

Multivariate Mapping

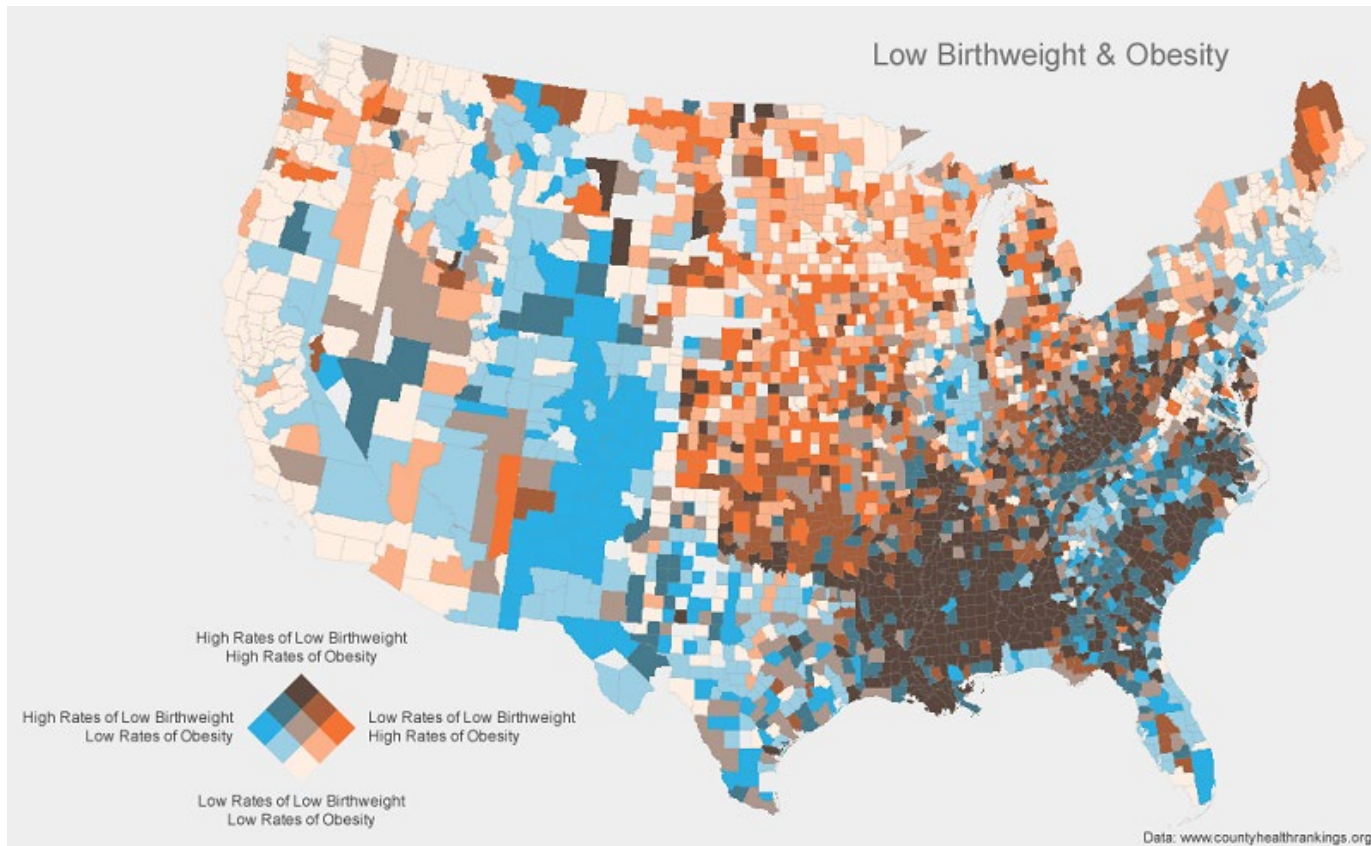
GEOG 5201 – Spring 2022

Outline

- Concepts of multivariate mapping
- Multivariate mapping techniques
 - Maps compared
 - Choropleth maps (small multiples)
 - Maps combined
 - Trivariate choropleth maps
 - Multivariate dot maps
 - Multivariate point symbol maps
 - Combining different types of symbols

Recall Bivariate Mapping

- The display of **two** attributes (or variables)



