Cartograms

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References

Dorling, D., 1994. Cartograms for Visualizing Human Geography. In: H.H.a.D.J. Unwin (Editor), Visualization in Geographical Information Systems. Wiley and Sons, Chichester, pp. 85-101.

Dorling, D., (1996): *Area Cartograms: Their Use and Creation*, Concepts and Techniques in Modern Geography (CATMOG), 59,

Tobler, Waldo. "Thirty Five Years of Computer Cartograms." *Annals of the Association of American Geographers* 94, no. 1 (2004): 58-73.

References

- Herzog, Adrian (2003): "Developing Cartographic Applets for the Internet", in: Michael P. Peterson (ed.): *Maps and the Internet, Vol. 1*, ISBN: 0-08-044201-3, 468pp., p. 115-128.
- Dykes, Jasond and David Unwin (1996): *Maps of the Census: a Rough Guide*.
- Dougenik, James. A., Nicholas R. Chrisman and Duane R. Niemeyer (1985): "An Algorithm to Construct Continous Area Cartograms", *Professional Geographer*, 37 (1), 75-81.
- Jackel C.B. 1997 Using ArcView to Create Contiguous and Noncontiguous Area Cartograms," Cartography and Geographic Information Systems, vol. 24(2): 101-109

References

- Lots of related references at
- www.geog.ucsb.edu/~sara/html/mapping/election/background.html
- Dorling, D.,. From Computer Cartography to /Spatial Visualization: A New Cartogram Algorithm. *Auto Carto 11 Proceedings.* Minneapolis: ACSM-ASPRS, 1993. 1: 208-217 .
- Listen to Dan: www.csiss.org/streaming_video/csiss/dorling_cartograms.htm

- Sara Fabrikant's work on cartographic variations on the presidential election 2000 theme: www.geog.ucsb.edu/~sara/html/mapping/election/map.html

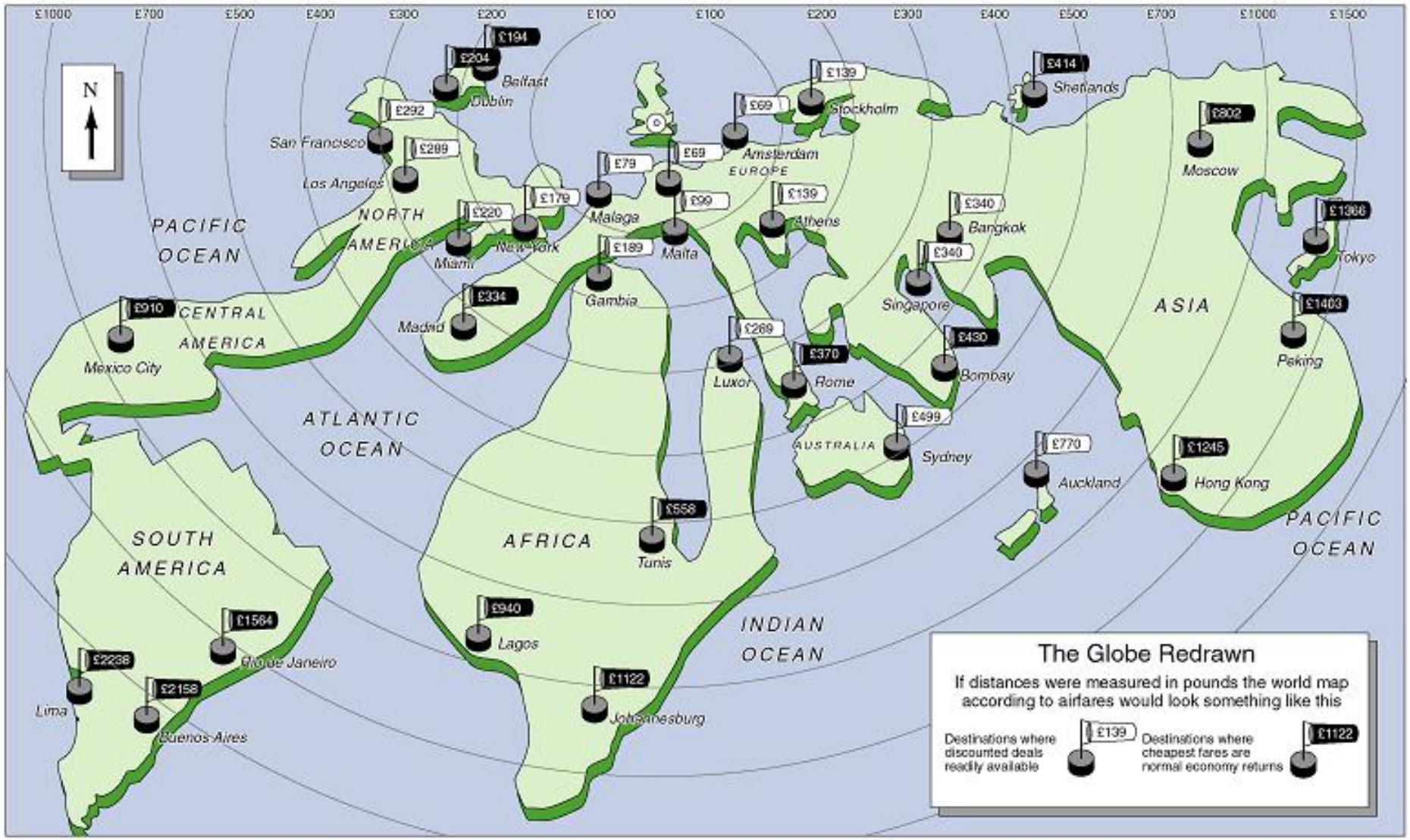
sources

- http://spatial.ly/2013/05/visualising-human-geography/
- http://www.telegraph.co.uk/technology/internet/8204092/Data-mapping-visualisations-the-best-on-the-web.html?image=2
- http://www.theguardian.com/news/datablog/2012/jul/24/danny-dorling-visualise-social-structure
- http://damiencummings.blogspot.co.uk/2010/12/facebook-relationships-visualised.html
- Facebook
- Social graphs
- http://about.yatedo.com/en/manage-your-digital-id/profile/
- http://www.digitalurban.org/2013/04/visualising-spatial-and-social-media-working-paper-190-from-the-centre-for-advanced-spatial-analysis.html

Types of Space

- Standard maps in Euclidean space
  - Metric space: Geometrical measures
- Other possible spaces to map:
  - Equal population density spaces- people, not land, the focus.
  - Topological spaces.
  - Cognitive spaces…
- Visualisation possibilities in comparing or superimposing alternative spaces on Euclidean space.

Idea of distorting space to represent other variables….(Date: BE before easyjet)



