Techniques

Geographic Visualization

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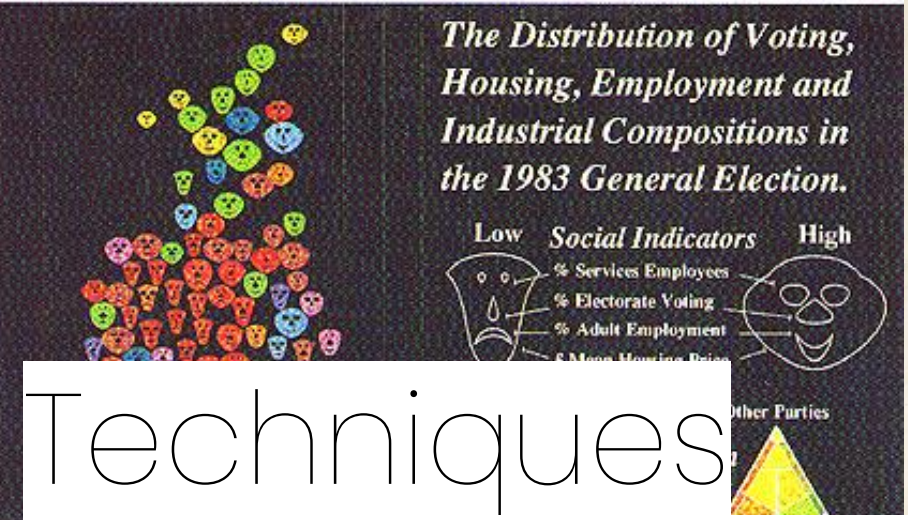
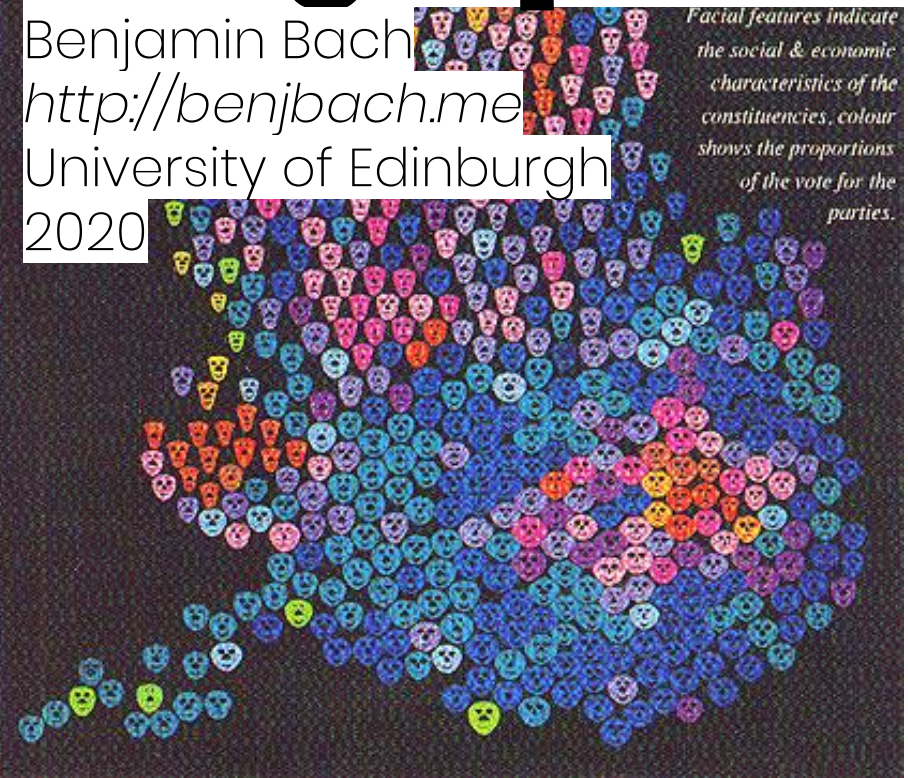
http://benjbach.me
University of Edinburgh
2020



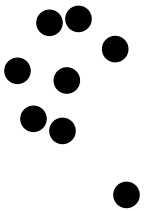


Outline

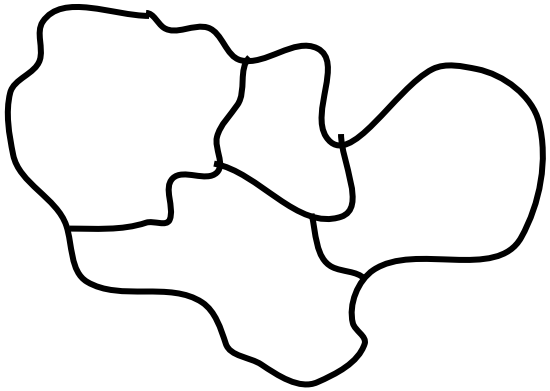
- Tasks
- Map projections
- Visualizing area data
- Visualizing point data
- Visualizing trajectories
- Visualizing time

Tasks

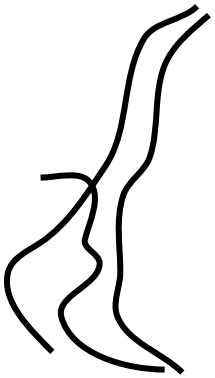
- **Locations (0D, Points)**
  - Distribution
  - Sensity
  - Values
  - Distances
  - Temporality



- **Areas (2D)**
  - Comparison
  - Max/min values
  - Geographic areas + trends and outliers
  - temporality

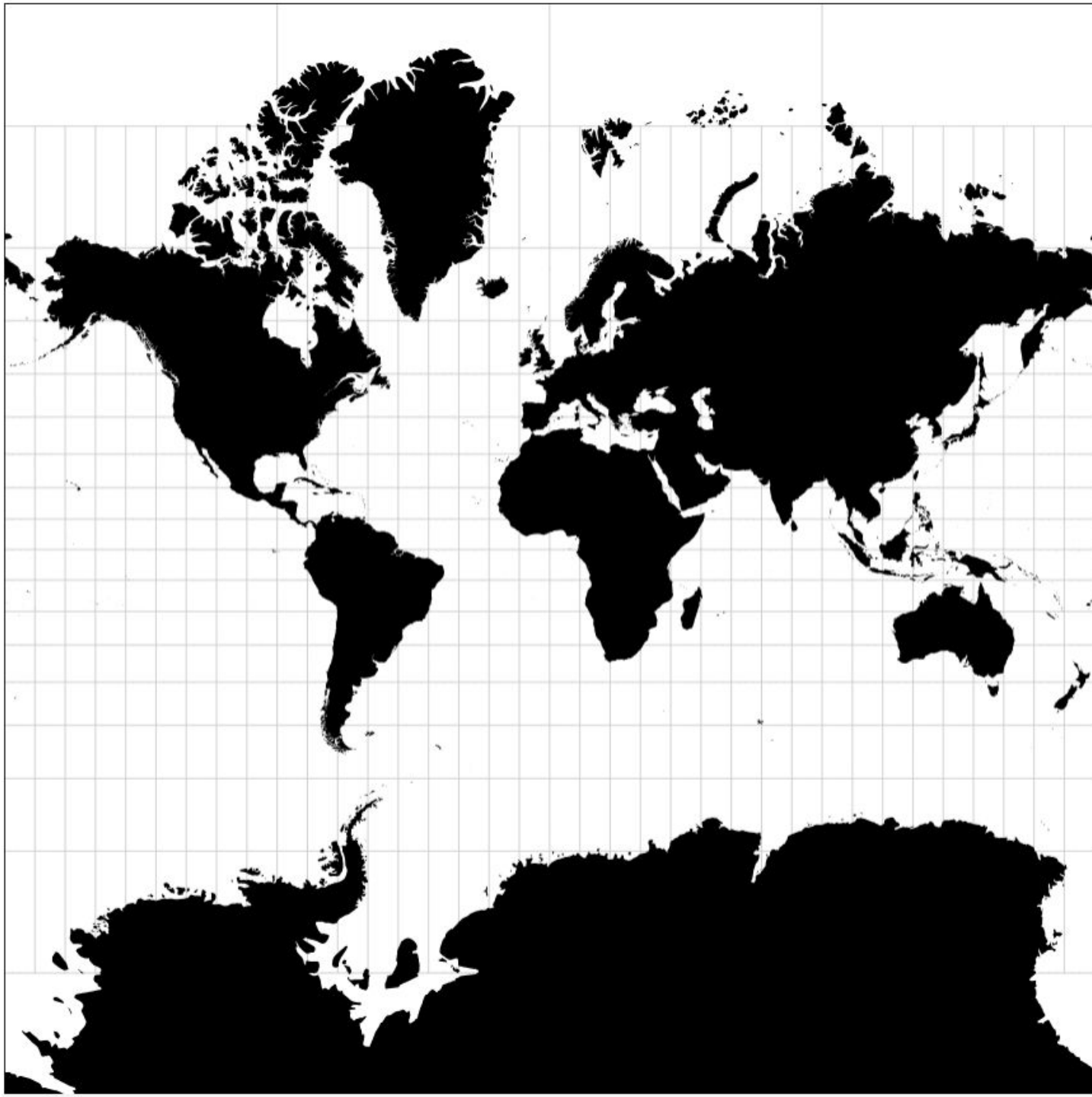


- **Trajectories (1D, lines)**
  - Locations
  - Common paths
  - Directionality
  - Temporality



Map Projections

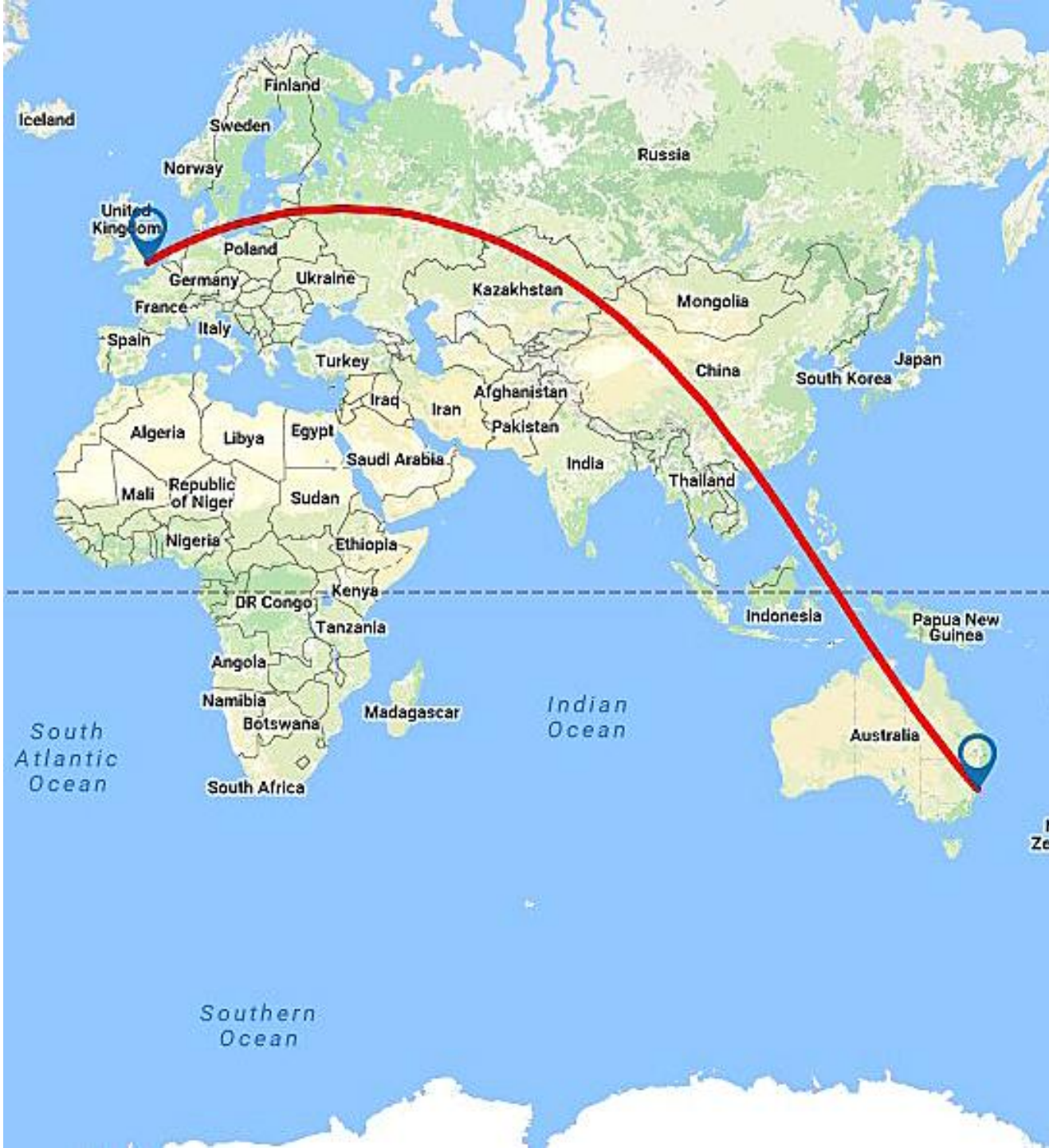
The True Size Of...



