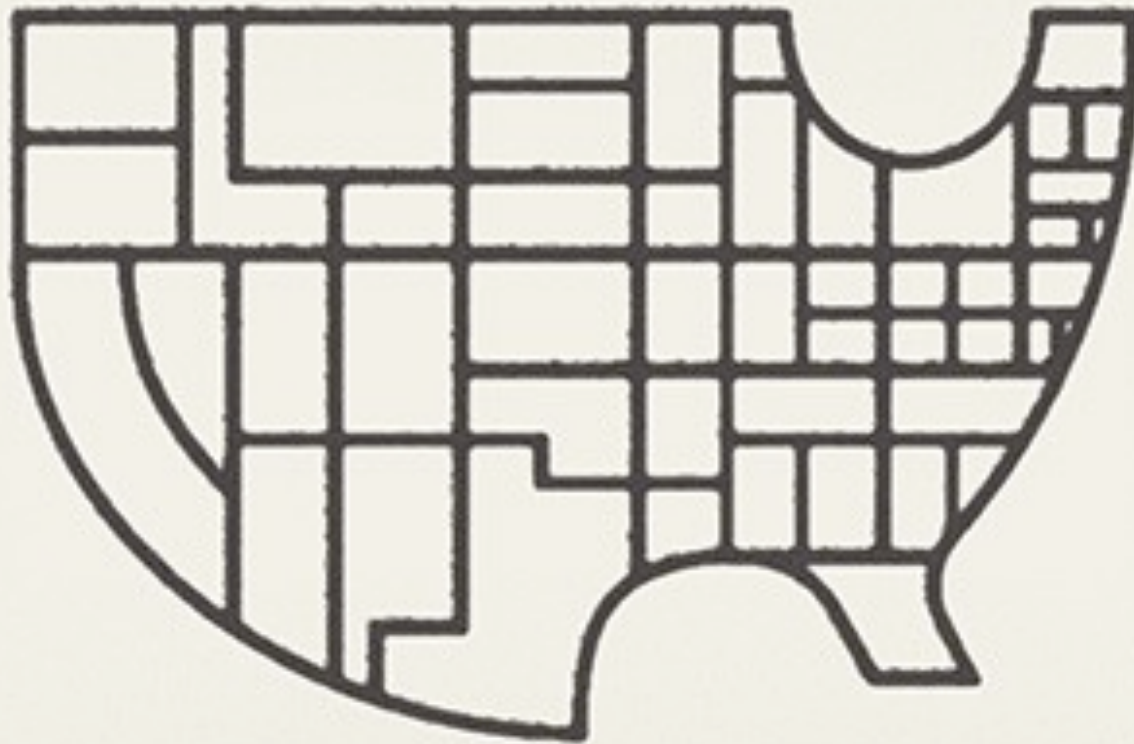
Isochrones are isolines for time



# Cartograms

Distort Shape to Convey Quantities

**Major distortions  
can stay recognizable**



## New York Times ratings

**198**

Safe Dem.

**16**

Leaning Dem.

**17**

Toss up

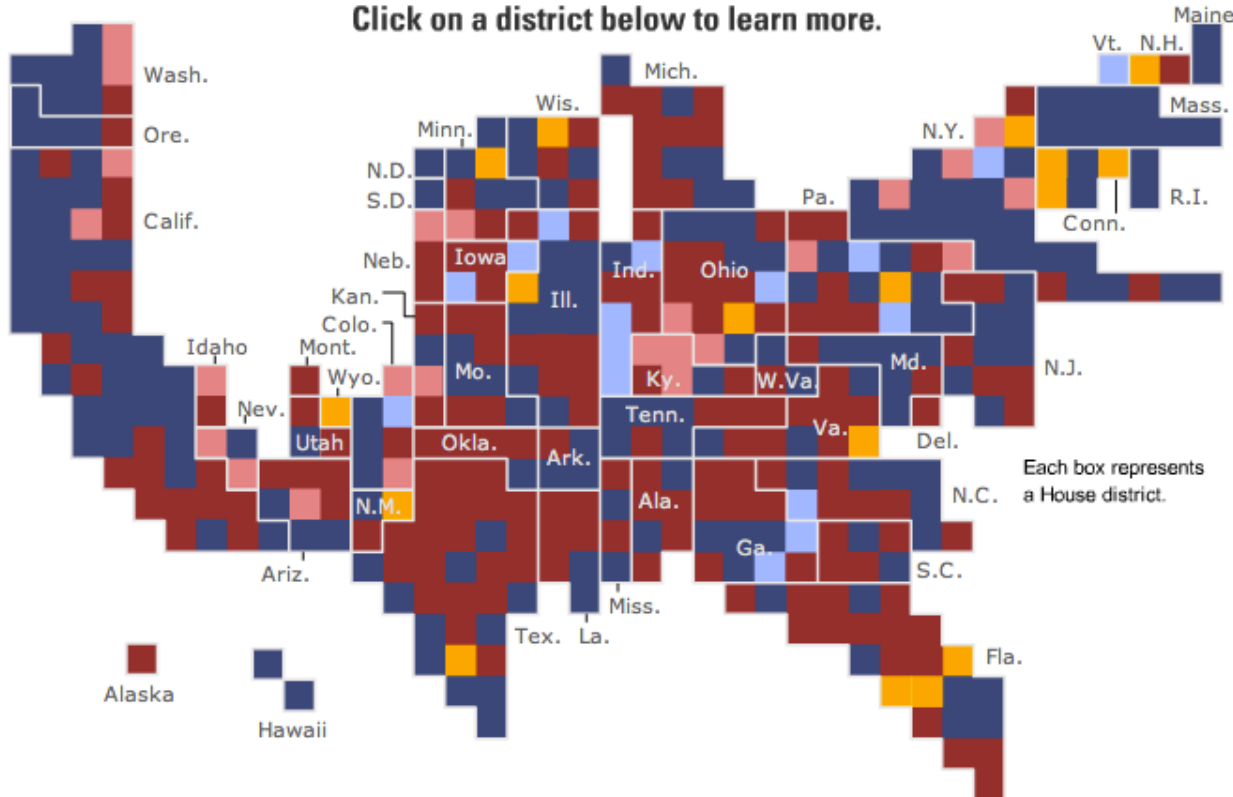
**24**

Leaning Rep.

**180**

Safe Rep.

Click on a district below to learn more.



