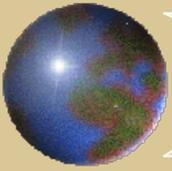




Multivariate Mapping: If One is Good, is Many Better?

Michael Larson
Oklahoma State University
Cartography Services



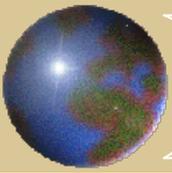
What to expect.

We will start off with a brief discussion on the two main general types of maps, the Reference/General-purpose map and the Statistical/Thematic map.

Next we will discuss single variable (univariate) maps followed closely by multiple variable (maps with more than one variable) maps, which includes the two variable (bivariate) maps as well as the more than two variable (multivariate) maps.

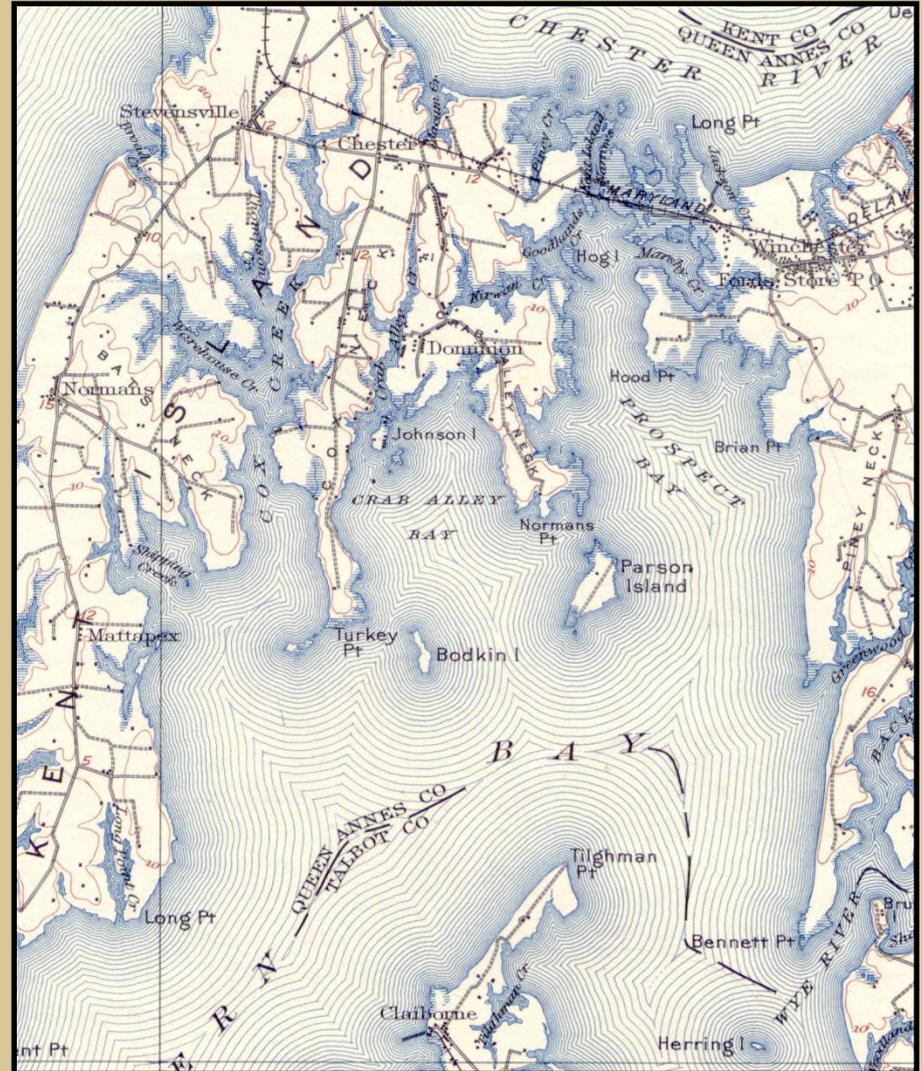
Examples and discussion of a couple of multivariate mapping techniques will round out the presentation.

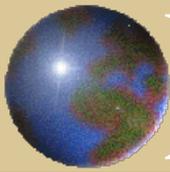
Questions and answers at the end.

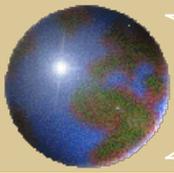


Reference or General-purpose maps

- Typically displays features from the geographical environment such as coastlines, lakes, political boundaries, roads and other similar objects
- Examples include topographic and Atlas maps
- They help you move or navigate across the landscape

