Geography 360
Principles of Cartography

April 17, 2006

Outlines

- Cartographic design principles
  - Enhancing visual hierarchies on maps
  - Kinds of numerical data and color scheme
- What is proportional symbol map?
  - What is it?
  - When to use?
- What are design considerations for proportional symbol mapping?
  - Three scaling methods
  - Others

Intellectual hierarchy & Visual hierarchy

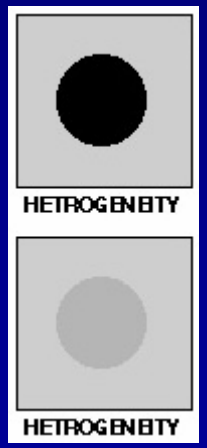
- A successful visual hierarchy shows you what is most important first; these elements **jump out**. Less important elements **fall back**
- A successful visual hierarchy clearly communicates the intellectual hierarchy and intent of your map
- What are techniques to help separate figure from ground?

Enhancing visual hierarchies on maps

How can depth be added to flat maps?

1. Contrast

Noticeable visual differences tend to separate figure from ground



Enhancing visual hierarchies on maps

How can depth be added to flat maps?

2. Details

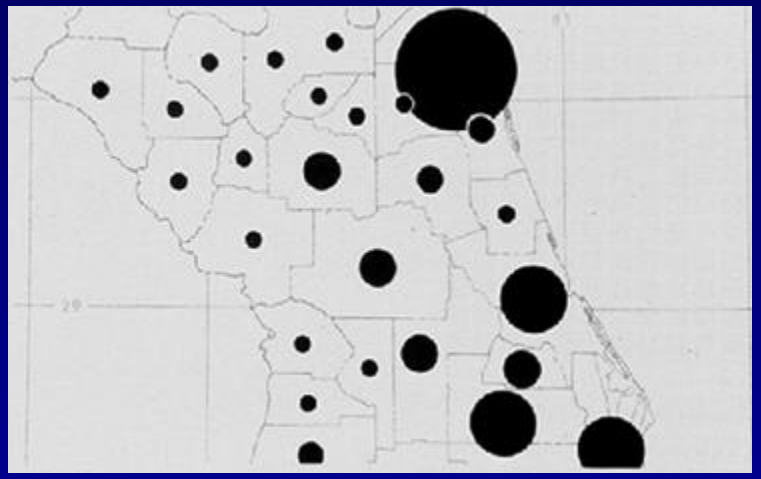
More details tend to separate figure from ground

Enhancing visual hierarchies on maps

How can depth be added to flat maps?

3. Edges

Objects with sharp edges tend to form a figure

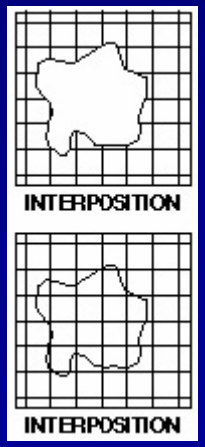


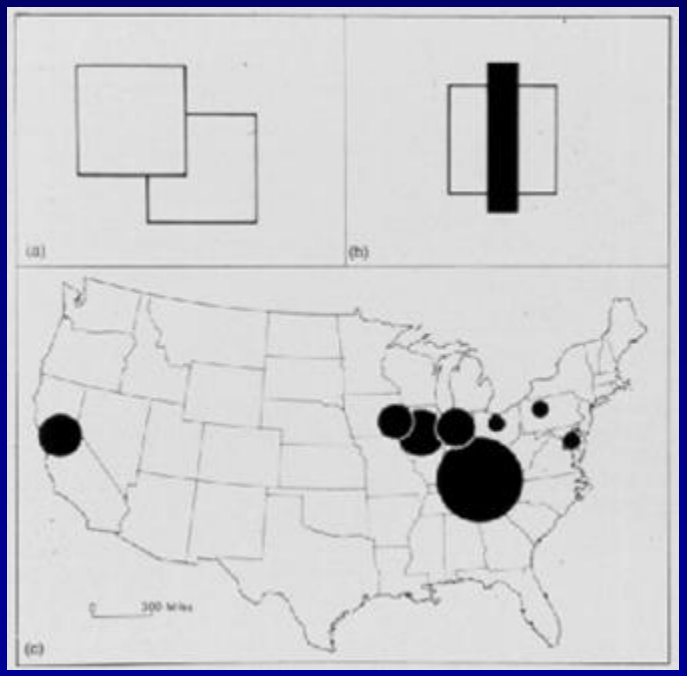
Enhancing visual hierarchies on maps

How can depth be added to flat maps?