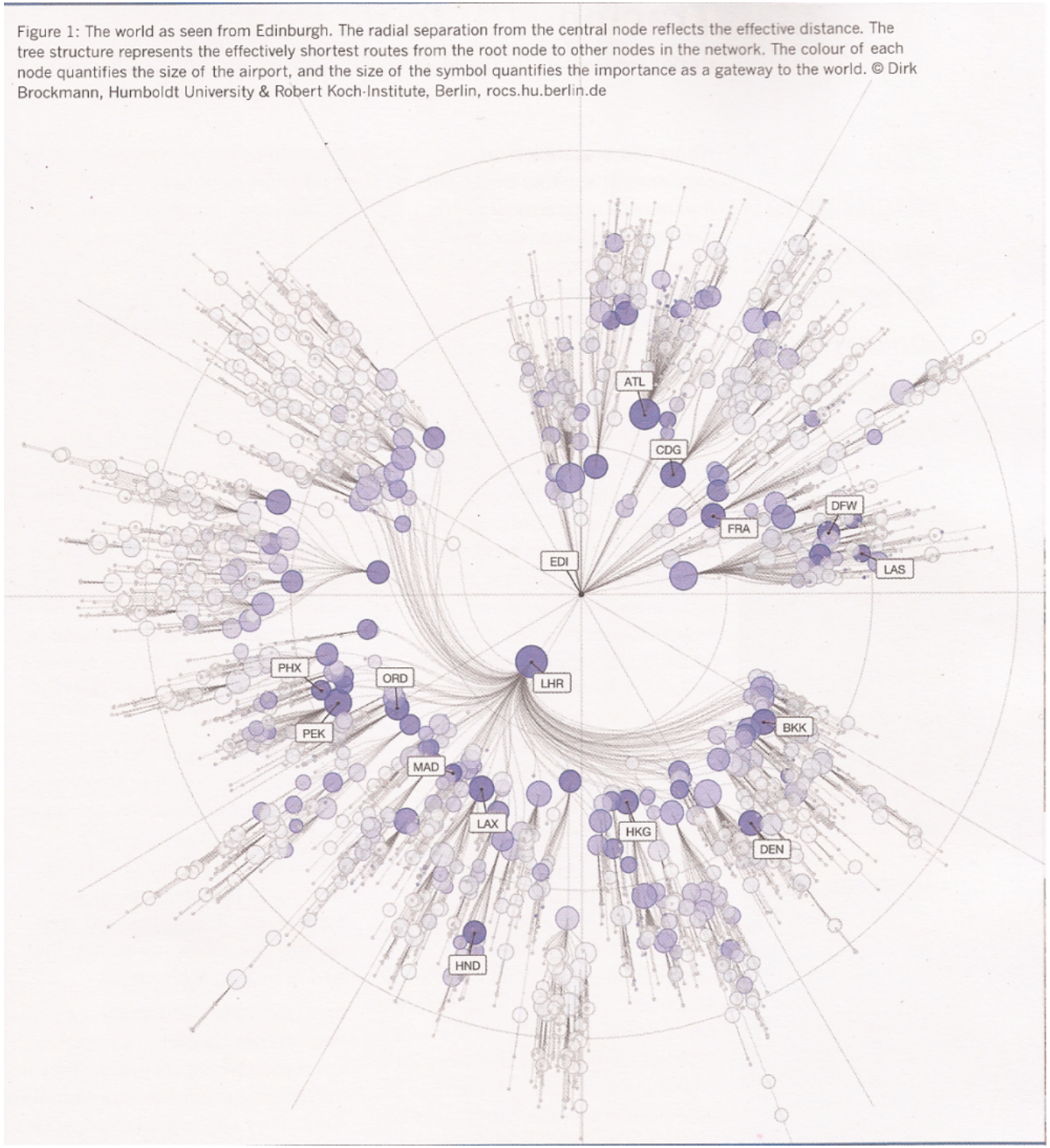
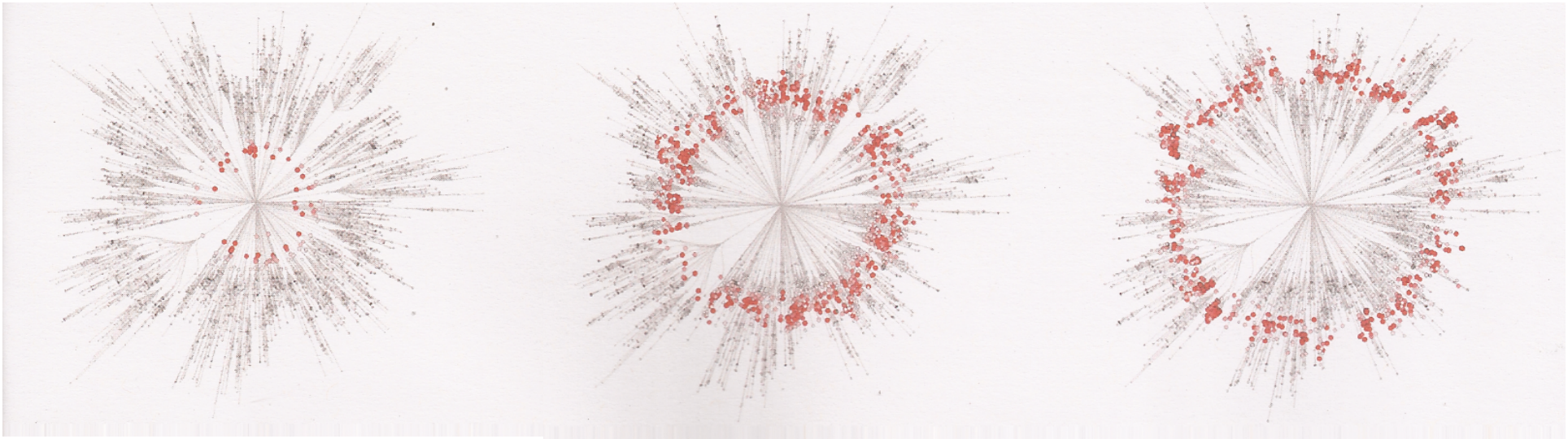
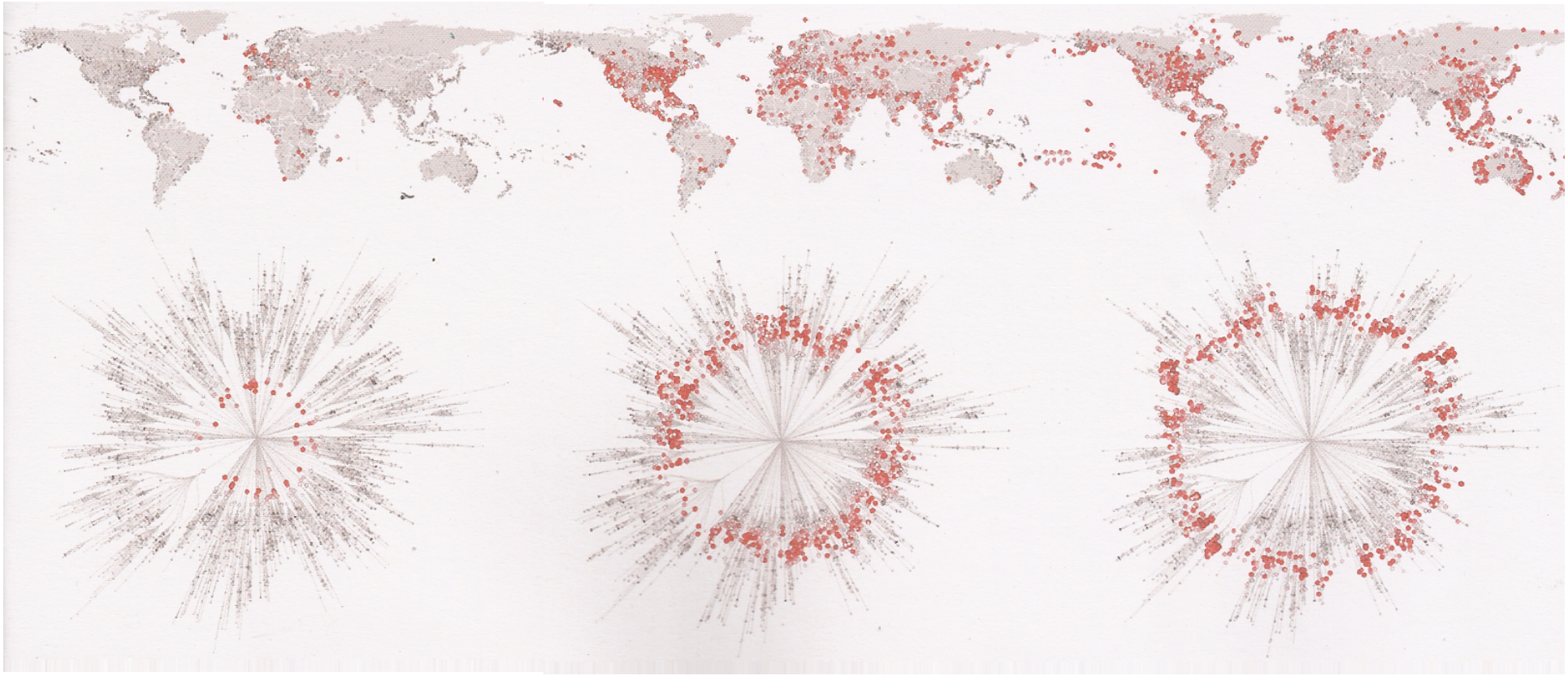
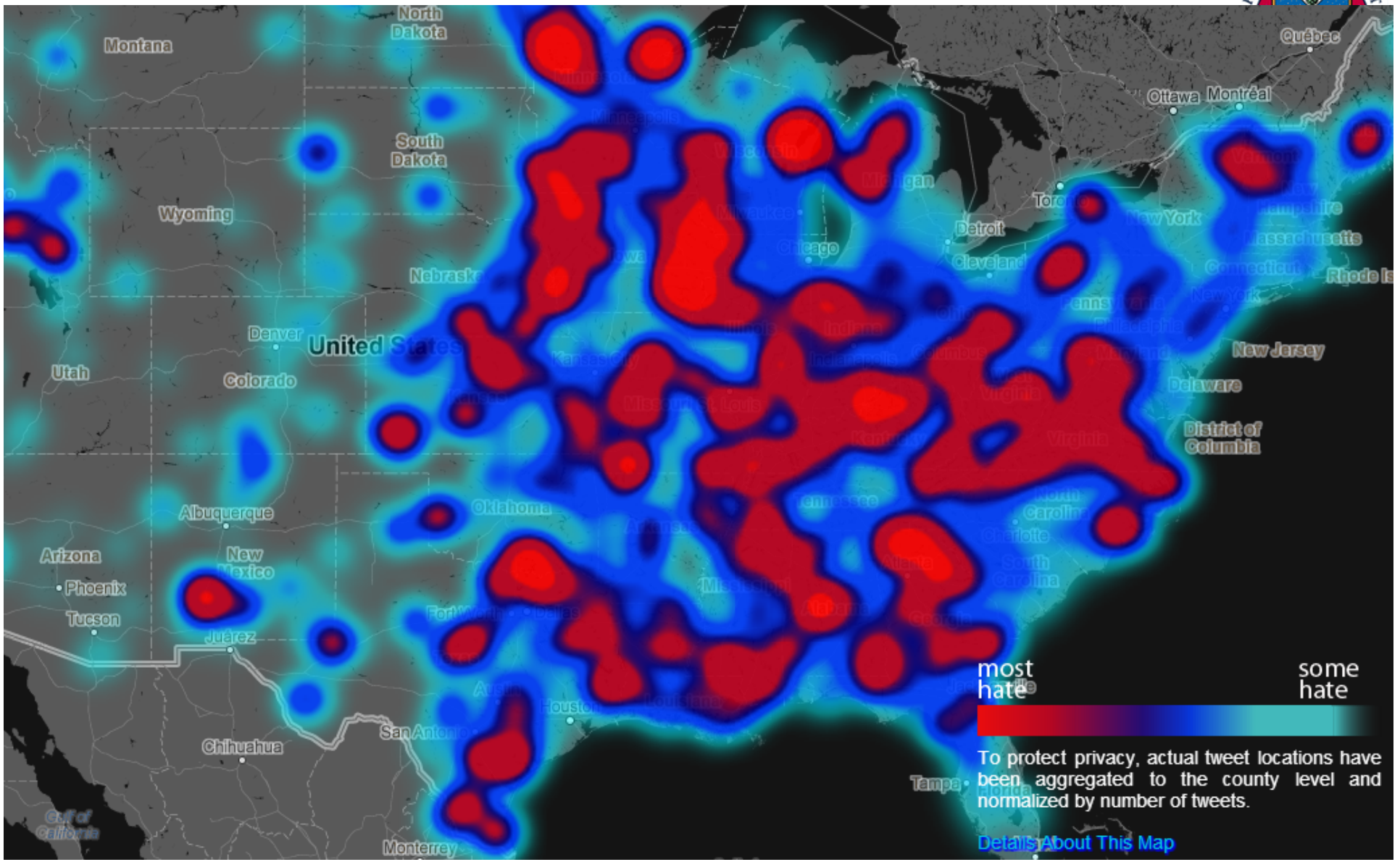


Figure 1: The world as seen from Edinburgh. The radial separation from the central node reflects the effective distance. The tree structure represents the effectively shortest routes from the root node to other nodes in the network. The colour of each node quantifies the size of the airport, and the size of the symbol quantifies the importance as a gateway to the world. © Dirk Brockmann, Humboldt University & Robert Koch-Institute, Berlin, rocs.hu.berlin.de






