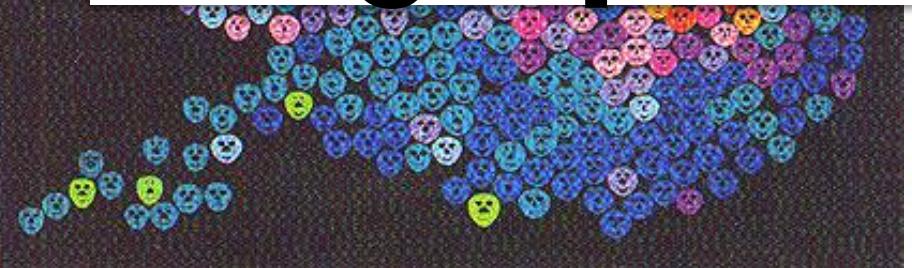


Session 4



Geographic Visualization



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Benjamin Bach

June 2022

<http://benjbach.me>
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Outline

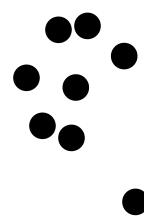
How to visualize geographic data?

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

Tasks

- **Locations (0D, Points)**

- Distribution
- Sensity
- Values
- Distances
- Temporality

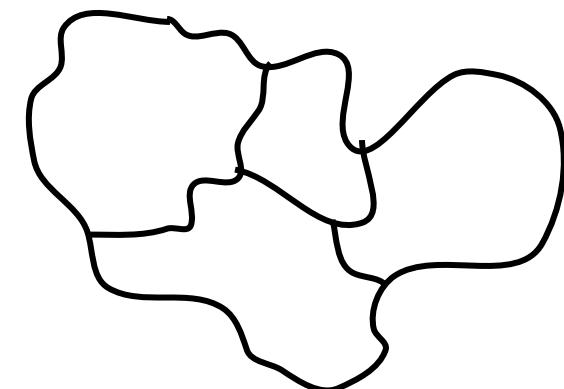
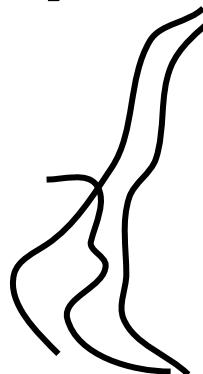


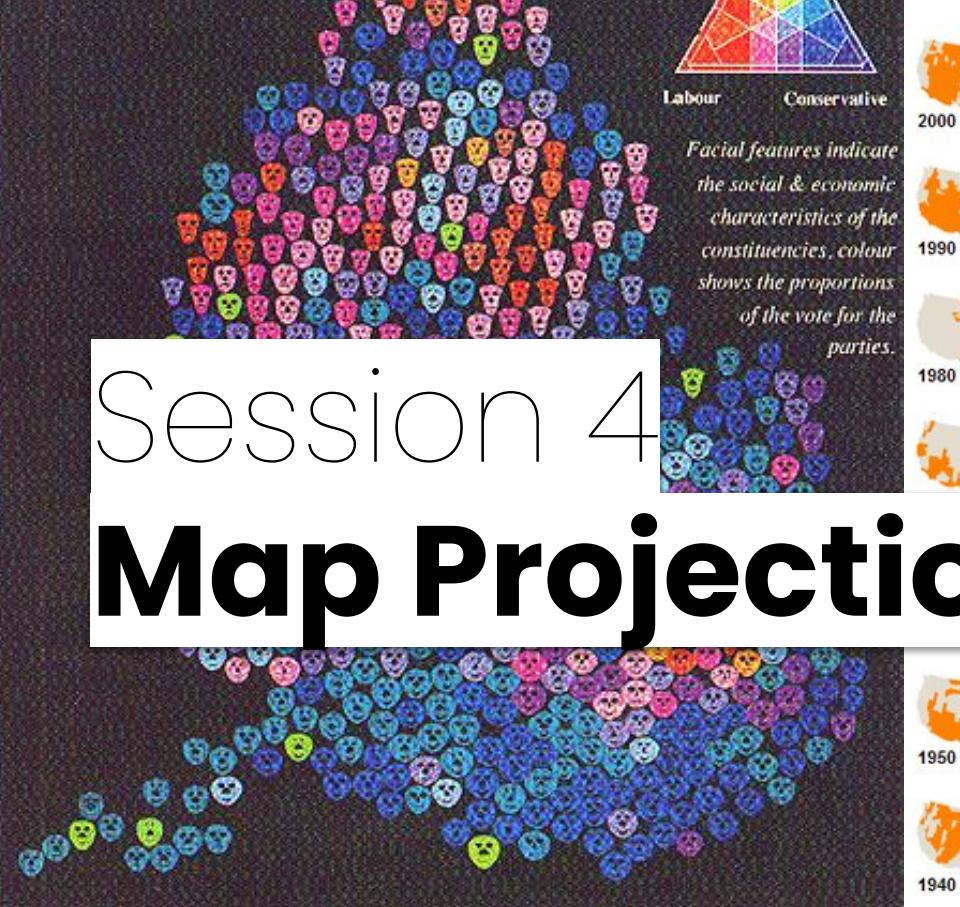
- **Areas (2D)**

- Comparison
- Max/min values
- Geographic areas + trends and outliers
- temporality

- **Trajectories (1D, lines)**

- Locations
- Common paths
- Directionality
- Temporality





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Map Projections



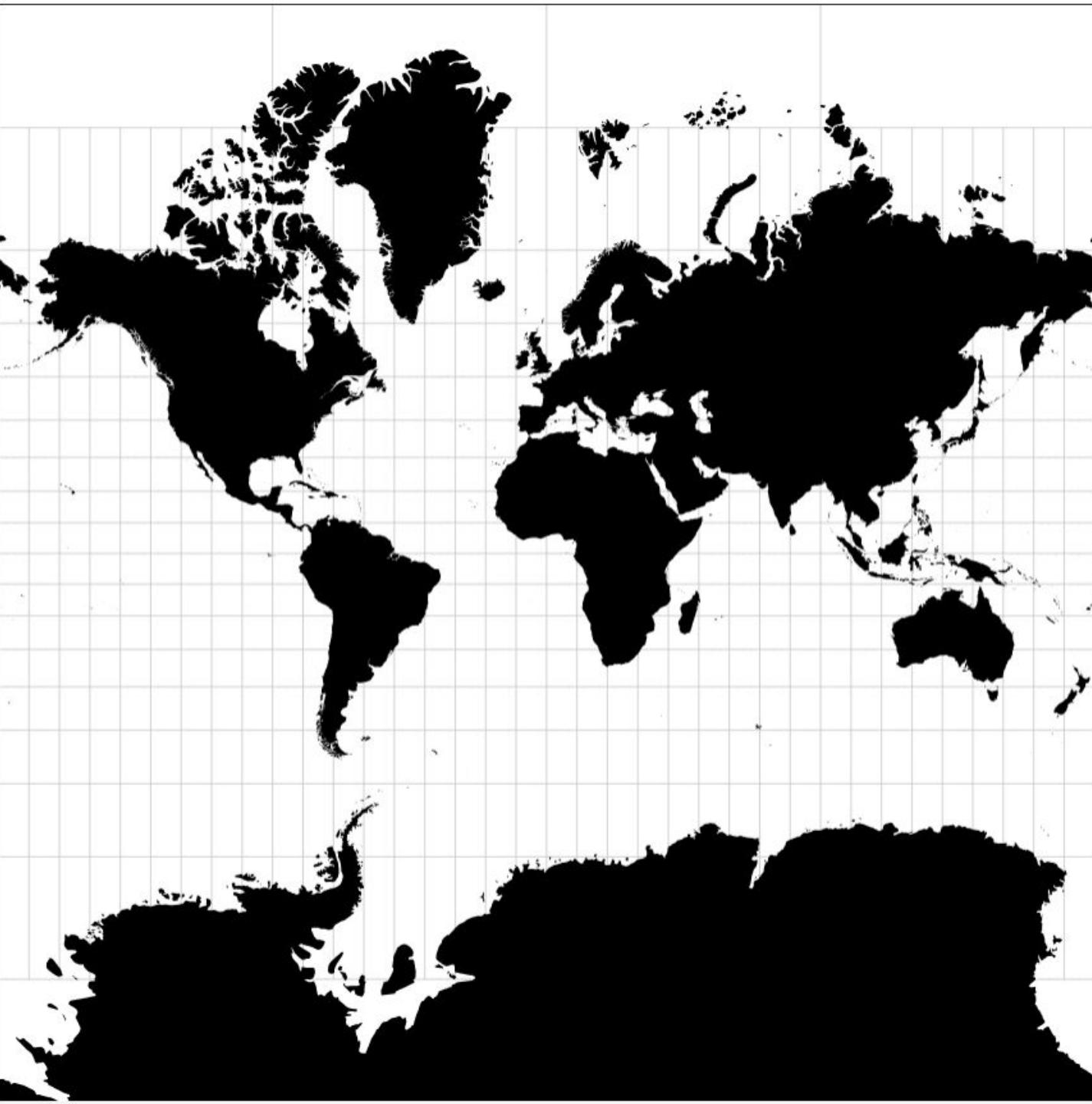
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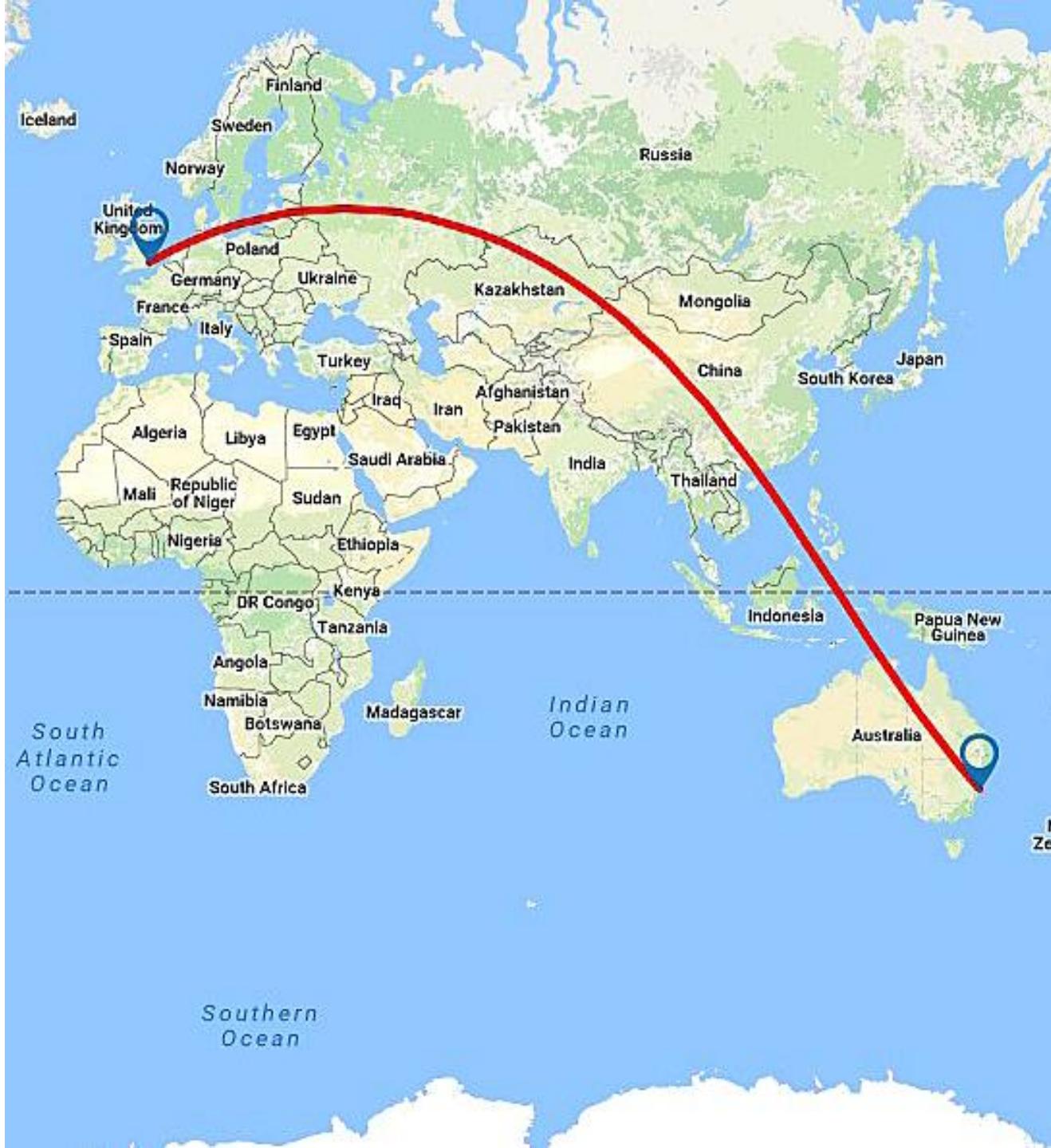
-- Not for external use --

The True Size Of...