4. Layering

The objects whose edge contours continue unbroken are the ones seen as being on top, thus forming figures



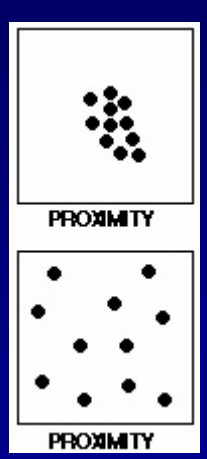


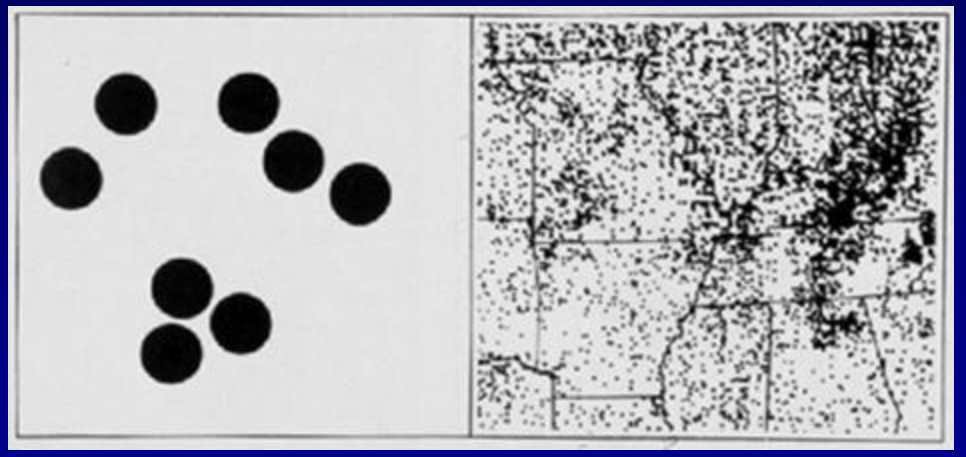
Enhancing visual hierarchies on maps

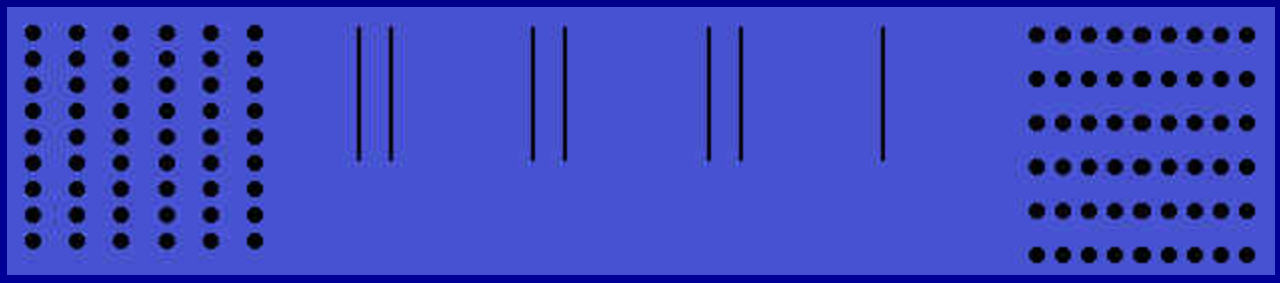
How can depth be added to flat maps?

5. Proximity

Objects close together tend to form a figure





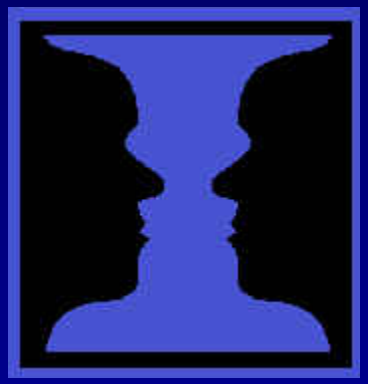


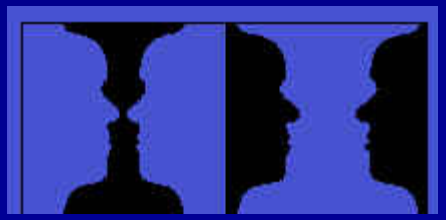
Enhancing visual hierarchies on maps

How can depth be added to flat maps?

