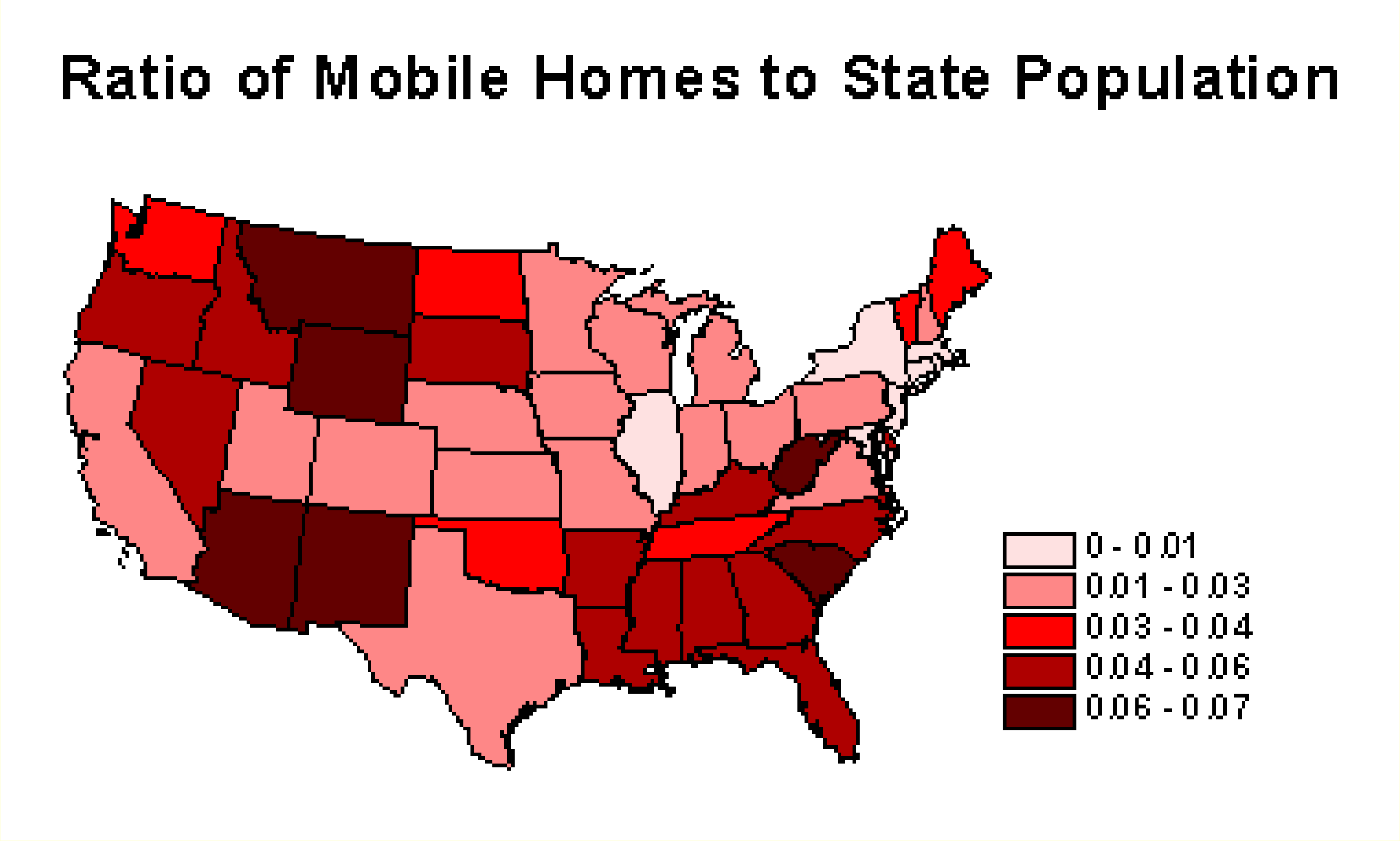
Map Design – Thematic Mapping

Our objectives:

- We will consider four thematic map types
  - choropleth
  - proportional symbol
  - dot density
  - cartograms
- understand decisions involved in classifying quantitative data in thematic maps

Choropleth Maps

- Greek: choros (place) + plethos (filled)



Choropleth Maps

- These use **polygonal enumeration units**
  - e.g. census tract, counties, watersheds, etc.
- Data values are generally **classified** into ranges
- Polygons can produce misleading impressions
  - area/size of polygon vs. quantity of thematic data value

Thematic Mapping Issue: Modifiable Area Unit Problem

- Assumption:
  - Mapped phenomena are **uniformly** spatially distributed within each polygon unit
  - This is usually not true!
- **Boundaries** of enumeration units are frequently **unrelated** to the spatial distribution of the phenomena being mapped
- This issue is always present when dealing with data collected or aggregated by polygon units

MAUP

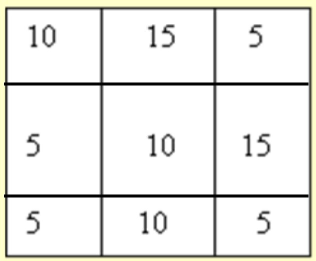
Modifiable Areal Unit Problem: (x represents the mean, below)

Scale Effects (a,b)

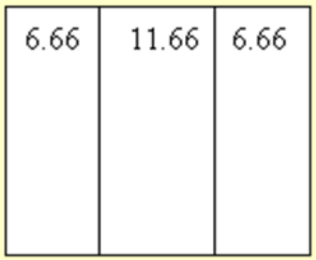
Zoning Effects (c,d)

<u>Note: the following numbers refer to quantities *per unit area*.</u>

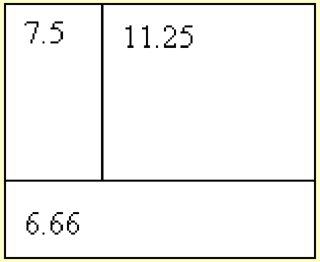
a)



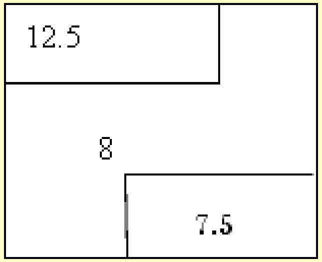
b)



c)



d)



<u>Summary</u>: As you "scale up" or choose different zoning boundaries, results change.

Classifying Thematic Data

- Data values are classified into ranges for many thematic maps (especially choropleth)
  - This aids the reader's interpretation of map
- Trade-off:
  - presenting the underlying data **accurately**

    VS.
  - **generalizing** data using classes
- Goal is to meaningfully classify the data
  - group features with similar values
  - assign them the same symbol/color
- But how to meaningfully classify the data?

Creating Classes

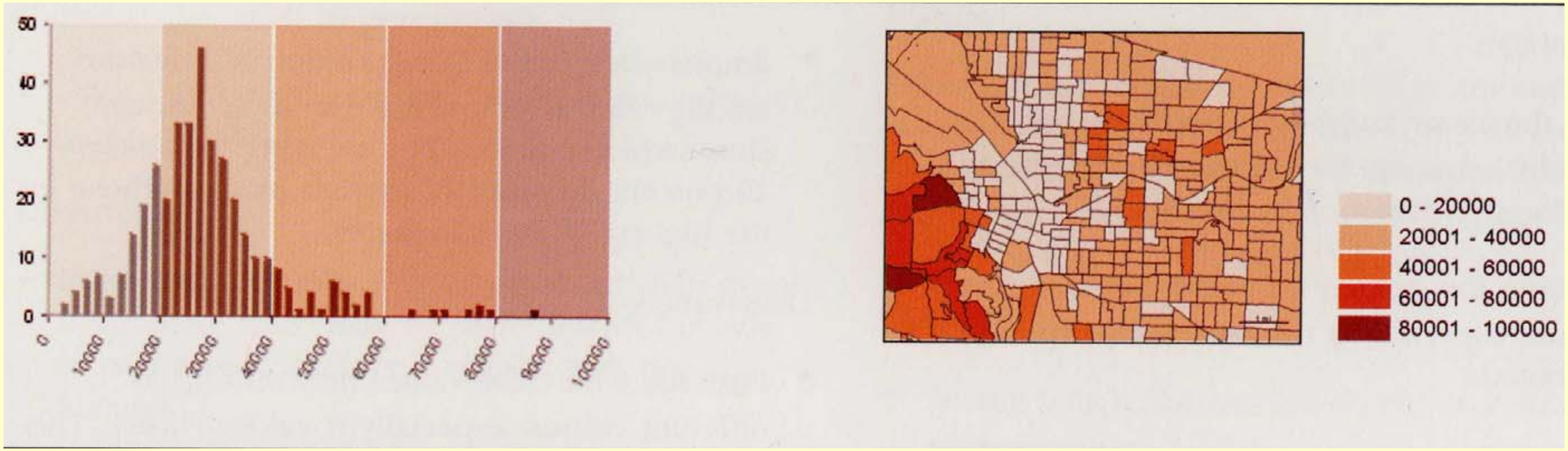
- How many classes should we use?
  - too few - obscures patterns
  - too many - confuses map reader
    - difficult to recognize more than seven classes