Montana
North Dakota
South Dakota
Wyoming
Nebraska
Denver
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Utah
Colorado
Albuquerque
Arizona
New Mexico
Phoenix
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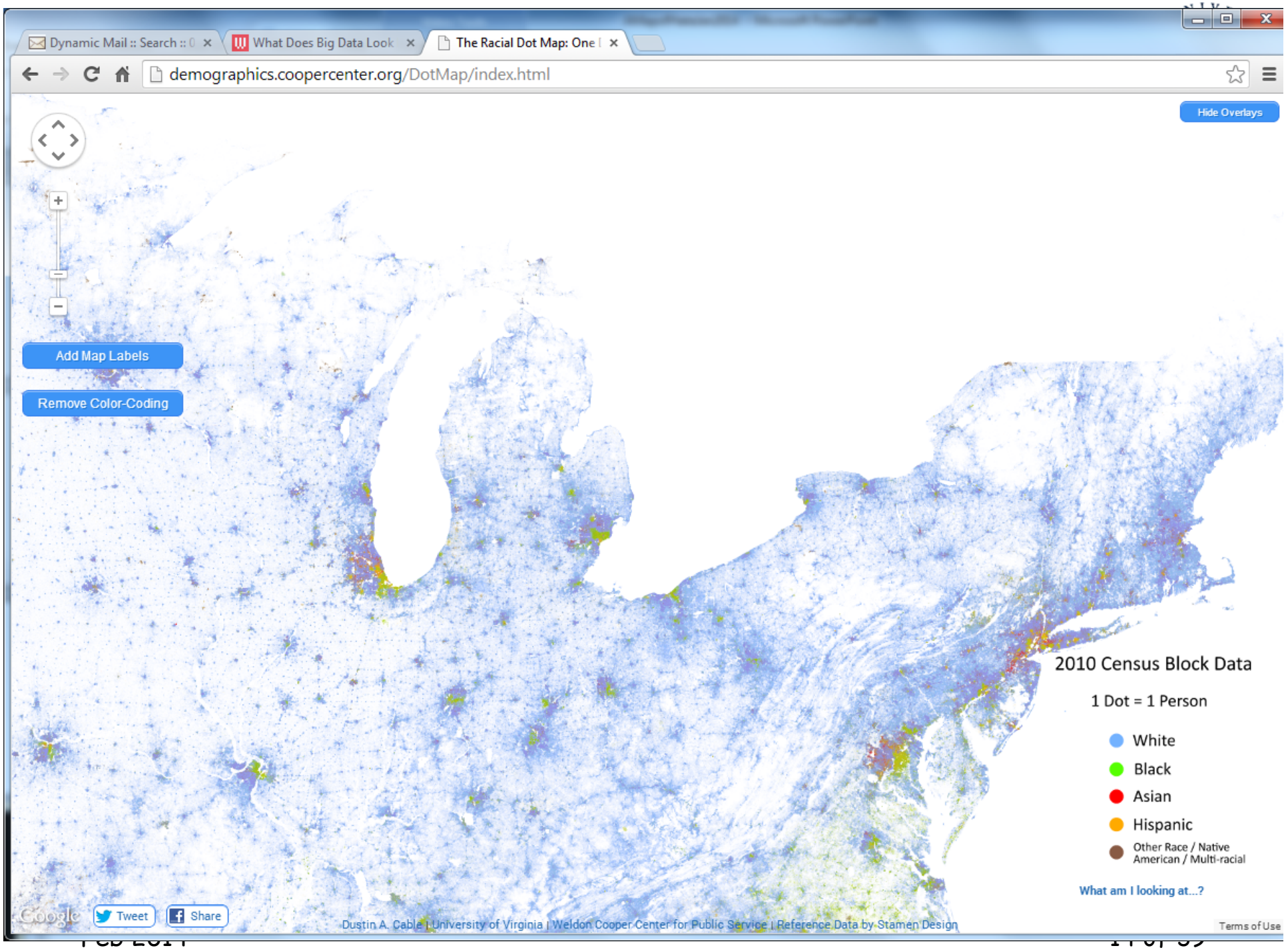
Juárez
Chihuahua
Monterrey
Gulf of California
Oklahoma
Houston
San Antonio
Tampa
Québec
Ottawa
Montréal
Detroit
Cleveland
Chicago
New York
New Jersey
Delaware
District of Columbia
Virginia
Carolina
Charlotte
South Carolina
most hate
some hate
To protect privacy, actual tweet locations have been aggregated to the county level and normalized by number of tweets.
Details About This Map


Facebook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What Does Big Data Look
The Racial Dot Map: One
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Remove Color-Coding
2010 Census Block Data
1 Dot = 1 Person
White
Black
Asian
Hispanic
Other Race / Native American / Multi-racial
What am I looking at...?
Tweet
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Dustin A. Cable | University of Virginia | Weldon Cooper Center for Public Service | Reference Data by Stamen Design
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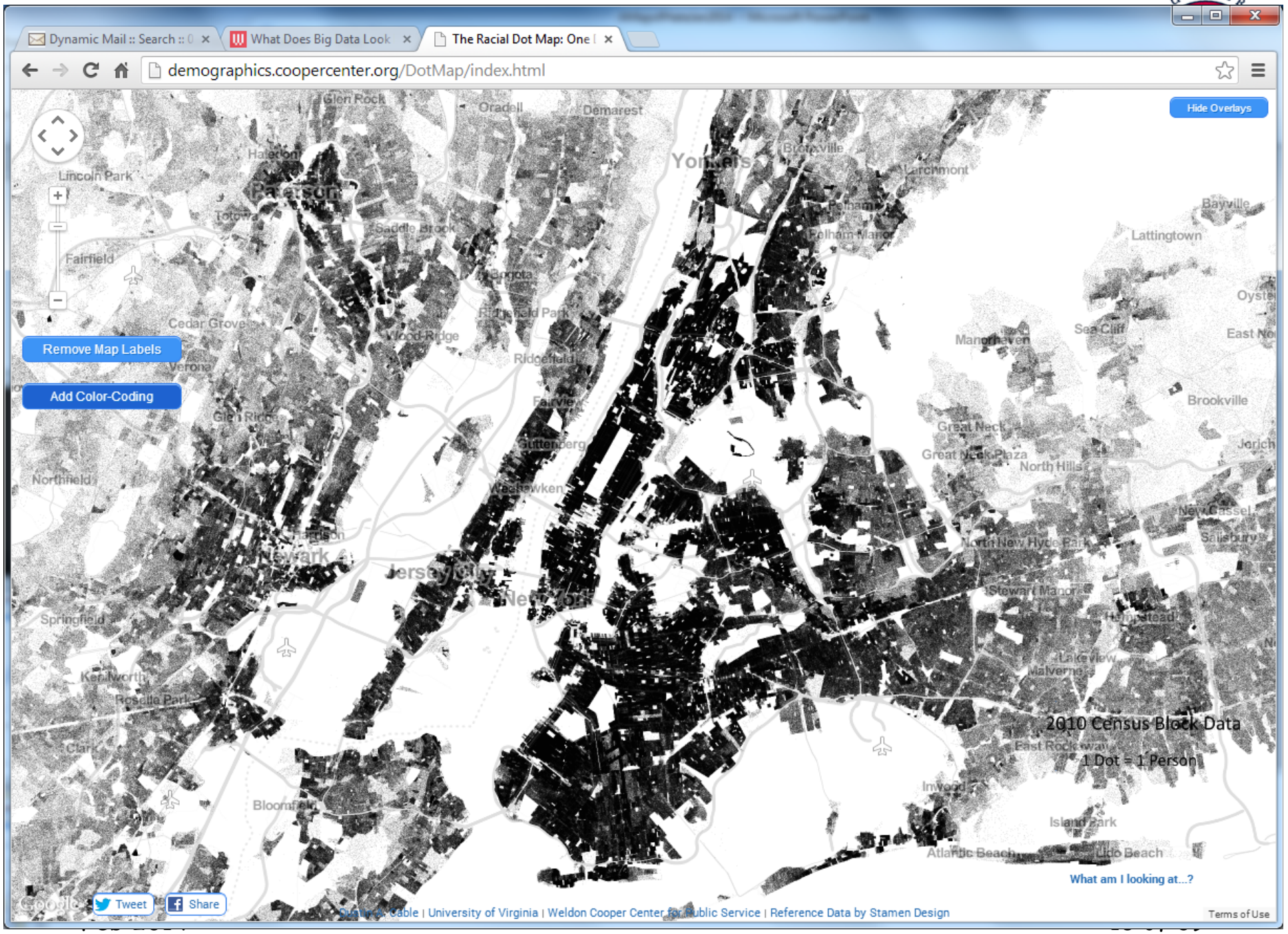
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What Does Big Data Look
The Racial Dot Map: One
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Hide Overlays
Remove Map Labels
Add Color-Coding
2010 Census Block Data
1 Dot = 1 Person
What am I looking at...?
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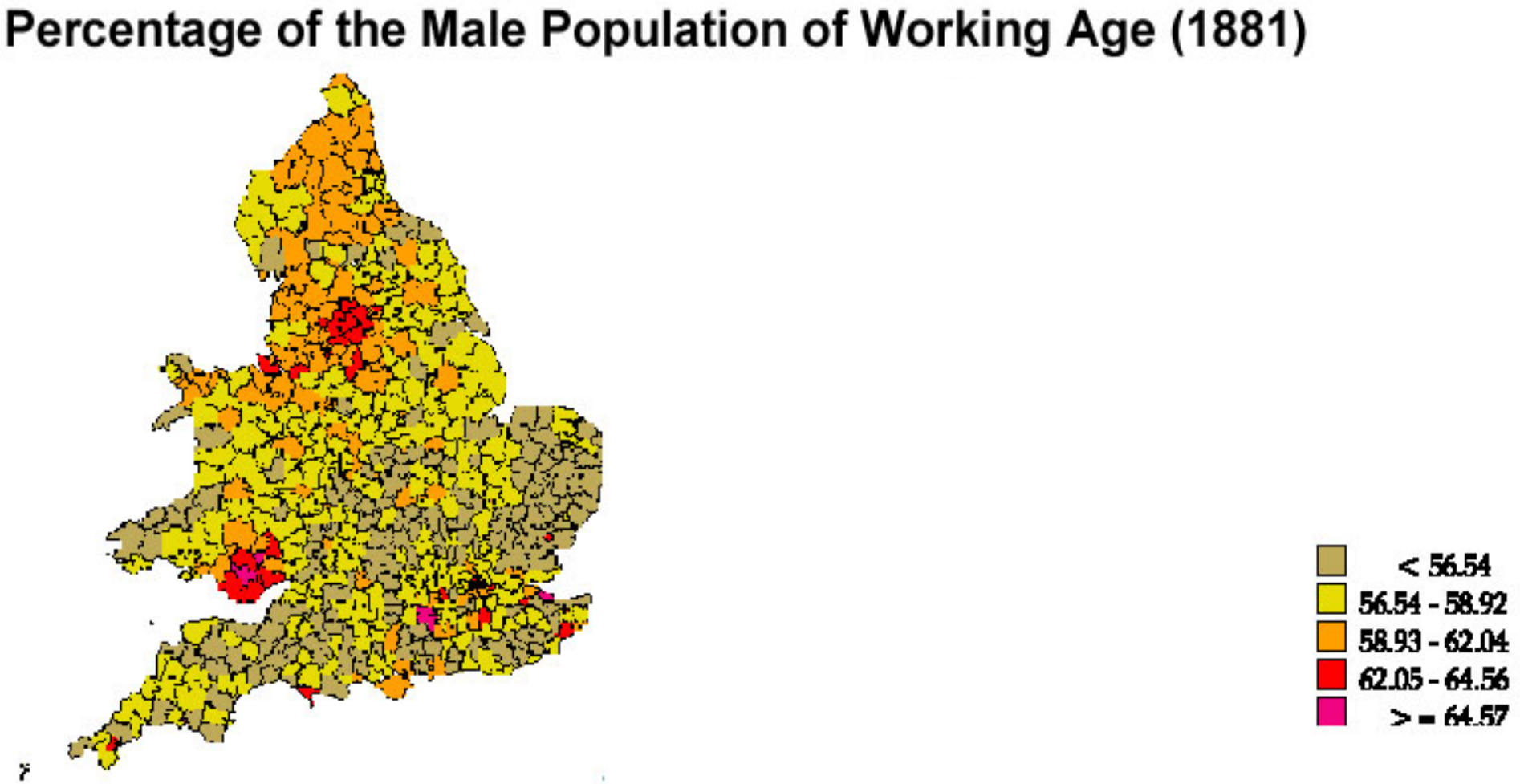
Our focus..