6. Smallness

Smaller areas tend to be seen as figures against larger background





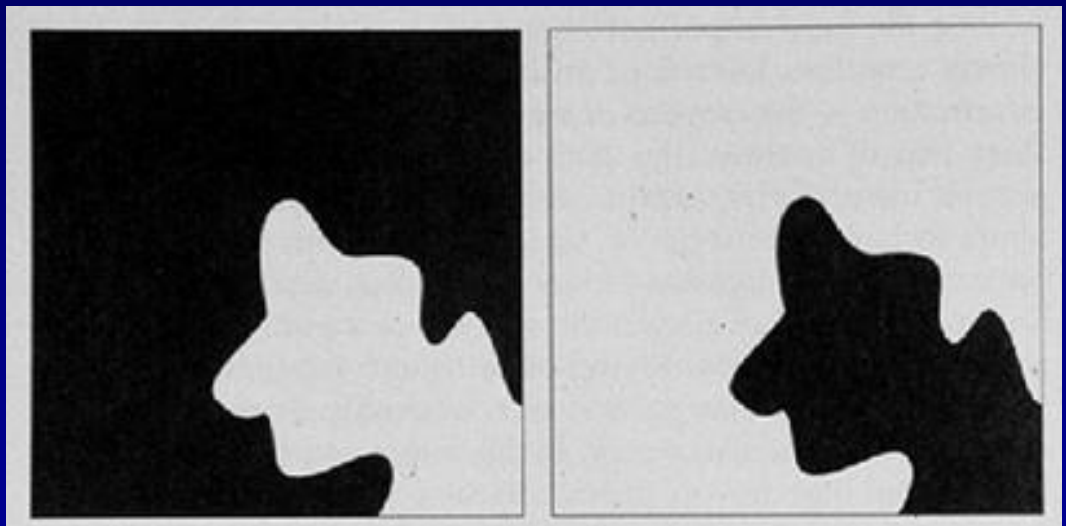


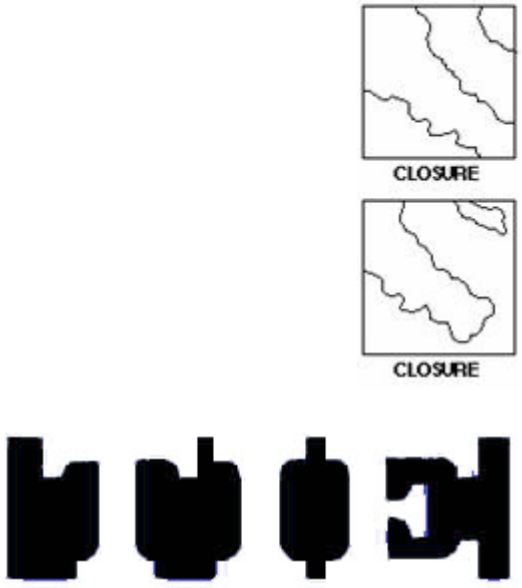
Figure 5.01 Value contrast is used here to visually differentiate two map regions (a chemical spill and a section of open sea). The difference in size between the chemical spill and the surrounding sea causes the spill area to appear as figure regardless of whether the shading is black spill-white sea or the reverse. Black oil is of course, the more mimetic choice.

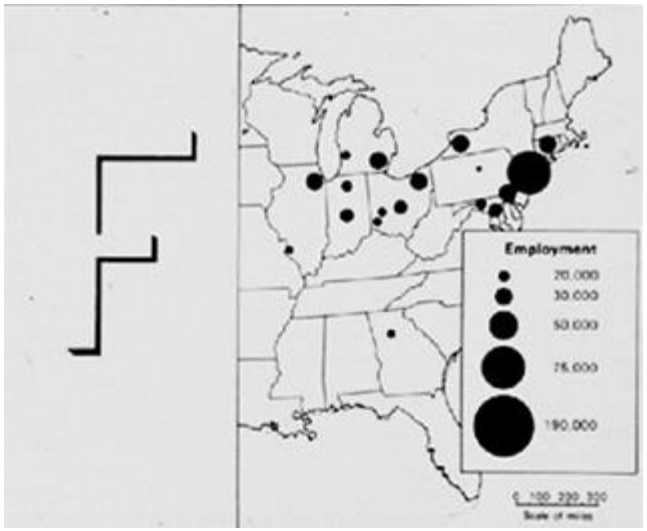
Enhancing visual hierarchies on maps

How can depth be added to flat maps?

7. Surroundness

Areas which can be seen as <u>surrounded by others</u> tend to be perceived as figures