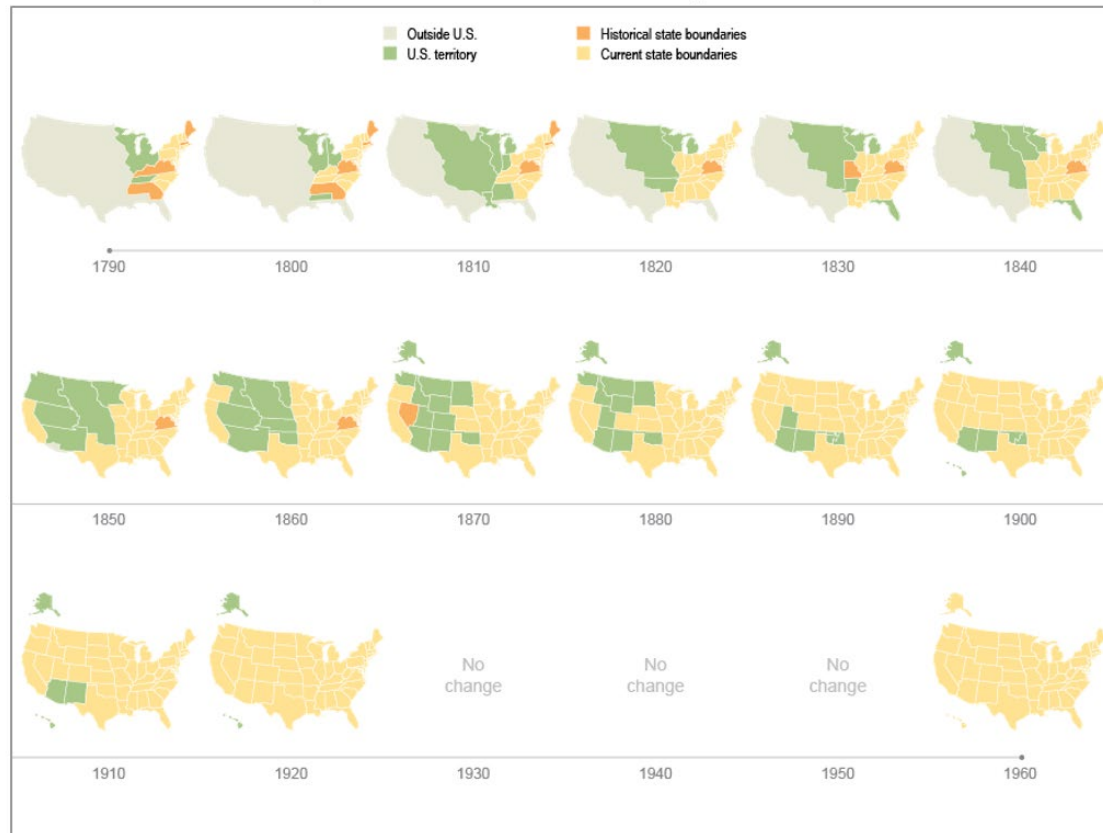
What is Multivariate Mapping?

- The cartographic display of **more than two** attributes (or variables) for data exploration using a single symbolization mechanism
- Bivariate maps are special multivariate maps
- Two major layouts
 - Comparing
 - Combining

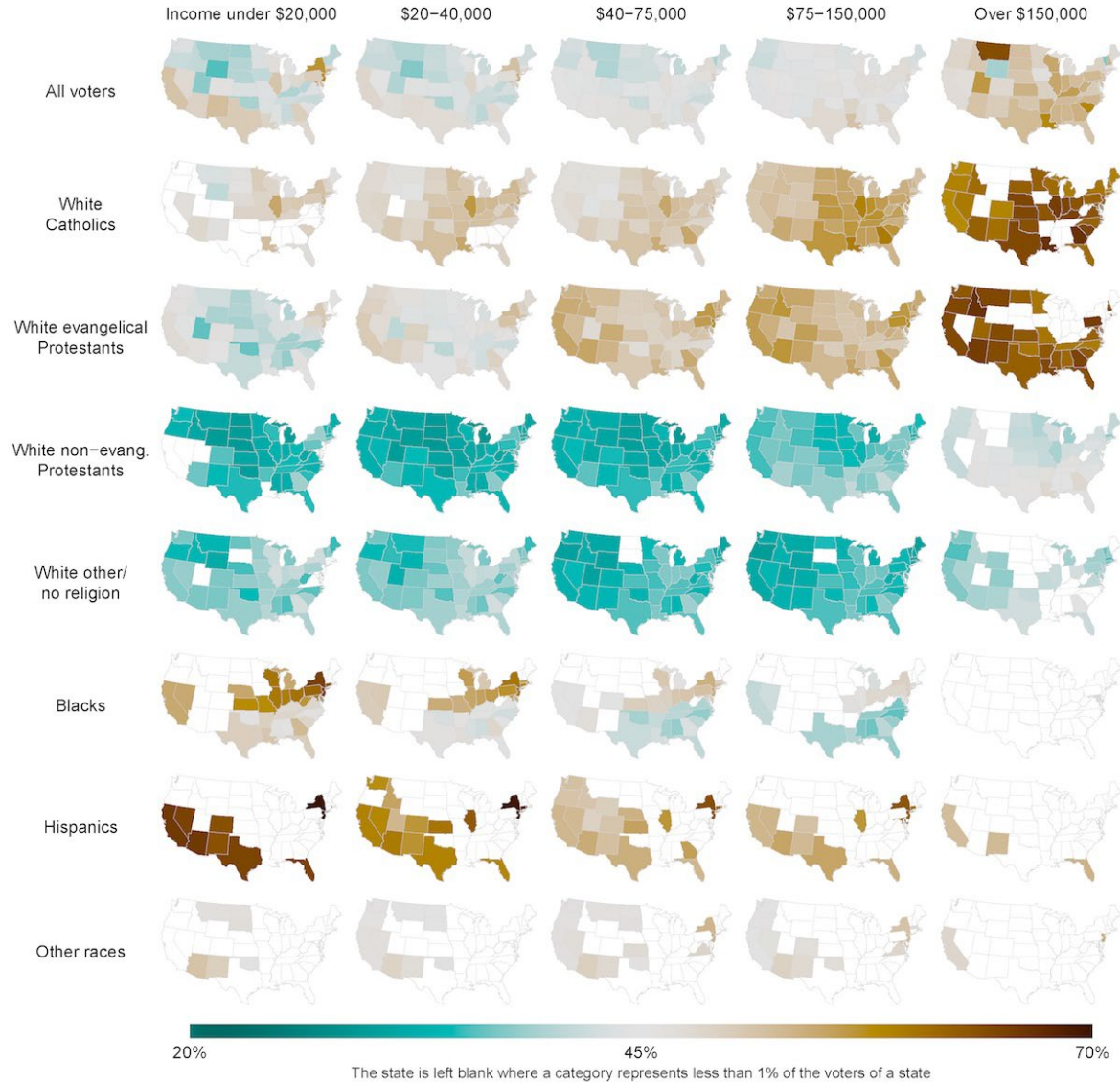
Maps Compared

- A series of small maps to be shown for each variable; result in **small multiples**

U.S. Territory and Statehood Status by Decade, 1790-1960



2000: Do you support school vouchers?