## ANALYZE RACES

## CREATE OUTCOMES

Shade the map using the pulldown...

New York Times ratings

...then show only certain states

New York Times ratings ?

Democrat: ☐ Safe ☐ Leaning ☐ Toss Up

Republican: ☐ Safe ☐ Leaning

Current Rep. ☐ Dem. ☐ Rep.

Margin in 2004 House race

Democrat: ☐ >50% ☐ 25-50% ☐ <25%

Republican: ☐ >50% ☐ 25-50% ☐ <25%

Votes for president

☐ Kerry ☐ Gore

☐ Bush ☐ Bush

Appearances by big fundraisers ?

☐ George W. Bush ☐ Bill Clinton

☐ Races to watch ?

☐ Open races

☐ Switch districts ?

Urbanization

☐ Urban ☐ Suburban ☐ Rural ☐ Mixed

Race/Ethnicity

☐ White ☐ Black ☐ Hispanic

Median income

☐ <\$30K ☐ \$30-50K ☐ >\$50K

RESET

# Block Cartogram: Discrete Units

NY Times



**Joseph R. Biden Jr.**

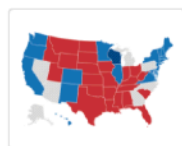
87

**remaining**

214

**Donald J. Trump**

67,075,300 votes (48.0%)



  Biden  
  Trump  
 Win Flip  
 Reporting votes

## Cartogram

[NY Times]

# China Still Dominates, but Some Manufacturers Look Elsewhere

While China maintains its overwhelming dominance in manufacturing, multinational companies are looking for ways to limit their reliance on factories there. [Related Article »](#)

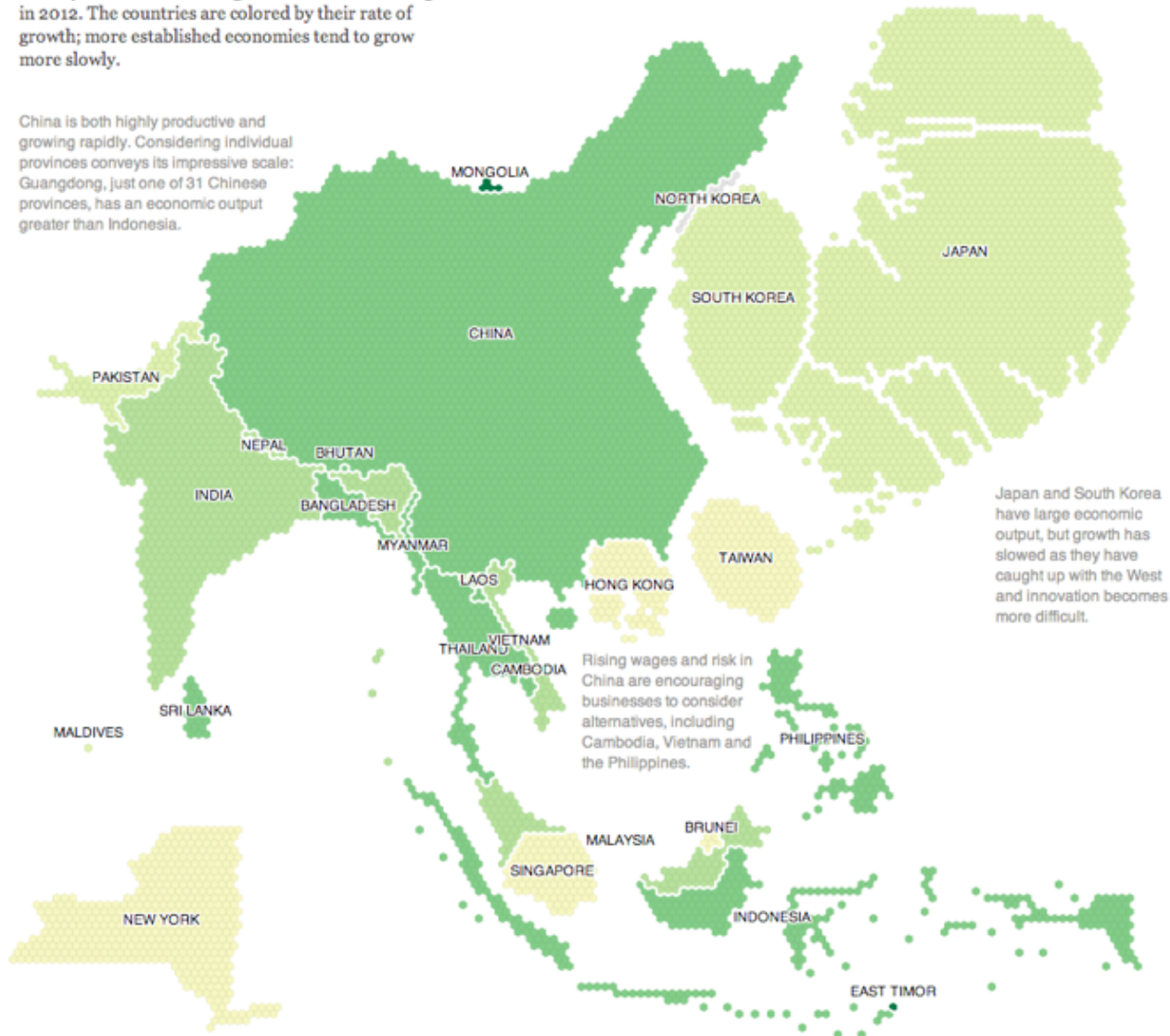
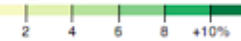
## Economic Output

In this map, geography is distorted so that each country is **sized according to its economic output in 2012**. The countries are colored by their rate of growth; more established economies tend to grow more slowly.