Creating Classes

- Methods to create classes
  - assign classes **manually**
  - **equal intervals**: This ignores the data distribution
  - **“natural” breaks**
  - **quartiles**: top 25%, 25% above middle, 25% below middle, bottom 25% (quintiles uses 20%)
  - **standard deviation**: mean+1s, mean-1s, mean+2s, mean-2s, …

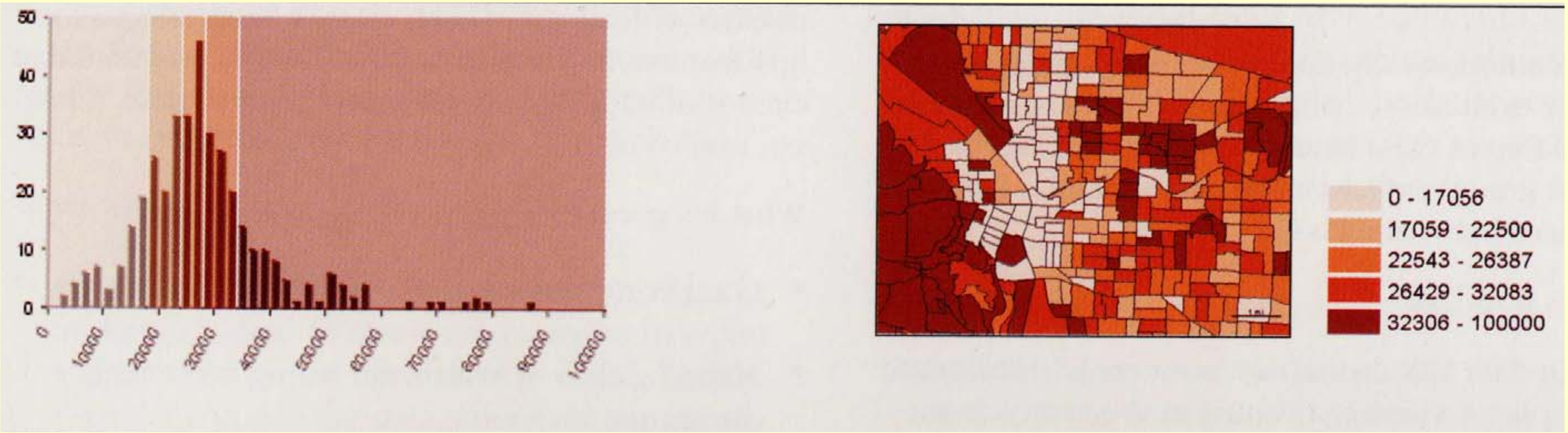
The Effect of Classification

- **Equal Interval**
  - Splits data into user-specified number of classes of equal width
  - Each class has a different number of observations



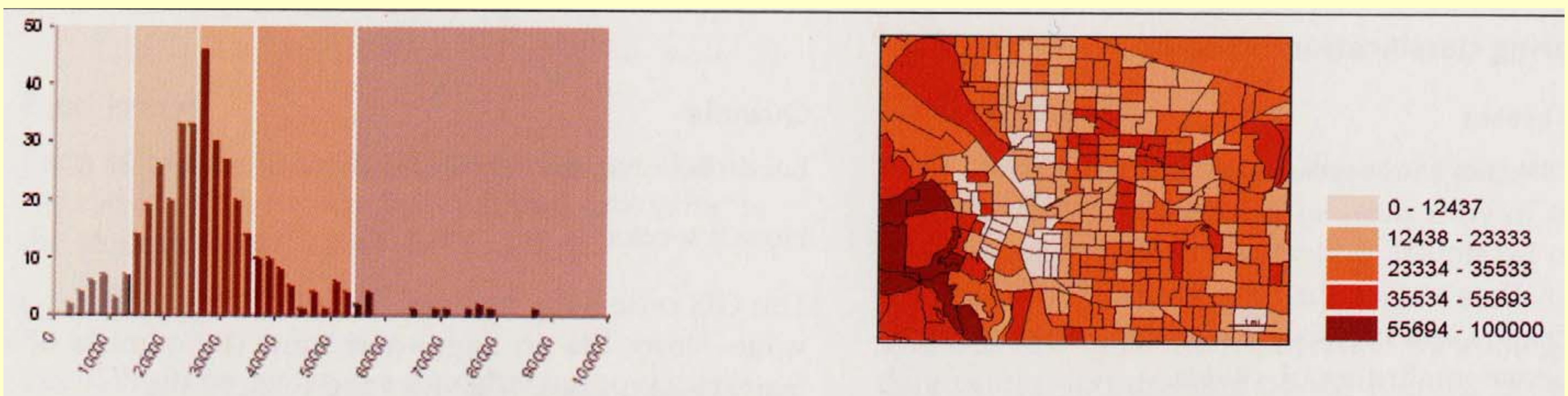
The Effect of Classification

- **Quantiles**
  - Data divided so that there are an equal number of observations are in each class
  - Some classes can have quite narrow intervals



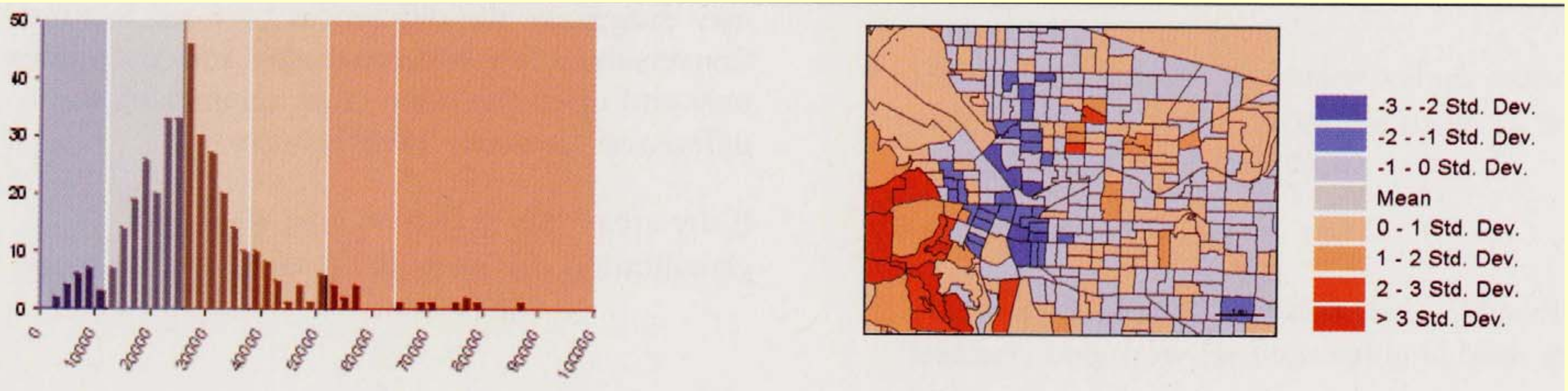
The Effect of Classification

- **Natural Breaks**
  - Splits data into classes based on natural breaks represented in the data histogram



The Effect of Classification

- **Standard Deviation**
  - – Mean + or – Std. Deviation(s)