Kinds of numerical data

Extending the four levels of measurement

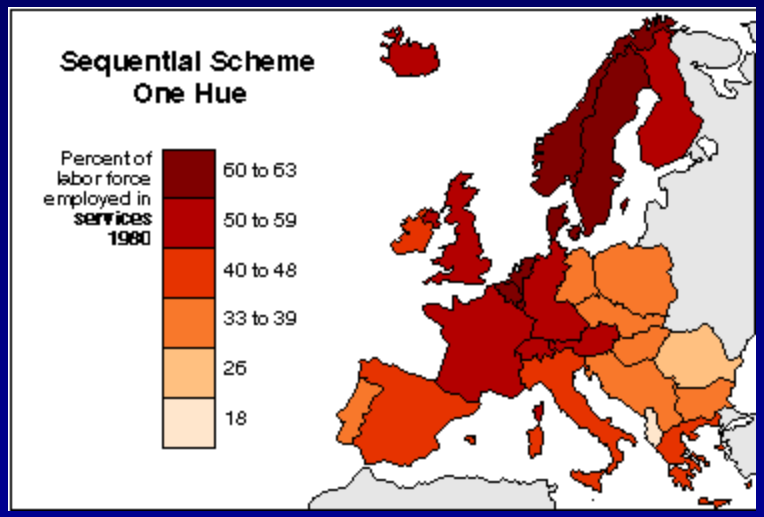
- Unipolar data
  - Has no natural dividing point
  - e.g. per capita income
- Bipolar data
  - Has natural dividing point
  - e.g. percentage of population change, deviation from the mean
  - Thus data can be logically into two parts

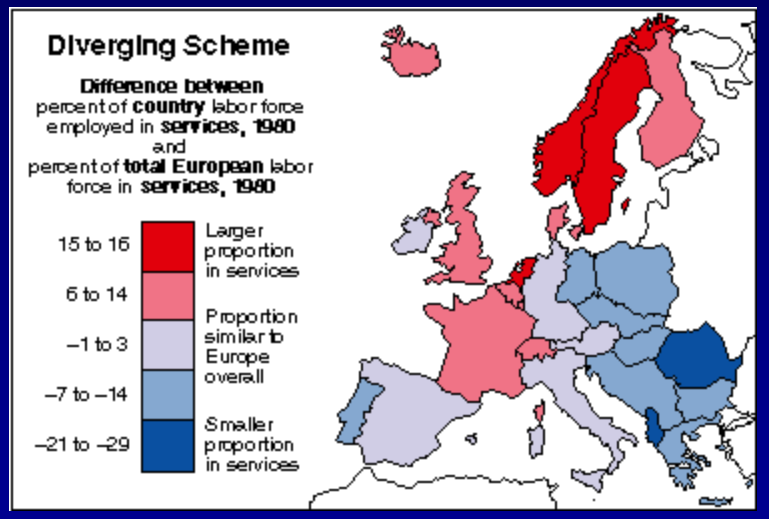
Appropriate color scheme based upon kind of data

- For unipolar data, use sequential scheme
  - Sequential steps in lightness by holding hue and saturation constant
  - Color Plate 13.1
- For bipolar data, use diverging scheme
  - Two hues diverge from a common light hue neutral gray
  - Color Plate 13.3

