lecture 12: spatial data

November 1, 2017

much of this slide deck is modified from my OpenVisConf talk, How Spatial Polygons Shape Our World.

Amelia McNamara
@AmeliaMN

The problem with maps is that the world looks like a map. We don't have that problem with other visualizations. @tmcw #NICAR14

9:15 AM - 28 Feb 2014

flickr: MattHagedorn

Types of geographic data

Points

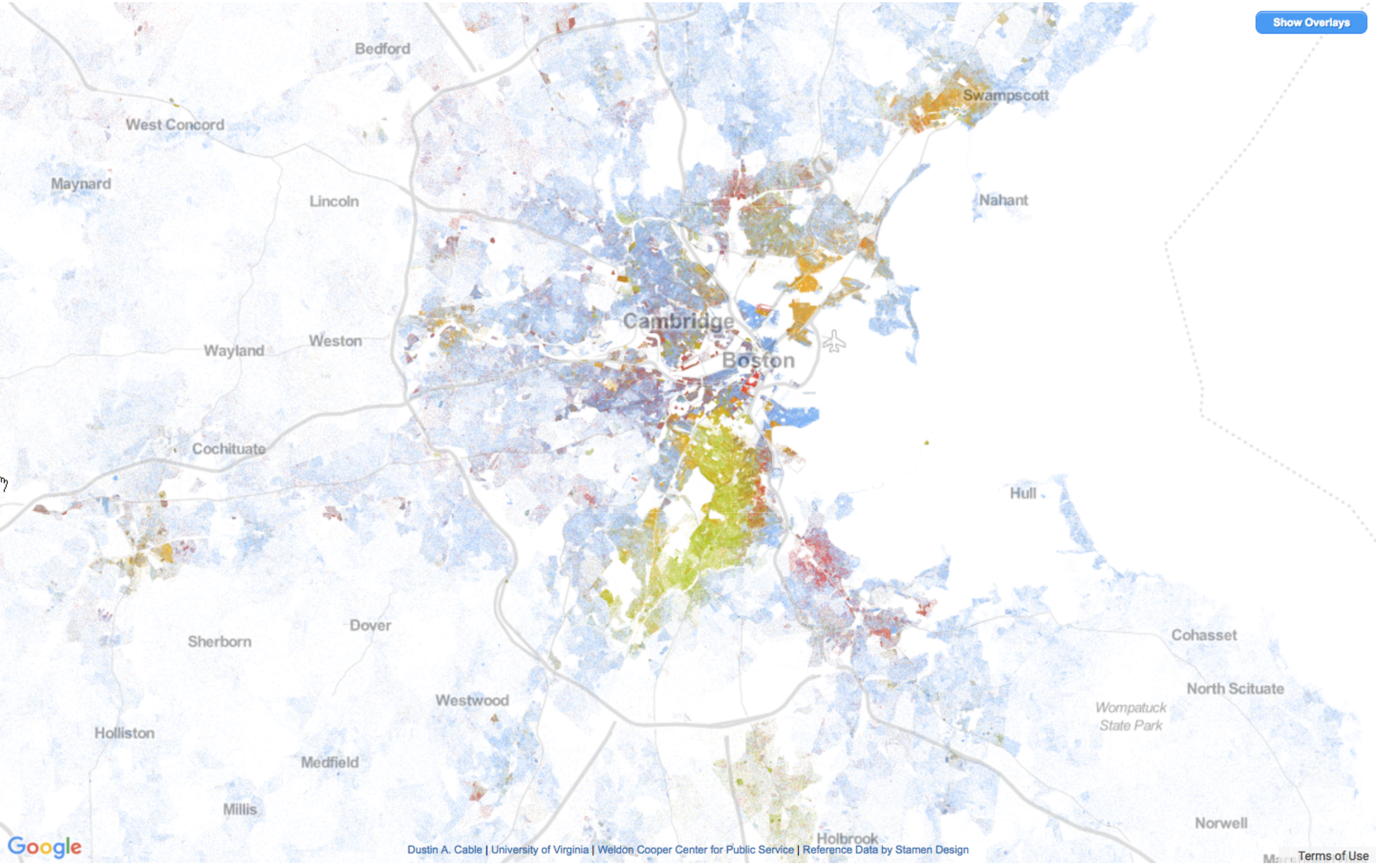
Lines

Polygons

flickr: mulad

Points

flickr: MattHagedorn

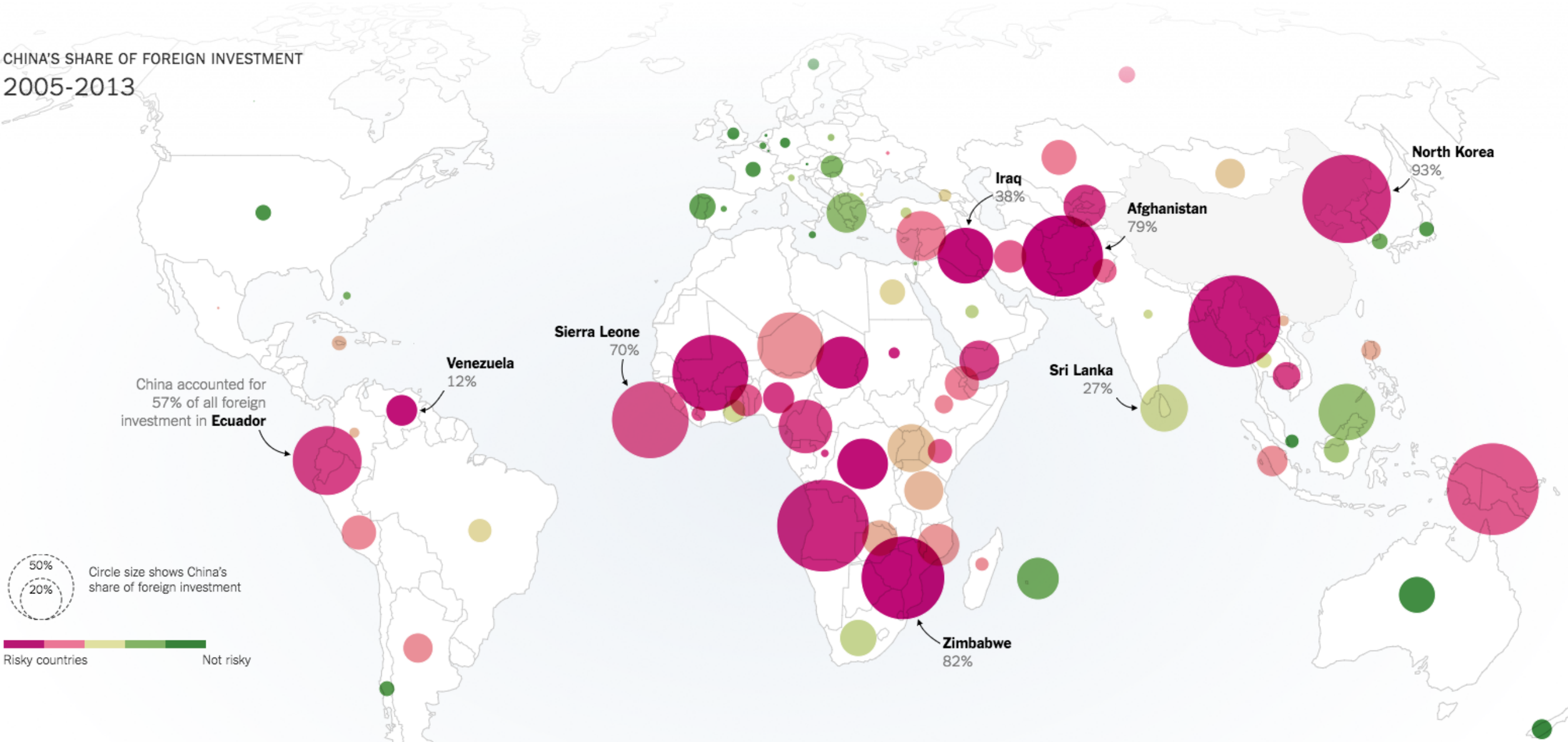


http://bit.ly/CensusDotMap

The World According to China

By GREGOR AISCH, JOSH KELLER and K.K. REBECCA LAI

China's enormous overseas spending has helped it displace the United States and Europe as the leading financial power in large parts of the developing world. Here's where China has the most influence, based on its share of foreign investment since 2005. RELATED ARTICLE



https://www.nytimes.com/interactive/2015/07/24/business/international/the-world-according-to-china-investment-maps.html?, via Jordan Crouser

Points over time

http://projects.flowingdata.com/walmart/

Lines?

flickr: MattHagedorn

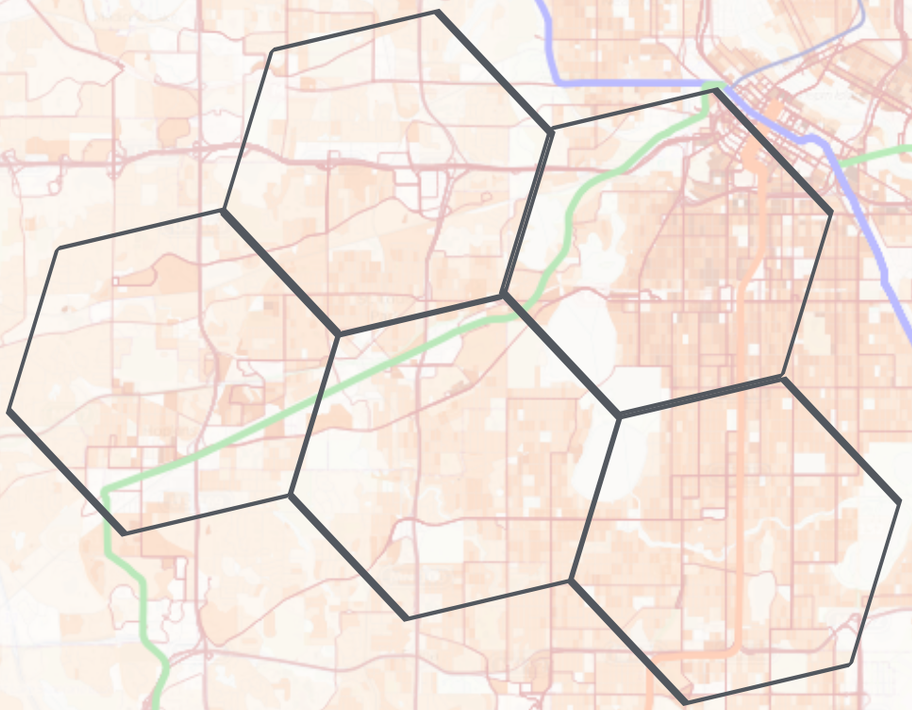
http://www.capsca.org/Meetings/Global2012/2012CAPSCAGlobal-2-6.pdf, via Jordan Crouser

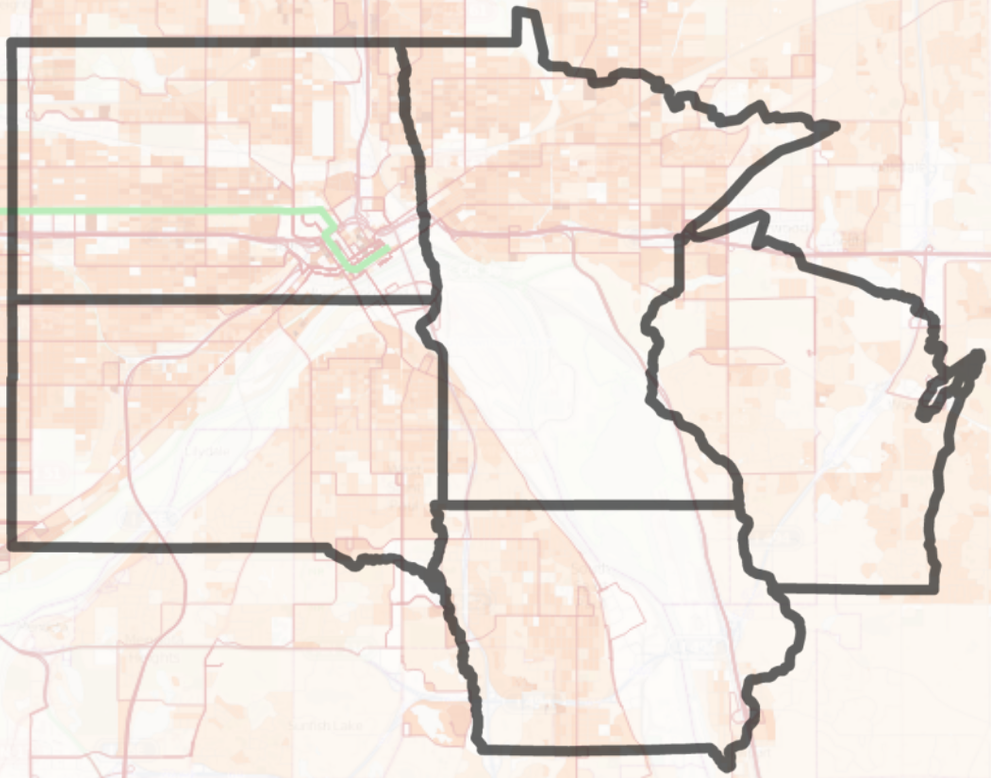
Ben Fry, All Streets. http://benfry.com/allstreets/map5.html