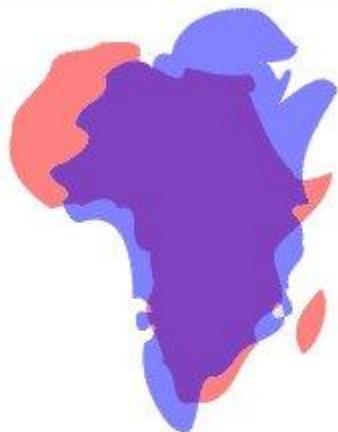


Projections: Trajectories

Direct flight:
London-Sydney



The True Size of Africa



Mercator



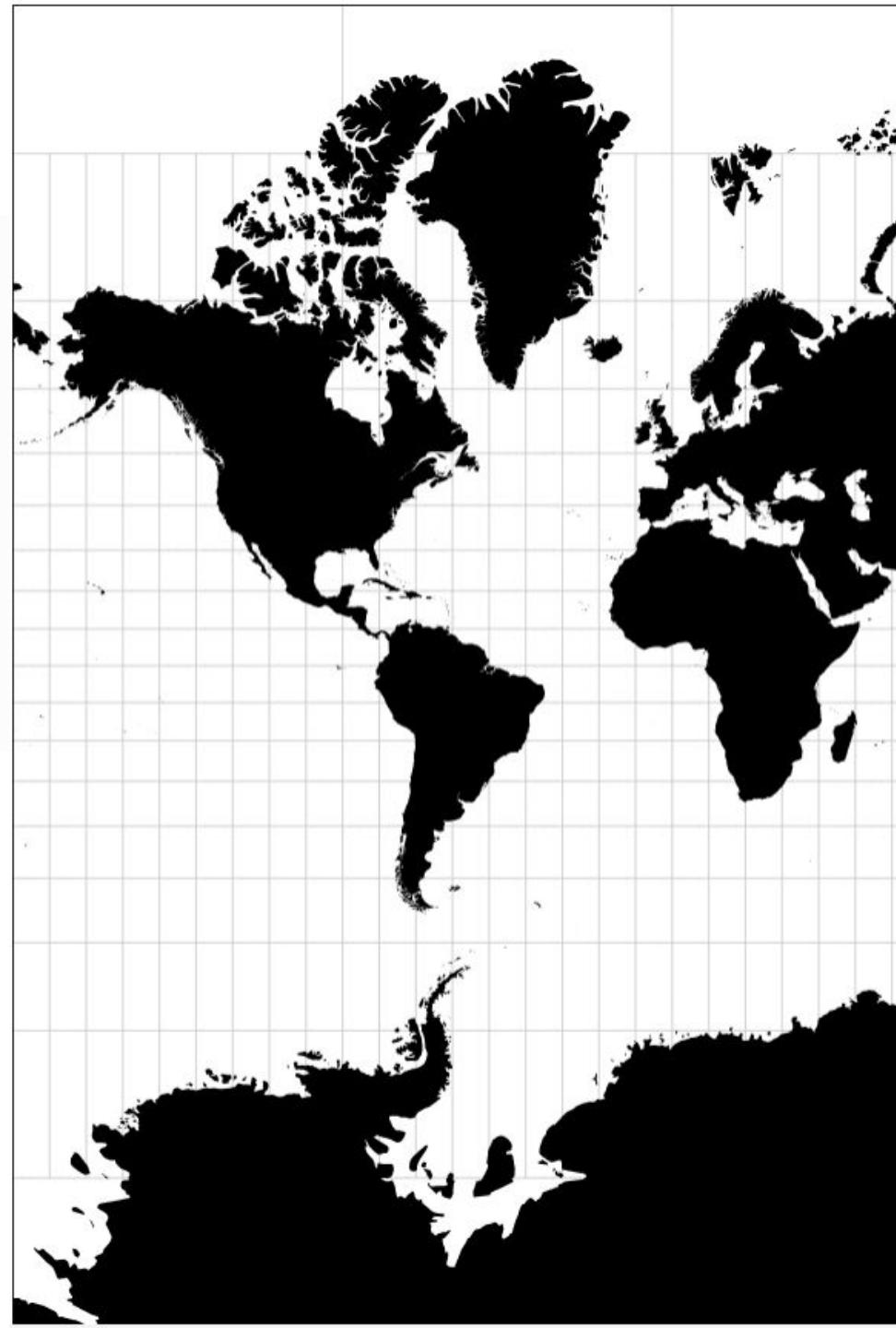
Actual



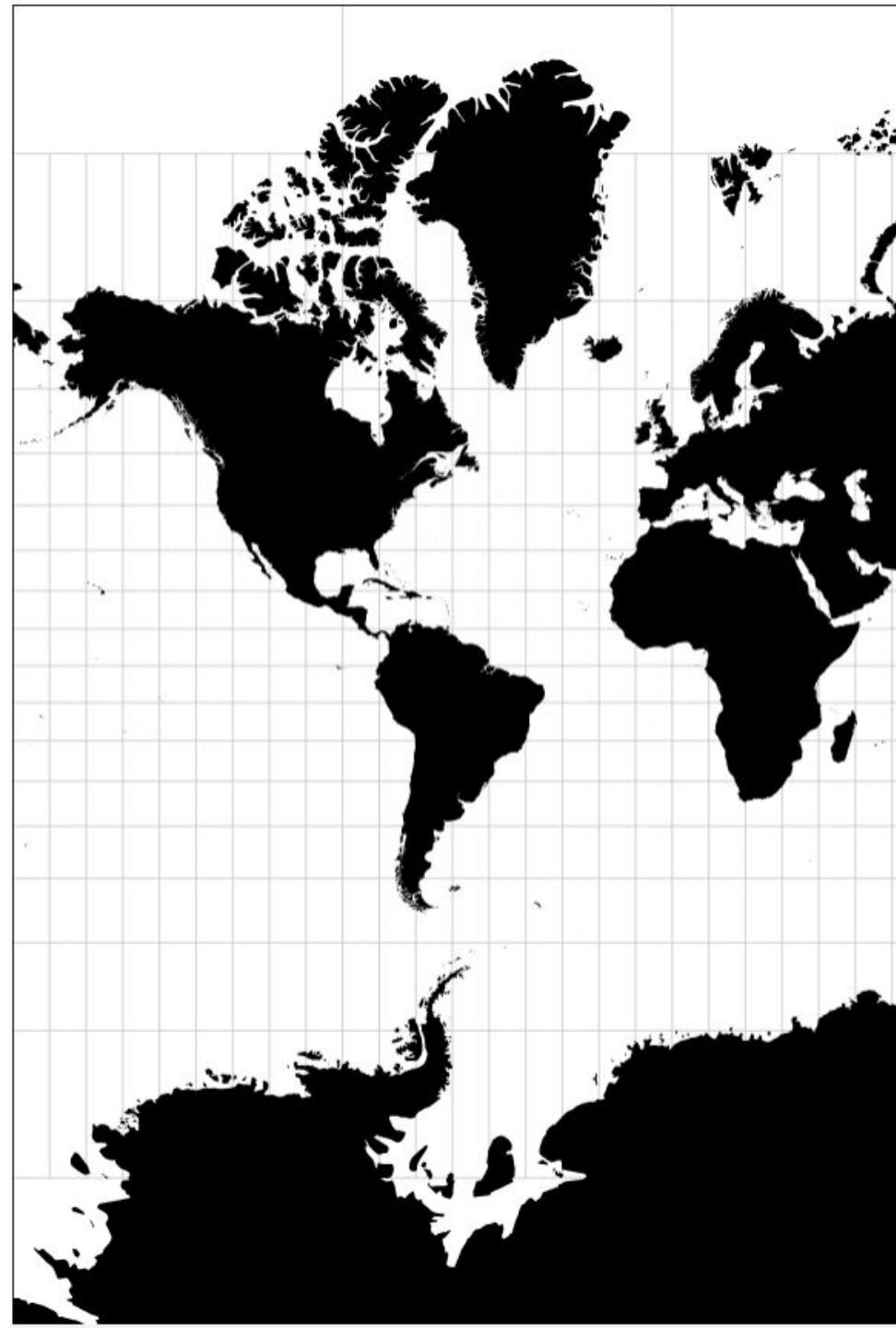
United States



Europe

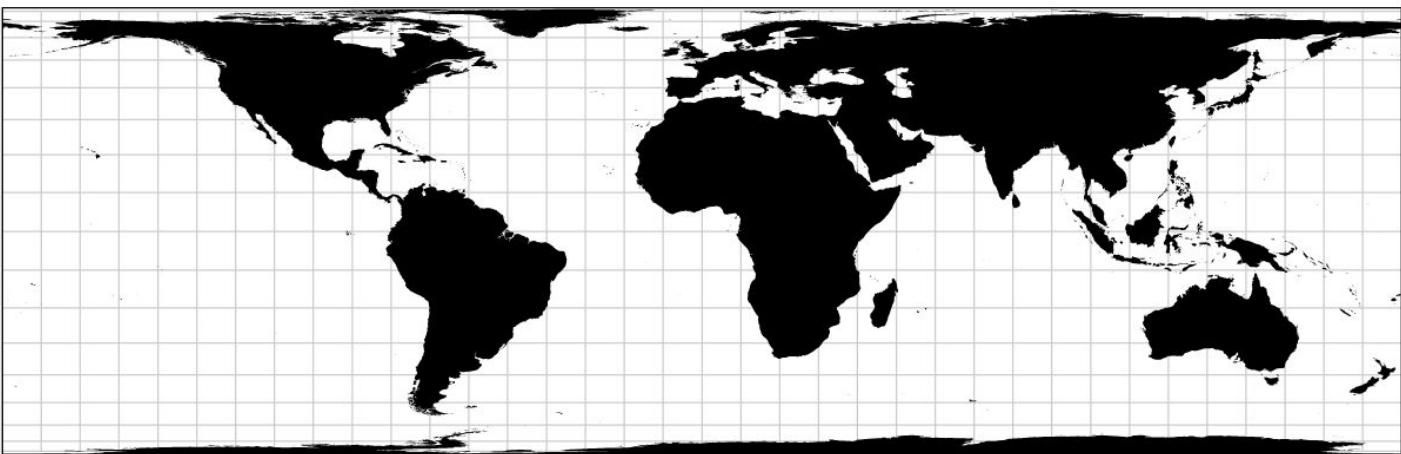


Merkator Projection

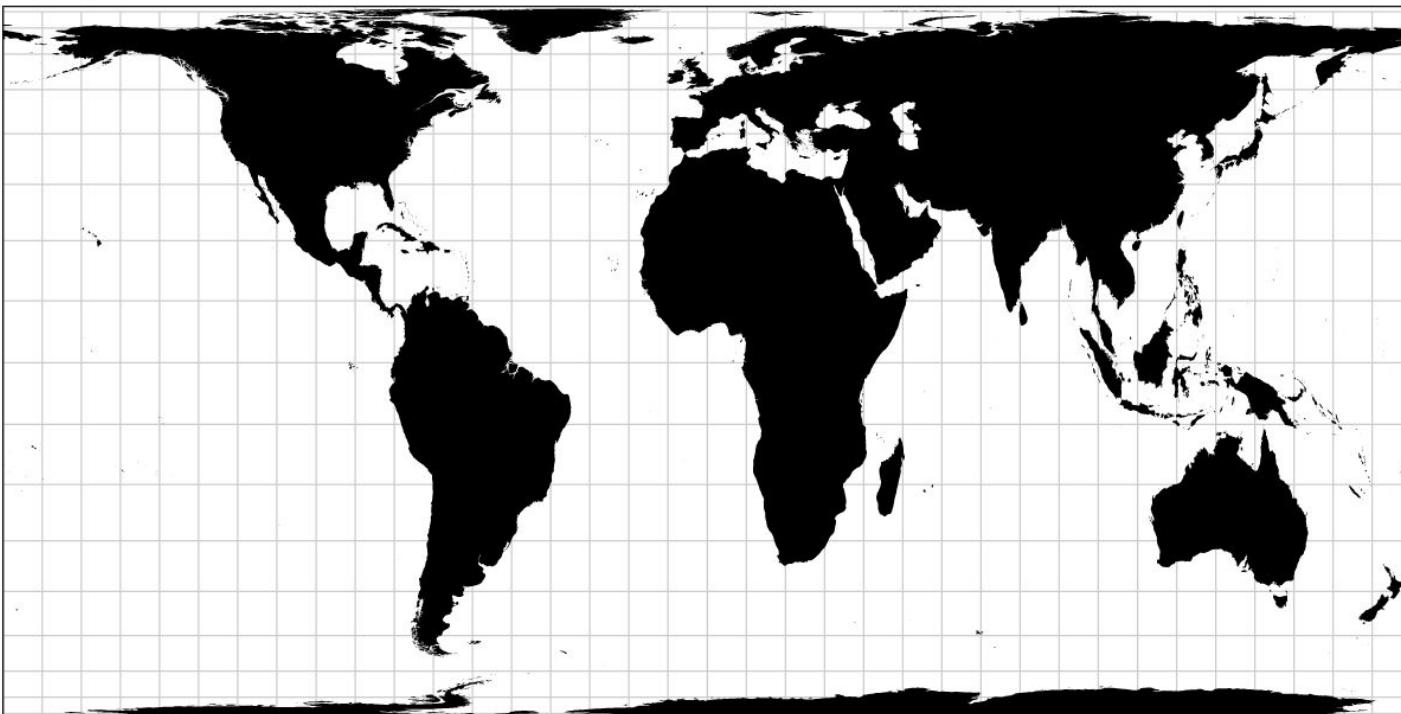


Area preserving projections

Lambert:

