

# GEO 309 – Intro to GIS

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# Topics

- Discussion – Dodds
- Choropleth mapping
  - Normalizing data
  - Creating usable measures
  - Classification schemes
- Proportional symbols
- Dot density

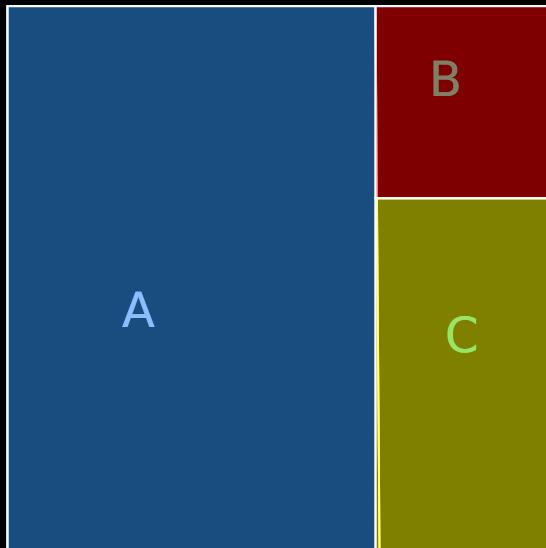
# Discussion – Dodds

- Dodds, K.J. 1993. Geopolitics, cartography and the state in South America. *Geopolitics*, 12(4): 361-381.

# Choropleth Maps

- Area is what we symbolize
  - Magnitude of values
  - Occur in boundaries
  - Distinct color/shading schemes
- Data
  - Aggregated to areal units
  - Derived values (e.g., interval)

# Choropleth Maps

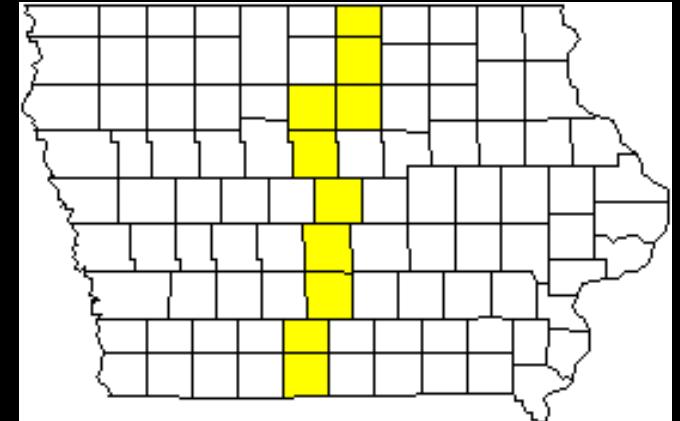


	Area (sq. m)	Pop.	Density
A	100	500	<b>5</b>
B	10	100	<b>10</b>
C	25	200	<b>8</b>

- What are some exceptions?

# Choropleth Maps – Size and Shape

- *Ideal use of Choropleth method*
  - Unit areas should be of relatively equal size to control for uneven generalization
  - Unit areas should be small enough to capture spatial variation
  - Regular and smaller shapes are preferred



# Choropleth Maps – Size and Shape



Not So Good for Choropleth



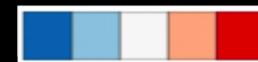
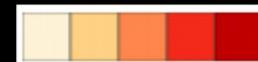
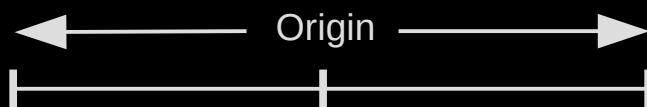
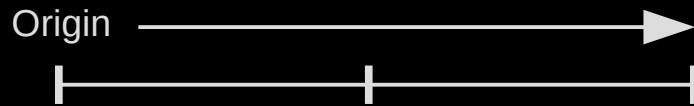
Good for Choropleth

# Choropleth Maps - Shading

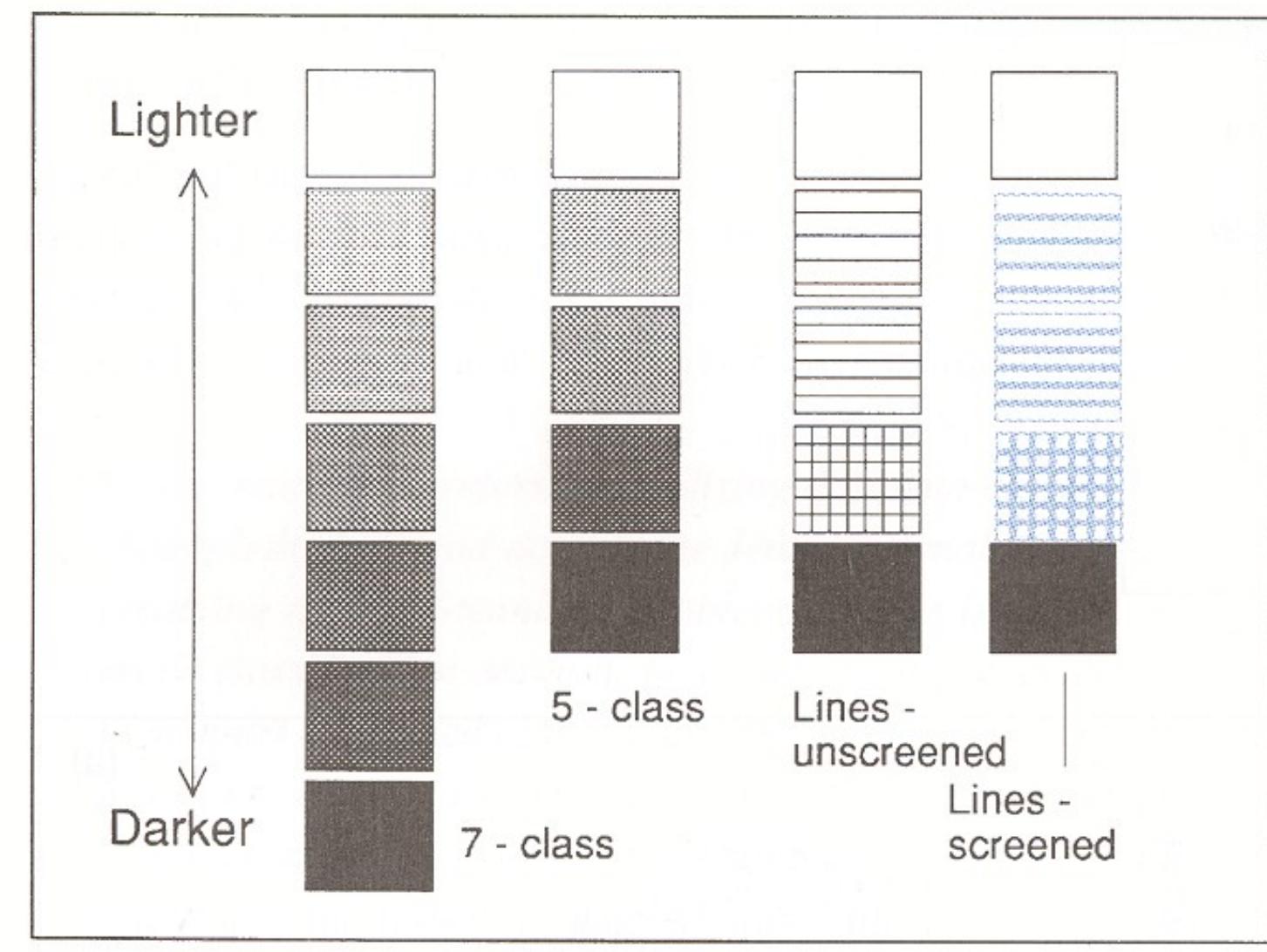
- Key Principles
  - Highest value – darkest tone
  - Lowest value – lightest tone
  - Texture – held relatively constant
- Potential Issues
  - Issues of representation
    - Reification (abstract as concrete)

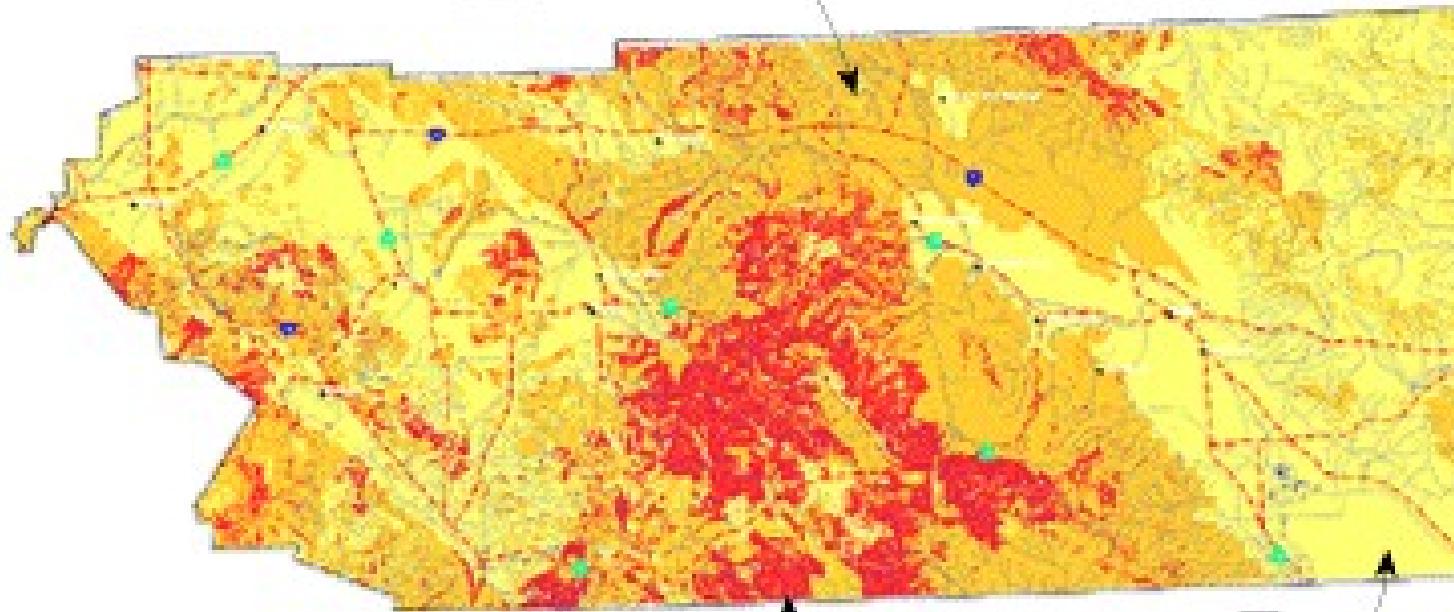
# Choropleth Maps - Shading

- Data
  - Sequential scheme
    - Unipolar data
  - Diverging scheme
    - Bipolar data
  - Spectral schemes
    - Sequential
    - Divergent
  - Qualitative