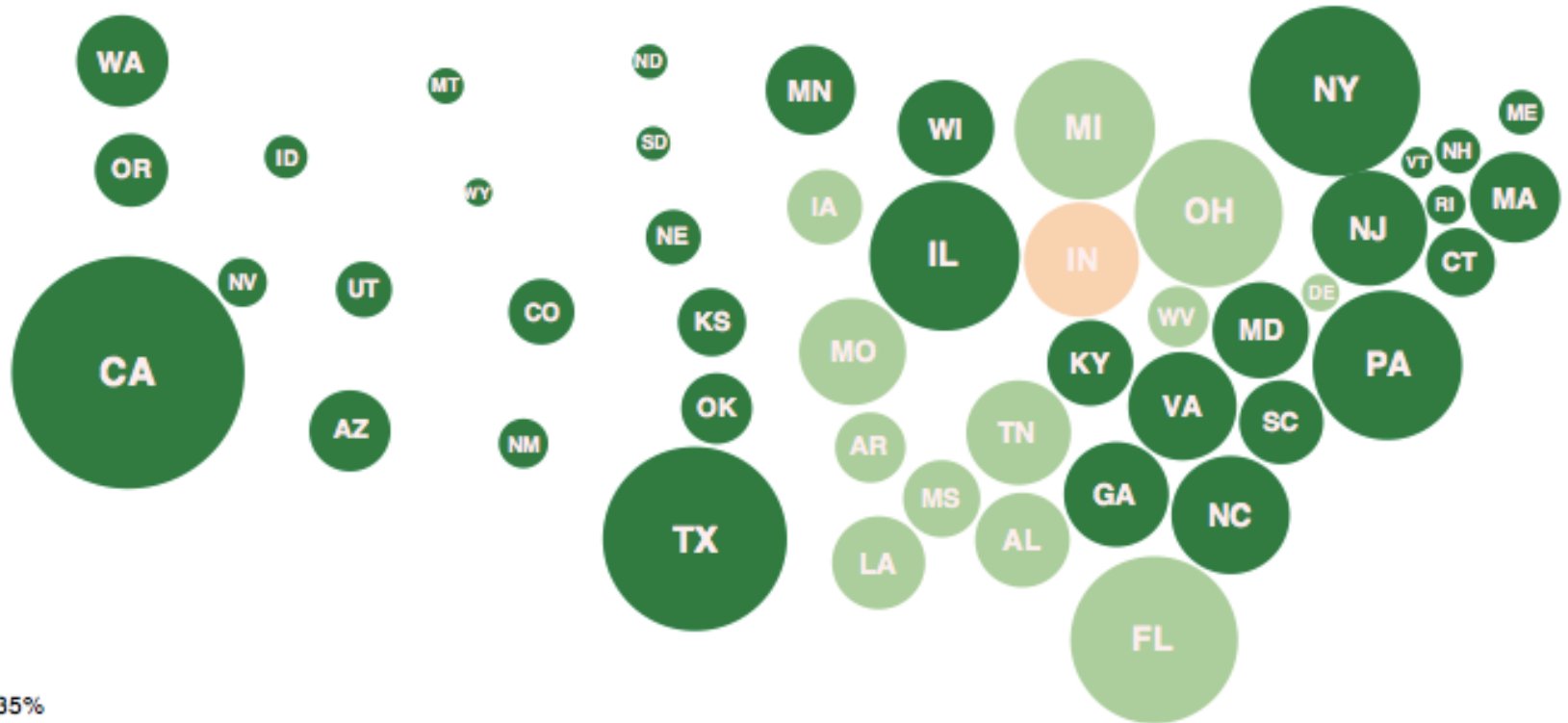
China is both highly productive and growing rapidly. Considering individual provinces conveys its impressive scale: Guangdong, just one of 31 Chinese provinces, has an economic output greater than Indonesia.

Each hexagon represents \$2.7 billion in G.D.P.

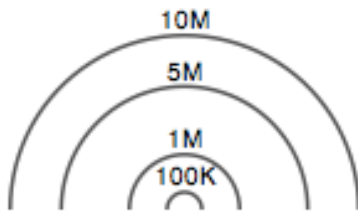
G.D.P. growth, 2011 to 2012



New York shown for comparison.