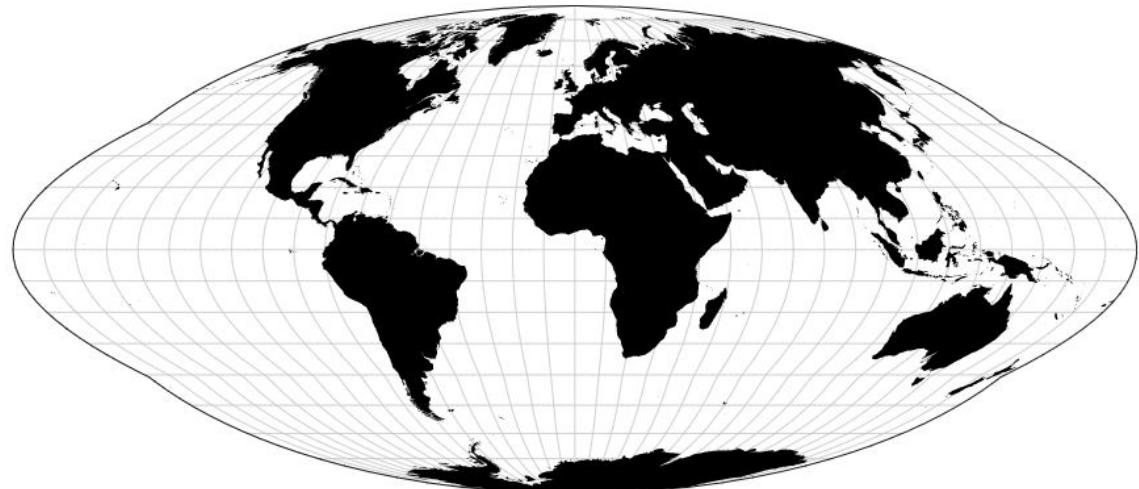


Hobo-Dyer

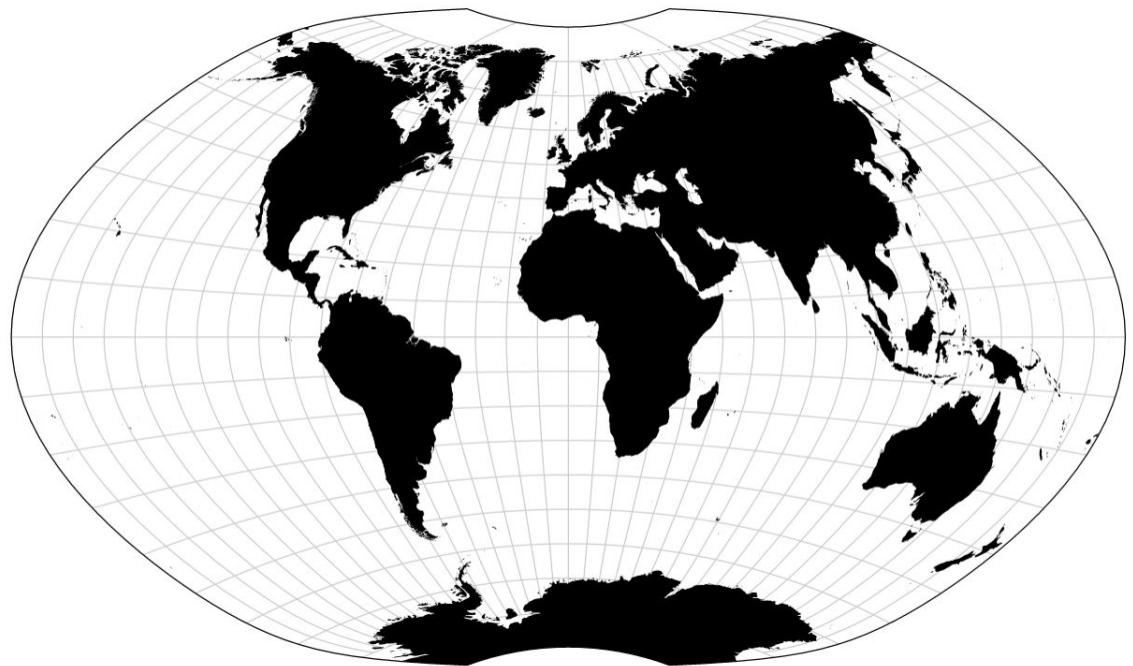


Trade-offs

Goode Homolosine

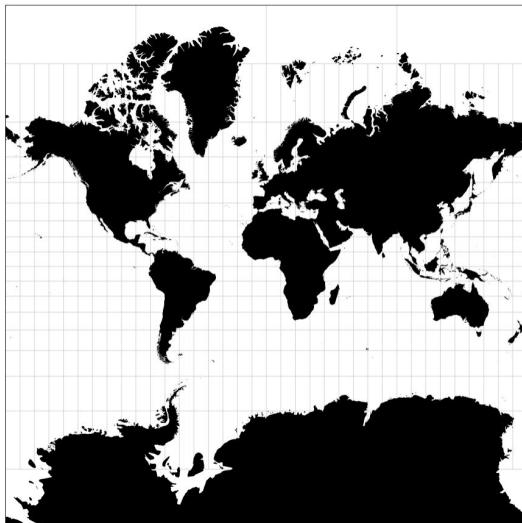


Ginzburg IV



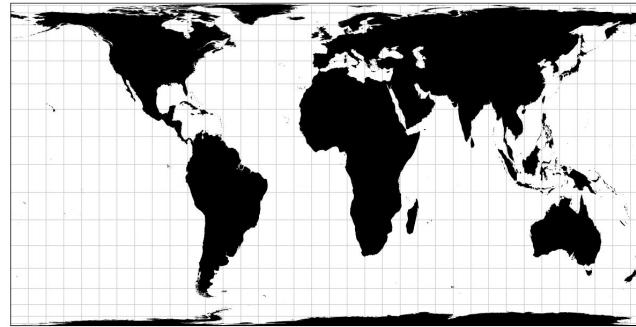
Projections

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



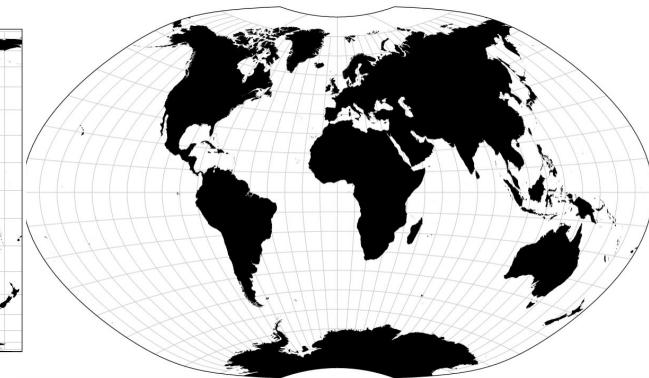
Merkator

Preserves shape



Hobo-Dyer

Preserves area



Ginzburg IV

Local projections: Conic Conformal



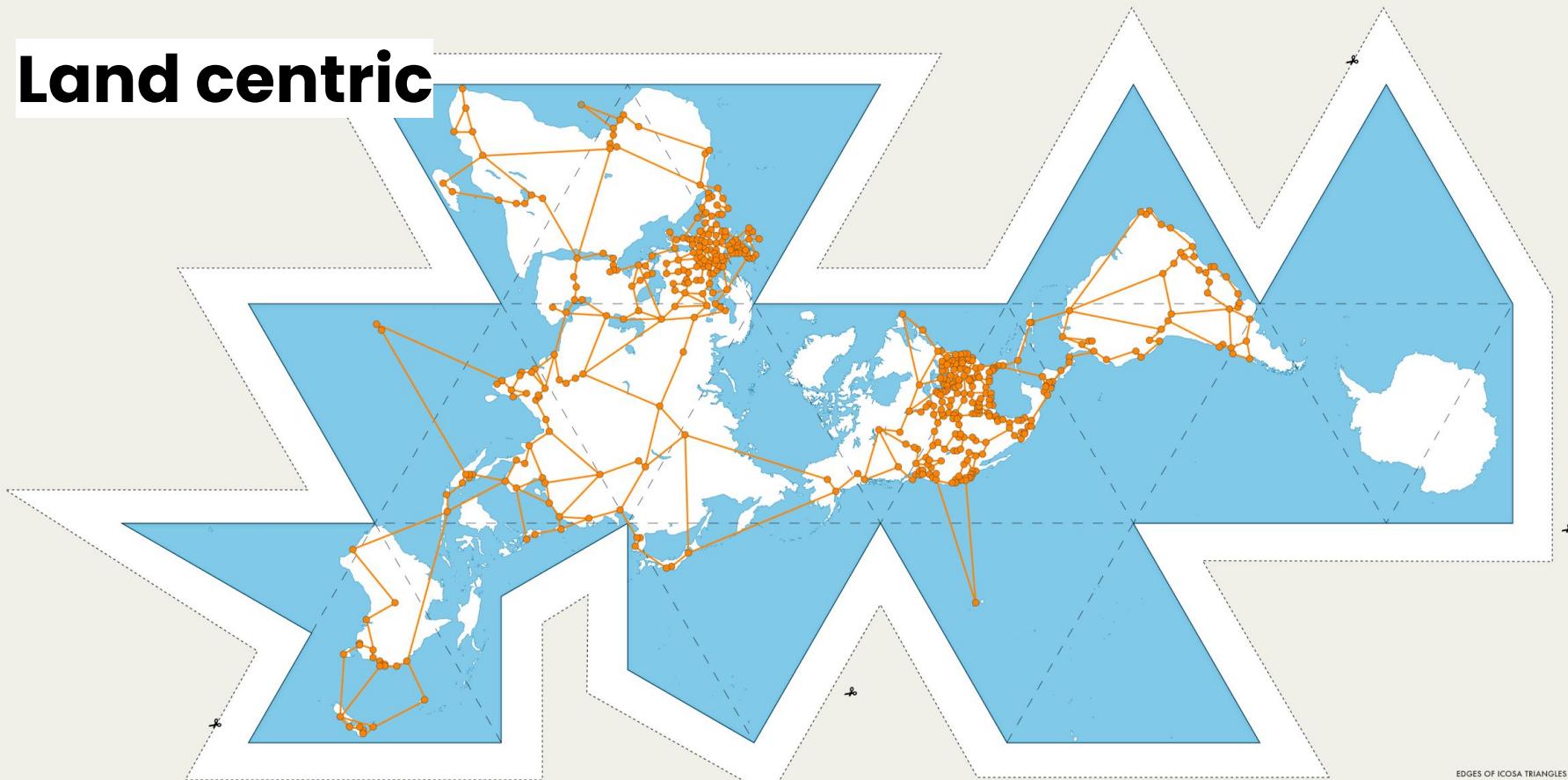
Alternative Projections: Ocean centric



THE DATA VISUALIZATION SOCIETY MAP OF GLOBAL CONNECTIVITY

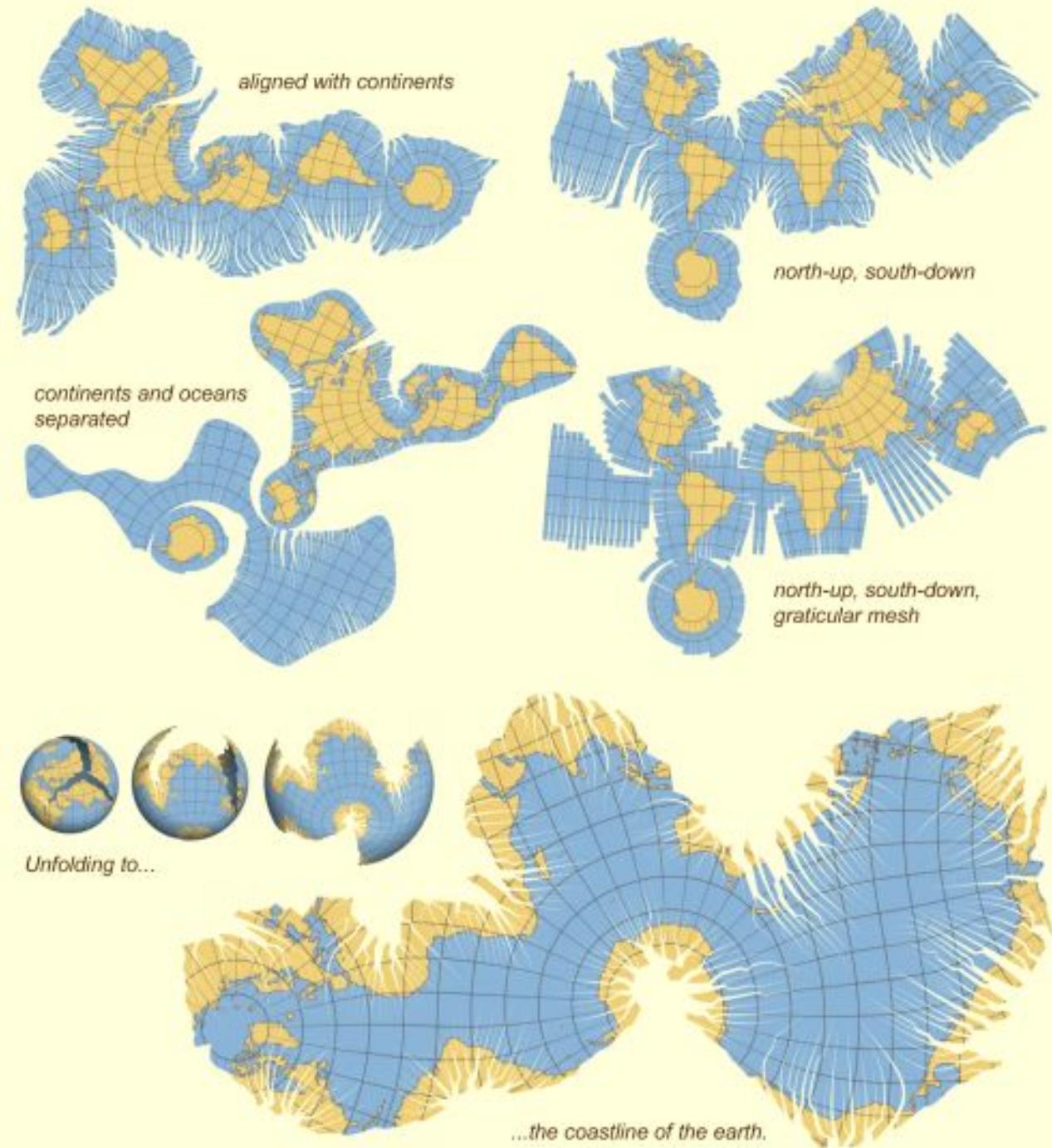
ON THE DYMAXION AIR-OCEAN WORLD MAP OF SPACESHIP EARTH

Land centric

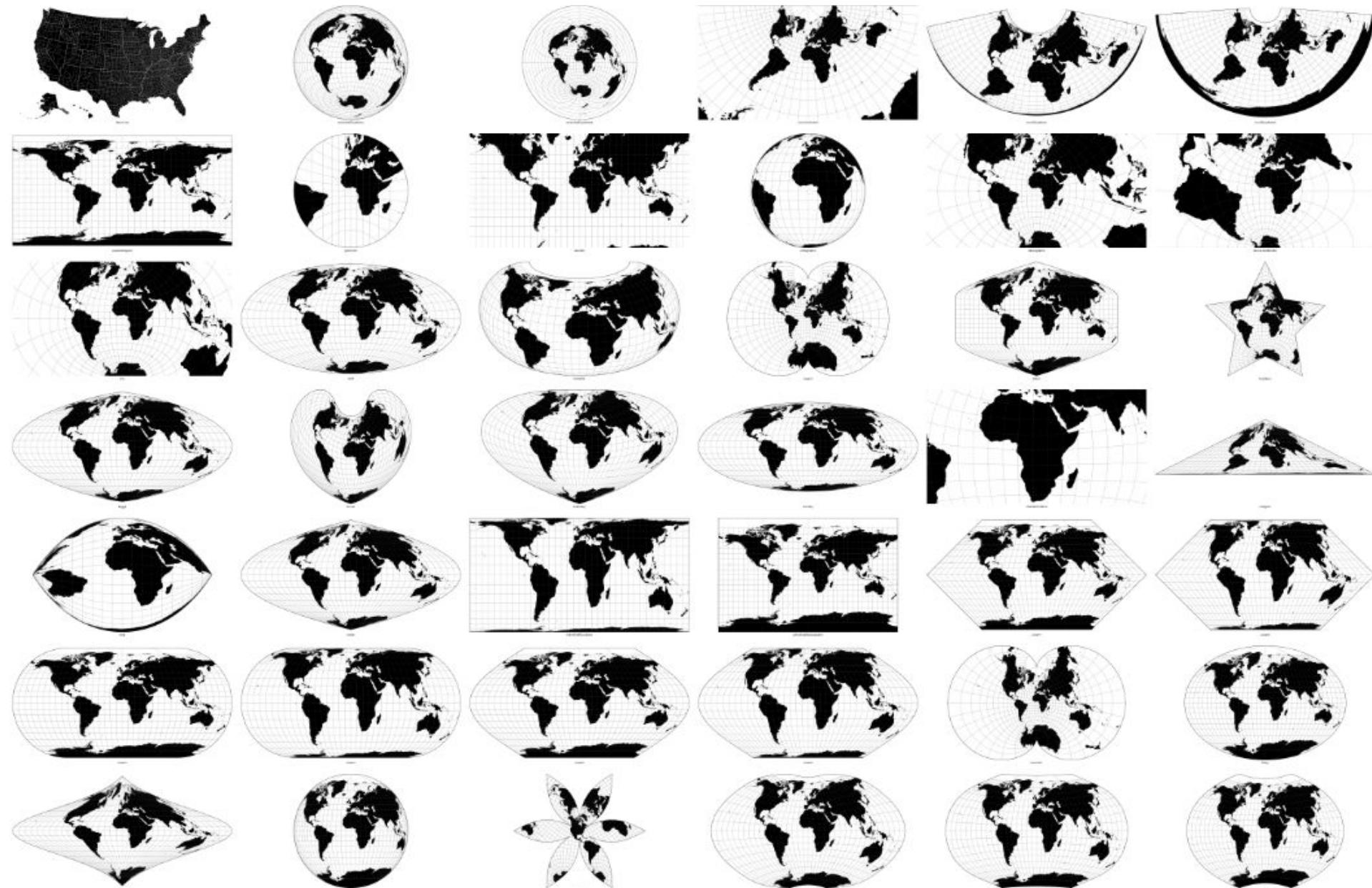


<https://medium.com/nightingale/a-little-help-from-my-friends-a-look-inside-the-data-visualization-society-map-of-global-ab5547149fe9>

More projections



More projections...





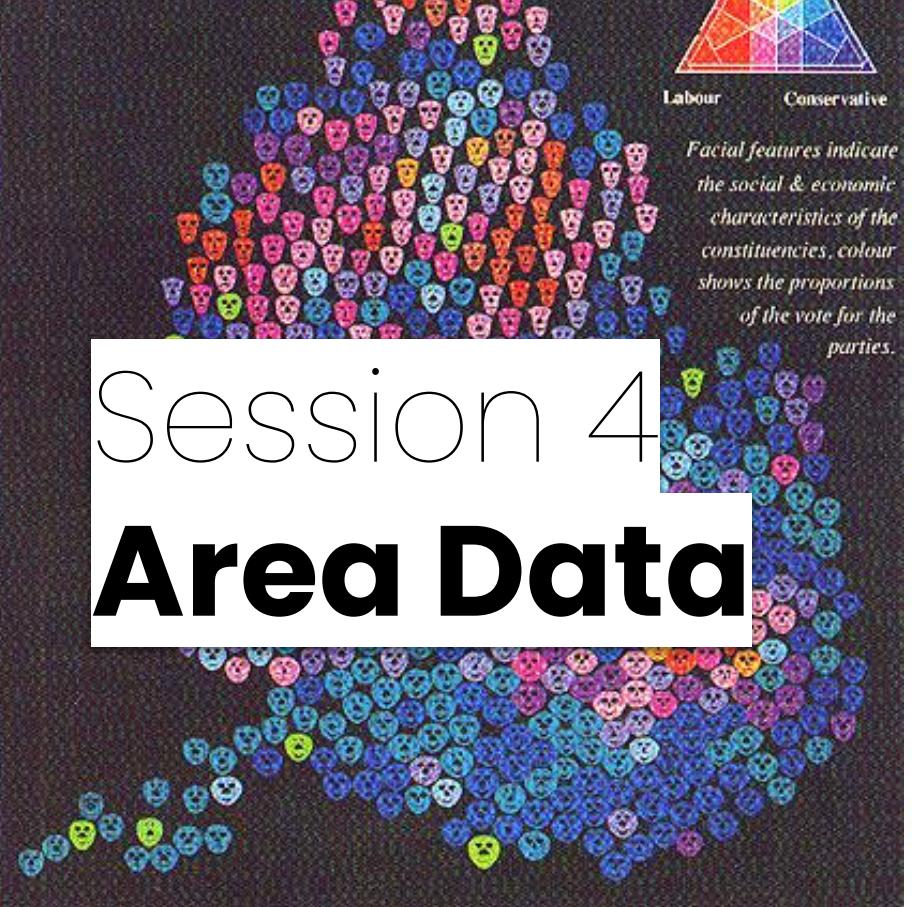
Van der Grinten II



Pause

Copyright © [Jason Davies](#). Based on Mike's [Projection Transitions](#).

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



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Area Data



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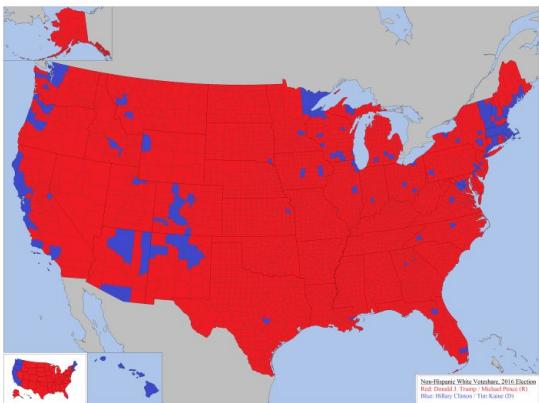
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Most intuitive ... most harmful



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

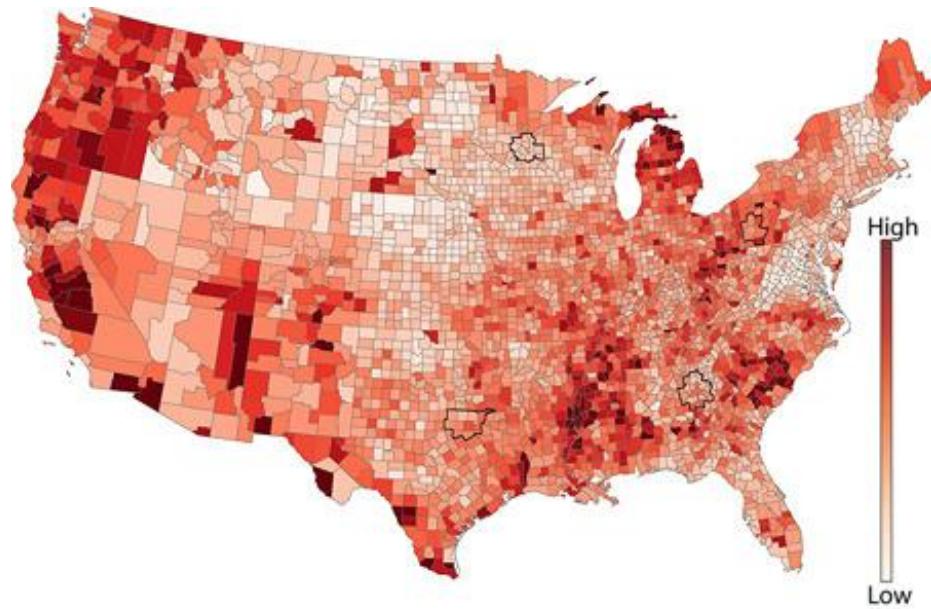
Choropleth maps

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

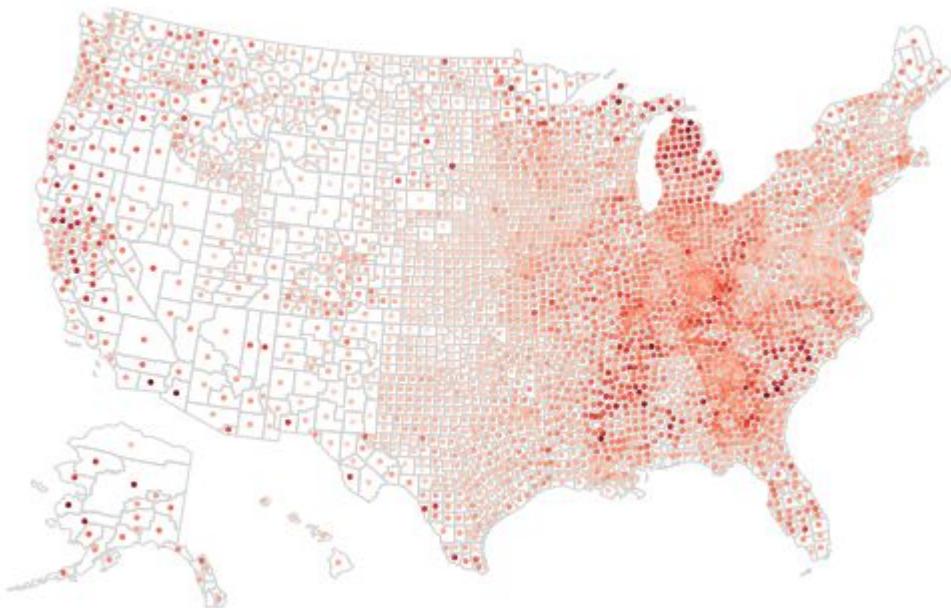
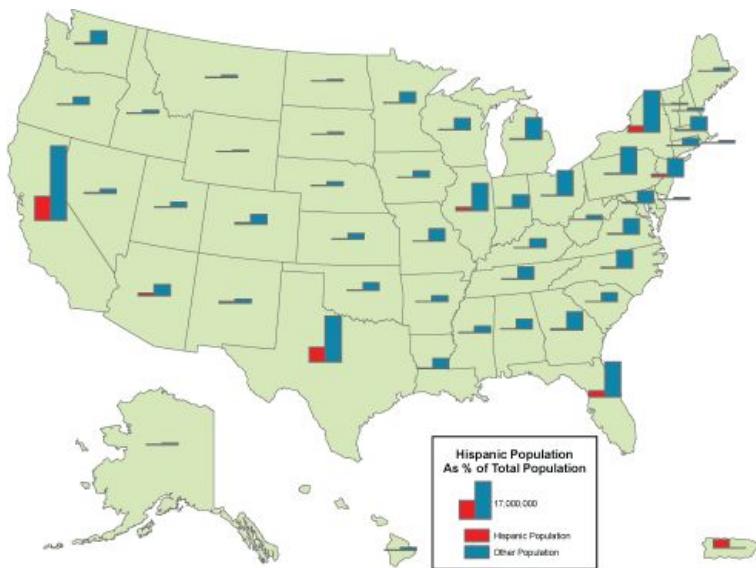
Choropleth alternatives

Dot-maps:

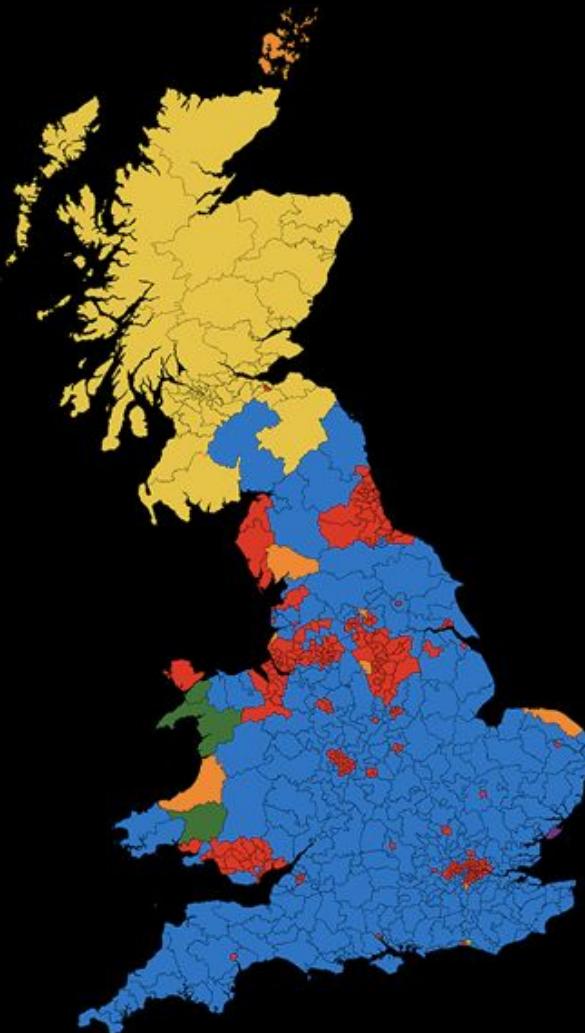
- Each area becomes dot
- Map shows area density as well as values
- values