# Legends



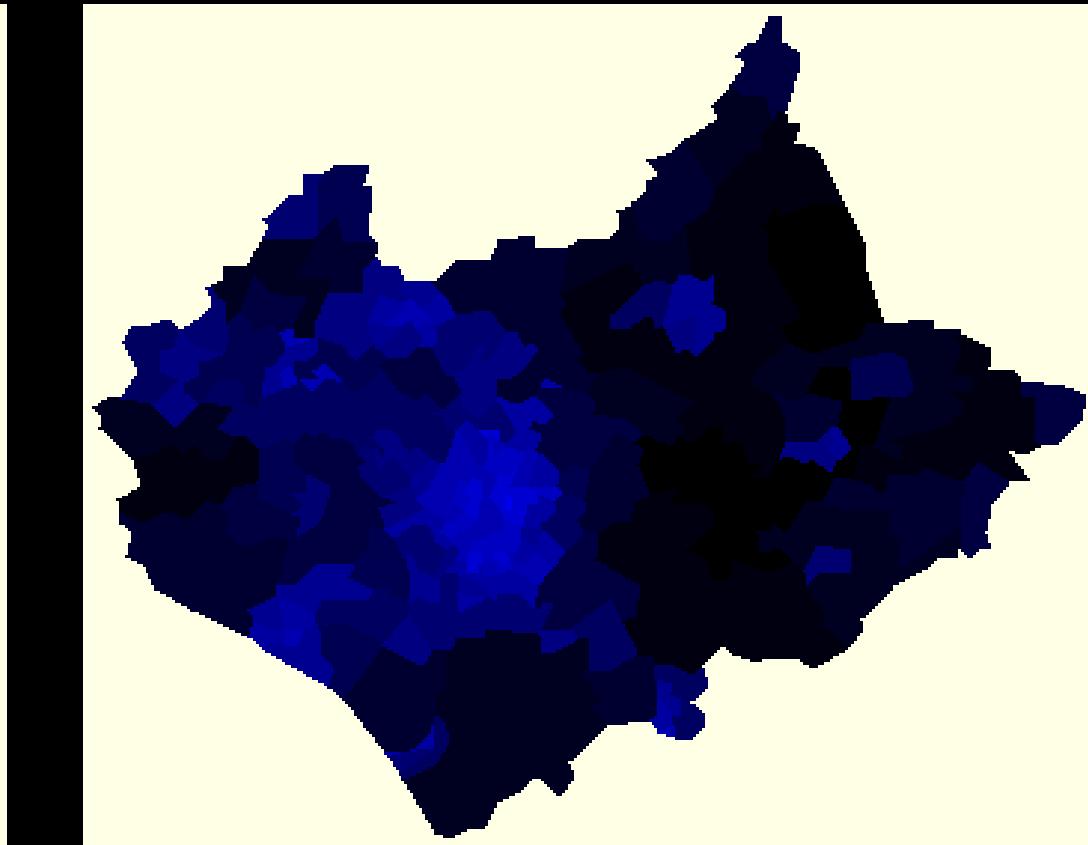
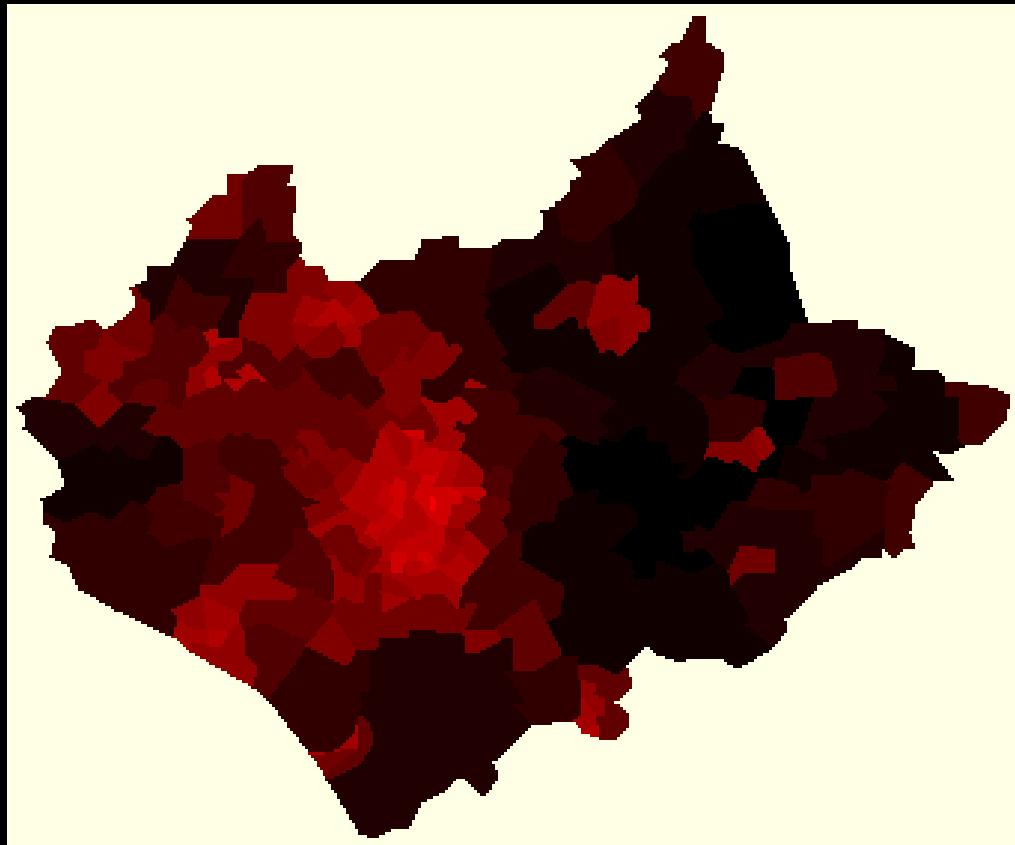


High Hazard

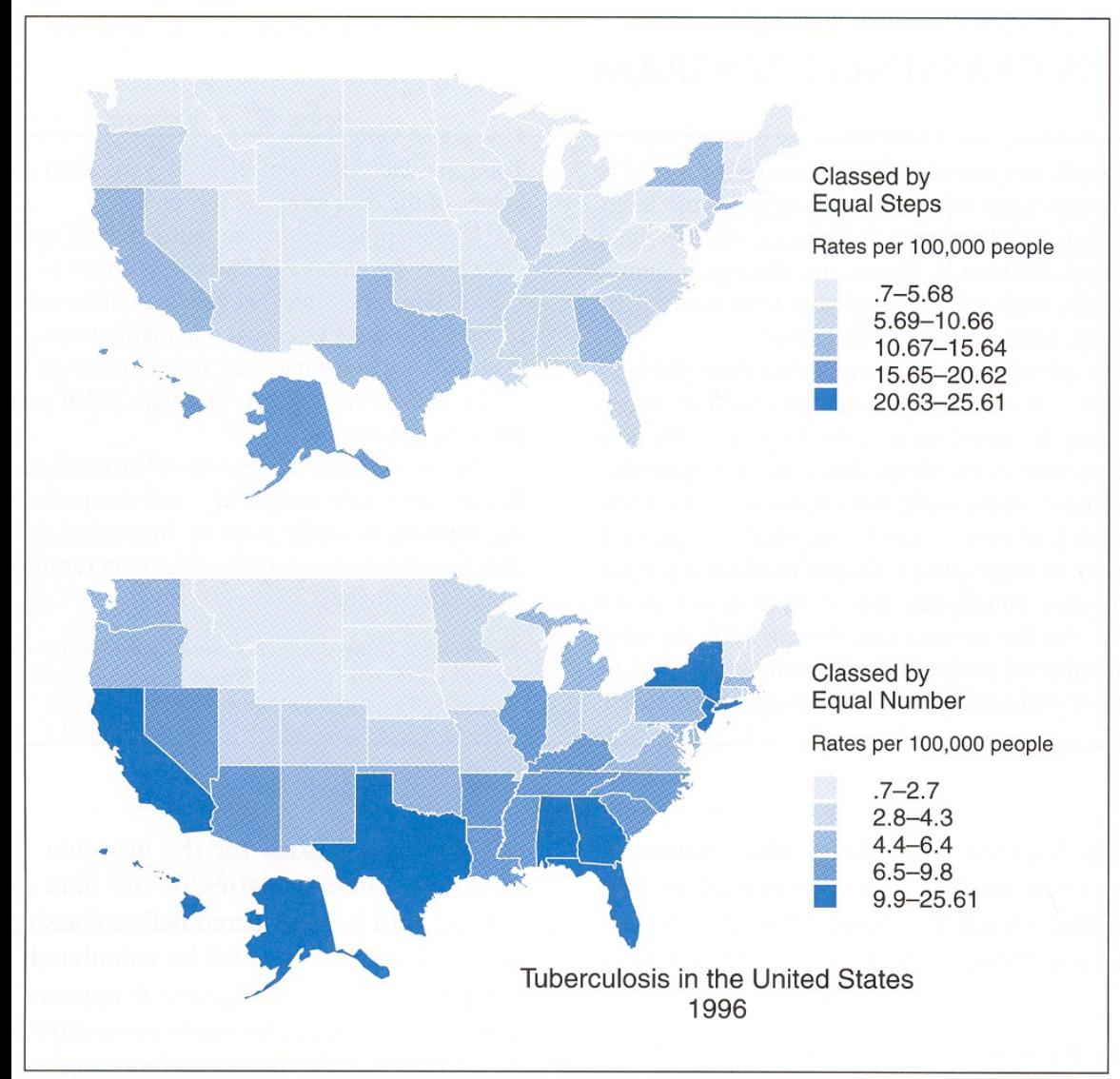
Very High Hazard

Moderate Hazard

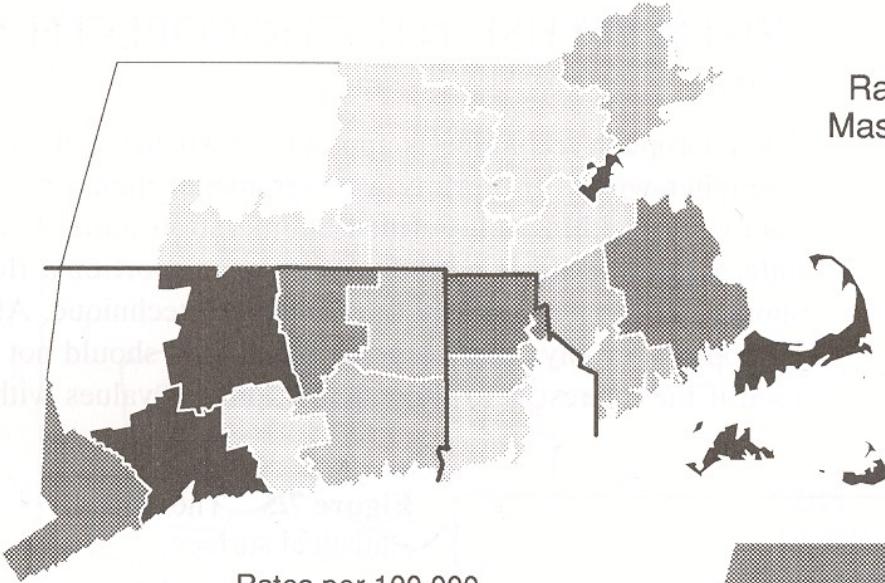
# Density



- Value
- Hue
- Intensity



# Variations to Area of Aggregation

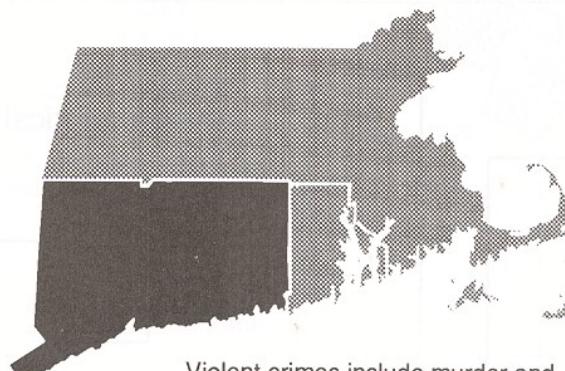


Rates of Violent Crimes in  
Massachusetts, Connecticut  
and Rhode Island

1985

by county

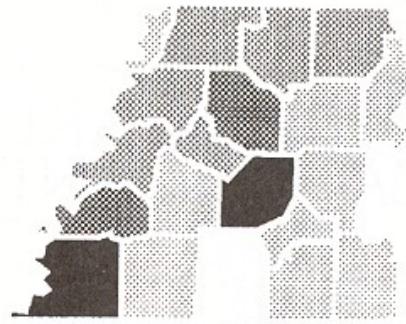
State averages (per 100,000):  
Connecticut - 5,423  
Massachusetts - 4,721  
Rhode Island - 4,708



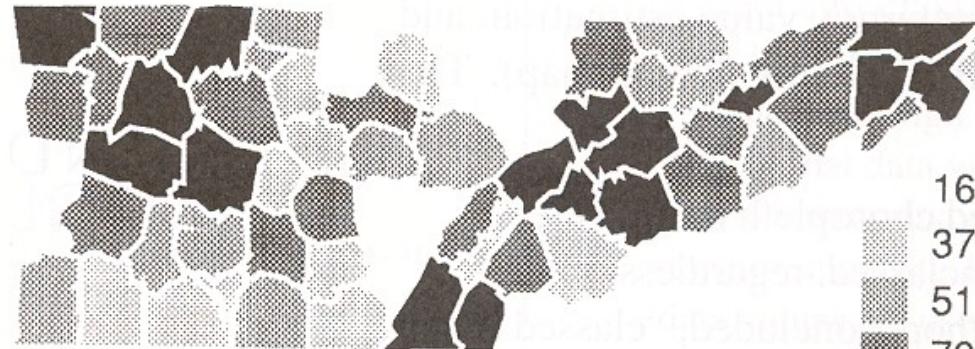
Violent crimes include murder and  
non-negligent manslaughter, forcible  
rape, robbery, and aggravated assault

Source of data: United States County and City Data Book, 1988

Because Connecticut's average of 5,423 does not fall in the classed array of all county values,  
it was placed in the nearest, or highest, class when mapped at the state level.