Reading: Slocum section 13.3.1

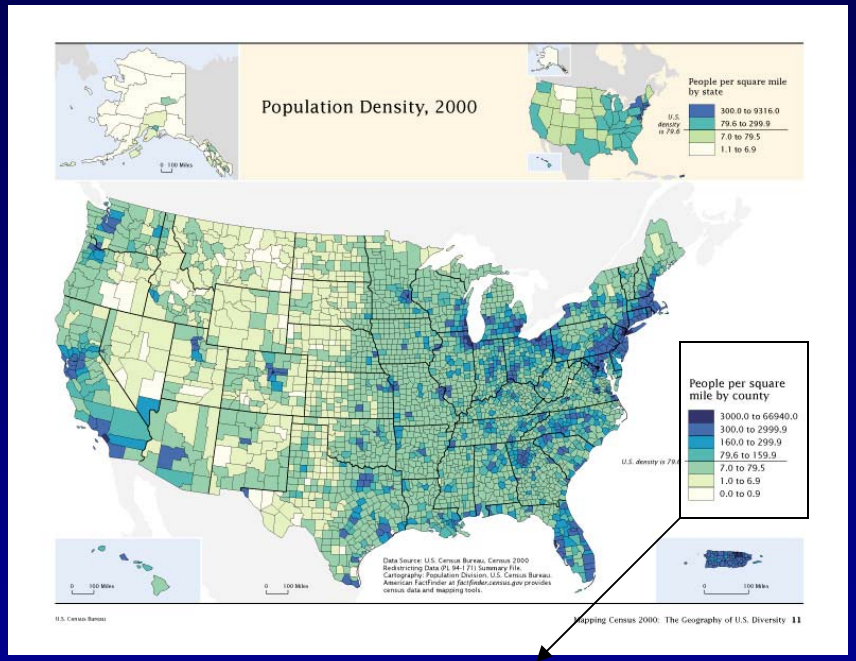
Sequential & diverging scheme

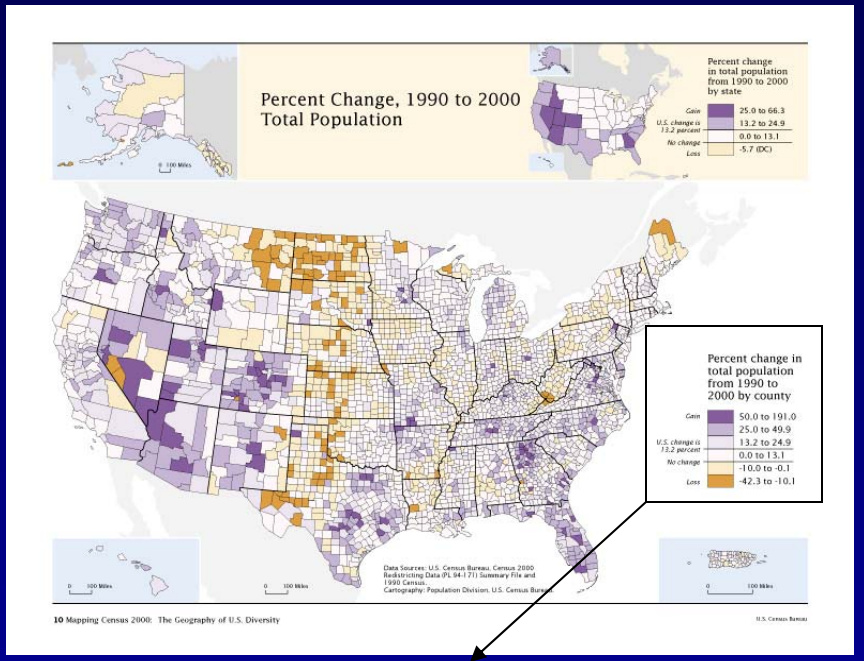


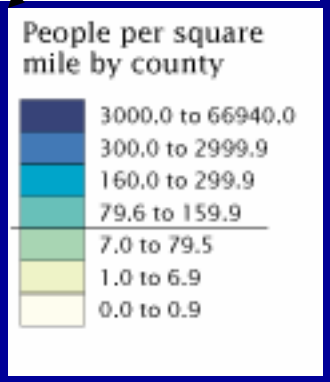


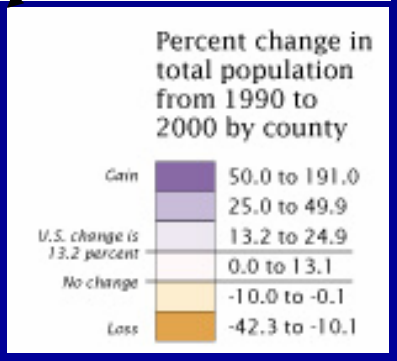
For more, visit the website for ColorBrewer