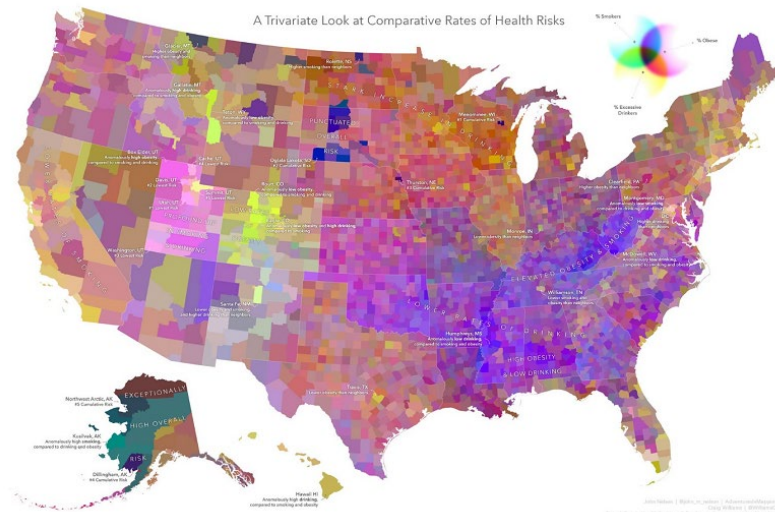
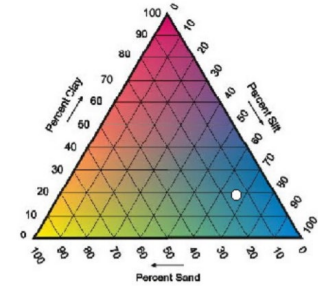


Maps Combined

- Multiple variables to be shown on the same map
 - Integral symbols
 - Trivariate choropleth maps
 - Multivariate point symbol maps
 - Separable symbols
 - Combining different types of symbols

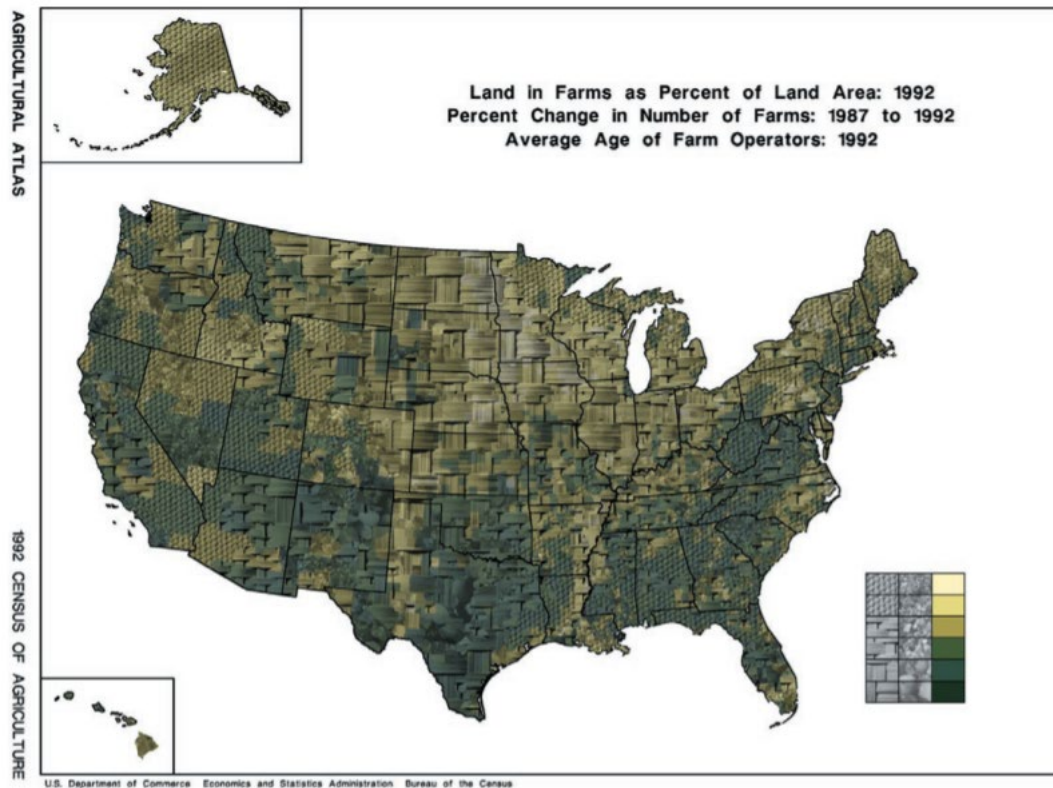
Maps Combined I: Trivariate choropleth maps

- Blending three colored choropleth maps into a single choropleth map
- Ideally, this approach should be used only for three attributes that add to 100%
 - Colors will be restricted to a triangular two-dimensional space
 - Examples:
 - Soil texture -- percent sand, silt, and clay
 - Voting data -- percent voting Republican, Democrat, and independent



Maps Combined I: Trivariate choropleth maps

- An alternative is to use **textures/patterns** as a substitute for smooth, colored tones