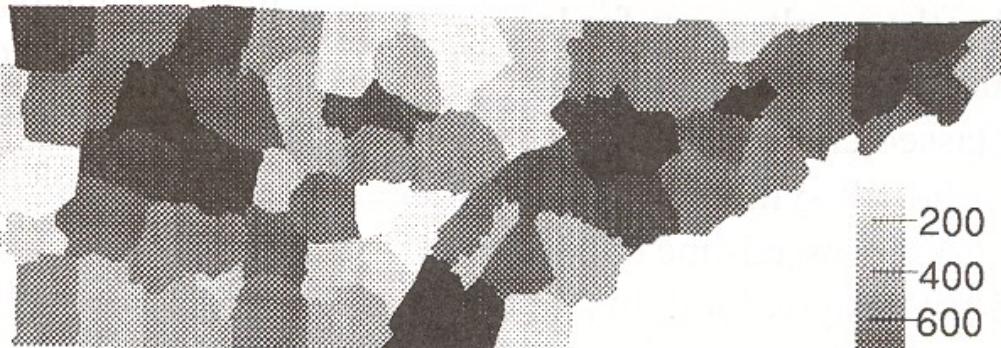
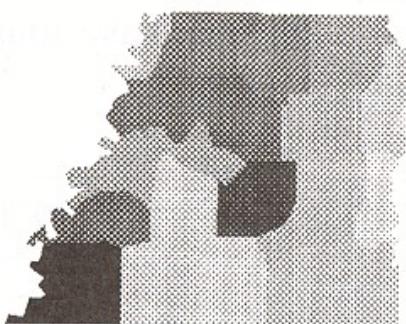


Population Density in Tennessee  
1990



Classed data values:  
Population per square mile

16 - 36  
37 - 50  
51 - 71  
72 - 132  
133 - 1070

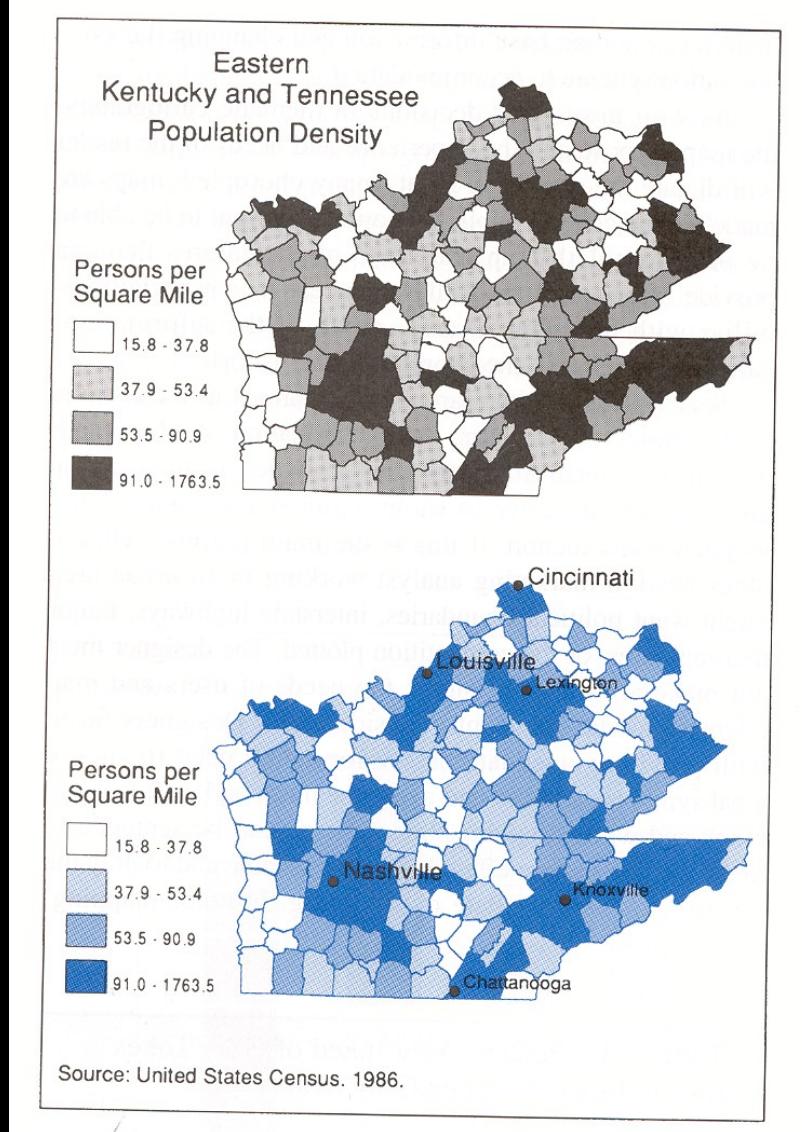


Unclassed data values:  
Population per square mile

200  
400  
600  
800  
1000

Source of data: United States Census of Population, 1990.

# Color vs Grayscale



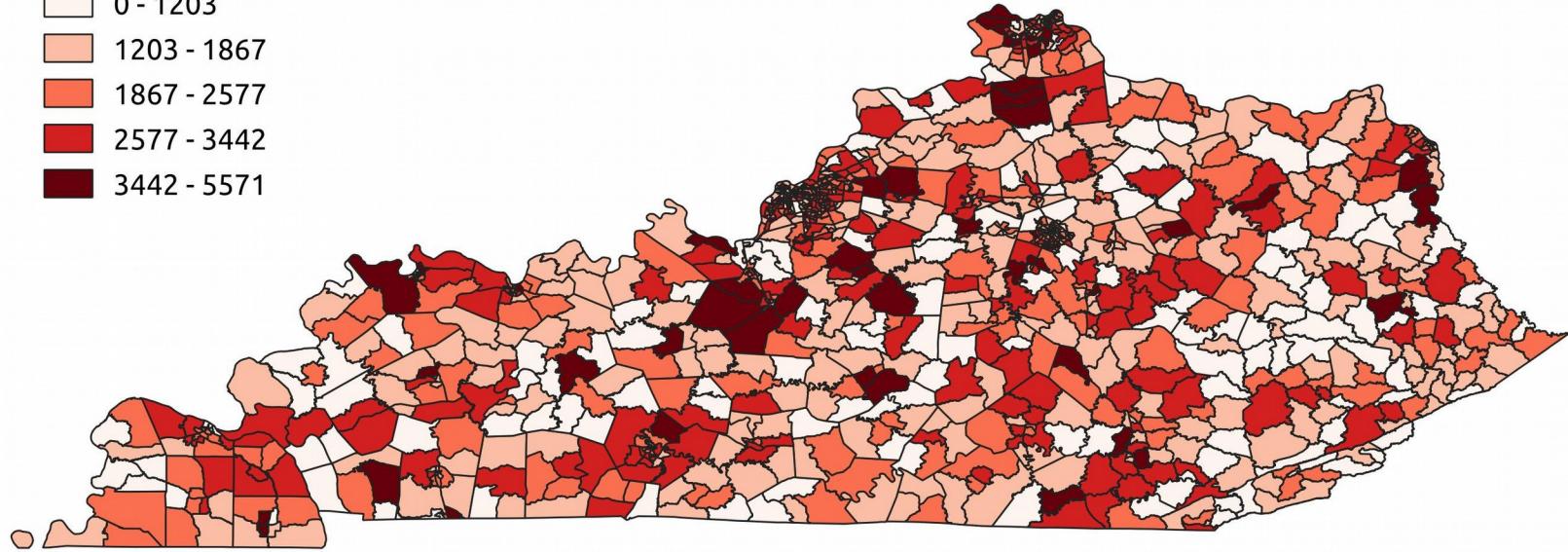
# Choropleth Maps

- Data Normalization
  - Establishing a quantitative field as a percent or ratio
  - We normalize data
    - To ensure the distribution of a spatial phenomena
    - Is representing an accurate relationship
    - In the context of a larger spatial phenomena or areal unit
  - Example
    - Women per Total Population