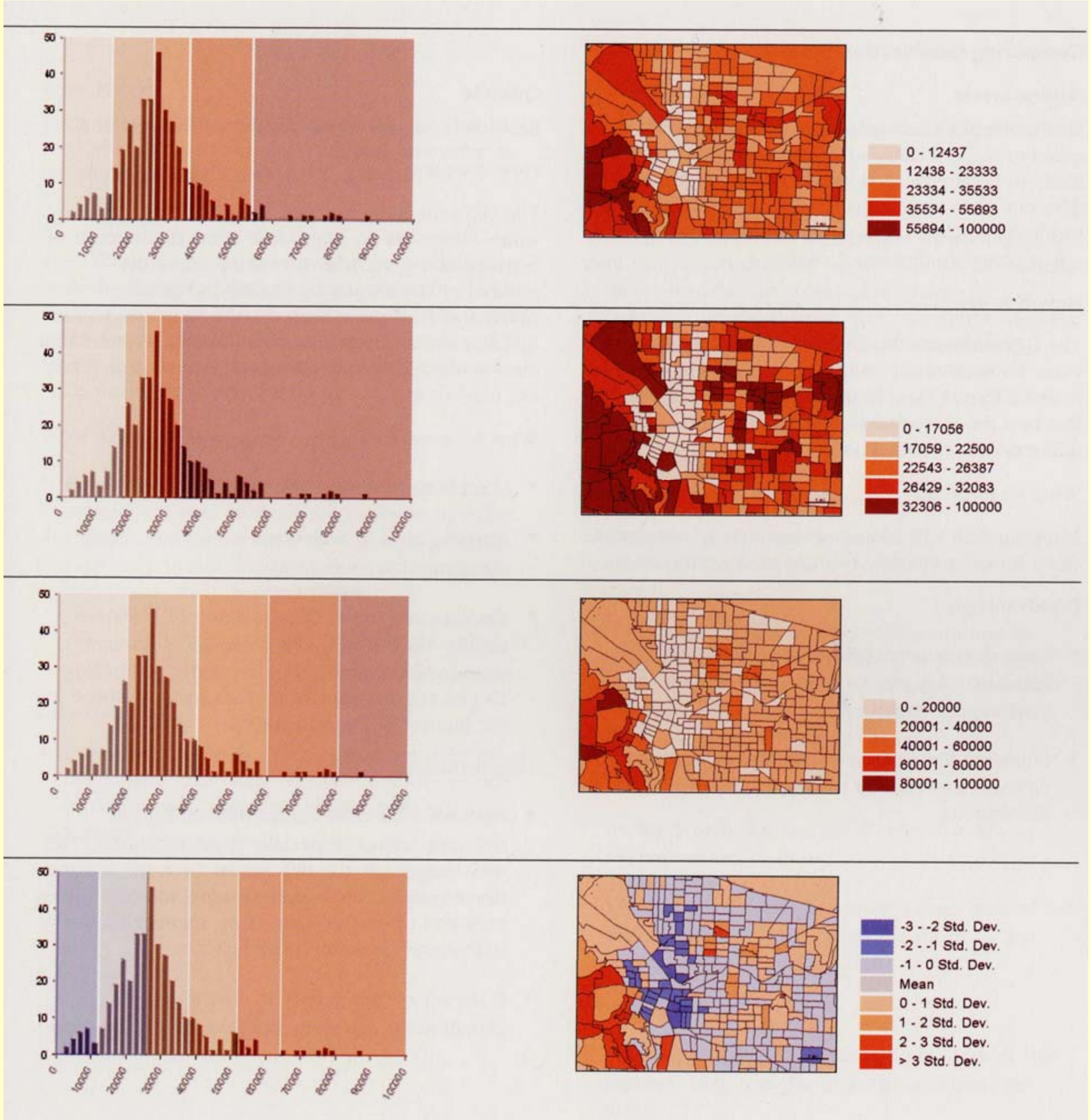


Natural Breaks

Quantiles

Equal Interval

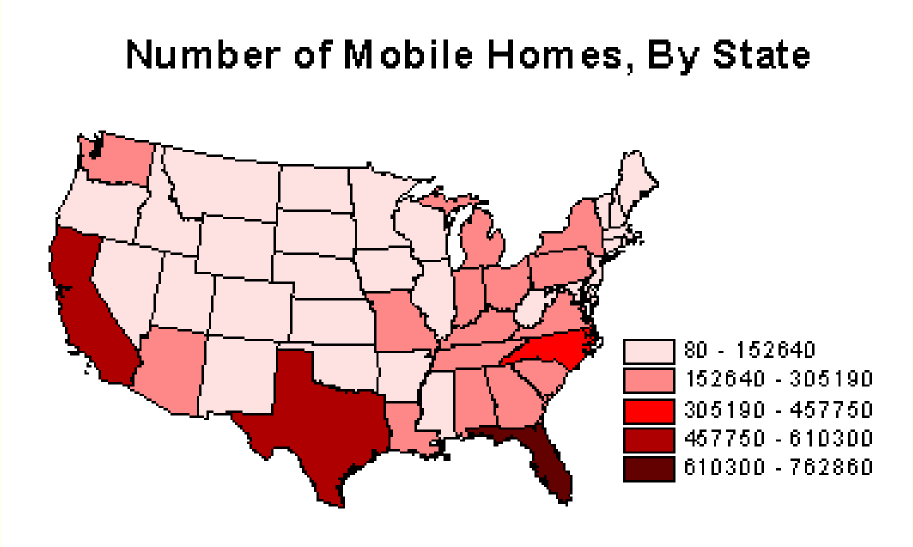
Standard Deviation



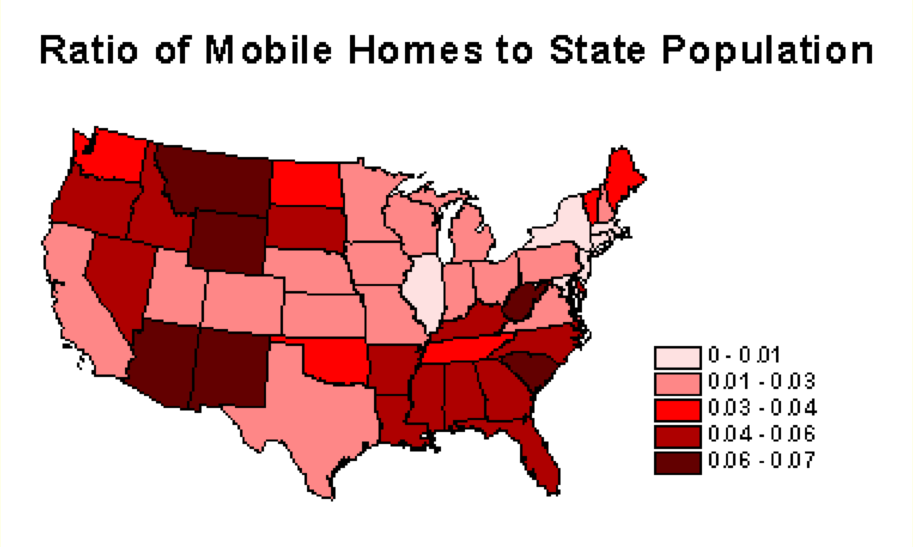
Thematic Mapping Issue: Counts Vs. Ratios

- When mapping count data, a problem frequently occurs where smaller enumeration units have lower counts than larger enumeration units simply because of their size. This masks the actual spatial distribution of the phenomena.
- **Solution:** map densities by area, e.g. population density, or generate other derived ratios, e.g. per capita income, automobile accidents per road mile