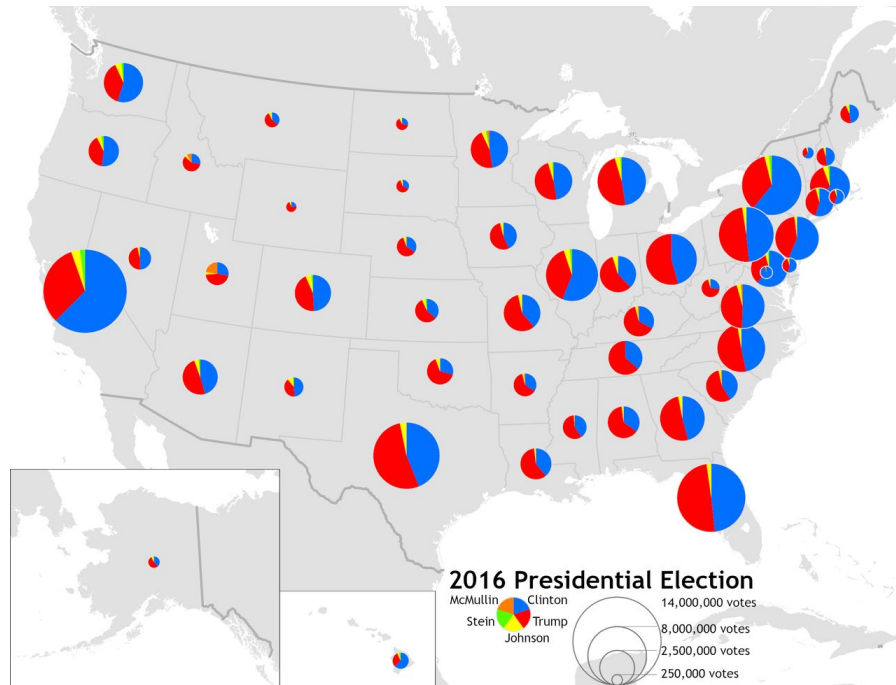


Question 2-2-1

Name three variables that you think are suitable to be represented using a trivariate choropleth map (with color only). Explain.

Maps Combined II: Multivariate Point Symbol Maps

- **Related attributes: measured in the same units and part of a larger whole**
 - Example: percentages of White, Black/African American, Asian/Pacific Islander, Native American
 - Depicted using **pie chart**



The size of pie charts is also proportional to the number of voters!

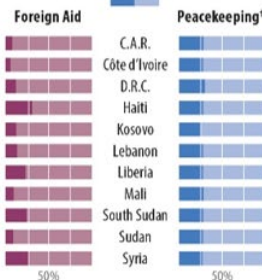
The Costs of Keeping Peace

May 29th marked the International Day of United Nations Peacekeepers. More than **3,500** peacekeepers have died since the first mission in 1948. As of April 30, 2017, over **112,000** troops, observers, police, and civilians representing 124 countries were participating in **16 UN Peacekeeping Operations (UNPKOs)** at a cost of **\$7.87 billion**. However, UN peacekeeping represents only one part of the international community's investment toward the prevention of relapse into violent conflict. International foreign aid programs work parallel to peacekeeping efforts to ensure gains won at the negotiating table are not lost.

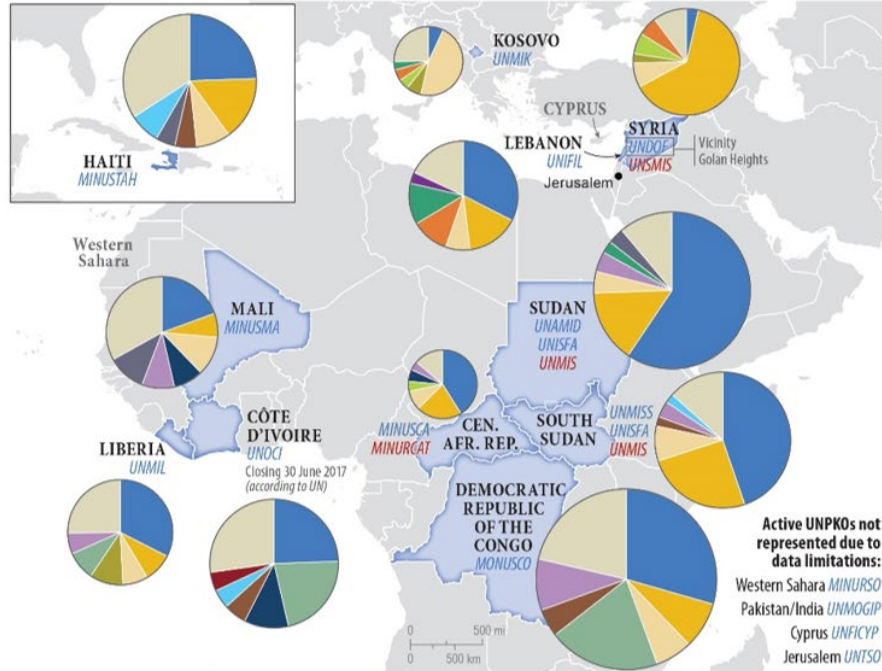
From 2010-2015 the total amount of international funding contributed to peacekeeping (\$42.9 billion*) and foreign aid (\$95.3 billion**) in the highlighted countries exceeded **\$138 billion**.