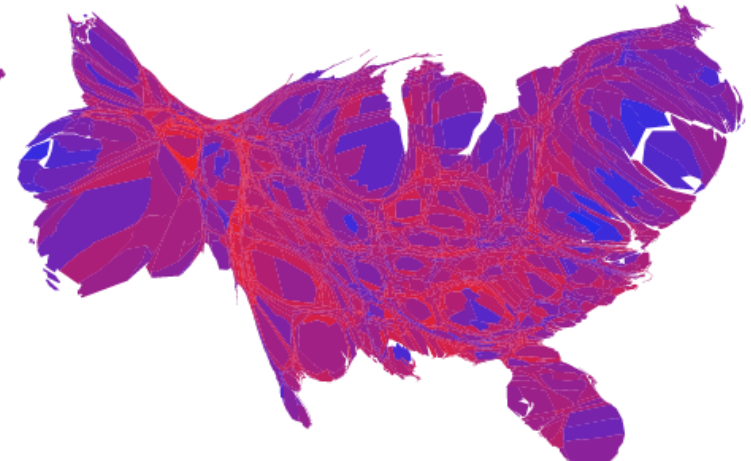
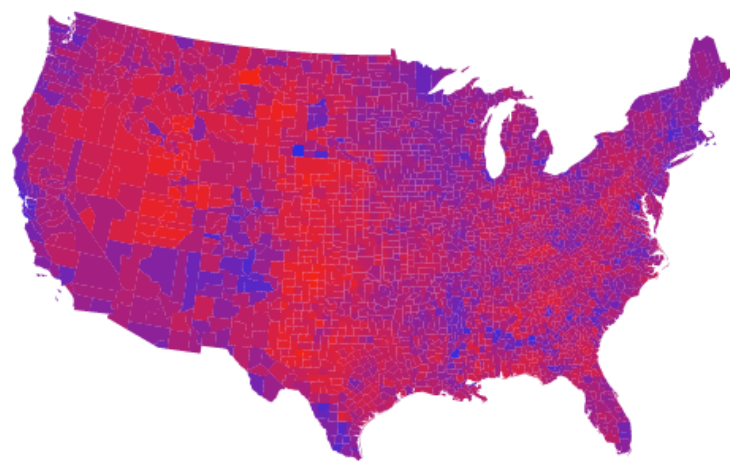
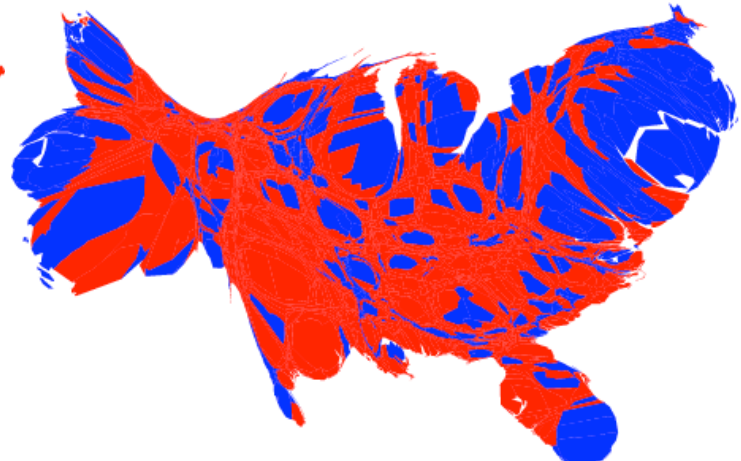
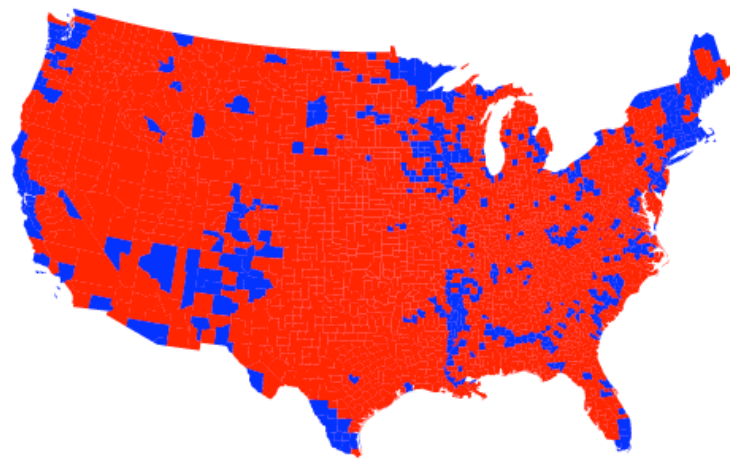
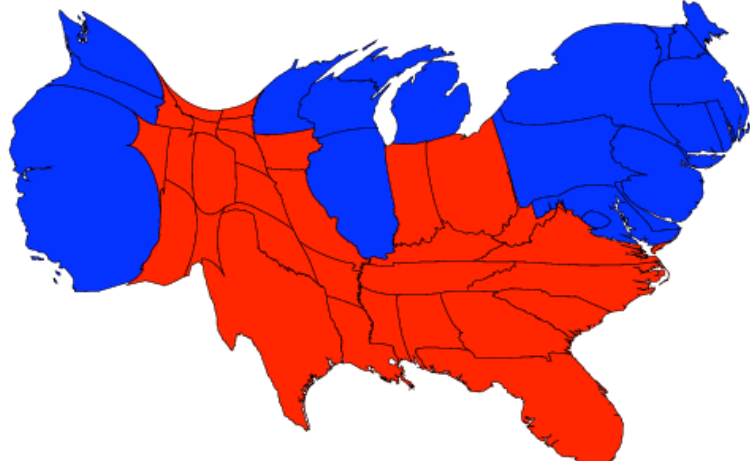
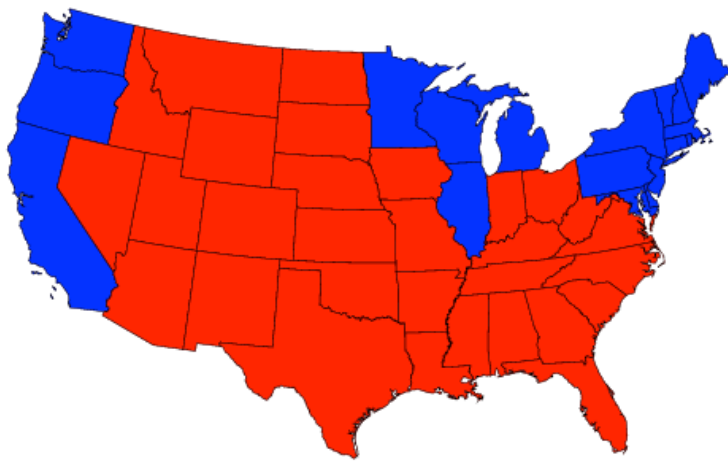
32 - 35%  
29 - 32%  
26 - 29%  
23 - 26%  
20 - 23%  
17 - 20%  
14 - 17%



## Dorling Cartogram: Sized Circles







# Physical Diffusion Model

[Newman 2004]