Thematic Mapping Issue: Counts Vs. Ratios

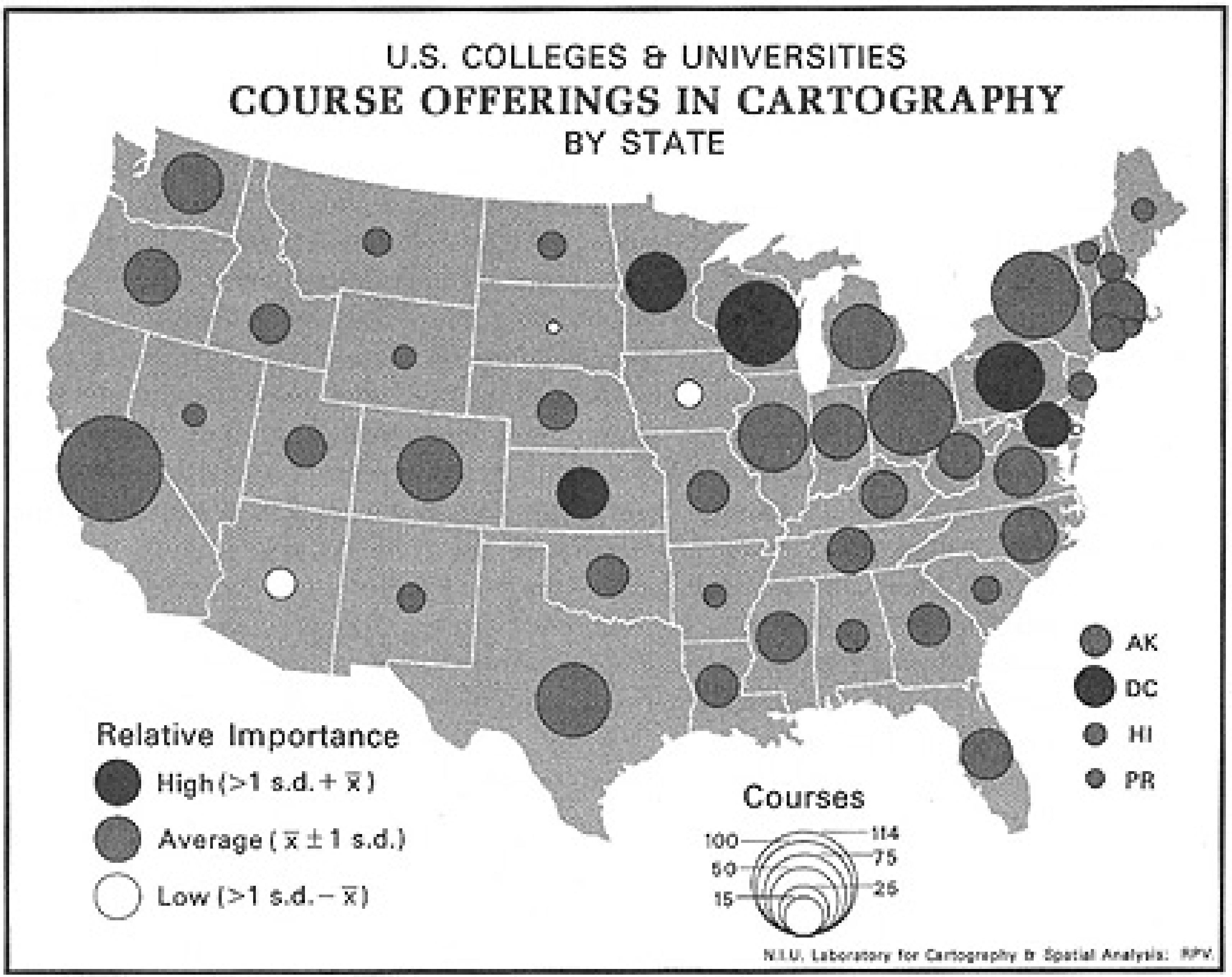


- raw count (absolute) values may present a misleading picture



- Solution:
- **normalize** the data
- ratio values

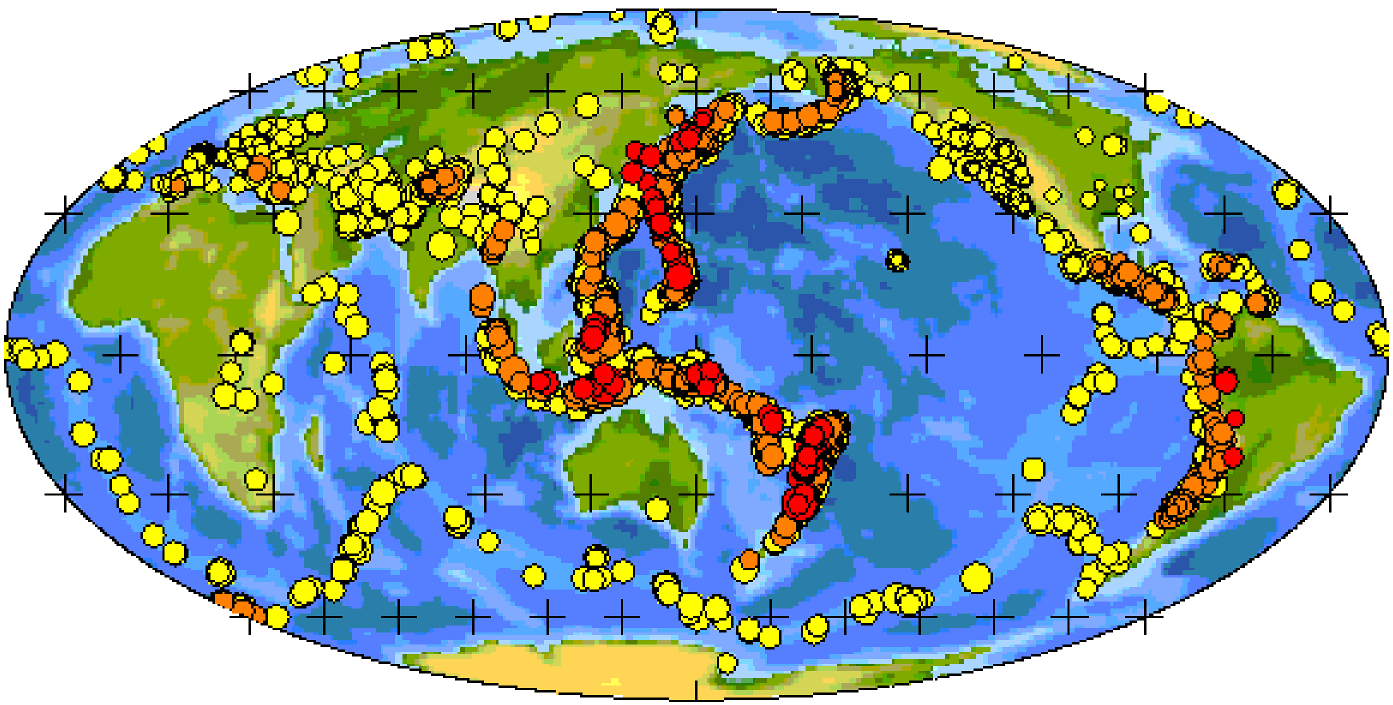
Proportional Symbol Maps



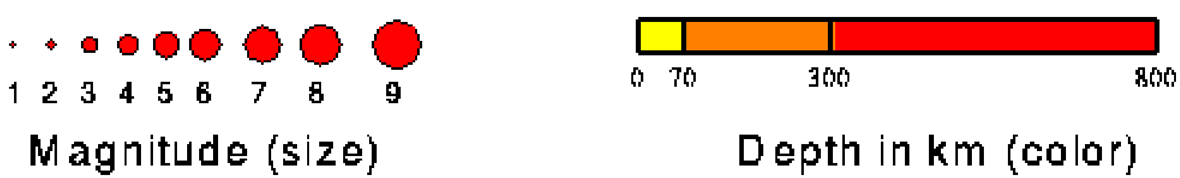
Proportional Symbol Maps

- Size of symbol is **proportional** to size of data value
  - also called graduated symbol maps
- Frequently used for mapping points' attributes
  - avoids distortions due to area size as seen in choropleth maps