Sequential & diverging scheme

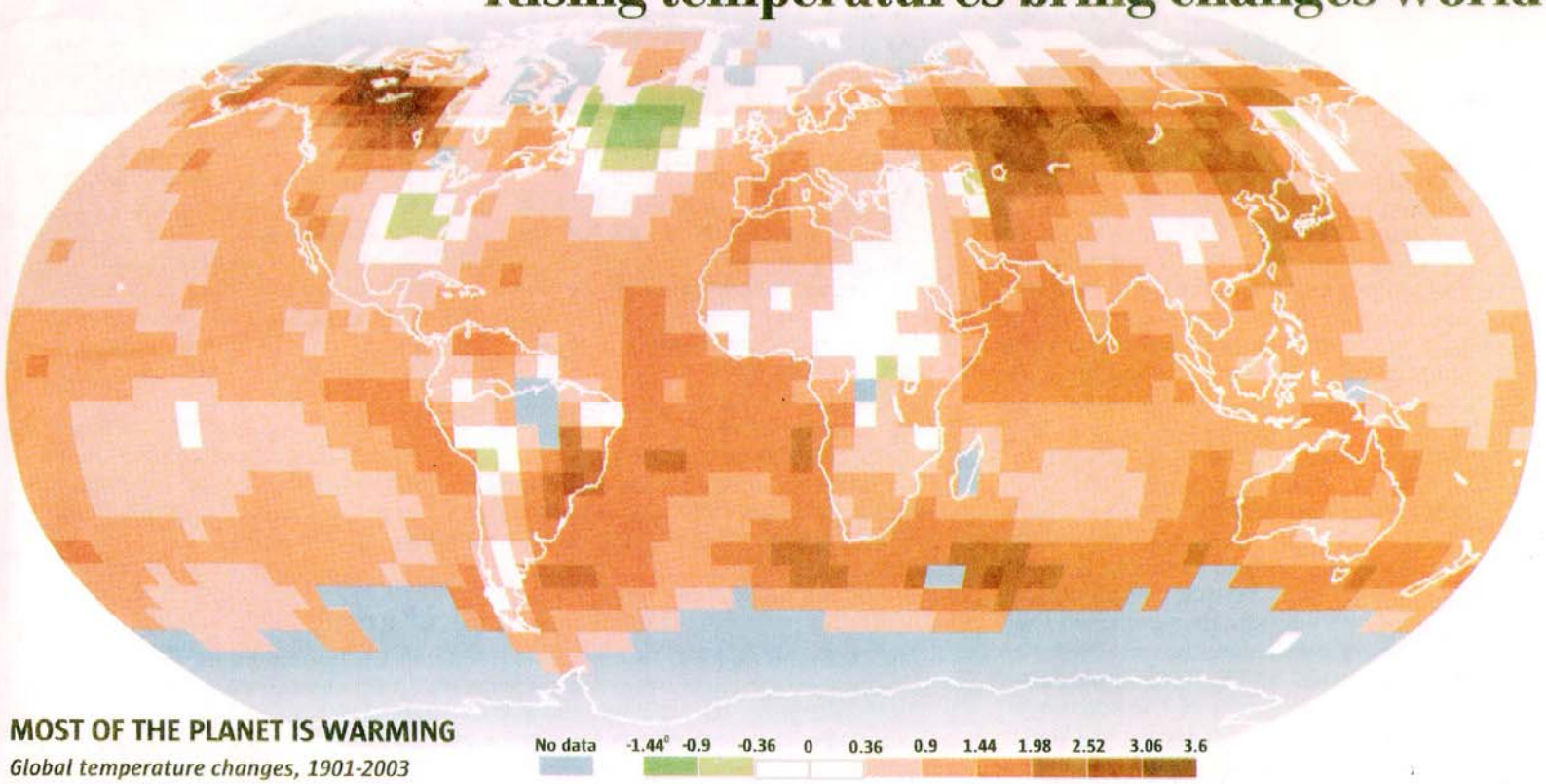








Rising temperatures bring changes worldv



MOST OF THE PLANET IS WARMING

Global temperature changes, 1901-2003

The northern latitudes are heating up most rapidly, as predicted by global-warming models.

Proportional symbol map

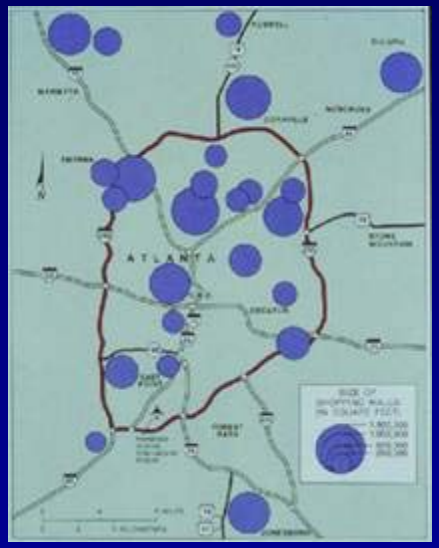
- What is a proportional symbol map?
- Three scaling methods
- Design considerations

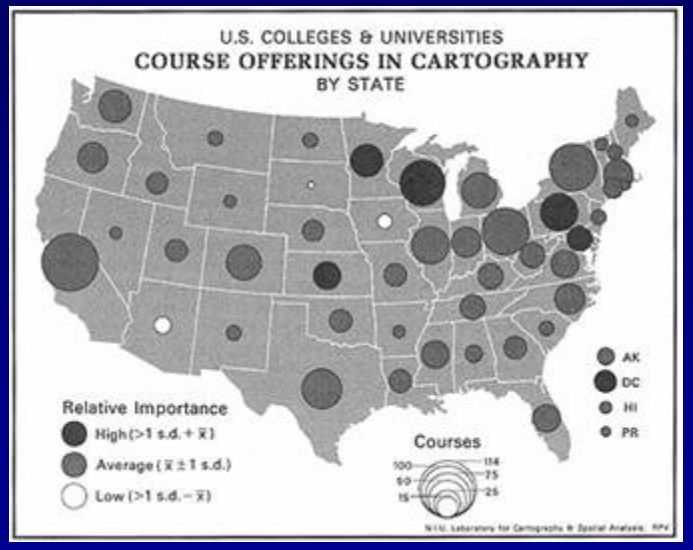
Proportional symbol map

- Shows magnitudes of phenomena at **point** locations
  - e.g. population by cities on a national map
- Symbols are **scaled** in a way that reflects "data value" magnitude
  - How symbols are scaled? → three common scaling methods {mathematical, perceptual, range-graded scaling}

Is the point location real?

Revenue of shopping malls in LA





True point data

Conceptual point data

Use centroid

When to use?