# Flow Maps

Convey Flux Between Locations

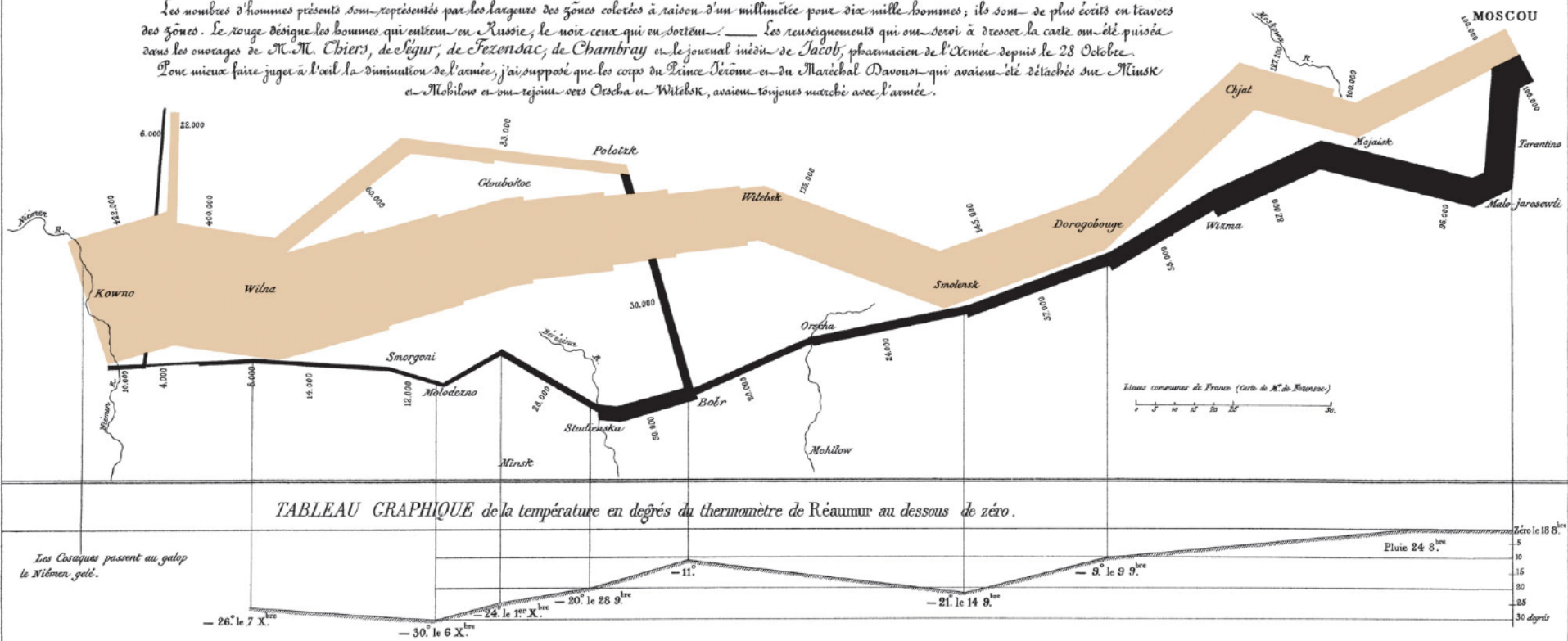
# Minard 1869: Napoleon's march

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

Dressée par M. MINARD, Inspecteur Général des Ponts et Chaussées en retraite Paris, le 20 Novembre 1869.

Les nombres d'hommes présents sont représentés par les largeurs des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en travers 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. Thiers, de Ségur, de Fezensac, de Chambray et le journal inédit 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 Jérôme et du Maréchal Davoust qui avaient été détachés sur Minsk et Mohilew en ont rejoint vers Orscha et Witebsk, avaient toujours marché avec l'armée.



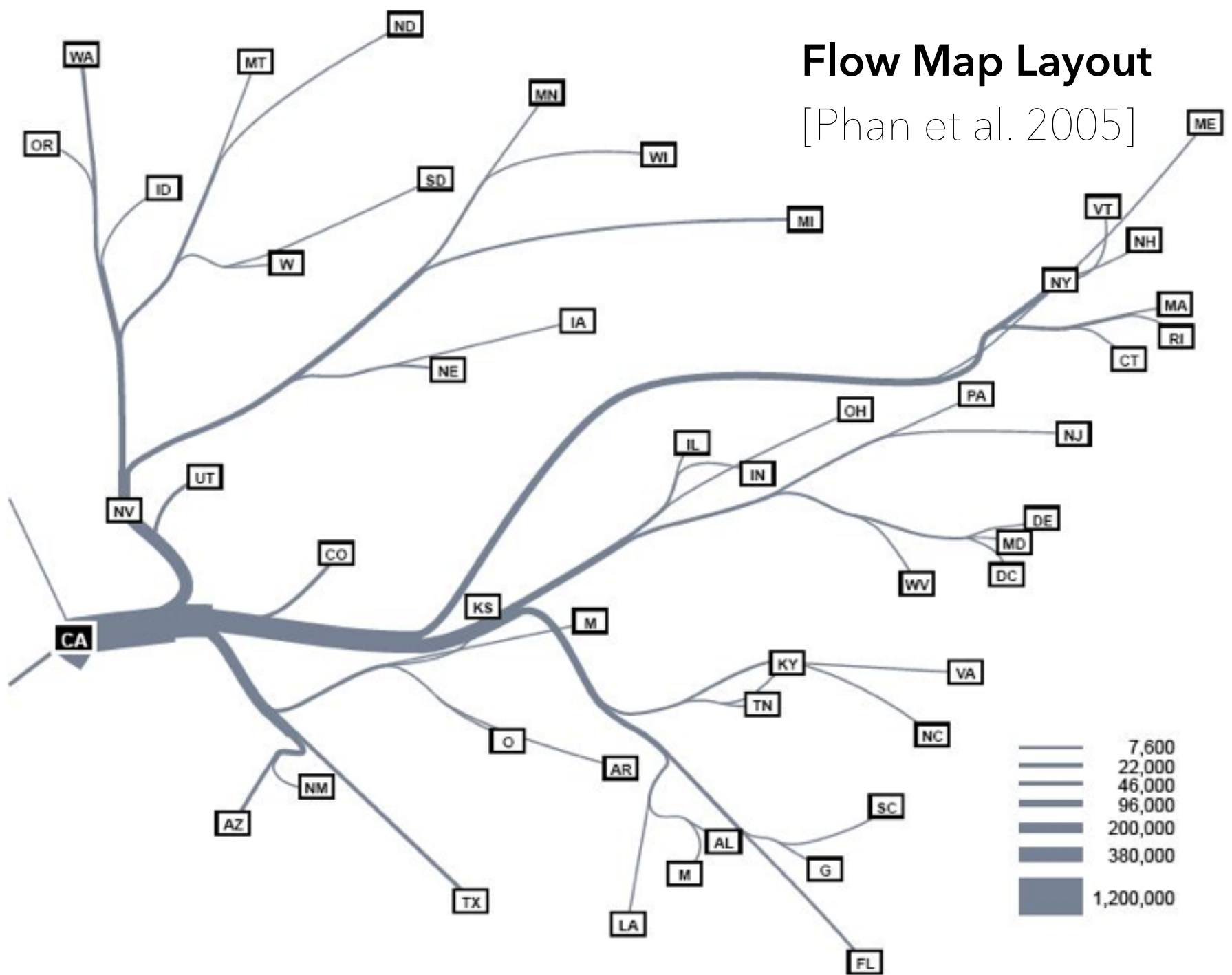






# Flow Map Layout

[Phan et al. 2005]