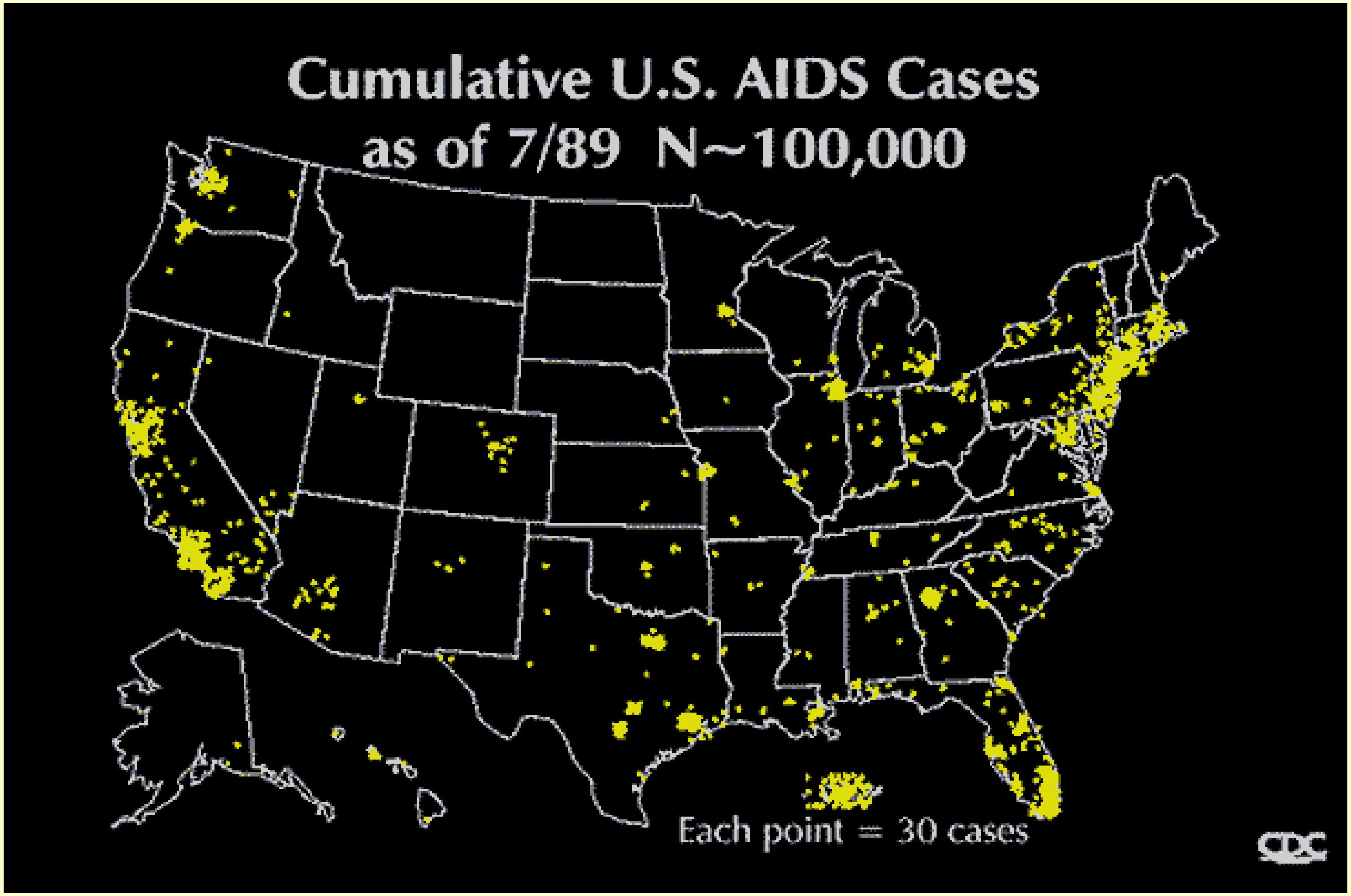
04/01/1997 - 06/30/1997 M > 2.0



CNSS Earthquake Catalog



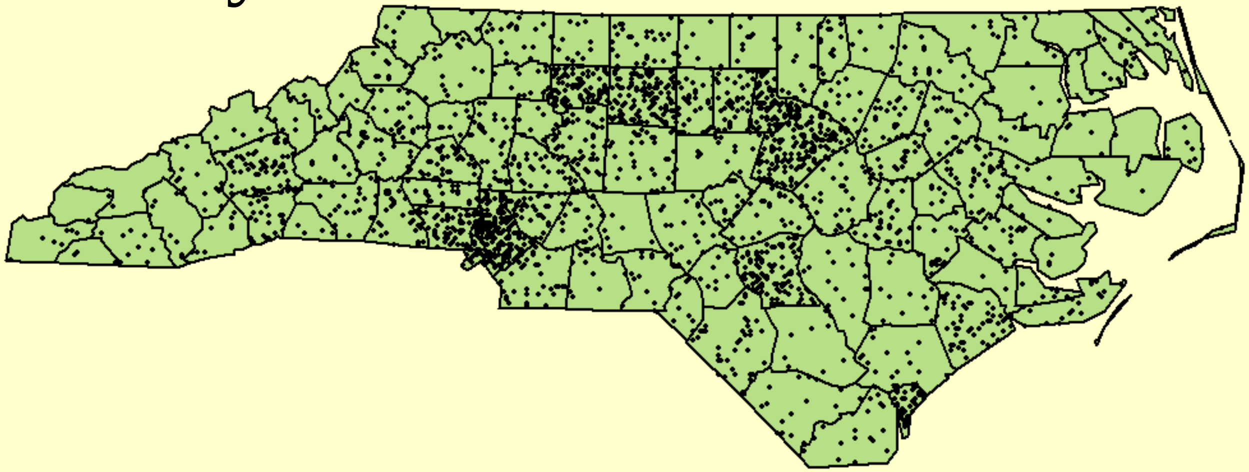
Dot Density Maps

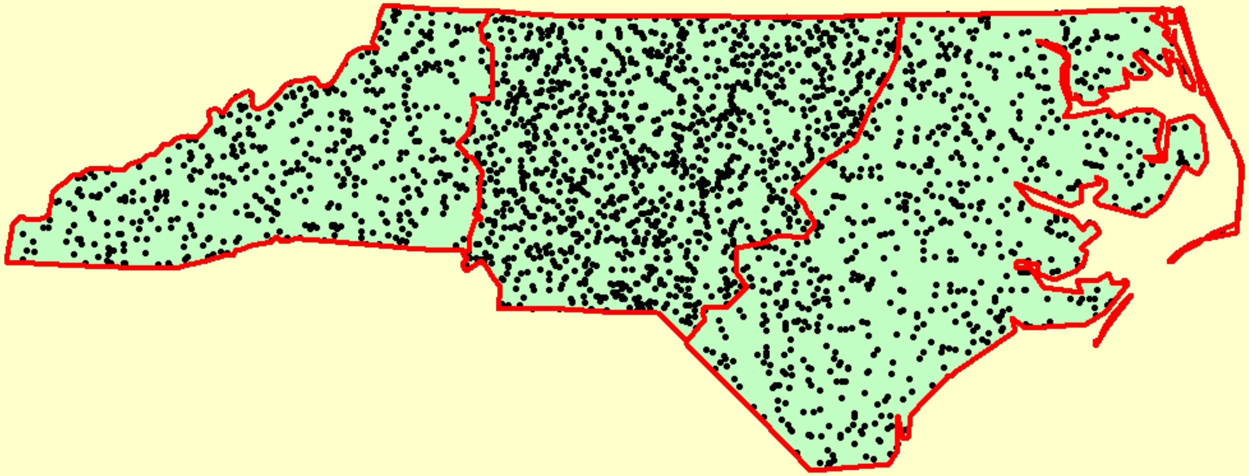


Map credits/source: Division of HIV/AIDS Prevention, National Center for HIV, STD, and TB Prevention (NCHSTP), Centers for Disease Control.