Cost sharing 2010-2015

U.S. percent of total International percent of total

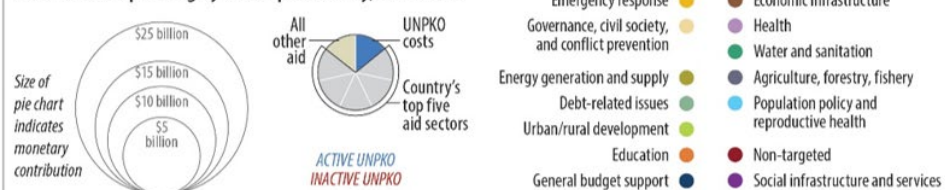


*Does not reflect costs associated with UN Special Political Missions or Good Offices Engagements.
 **Includes preliminary 2014-2015 data provided by AidData, College of William and Mary, May 2017.
 *Reflects combined costs of all UNPKOs deployed to highlighted countries: 2010-2015.



Active UNPKOs not represented due to data limitations:
 Western Sahara MINURSO
 Pakistan/India UNMOGIP
 Cyprus UNFICYP
 Jerusalem UNTSO

International spending by sector per country, 2010-2015



Names and boundary representation are not necessarily authoritative

Sources: UNDPKO; U.S. Department of State; William & Mary AidData, 2017

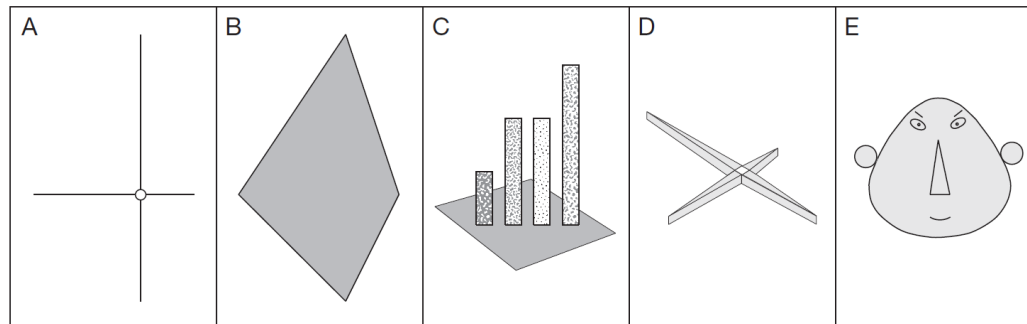
June 7, 2017 - U1600 STATE (HIU)

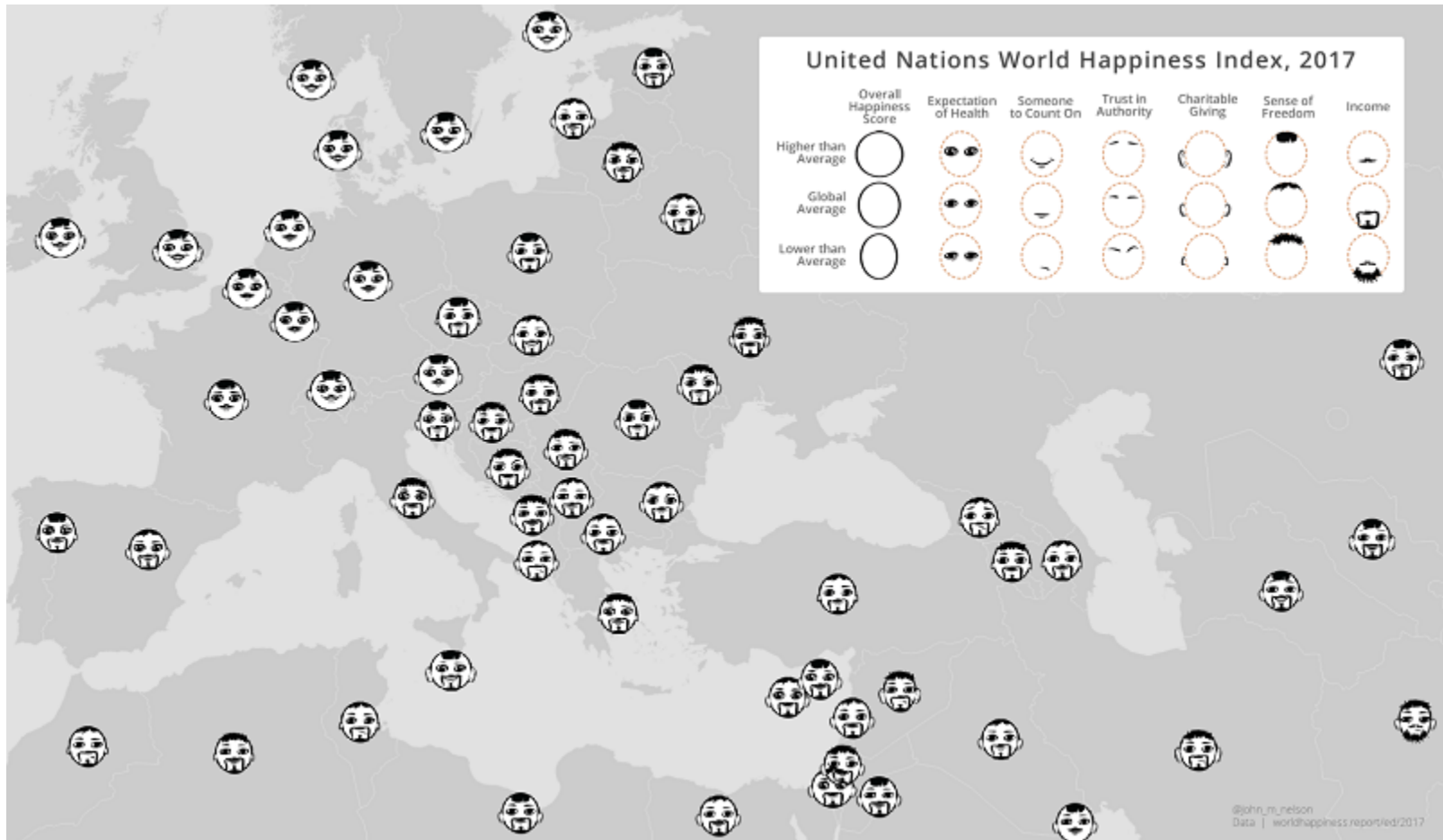
A multivariate map using pie charts showing the total amount of international funding for peacekeeping