Choropleth map vs. Cartogram



Source: Dorling, D (1996).

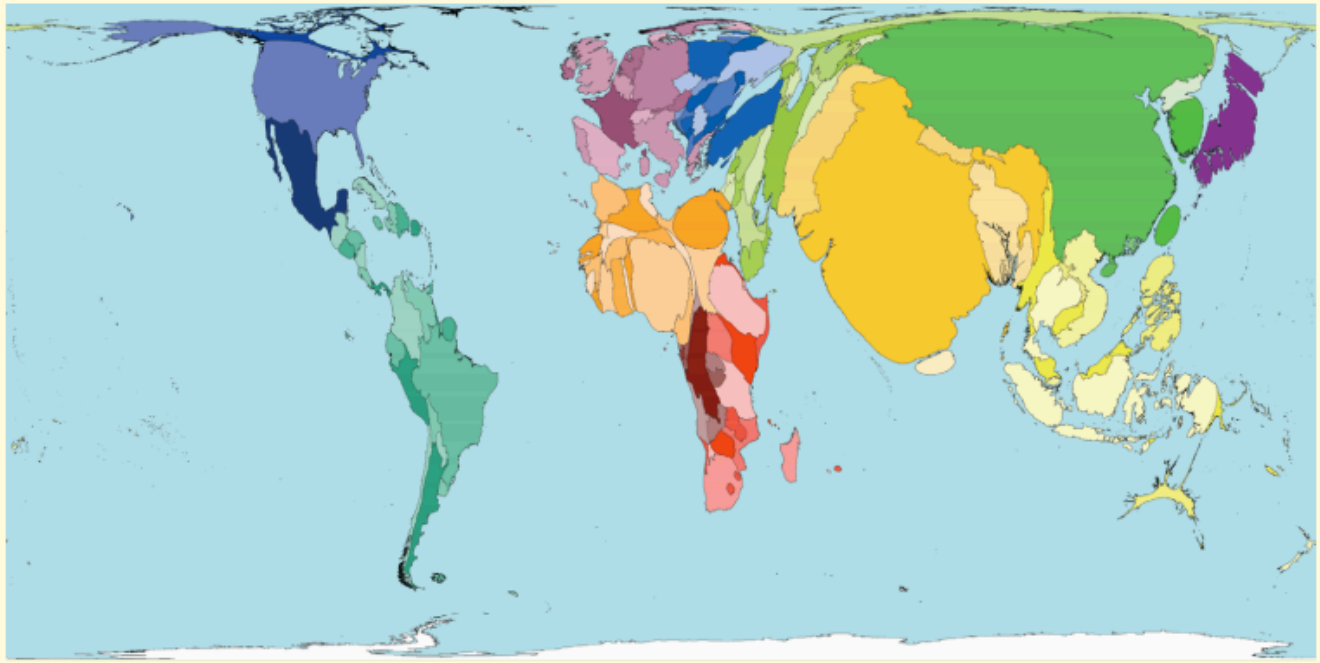
The Concept of the Cartogram

- ‘Suppose that one could stretch a geographical map so that areas containing many people would appear large, and areas containing few people would appear small’

Tobler 1973 p215

Total Population

Produced by the SASI group (Sheffield) and Mark Newman (Michigan)

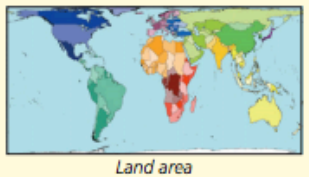


In Spring 2000 world population estimates reached 6 billion; that is 6 thousand million. The distribution of the earth's population is shown in this map.

India, China and Japan appear large on the map because they have large populations. Panama, Namibia and Guinea-Bissau have small populations so are barely visible on the map.

Population is very weakly related to land area. However, Sudan, which is geographically the largest country in Africa, has a smaller population than Nigeria, Egypt, Ethiopia, Democratic Republic of Congo, South Africa or Tanzania.

The size of each territory shows the relative propotion of the world's population living there.



Land area

Technical notes

- Data source: United Nations Development Programme, 2004, Human Development Report.
- Population data is from 2002
- The population not included is estimated as 2 to 3 million (see Appendix map 2).
- See website for further information.

MOST AND FEWEST PEOPLE

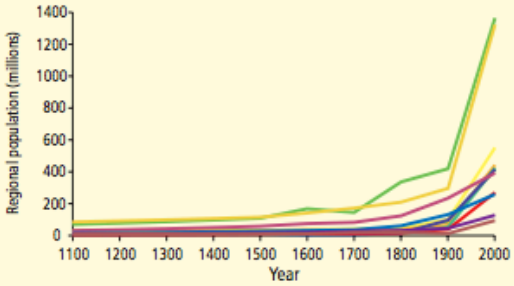
Rank	Territory	Value
1	China	1295
2	India	1050
3	United States	291
4	Indonesia	217
5	Brazil	176
6	Pakistan	150
7	Russian Federation	144
8	Bangladesh	144
9	Japan	128
10	Nigeria	121

millions

Rank	Territory	Value
191	Saint Kitts & Nevis	42
192	Monaco	34
193	Liechtenstein	33
194	San Marino	27
195	Palau	20
196	Cook Islands	18
197	Nauru	13
198	Tuvalu	10
199	Niue	2
200	Holy See	1

thousands

WORLD POPULATION BY REGION



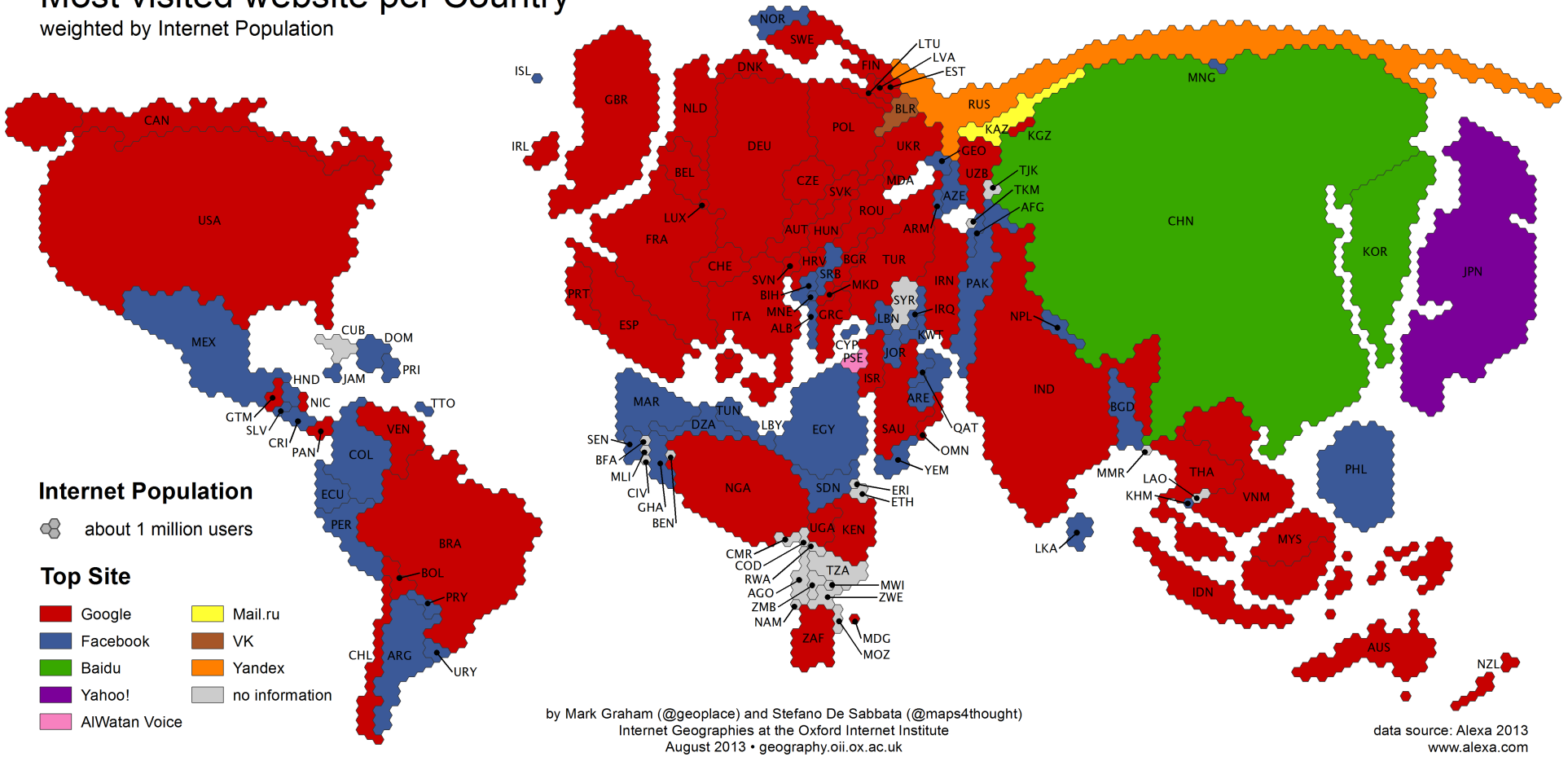
"Out of every 100 persons added to the population in the coming decade, 97 will live in developing countries."