Dot Density Maps

- Population by county





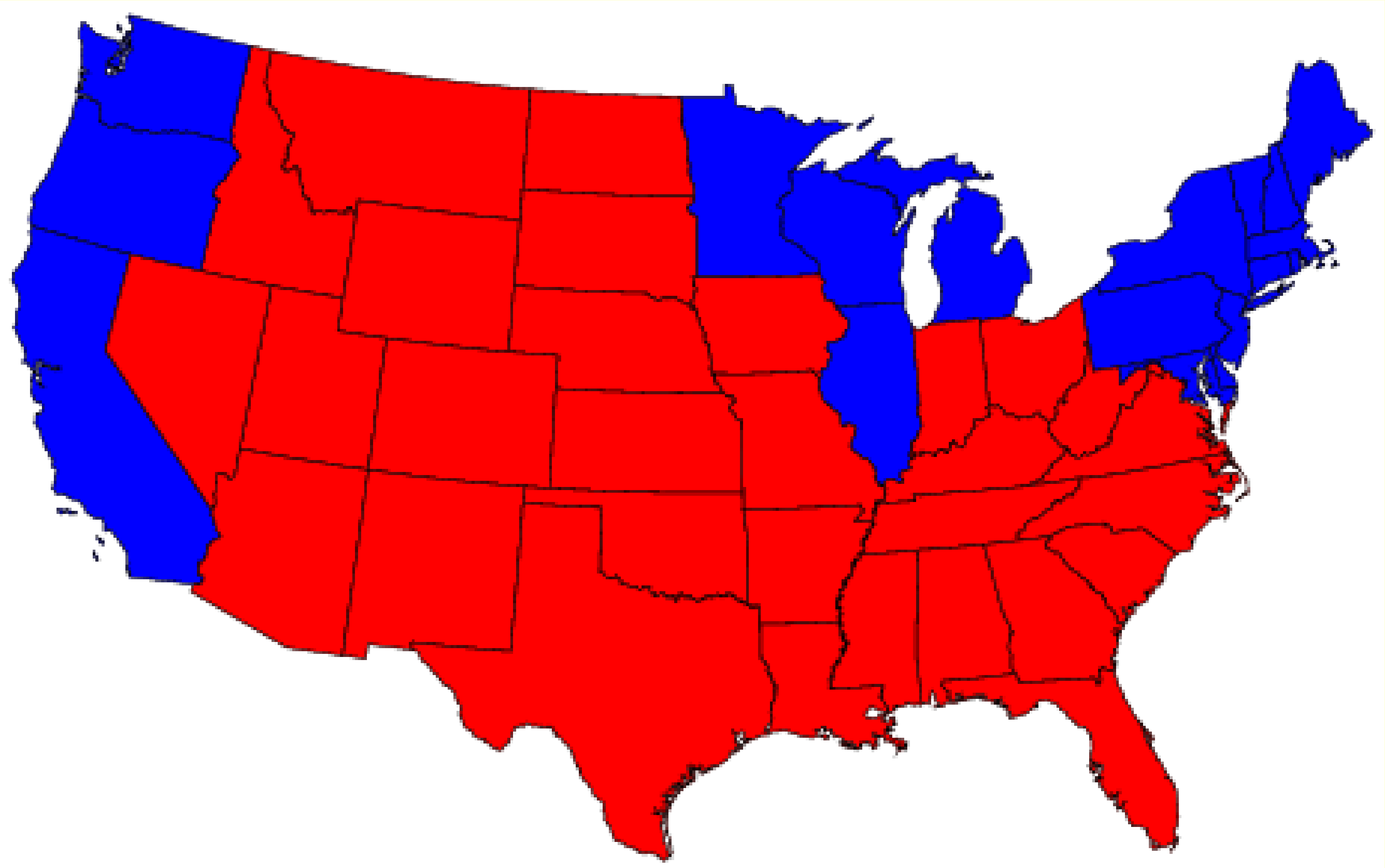
Dot Density Maps

- Dot density maps provide an immediate picture of density over area
- 1 dot = some quantity of data value
  - e.g. 1 dot = 500 persons
  - the quantity is generally associated with polygon enumeration unit
    - MAUP still exists
- **Placement** of dots within polygon enumeration units can be an issue, especially with sparse data

Cartograms

- Instead of normalizing data within polygons:
  - We can **change** the **polygons** themselves!
  - Maps that do this are known as **cartograms**
  - Cartograms **distort** the **size and shape** of polygons to portray sizes proportional to some quantity other than physical area

Conventional Map of 2004 Election Results by State



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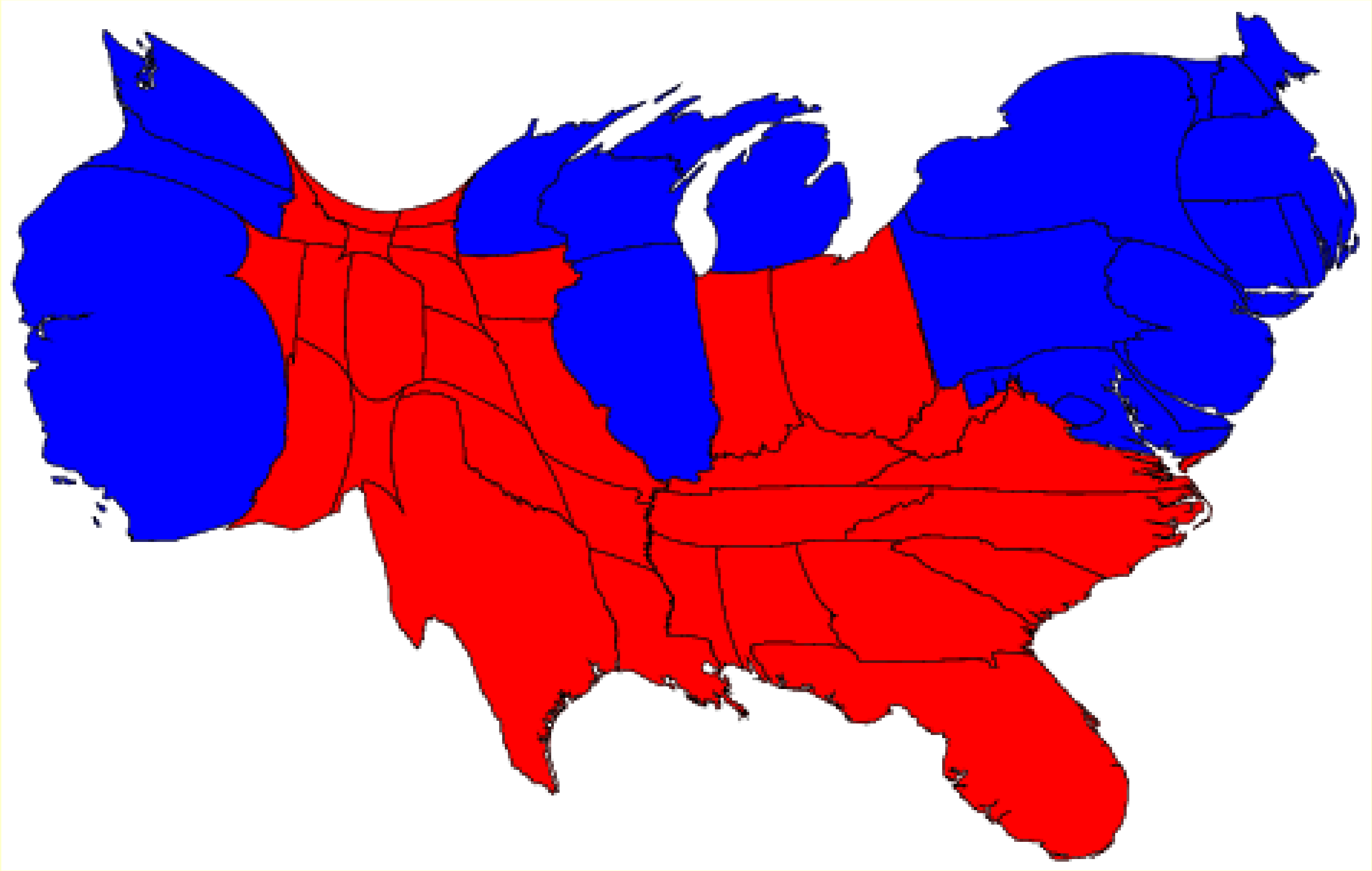
http://www-personal.umich.edu/~mejn/election/

Population Cartogram of 2004 Election Results by State



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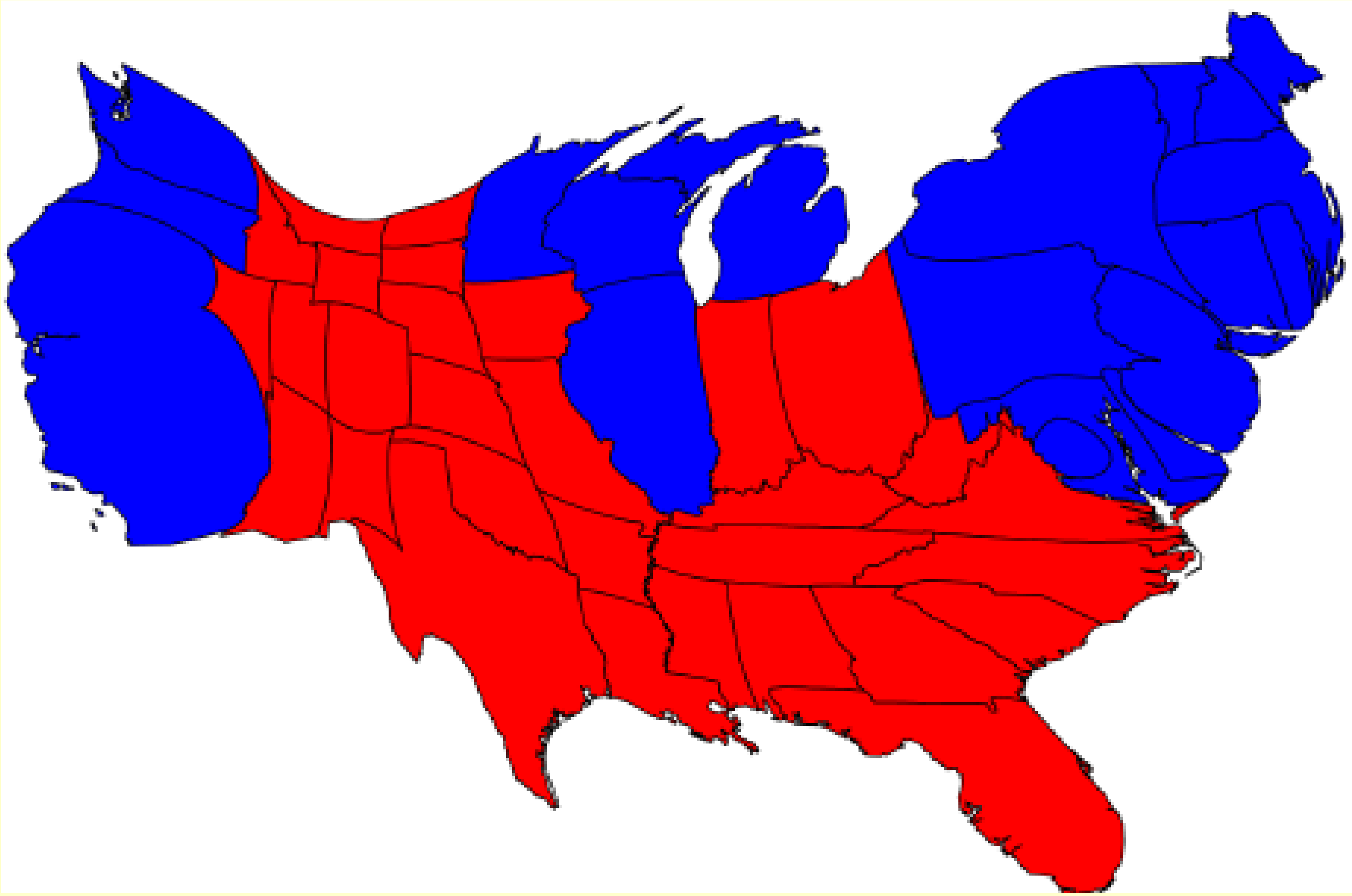
Electoral College Cartogram of 2004 Election Results by State