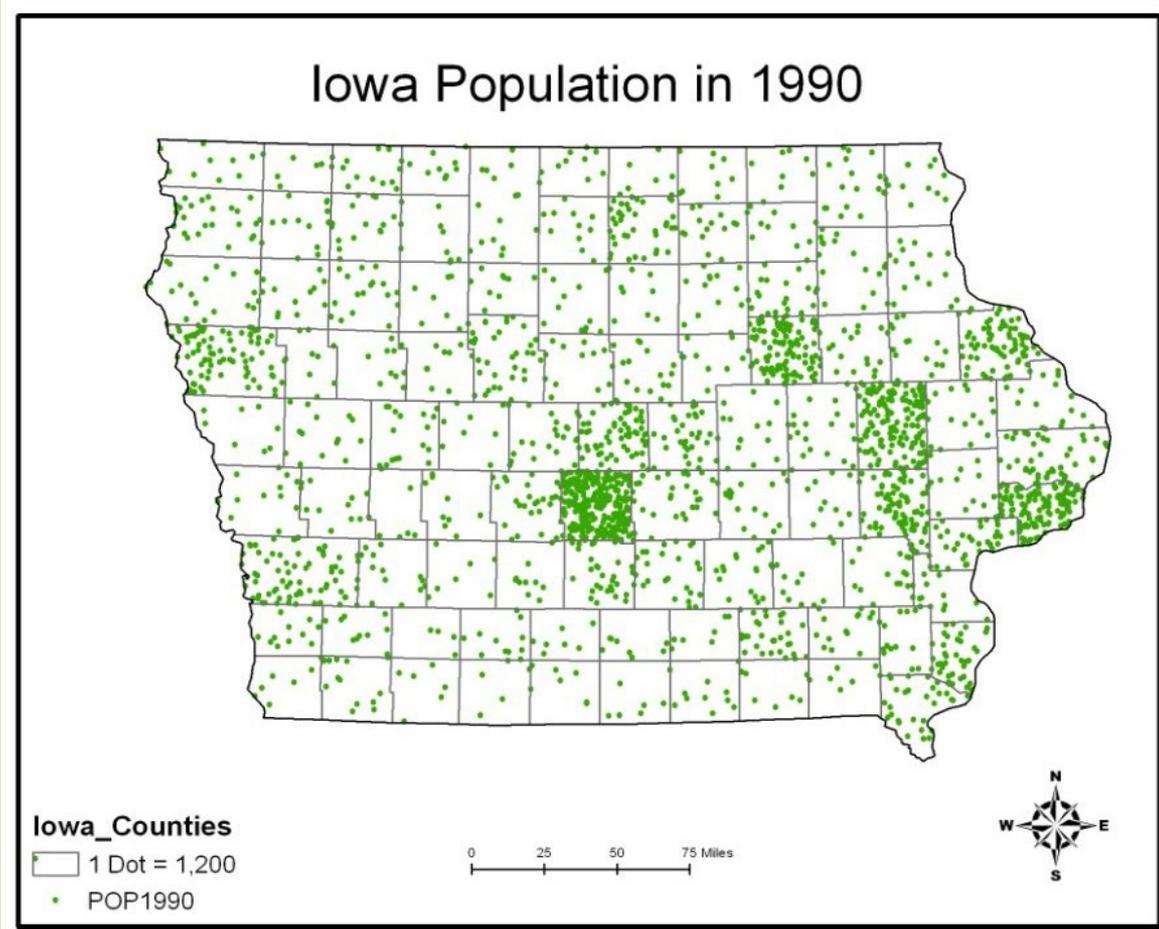


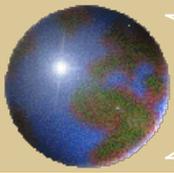




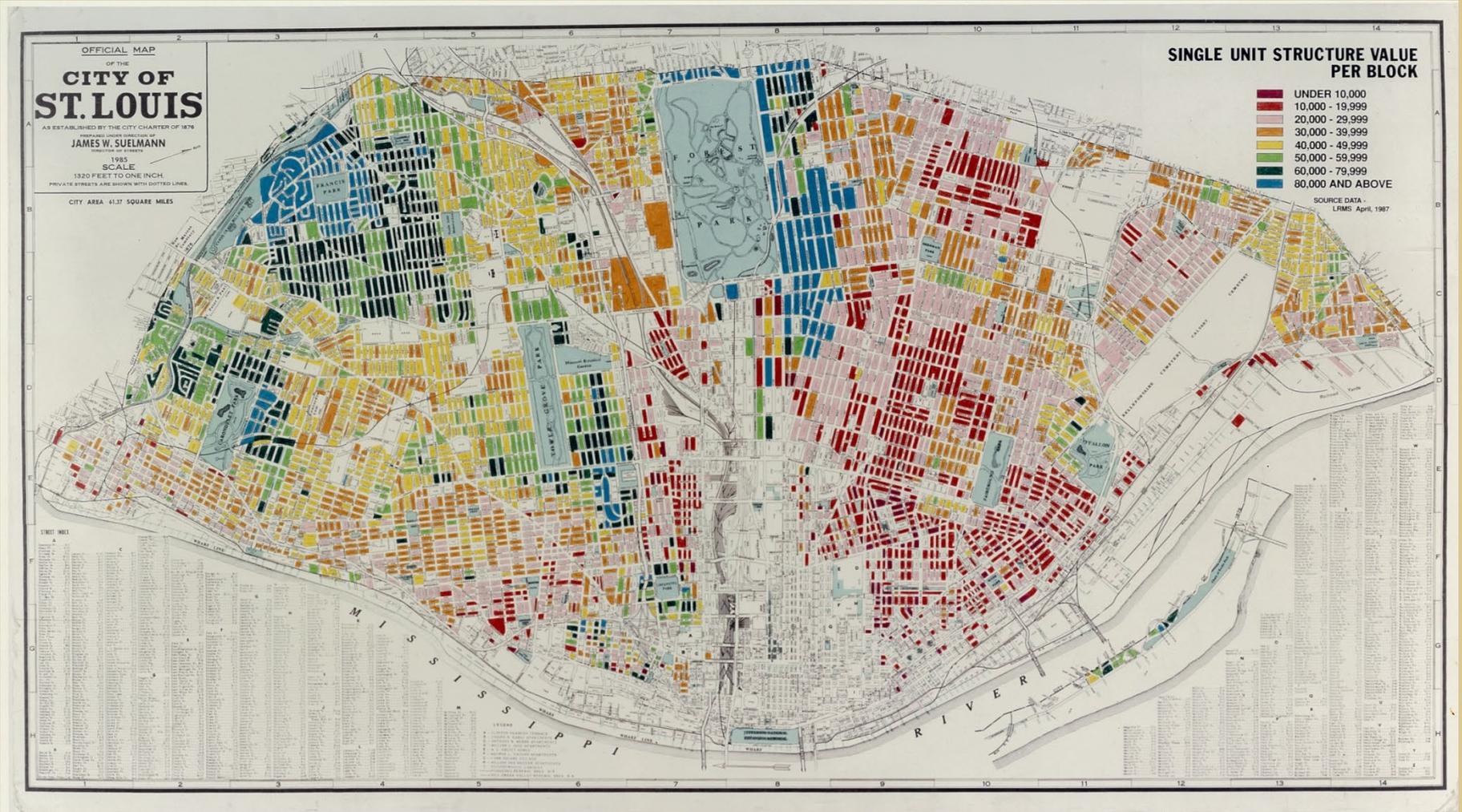
Statistical/Thematic Maps

- ❖ Presents a graphical theme usually about a single subject
- ❖ While typically used to display various human activities, thematic maps often show a wide variety of physical phenomena
- ❖ These maps can include one, two, or multiple variables giving rise to univariate, bivariate, or multivariate maps