## Count of Women per Tract

KY\_CensusTract

- 0 - 1203
- 1203 - 1867
- 1867 - 2577
- 2577 - 3442
- 3442 - 5571



## Women per Total Tract Population

KY\_CensusTract

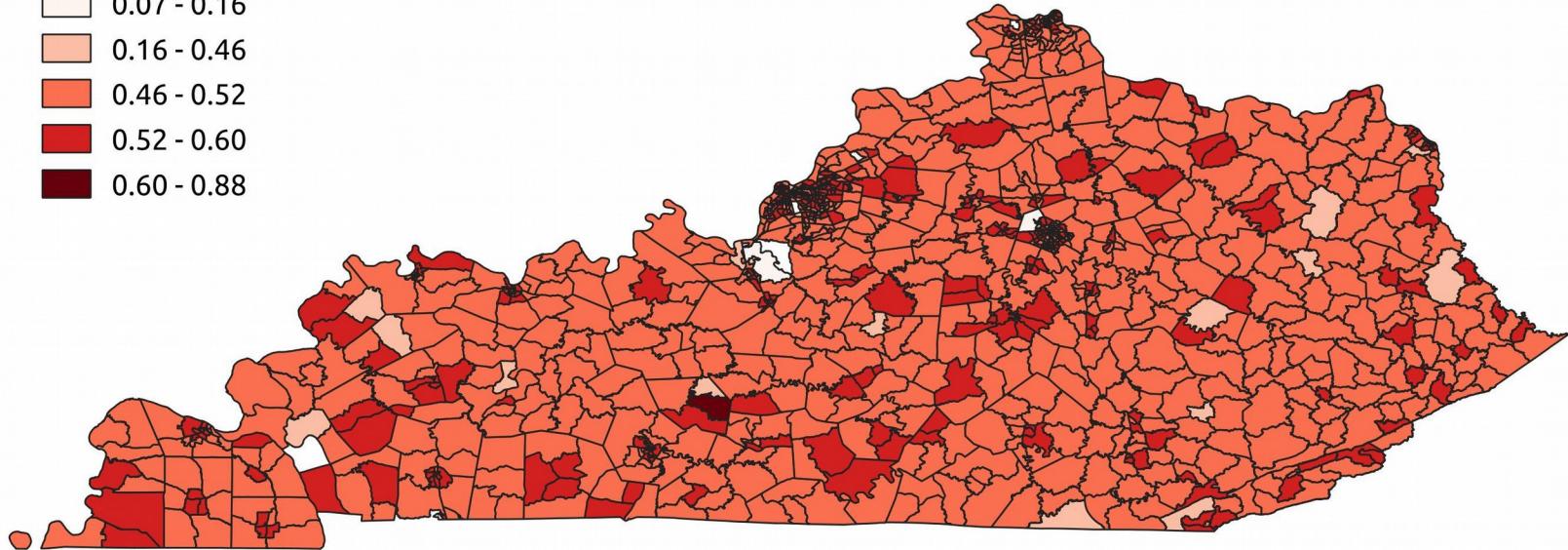
0.07 - 0.16

0.16 - 0.46

0.46 - 0.52

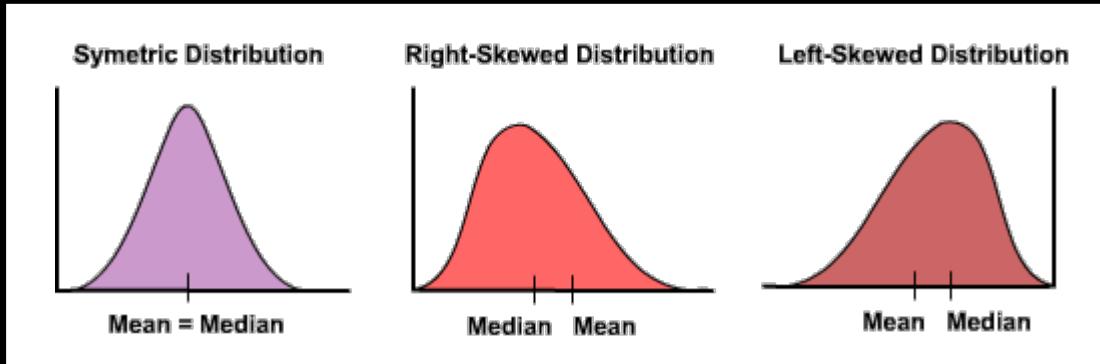
0.52 - 0.60

0.60 - 0.88



# Choropleth Maps

- Data Normalization
  - Statistical Normalization
    - Skewness
      - Log and square root positive data transformations
    - Min-Max Normalization (0-1)
    - Z Normalization (# of SD away from mean)



# Choropleth Maps

- Creating usable measures
  - Metrics
    - Transform
      - Qualitative > quantitative
      - Quantitative > quantitative
    - Can assist in mapping qualitative features
  - Derivative measures
    - Normalization or transformation
    - Algorithmic output

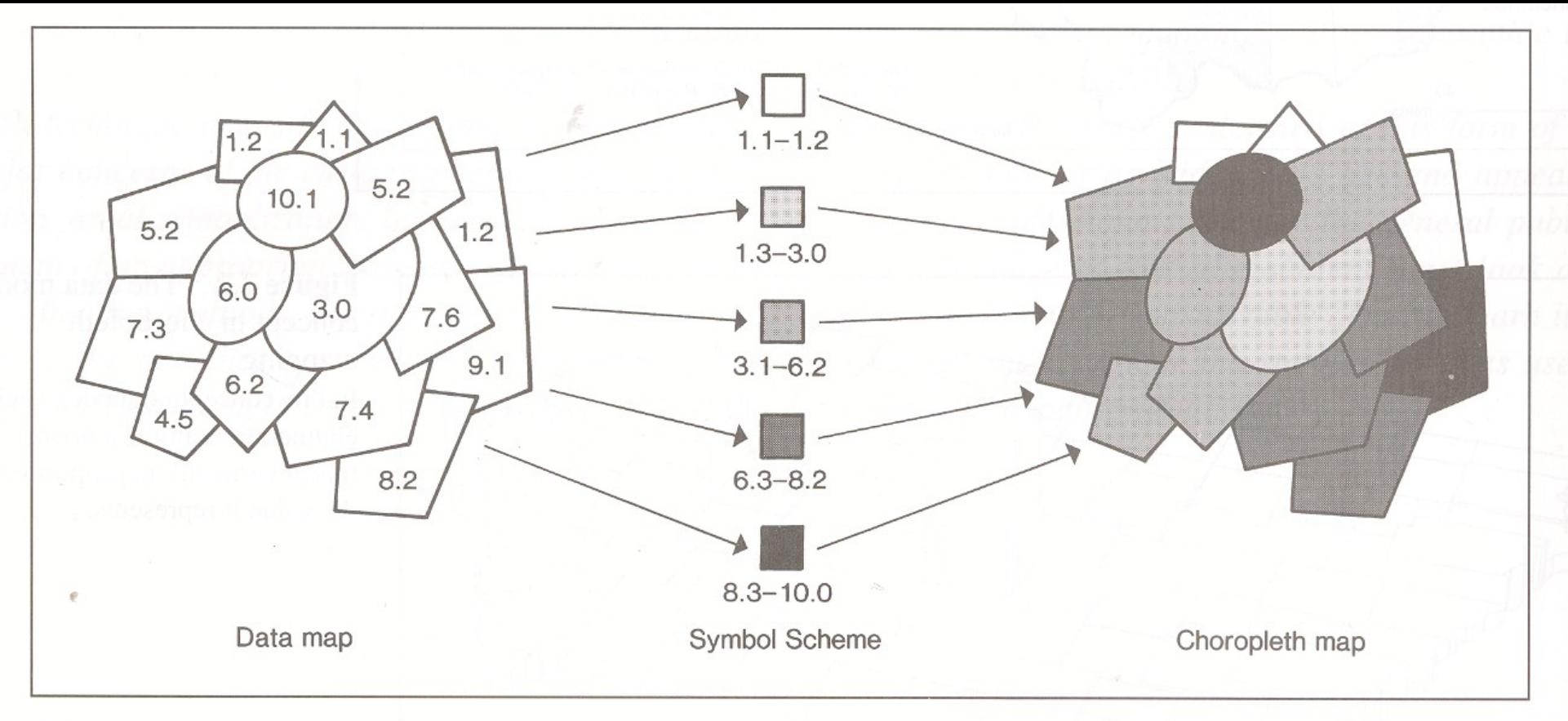
# Choropleth Maps

- Creating usable measures
  - Calculation of population density
    - Population / Unit of land area or volume
      - Generally square miles or square kilometers
      - For volume, use cube units
    - Uses
      - Population growth within a given area
    - Limitations
      - Size and Shape of area may give misleading measure

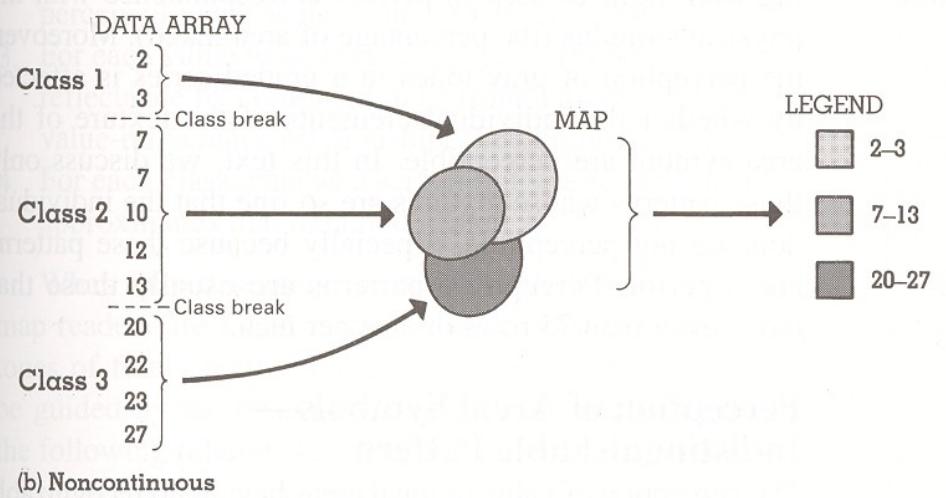
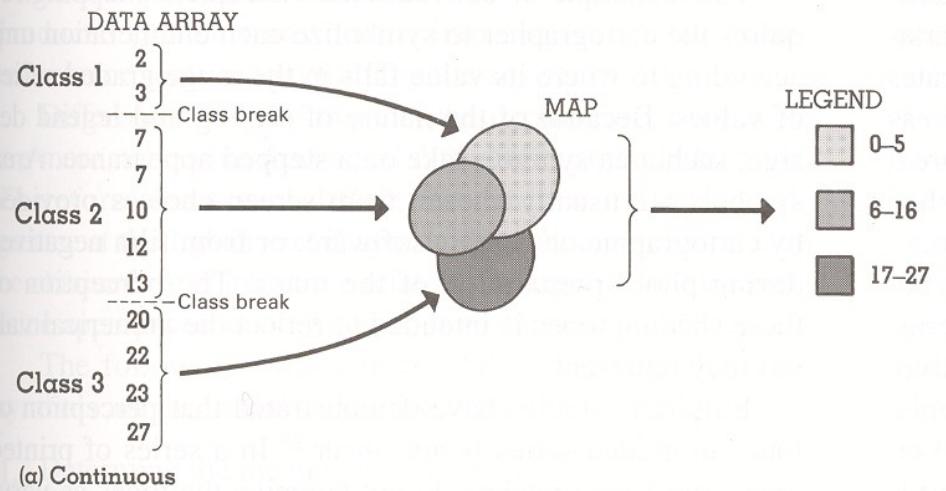
# Choropleth Maps

- Data Classification
  - Number of classes
    - Amount of statistical detail read from the map
    - More == Complex <> Simple == Less
      - Readability
      - Data distribution complexity
      - Color vs Grayscale

# Choropleth Maps



# Continuous VS Noncontinuous



# Choropleth Maps

- Data Classification
  - Class Intervals
    - Equal Interval
    - Quantiles
    - Natural Breaks
    - Optimal
    - Standard Deviation

# Choropleth Maps

- Equal Interval
  - Or equal steps
  - Observations categorized into equal ranges
    - Take class range from min. value to max. value
    - Divide by number of classes
    - Establish class limits from above
    - Bin each observation into its class

# Choropleth Maps

- Equal Interval
  - Range = 45 - 0
  - Class width =  $(45 - 0) / 5 = 9$
  - Compute class limits
    - 0 – 9
    - 10 – 18
    - 19 – 27
    - 28 – 36
    - 37 – 45

# Choropleth Maps

- Equal Interval
  - Advantages
    - Simple and easy to compute
    - Easy to interpret
    - No missing values in the legend
  - Disadvantages
    - Distribution of data not considered
    - Can have empty classes

# Choropleth Maps

- Quantiles
  - Equal number of observations in each category
    - Data in ascending order
    - Divide number of enumeration units by the number of classes desired
    - Bin rank-ordered data until desired members in class is obtained

# Choropleth Maps

- Quantiles
  - Example
    - Arrange data in ascending order (70 observations)
    - Divide by number of desired classes
      - $70 / 5 = 14$
    - Bin rank-ordered data from 1 through 70
      - Observations 1 – 14
      - Observations 15 – 28
      - Observations 29 – 42
      - Observations 43 – 56
      - Observations 57 – 70

# Choropleth Maps

- Quantiles
  - Advantages
    - Easy to compute manually
    - Empty classes not possible
    - Useful for mapping ranked order data
  - Disadvantages
    - Gaps in legend may confuse the reader
    - Distribution of data not considered
    - Classes may contain very low or very high values