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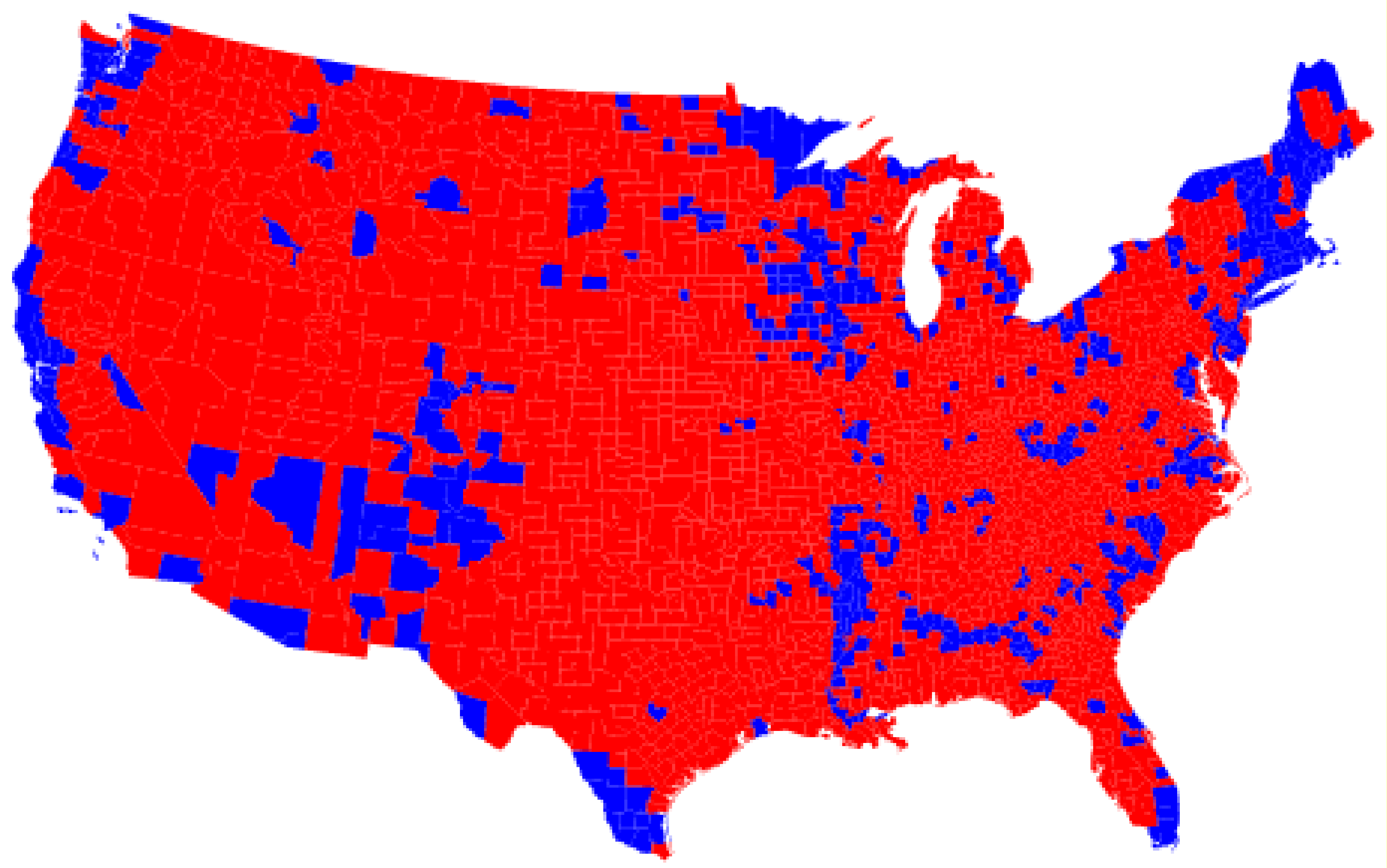
Conventional Map of 2004 Election Results by County



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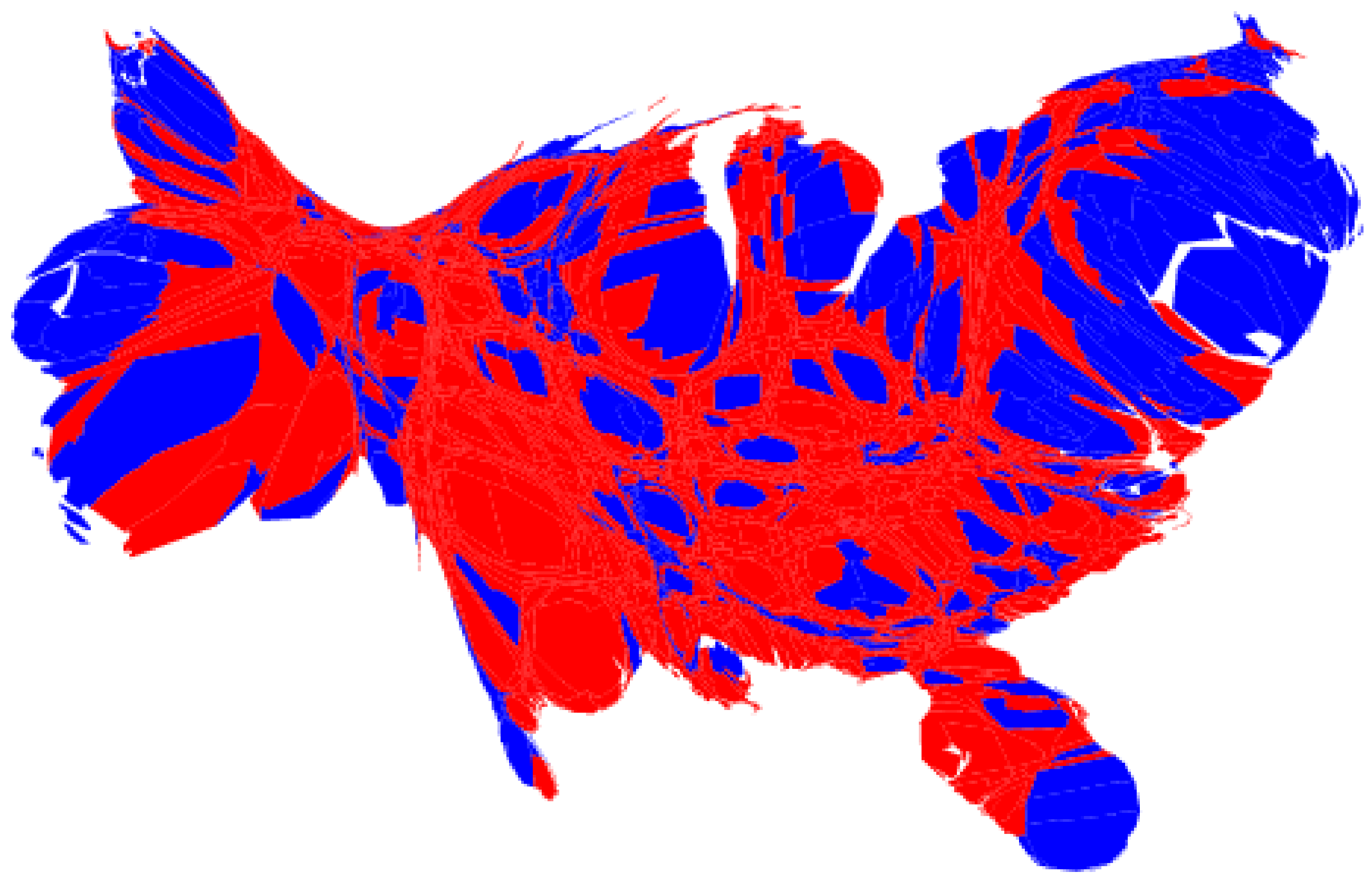