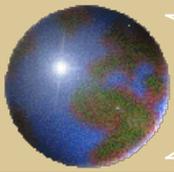




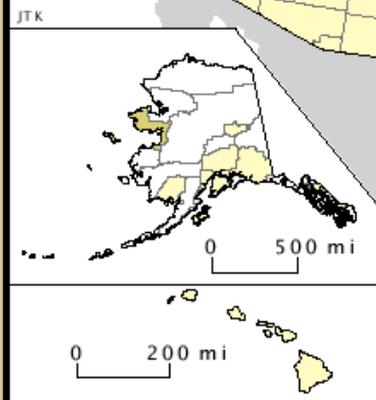
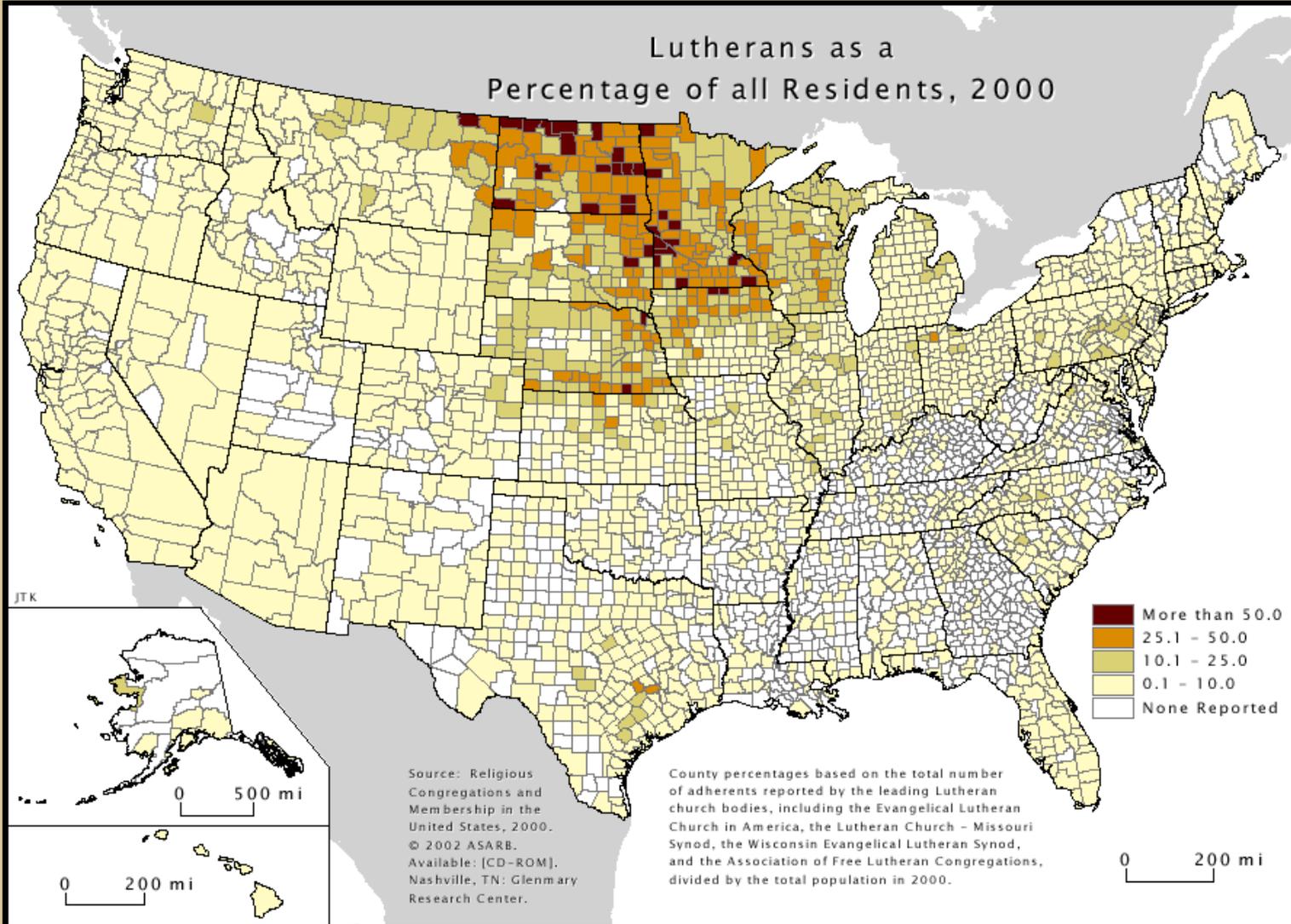
Univariate maps



A single theme on a reference background



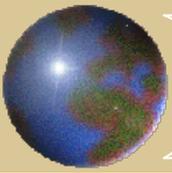
Lutherans as a Percentage of all Residents, 2000



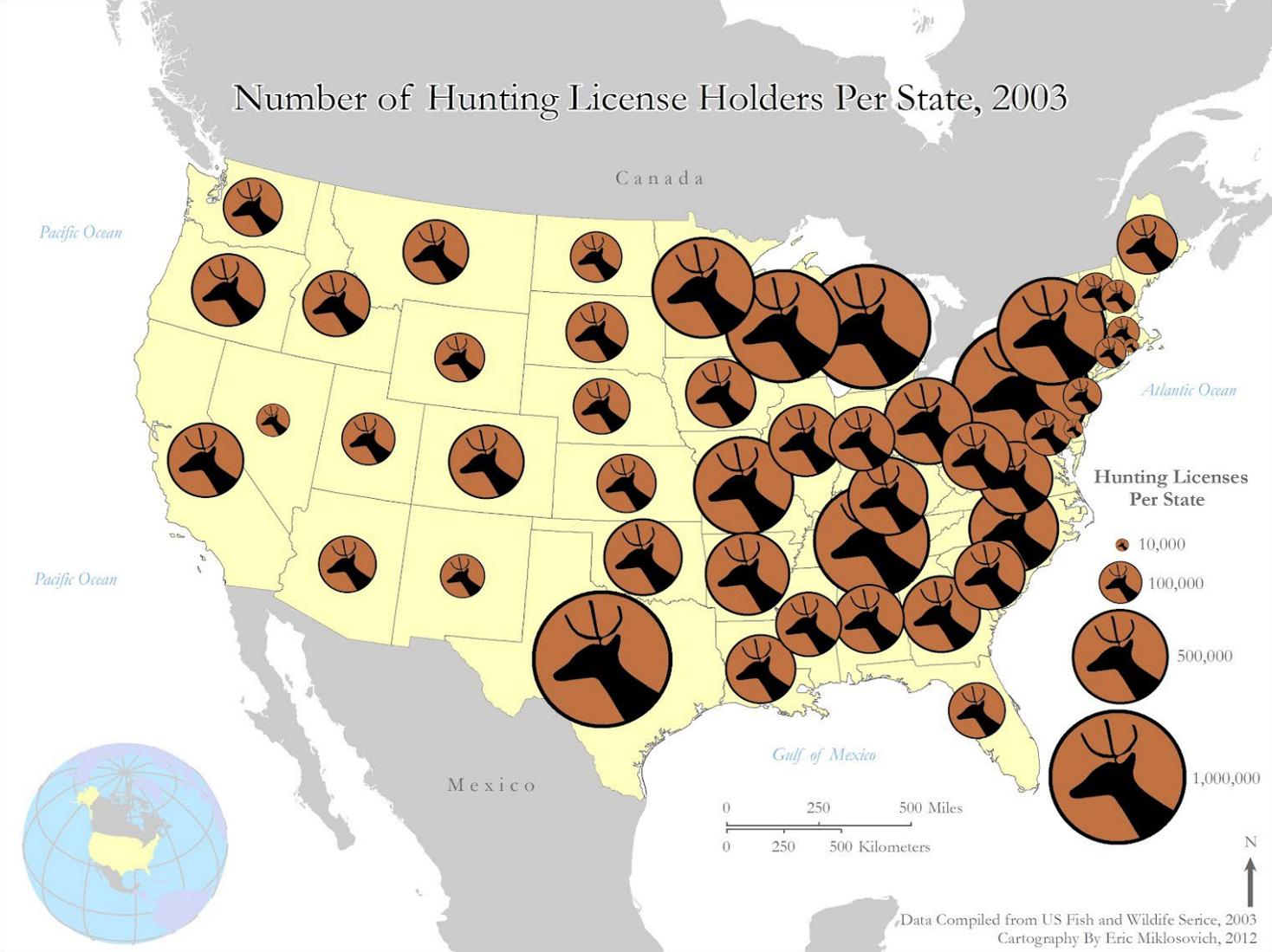
Source: Religious Congregations and Membership in the United States, 2000. © 2002 ASARB. Available: [CD-ROM]. Nashville, TN: Glenmary Research Center.