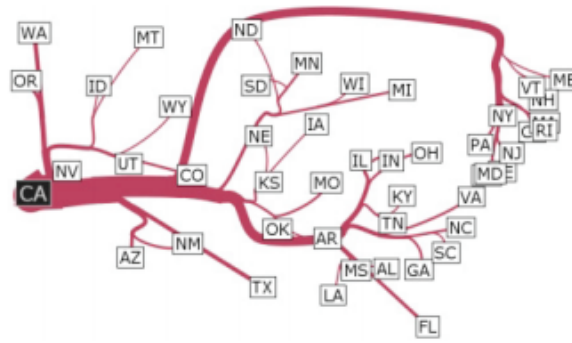


# Migration from California, '95-'00

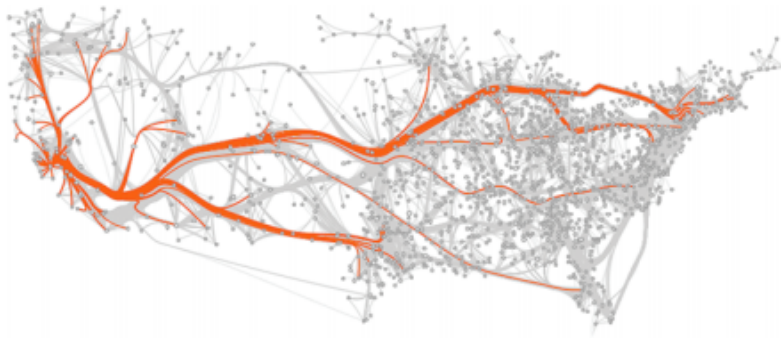
Tobler 1987



Phan et al. 2005



Verbeek et al. 2011



Cui et al. 2008



Holten & van Wijk 2009

# wind map

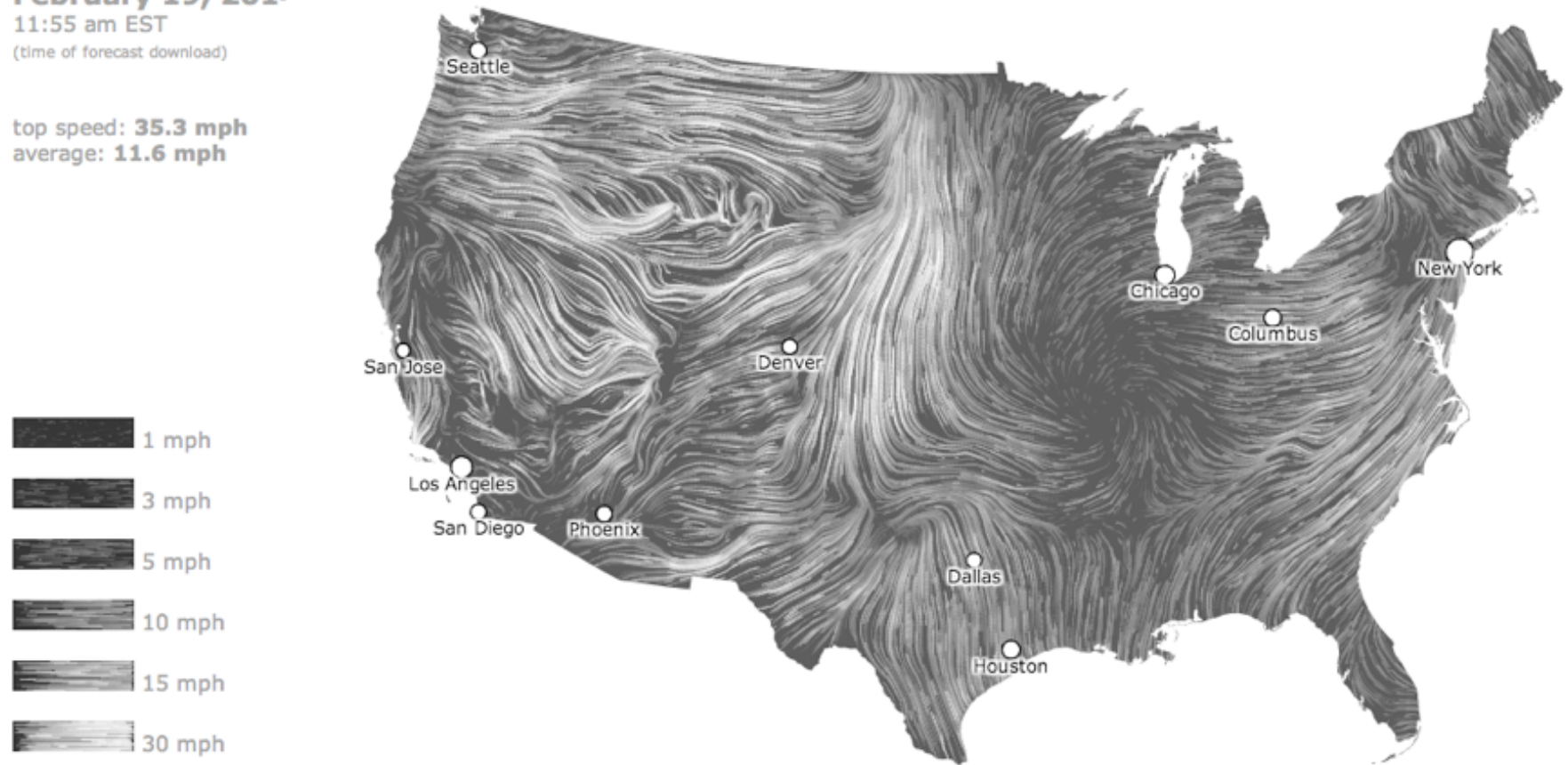
**February 19, 2014**

11:55 am EST

(time of forecast download)