- Consider the models of geographic phenomenon
  - Discrete: total counts can be used
  - Abrupt: gap between point locations

Compare to choropleth map and dot map

Three scaling methods

- Mathematical (proportional) scaling
- Perceptual (apparent or psychological) scaling
- Range-graded scaling

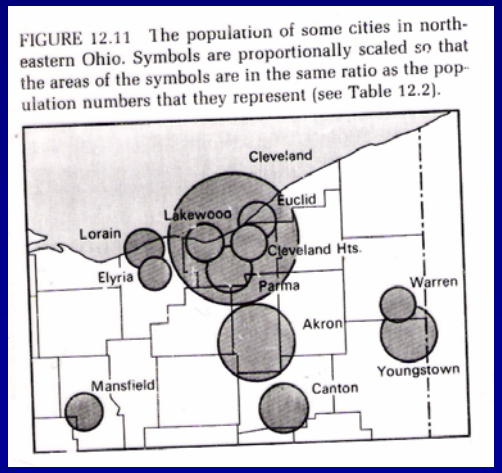


FIGURE 12.11 The population of some cities in northeastern Ohio. Symbols are proportionally scaled so that the areas of the symbols are in the same ratio as the population numbers that they represent (see Table 12.2).

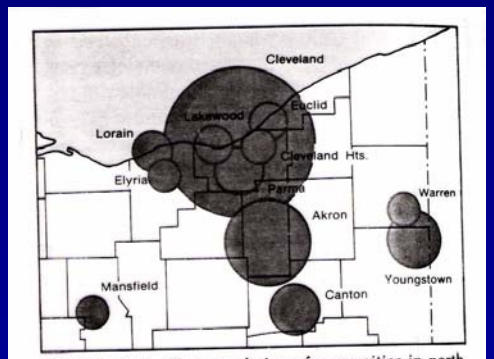


FIGURE 12.22 The population of some cities in northeastern Ohio. Symbols are psychologically scaled so that the areas of the symbols visually connote the correct ratios between the population numbers that they represent (see Table 12.2).

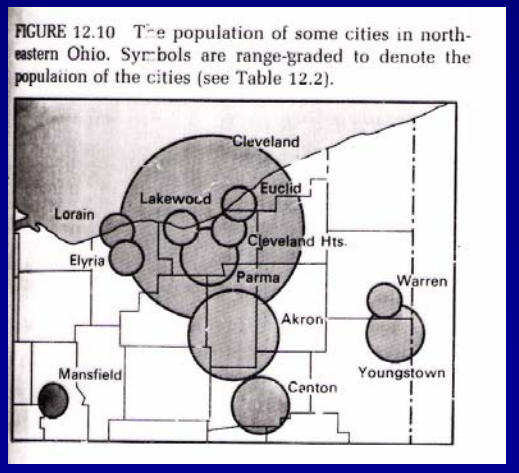
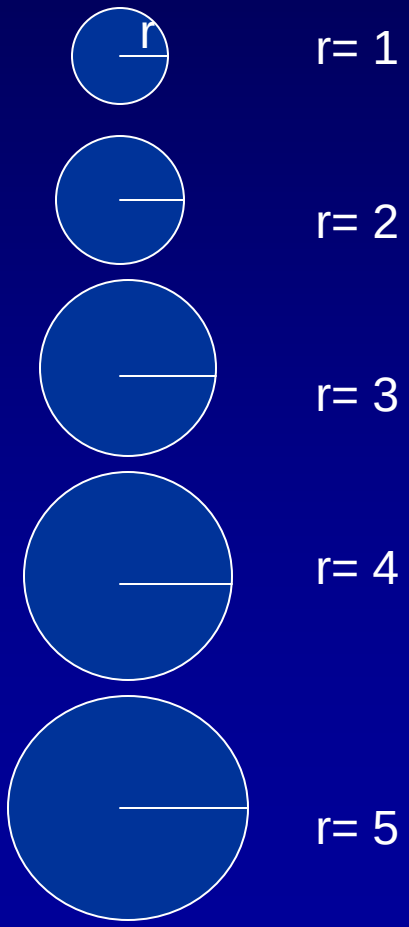


FIGURE 12.10 The population of some cities in northeastern Ohio. Symbols are range-graded to denote the population of the cities (see Table 12.2).