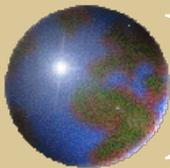
County percentages based on the total number of adherents reported by the leading Lutheran church bodies, including the Evangelical Lutheran Church in America, the Lutheran Church - Missouri Synod, the Wisconsin Evangelical Lutheran Synod, and the Association of Free Lutheran Congregations, divided by the total population in 2000.



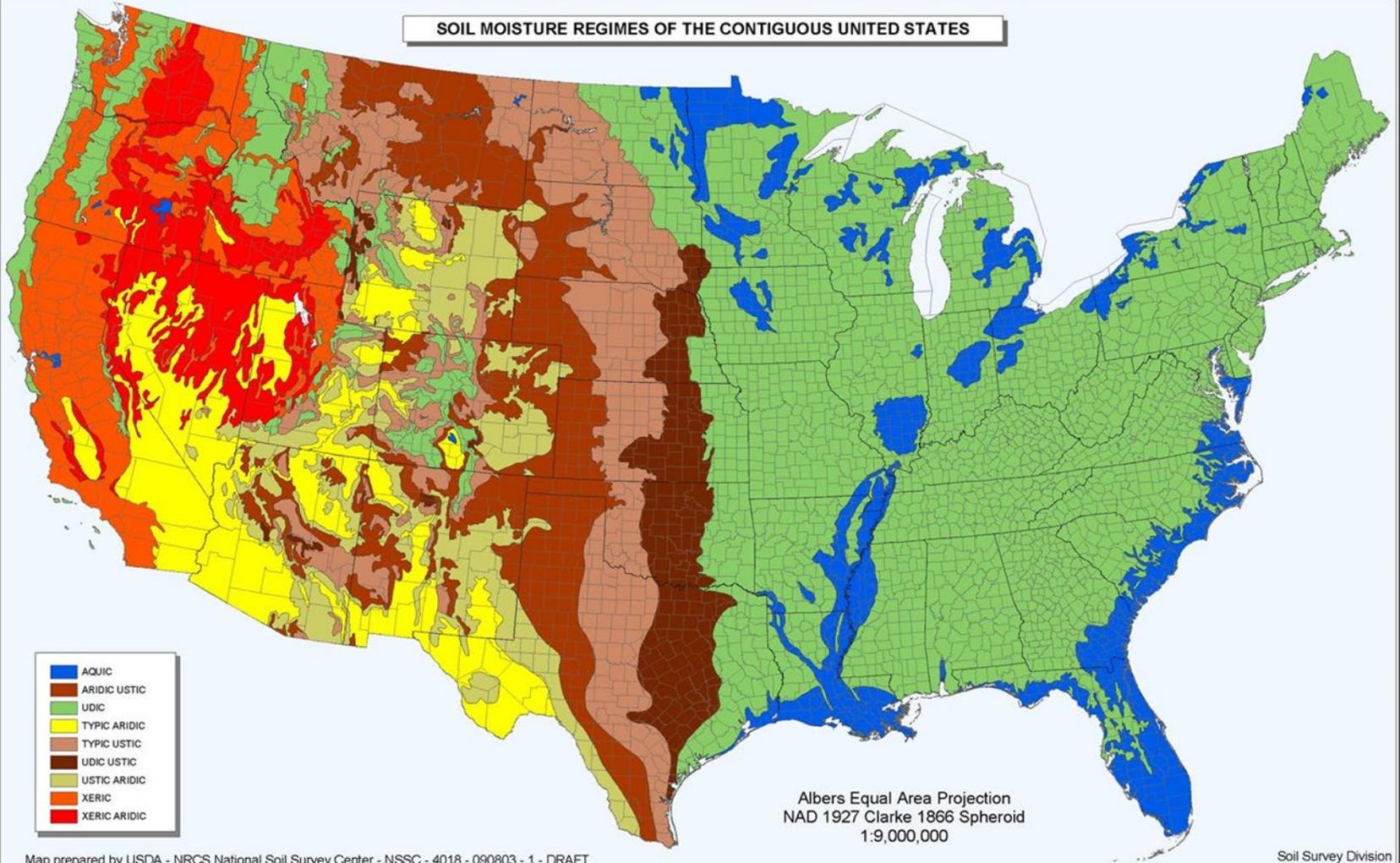


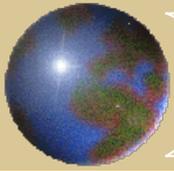
Number of Hunting License Holders Per State, 2003





SOIL MOISTURE REGIMES OF THE CONTIGUOUS UNITED STATES





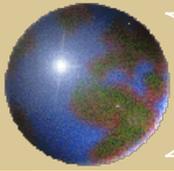
What is multivariate mapping?