Polygons

flickr: MattHagedorn

Polygons can be regular or irregular





flickr: mulad

A **choropleth map** is one in which areas (polygons) are shaded according to some value

flickr: viriyincy

All maps of parameter estimates are misleading

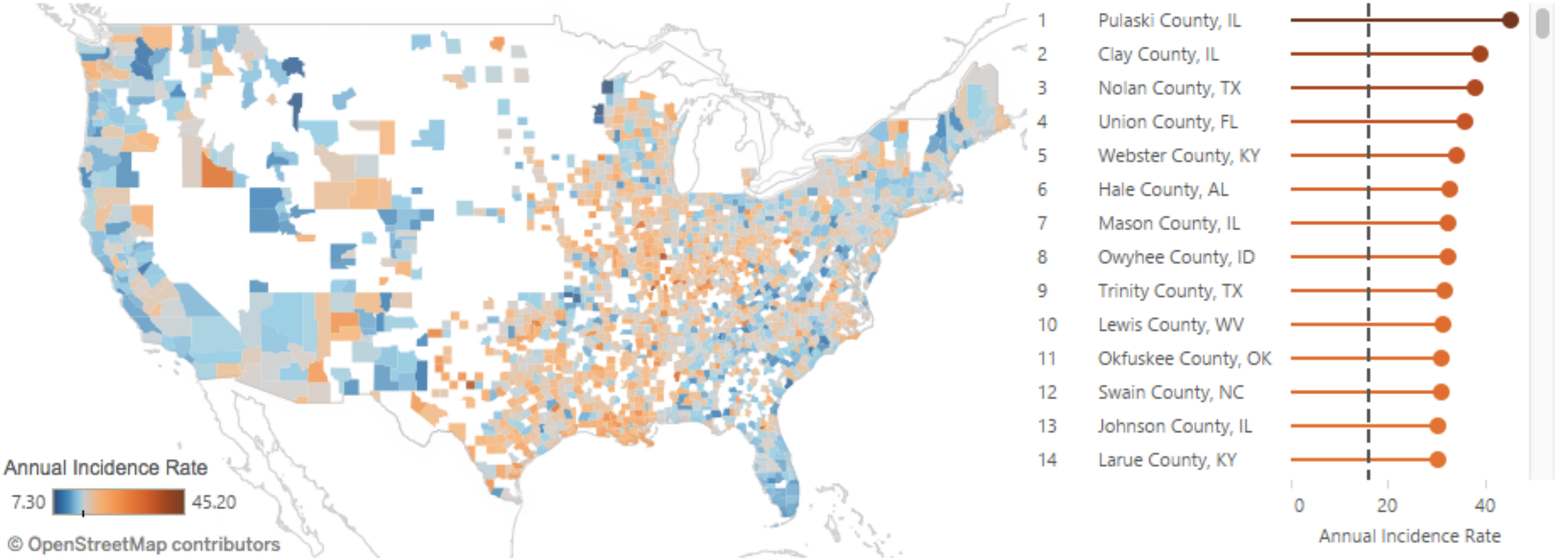
Andrew Gelman and Phillip Price.

http://bit.ly/AllMaps

flickr: mulad

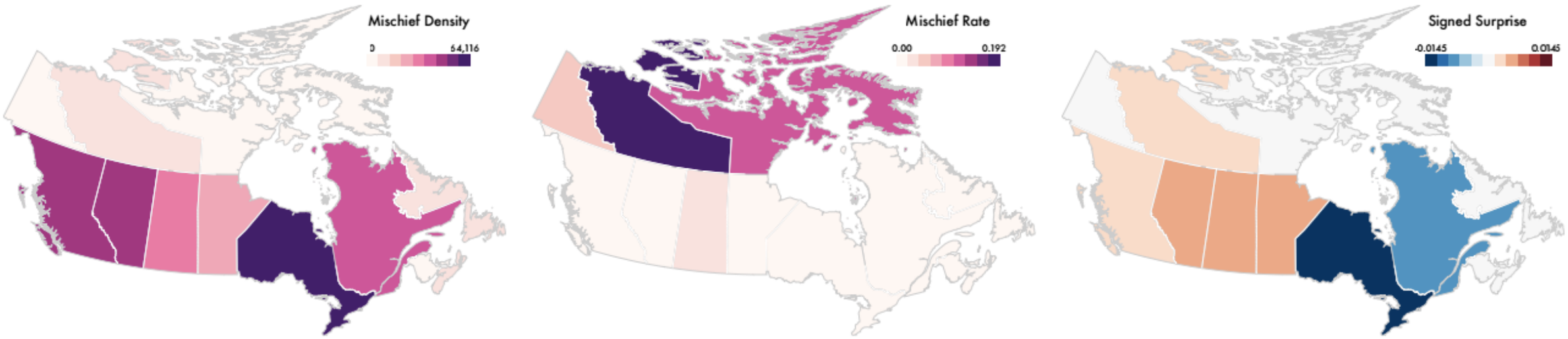
KidneyCancer | About

Kidney Cancer and Insensitivity to Sample Size



http://dataremixed.com/2015/01/avoiding-data-pitfalls-part-2/

Surprise! Bayesian Weighting for De-Biasing Thematic Maps.



(a) The **Event Density** of "mischief" in Canada.

(b) The per-capita **Event Rate** of mischief.

(c) The **Surprise Map** of mischief.