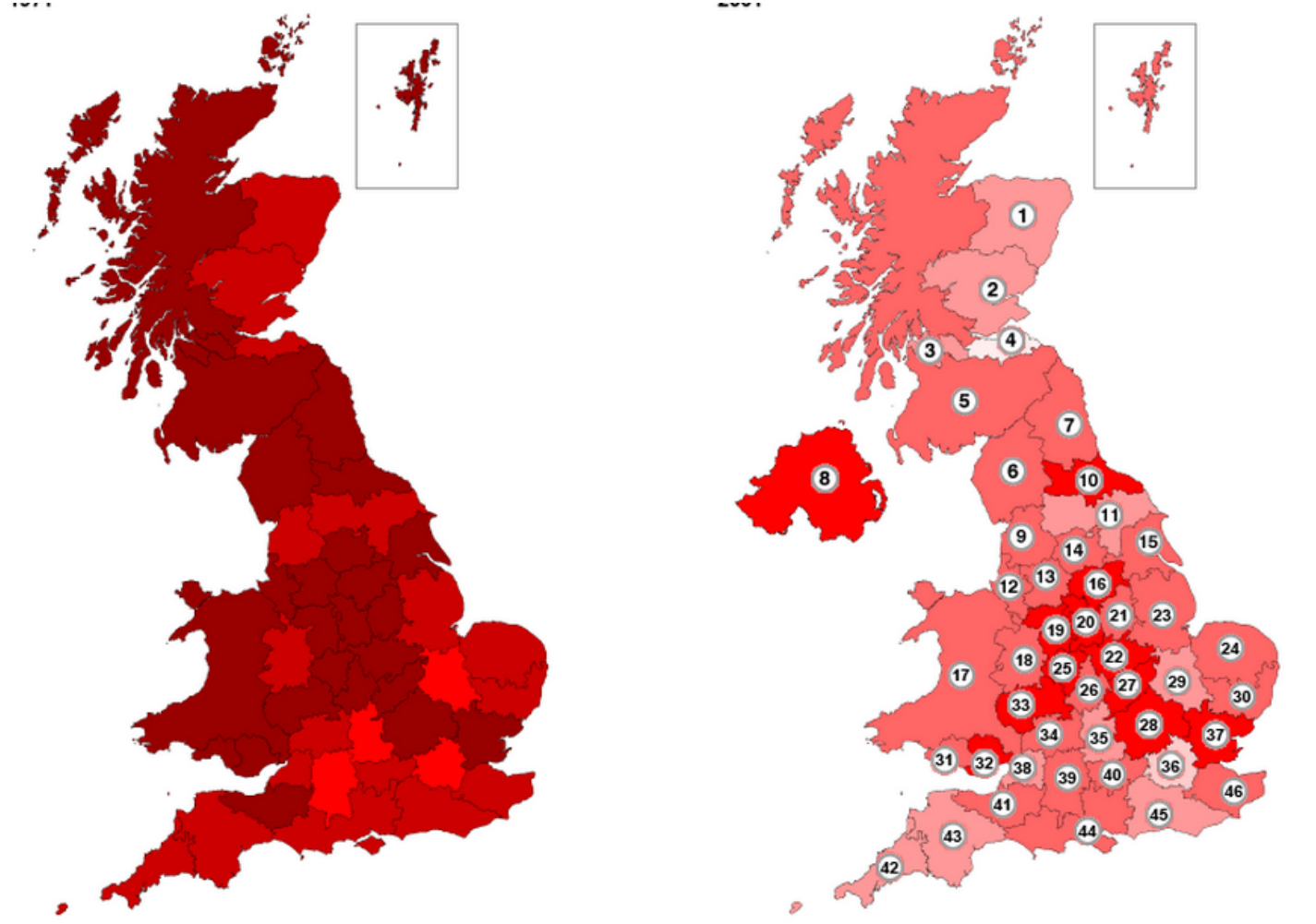
Hania Zlotnik, 2005

Map 002

Most visited website per Country

weighted by Internet Population





No 1971 data available for Northern Ireland

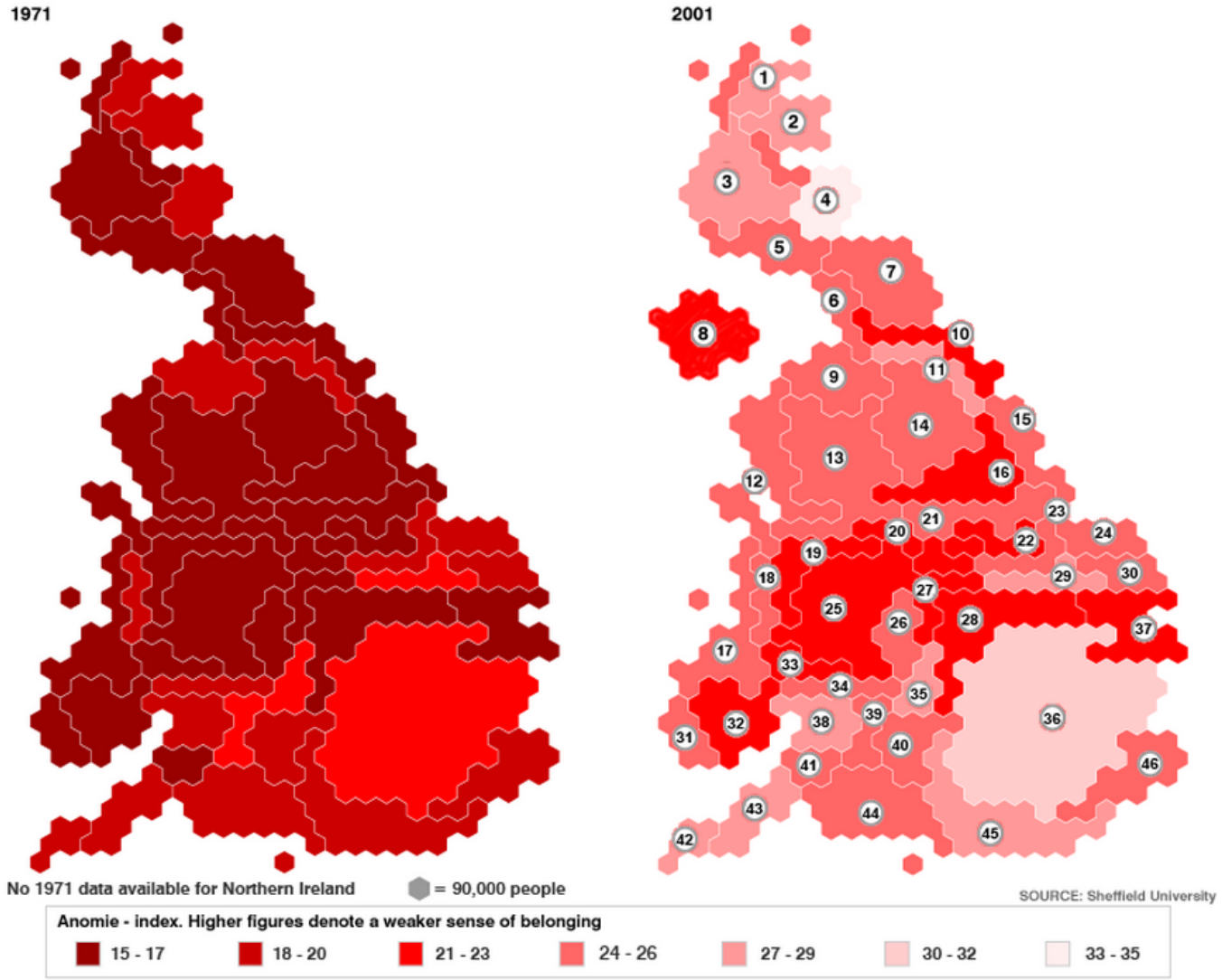
SOURCE: Sheffield University

Anomie - index. Higher figures denote a weaker sense of belonging

15 - 17 | 18 - 20 | 21 - 23 | 24 - 26 | 27 - 29 | 30 - 32 | 33 - 35

BBC local radio stations

1. Aberdeen*
2. Dundee*
3. Glasgow*
4. Edinburgh*
5. Scotland*
6. Cumbria
7. Newcastle
8. Ulster
9. Lancashire
10. Tees
11. York
12. Merseyside
13. Manchester
14. Leeds
15. Humberside
16. Sheffield
17. Wales*
18. Shropshire
19. Stoke
20. Derby
21. Nottingham
22. Leicester
23. Lincolnshire
24. Norfolk
25. WM
26. Coventry and Warks.
27. Northampton
28. Three Counties
29. Cambridgeshire
30. Suffolk
31. Swansea*
32. Cardiff*
33. Hereford & Worcs.
34. Gloucestershire
35. Oxford
36. London
37. Essex
38. Bristol
39. Wiltshire
40. Berkshire
41. Somerset
42. Cornwall
43. Devon
44. Solent
45. S. Counties
46. Kent



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1. Aberdeen*
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32. Cardiff*
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36. London
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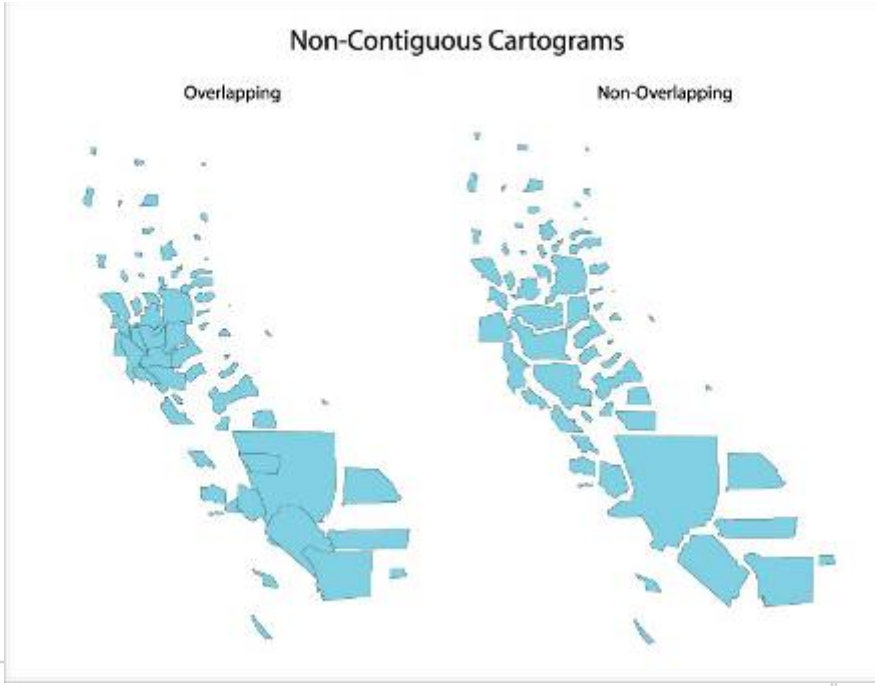
38. Bristol
39. Wiltshire
40. Berkshire
41. Somerset
42. Cornwall
43. Devon
44. Solent
45. S. Counties
46. Kent