# Choropleth Maps

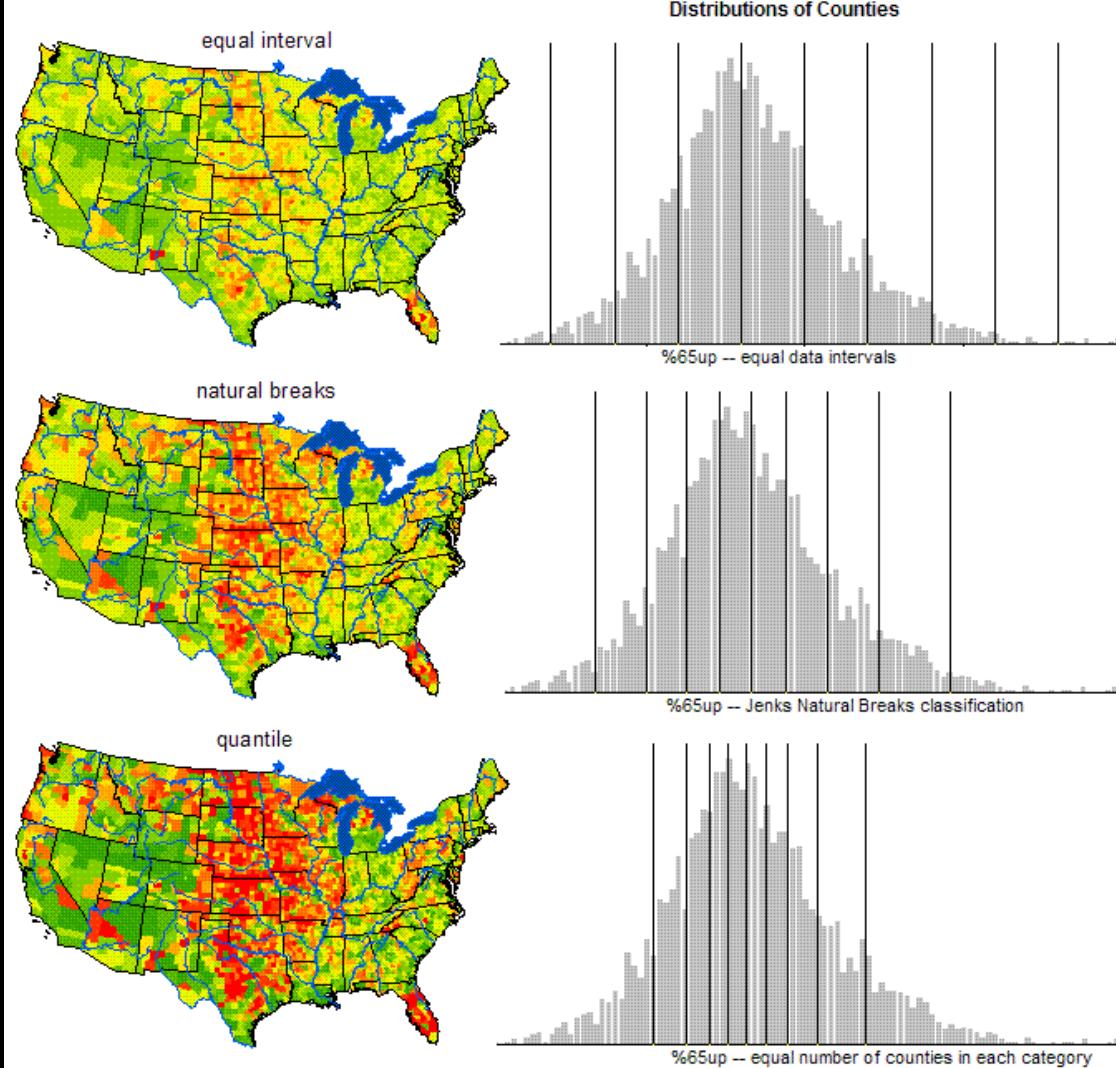
- Natural Breaks
  - Observations categorized into classes with smallest variance
    - Group similar values together
  - Can be done with visual inspection
  - Often uses optimal class breaks

# Choropleth Maps

- Natural Breaks
  - Advantages
    - Considers characteristics of actual distribution
  - Disadvantages
    - May result in gaps in the legend
    - Decision on class limits are subjective
      - Vary among map makers

## COMPARISON OF CLASSIFICATION METHODS

Percentage of US Population Age 65 or Older, by County



# Choropleth Maps

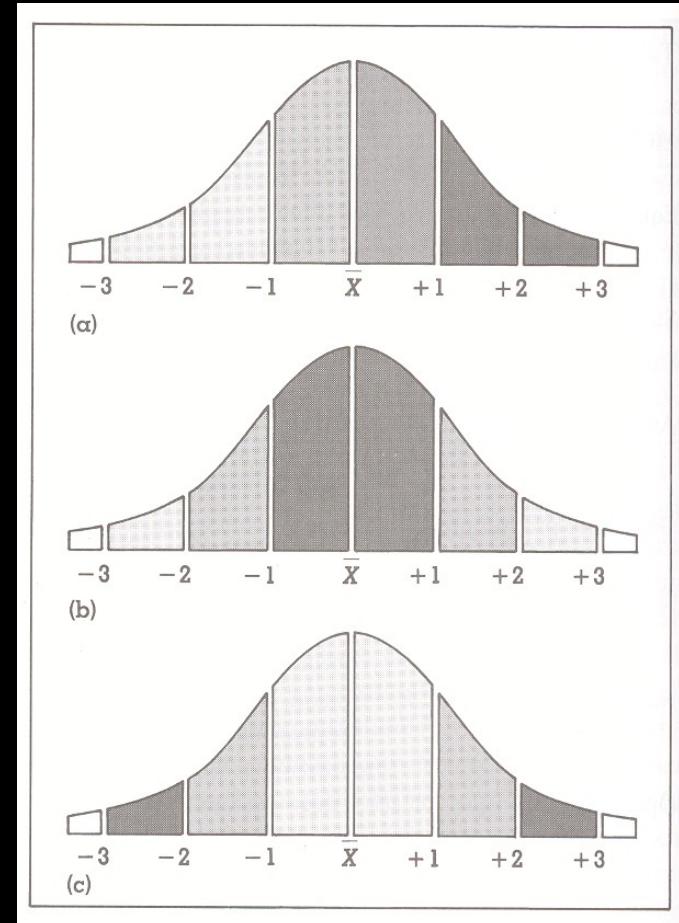
- Optimal
  - Forms groups that are internally homogeneous
    - Similar thing belongs to same class
  - A mathematical procedure that provides the best solution
  - Most popular
    - Jenk's Optimization methods

# Choropleth Maps

- Optimal
  - Advantages
    - Considers the characteristics of data distribution
    - Empty classes not possible
    - Maximizes similarities within classes and differences between classes
  - Disadvantages
    - Difficult to conceptualize
    - Difficult to compute

# Choropleth Maps

- Standard deviation
  - Used if data is in normal distribution
    - Bell curve



# Choropleth Maps

- Standard deviation
  - Advantages
    - Shows the actual distribution of data
    - Gaps in legend can be avoided
  - Disadvantages
    - Works well with normally distributed data
    - An understanding of statistics required to read the map

# Choropleth Maps

- Interval Selection Process
  - Exogenous
    - Based on specific value
    - e.g., Income to define poverty
  - Arbitrary
    - No relevance to data distribution
    - e.g., using rounded numbers
      - 0 – 10
      - 11 – 20
      - Etc.

# Choropleth Maps

- Interval Selection Process
  - Idiographic
    - Examined patterns in data distribution
    - Natural breaks or optimal methods
  - Serial
    - Systematic intervals or mixed method
    - Equal steps or standard deviation

Choropleth Maps  
Questions?

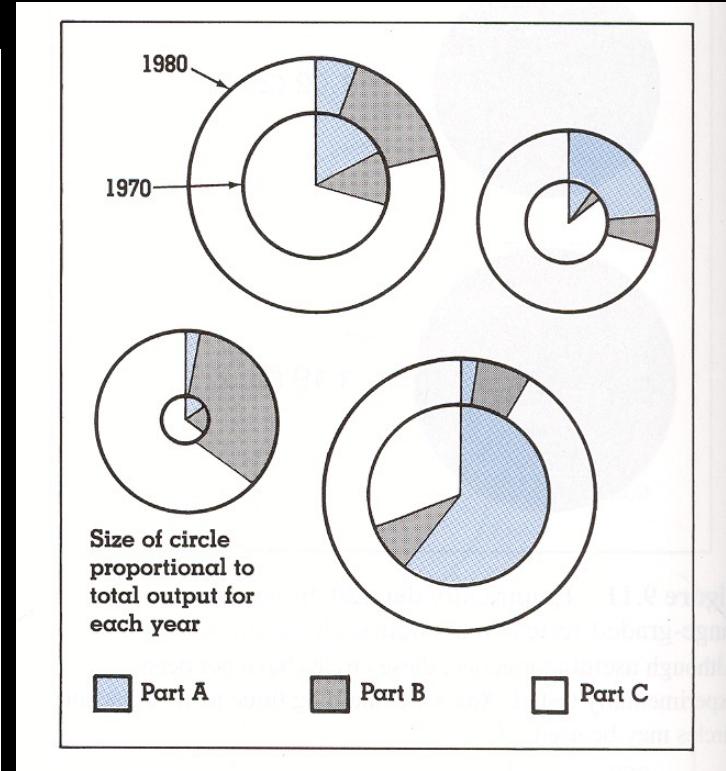
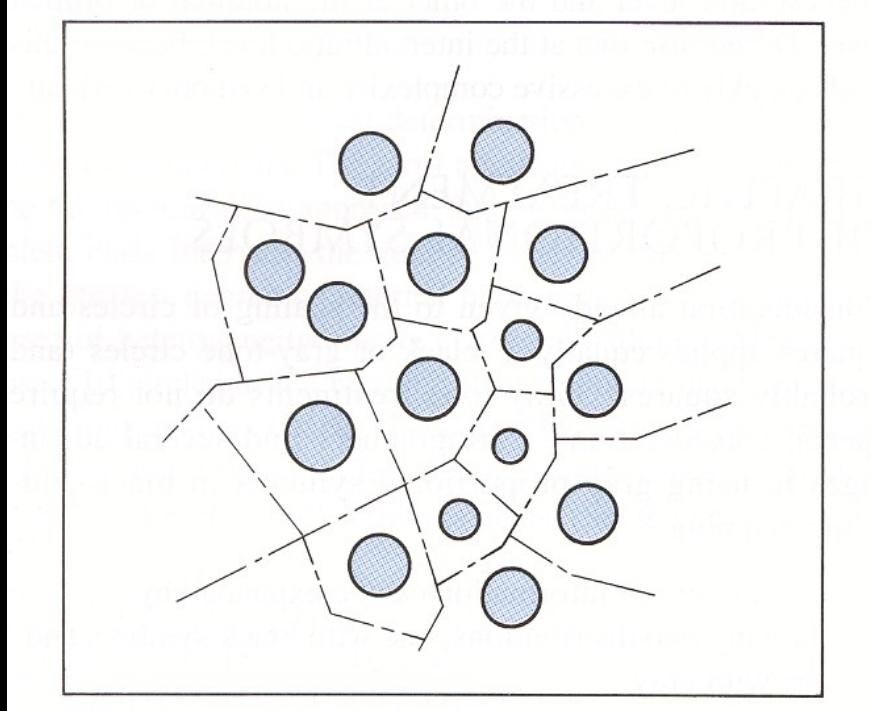
# Proportional Symbol Maps

- Relative magnitude of phenomena at point locations
- Symbols
  - Size of the symbol > proportional to the quantities they represent
  - Geometric (linear, areal, volume)
  - Pictographic
- Also known and graduate symbol map