Michael Correll and Jeffrey Heer

http://bit.ly/SurpriseMaps

Area gives a lot of visual weight

365 ☑ **Obama**
Electoral Votes
Projected Winner

0
undecided

173 **McCain**
Electoral Votes

Popular vote: 66,862,039

270 needed to win

Popular vote: 58,319,442

State winners
County bubbles
County leaders
Voting shifts

ZOOM IN

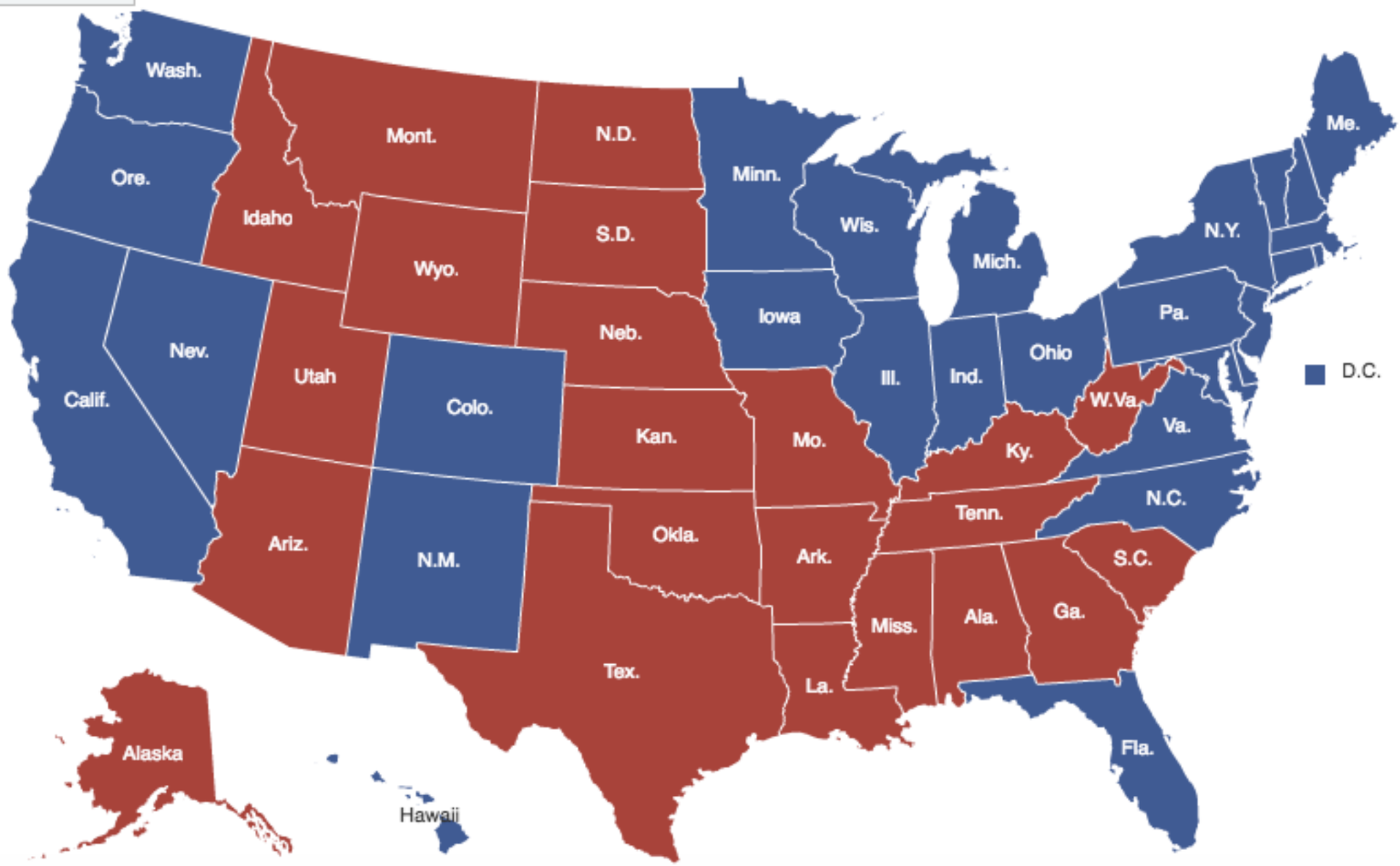
Year

'08 '04 '00 '96 '92

Map key

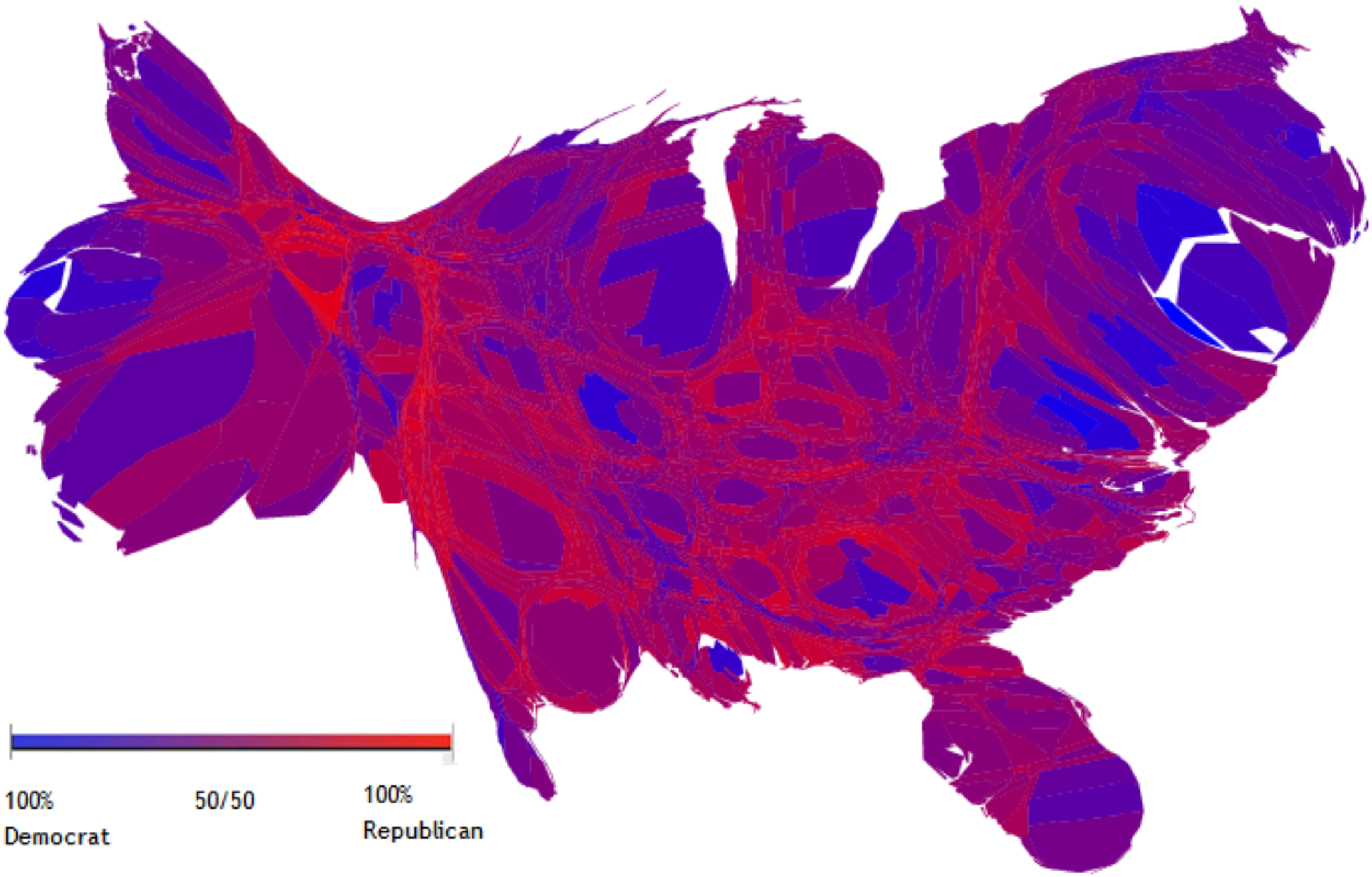
DEMOCRATS
Lead Win

REPUBLICANS
Lead Win



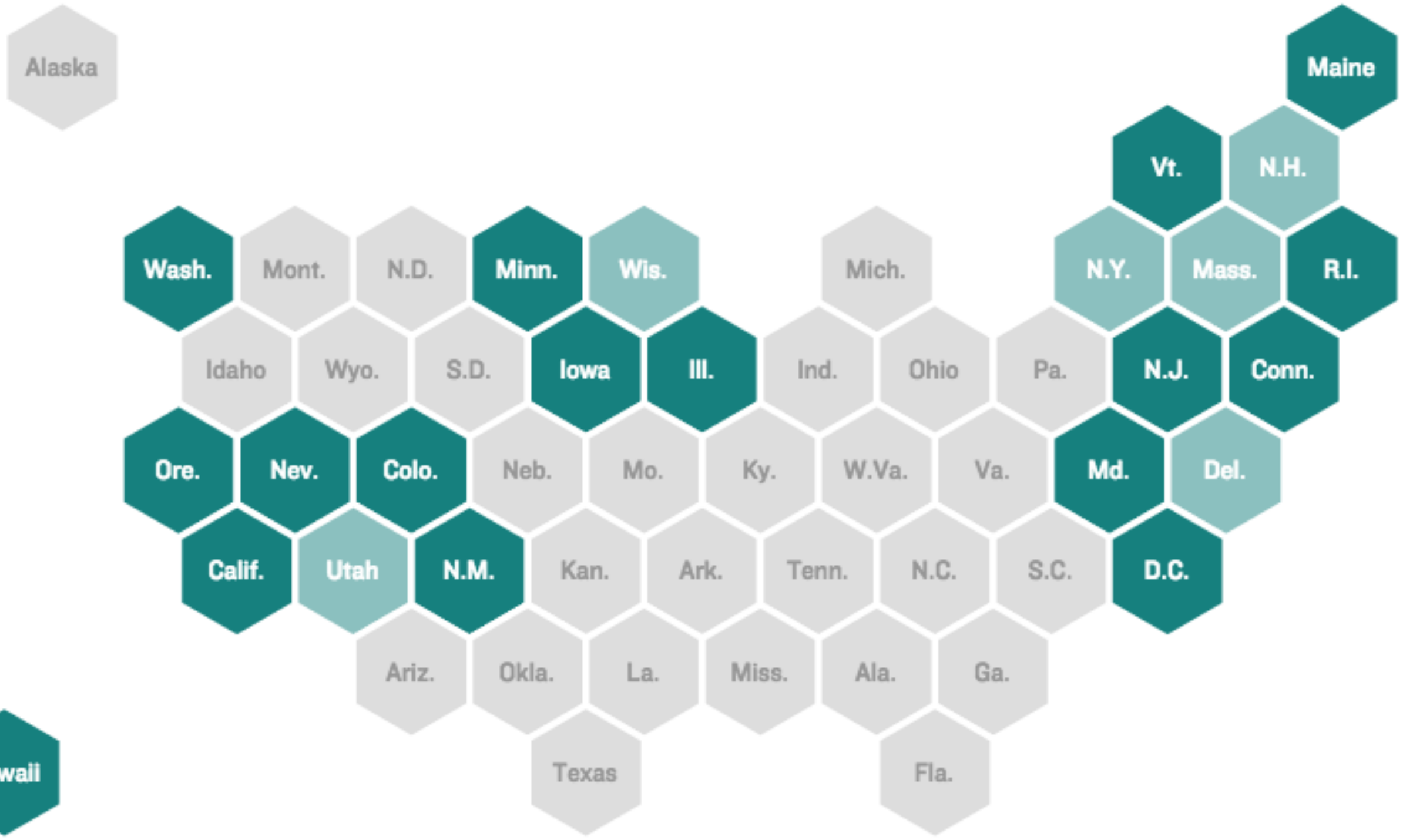
http://www.nytimes.com/elections/2008/results/president/map.html

Cartogram

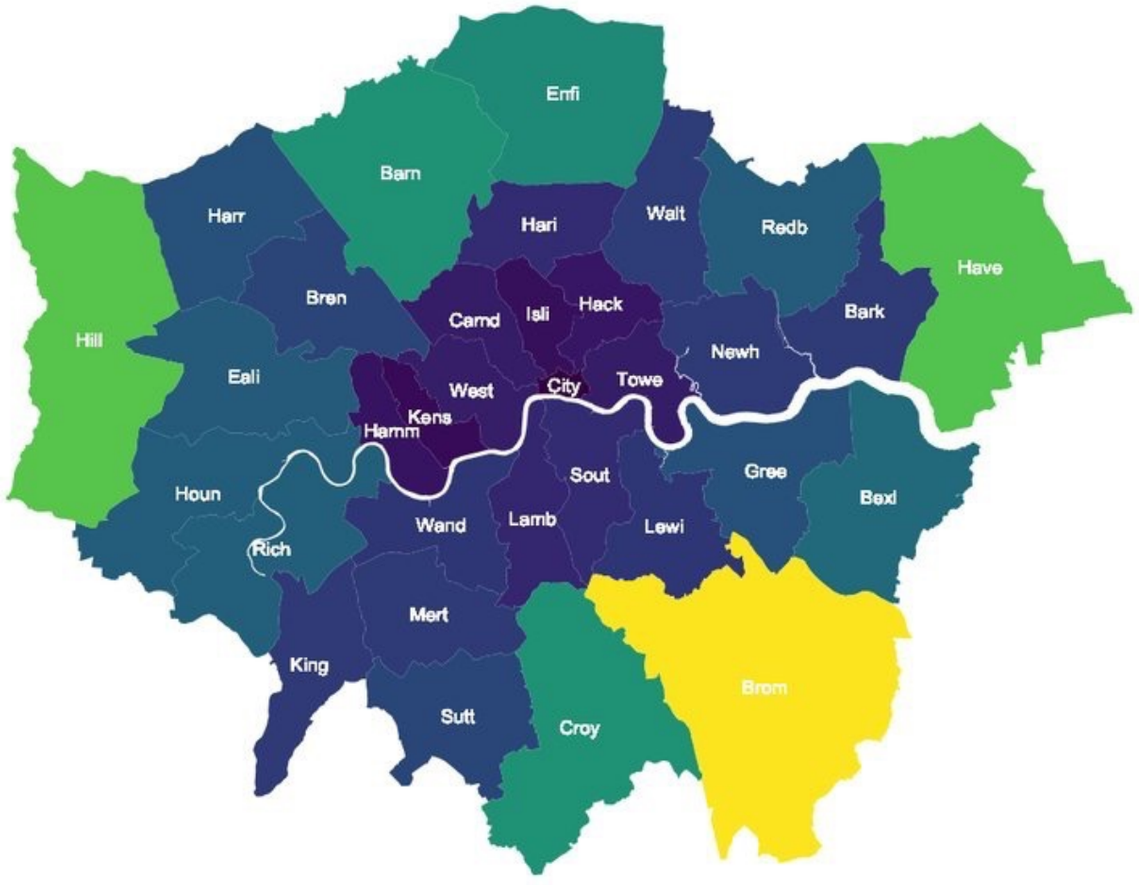


wikipedia: M. E. J. Newman

Cartogram



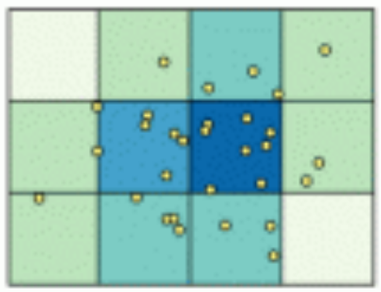
http://blog.apps.npr.org/2015/05/11/hex-tile-maps.html

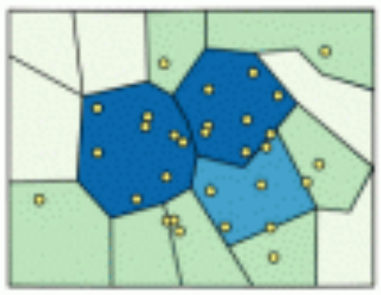


https://twitter.com/iammrbailey/status/925346870381240320/photo/1

Modifiable Areal Unit Problem

"The areal units (zonal objects) used in many geographical studies are arbitrary, modifiable, and subject to the whims and fancies of whoever is doing, or did, the aggregating"
- Stan Openshaw





http://gispopsci.org/maup/

flickr: mulad

Gerrymandering

wikipedia: Elkanah Tisdale (1771-1835) (often falsely attributed to Gilbert Stuart)[1] - Originally published in the Boston Centinel, 1812.