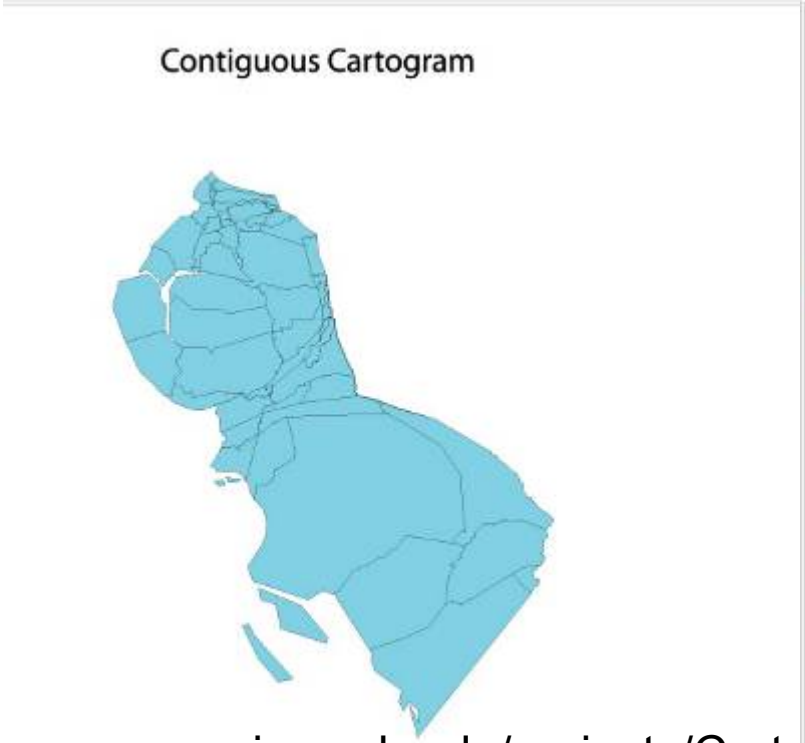
Percentage of the Male Population of Working Age 1851-1911

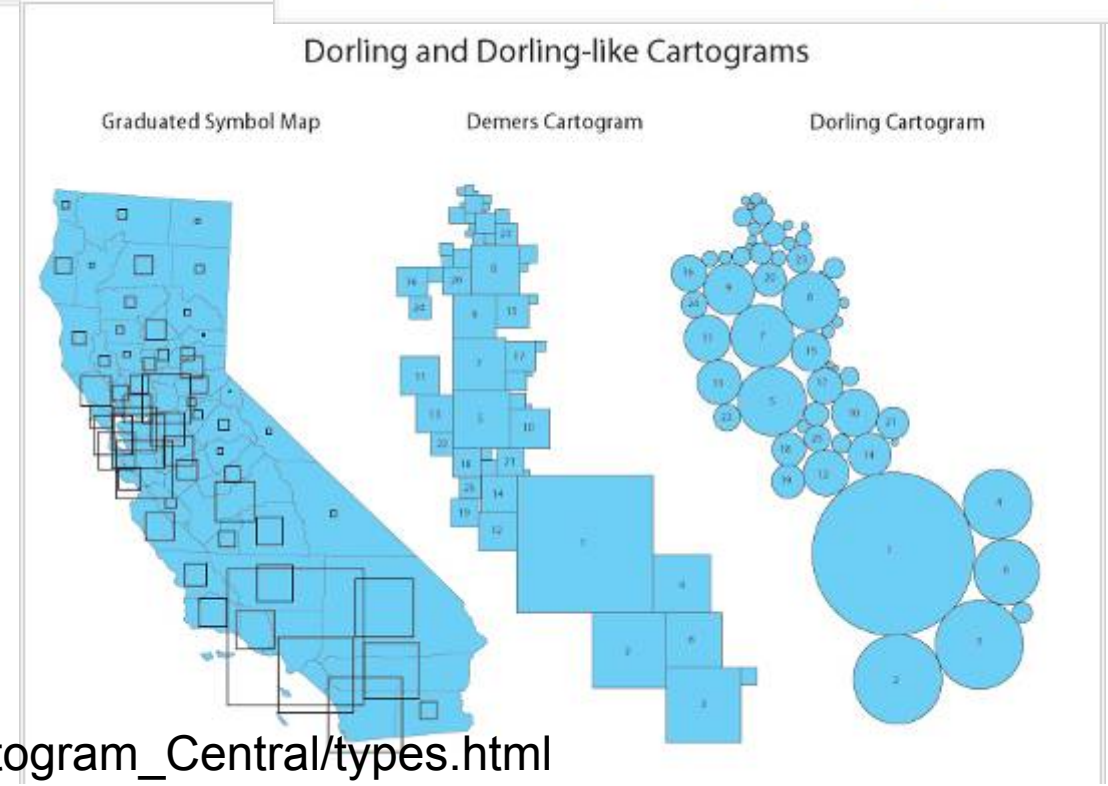
www.csiss.org/classics/archive/cartogram.html

Cartogram Types

Maintenance of spatial contiguity (Dougenik et al. 1985), and non continuous (Dorling & Demers)







www.ncgia.ucsb.edu/projects/Cartogram_Central/types.html

Continuous: Algorithm

- Models the forces exerted among polygons.
- Combination of force field concepts and a distance decay function.
- Each polygon exerts a force on the adjacent boundary nodes – producing a vector result.
- A distance decay function is applied to reduce the effect of polygon boundaries further away from a given node for which the vector is being calculated (Following Tobler's first law).
- When summed for all the adjacent polygons, the node is displaced by the resultant vector
- The force is proportional to the sqrt of the difference between the current and desired area.
- Acting on each boundary coordinate, in inverse proportion to distance.
- Iterative

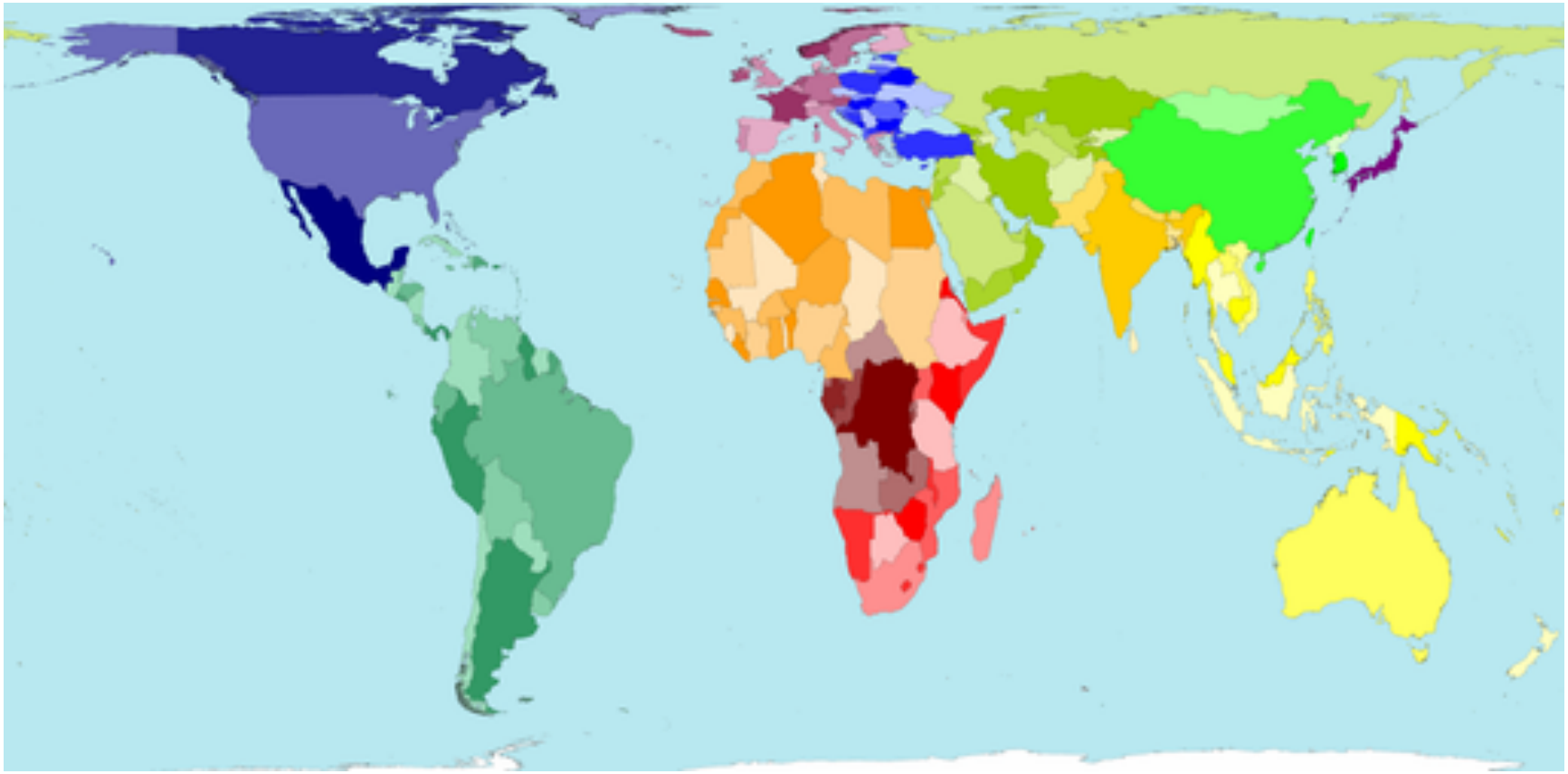
$$F_{ij} = (P_j - q_j)\, p_j / d_{ij}$$

- Where F_{ij} = force exerted by polygon j on vertex i
- P_j = sqrt (actual area) / sqrt (π)
- q_j = sqrt(desired area) / sqrt (π)
- d_{ij} = distance from centroid of polygon j to vertex i
- A positive value of the force pushes the vertex away from the centroid, while a negative force pulls it towards the centroid.
- For each boundary node, the resulting vector is the sum of forces from all polygons.
- The greater the difference between actual and desired area, the greater the vector.
- In each iteration, the sum of the forces from all polygons exerted on every vertex is calculated to displace the vertex.
- Iteration stops when the difference between the actual and desired area is beneath a defined threshold.