It is the process of mapping more than one variable or geographical phenomena on a single thematic map.

This is usually done to overcome the problems associated with comparing variables on separate maps.

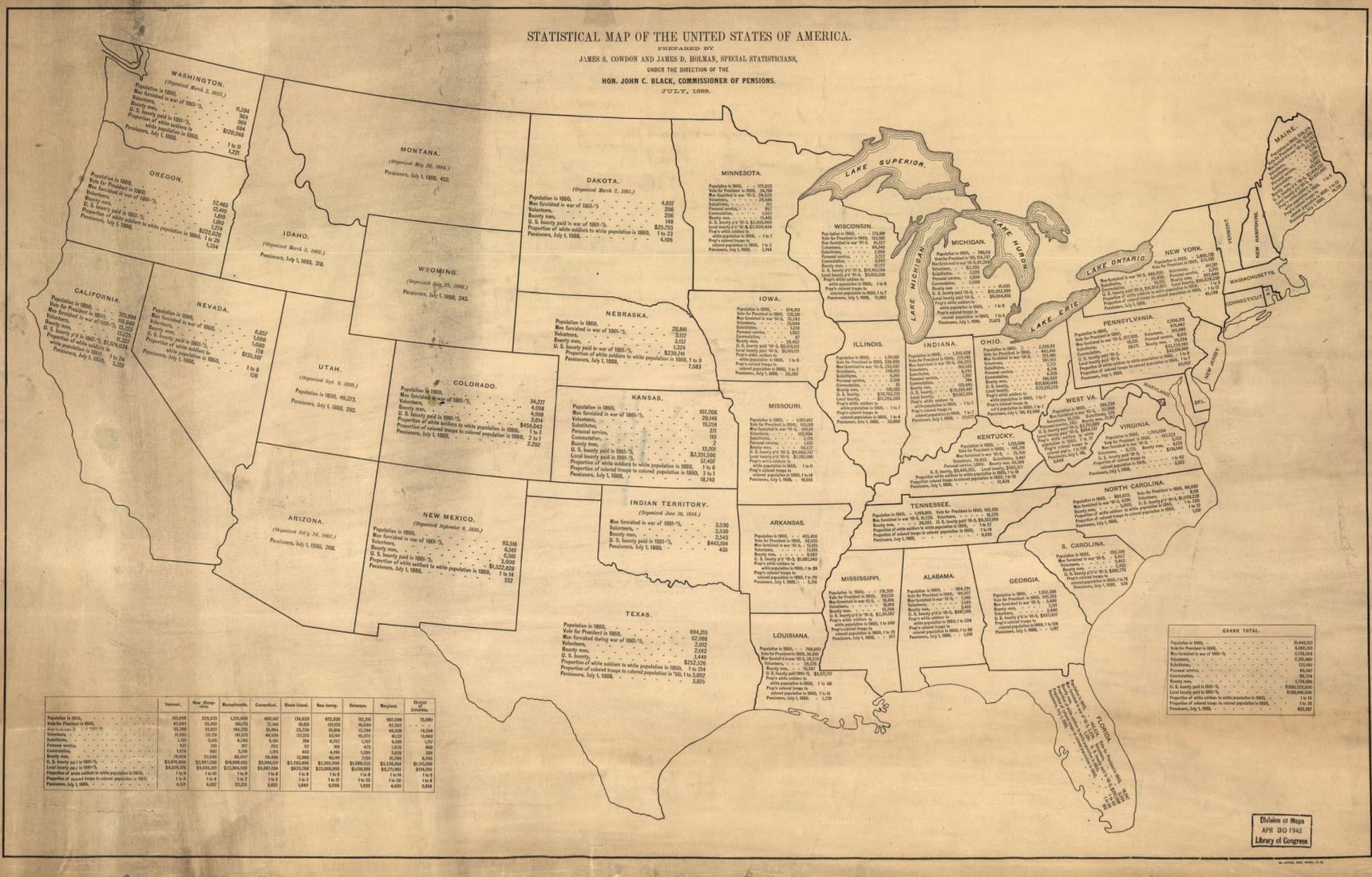
Can be a great tool for examining spatial patterns of cross-correlation between features.

Caution must be taken as you increase the number of variables mapped together. Increasing the complexity of the map can often lead to a decrease in readability and clarity.



STATISTICAL MAP OF THE UNITED STATES OF AMERICA.

PREPARED BY JAMES S. COWDON AND JAMES D. HOLMAN, SPECIAL STATISTICIANS, UNDER THE DIRECTION OF THE HON. JOHN C. BLACK, COMMISSIONER OF PENSIONS. JULY, 1888.