"Bar-maps":

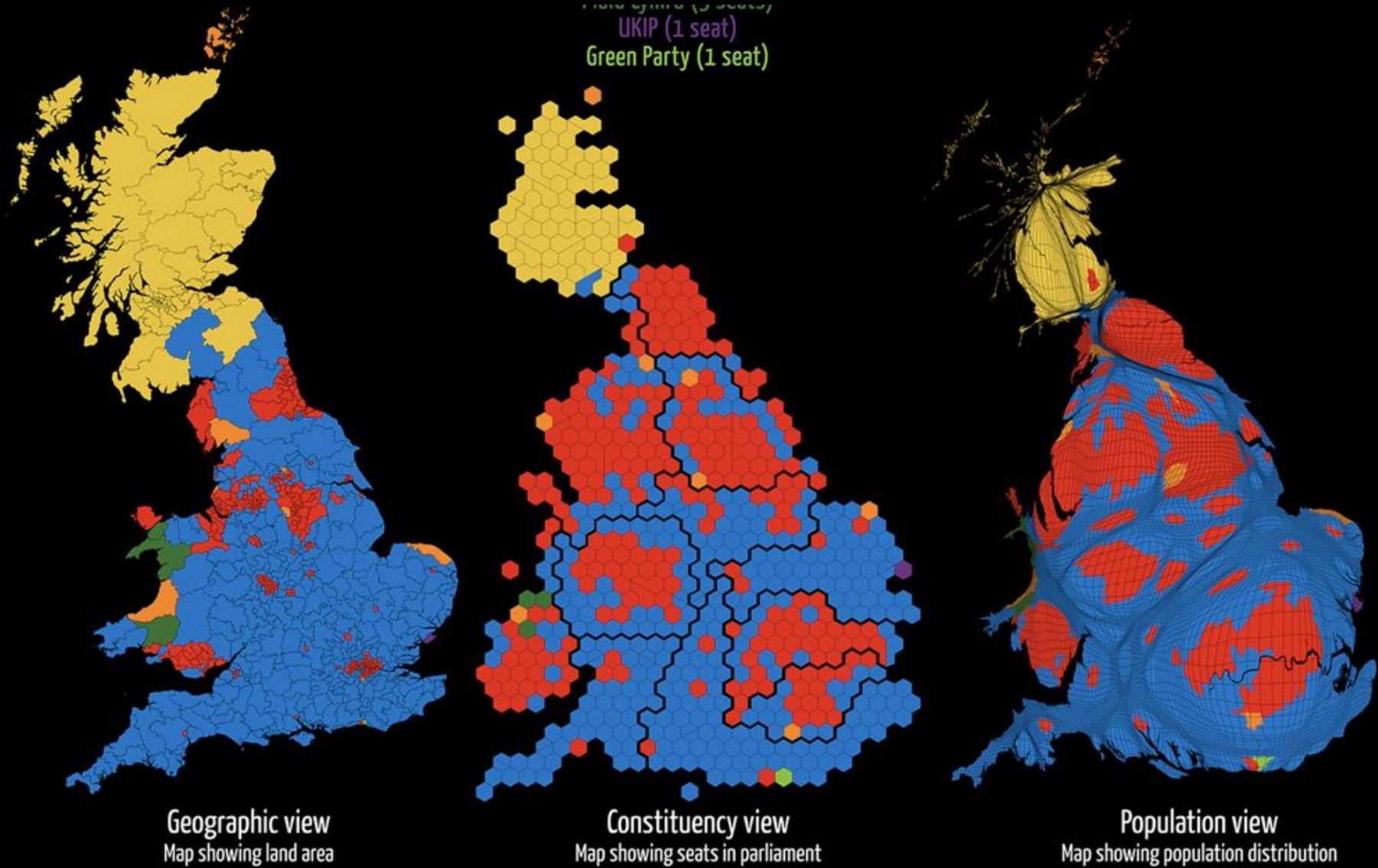


Choropleth alternatives: Distortions



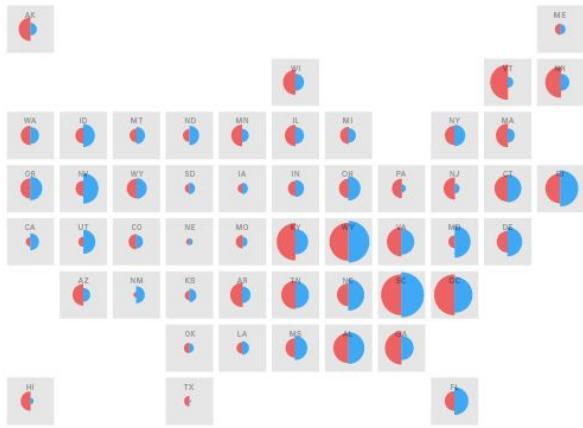
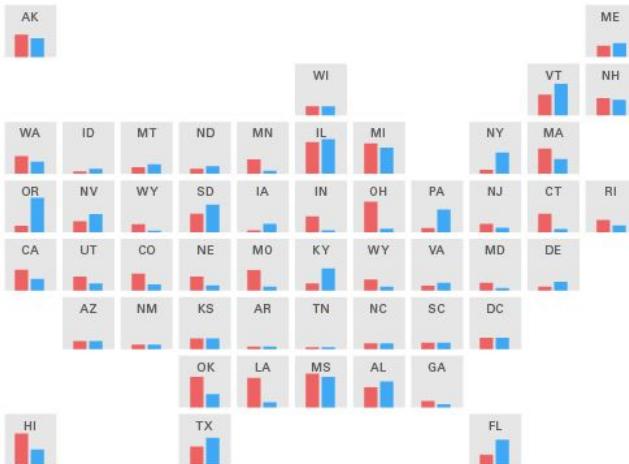
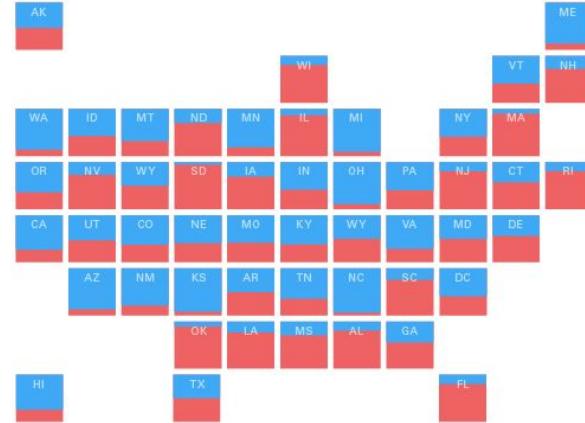
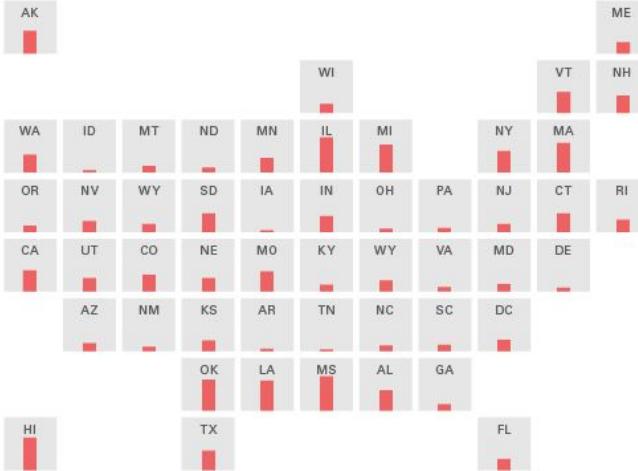
Geographic view
Map showing land area

Choropleth alternatives: Distortions

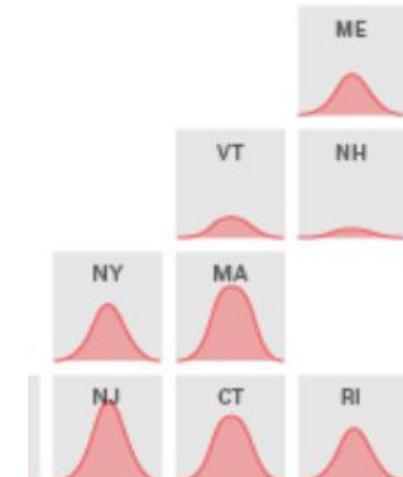
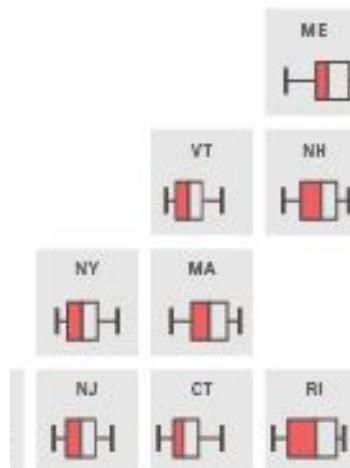
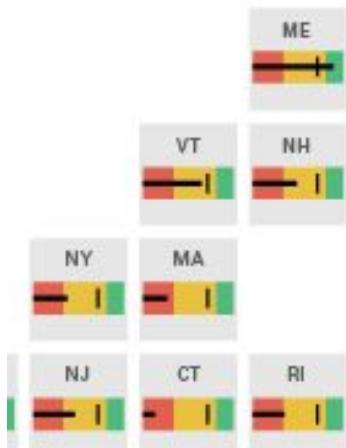
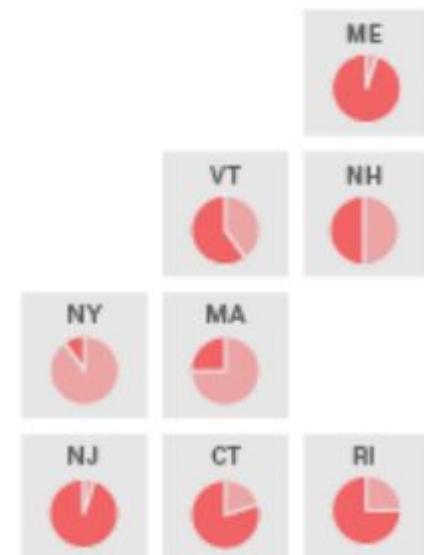
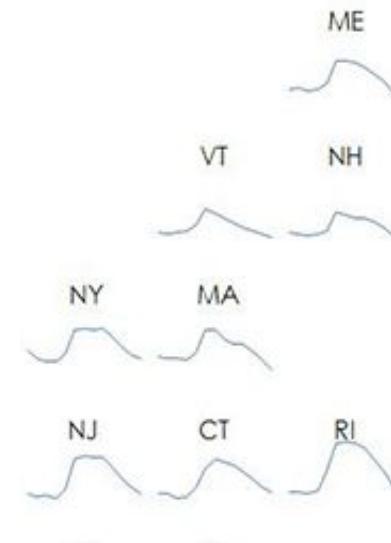
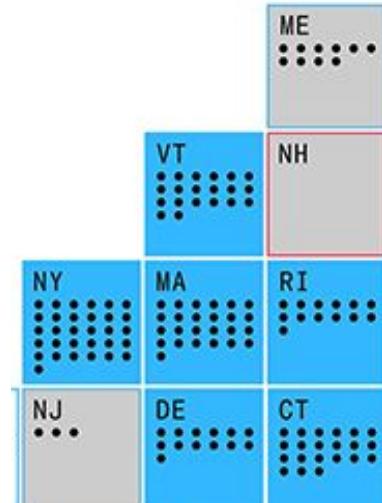
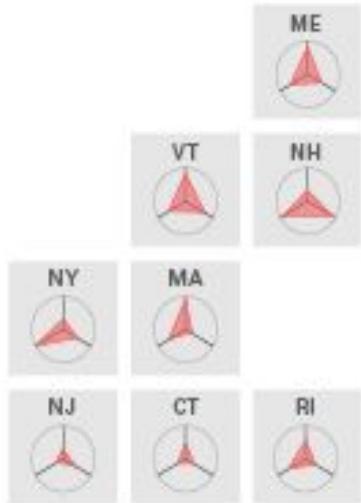