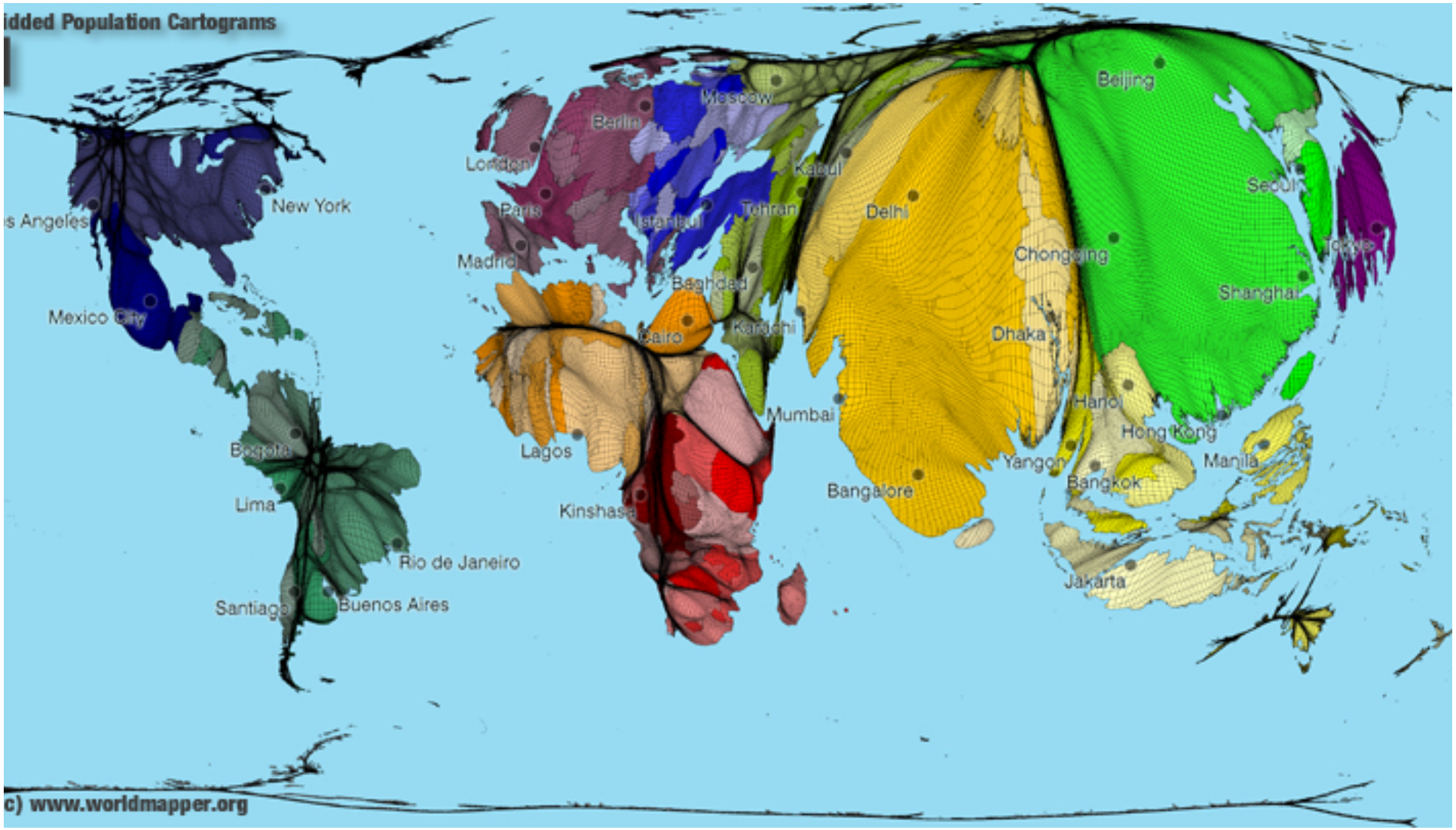
Du & Liu

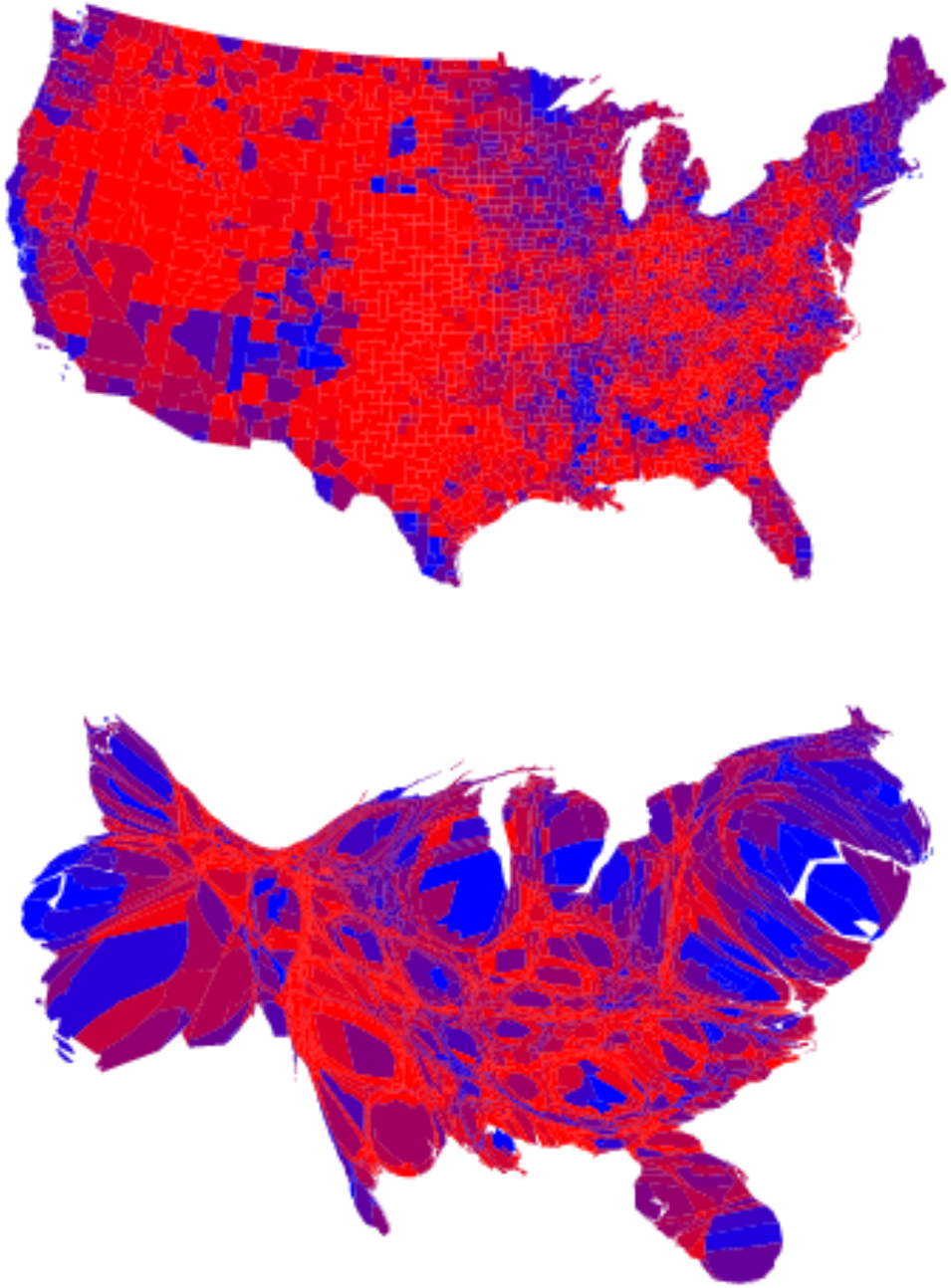
http://gis.esri.com/library/userconf/proc99/proceed/papers/pap489/p489.htm