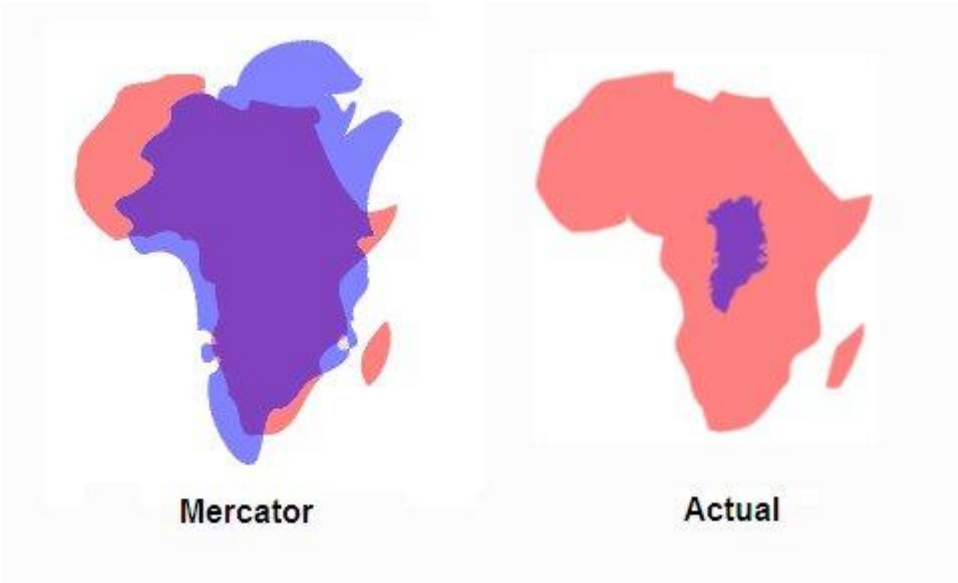
https://thetruesize.com/

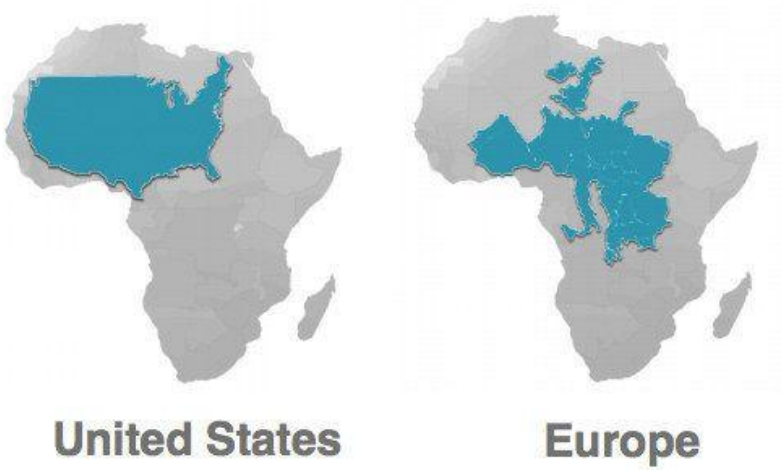
Projections: Trajectories

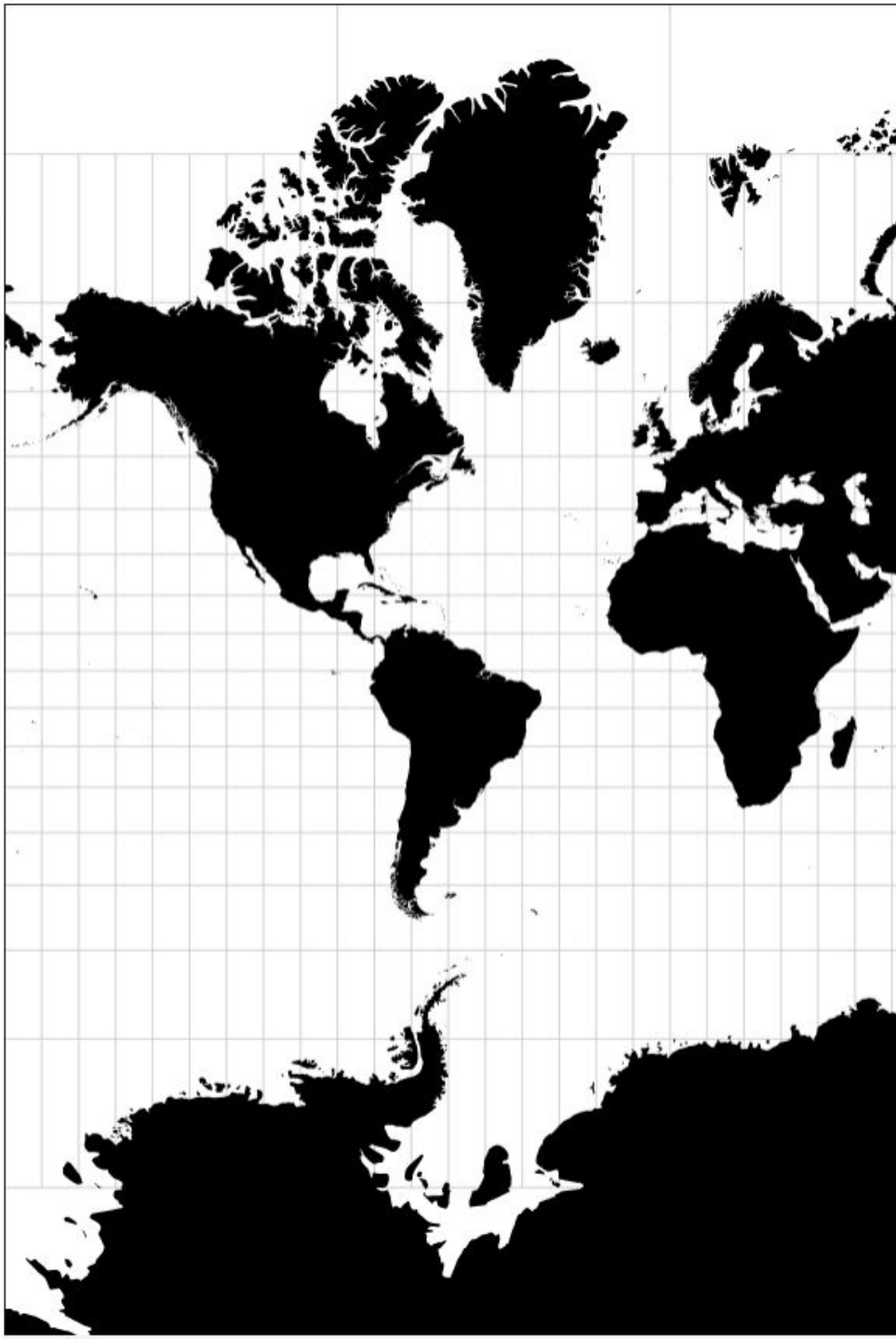
Direct flight: London-Sydney



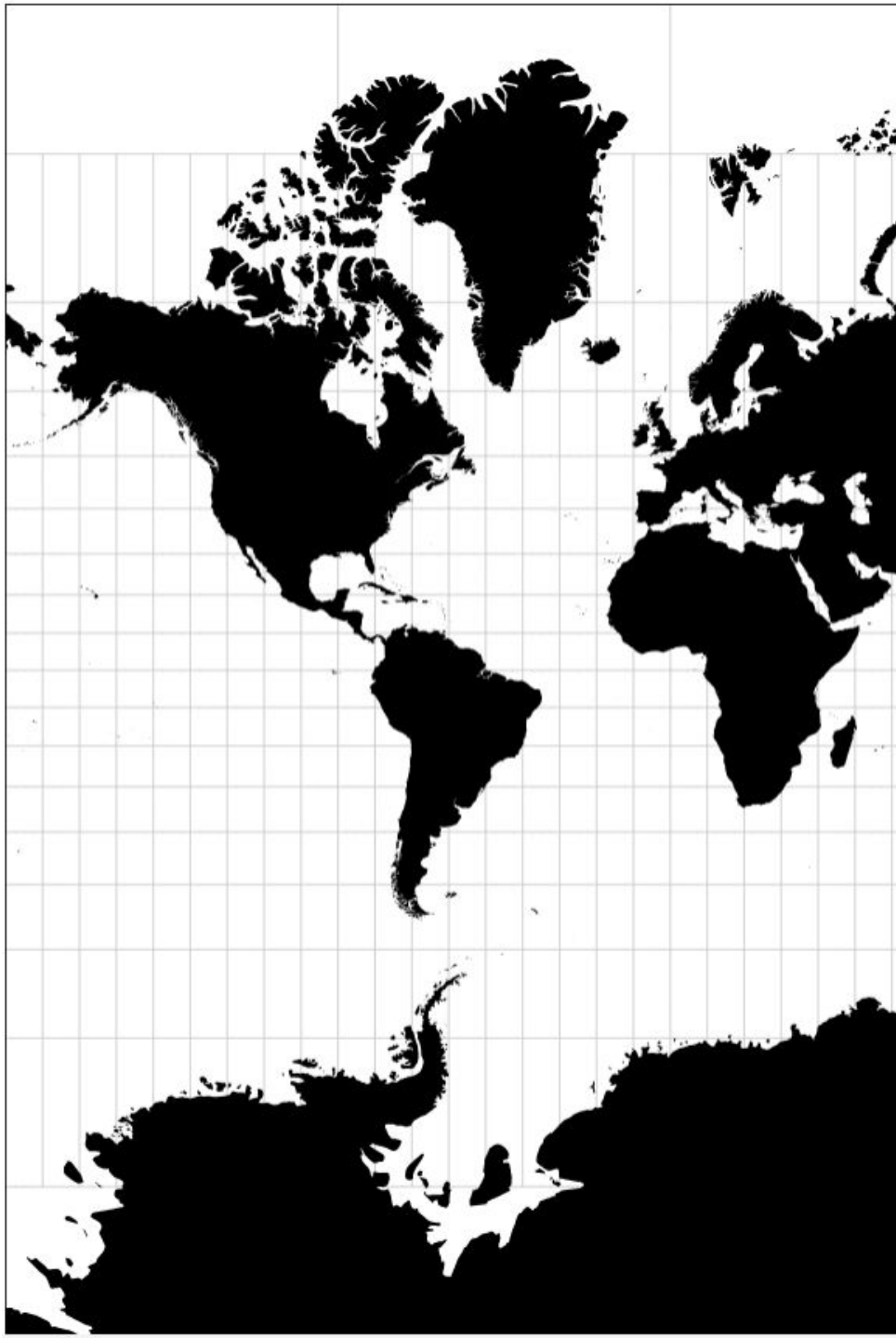
The True Size of Africa





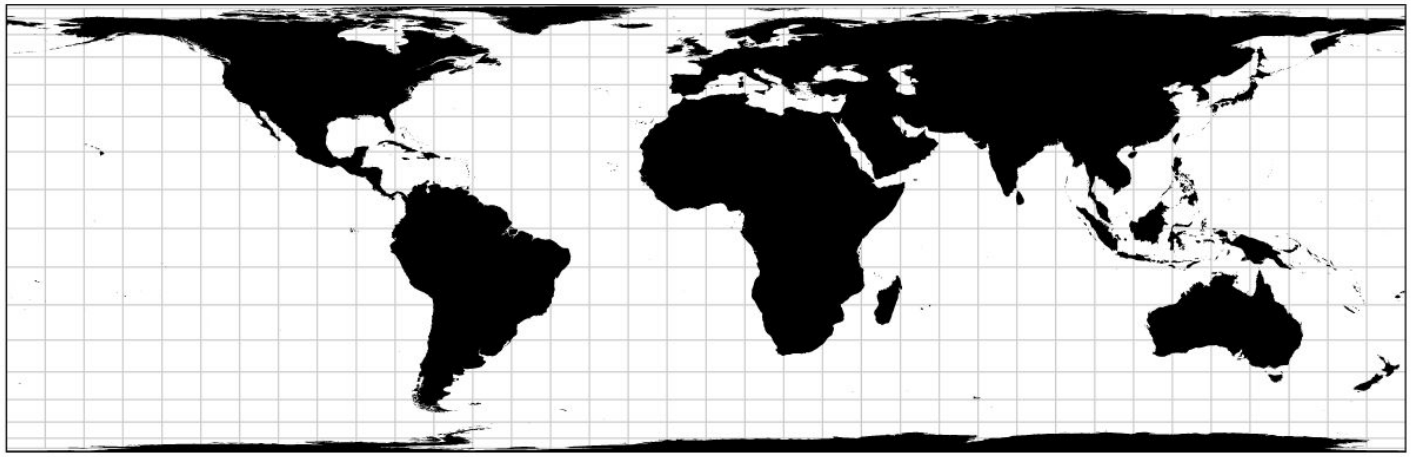


Merkator Projection

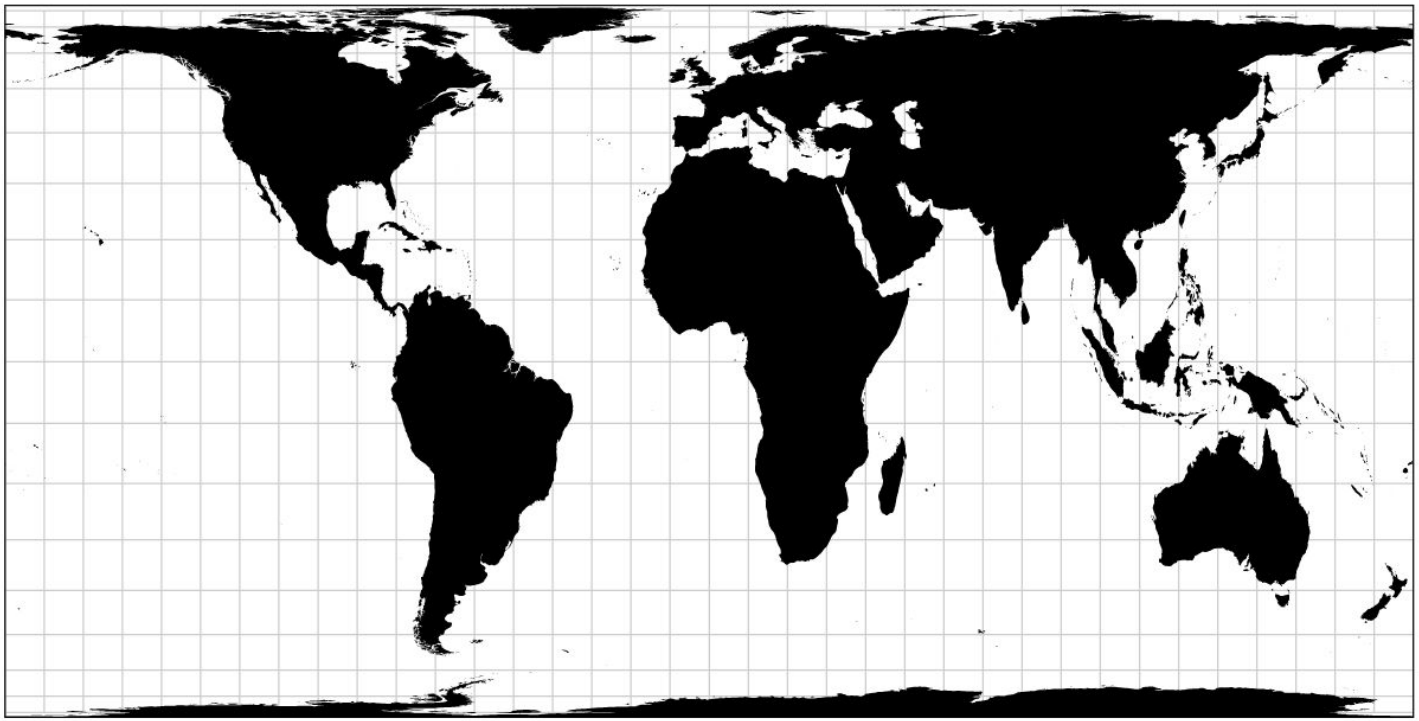


Area preserving projections

Lambert:

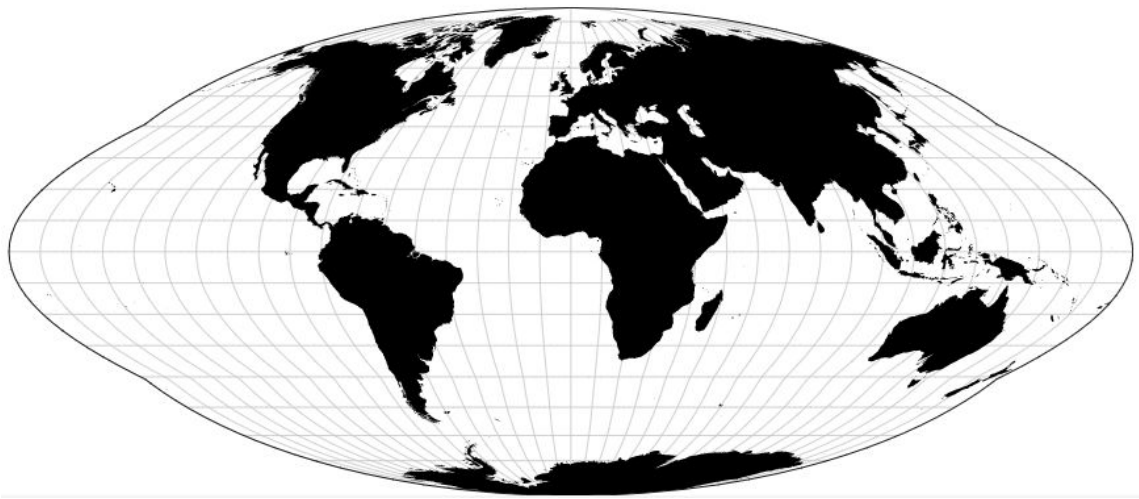


Hobo-Dyer

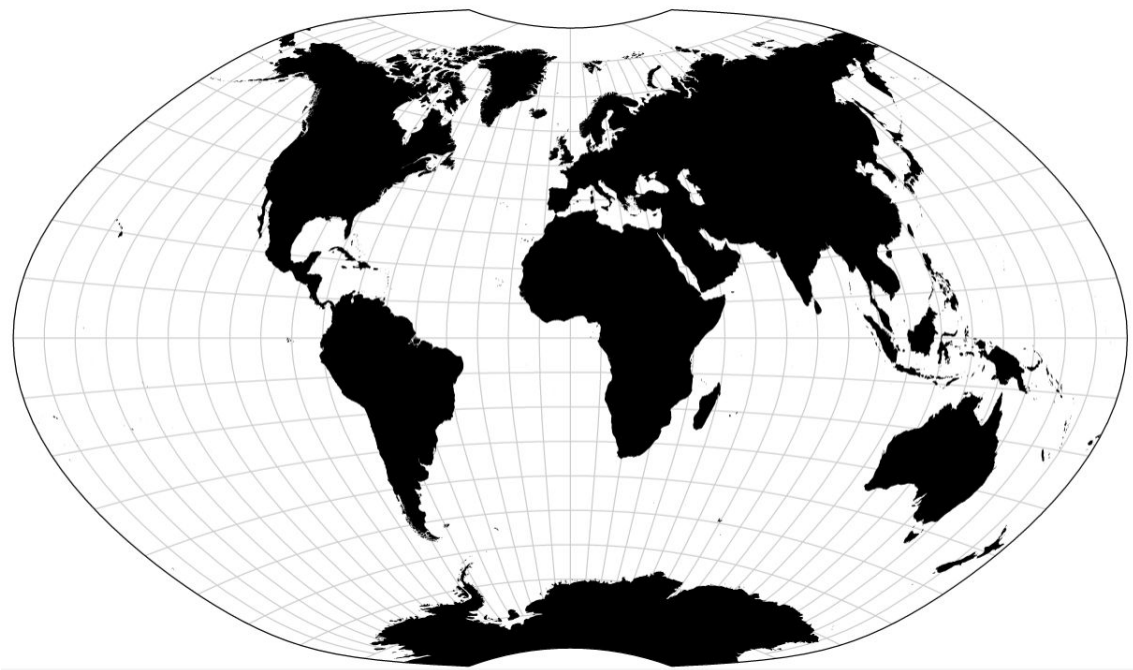


Trade-offs

Goode Homolosine

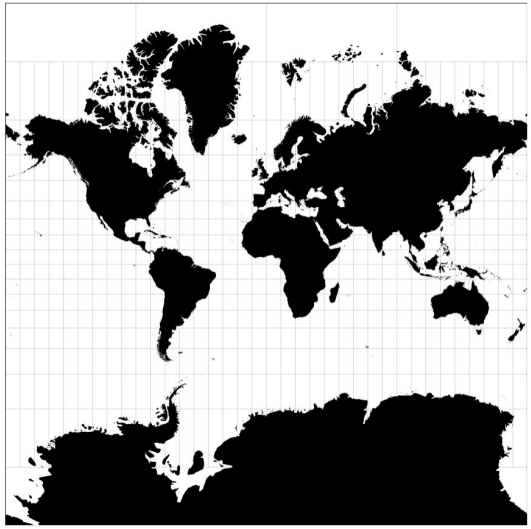


Ginzburgh IV



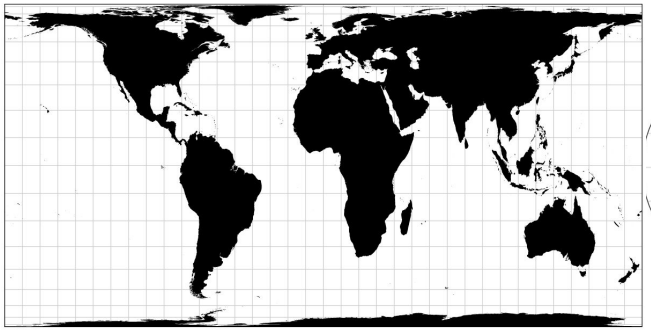
Projections

- Preserve: shape, area, or angle, distance, direction
- Any projection can only preserve 1-2, not more
- > Tradeoff