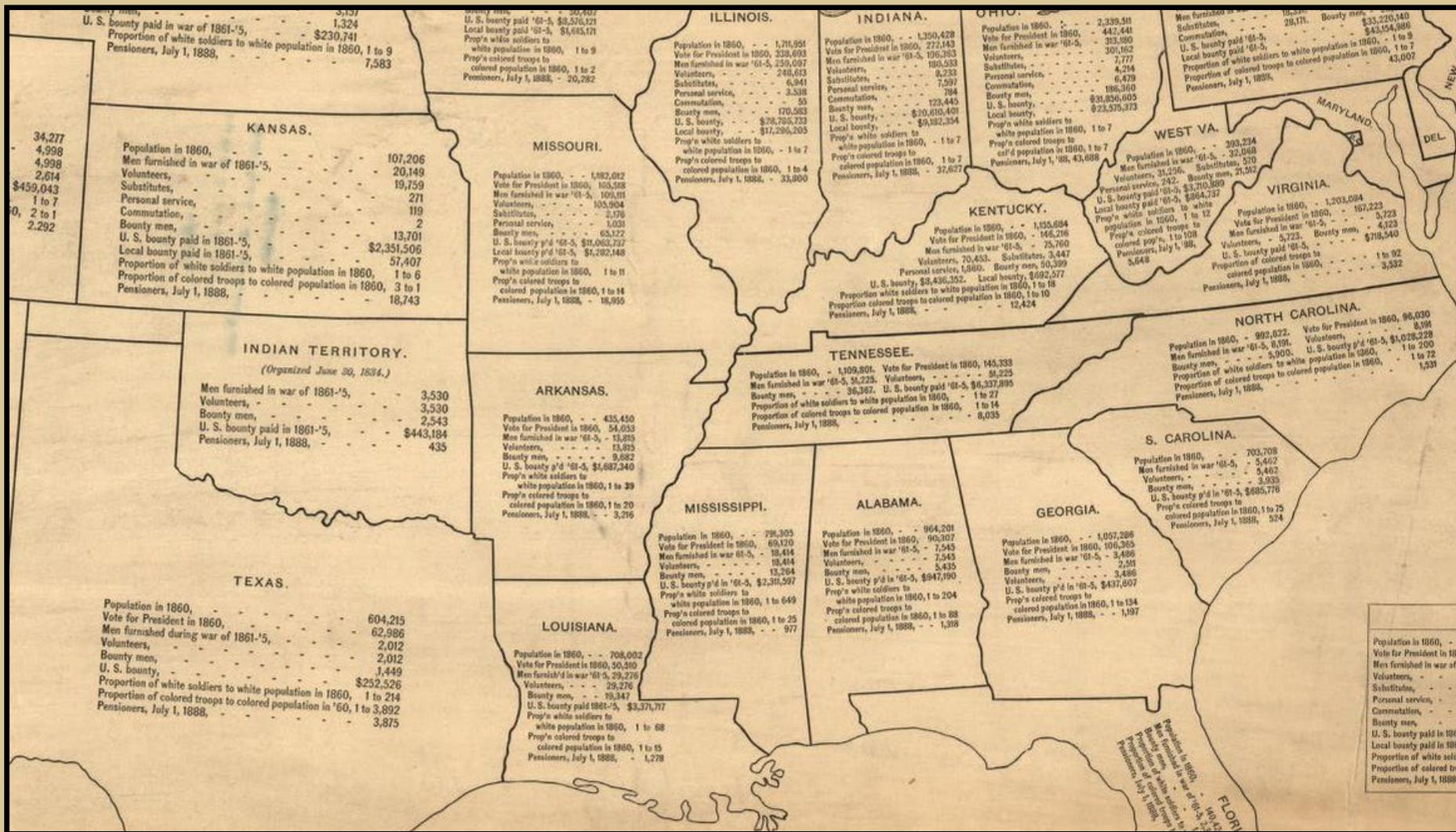
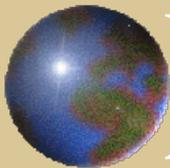


	Vermont.	New Hampshire.	Maine.	Connecticut.	Rhode Island.	New Jersey.	Delaware.	Maryland.	District of Columbia.
Population in 1880.	230,000	376,010	1,270,000	660,487	174,033	672,000	92,200	692,000	50,000
Male for Pension in 1880.	62,840	65,010	160,750	77,460	30,910	170,070	16,810	92,000	14,250
Male for Pension in 1888.	70,000	70,000	160,750	80,000	33,250	170,000	17,200	92,000	14,250
Female in 1880.	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Female in 1888.	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
U. S. Army paid in 1880-5.	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000
U. S. Army paid in 1888-5.	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000
Land bounty paid in 1880-5.	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000
Land bounty paid in 1888-5.	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000
Proportion of white soldiers to white population in 1880.	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10
Proportion of white soldiers to white population in 1888.	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10
Proportion of colored troops to colored population in 1880.	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10
Proportion of colored troops to colored population in 1888.	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10	1 to 10

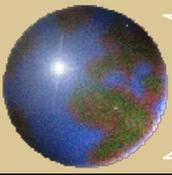
GRAND TOTAL.	
Population in 1880.	3,443,310
Male for Pension in 1880.	4,600,000
Male for Pension in 1888.	2,700,000
Female in 1880.	10,000,000
Female in 1888.	10,000,000
U. S. Army paid in 1880-5.	\$200,000,000
U. S. Army paid in 1888-5.	\$200,000,000
Land bounty paid in 1880-5.	\$200,000,000
Land bounty paid in 1888-5.	\$200,000,000
Proportion of white soldiers to white population in 1880.	1 to 10
Proportion of white soldiers to white population in 1888.	1 to 10
Proportion of colored troops to colored population in 1880.	1 to 10
Proportion of colored troops to colored population in 1888.	1 to 10

Division of Maps APR 30 1942 Library of Congress

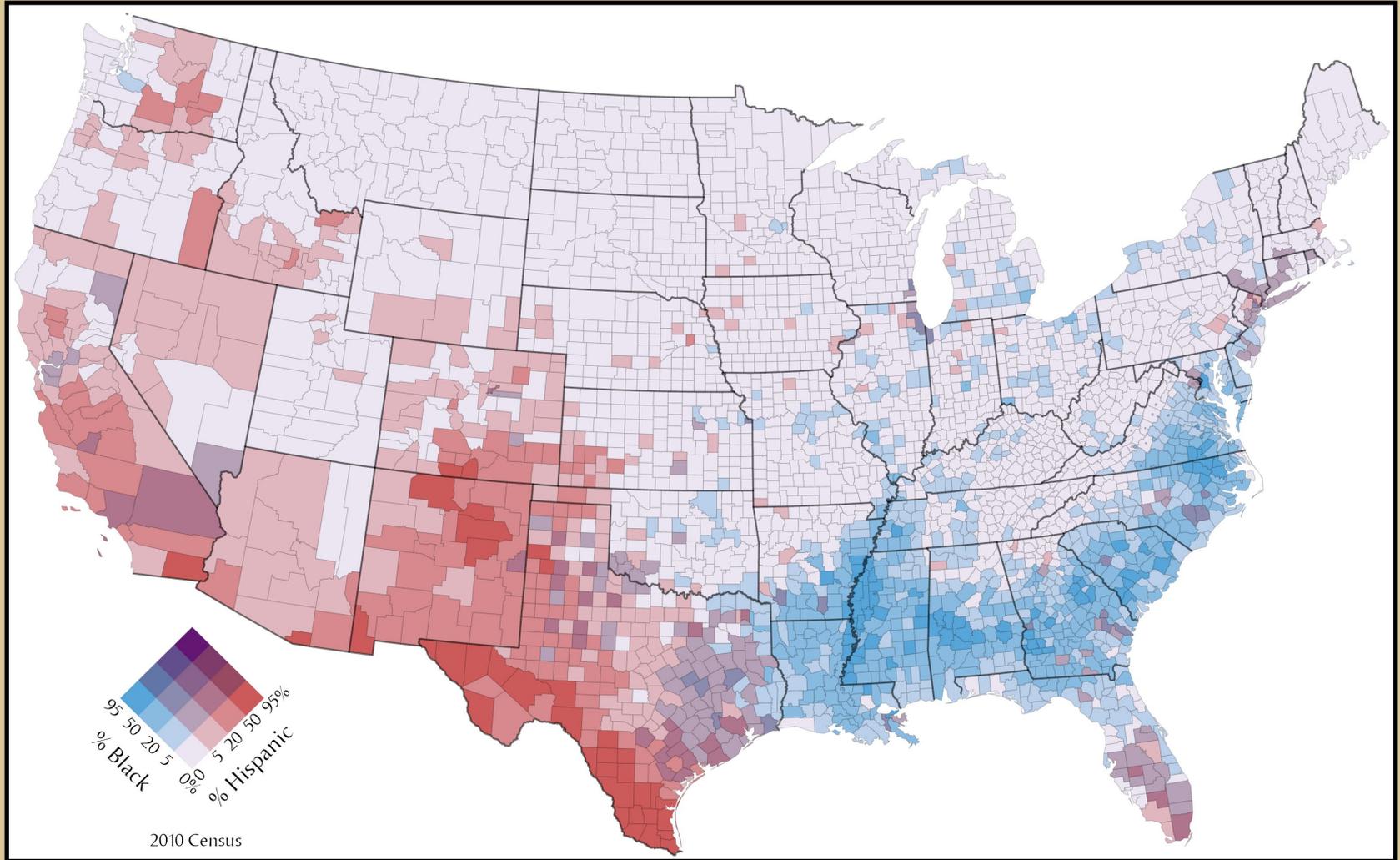
Statistical map of the United States of America, Cowdon, James S. and Holman, James D., Wash., D.C. M. Joyce, Eng. 1888.