Maps Combined II: Multivariate Point Symbol Maps

- Commonly used glyphs

- A. Multivariate ray-glyphs or stars: the length of rays are proportional to the values of attributes
- B. Polygonal glyphs or snowflakes: a polygon connects the endpoints of the rays shown in A
- C. Three dimensional bars: the height of bars is proportional to the magnitude of attributes
- D. Data jacks: the spikes of the jack are proportional to the magnitude of each attribute
- E. Chernoff faces: individual facial features (e.g., the size of the eyes) are associated with individual attributes





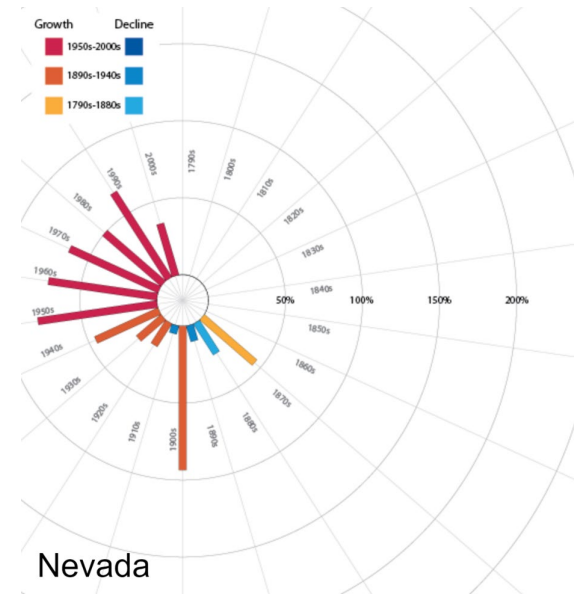
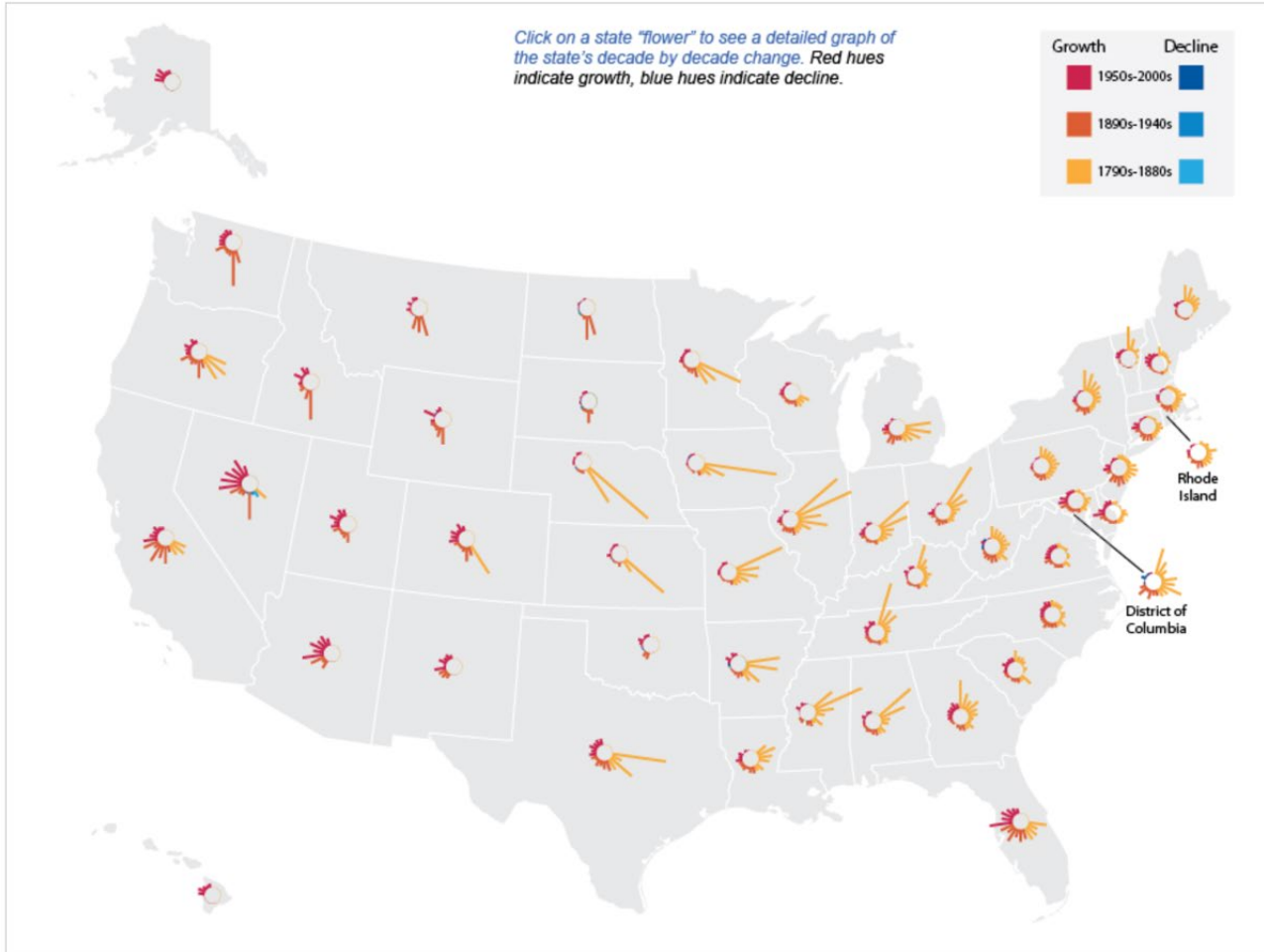
A Chernoff map showing the overall happiness and the relative strength of six happiness influences