Choropleth alternatives

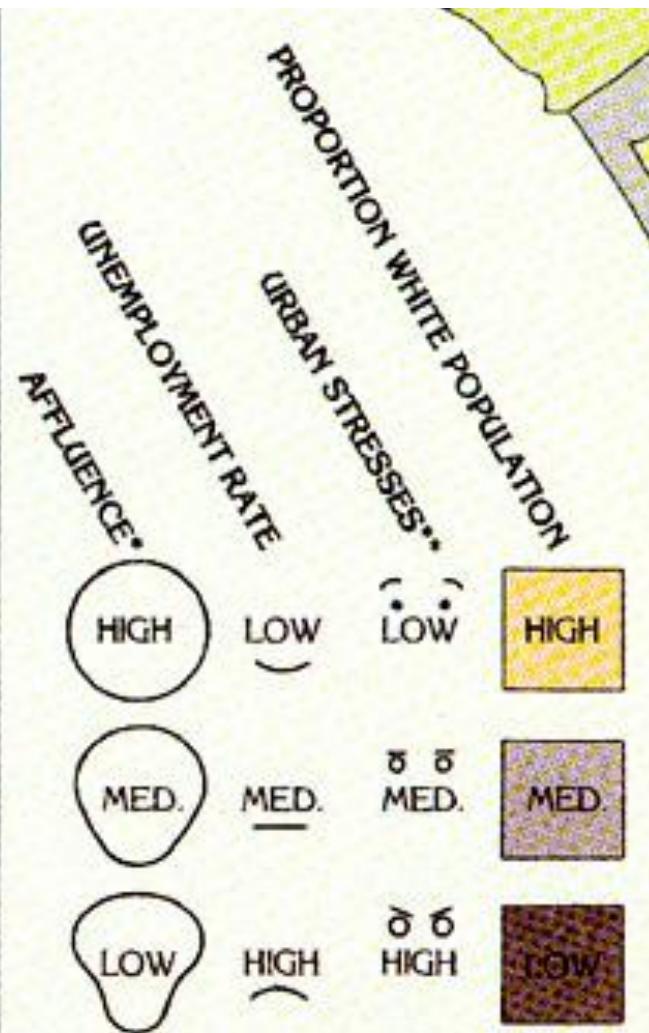
Equal Areas + Glyphs



Multivariate map data: Glyphs



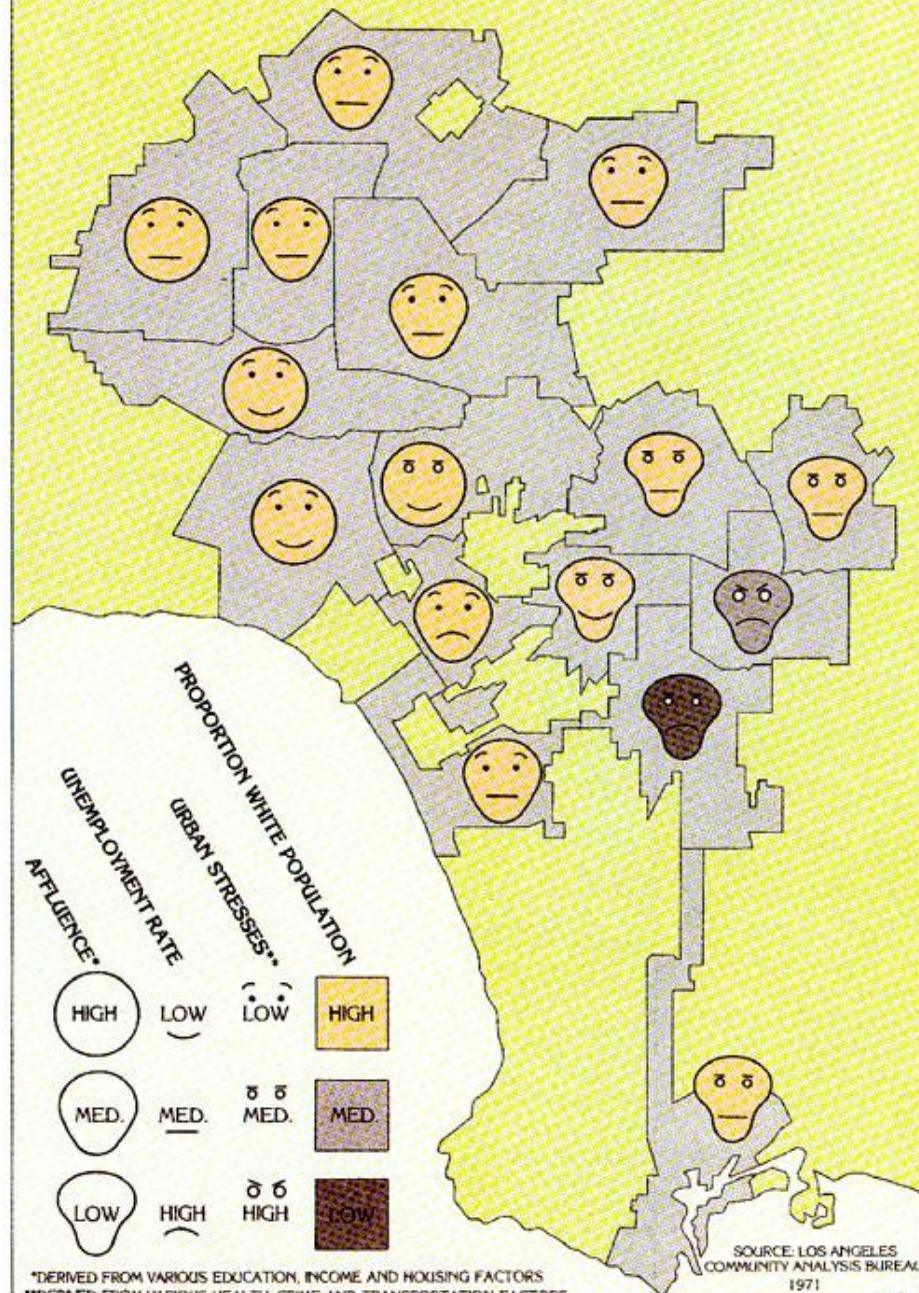
Chernoff Faces



*DERIVED FROM VARIOUS EDUCATION, INCOME AND I

**DERIVED FROM VARIOUS HEALTH, CRIME AND TRANS

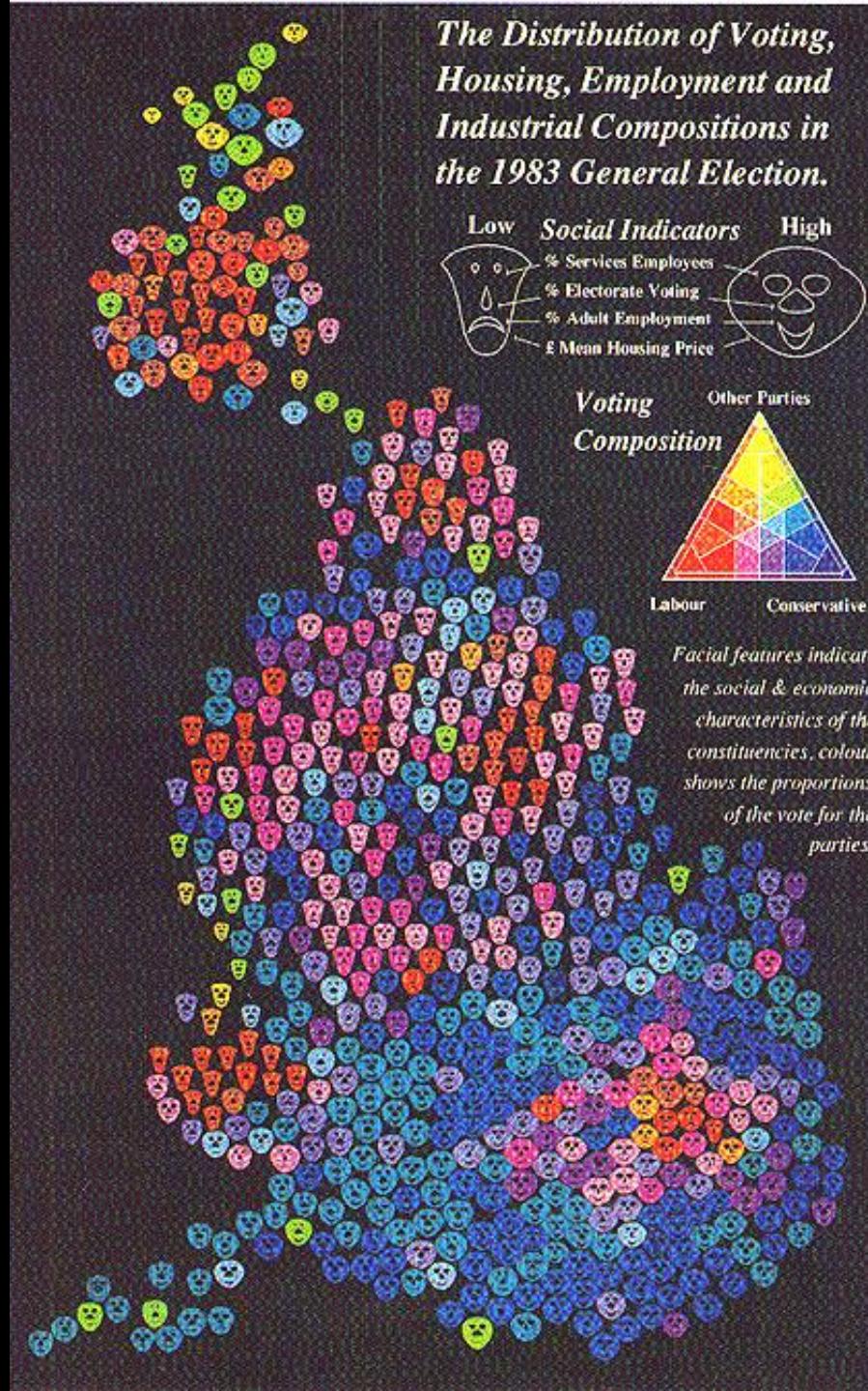
Life in Los Angeles



Chernoff Faces

- + Individual values
- + Spatial correlation

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

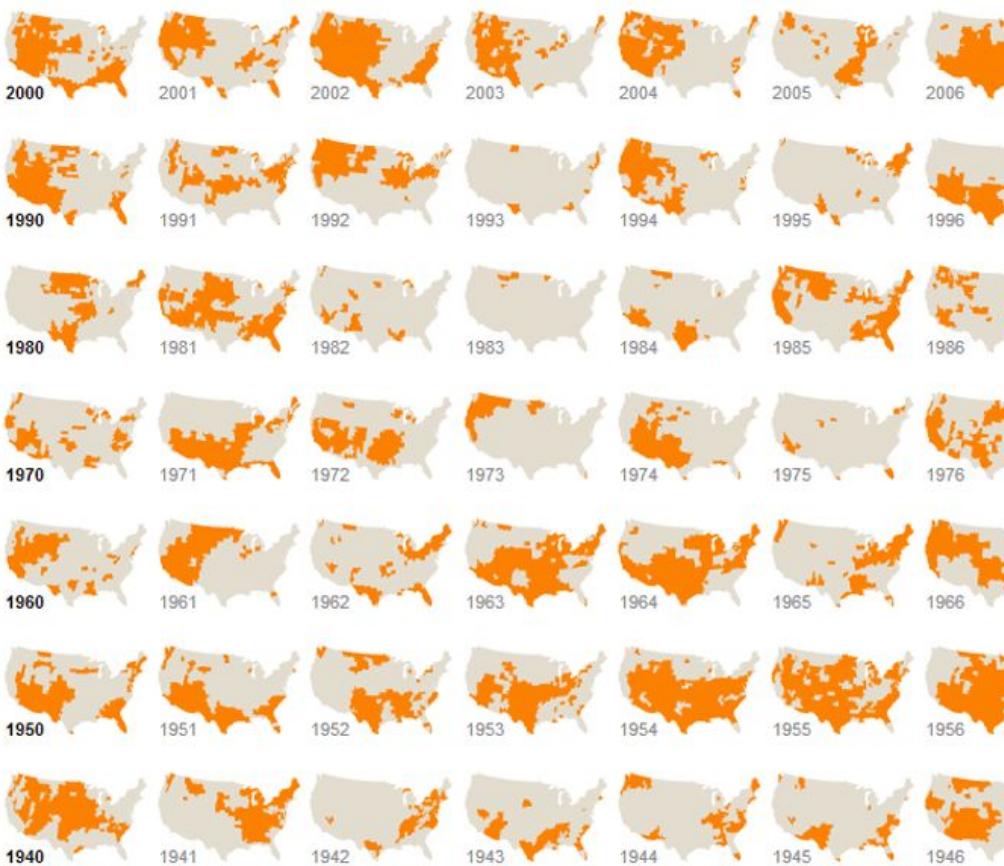
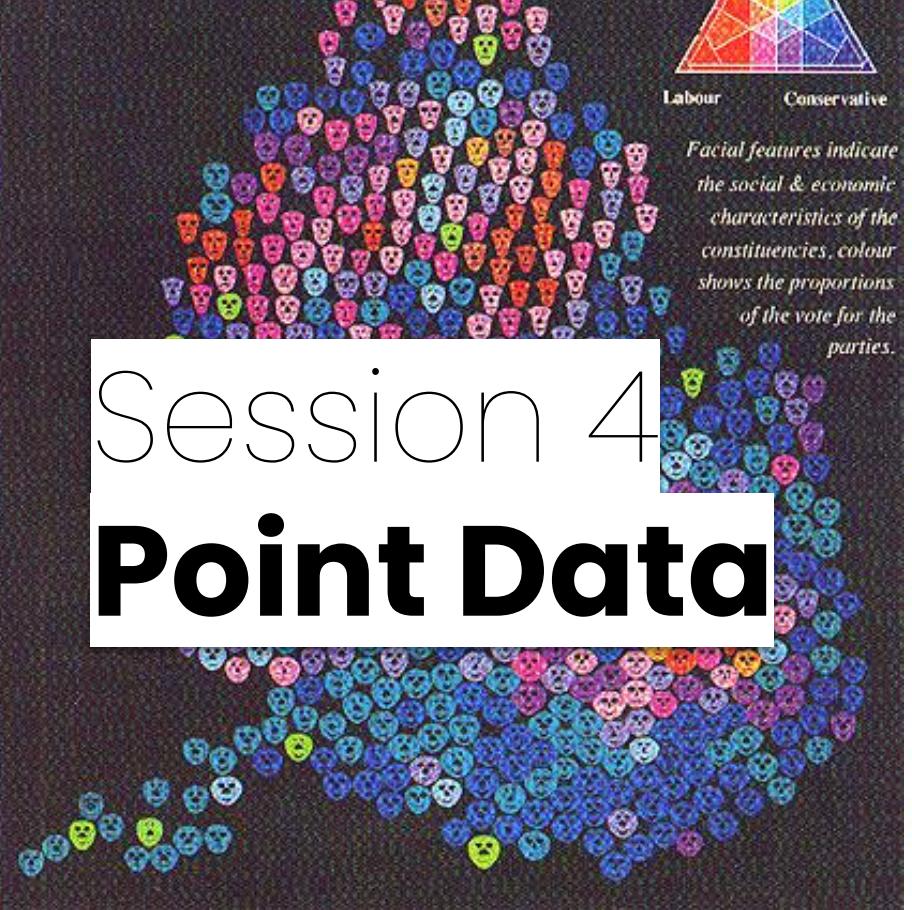


2000: State-level support (orange) or opposition (green) on school vouchers, relative to the national average of 45% support

Small Multiples



Orange and green colors correspond to states where support for vouchers was greater or less than the national average. The seven ethnicreligious categories are mutually exclusive. "Evangelicals" includes Mormons as well as born-again Protestants. Where a category represents less than 1% of the voters of a state, the state is left blank.



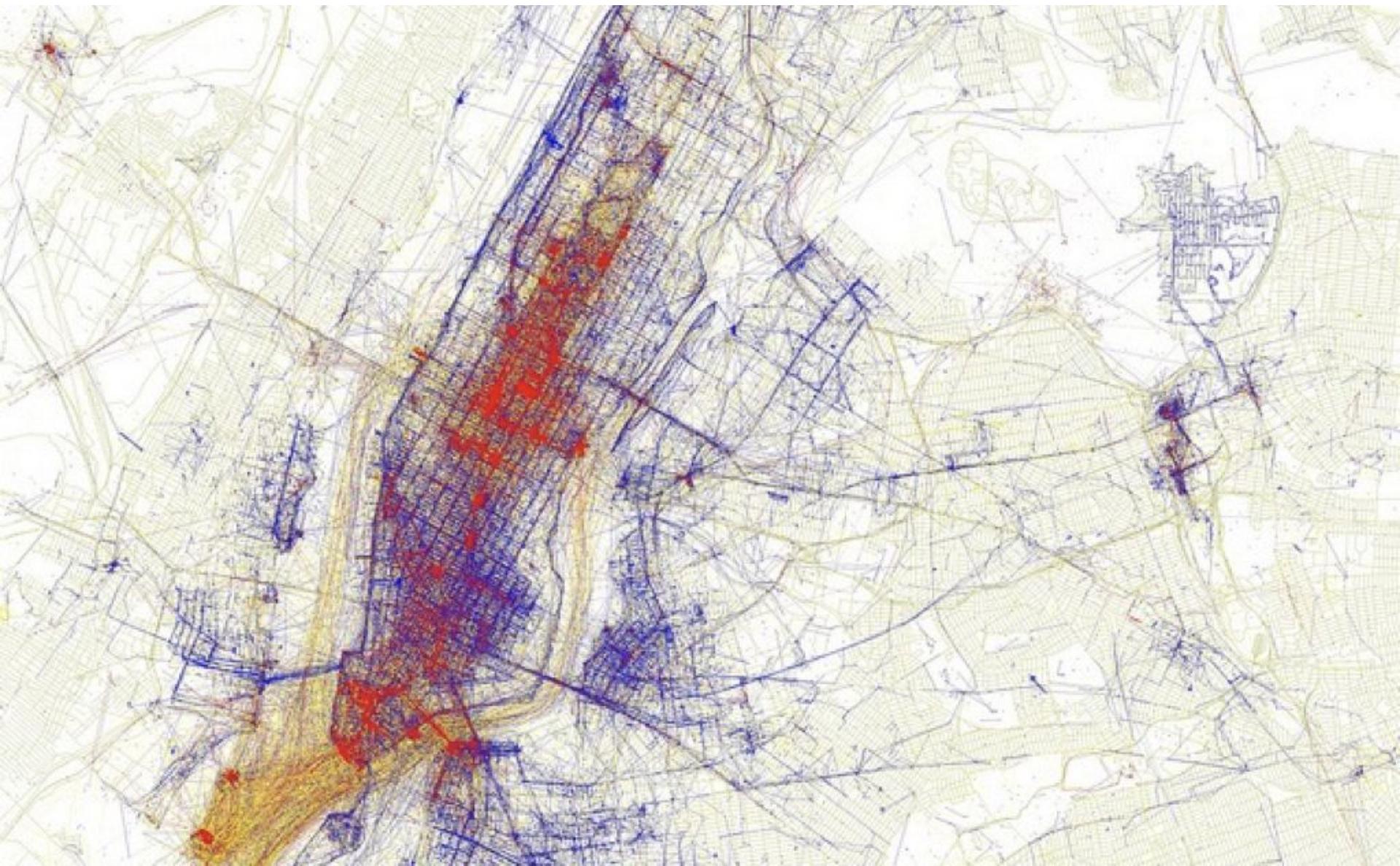
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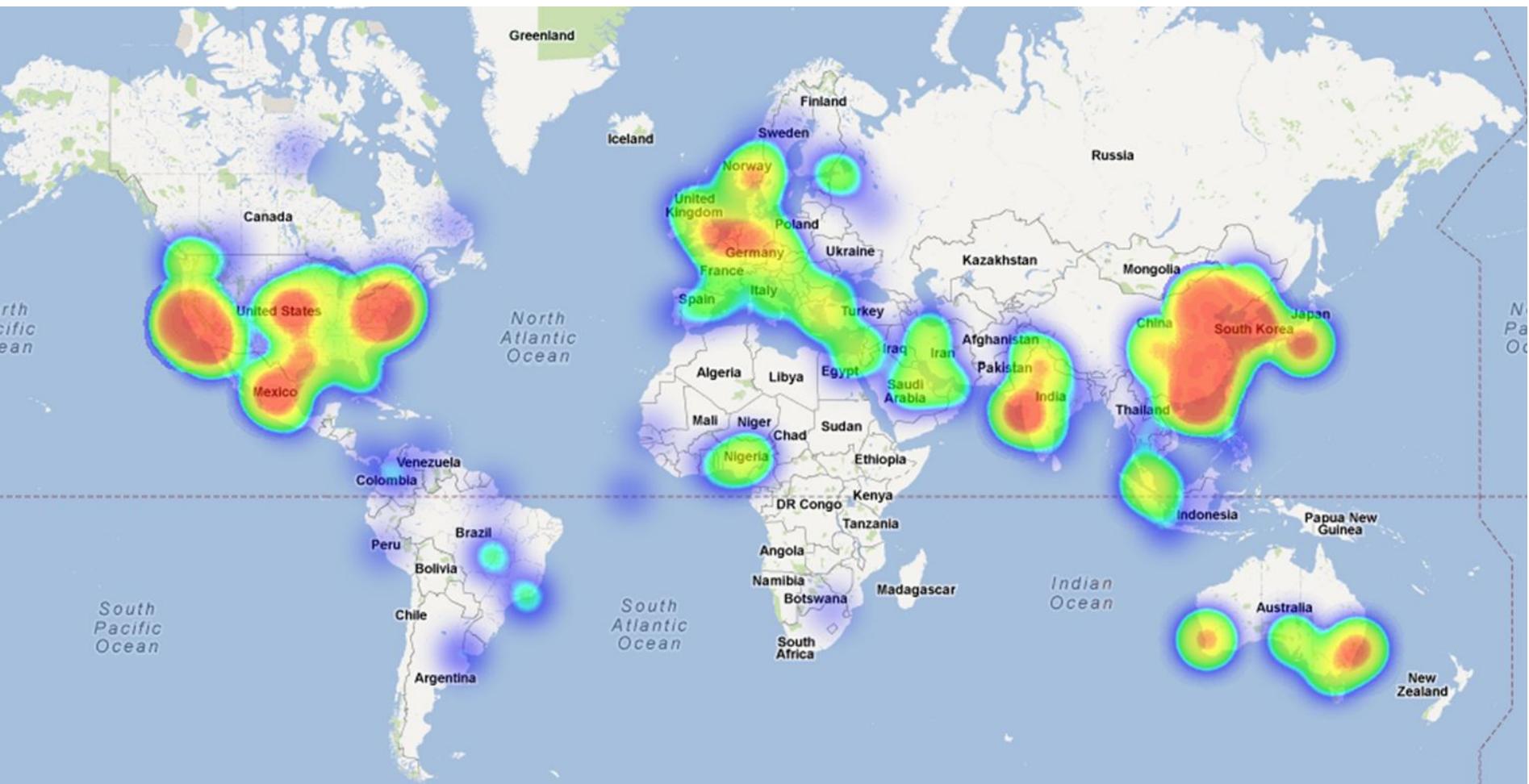
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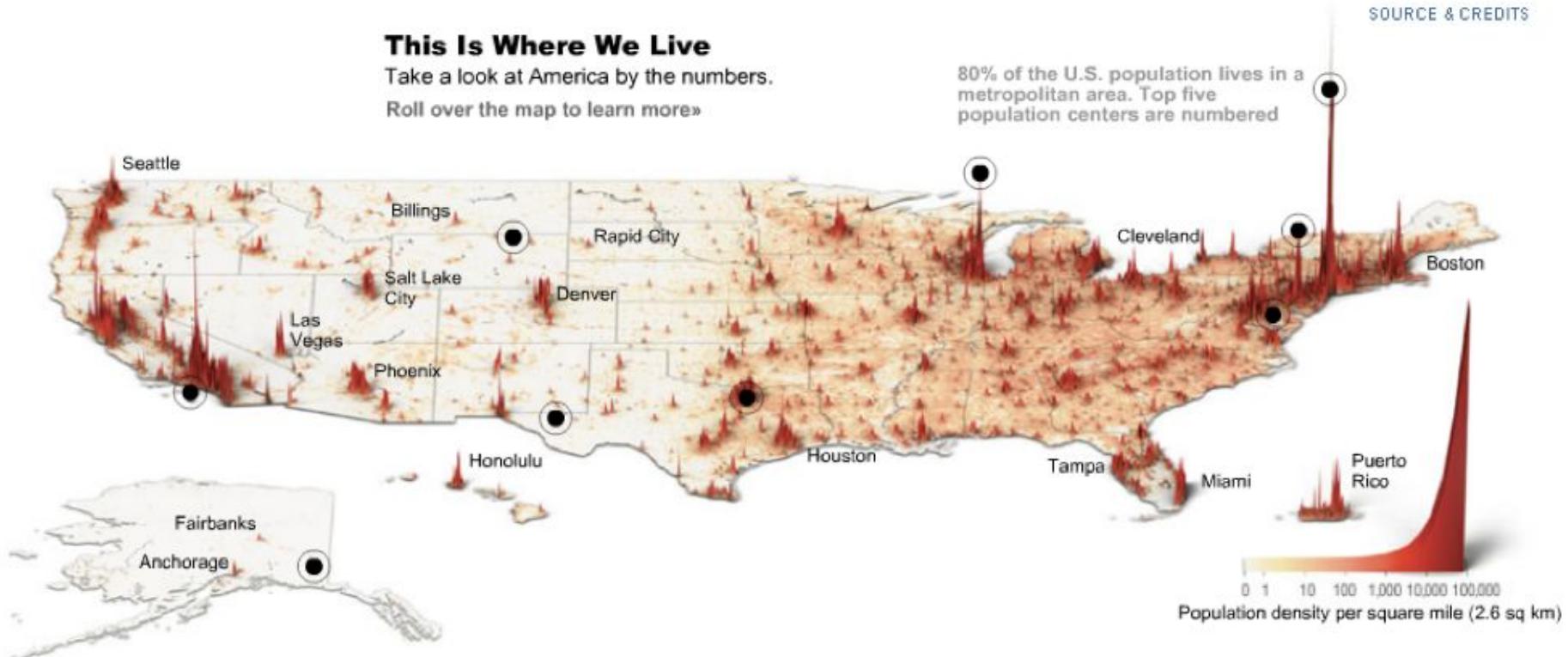
Point map