top speed: **35.3 mph**

average: **11.6 mph**



Wattenberg & Viegas

# How Obama Won Re-election

Whites Were Outvoted

Women

Hispanics

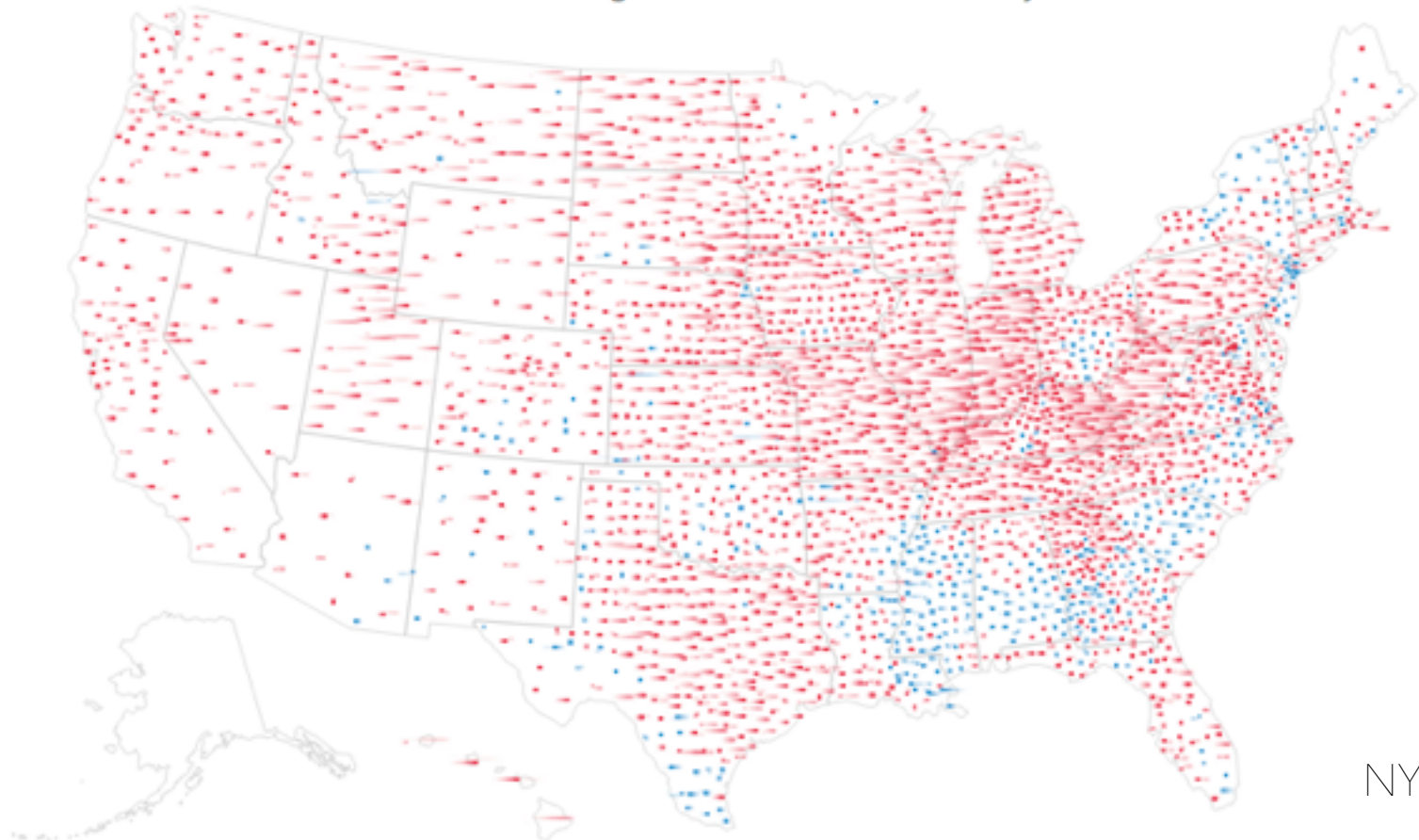
Youth

## Romney's Shift Wasn't Enough

2008

2012

Most of the nation shifted to the right in Tuesday's vote, but not far enough to secure a win for Mitt Romney.



NY Times



# Generalization

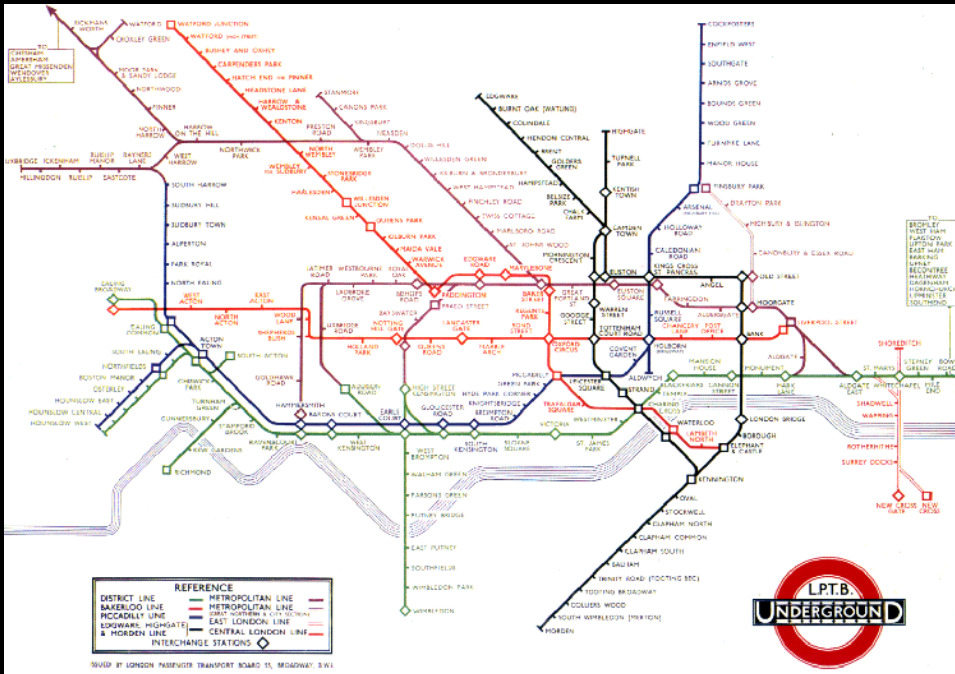
Abstraction to Convey Topology



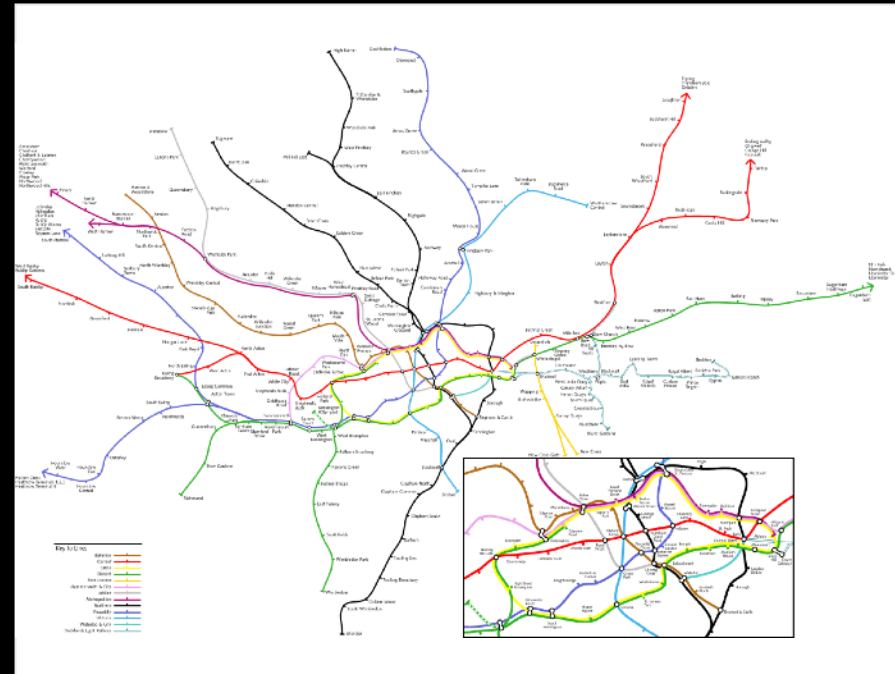




# Beck's London tube diagram



London Underground [Beck 33]