Gerrymandering: Last Week Tonight with John Oliver (HBO)

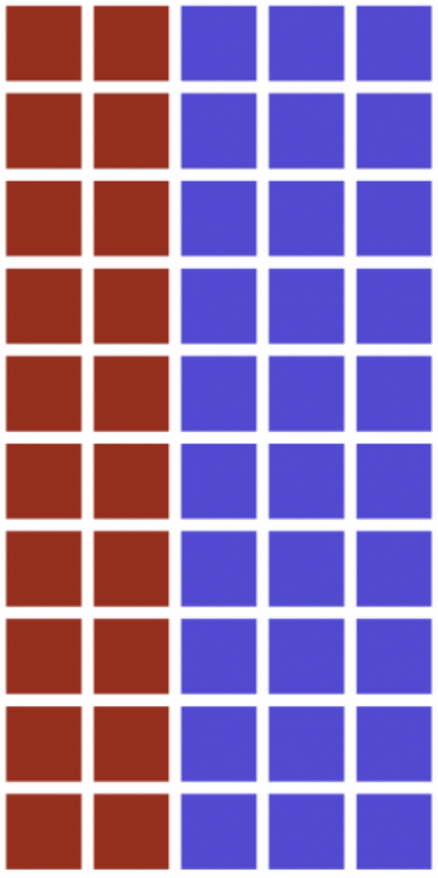
1:11 / 19:33

http://bit.ly/LWT_gerrymandering

Gerrymandering, explained

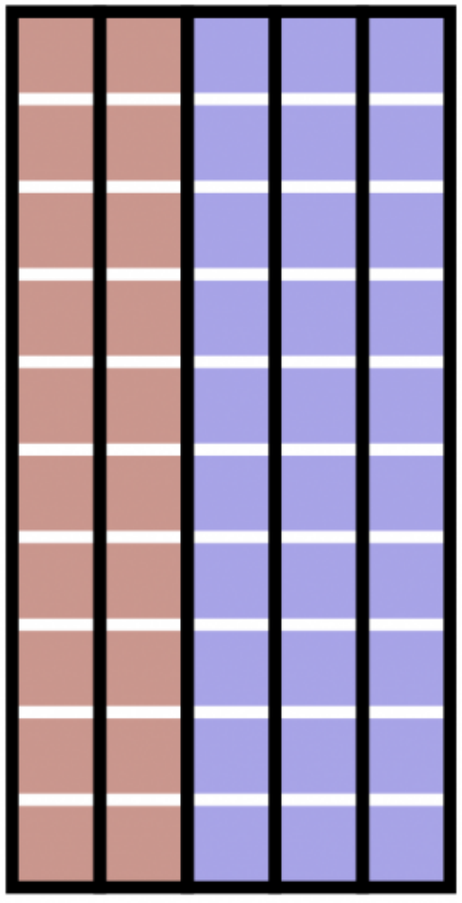
Three different ways to divide 50 people into five districts

50 people



60% blue, 40% red

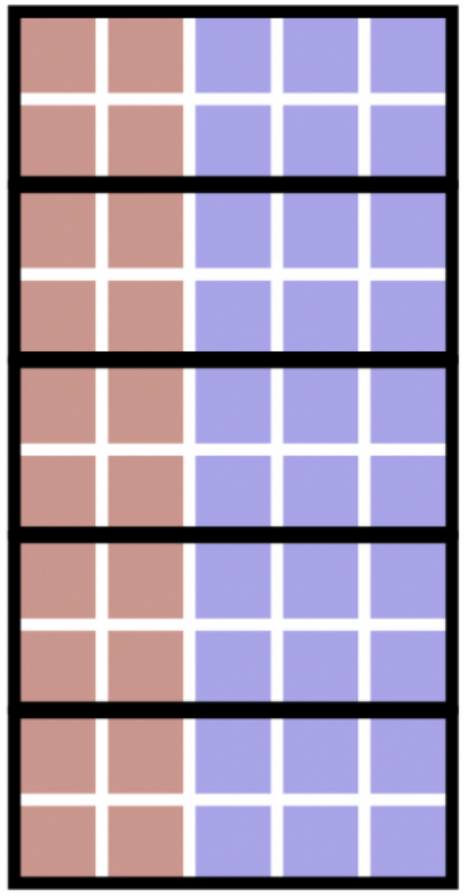
1. Perfect representation



3 blue districts, 2 red districts

BLUE WINS

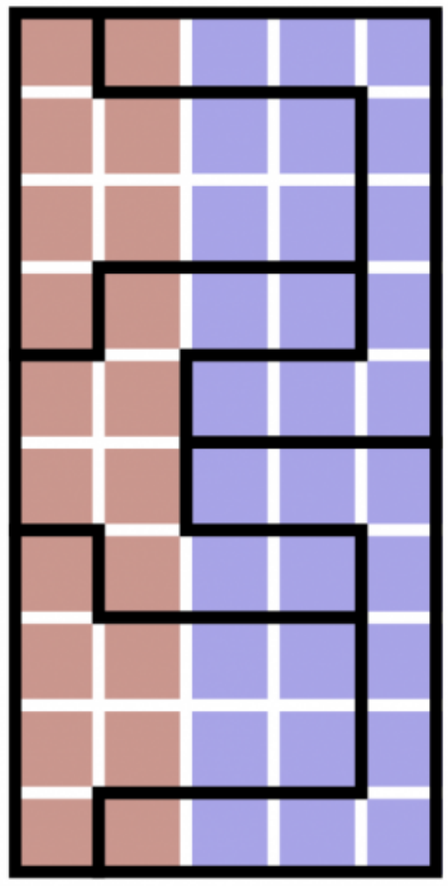
2. Compact, but unfair



5 blue districts, 0 red districts

BLUE WINS

3. Neither compact nor fair



2 blue districts, 3 red districts

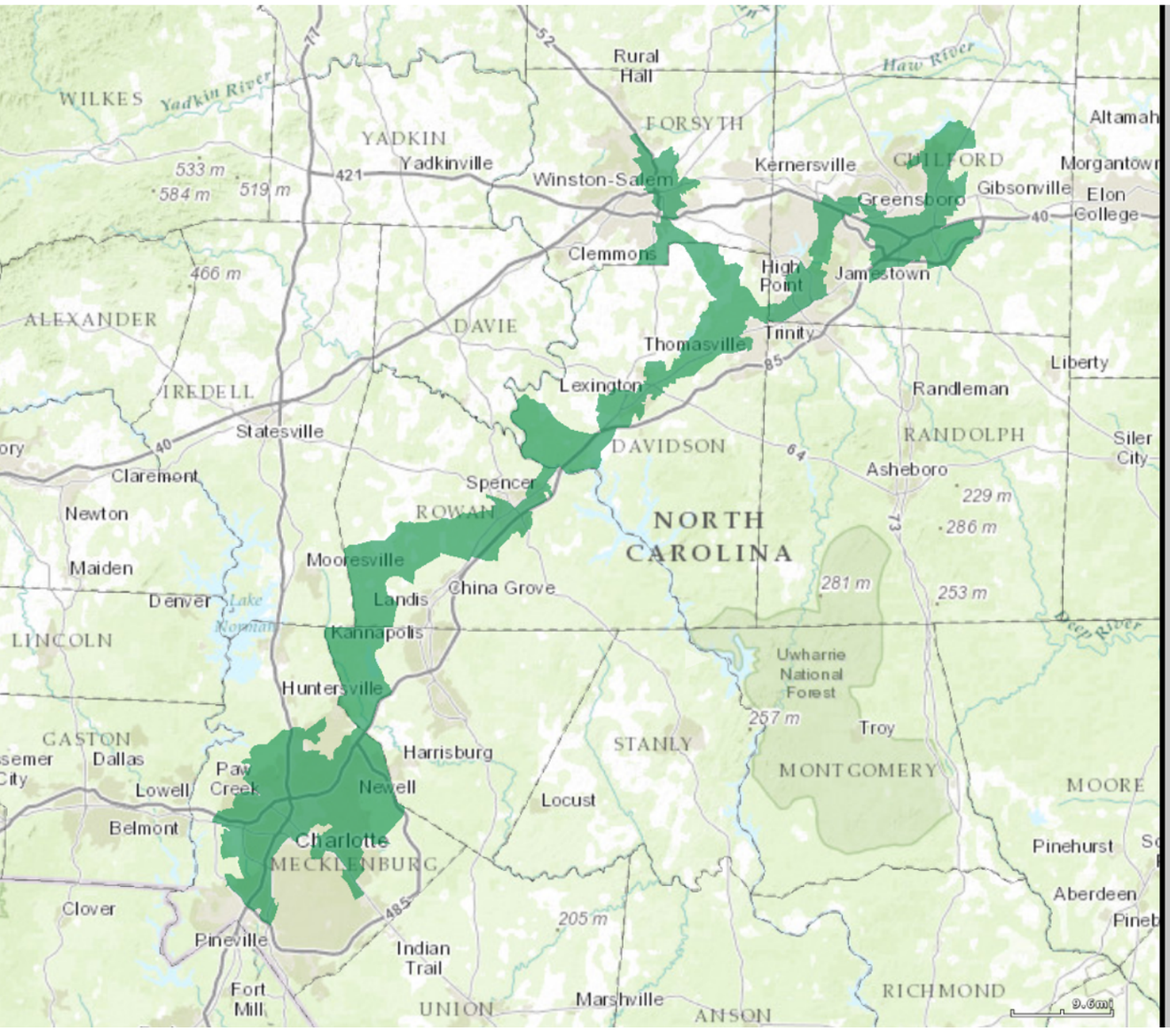
RED WINS

WASHINGTONPOST.COM/**WONKBLOG**

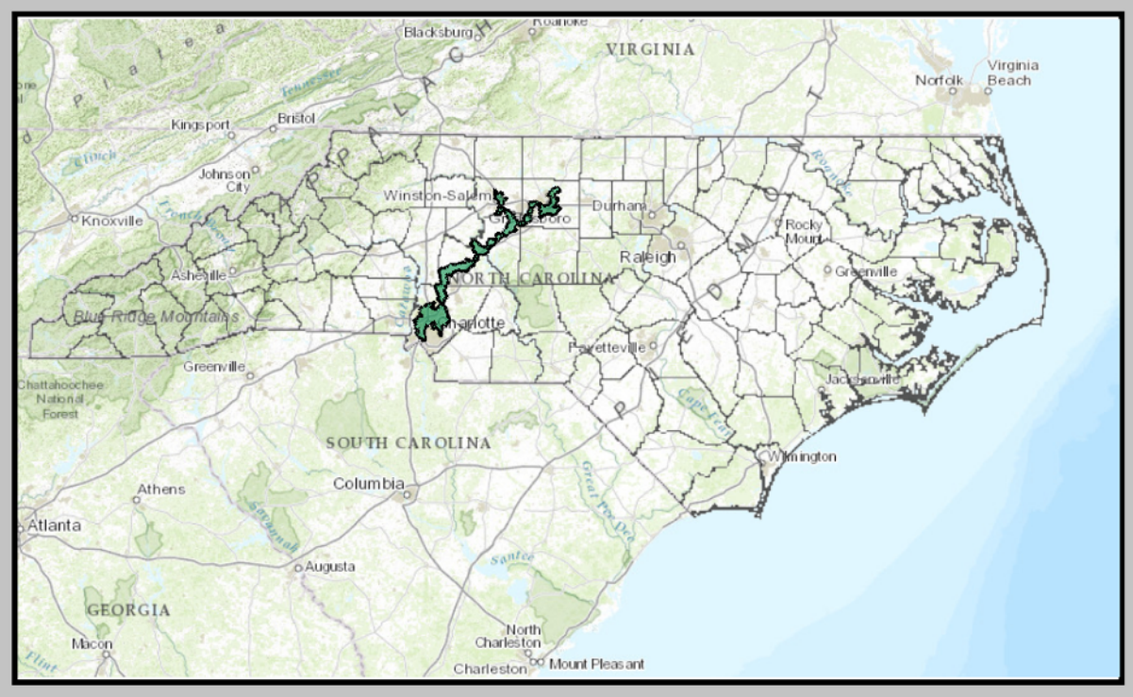
Adapted from Stephen Nass

https://www.washingtonpost.com/news/wonk/wp/2015/03/01/this-is-the-best-explanation-of-gerrymandering-you-will-ever-see