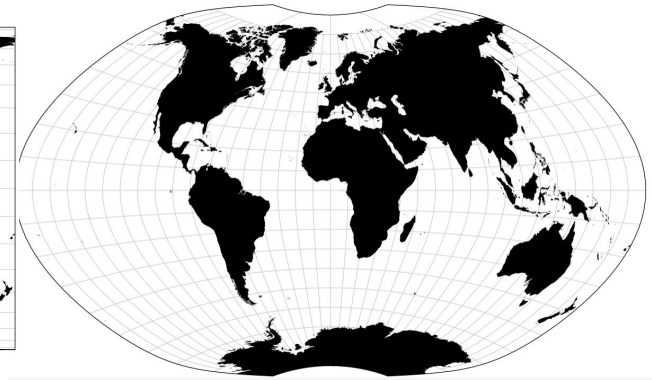
Merkator

Preserves shape



Hobo-Dyer

Preserves area



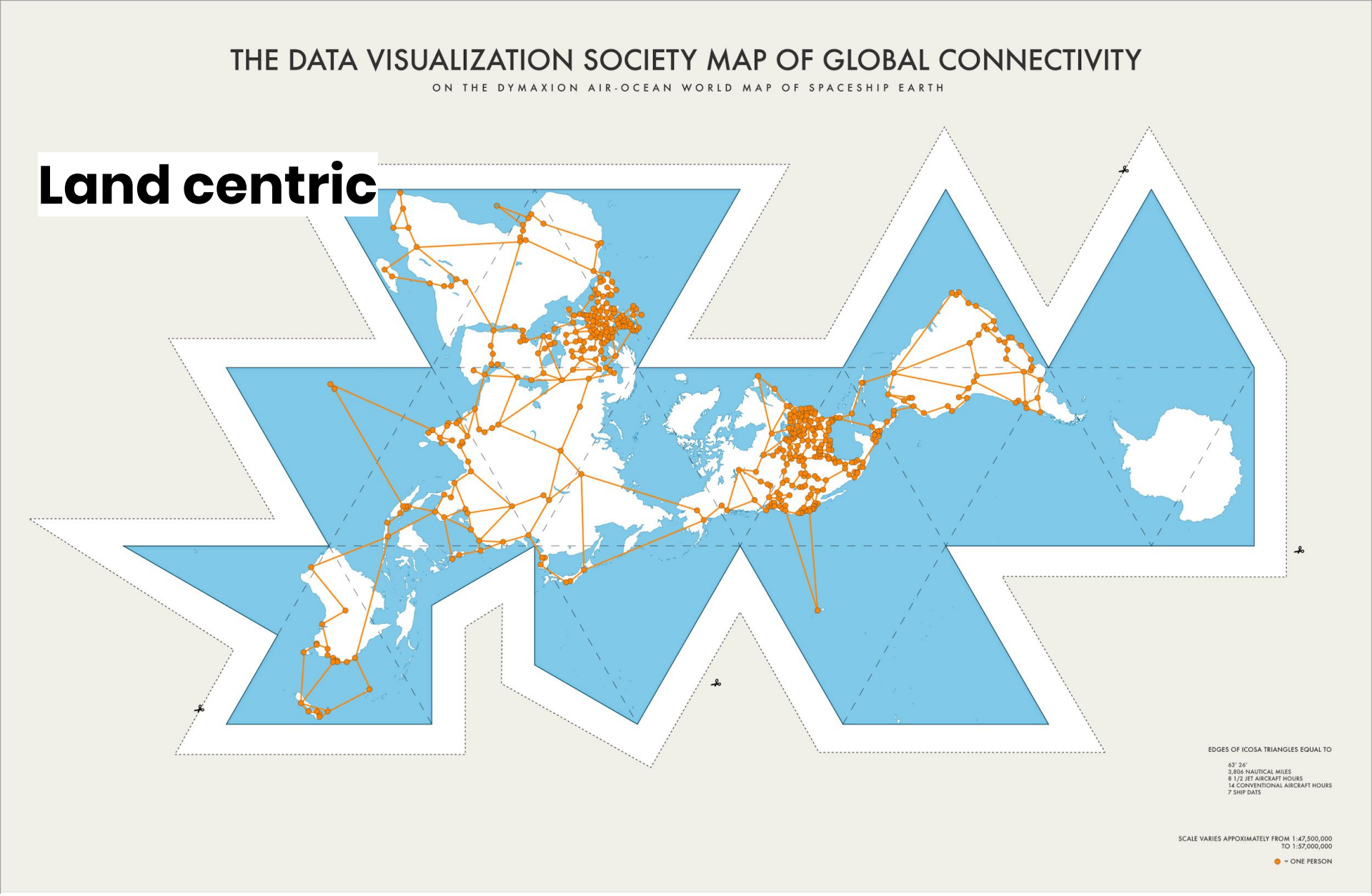
Ginzburgh IV

Local projections: Conic Conformal

Alternative Projections: Ocean centric

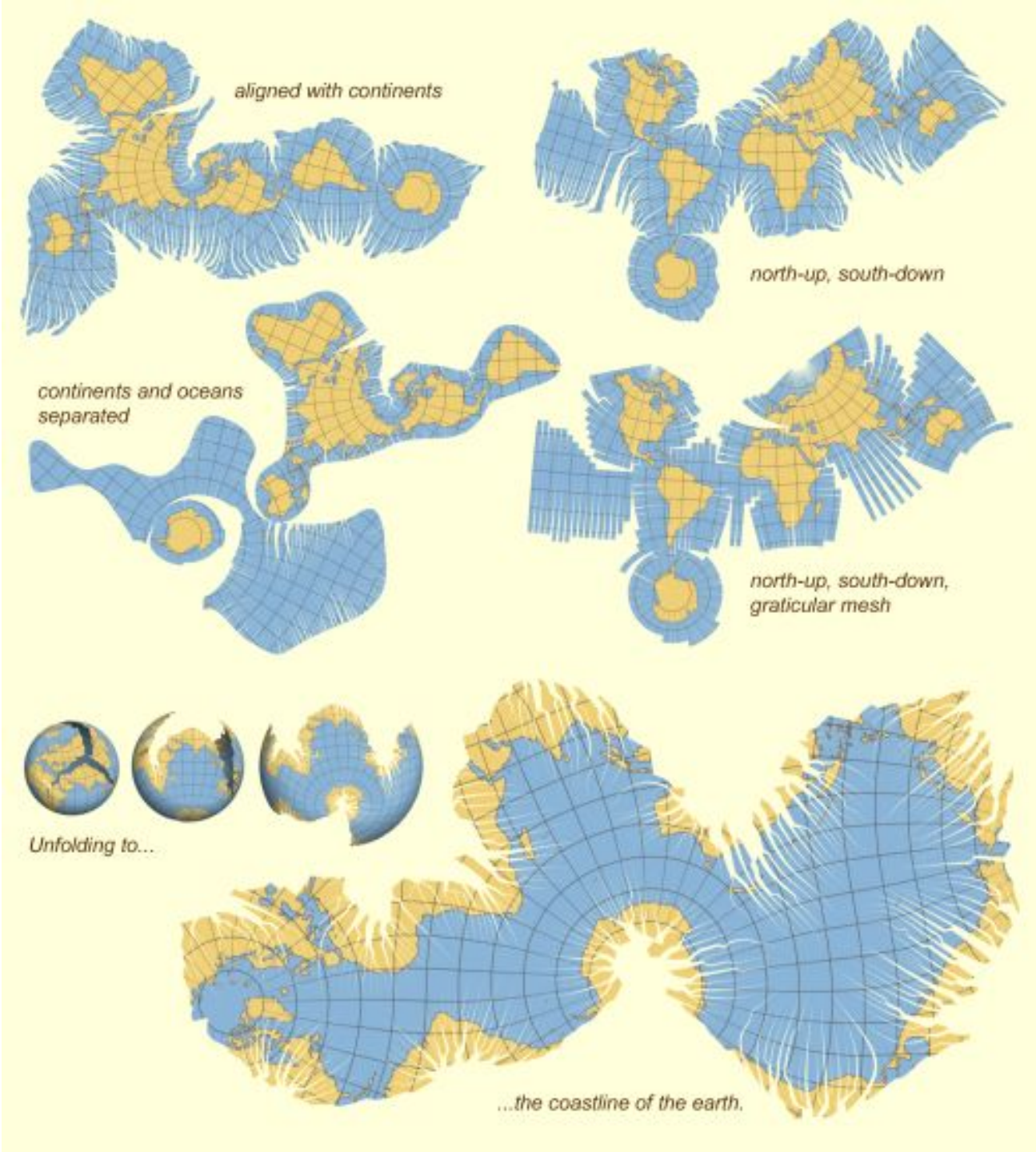
Source : Athelstan Spilhaus, *Atlas of*
World with Geophysical Boundaries, 1
Cartographie : Clara Dealbe

Land centric



https://medium.com/nightingale/a-little-help-from-my-friends-a-look-inside-the-data-visualization-society-map-of-global-ab5547149fe9

More projections

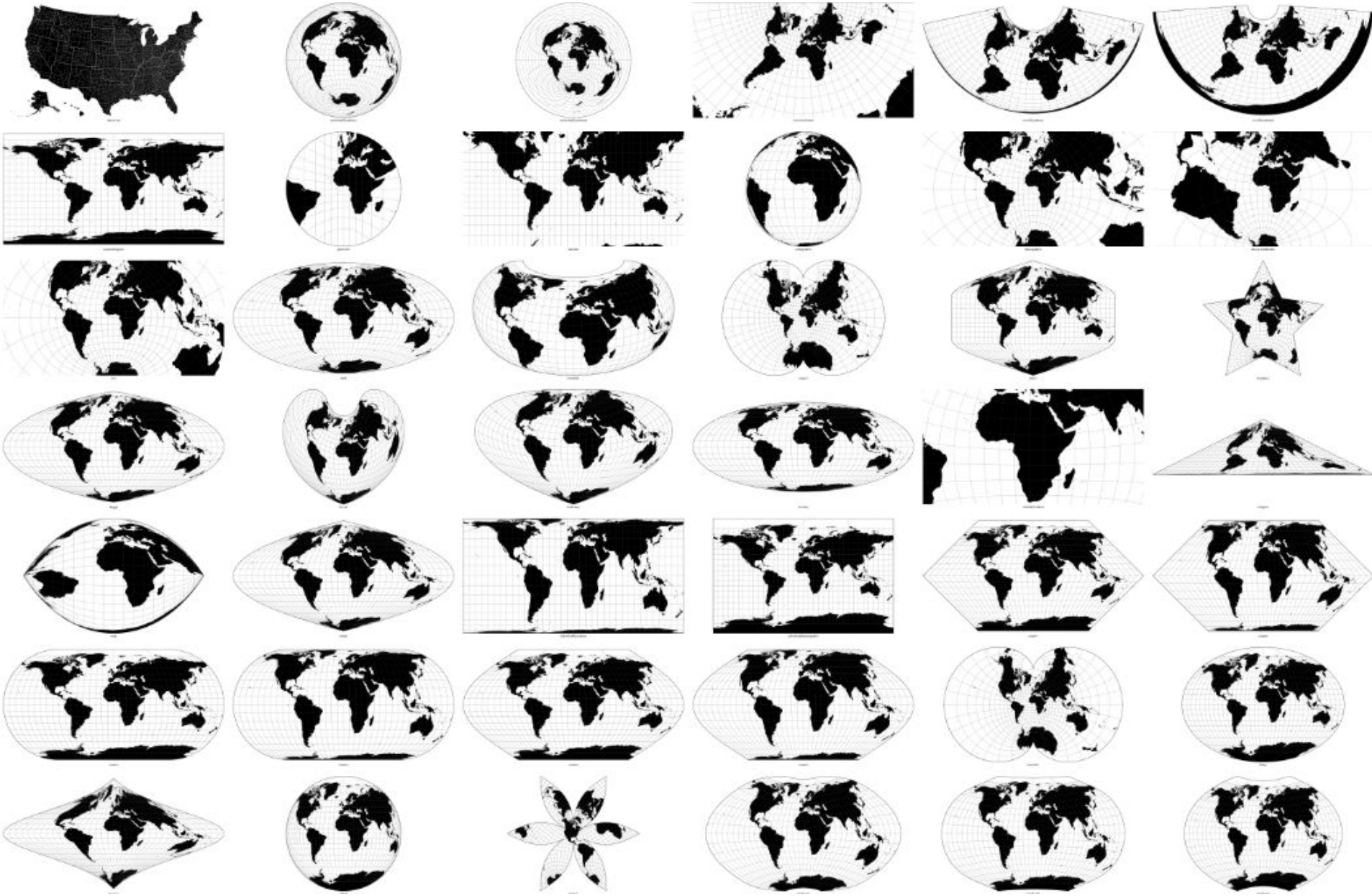


https://www.win.tue.nl/~vanwijk/myriahedral/geo_aligned_maps.png

https://github.com/d3/d3-geo-projection

https://github.com/d3/d3-geo

More projections…

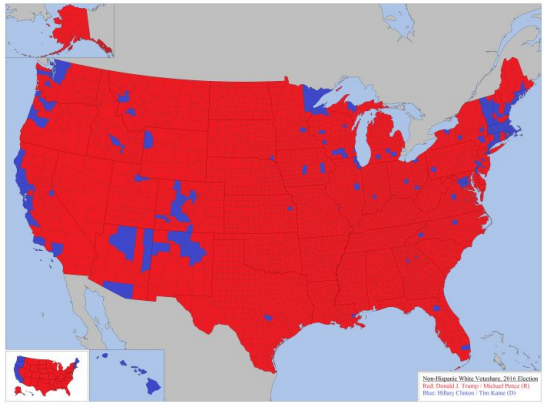


Van der Grinten II | Pause

https://www.jasondavies.com/maps/transition/

Visualizing **Area Data**

Most intuitive … most harmful



Choropleth maps

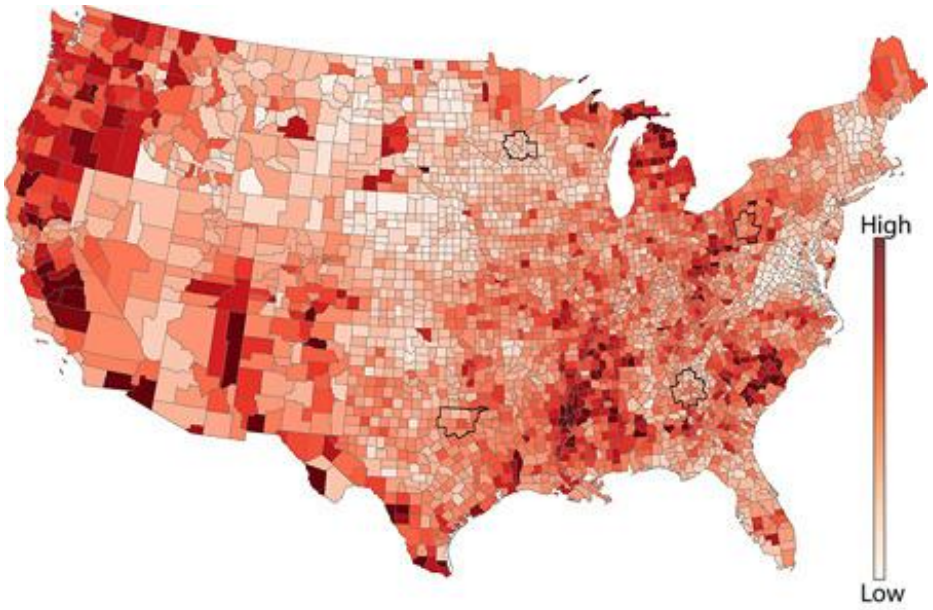
- Work well when comparing total surfaces
- Don't work well when showing data with different densities per area:

- Overemphasize large areas
- Hide small areas
- Overemphasize areas with low data-densities
- Underemphasize areas with high data-densities.