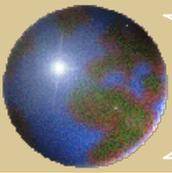
Statistical map of the United States of America,
 Cowdon, James S. and Holman, James D.,
 Wash., D.C. M. Joyce, Eng. 1888.



Bivariate maps



Bivariate choropleth map comparing the Black (blue) and Hispanic (red) populations in the United States, 2010 census; shades of purple show significant proportions of both groups.

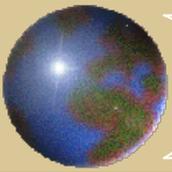


Bivariate colors – ArcGIS Pro Documentation

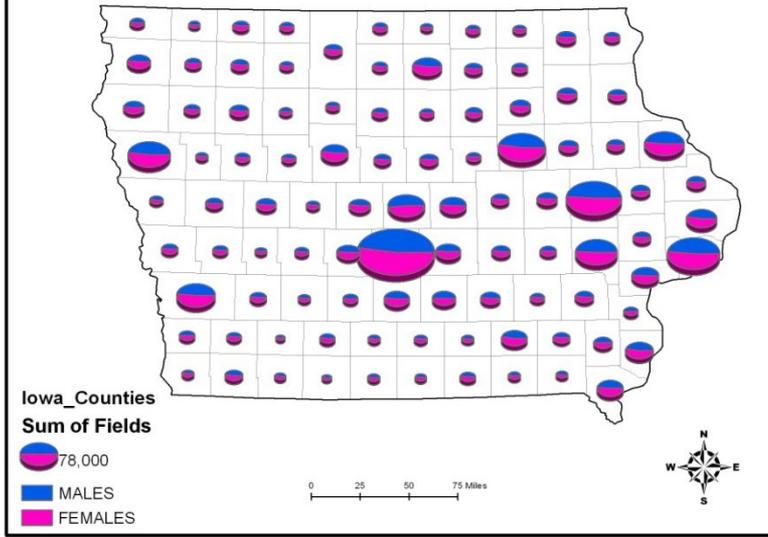
2 variables with 3 classes each will yield a total of 9 possible combinations

2 variables with 4 classes each will yield a total of 16 possible combinations

At this rate we start to quickly lose the ability to distinguish the various shades of color from each other.



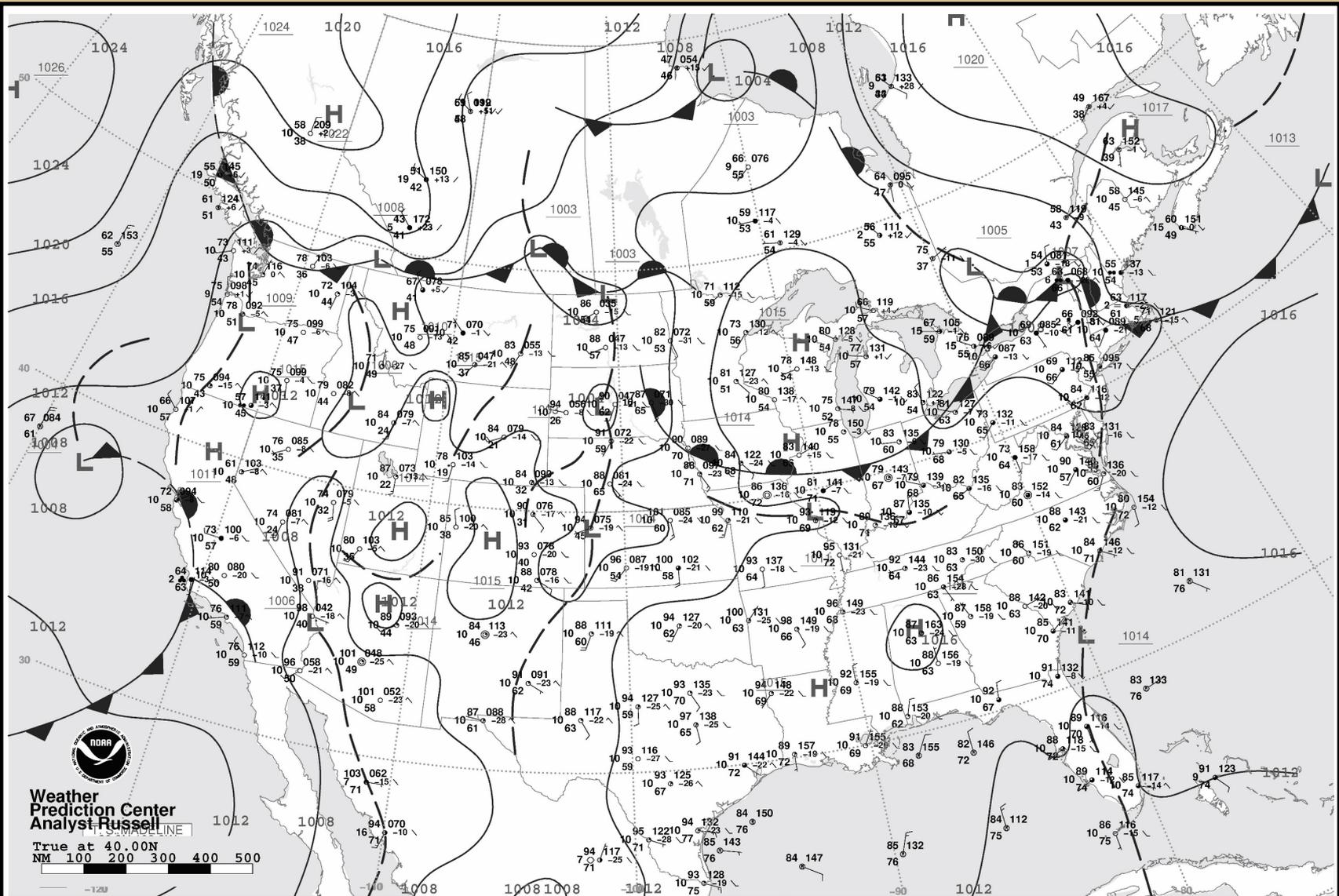
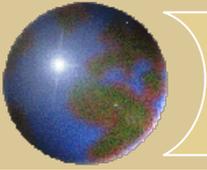
Number of Males and Females in Iowa in 1990