North Carolina’s 12th district

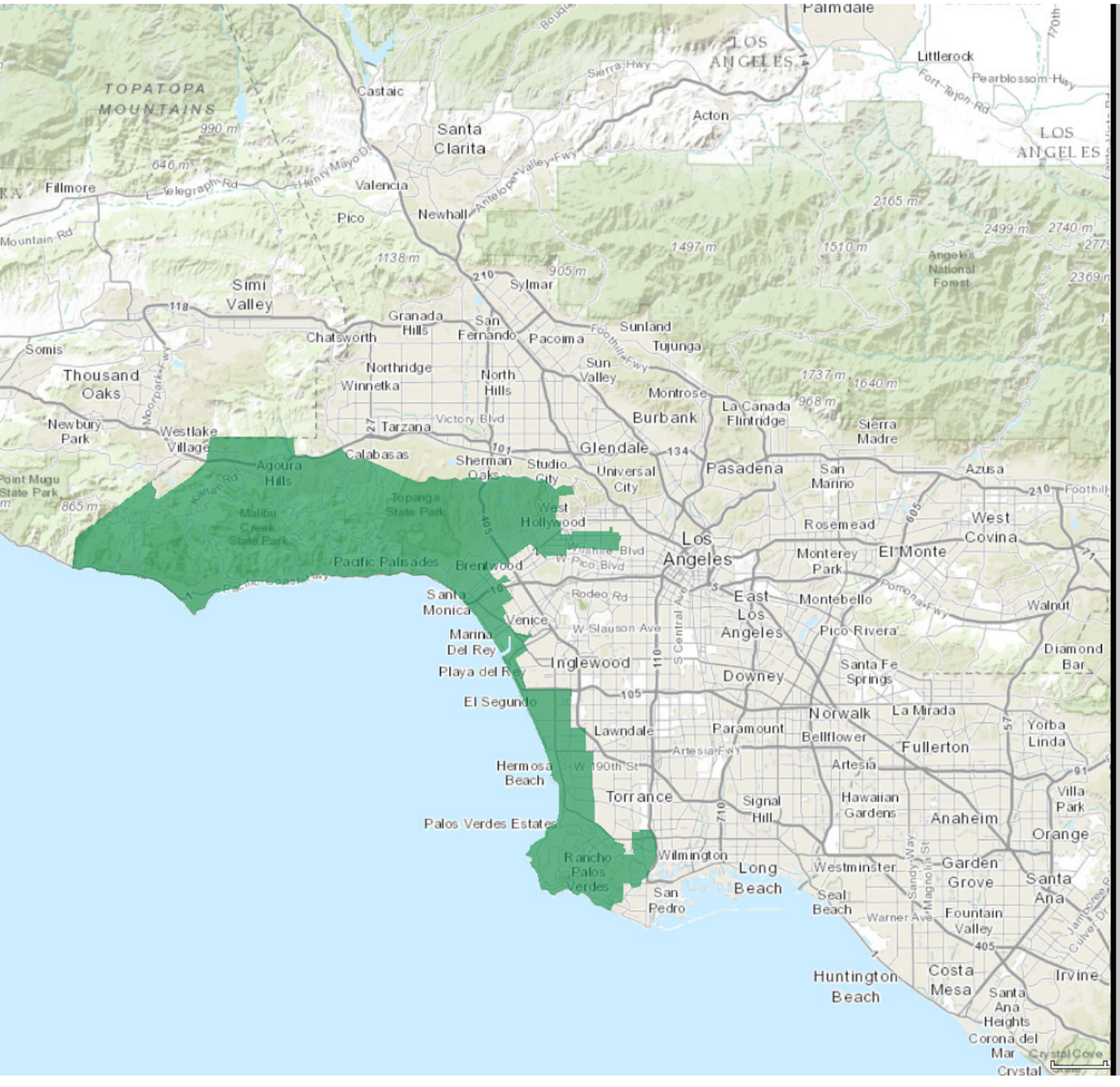


North Carolina US District 12



US Congressional districts since 2013
Source: http://nationalatlas.gov, 1 Million Scale project.

California's 33rd district



California US District 33

US Congressional districts since 2013
Source: http://nationalatlas.gov, 1 Million Scale project.