Geographic version of map

**Principle:** Straighten lines to emphasize stop sequence

**Technique used to emphasize/de-emphasize information**





People *love* tube maps...

[Huffman]

# Route Maps: Bellevue to Seattle



# Map Design via Optimization [Agrawala '01]

## Set of graphic elements

Roads, labels, cross-streets, ...

## Choose visual attributes

Position, orientation, size, ...

Distortions increase flexibility

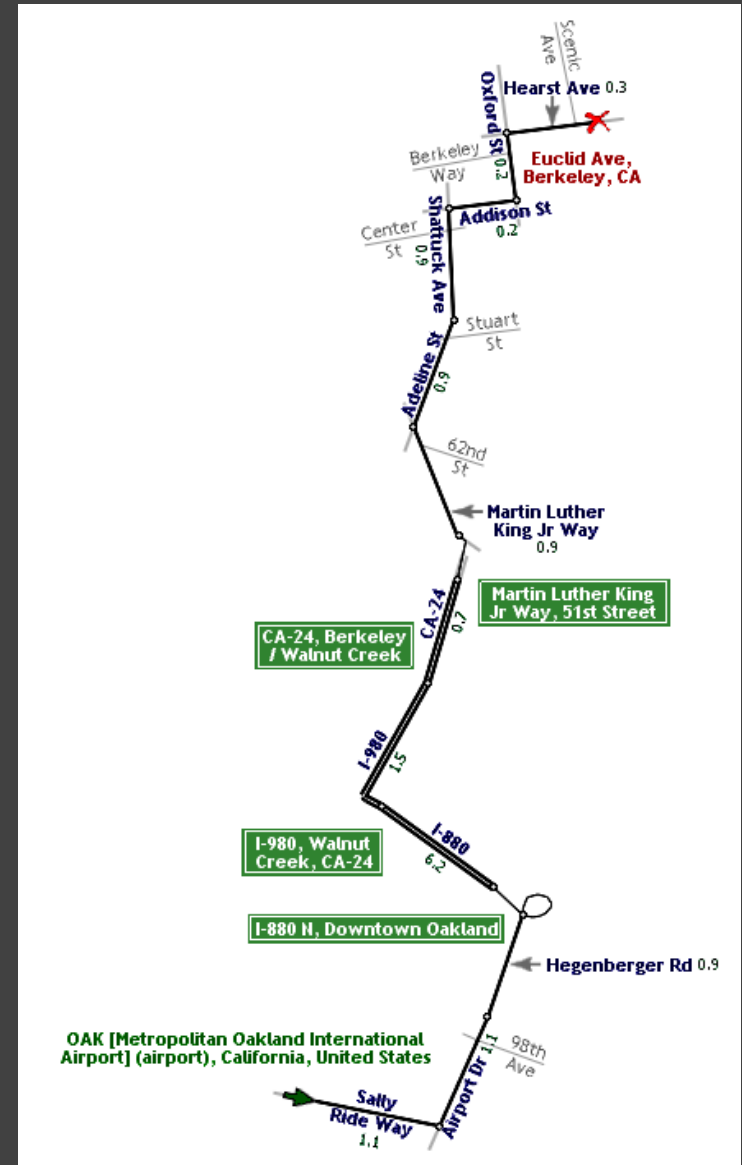
## Develop constraints based on design principles

## Simulated annealing

Perturb: Form a layout

Score: Evaluate quality

Minimize score



# Road Layout Constraints [Agrawala '01]

## Length

Ensure all roads visible

$$((L_{\min} - l(r_i)) / L_{\min})^2 * W_{\text{small}}$$

Maintain ordering by length

$$W_{\text{shuffle}}$$

## Orientation

Maintain original orientation

$$|\alpha_{\text{curr}}(r_i) - \alpha_{\text{orig}}(r_i)| * W_{\text{orient}}$$

## Topological errors

Prevent false

$$\min(d_{\text{origin}}, d_{\text{dest}}) * W_{\text{false}}$$

Prevent missing

$$d * W_{\text{missing}}$$

Ensure separation

$$\min(d_{\text{ext}}, E) * \text{Ext}$$

## Overall route shape

Maintain endpoint direction

$$|\alpha_{\text{curr}}(v) - \alpha_{\text{orig}}(v)| * W_{\text{enddir}}$$

Maintain endpoint distance

$$|d_{\text{curr}}(v) - d_{\text{orig}}(v)| * W_{\text{enddist}}$$



# Tools

# Software Tools

## Web Tools

**d3-geo**: projections, paths and more

**GeoJSON**: JSON format for geo data

**TopoJSON**: topology -> compressed GeoJSON

**MapShaper**: online editor for map data

**Leaflet**: open-source, customizable map tile system

## Other

**PostGIS**: Postgres DB extensions for geo data

**Mapnik**: Render your own map tiles!

# Data Resources

## Natural Earth Data

[naturalearthdata.com](https://naturalearthdata.com)

## OpenStreetMap

[openstreetmap.org](https://openstreetmap.org)

## U.S. Government

[nationalatlas.gov](https://nationalatlas.gov), [census.gov](https://census.gov), [usgs.gov](https://usgs.gov)

# Tutorials

## Cartographic Visualization in Vega-Lite

<https://observablehq.com/@uwdata/cartographic-visualization>

## Command-Line Cartography

<https://medium.com/@mbostock/command-line-cartography-part-1-897aa8f8ca2c>

## How to Infer Topology

<http://bost.ocks.org/mike/topology/>