# Proportional Symbol Maps

- When to use?
  - To much data for a dot map
  - To show totals over an area
    - To centroid
  - To show totals at points
    - Absolute or derived values
    - NOT densities

# Proportional Symbol Maps



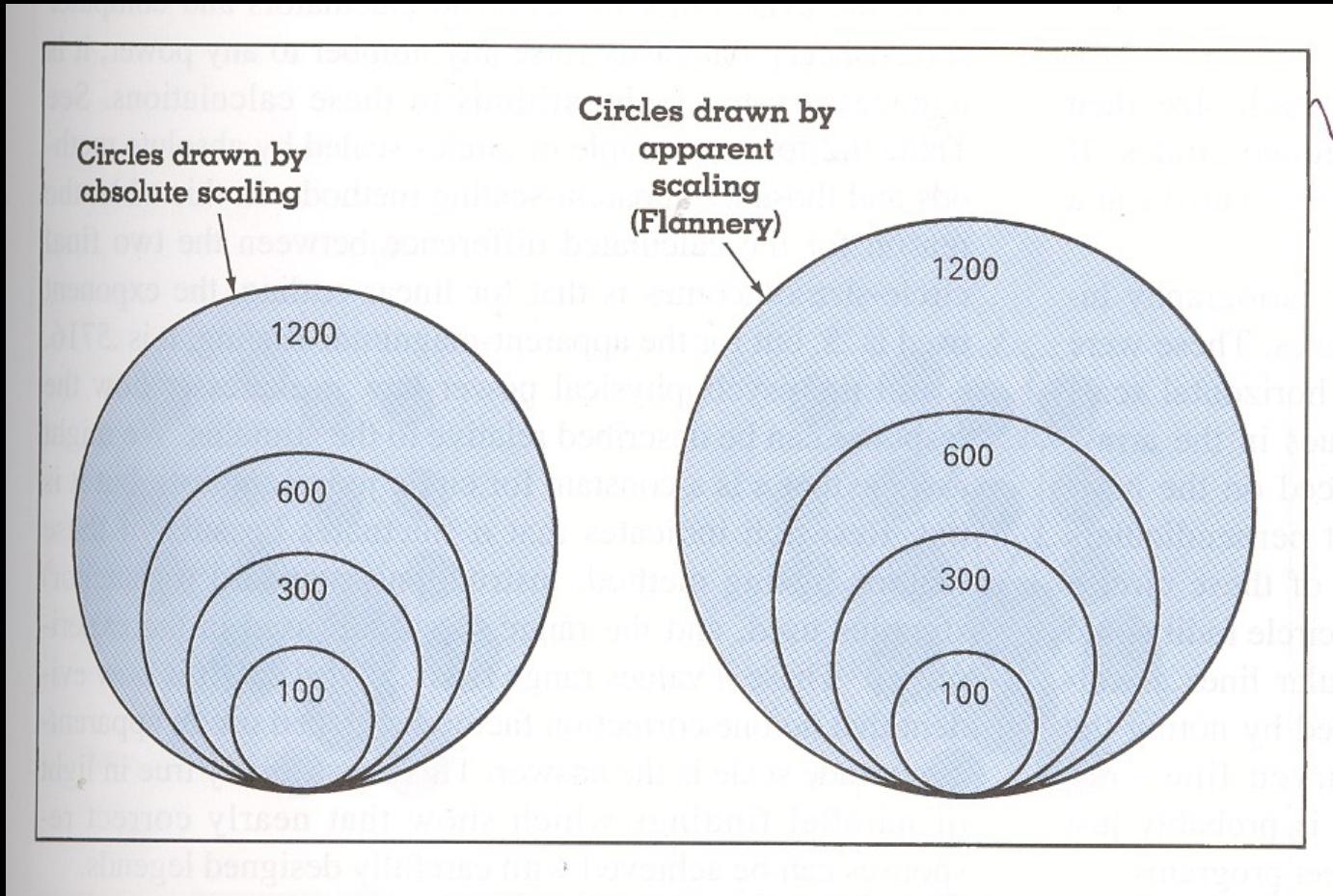
# Proportional Symbol Maps

- Geometric Symbol Types
  - Linear
    - Easy to use on small ranges of data
    - Issue of overlap and not suited for extreme values
  - Areal
    - Wide range of values and minimum overlap
    - Issues with magnitude and comparison
    - Circles most common
    - Squares introduce rectangularity
  - 3D

# Proportional Symbol Maps

- Symbol Scaling
  - Proportional or Absolute Grading
    - Size = direct proportion of data value
    - Circle Radius = square root of data value
  - Perceptual or Apparent Magnitude Grading
    - Emphasize larger symbols
    - Made to offset misinterpretation

# Proportional Symbol Maps

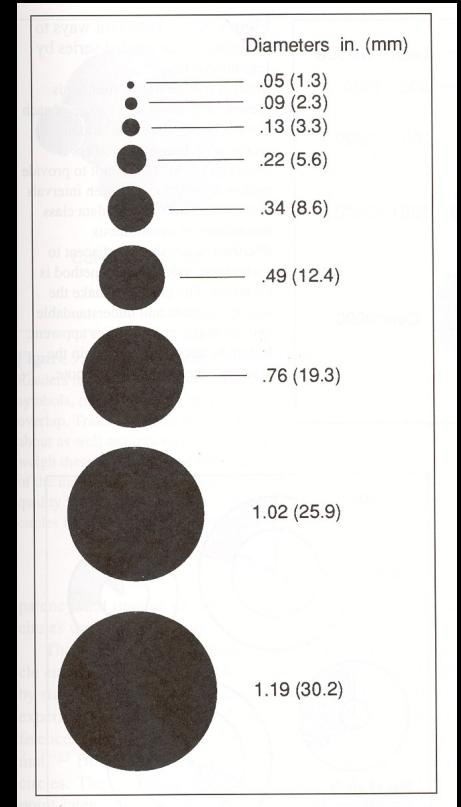
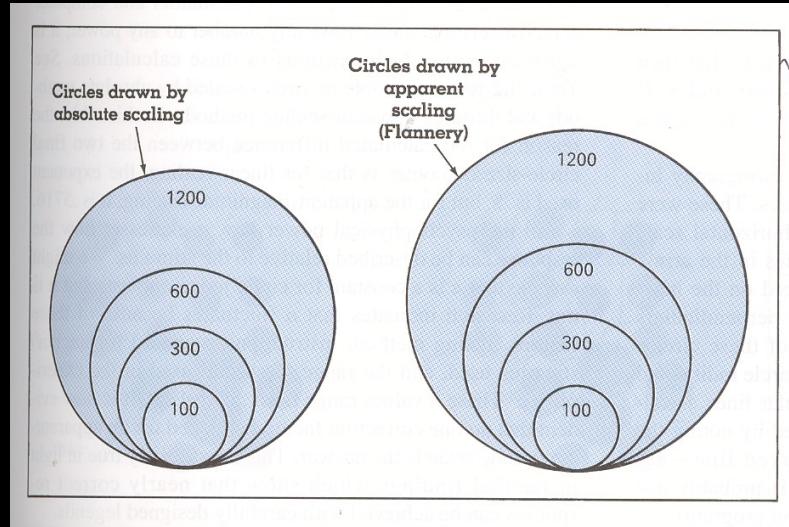


# Proportional Symbol Maps

- Symbol Scaling
  - Range or Group graded
    - Data grouped into classes
    - Each symbol represents a class range
    - Helps map readers with legend symbols and contrast
    - Easy to misinterpret and may create false patterns