Land Area

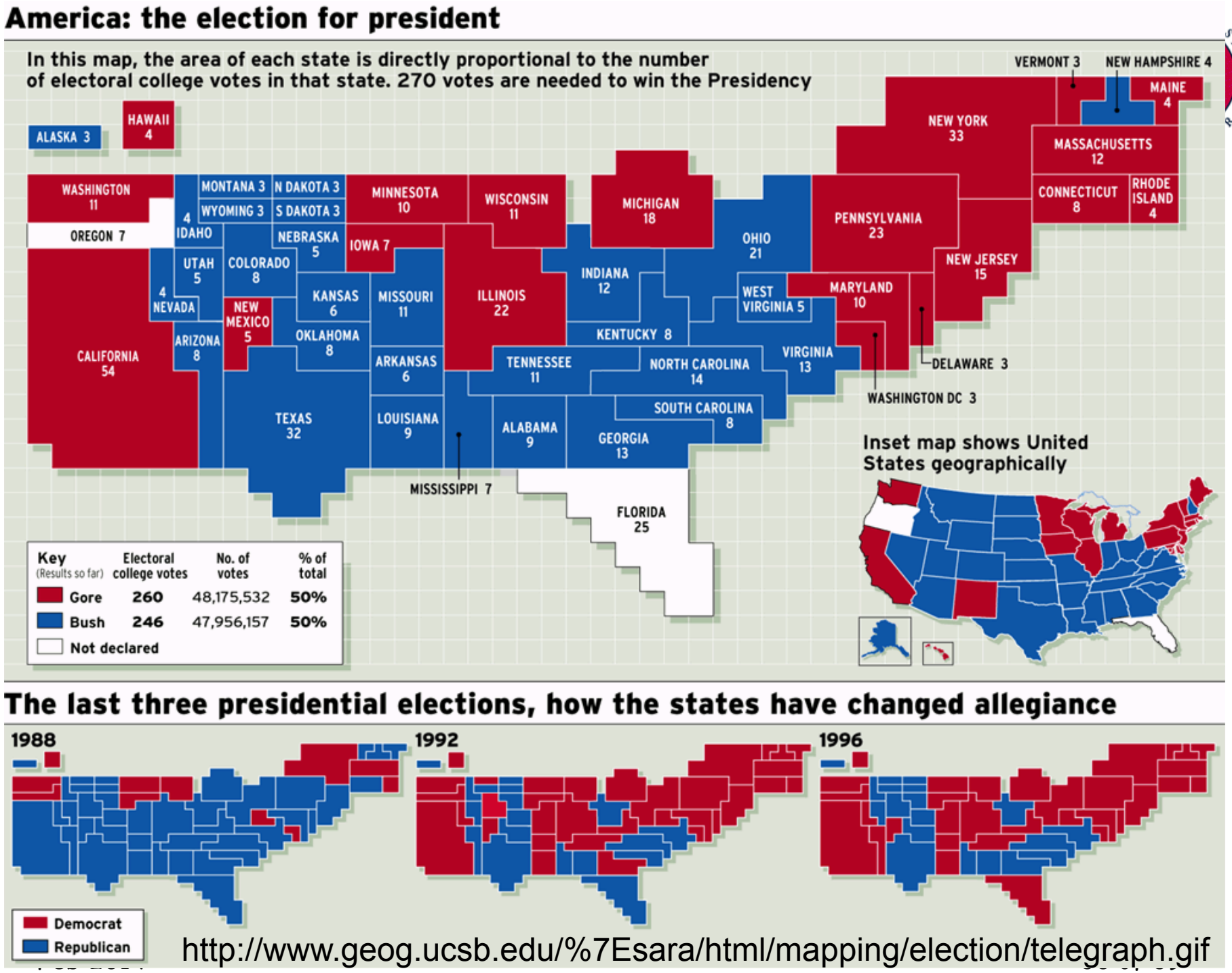


Total Population





Election Results by County Using a Non Linear Color Scale
Red--70% GOP
Blue--70% Dem.


America: the election for president
In this map, the area of each state is directly proportional to the number of electoral college votes in that state. 270 votes are needed to win the Presidency
ALASKA 3
HAWAII 4
WASHINGTON 11
OREGON 7
CALIFORNIA 54
4 IDAHO
MONTANA 3
WYOMING 3
N DAKOTA 3
S DAKOTA 3
NEBRASKA 5
UTAH 5
4 NEVADA
COLORADO 8
NEW MEXICO 5
ARIZONA 8
KANSAS 6
OKLAHOMA 8
TEXAS 32
MINNESOTA 10
IOWA 7
MISSOURI 11
ARKANSAS 6
LOUISIANA 9
WISCONSIN 11
ILLINOIS 22
MICHIGAN 18
INDIANA 12
KENTUCKY 8
TENNESSEE 11
MISSISSIPPI 7
ALABAMA 9
GEORGIA 13
FLORIDA 25
SOUTH CAROLINA 8
NORTH CAROLINA 14
VIRGINIA 13
WEST VIRGINIA 5
OHIO 21
PENNSYLVANIA 23
NEW YORK 33
VERMONT 3
NEW HAMPSHIRE 4
MAINE 4
MASSACHUSETTS 12
CONNECTICUT 8
RHODE ISLAND 4
NEW JERSEY 15
MARYLAND 10
DELAWARE 3
WASHINGTON DC 3
Inset map shows United States geographically
Key (Results so far)
Electoral college votes
No. of votes
% of total
Gore 260 48,175,532 50%
Bush 246 47,956,157 50%
Not declared
The last three presidential elections, how the states have changed allegiance
1988
1992
1996
Democrat
Republican
http://www.geog.ucsb.edu/%7Esara/html/mapping/election/telegraph.gif

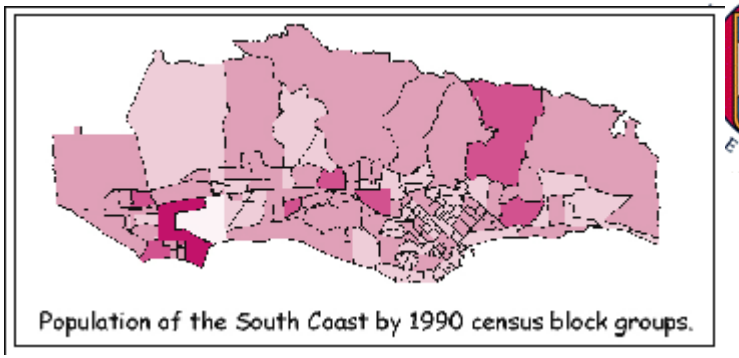
Alternatively….non continuous

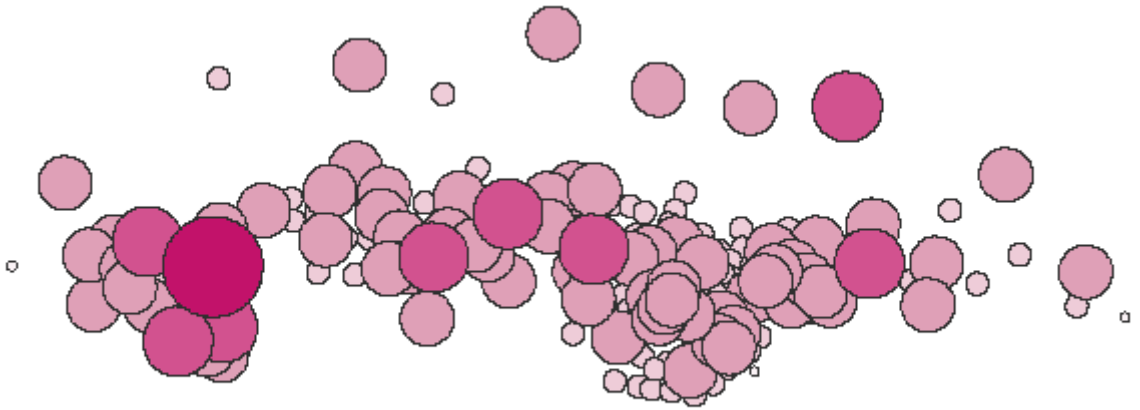
Non continuous circle cartograms

- Each circle proportional to region's population
- Each circle borders as many of the place's correct geographical neighbours as possible
- Generate a contiguity matrix – neighbourhood index, the strength of the link proportional to the length of shared boundary.
- Position circle at centre of region, proportionate to value of region.
- All overlapping circles are repelled, while attracting those with which they share a common border

Figure 11.1 Illustration of a cartogram of British county populations evolving

Figure 11.2 Contiguity on the local authority districts population cartogram





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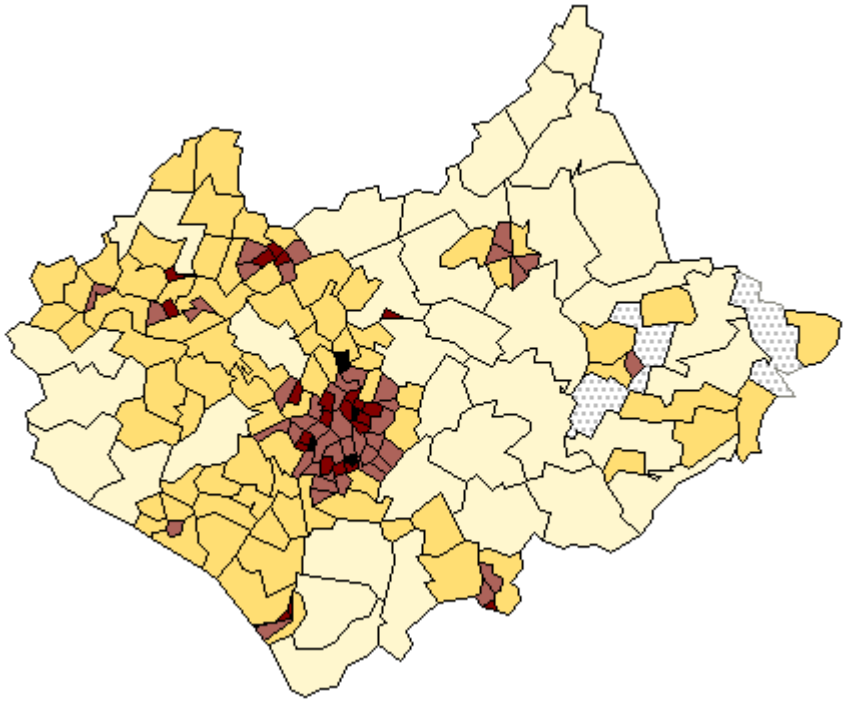

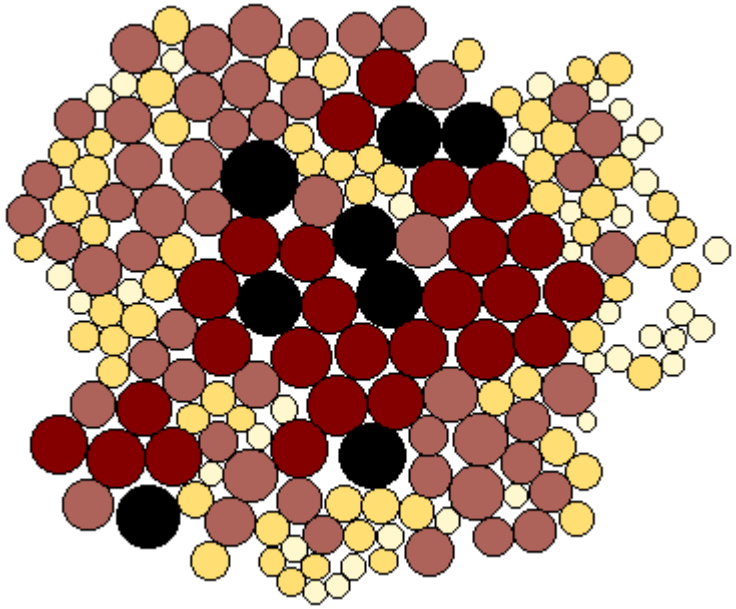

Enumeration districts designed to contain roughly equal numbers of people.

Shaded – inversely proportional to size

Circle size and shade proportional to zone population.

Cartogram highlights the relatively small numbers of people in the identified commuter belt which is over-represented by the land area map due to the large areas which the commuters occupy.

A fairer yet more distorted picture?

end