Heat maps

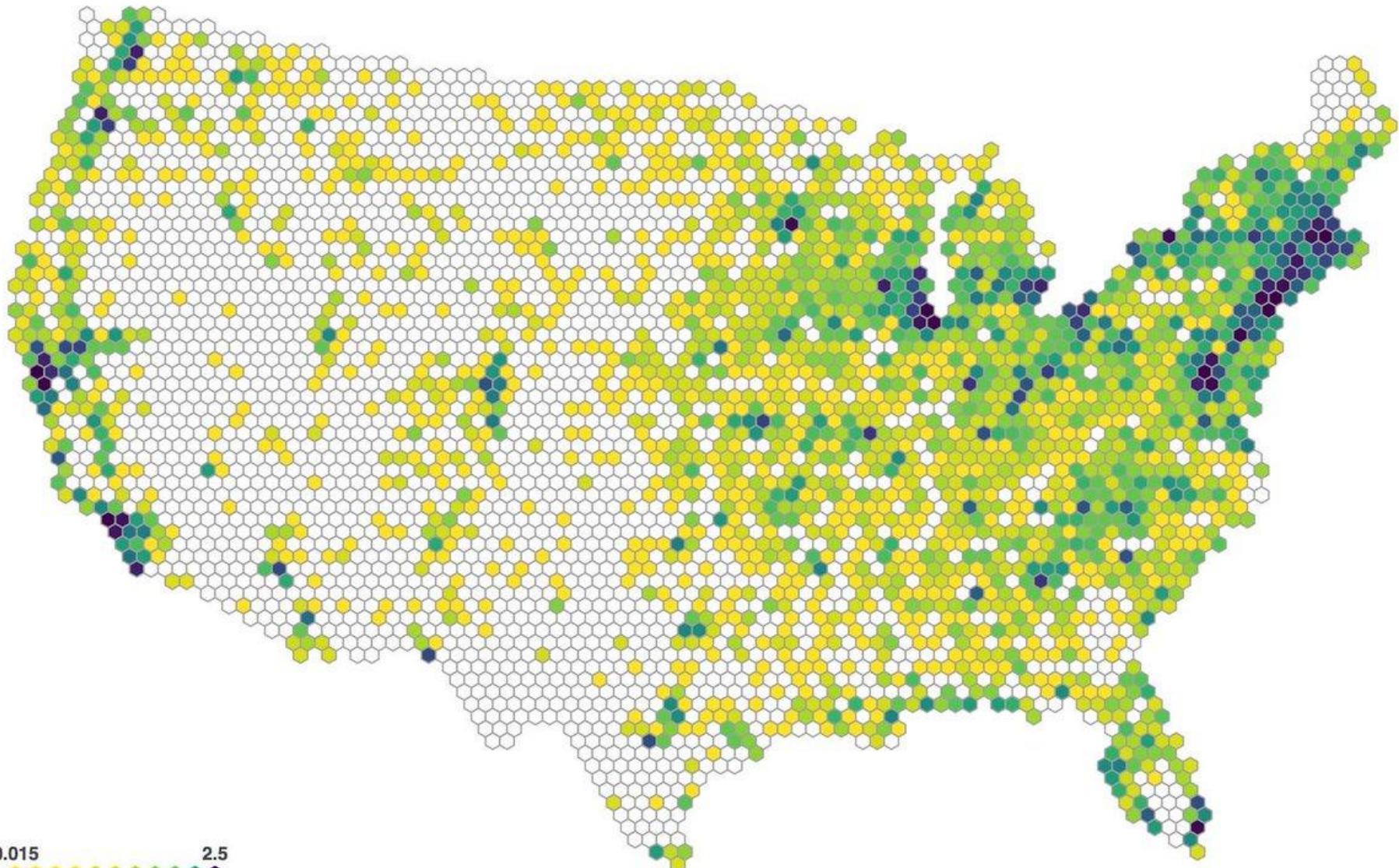


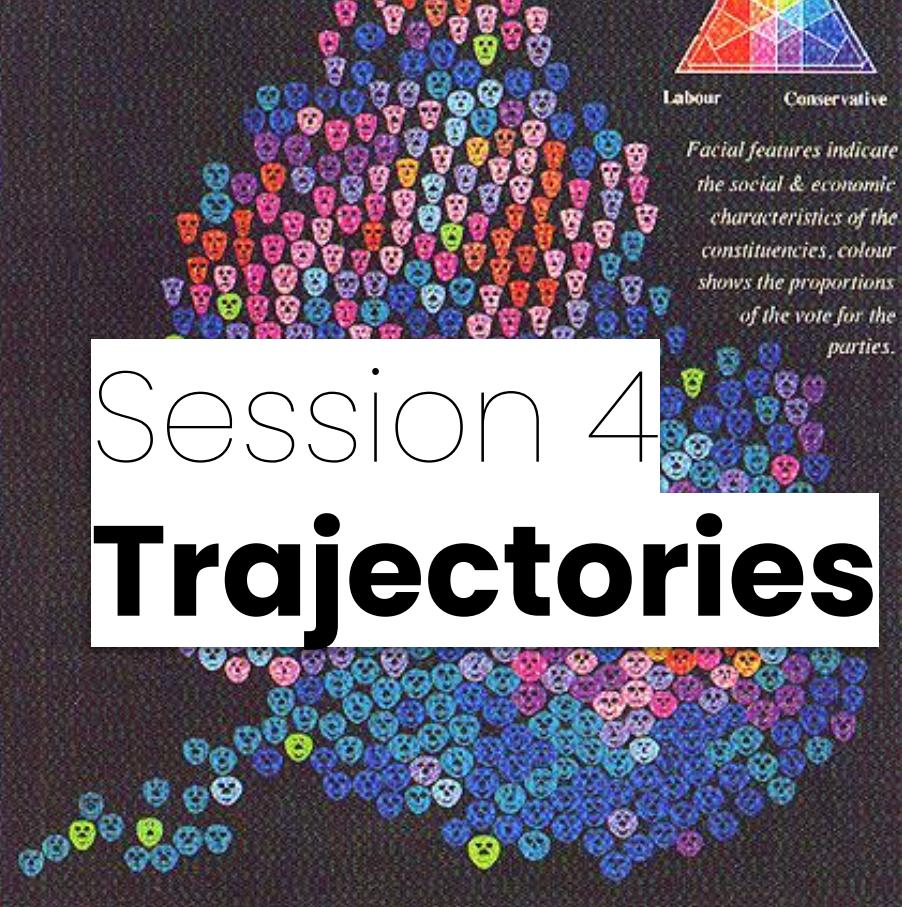
Elevation map



- + Can show huge differences in values
- + Allows for comparison
- Geographic distortion
- Possible occlusion

Binning





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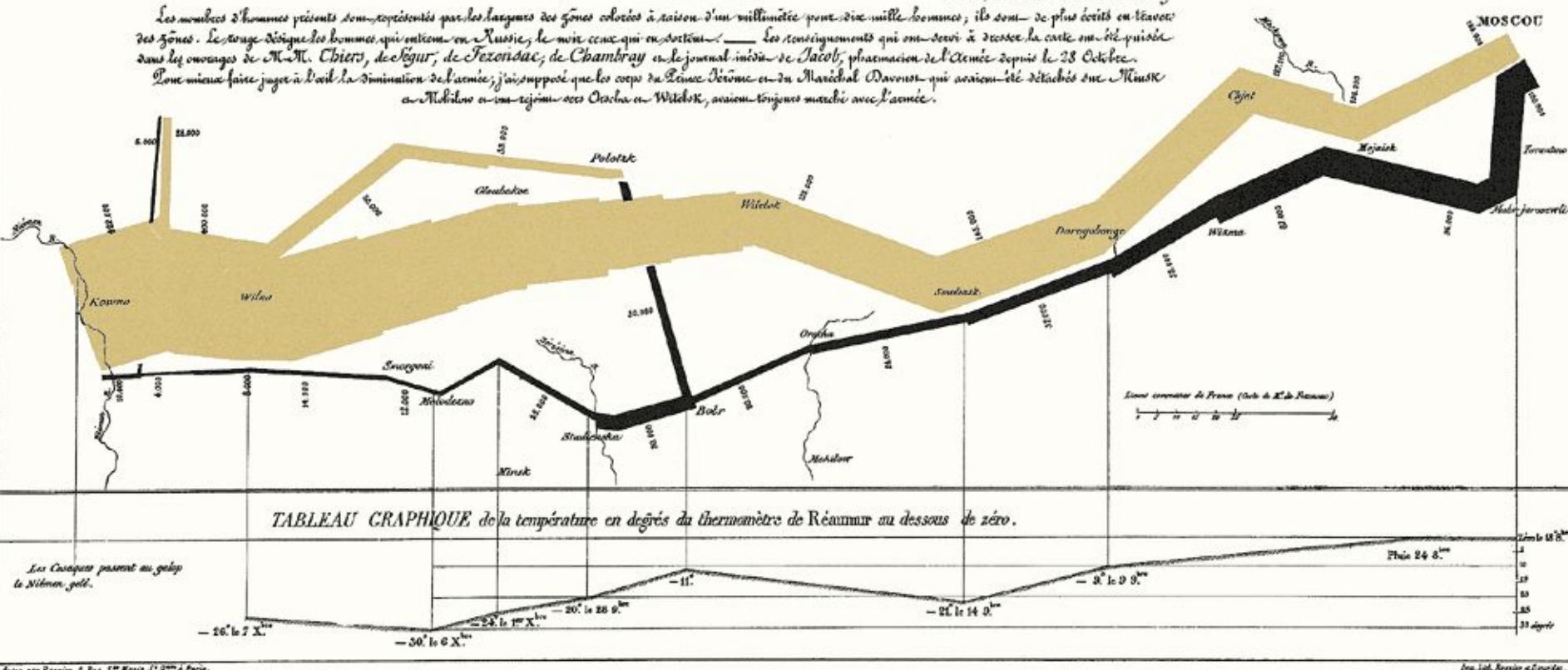
Carte Figurative des pertes successives en hommes de l'Armée Française dans la Campagne de Russie 1812-1813.

Demande à M. Minard, Inspecteur Général des Ponts et Chaussées en rédaction.

Paris, le 20. November. 1869

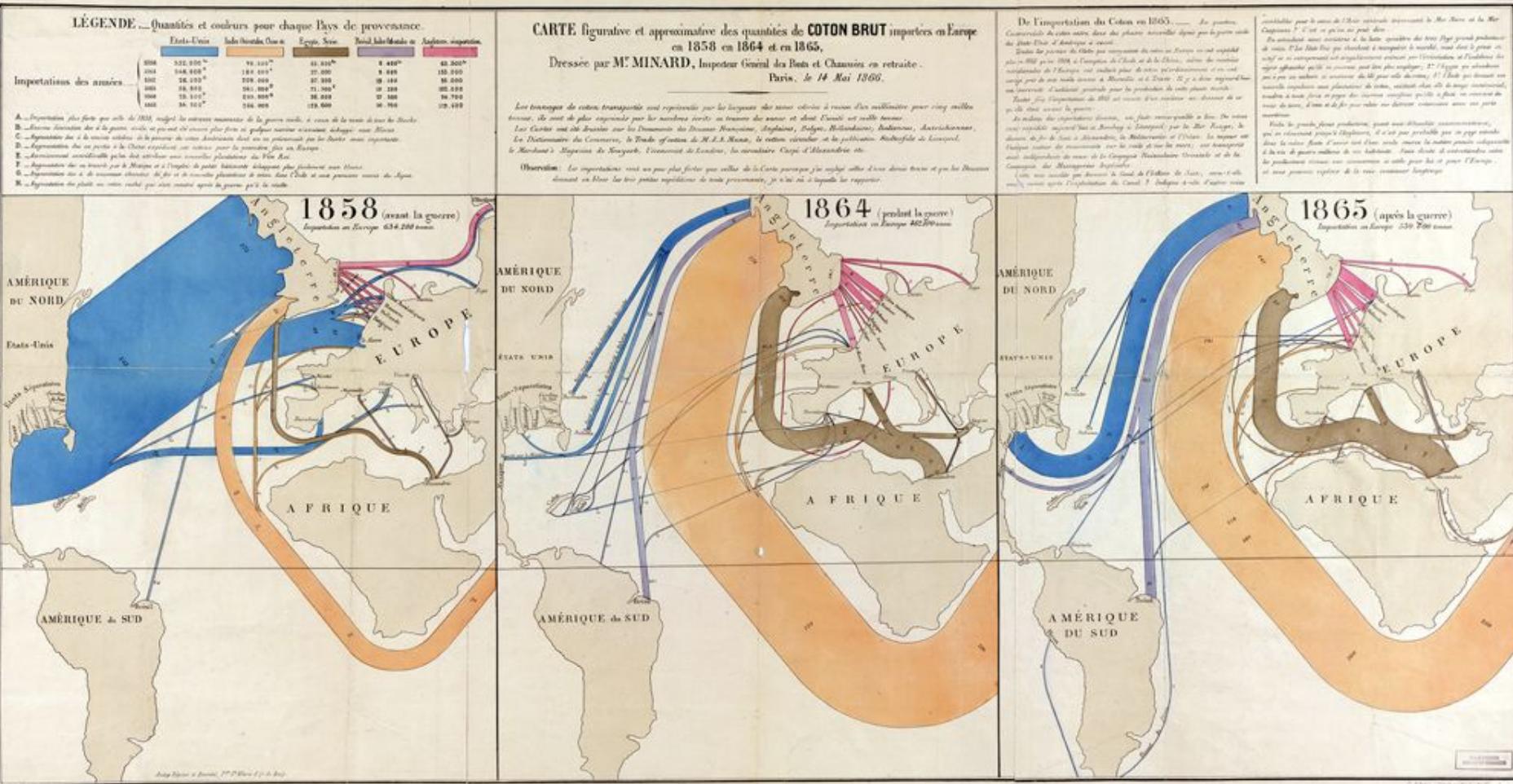
Les nombreuses plaintes sont, rappelées par les langues des zones colonisées à raison d'un milliardaire pour dix mille hommes; ils sont de plus écrits en faveur des zones. Le rouge démontre la bonté qui réigne en Russie, le noir cesse qui en sortira. — Les renseignements qui ont servi à dresser la carte sont tirés dans les ouvrages de M.-M. Chiers, de Séguir, de Férouzeau, de Chambray et le journal intitulé de Jacob, publication de l'Académie depuis le 28 Octobre.

Une autre fois, juge à l'ail la démission de l'amie; j'ai supposé que les corps de l'ame, l'ame et du Maréchal Davout, qui avaient été détachés pour l'assister au repos, étaient rentrés avec l'amie.