The Distribution of Voting, Housing, Employment and Industrial Compositions in the 1983 General Election.

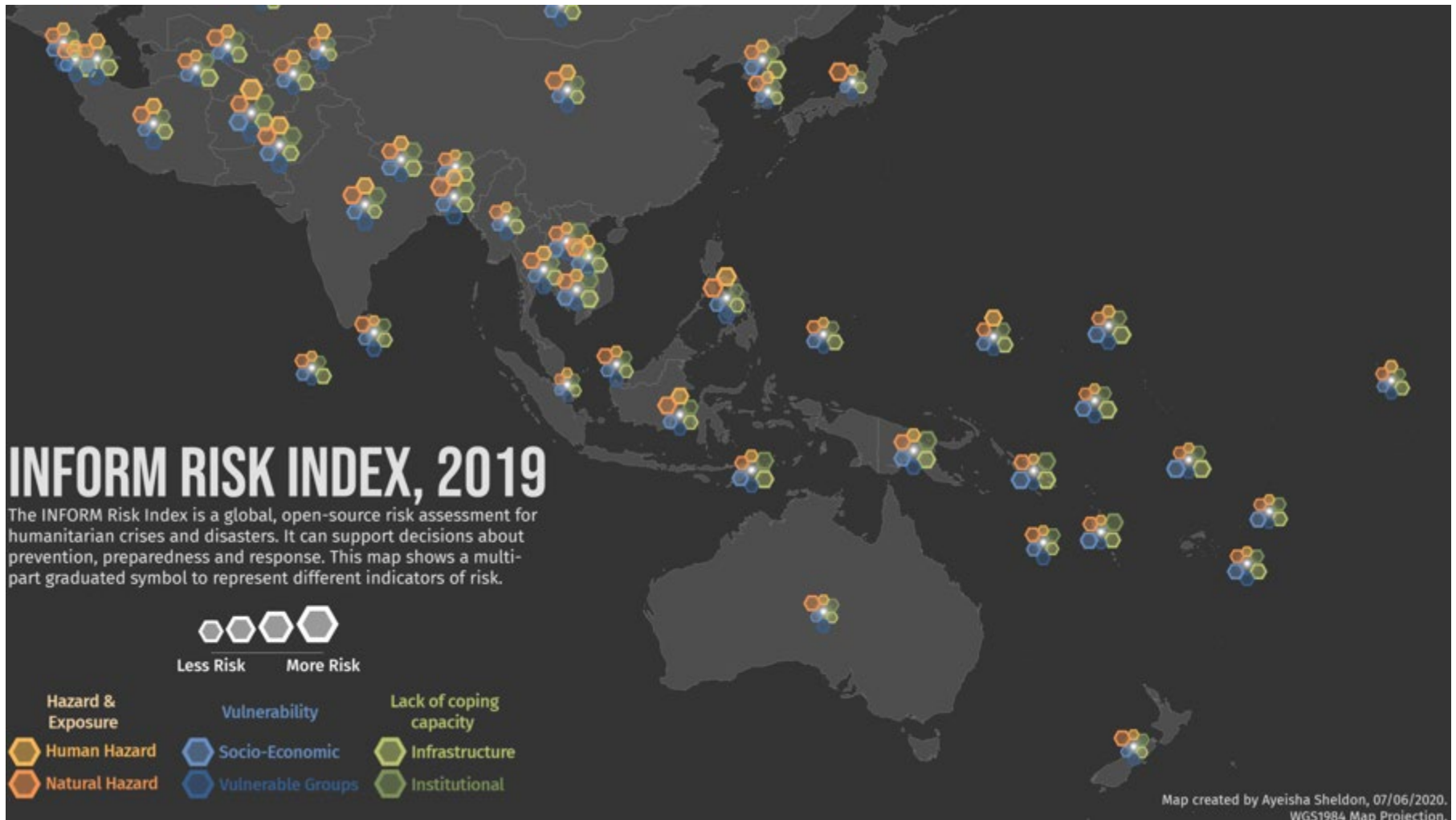


A Chernoff map showing the distribution of voting, housing, employment, and industrial compositions in the 1983 general election