mission

Perform a Partisan Gerrymander
Gain a third Democratic district

Ver. 1.0.1

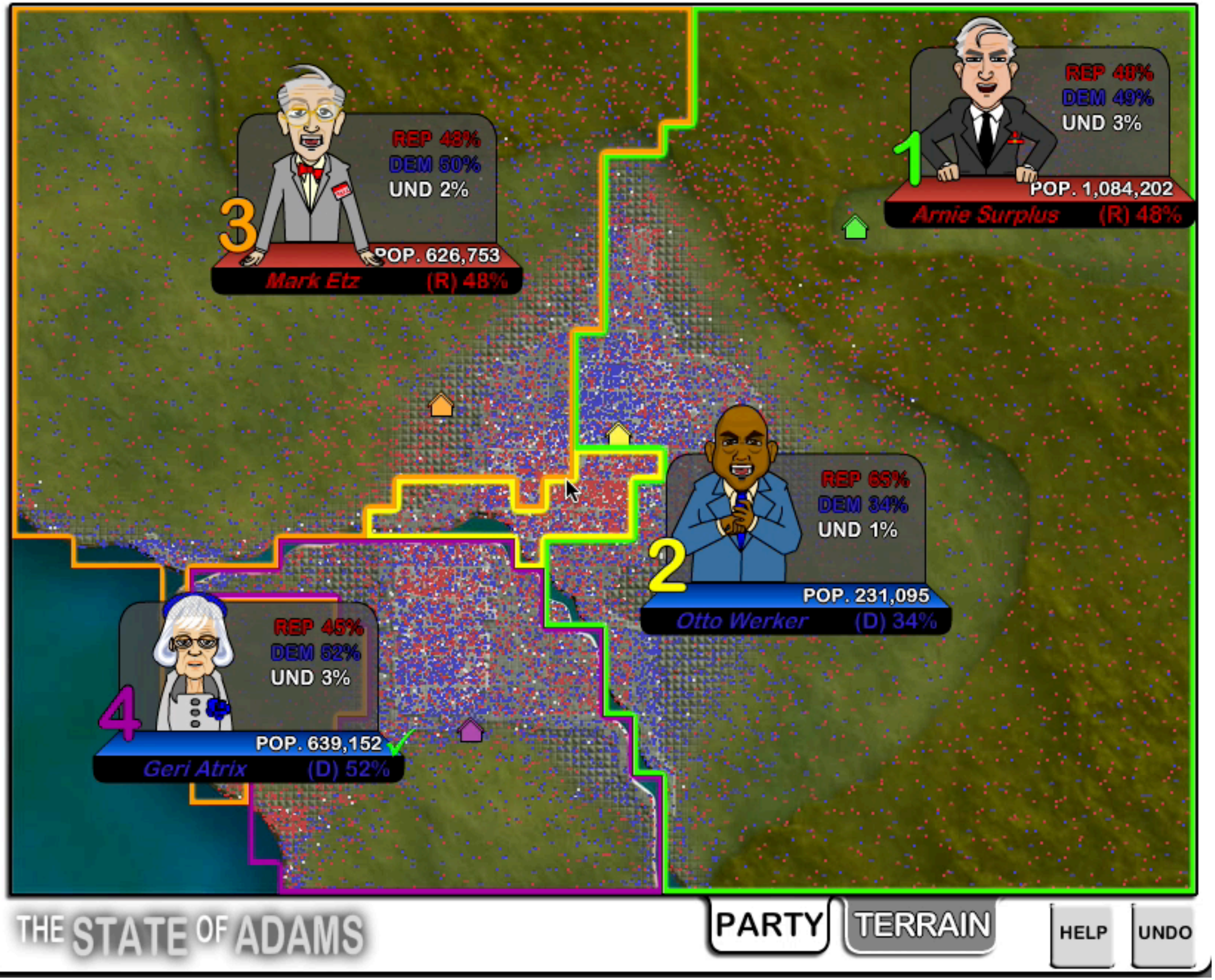
THE ReDISTRICTING GAME

1 DRAW & REDRAW MAP

2 GET FEED BACK

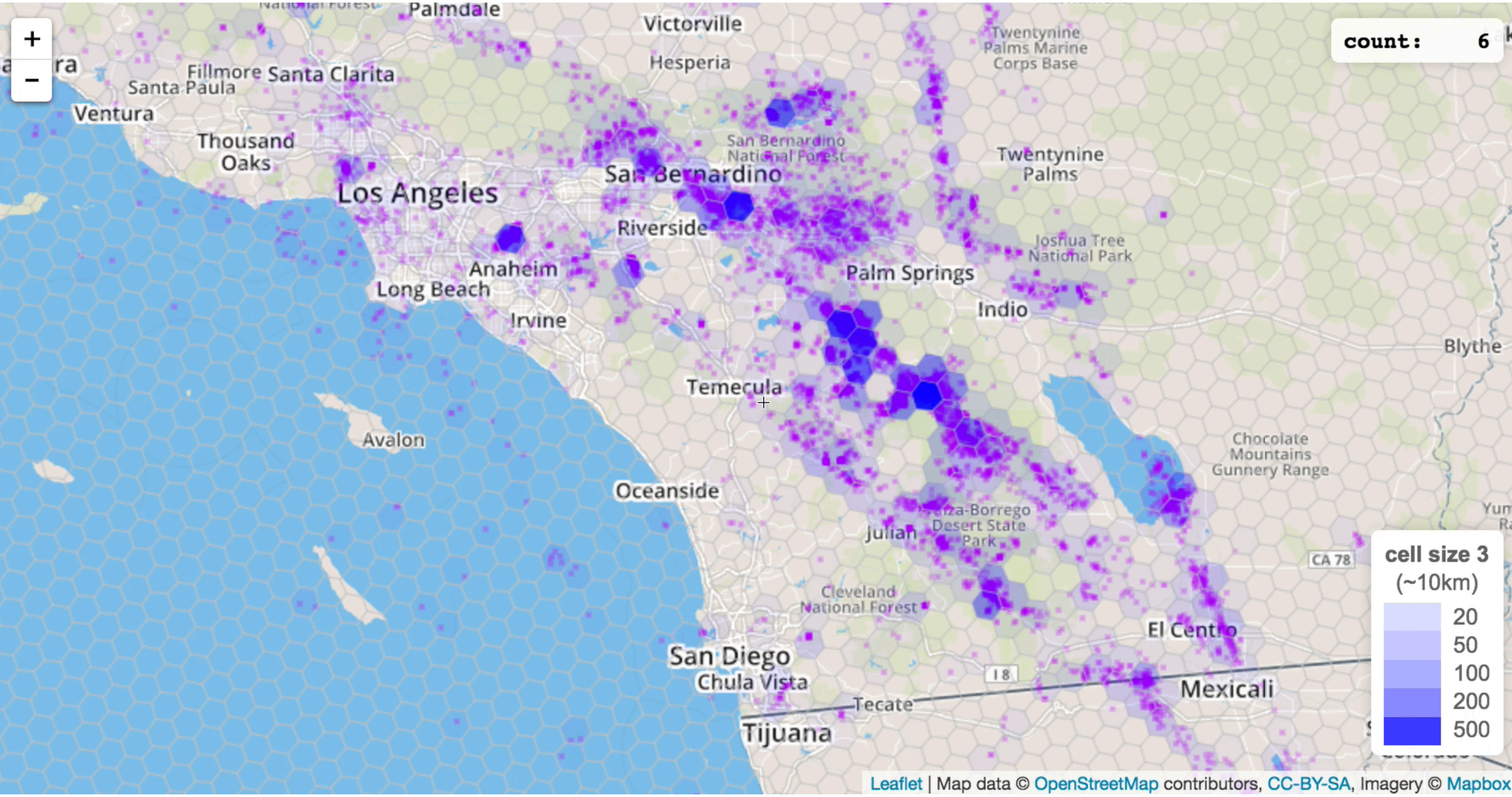
3 SUBMIT FOR APPROVAL

(17,14)
Pop: 12001
DEM: 50%
REP: 50%
UND: 0%
MISSION GOAL



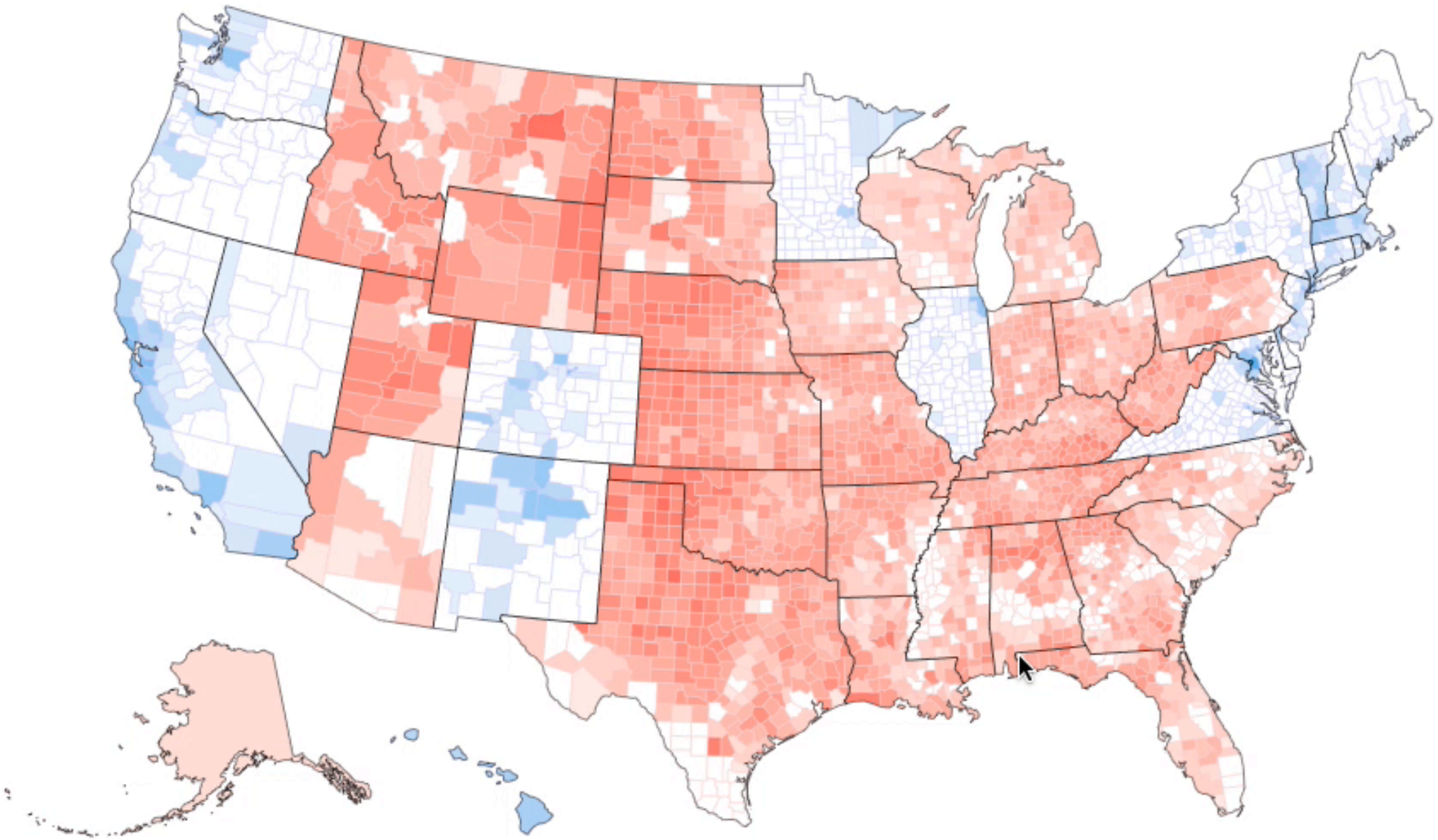
PARTY TERRAIN HELP UNDO

http://redistrictinggame.org/



Lunzer and McNamara, www.bit.ly/spatial_agg

233 305



Instructions

How few counties can you move to make Hillary Clinton win the 2016 election?

Choose a county (or several) to move to a new state. Then click the **Move** button and the state you want to move your counties to.

We'll automatically recompute the number of electoral votes the state would get with their new counties, and update the electoral vote. However, we don't account for Maine and Nebraska's splitting of votes by congressional district.

Weep at how arbitrary our electoral system is.

Move

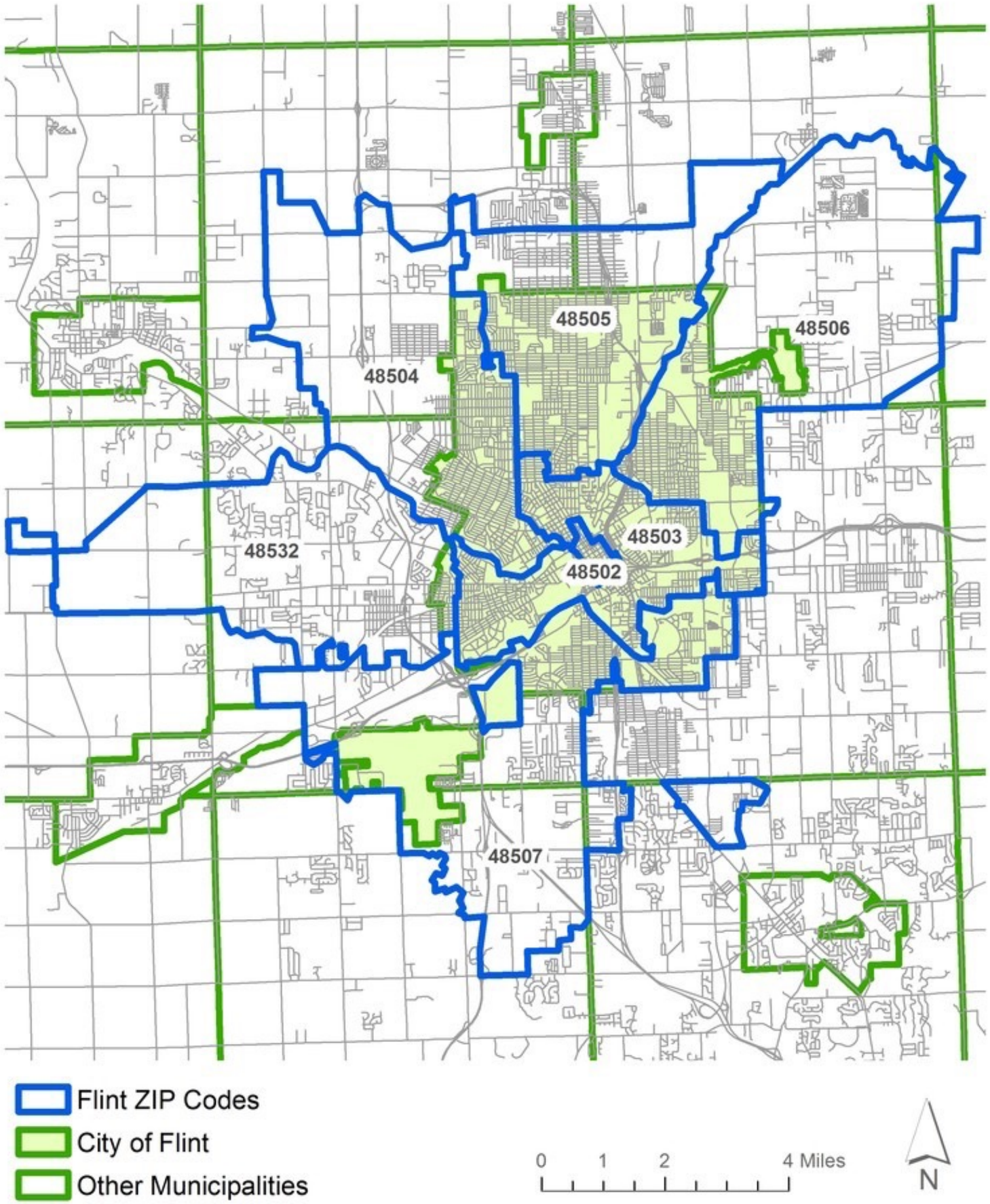
Hide Counties

Share

Year: 2016

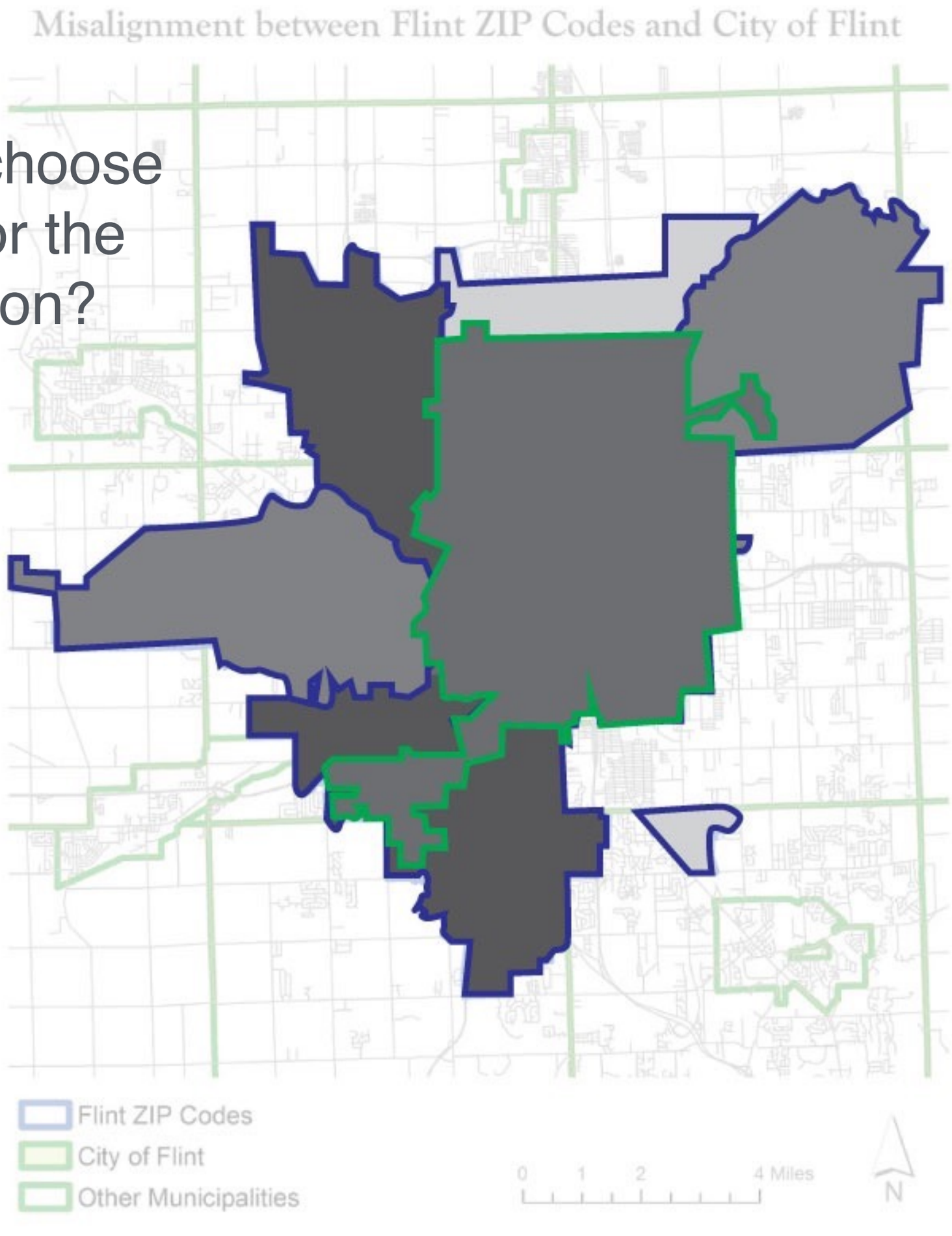
http://kevinhayeswilson.com/redraw/

Misalignment between Flint ZIP Codes and City of Flint



http://theconversation.com/how-zip-codes-nearly-masked-the-lead-problem-in-flint-65626