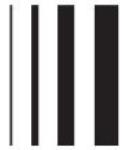
Charles Joseph Minard (1781-1870)

Flow Diagram



Encoding information

Thickness



Hue



Transparency, Saturation, Brightness



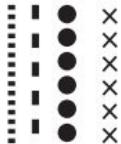
Texture



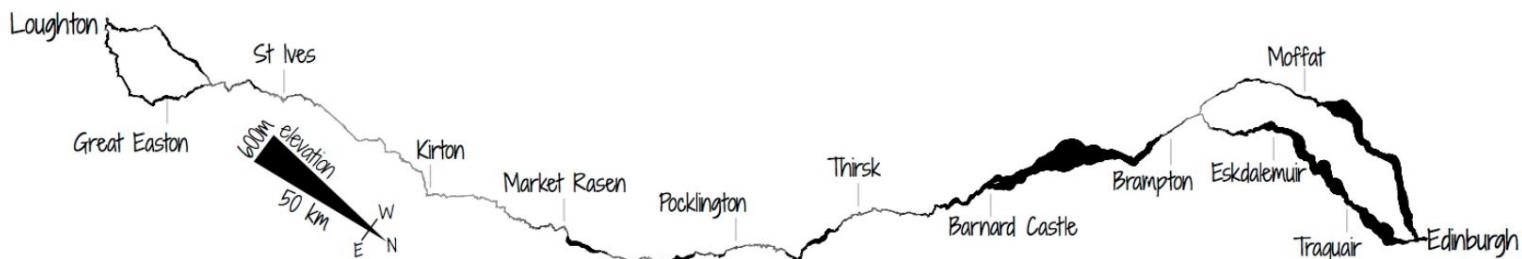
Text

Text along a curve to encode data

Particles

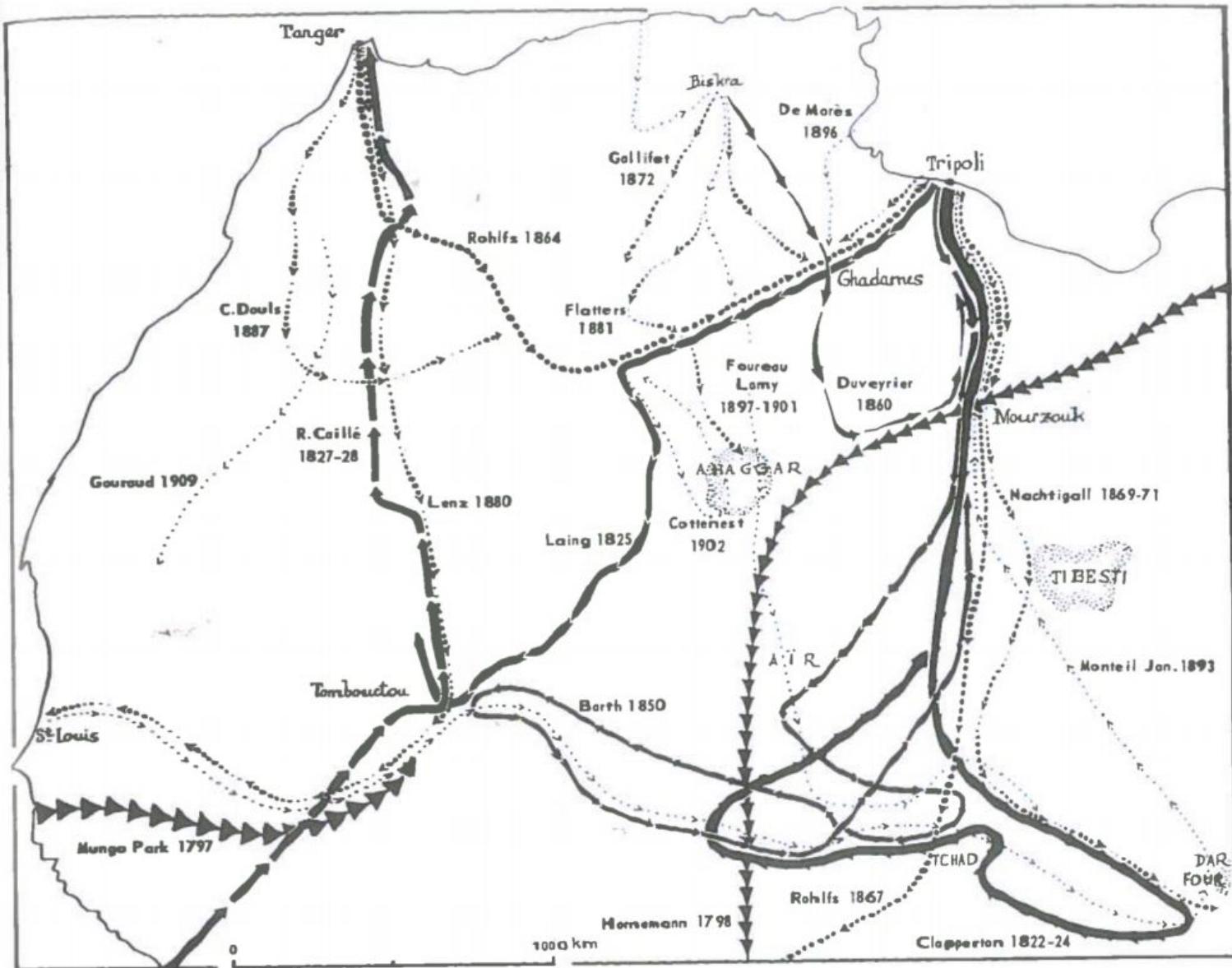
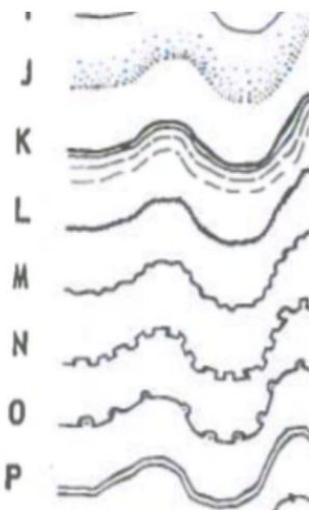


<https://medium.com/the-data-experience/bicycles-in-the-city-f9529d918388>

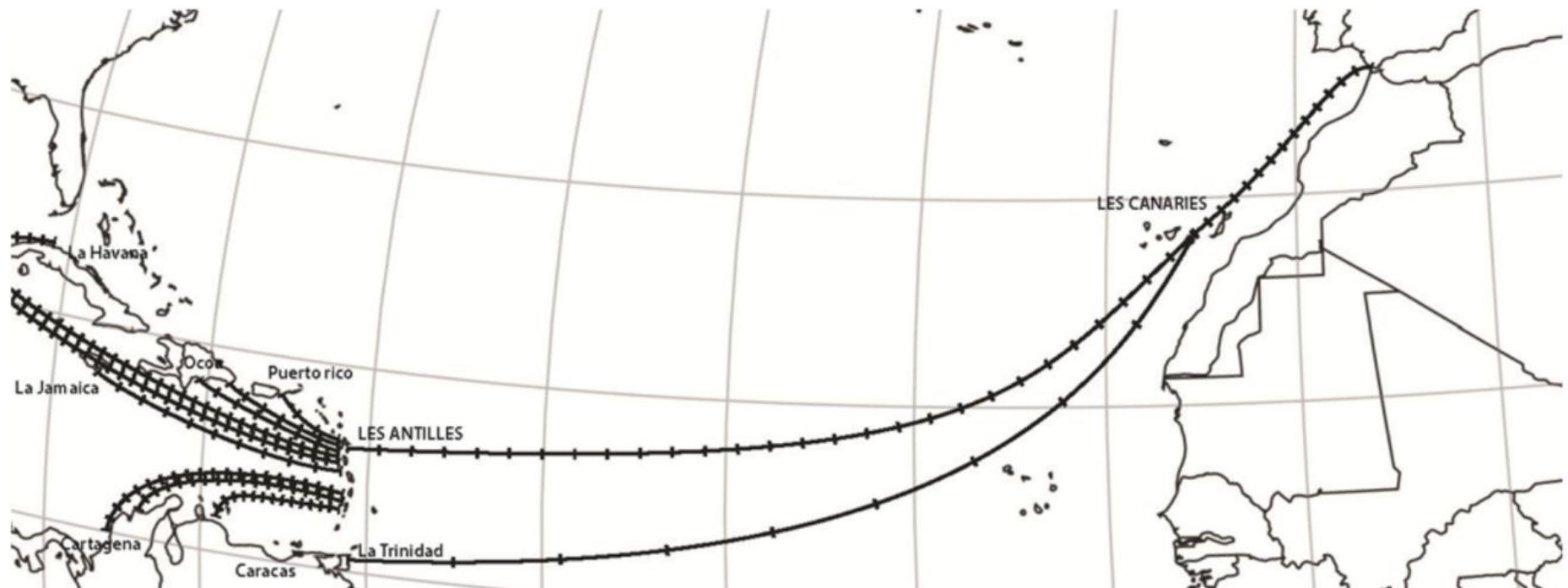


Wood, Jo. "Visualizing personal progress in participatory sports cycling events." *IEEE Computer Graphics and Applications* 35.4 (2015): 73-81.