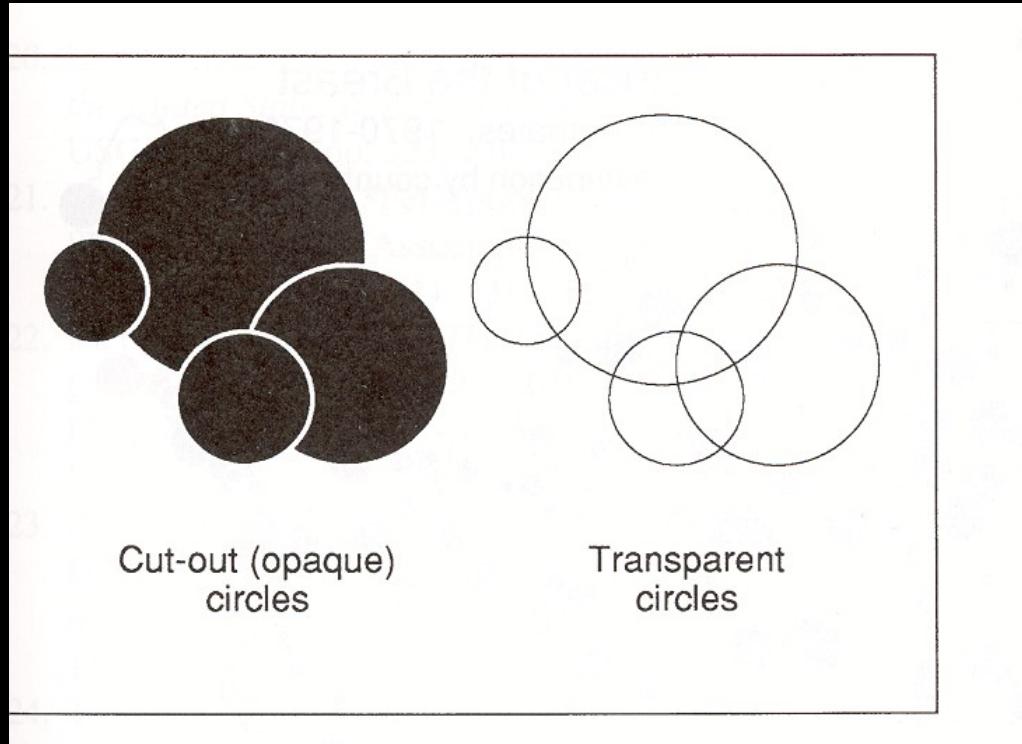
# Proportional Symbol Maps

- Legend Design
  - Nested
  - Linear

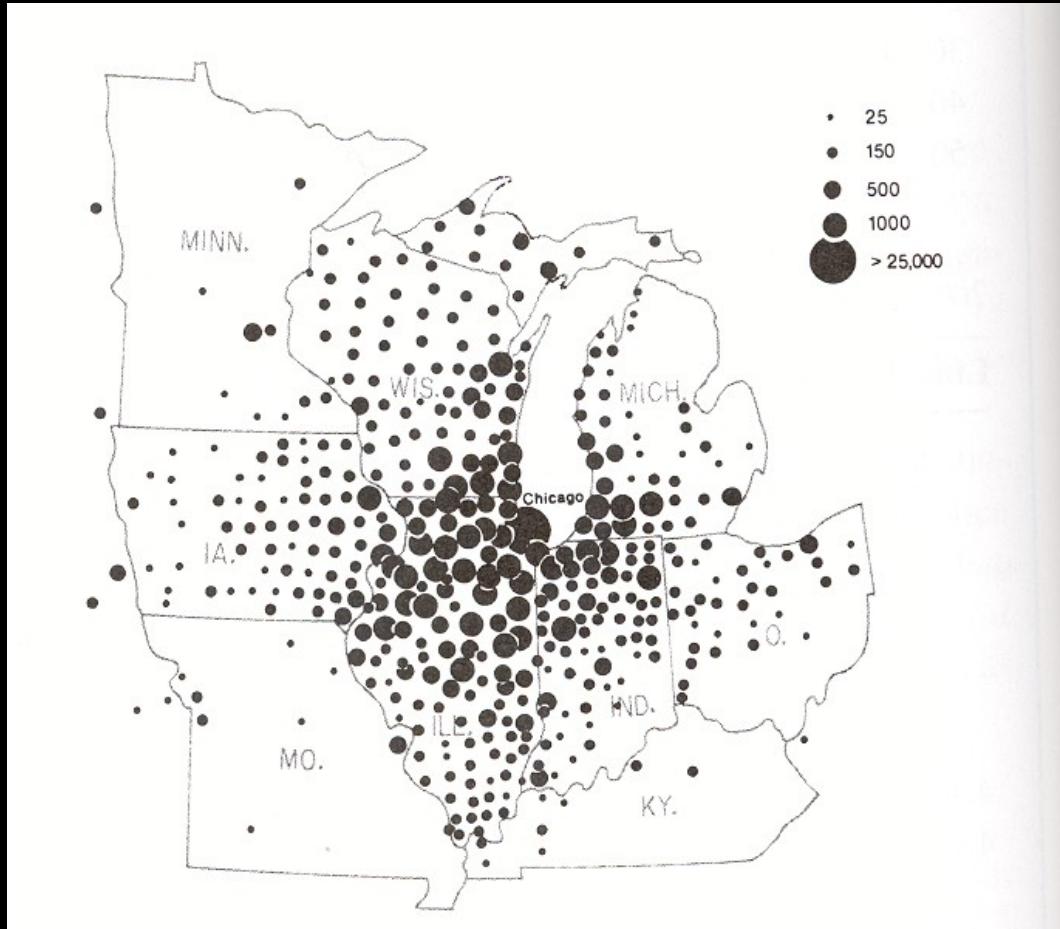


# Proportional Symbol Maps

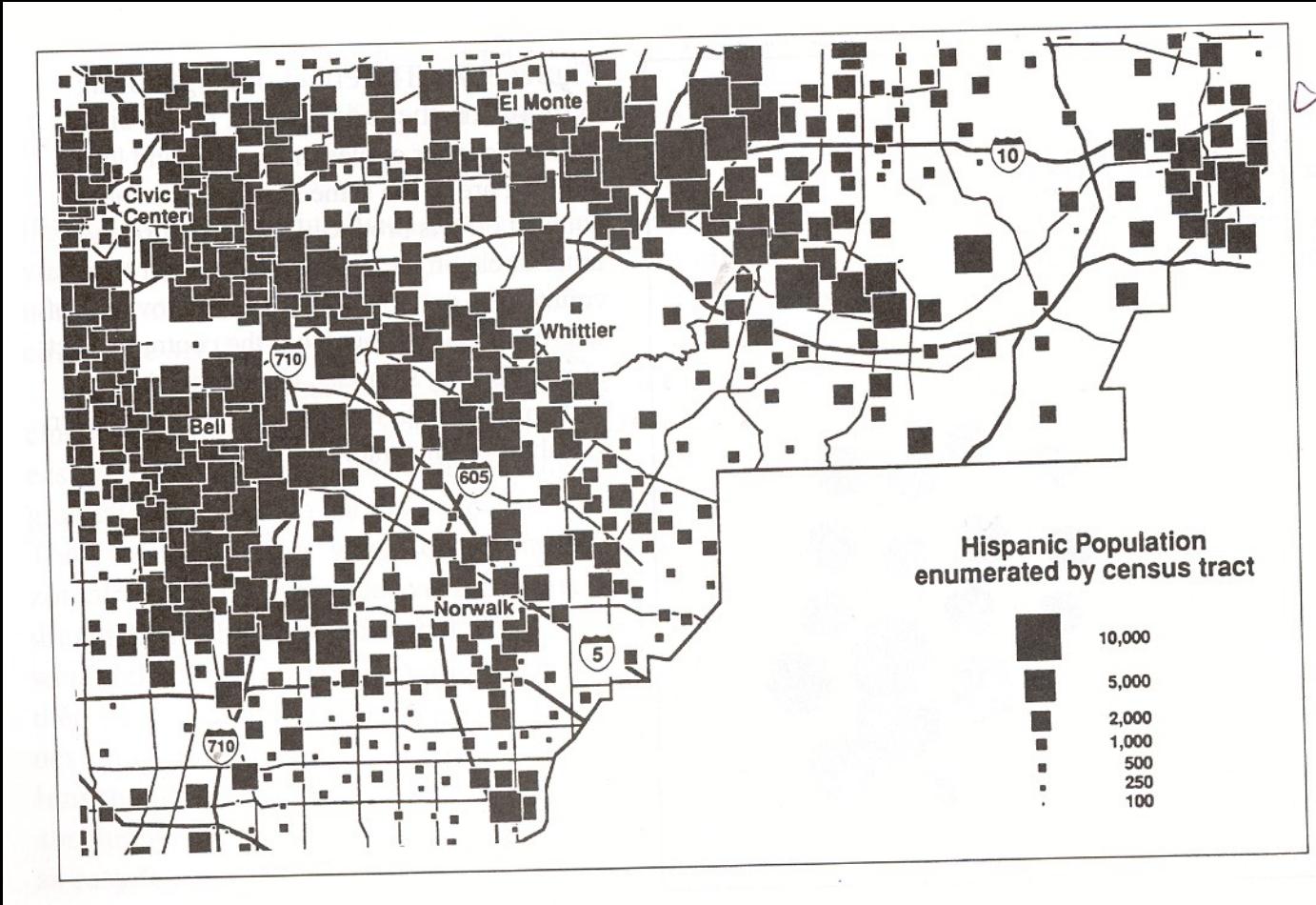
- Symbol Overlap
  - Neither too full or too empty
  - Smallest values in foreground
    - To largest values in background
  - Opaque (Cut-out) Shapes
    - Outline not visible
    - Size estimation difficult
  - Transparent Shapes
    - Poor figure/ground
    - Lack of visual hierarchy



# Proportional Symbol Maps

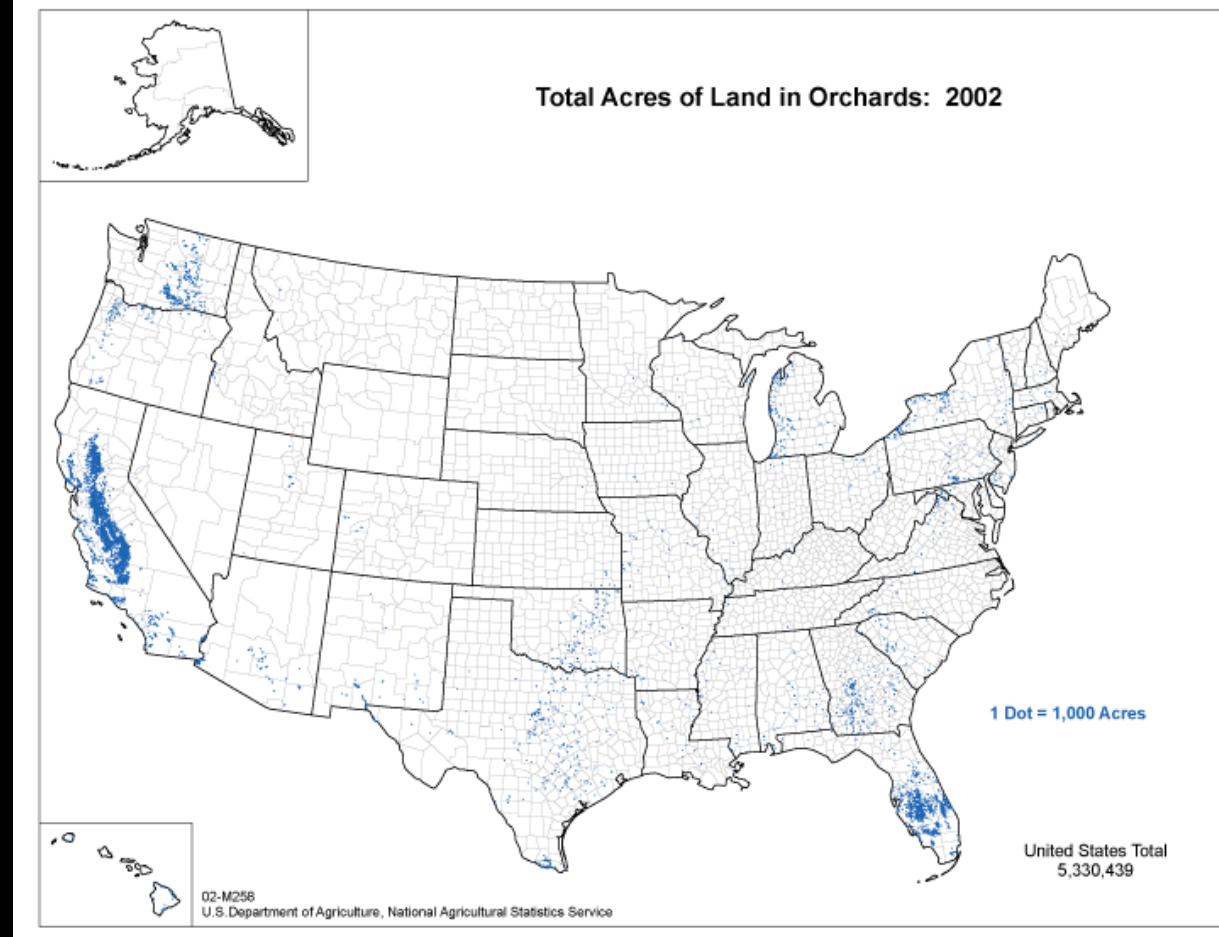


# Proportional Symbol Maps



# Proportional Symbol Maps Questions?

# Dot Maps

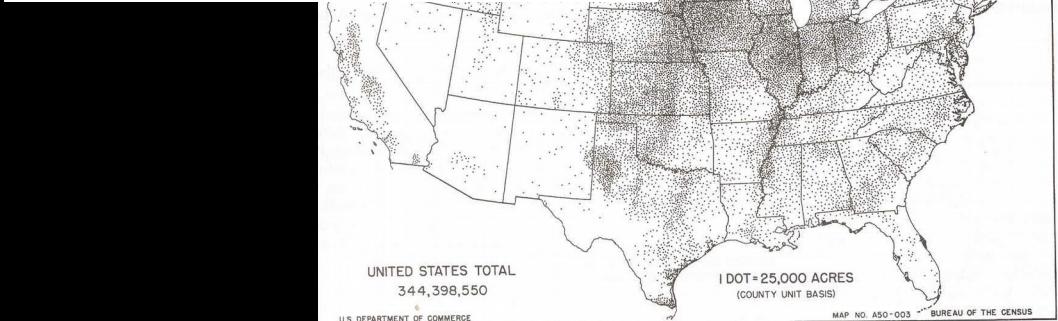
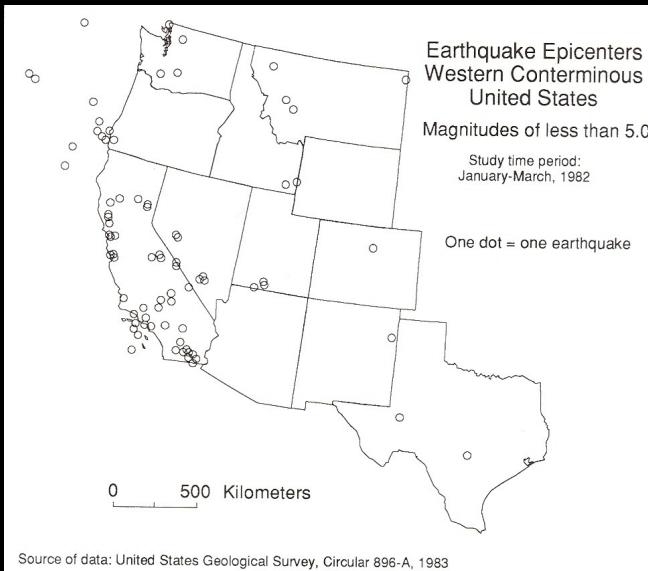