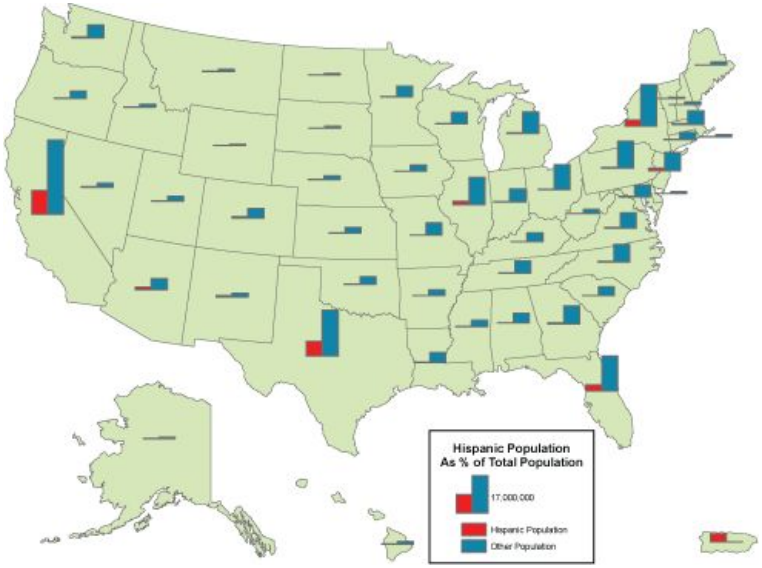
Choropleth alternatives

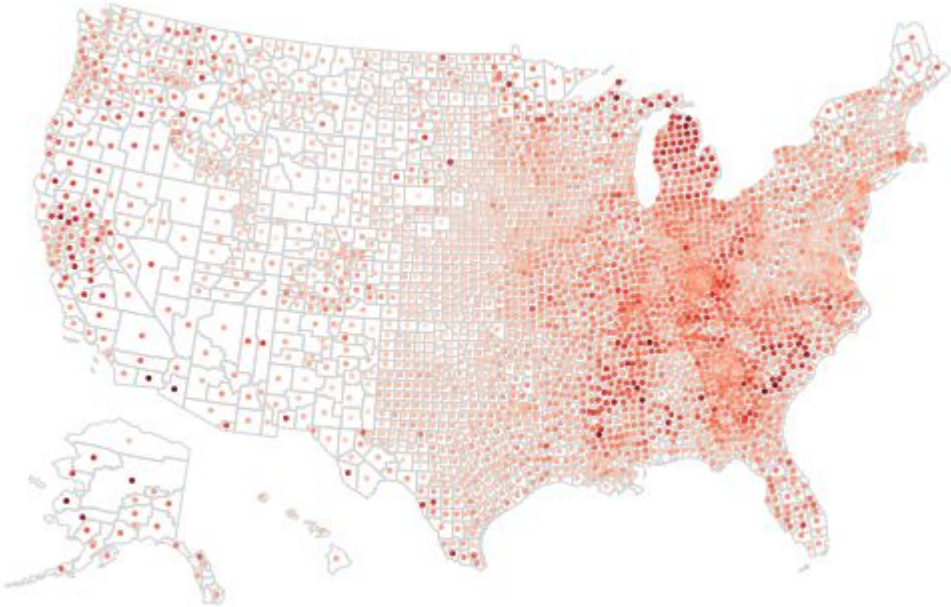
Dot-maps:

- Each area becomes dot
- Map shows area density as well as
- values

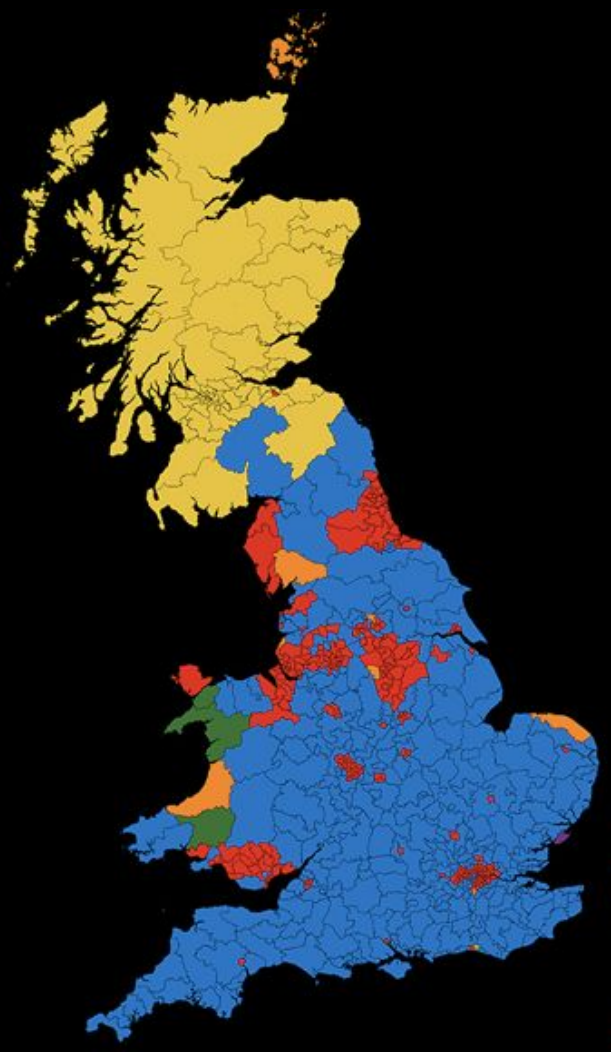


"Bar-maps":



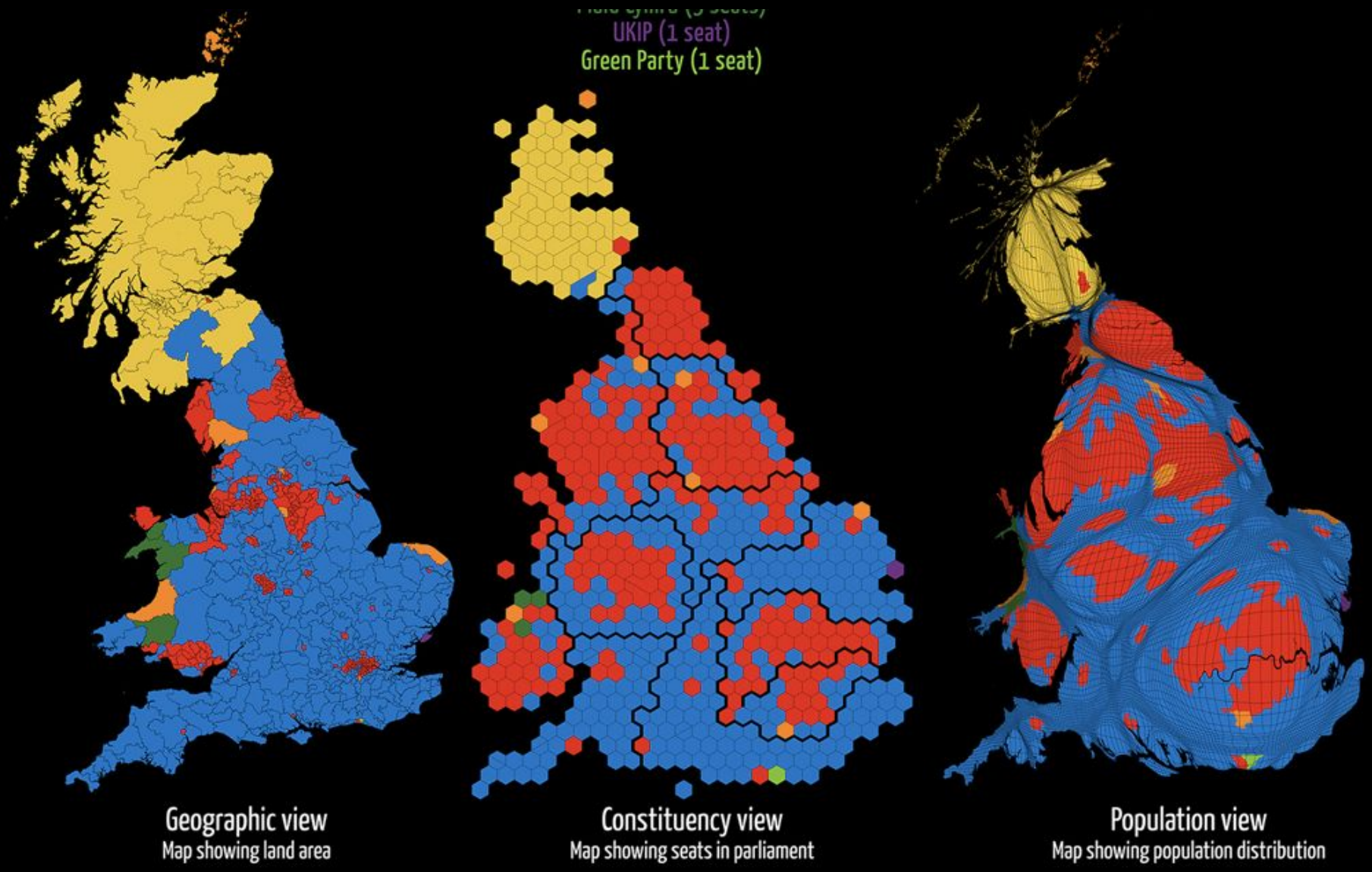


Choropleth alternatives: **Distortions**

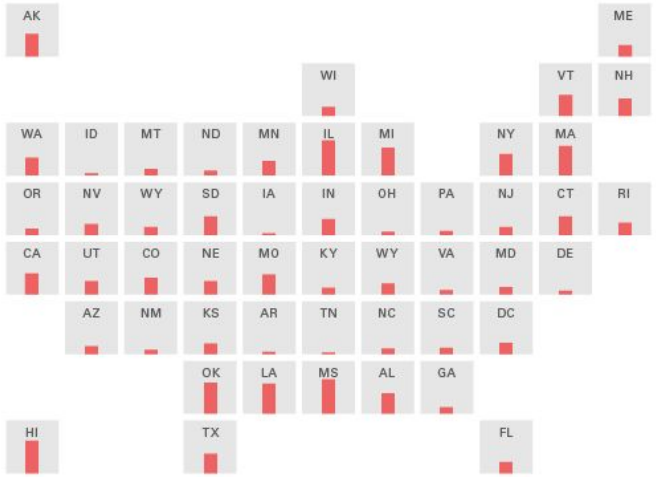


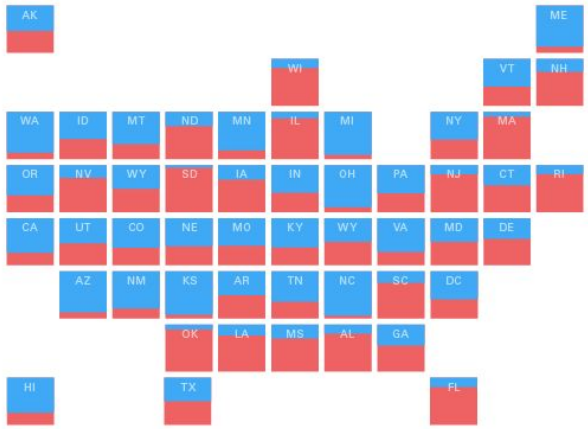
Geographic view
Map showing land area

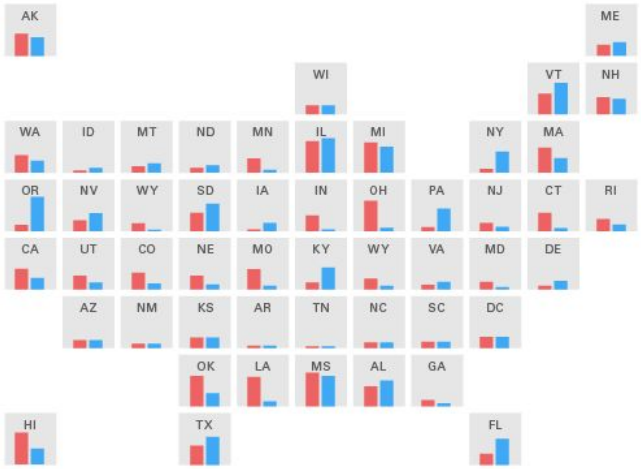
Choropleth alternatives: **Distortions**

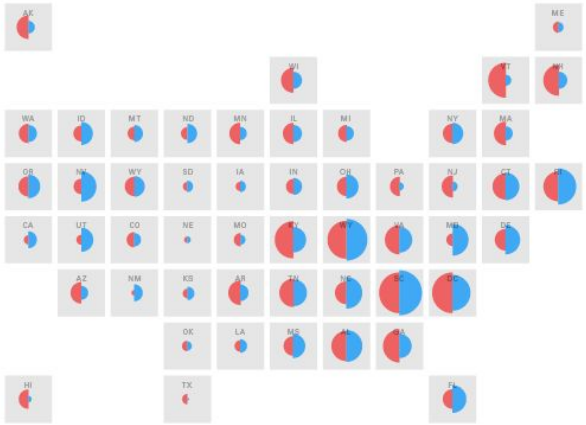


Choropleth alternatives
Equal Areas + Glyphs



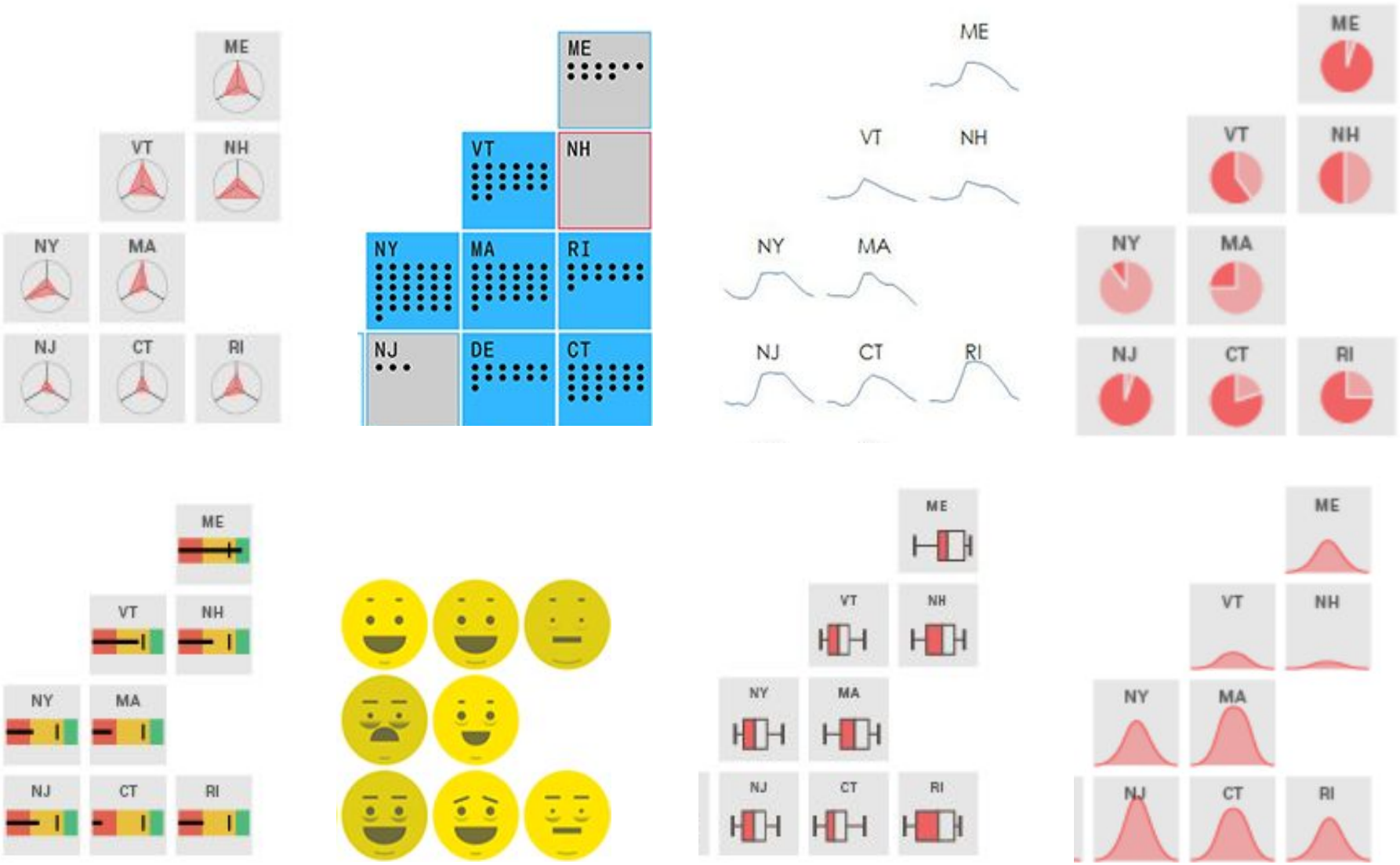






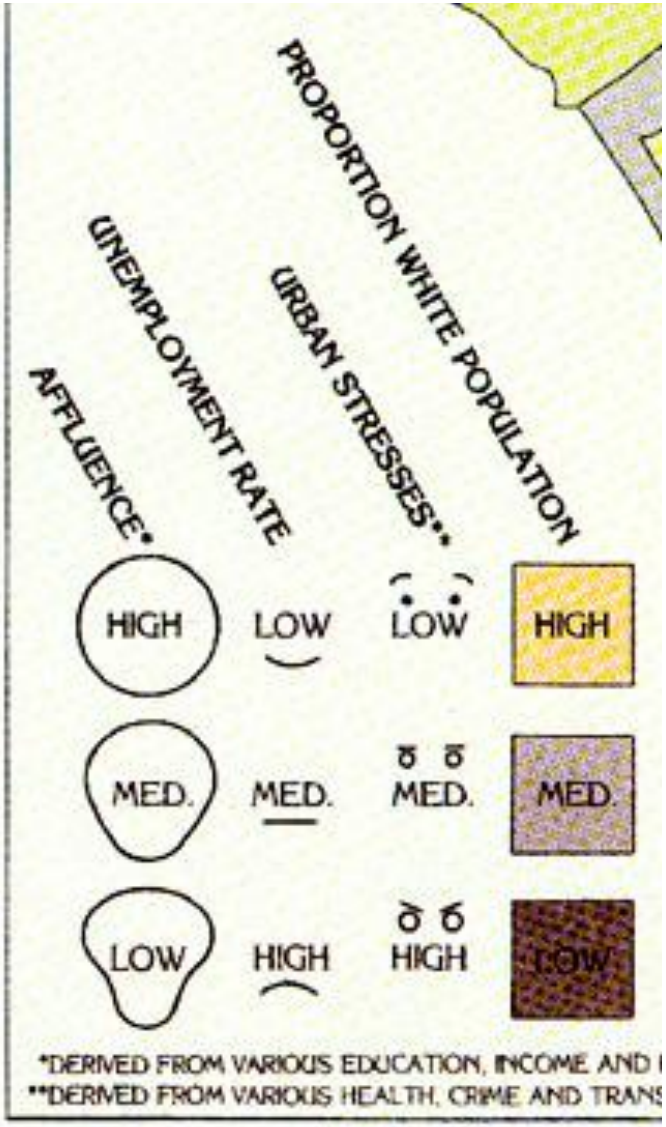
http://datavizcatalogue.com/blog/chart-combinations-tile-grid-maps/