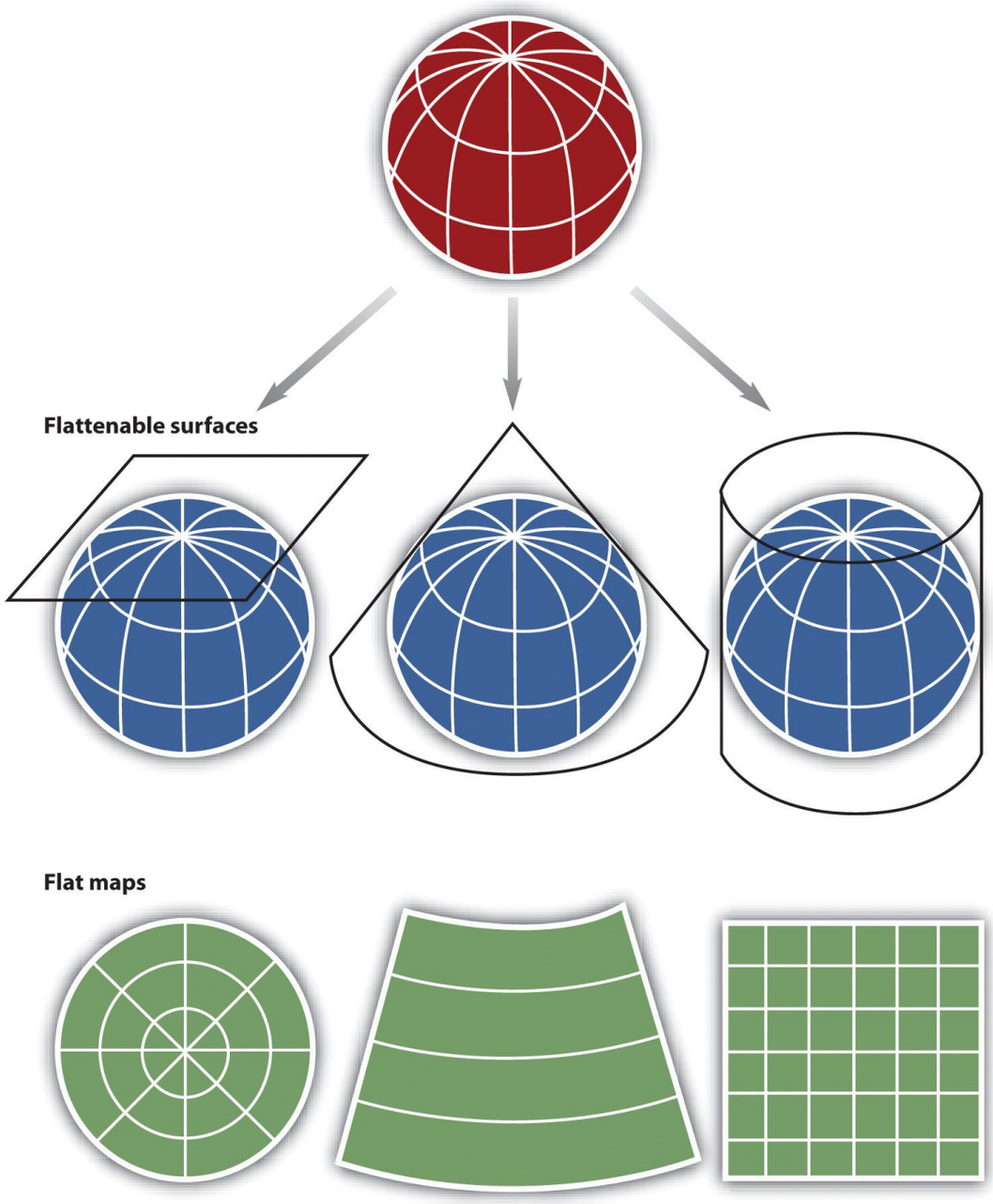
How do we choose the value for the green region?



Projections

flickr: MattHagedorn

Map projections



Campbell, J.E., & Shin, M. (2012). Geographic Information System Basics.

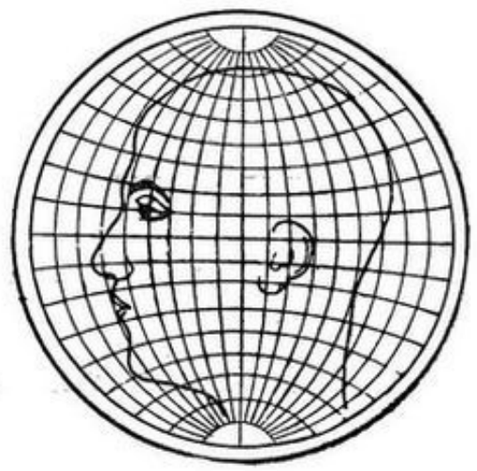


Fig. 42.—Man's head drawn on globular projection.

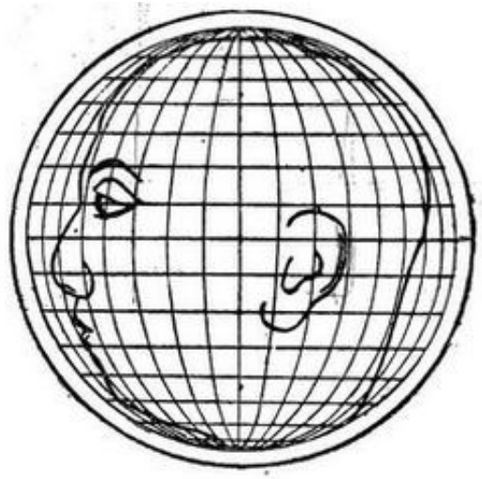


Fig. 43.—Man's head plotted on orthographic projection.

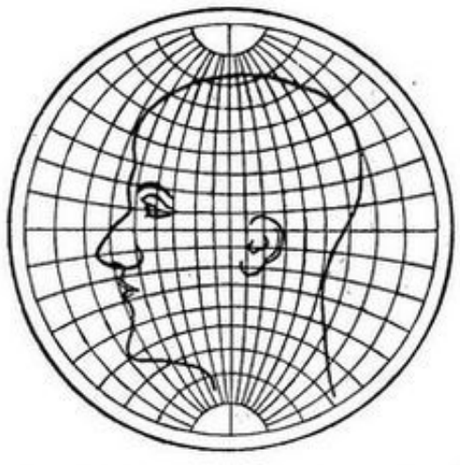


Fig. 44.—Man's head plotted on stereographic projection.

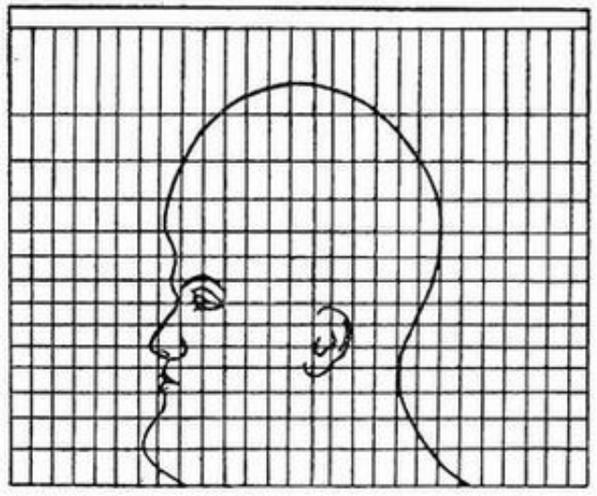
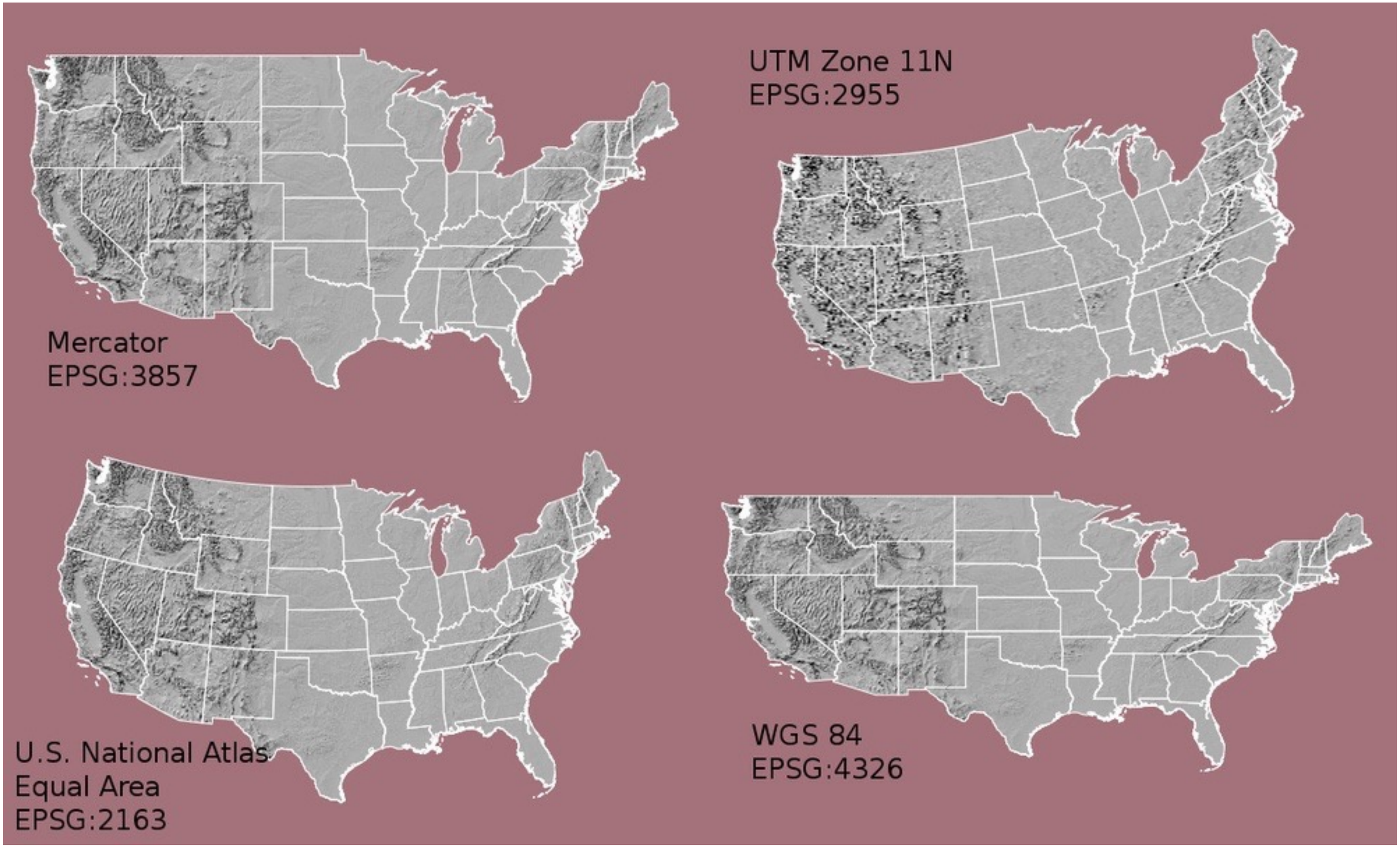


Fig. 45.—Man's head plotted on Mercator projection.

Deetz, C. H., & Adams, O. S. (1921). Elements of map projection with applications to map and chart construction.

via Jordan Crouser



https://source.opennews.org/articles/choosing-right-map-projection

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!

ROBINSON

YOU HAVE A COMFORTABLE PAIR OF RUNNING SHOES THAT YOU WEAR EVERYWHERE. YOU LIKE COFFEE AND ENJOY THE BEATLES. YOU THINK THE ROBINSON IS THE BEST-LOOKING PROJECTION, HANDS DOWN.

DYMAXION

YOU LIKE ISAAC ASIMOV, XML, AND SHOES WITH TOES. YOU THINK THE SEGWAY GOT A BAD RAP. YOU OWN 3D GOGGLES, WHICH YOU USE TO VIEW ROTATING MODELS OF BETTER 3D GOGGLES. YOU TYPE IN DVORAK.

WINKEL-TRIPEL

NATIONAL GEOGRAPHIC ADOPTED THE WINKEL-TRIPEL IN 1998, BUT YOU'VE BEEN A W-T FAN SINCE *LONG* BEFORE "NAT GEO" SHOWED UP. YOU'RE WORRIED IT'S GETTING PLAYED OUT, AND ARE THINKING OF SWITCHING TO THE KAVRAYSKIY. YOU ONCE LEFT A PARTY IN DISGUST WHEN

GOODE HOMOLOSINE

THEY SAY MAPPING THE EARTH ON A 2D SURFACE IS LIKE FLATTENING AN ORANGE PEEL, WHICH SEEMS EASY ENOUGH TO YOU. YOU LIKE EASY SOLUTIONS. YOU THINK WE WOULDN'T HAVE SO MANY PROBLEMS IF WE'D JUST ELECT *NORMAL* PEOPLE TO CONGRESS INSTEAD OF POLITICIANS. YOU THINK AIRLINES SHOULD JUST BUY

https://xkcd.com/977/

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GOODE HOMOLOSINE

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HOBO-DYER

YOU WANT TO AVOID CULTURAL IMPERIALISM, BUT YOU'VE HEARD BAD THINGS ABOUT GALL-PETERS. YOU'RE CONFLICT-AVERSE AND BUY ORGANIC. YOU USE A RECENTLY-INVENTED SET OF GENDER-NEUTRAL PRONOUNS AND THINK THAT WHAT THE WORLD NEEDS IS A REVOLUTION IN CONSCIOUSNESS.