Blooming States, US Census Bureau



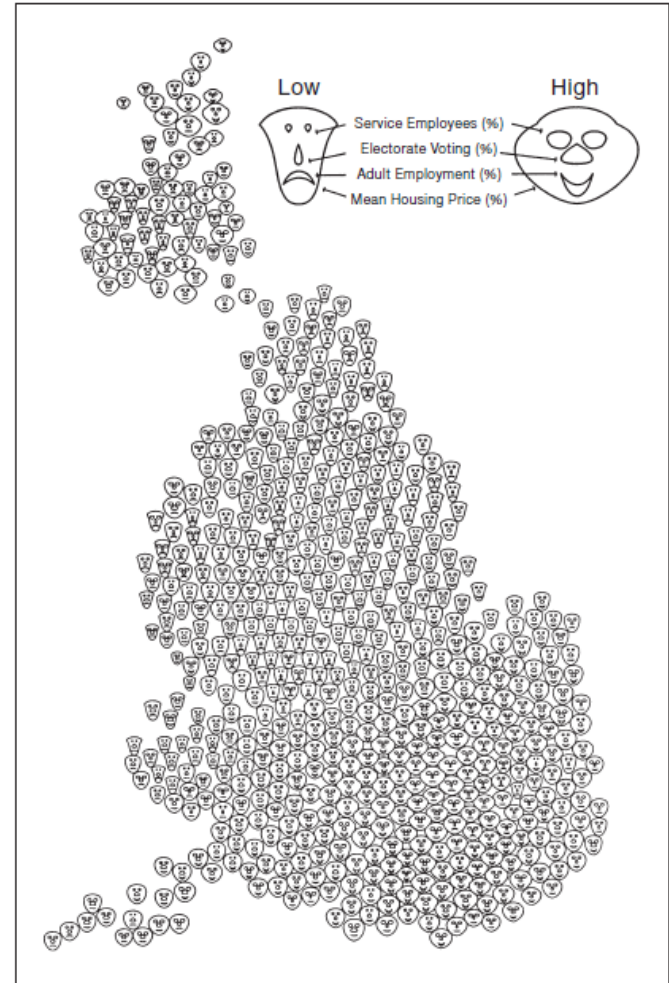
A map created with multivariate ray-glyphs showing the state population change from 1790 to 2000



A glyph map showing the risks of humanitarian crises and disasters

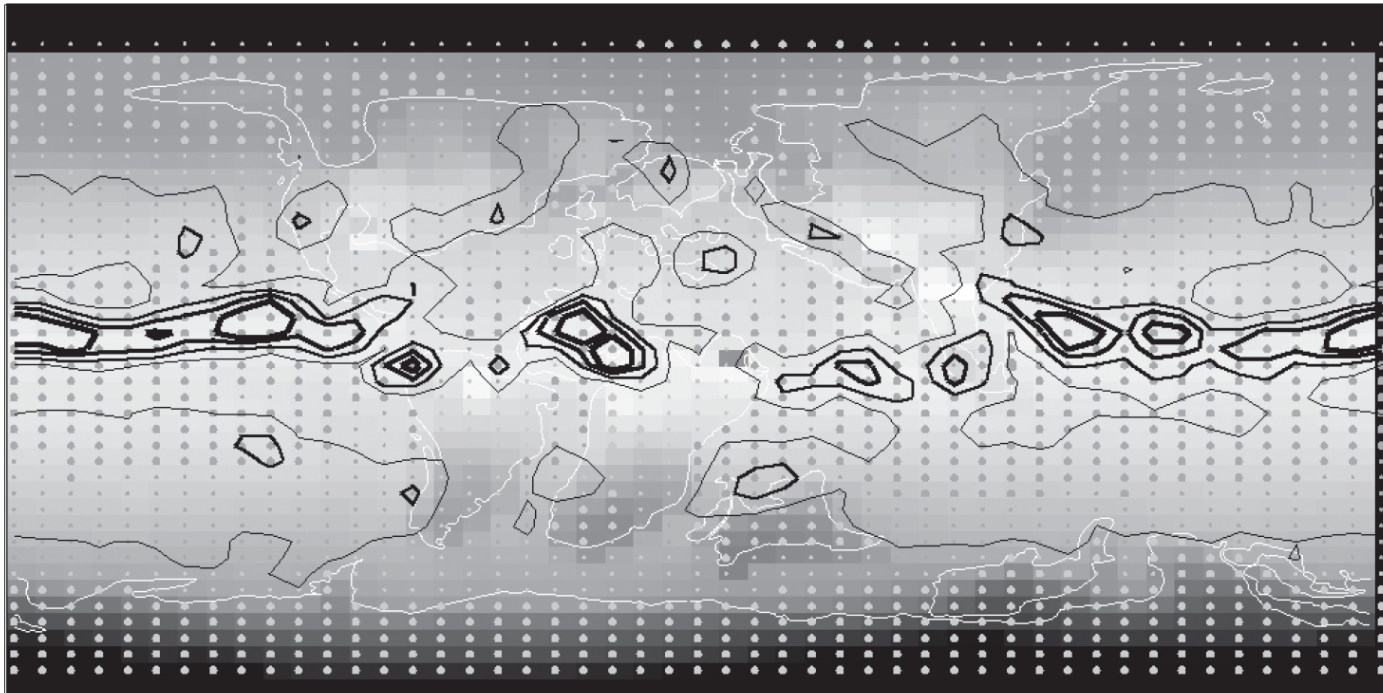
Question 2-2-2

Explain why Chernoff faces are appropriate symbolizations for the four attributes: percentages of service employees, electorate voting, adult employment, and mean housing price.



Maps Combined III: Combining Different Types of Symbols

- Use different types of symbols on the same map
 - Overlay lines, points, and area symbolizations
 - Example: use proportional symbols for mean annual evaporation, weighted isolines for precipitation, and choropleth shading for temperature



Question 2-2-3

Find a multivariate map from online resources. Discuss the map's layout and symbolization strategies. Please also provide a link to the map.

- Useful resources
 - [Census Interactive Gallery](#)
 - [Esri Map Gallery](#)
 - [Chronic Disease GIS Exchange Map Gallery](#)
 - [Map Gallery - WHO](#)