# Dot Maps

- Using appropriate point symbols
  - To show each discrete element
  - Of a spatial phenomena
- Absolute values only
- Uniform point symbols
- Repetition and placement of points
  - To show distribution of spatial phenomena

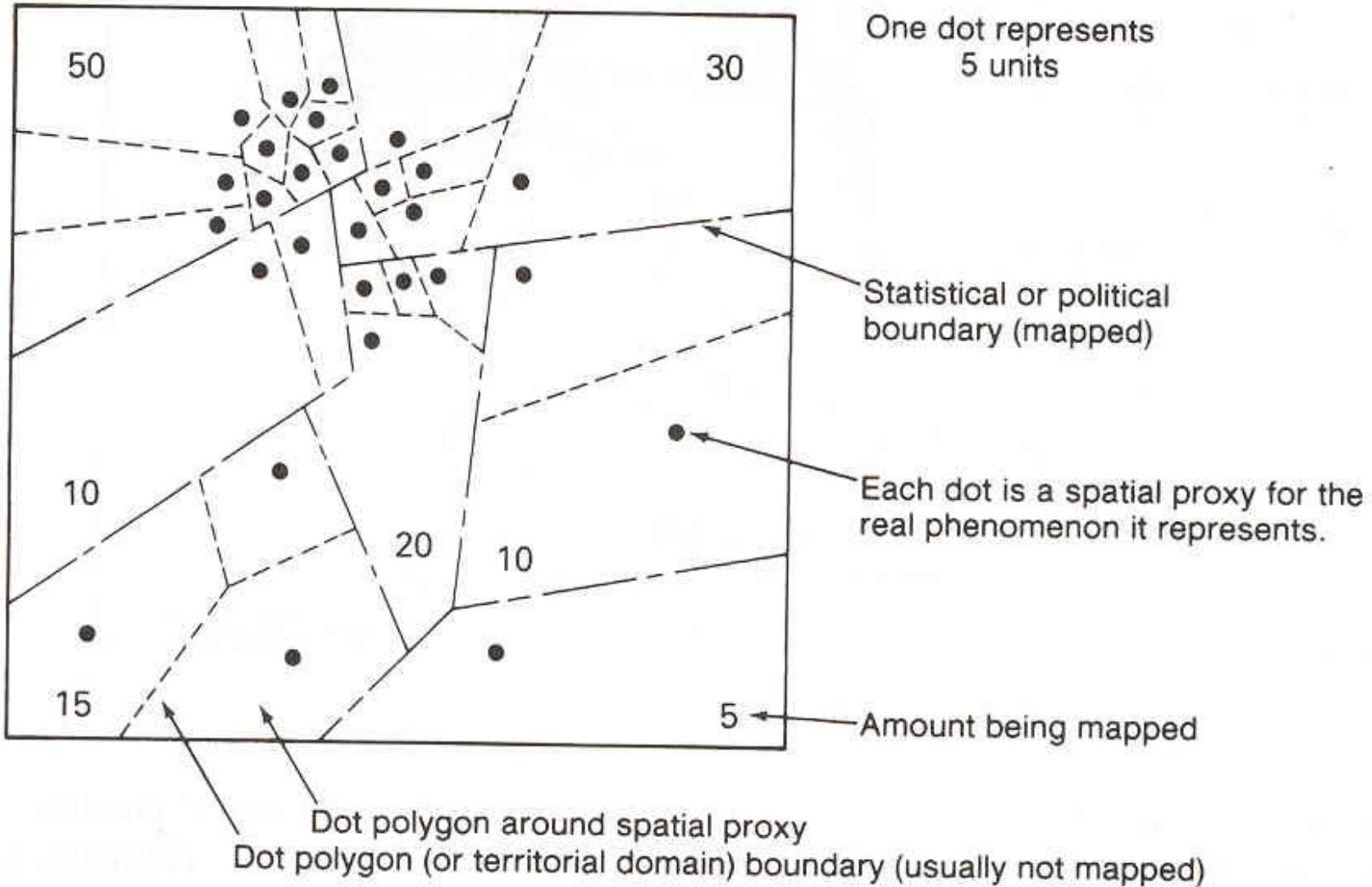
# Dot Maps

- Types of Points
  - One-to-one relationship
    - 1 dot represents one value
  - One-to-many relationship
    - 1 dot represents multiple values



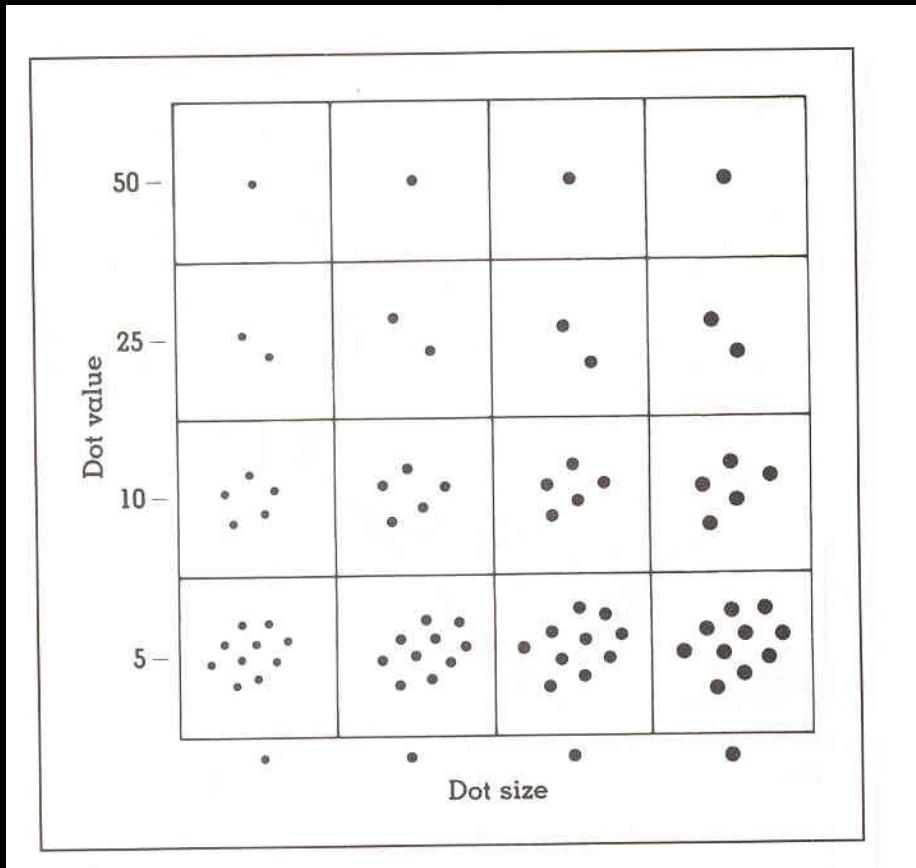
# Dot Maps

- Dot distribution
  - Center of gravity
  - Allow for counting to recover original data
  - Smooth transition through uniform pattern
- Design Considerations
  - Value and Size
  - Placement
  - Legend



# Dot Maps

- Value and Size
  - At least 2 or 3 dots in the unit with lowest quantity
  - Coalesce in unit with highest density
  - Symbol easy to understand



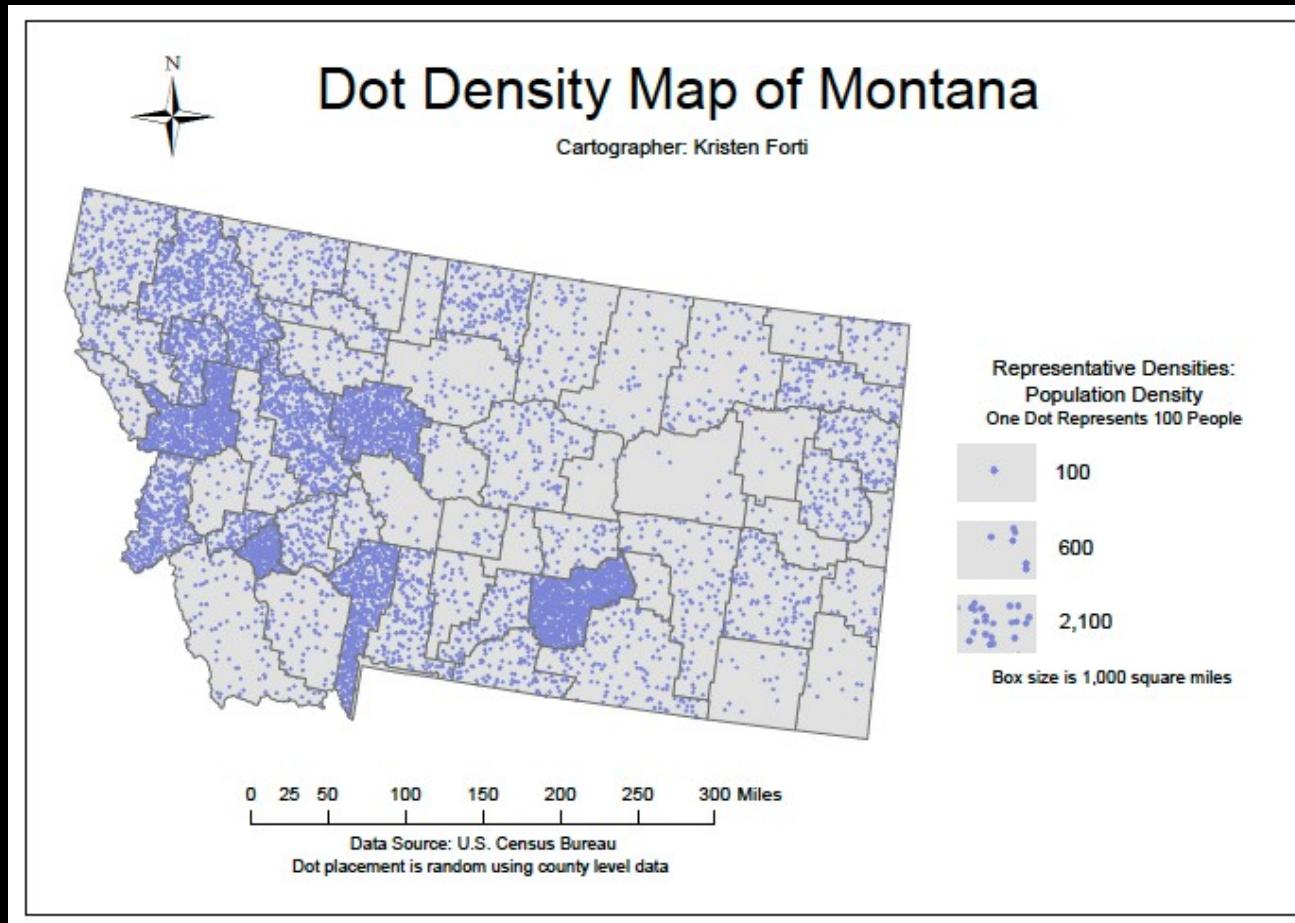
# Dot Maps

- Placement
  - As close to real distribution as possible
    - Center of gravity
    - Local knowledge
  - Software
    - Dots are placed randomly
    - Use smallest enumeration unit

# Dot Maps

- Legend
  - Statement
    - “one dots represents \_\_\_\_\_ units”
  - Set of density squares
    - At least 3
    - Low, middle, high

# Dot Maps



# Dot Maps

- Advantage
  - Simple and easy
  - Illustrates density of discontinuous phenomena
  - Can use more than one data set (multivariate)
- Disadvantage
  - Not a one-to-one interpretation
  - Density is not linear
  - High density makes recovering original data impossible

Dot Maps  
Questions?