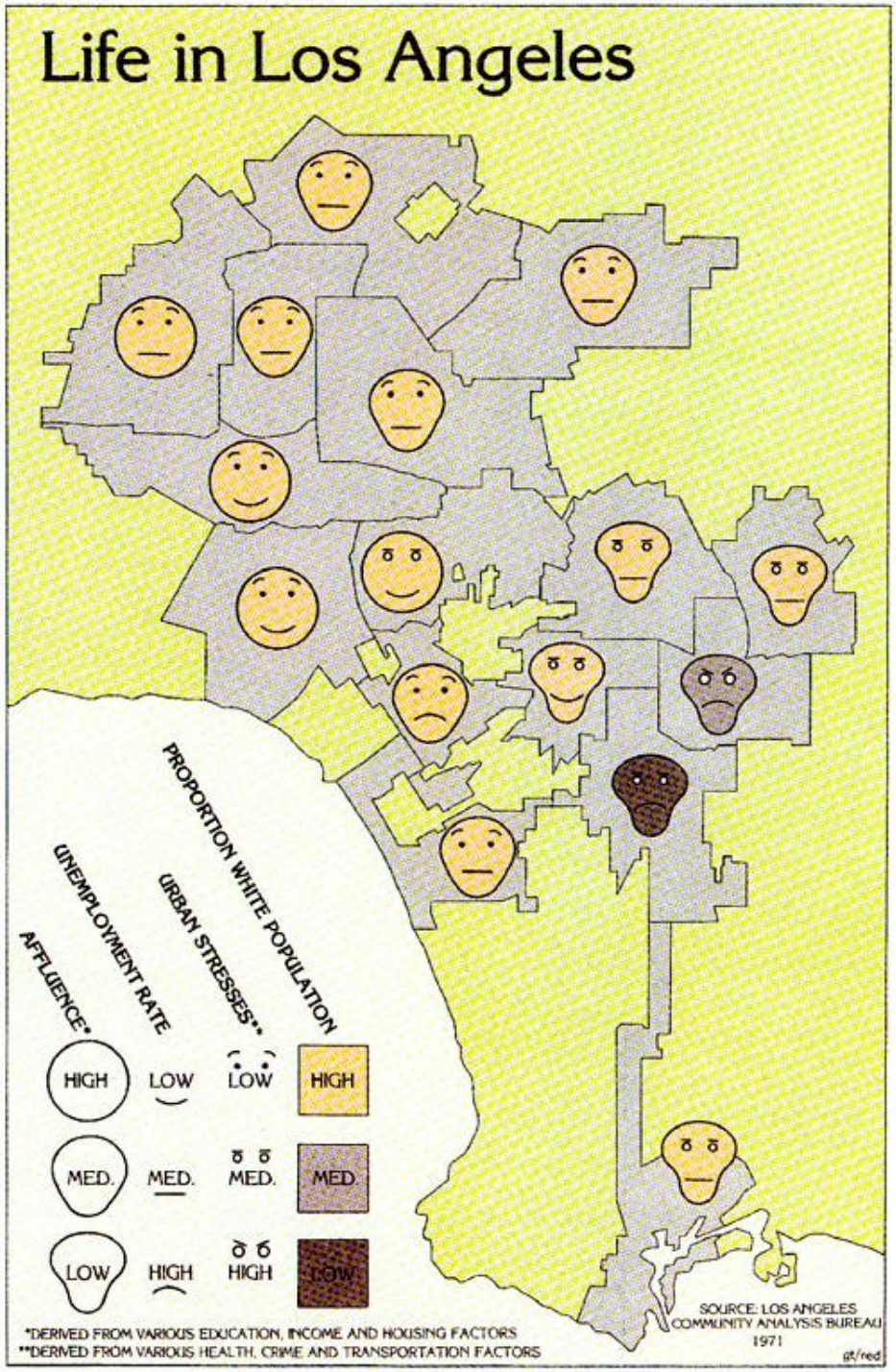
Multivariate map data: **Glyphs**



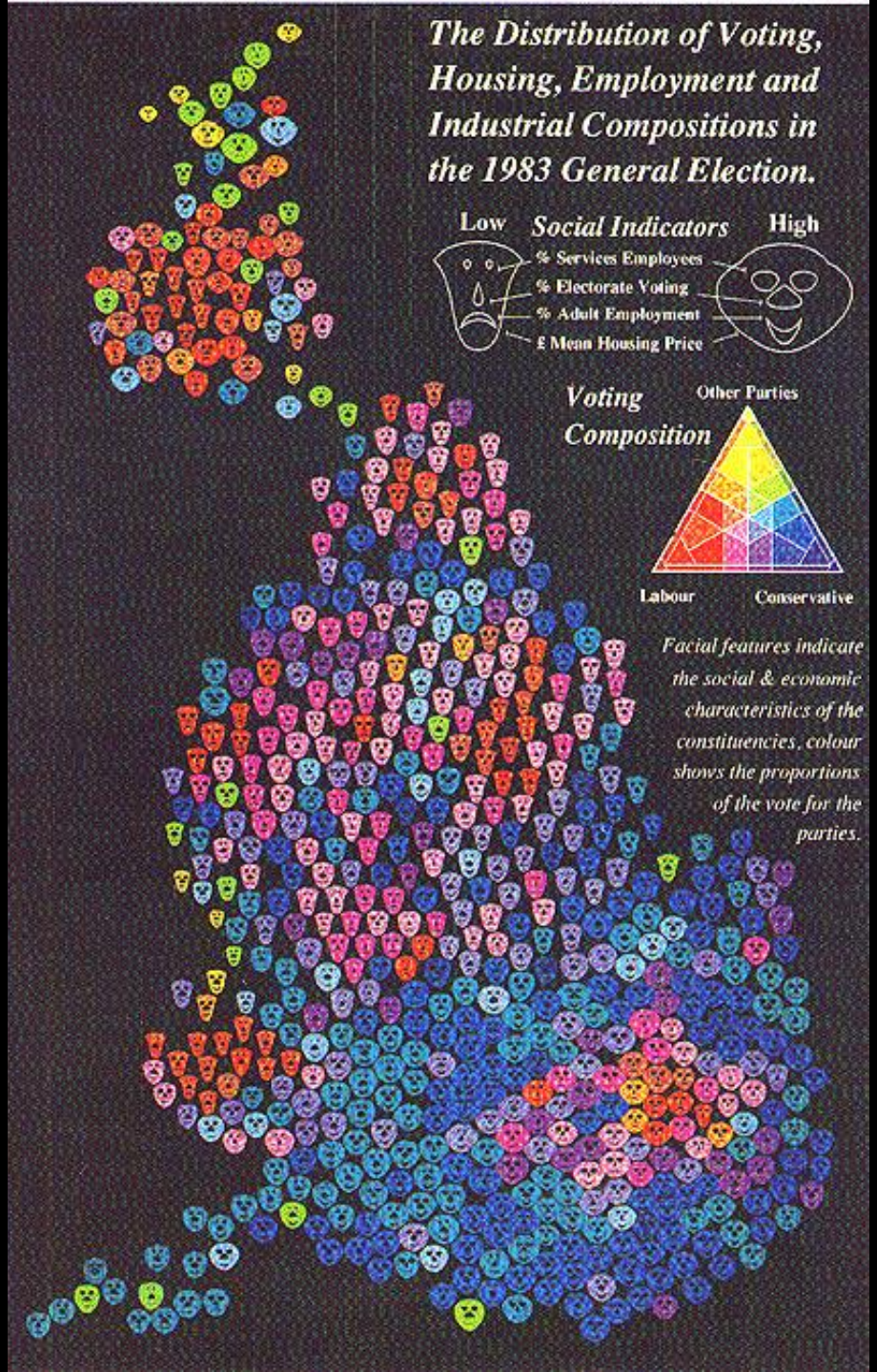
http://datavizcatalogue.com/blog/chart-combinations-tile-grid-maps/

Chernoff Faces





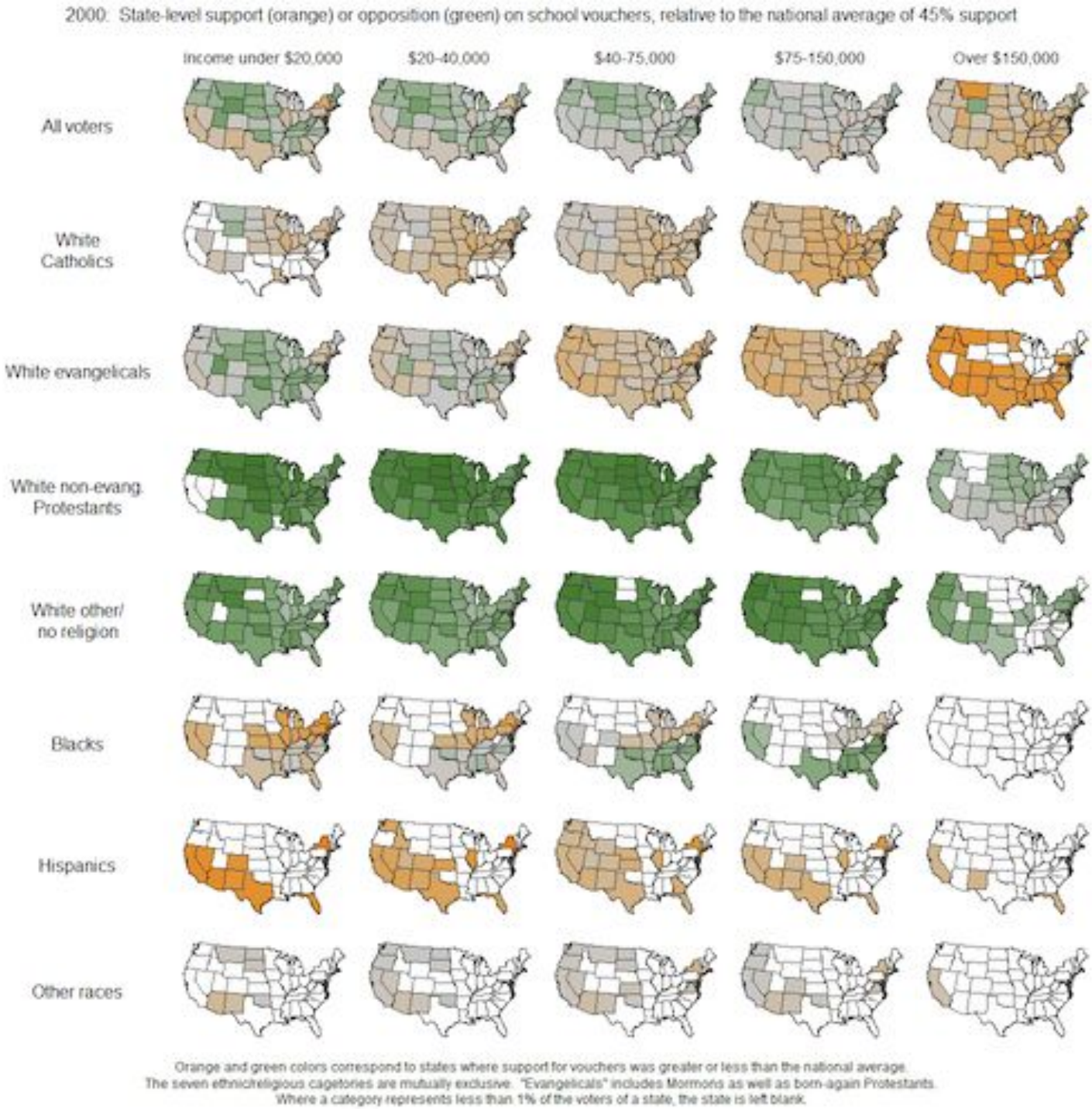
Chernoff Faces



+ Individual values
+ Spatial correlation

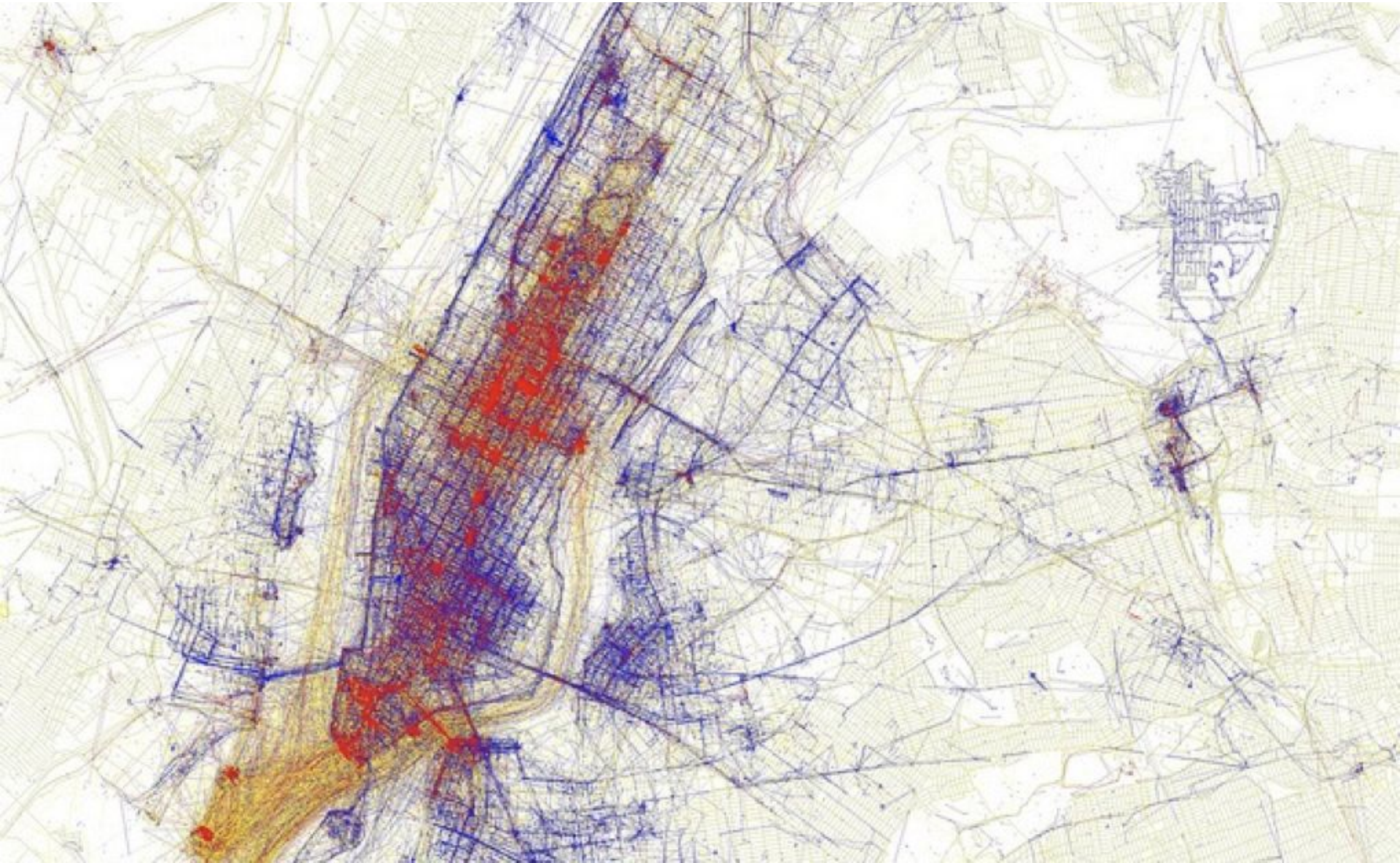
- Some vis-variables are more prominent
- Some vis-variables are hard to perceive and estimate