Gender distribution in Iowa, by county, using a combination of proportional and pie chart symbols

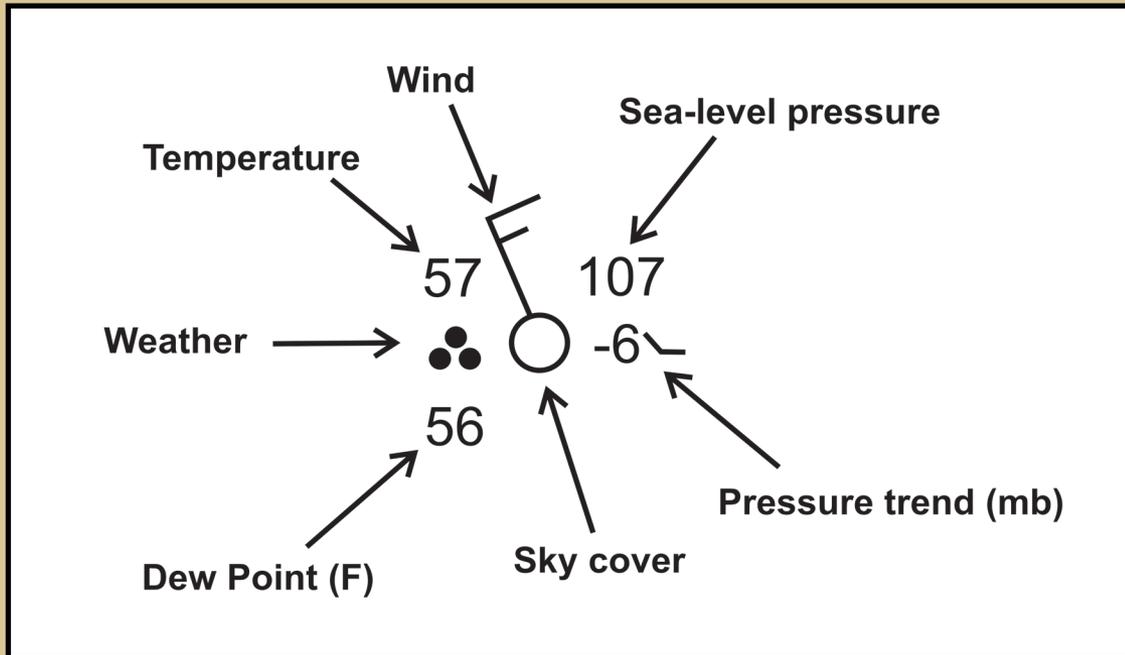
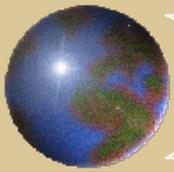
The map to the right shows one variable as a choropleth map (county pop), with a second variable shown as proportional symbols (deer accidents) on top.





Weather Prediction Center
Analyst: Russell
True at 40.00N
NM 100 200 300 400 500

MON SEP 19 2022 21 UTC
Surface Weather Map and Station Weather



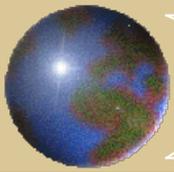
Adapted from the National Weather Service, Weather Prediction Center's Sample Station Plot, 9-19-2022

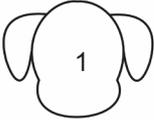
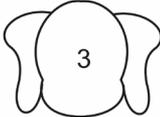
WEATHER

••	•••	••••	Rain (light, moderate, Heavy)
* *	* * *	* * * *	Snow (light, moderate, heavy)
⊆	⊆	⊆	Thunder (with rain, snow, no precipitation)
∇	∇		Shower (rain, snow)
	„		Drizzle
∞	∞		Freezing rain, Freezing drizzle
	△		Ice pellets/Sleet
=	≡		Fog (thin, thick)
	∞		Haze

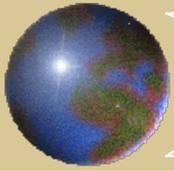
SKY COVER

○	Clear
⊏	Few clouds (less than 12% cloud cover, but sky is not clear)
⊓	Scattered clouds (approximately 25% cloud cover)
◐	Partly cloudy (approximately 50% cloud cover)
◑	Mostly cloudy (approximately 75% cloud cover)
●	Overcast
⊗	Sky Obscured
Ⓜ	Sky Cover Missing



 1 High	 2 Medium	 3 Low
 High	 Medium	 Low
 High	 Medium	 Low

111	112	113	211	212	213	311	312	313
								
121	122	123	221	222	223	321	322	323
								
131	132	133	231	232	233	331	332	333
								



Questions?