Texture



Time steps / velocity



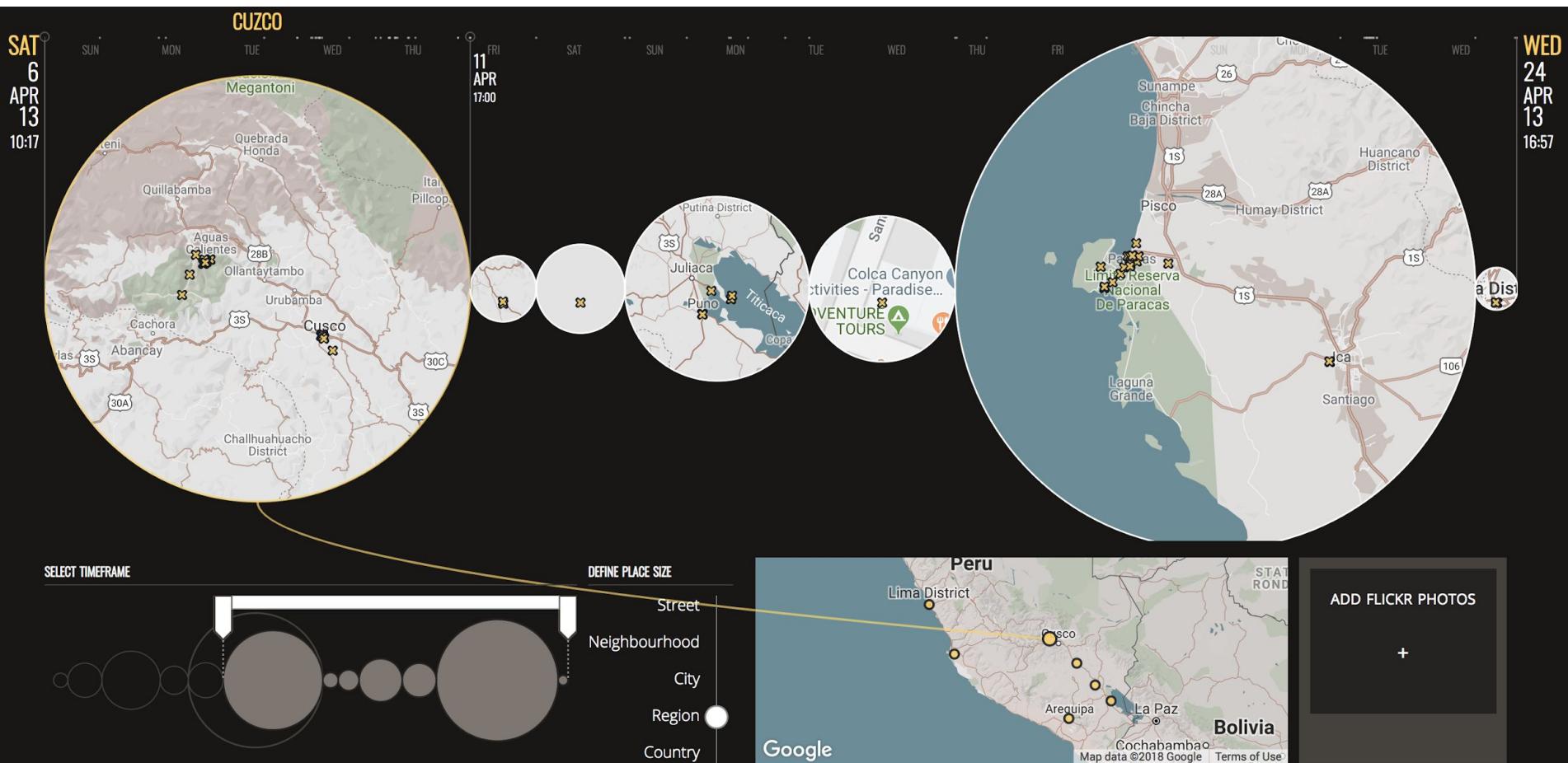
Columbus journeys to the Americas

Animation: animating particles

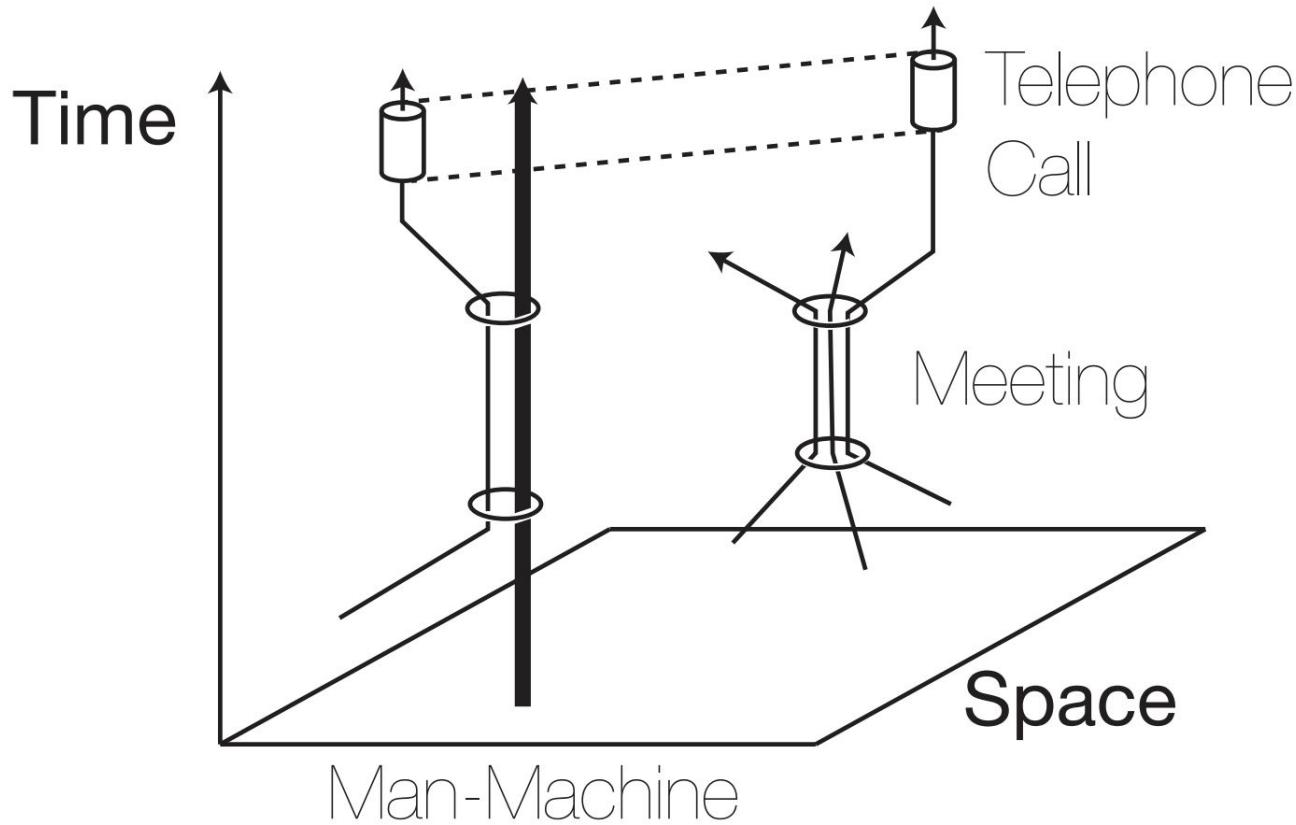
<http://ilda.saclay.inria.fr/flownet/>



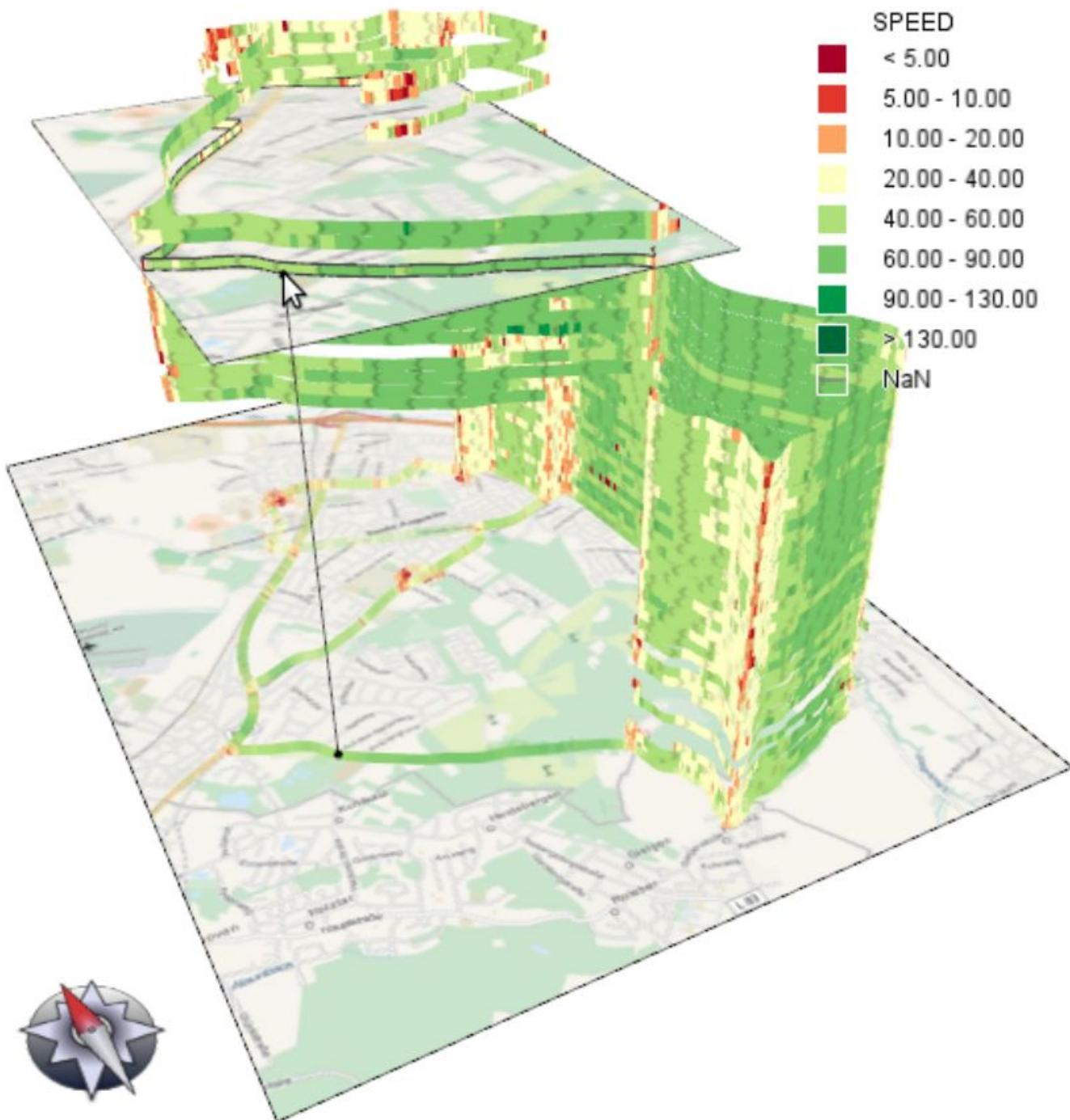
Visits



Space-Time Cubes

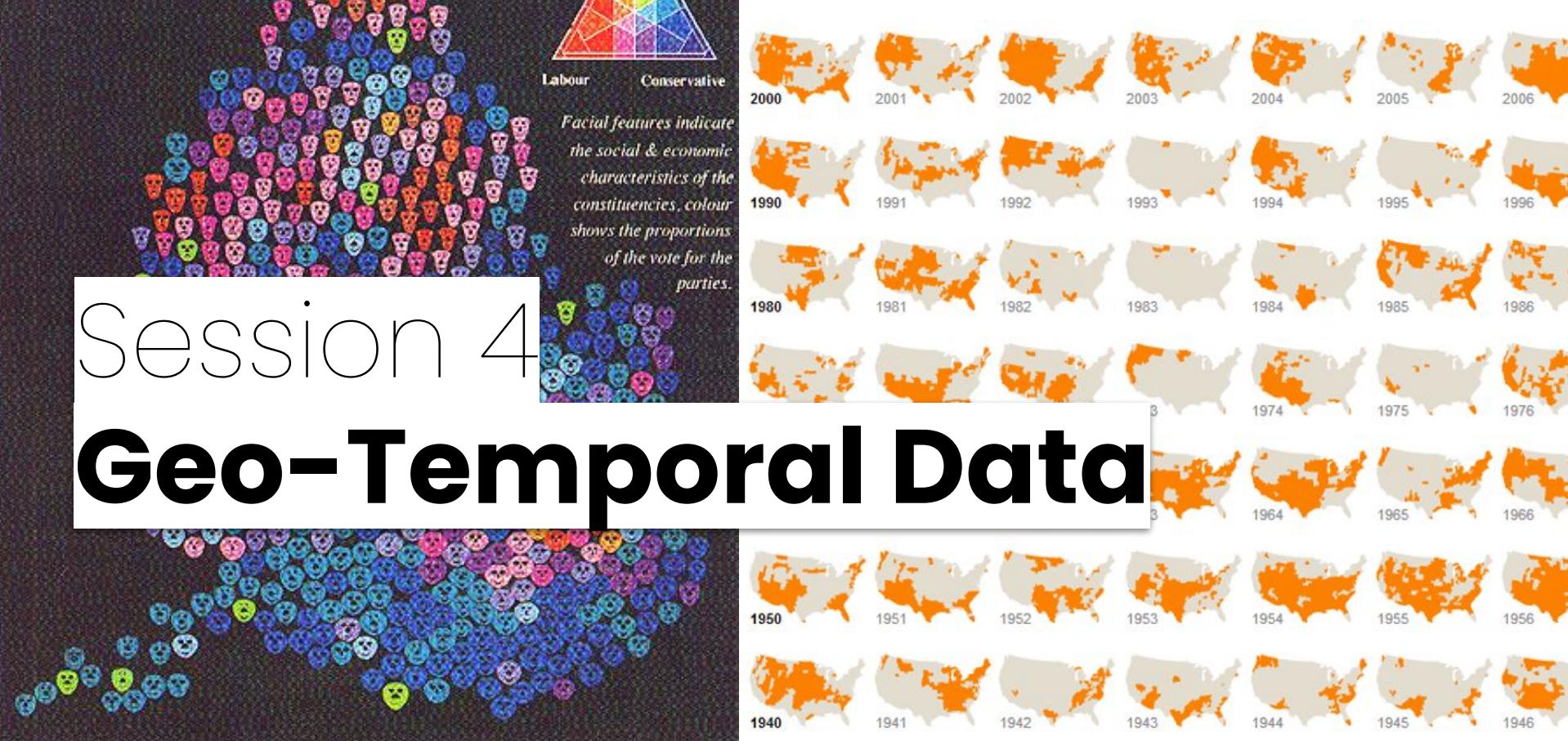


Bach, Benjamin, et al. "A Descriptive Framework for Temporal Data Visualizations Based on Generalized Space-Time Cubes." *Computer Graphics Forum*. Vol. 36. No. 6. 2017.



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





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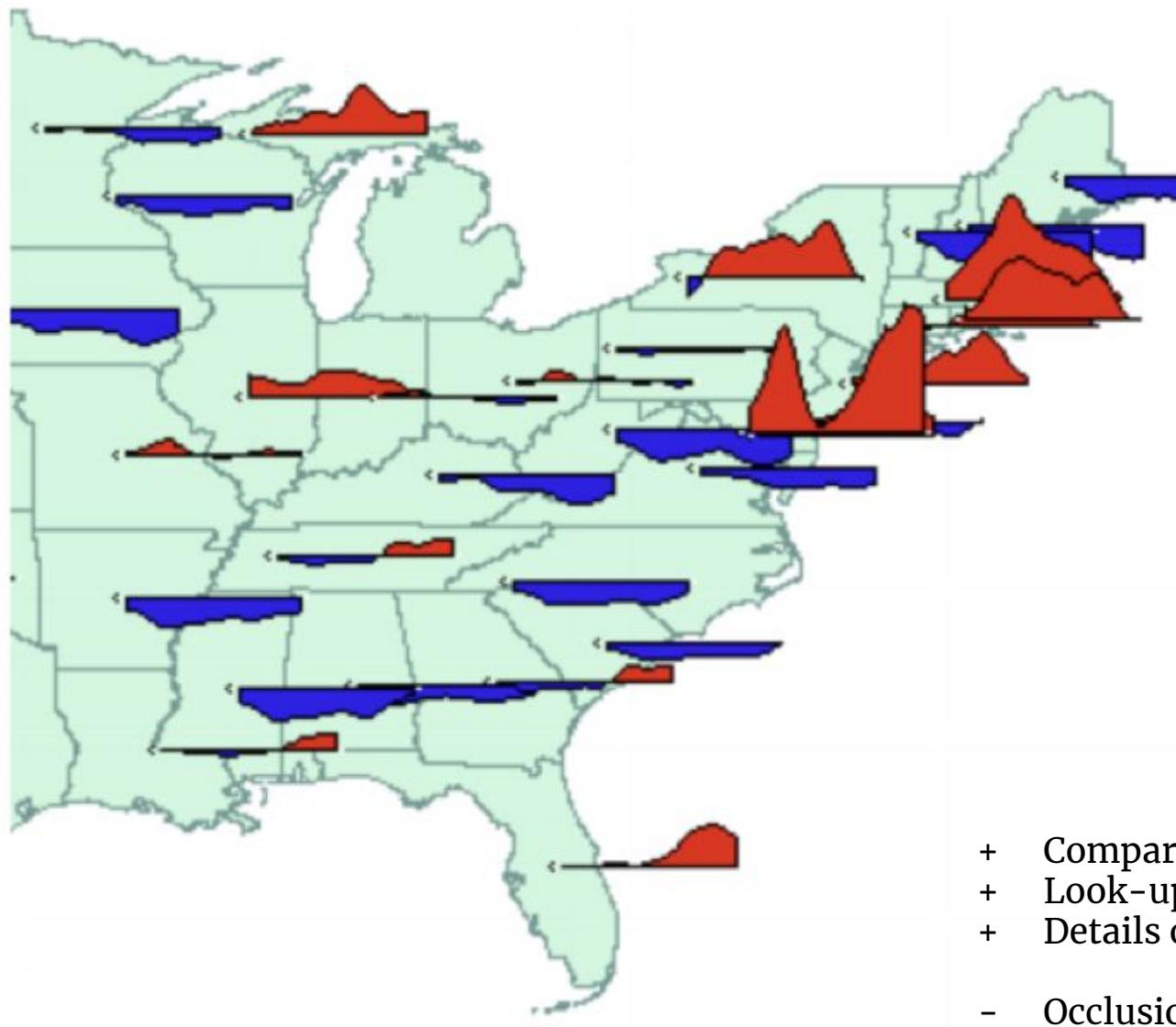
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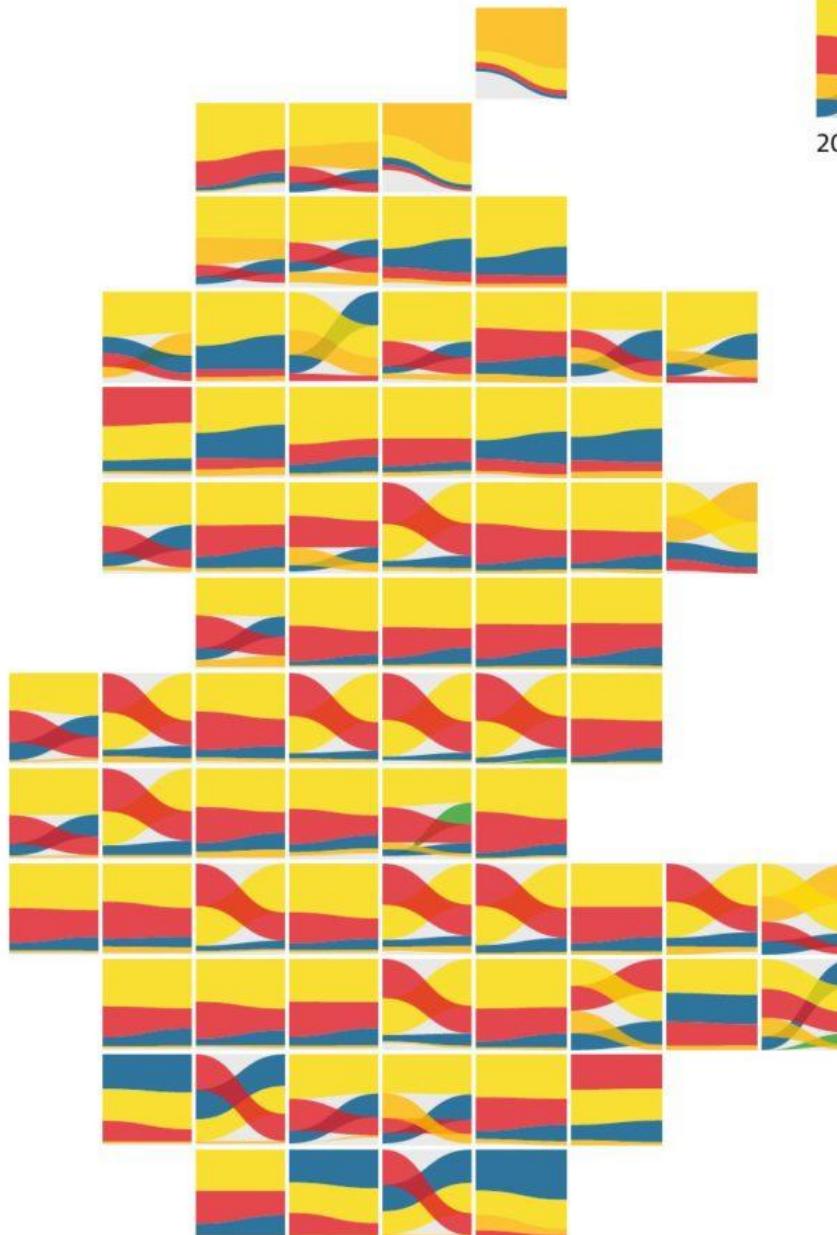
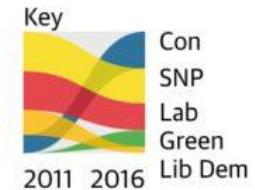
Small Multiples





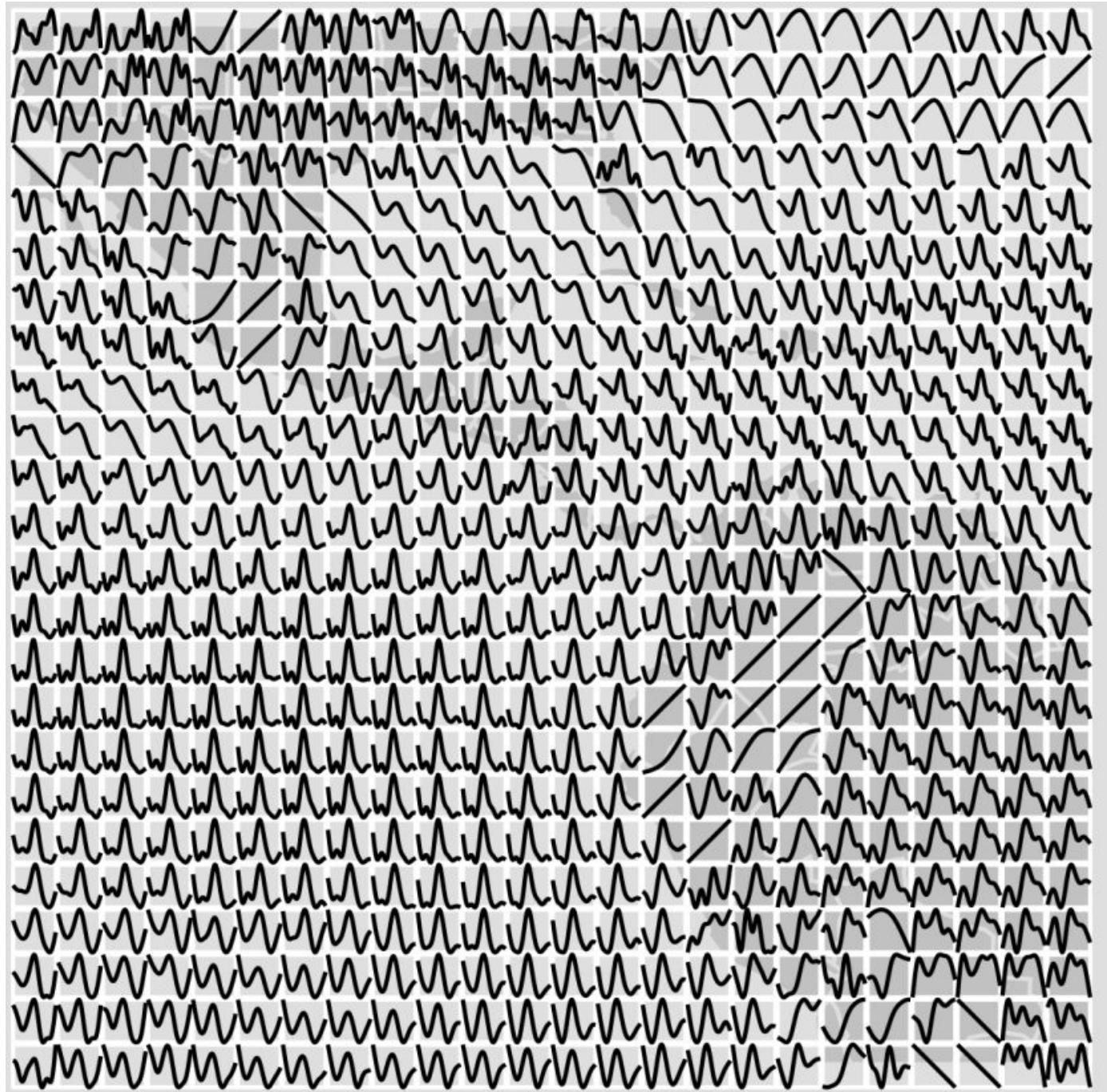
How Scotland's political geography changed, seat by seat

Geo-flow

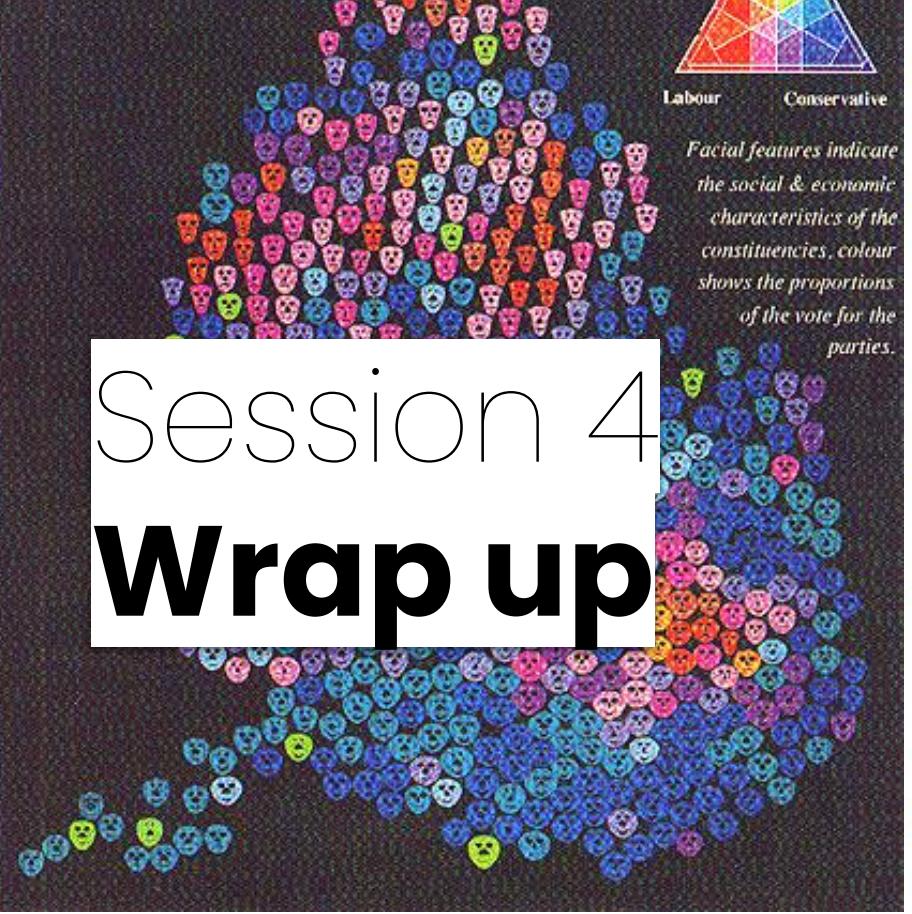


- + Compare regions
- + Look-up regions
- + Details on regions
- Compare far away glyphs
- Glyphs can become small

Glyph Maps



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



Session 4

Wrap up



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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.