Small Multiples

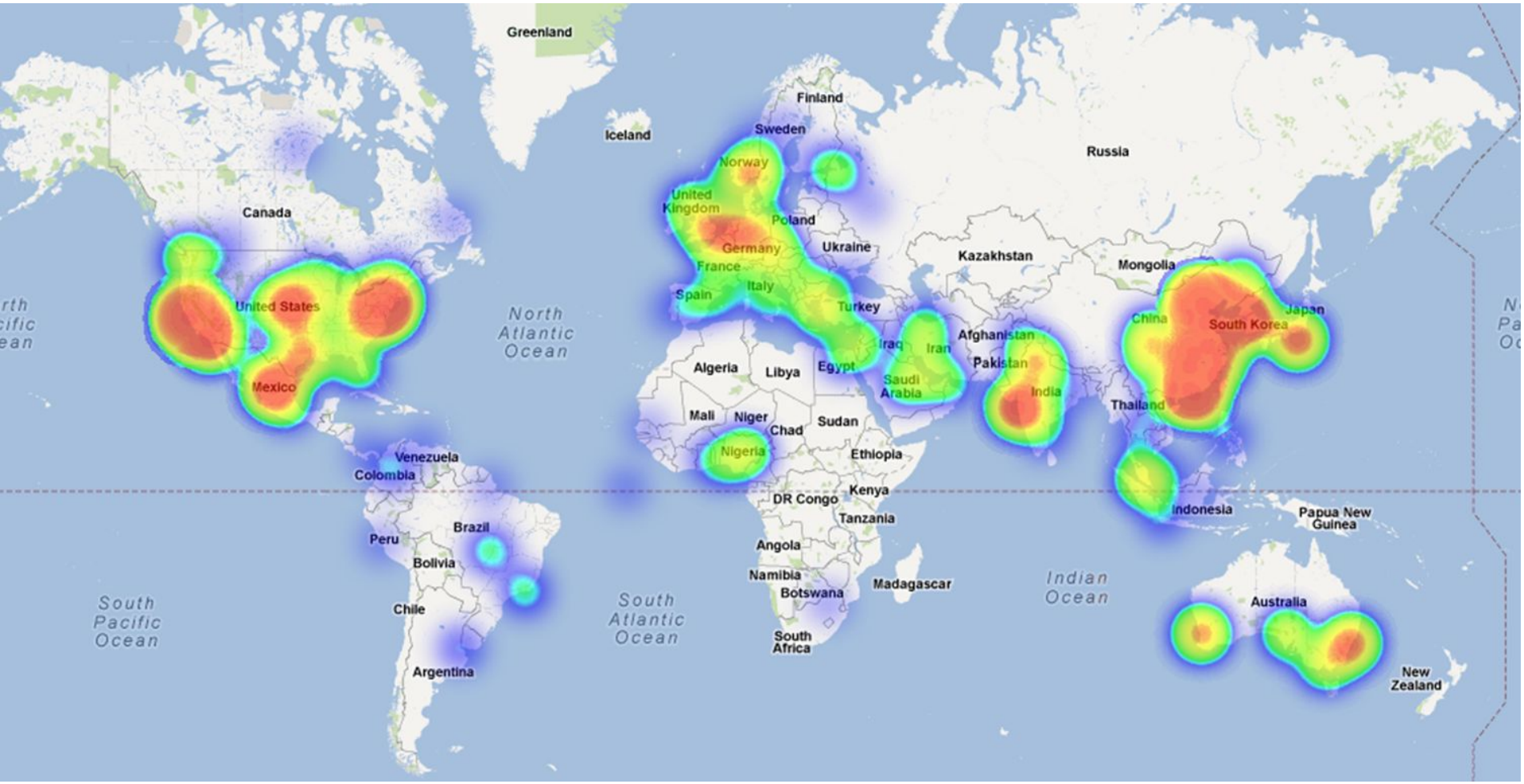


Visualizing **Point Data**

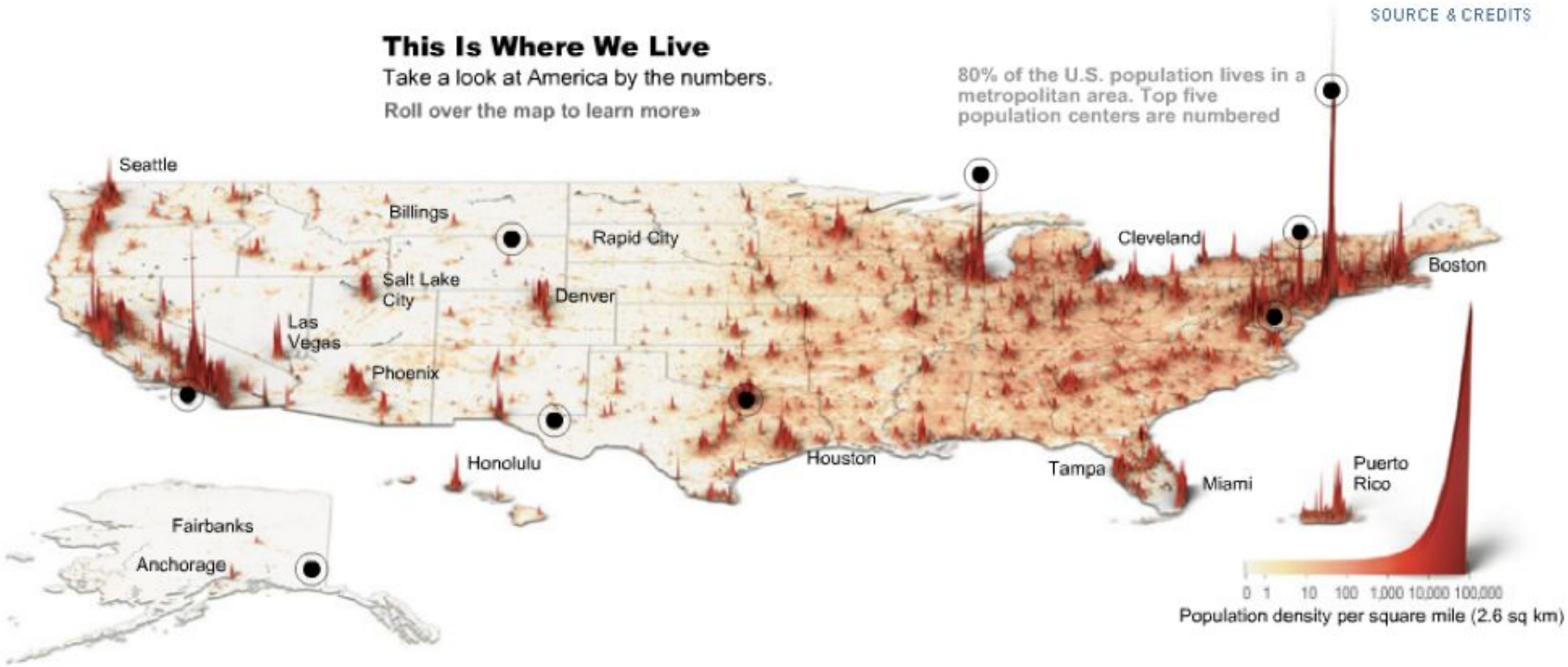
Point map



Heat maps


Greenland
Iceland
Finland
Sweden
Norway
Russia
United Kingdom
Poland
Canada
Germany
Ukraine
Kazakhstan
Mongolia
France
Italy
Spain
Turkey
United States
North Atlantic Ocean
China
South Korea
Japan
Iraq
Iran
Afghanistan
Pakistan
Algeria
Libya
Egypt
Saudi Arabia
India
Mexico
Thailand
Mali
Niger
Chad
Sudan
Nigeria
Ethiopia
Venezuela
Colombia
Kenya
DR Congo
Tanzania
Indonesia
Papua New Guinea
Brazil
Peru
Angola
Bolivia
Namibia
Botswana
Madagascar
Indian Ocean
South Pacific Ocean
Chile
South Atlantic Ocean
Australia
South Africa
Argentina
New Zealand

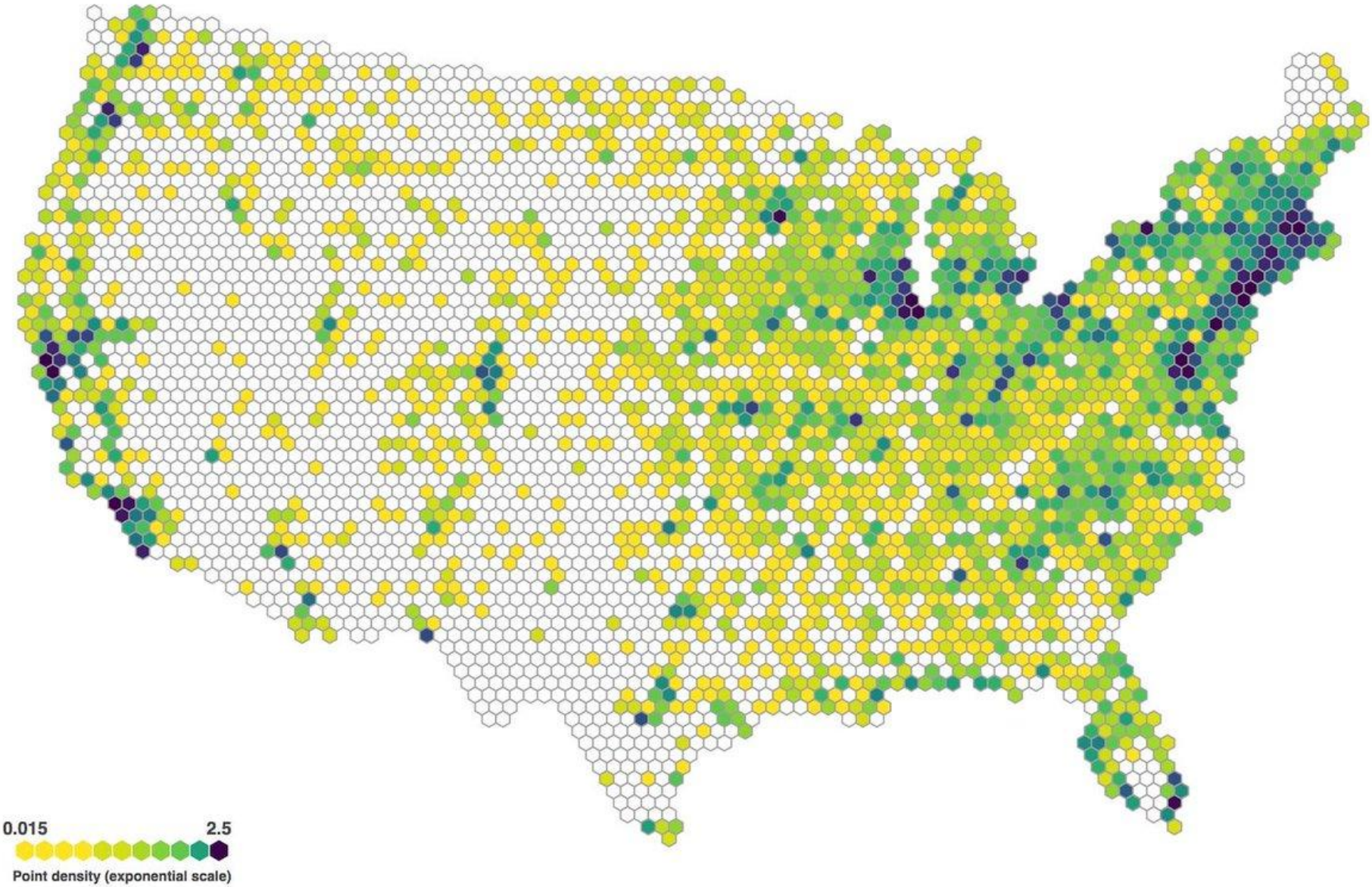
Elevation map



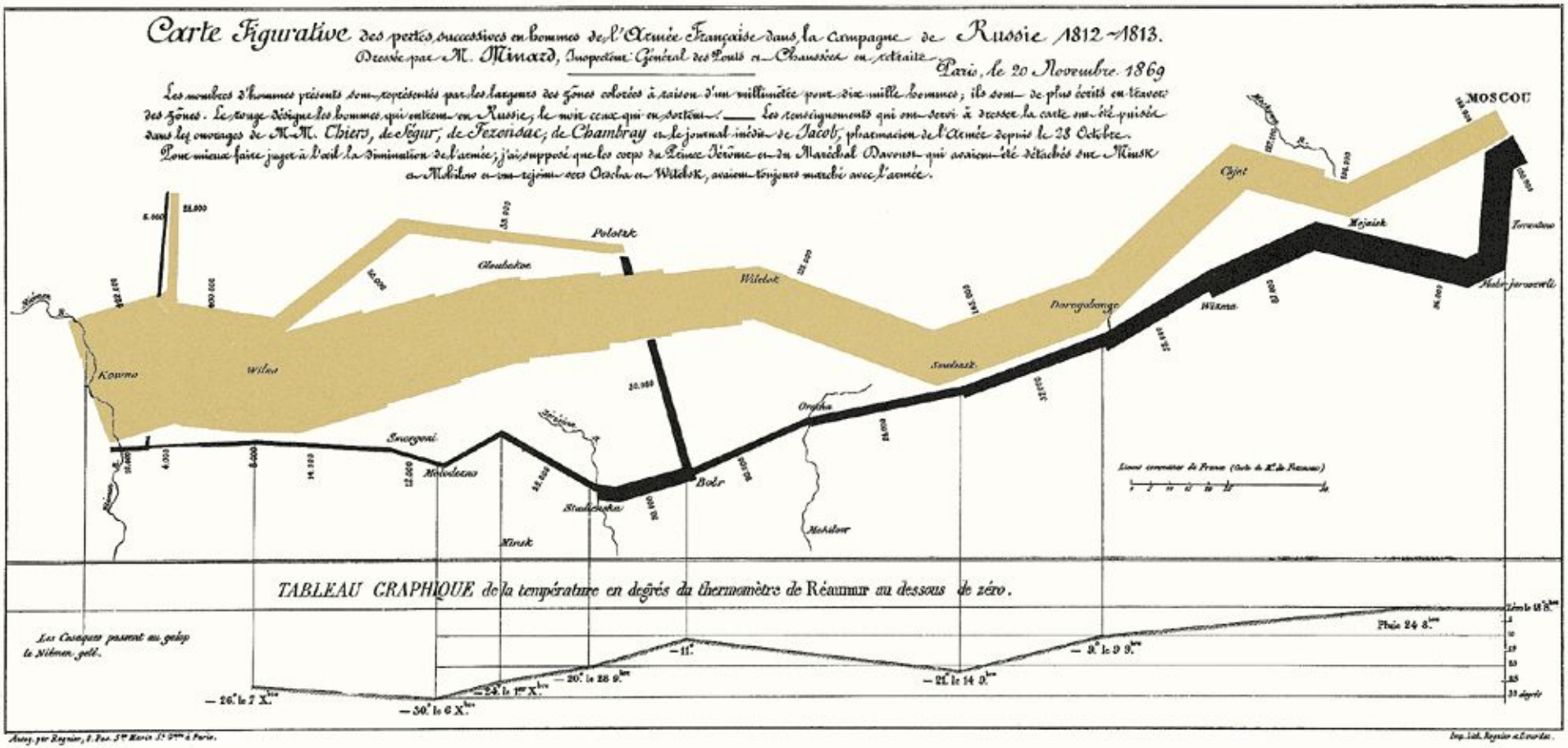
+ Can show huge differences in values
+ Allows for comparison

- Geographic distortion
- Possible occlusion

Binning

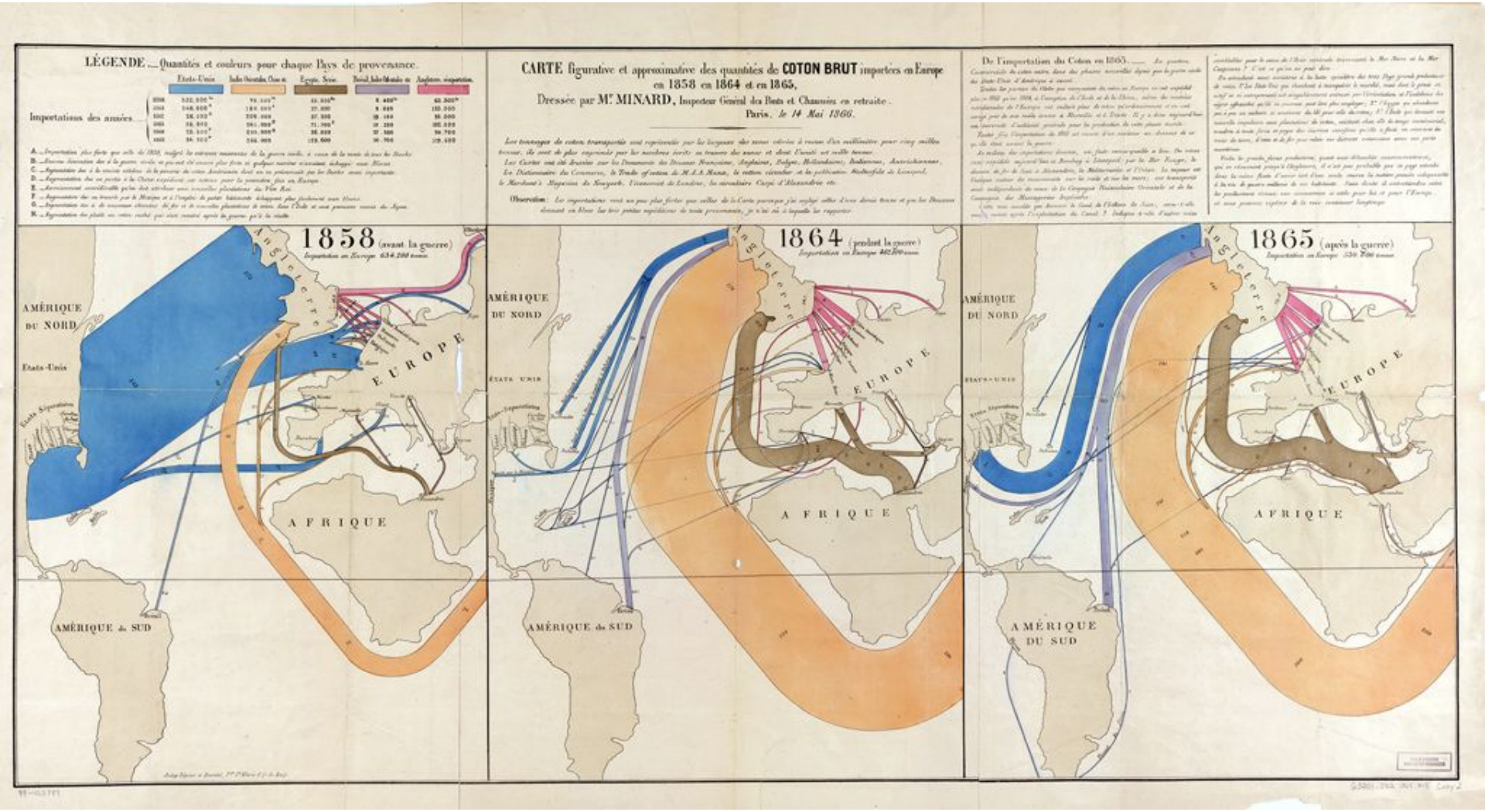


Visualizing **Trajectories**

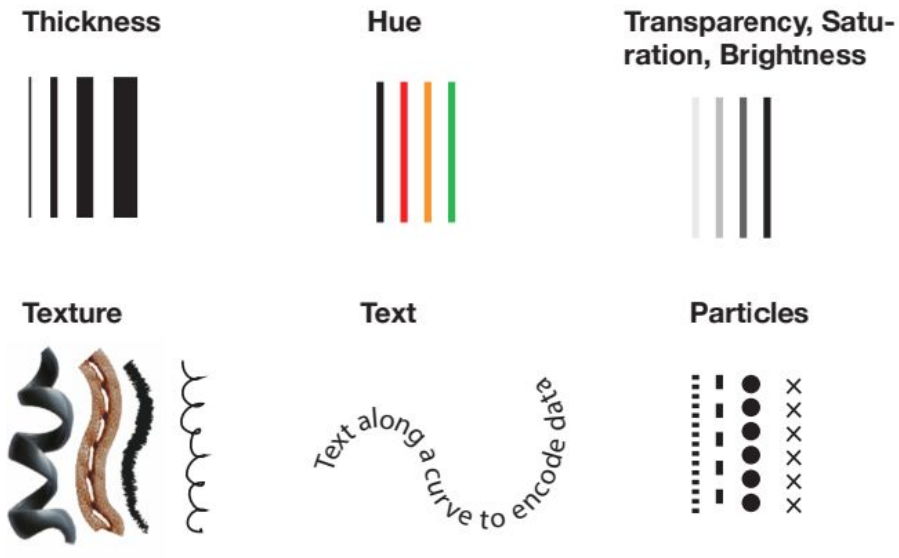


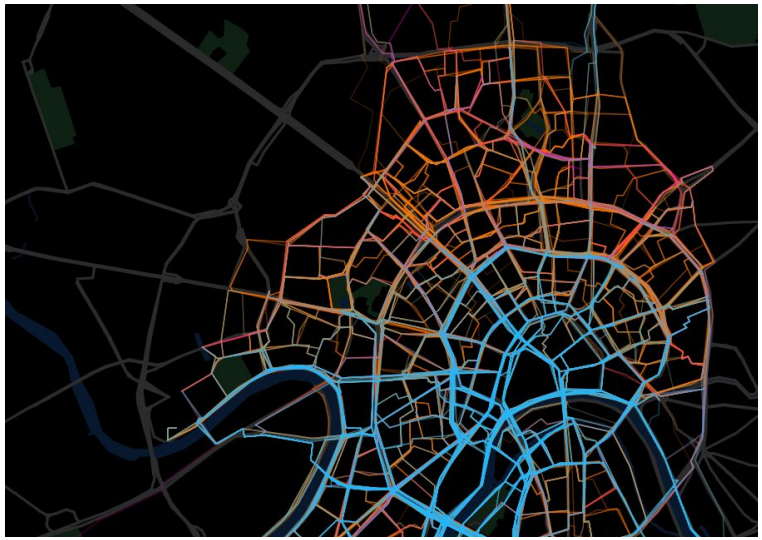
Charles Joseph Minard (1781–1870)