PLATE CARRÉE
(EQUIRECTANGULAR)

YOU THINK THIS ONE IS FINE. YOU LIKE HOW X AND Y MAP TO LATITUDE AND LONGITUDE. THE OTHER PROJECTIONS OVERCOMPLICATE THINGS. YOU WANT ME TO STOP ASKING ABOUT MAPS SO YOU CAN ENJOY DINNER.

A GLOBE!

YES, YOU'RE VERY CLEVER.

WATERMAN BUTTERFLY

REALLY? YOU KNOW THE WATERMAN? HAVE YOU SEEN THE 1909 CAHILL MAP IT'S BASED— ...YOU HAVE A FRAMED REPRODUCTION AT HOME?! WHOA. ...LISTEN, FORGET THESE QUESTIONS. ARE YOU DOING ANYTHING TONIGHT?

PEIRCE QUINCUNCIAL

GALL-PETERS

https://xkcd.com/977/

A GUEST SHOWED UP WEARING SHOES WITH TOES. YOUR FAVORITE MUSICAL GENRE IS "POST-".

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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.

FOOD FROM THE RESTAURANTS NEAR THE GATES AND SERVE *THAT* ON BOARD. YOU CHANGE YOUR CAR'S OIL, BUT SECRETLY WONDER IF YOU REALLY *NEED* TO.

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GALL-PETERS

I *HATE* YOU.

https://xkcd.com/977/

The **True Size** of **Africa**

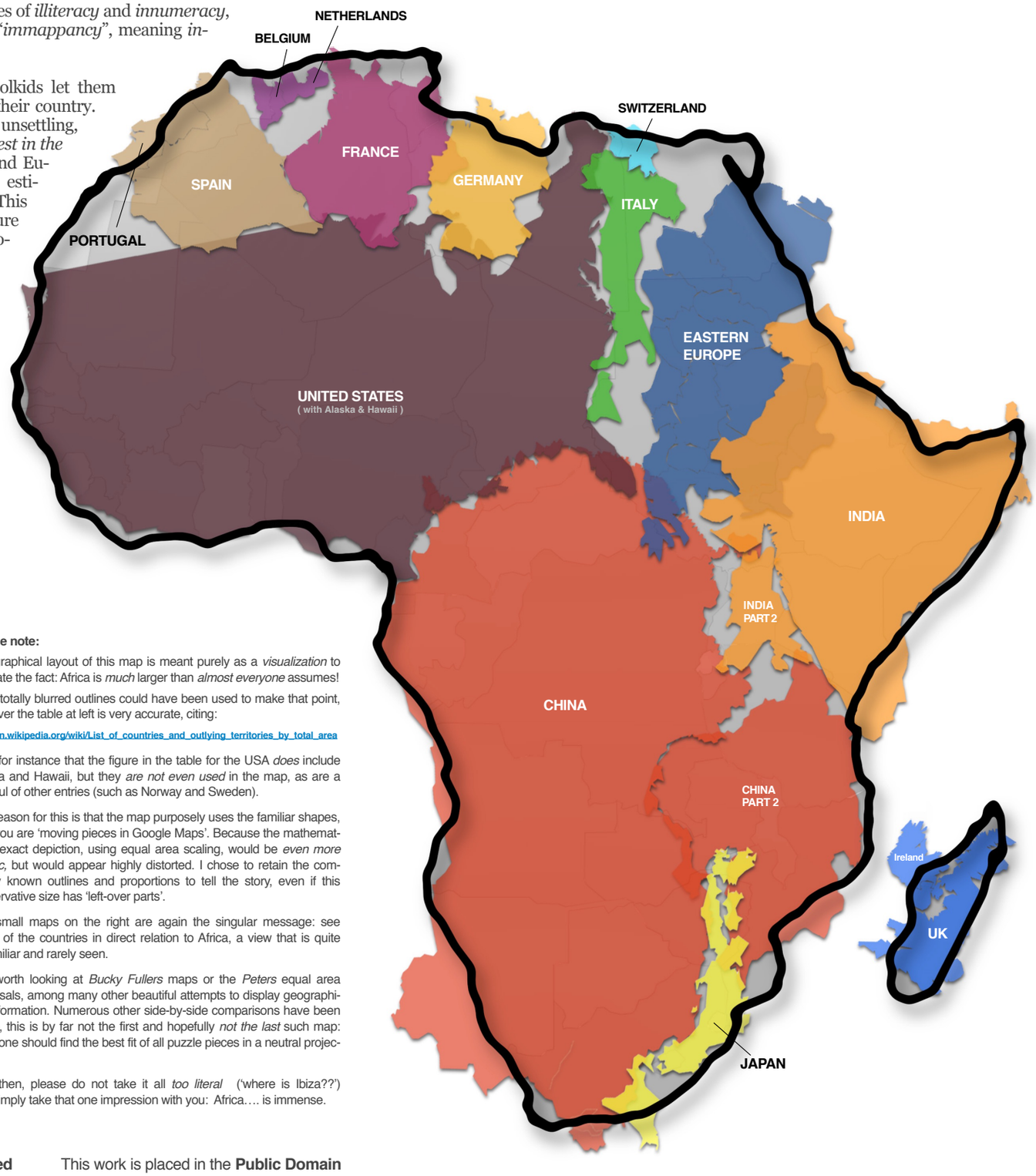
A small contribution in the fight against rampant *Immappancy,* by **Kai Krause**

In addition to the well known social issues of *illiteracy* and *innumeracy*, there also should be such a concept as "*immappancy*", meaning *insufficient geographical knowledge.*

A survey with random American schoolkids let them guess the population and land area of their country. Not entirely unexpected, but still rather unsettling, the majority chose *"1-2 billion"* and *"largest in the world"*, respectively. Even with Asian and European college students, geographical estimates were often off by factors of *2-3*. This is partly due to the highly distorted nature of the predominantly used mapping projections (such as *Mercator*).

A particularly extreme example is the worldwide misjudgement of the true size of Africa. This single image tries to embody the massive scale, which is larger than the *USA*, *China*, *India*, *Japan* and *all of Europe - combined!*

COUNTRY	AREA x 1000 km²
USA	9.629
China	9.573
India	3.287
Mexico	1.964
Peru	1.285
France	633
Spain	506
Papua New Guinea	462
Sweden	441
Japan	378
Germany	357
Norway	324
Italy	301
New Zealand	270
United Kingdom	243
Nepal	147
Bangladesh	144
Greece	132
TOTAL	**30.102**
AFRICA	**30.221**
Just for Reference: The Surface of the MOON	37.930



Please note:

The graphical layout of this map is meant purely as a *visualization* to illustrate the fact: Africa is *much* larger than *almost everyone* assumes!

Even totally blurred outlines could have been used to make that point, however the table at left is very accurate, citing:

http://en.wikipedia.org/wiki/List_of_countries_and_outlying_territories_by_total_area

Note for instance that the figure in the table for the USA *does* include Alaska and Hawaii, but they *are not even used* in the map, as are a handful of other entries (such as Norway and Sweden).

The reason for this is that the map purposely uses the familiar shapes, as if you are 'moving pieces in Google Maps'. Because the mathematically exact depiction, using equal area scaling, would be *even more drastic,* but would appear highly distorted. I chose to retain the commonly known outlines and proportions to tell the story, even if this conservative size has 'left-over parts'.

The small maps on the right are again the singular message: see some of the countries in direct relation to Africa, a view that is quite unfamiliar and rarely seen.

It is worth looking at *Bucky Fullers* maps or the *Peters* equal area proposals, among many other beautiful attempts to display geographical information. Numerous other side-by-side comparisons have been made, this is by far not the first and hopefully *not the last* such map: someone should find the best fit of all puzzle pieces in a neutral projection.

Until then, please do not take it all *too literal* ('where is Ibiza??') and simply take that one impression with you: Africa…. is immense.

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Top 100 Countries

Area in square kilometers, Percentage of World Total
Sources: Britannica, Wikipedia, Almanac 2010

United States

Europe

India

Japan

China

		AREA km²	%
1	Russia	17.098.242	11,50
2	Canada	9.984.670	6,70
3	China	9.596.961	6,40
4	United States	9.629.091	6,40
5	Brazil	8.514.877	5,70
6	Australia	7.692.024	5,20
7	India	3.287.263	2,30
8	Argentina	2.780.400	2,00
9	Kazakhstan	2.724.900	1,80
10	Sudan	2.505.813	1,70
11	Algeria	2.381.741	1,60
12	Congo	2.344.858	1,60
13	Greenland	2.166.086	1,50
14	Saudi Arabia	2.149.690	1,40
15	Mexico	1.964.375	1,30
16	Indonesia	1.860.360	1,30
17	Libya	1.759.540	1,20
18	Iran	1.628.750	1,10
19	Mongolia	1.564.100	1,10
20	Peru	1.285.216	0,86
21	Chad	1.284.000	0,86
22	Niger	1.267.000	0,85
23	Angola	1.246.700	0,85
24	Mali	1.240.192	0,83
25	South Africa	1.221.037	0,82
26	Colombia	1.141.748	0,76
27	Ethiopia	1.104.300	0,74
28	Bolivia	1.098.581	0,74
29	Mauritania	1.025.520	0,69
30	Egypt	1.002.000	0,67
31	Tanzania	945.087	0,63
32	Nigeria	923.768	0,62
33	Venezuela	912.050	0,61
34	Namibia	824.116	0,55
35	Mozambique	801.590	0,54
36	Pakistan	796.095	0,53
37	Turkey	783.562	0,53
38	Chile	756.102	0,51
39	Zambia	752.612	0,51
40	Myanmar	676.578	0,45
41	Afghanistan	652.090	0,44
42	Somalia	637.657	0,43
43	France	632.834	0,43
44	C. African Rep	622.984	0,42
45	Ukraine	603.500	0,41
46	Madagascar	587.041	0,39
47	Botswana	582.000	0,39
48	Kenya	580.367	0,39
49	Yemen	527.968	0,35
50	Thailand	513.120	0,34
51	Spain	505.992	0,34
52	Turkmenistan	488.100	0,33
53	Cameroon	475.442	0,32
54	Papua New Guinea	462.840	0,31
55	Uzbekistan	447.400	0,30
56	Morocco	446.550	0,30
57	Sweden	441.370	0,30
58	Iraq	438.317	0,29
59	Paraguay	406.752	0,27
60	Zimbabwe	390.757	0,26
61	Japan	377.930	0,25
62	Germany	357.114	0,24
63	Rep o.t. Congo	342.000	0,23
64	Finland	338.419	0,23
65	Vietnam	331.212	0,22
66	Malaysia	330.803	0,22
67	Norway	323.802	0,22
68	Côte d'Ivoire	322.463	0,22
69	Poland	312.685	0,21
70	Oman	309.500	0,21
71	Italy	301.336	0,20
72	Philippines	300.000	0,20
73	Burkina Faso	274.222	0,18
74	New Zealand	270.467	0,18
75	Gabon	267.668	0,18
76	Western Sahara	266.000	0,18
77	Ecuador	256.369	0,20
78	Guinea	245.857	0,17
79	United Kingdom	242.900	0,16
80	Uganda	241.038	0,16
81	Ghana	238.539	0,16
82	Romania	238.391	0,16
83	Laos	236.800	0,16
84	Guyana	214.969	0,14
85	Belarus	207.600	0,14
86	Kyrgyzstan	199.951	0,13
87	Senegal	196.722	0,13
88	Syria	185.180	0,12
89	Cambodia	181.035	0,12
90	Uruguay	176.215	0,12
91	Suriname	163.820	0,11
92	Tunisia	163.610	0,11
93	Nepal	147.181	0,10
94	Bangladesh	143.998	0,10
95	Tajikistan	143.100	0,10
96	Greece	131.957	0,09
97	Nicaragua	130.373	0,09
98	North Korea	120.538	0,08
99	Malawi	118.484	0,08
100	Eritrea	117.600	0,08
	TOP 100 TOTAL	132.632.524	89,34

http://kai.sub.blue/images/True-Size-of-Africa-kk-v3.pdf

Lab: mapping

Mapping lab

Using the TB data from the World Health Organization (who.csv)

- Create a geographic visualization
- Choose an appropriate projection
- Post your completed map to #lab6