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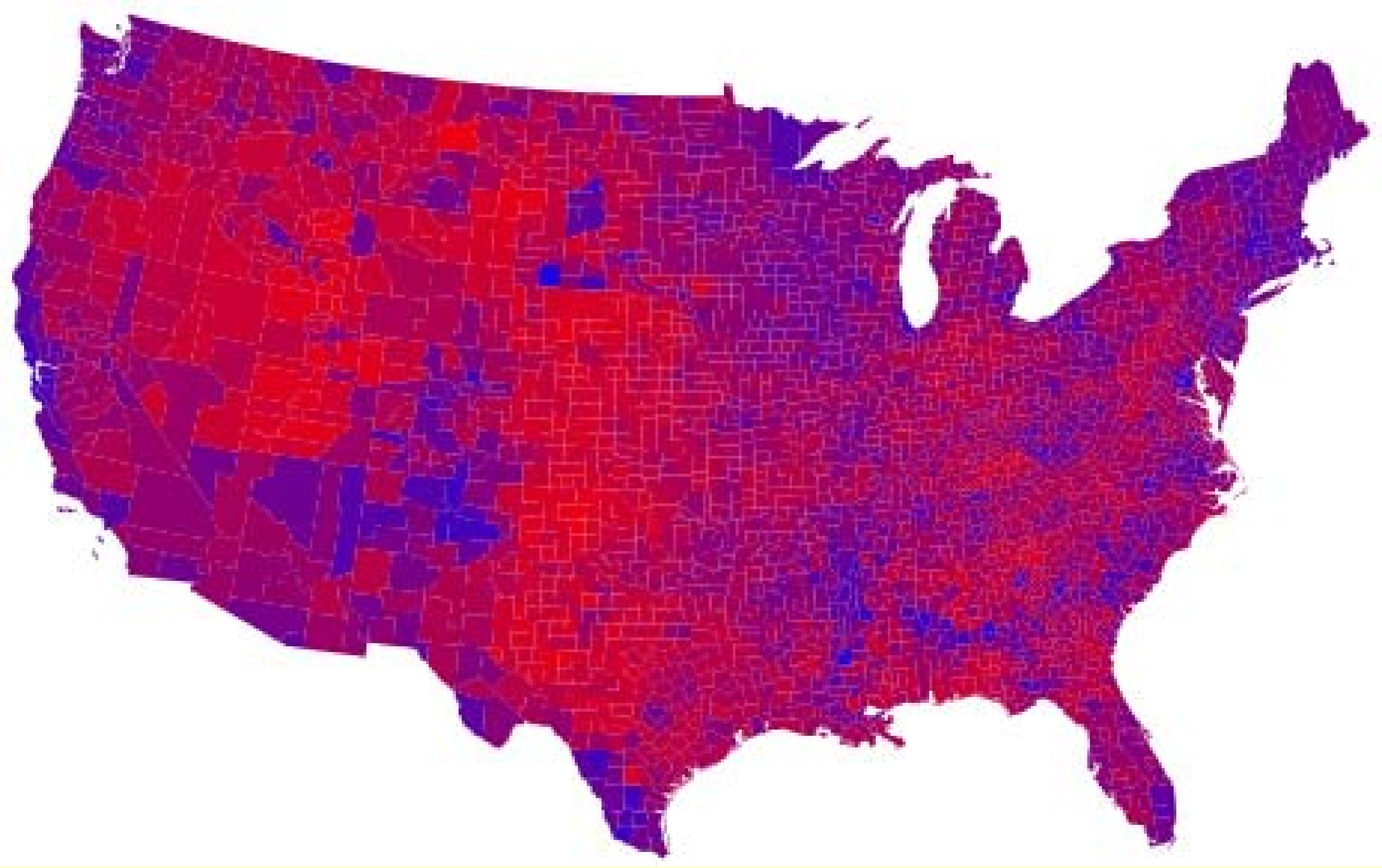
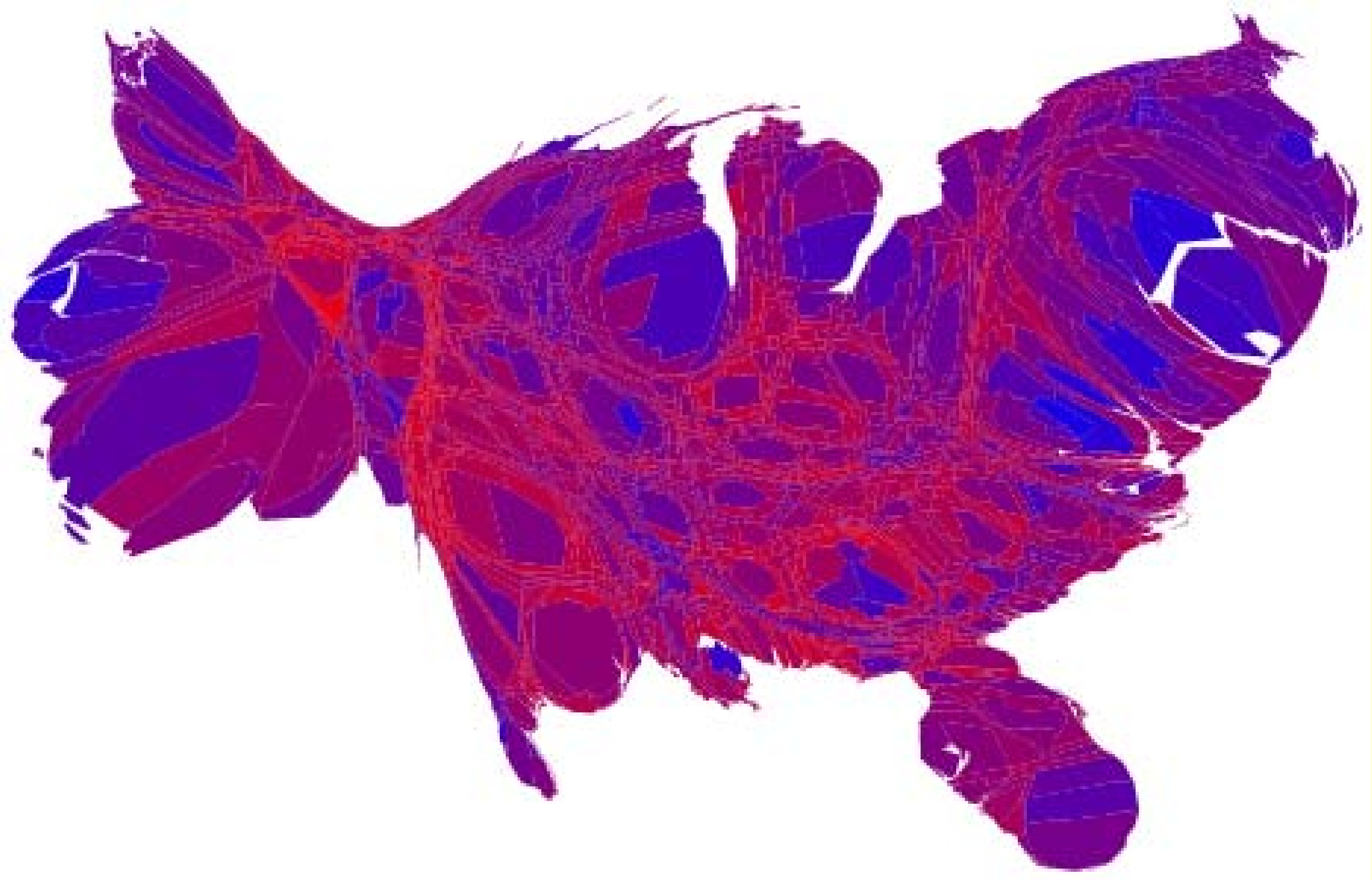
Graduated Color Map of 2004 Election Results by County



Robert J. Vanderbei – Princeton University

http://www.princeton.edu/~rvdb/JAVA/election2004/

Graduated Color Population Cartogram of 2004 Election Results by County



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