Flow Diagram

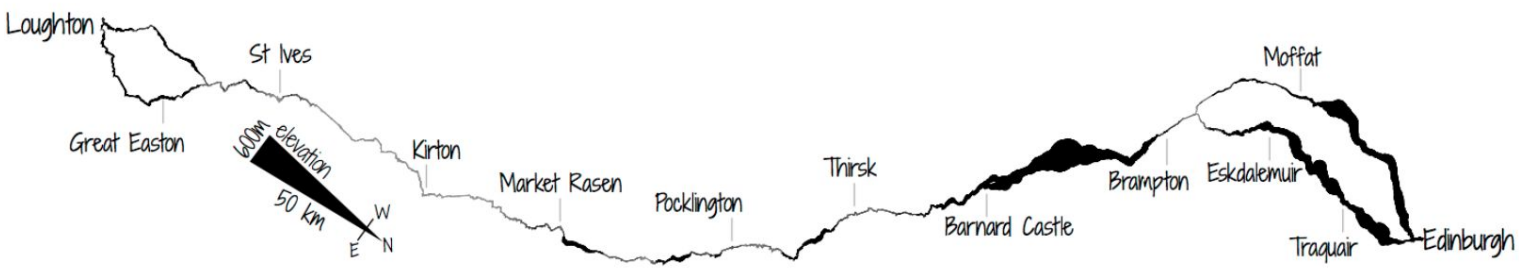


Encoding information



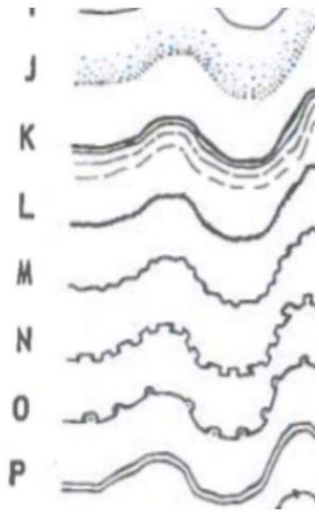


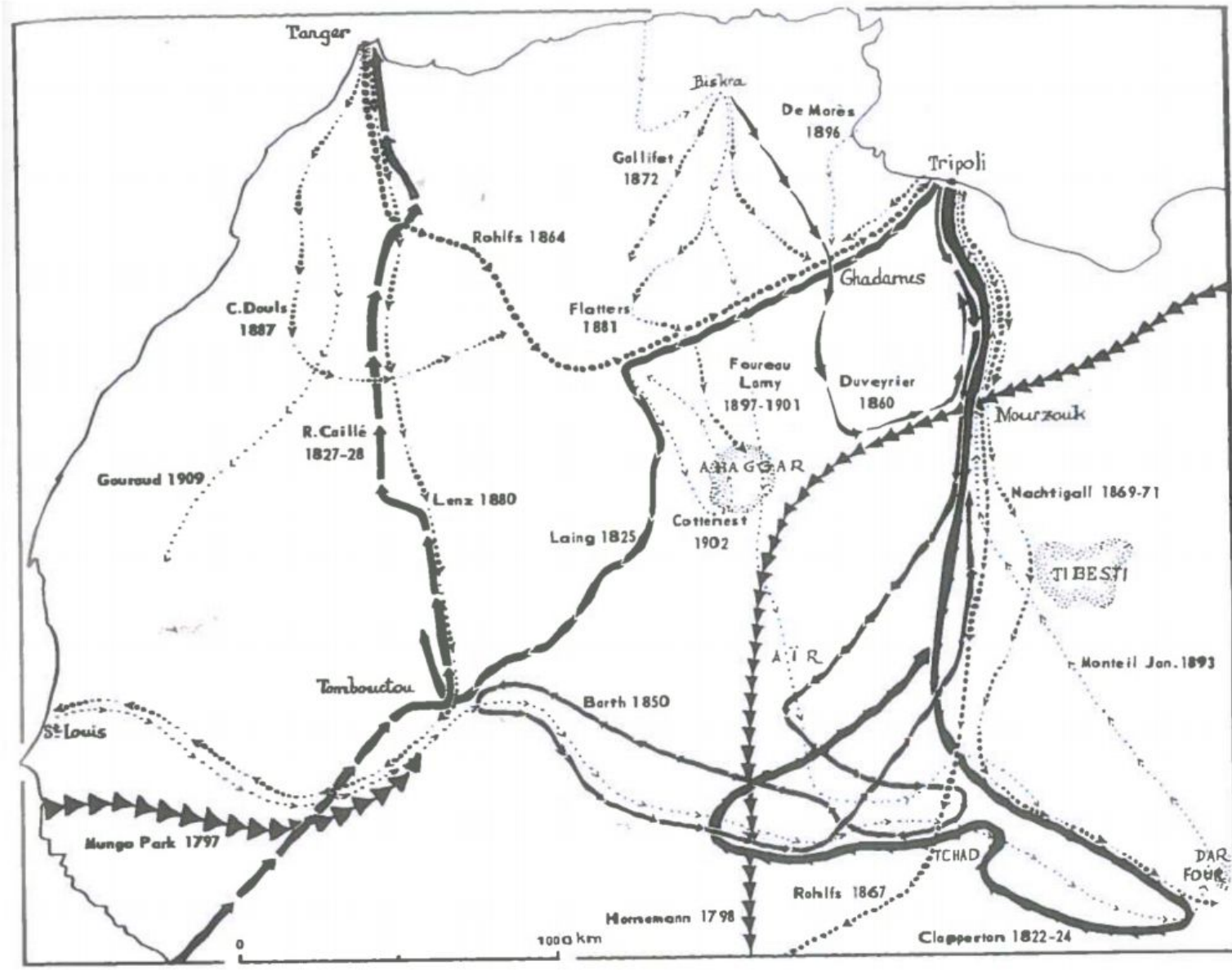
https://medium.com/the-data-experience/bicycles-in-the-city-f9529d918388



Wood, Jo. "Visualizing personal progress in participatory sports cycling events." *IEEE Computer Graphics and Applications* 35.4 (2015): 73-81.

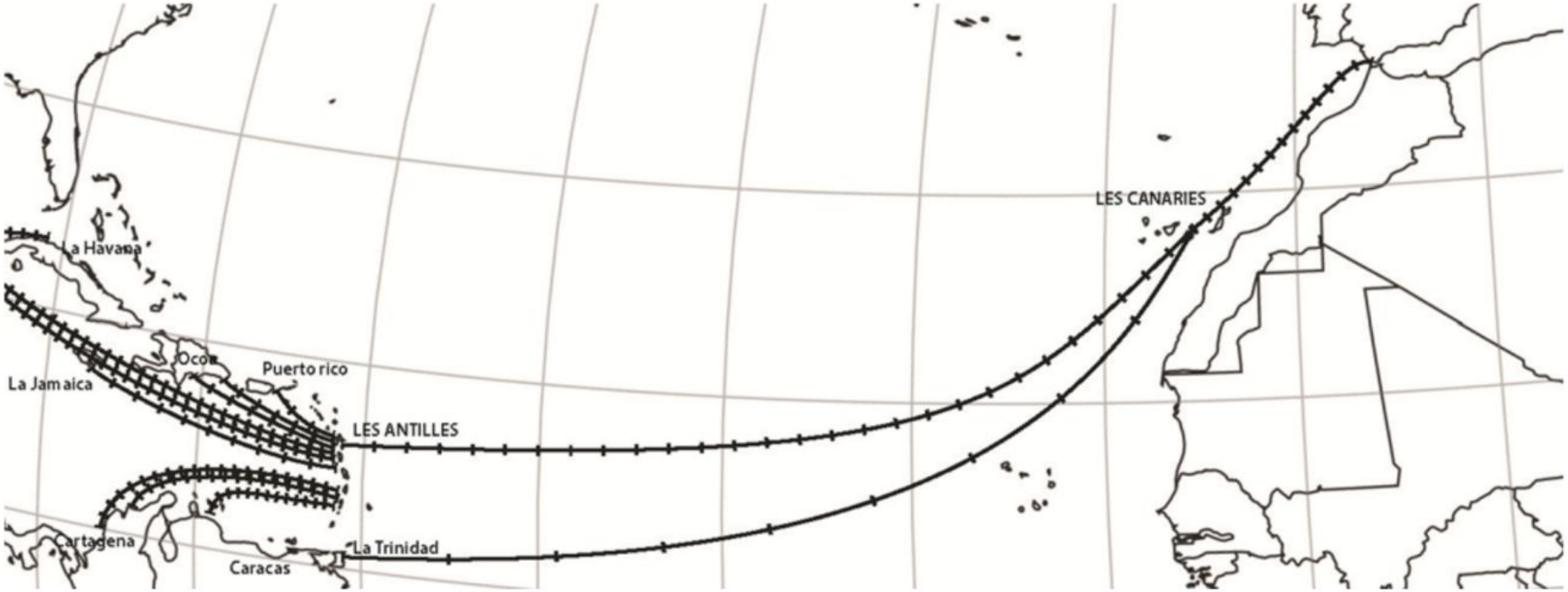
Texture





Bertin, Jacques. *Semiology of graphics; diagrams networks maps*. No. 04; QA90, B7.. 1983.

Time steps / velocity



Columbus journeys to the Americas

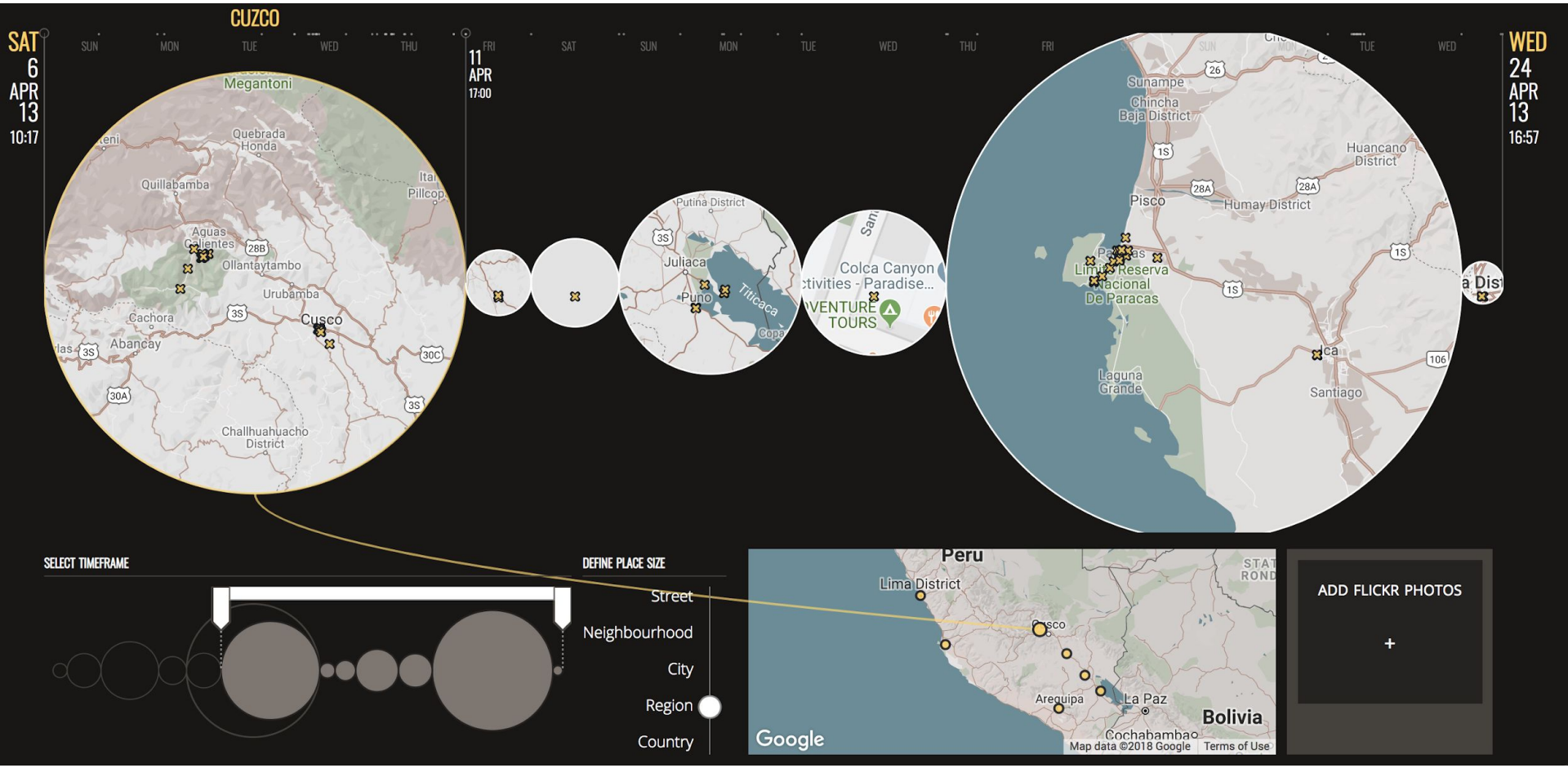
Bertin, Jacques. *Semiology of graphics; diagrams networks maps*. No. 04; QA90, B7.. 1983.

Animation: animating particles

http://ilda.saclay.inria.fr/flownet/

Romat, Hugo, et al. "Animated edge textures in node-link diagrams: A design space and initial evaluation." *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 2018.

Visits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16:57
Megantoni
Quebrada Honda
Quillabamba
Aguas Calientes
Ollantaytambo
Urubamba
Cachora
Cusco
Abancay
Challhuahuacho District
Pillcop
Putina District
Juliaca
Puno
Titicaca
Colca Canyon
ctivities - Paradise...
VENTURE TOURS
Sunampe
Chincha Baja District
Huancano District
Pisco
Humay District
Reserva Nacional De Paracas
Laguna Grande
Santiago
SELECT TIMEFRAME
DEFINE PLACE SIZE
Street
Neighbourhood
City
Region
Country
Peru
Lima District
Cusco
Arequipa
La Paz
Bolivia
Cochabamba
Google
Map data ©2018 Google
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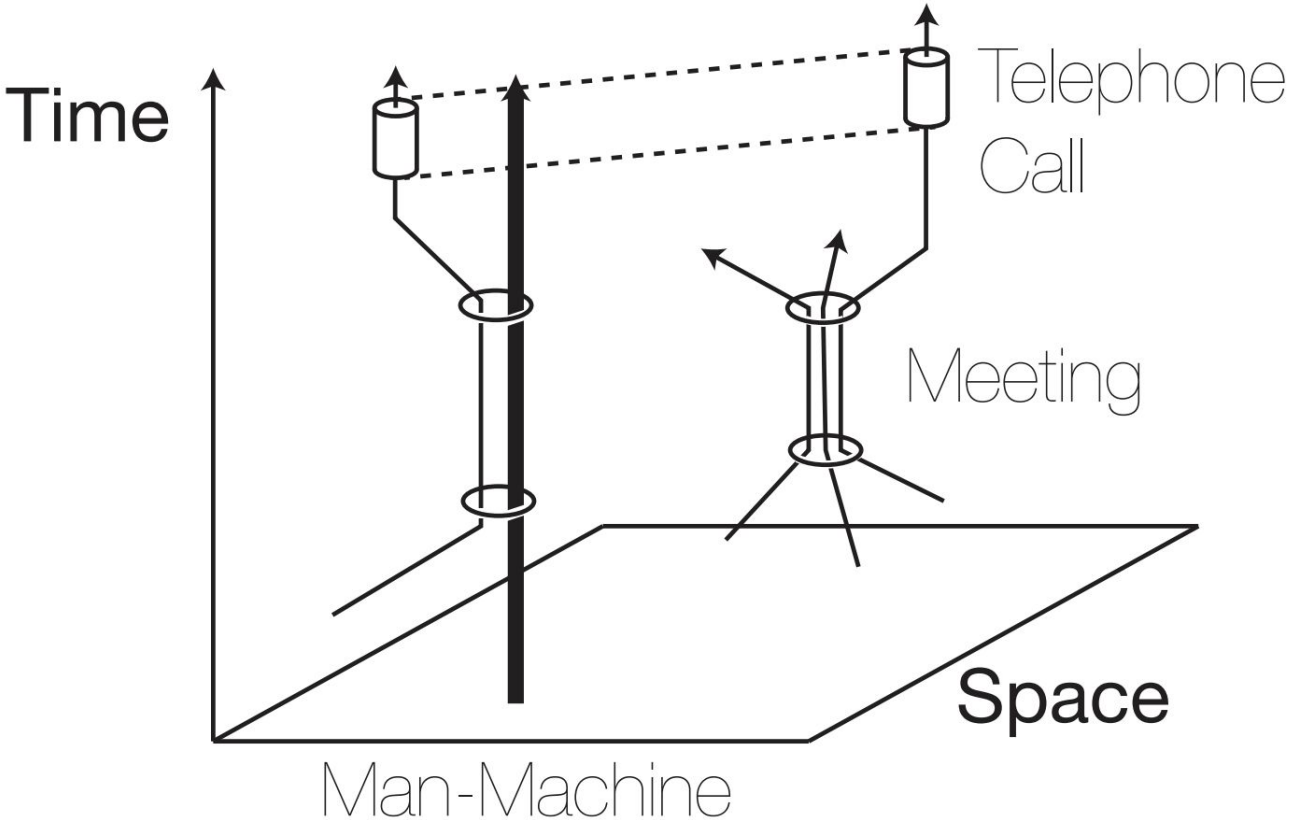
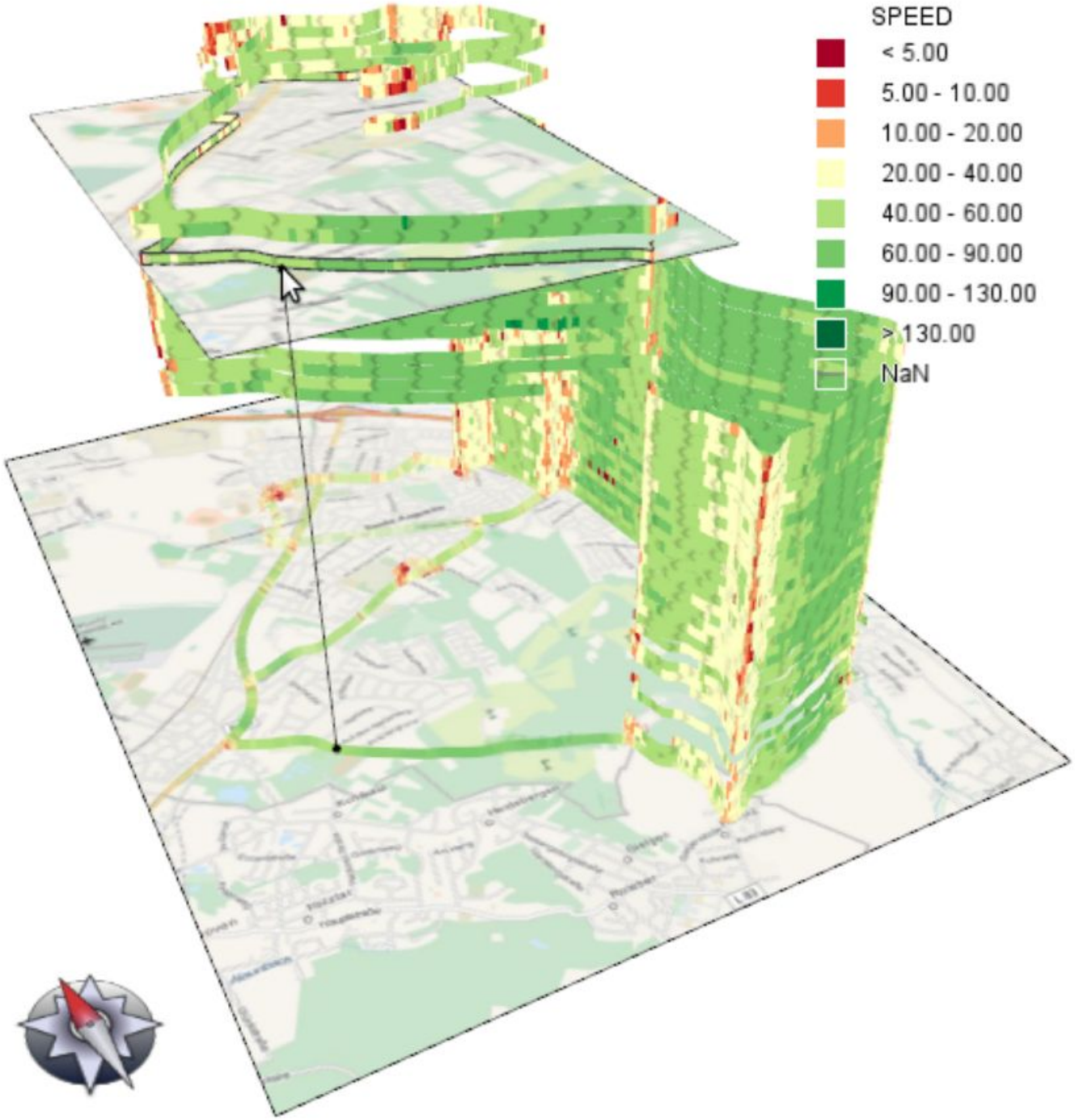
ADD FLICKR PHOTOS
+

Space-Time Cubes



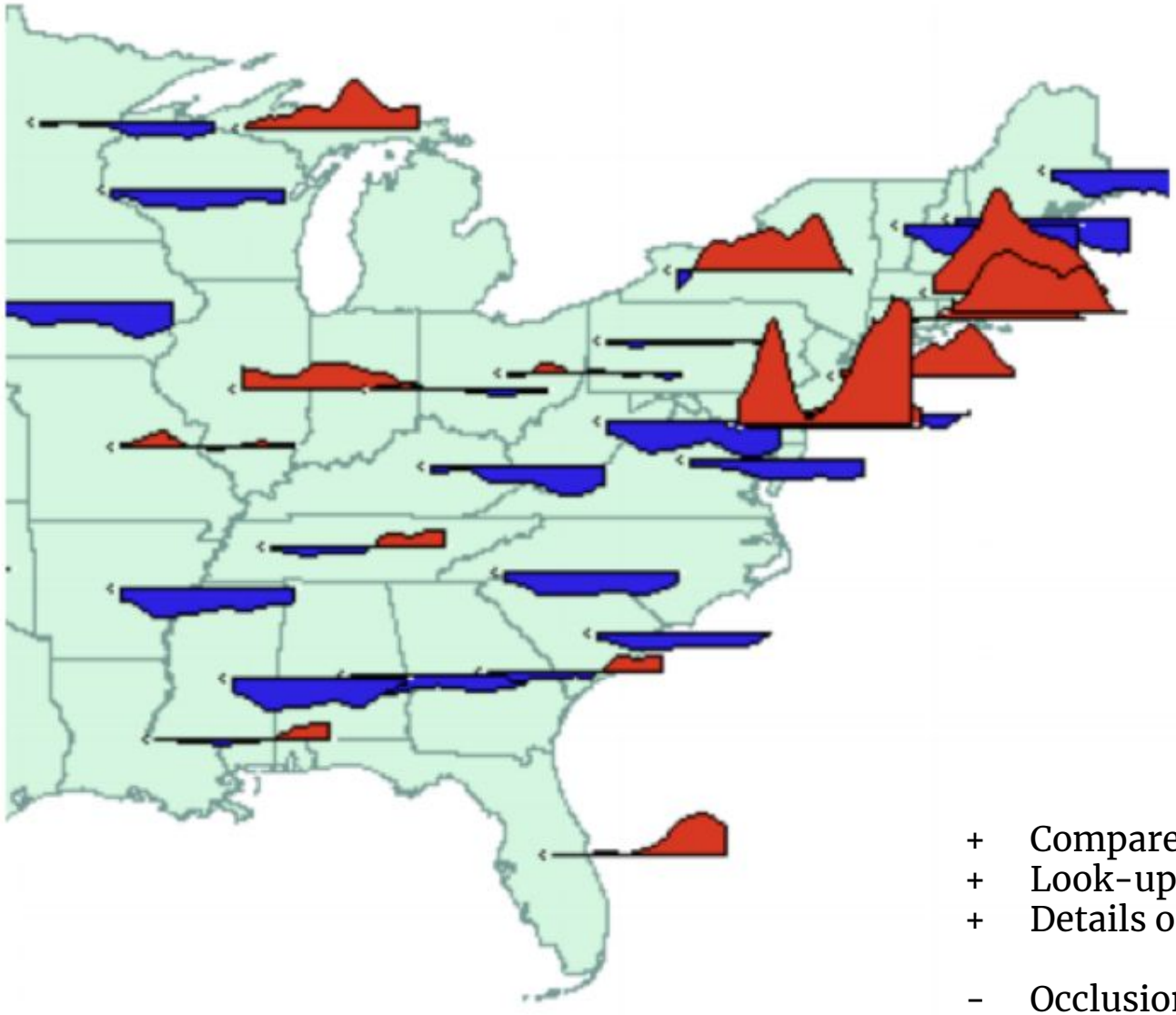
Bach, Benjamin, et al. "A Descriptive Framework for Temporal Data Visualizations Based on Generalized Space-Time Cubes." *Computer Graphics Forum*. Vol. 36. No. 6. 2017.



Tominski, Christian, et al. "Stacking-based visualization of trajectory attribute data." *IEEE Transactions on visualization and Computer Graphics* 18.12 (2012): 2565-2574.

Visualizing **Time**

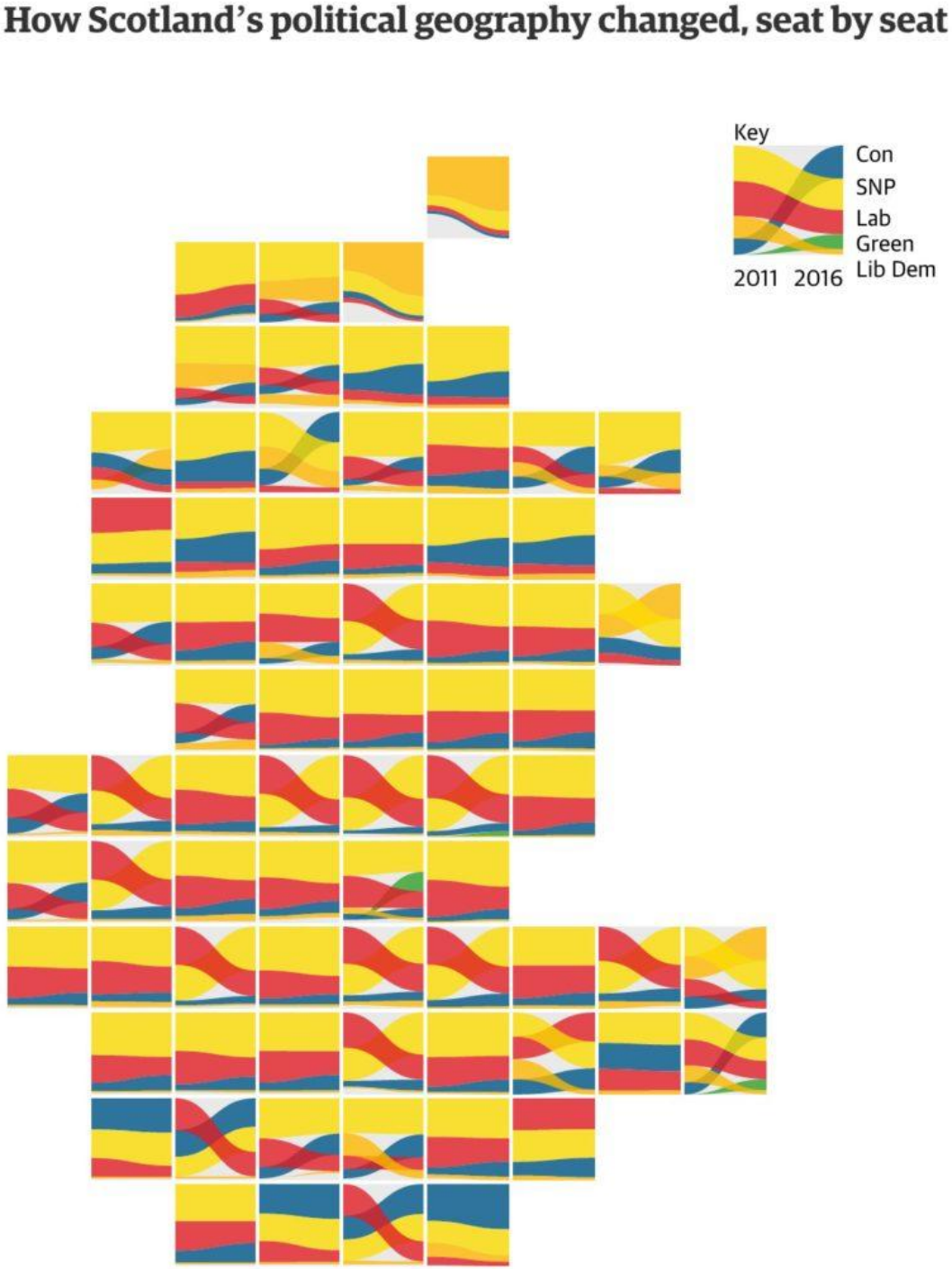
Small Multiples



+ Compare regions
+ Look-up regions
+ Details on regions

- Occlusion

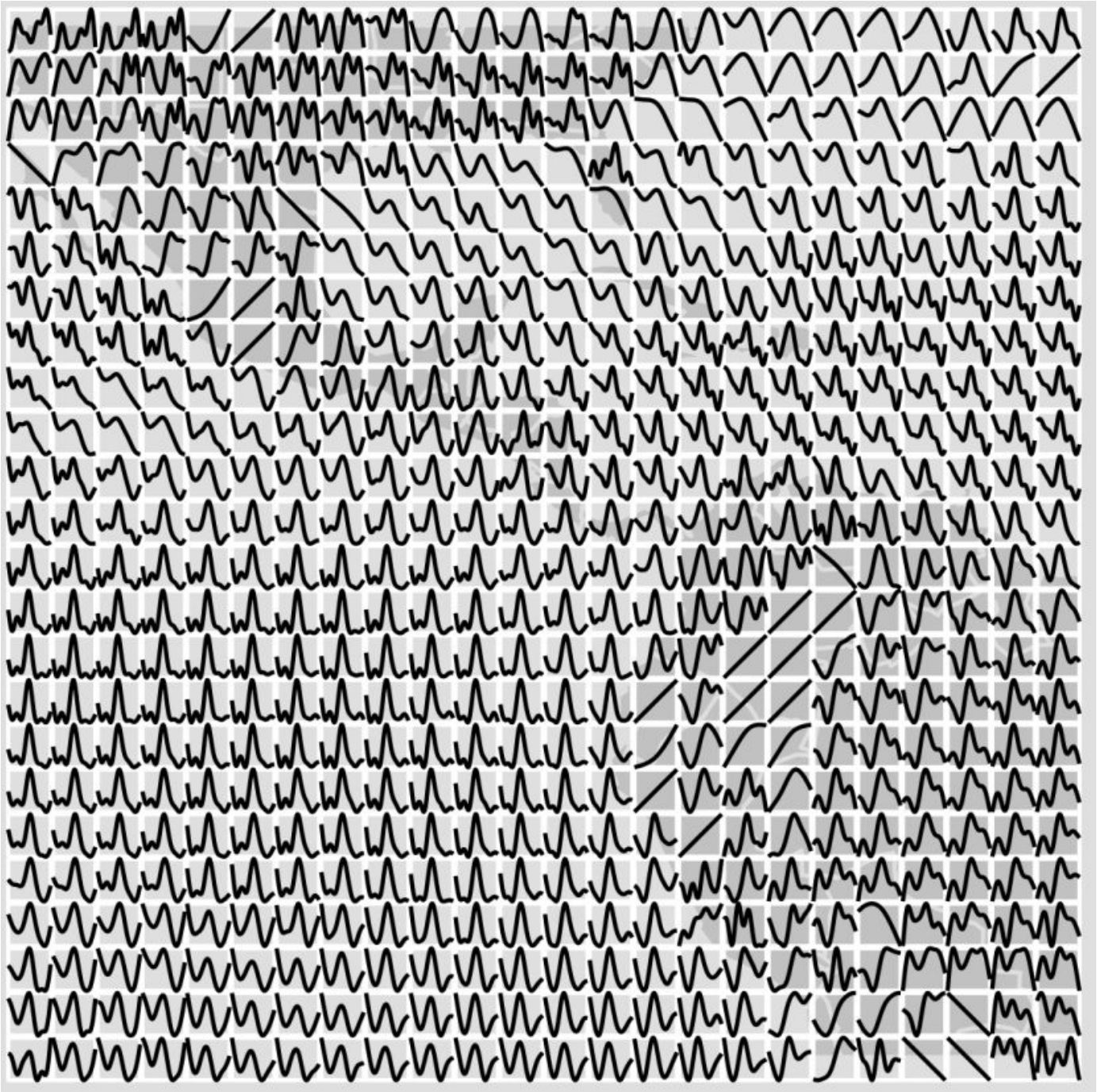
Geo-flow



+ Compare regions
+ Look-up regions
+ Details on regions

- Compare far away glyphs
- Glyphs can become small

Glyph Maps



https://vita.had.co.nz/papers/glyph-maps.pdf

Further reading

- Alberto Cairo: The Truthful Art: Chapter 10: Mapping Data
- Bertin, Jacques. *Semiology of graphics; diagrams networks maps*. No. 04; QA90, B7.. 1983.
- Andrienko, Gennady, et al. "Space, time and visual analytics." *International journal of geographical information science* 24.10 (2010): 1577-1600.
- Andrienko, Natalia, and Gennady Andrienko. *Exploratory analysis of spatial and temporal data: a systematic approach*. Springer Science & Business Media, 2006.
- Bach, Benjamin, et al. "A descriptive framework for temporal data visualizations based on generalized space-time cubes." *Computer Graphics Forum*. Vol. 36. No. 6. 2017.
- Bach, Benjamin, et al. "Ways of Visualizing Data on Curves." 2018.