Image source: Robinson et al “Elements of Cartography” 1995

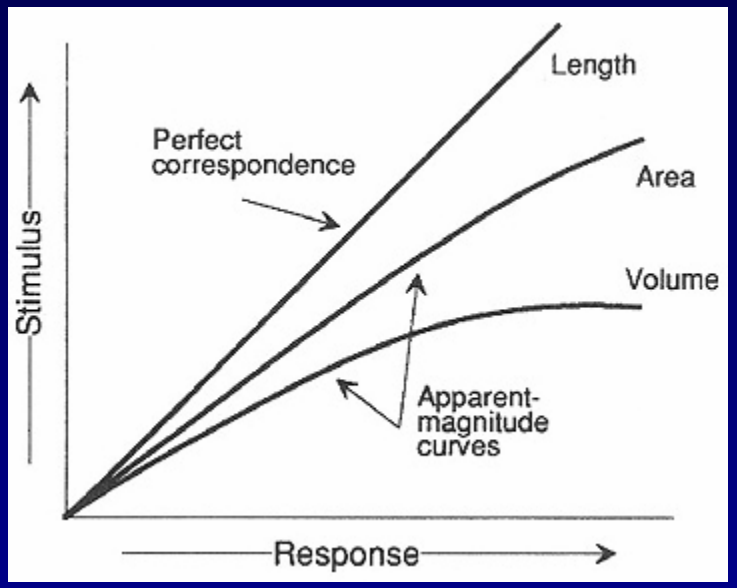
Mathematical scaling

- Data value
  - 10
  - 20
  - 30
  - 40
  - 50
- Symbol size



Area of symbol is directly proportional to the magnitude mapped

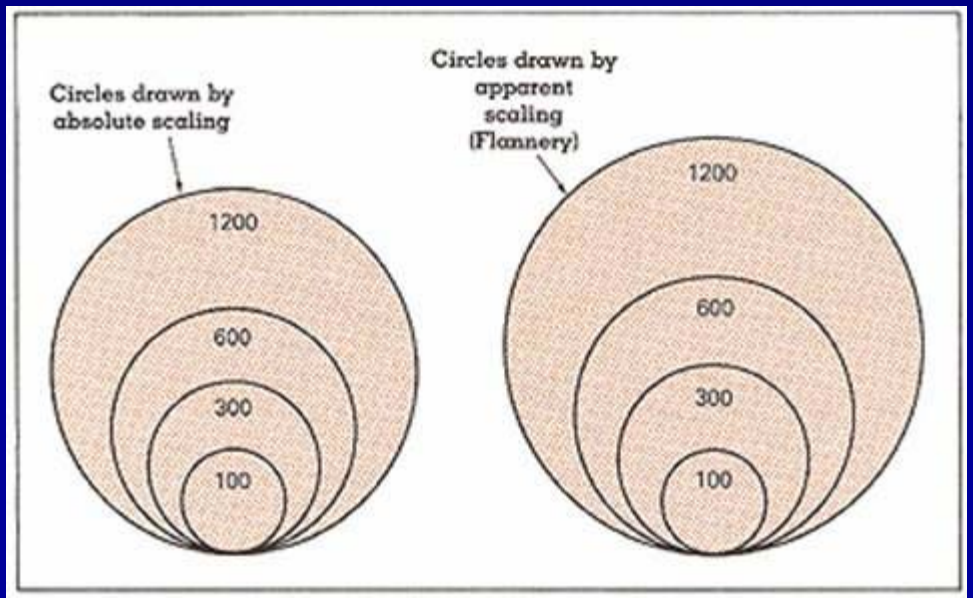
Rational behind perceptual scaling



- People tend to underestimate the size of symbols

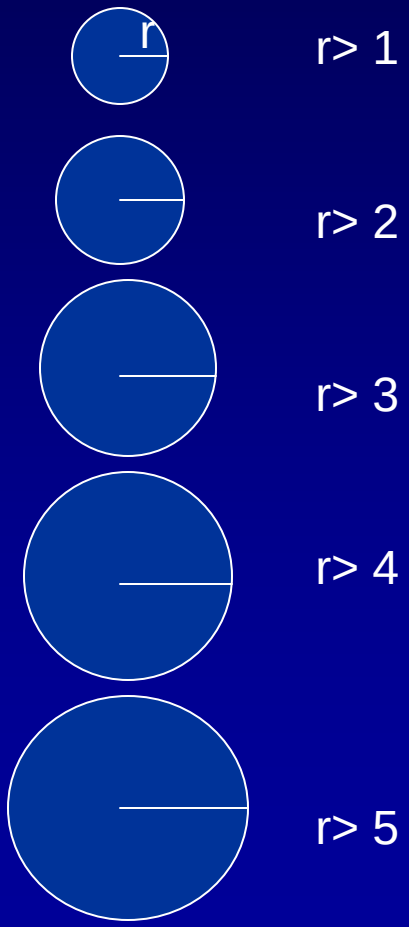
- Mathematical scaling might be modified to account for underestimation

Image source: Dent “Cartography” 1999



Perceptual scaling

- Data value
  - 10
  - 20
  - 30
  - 40
  - 50
- Symbol size



Area of symbol gets enlarged to compensate for underestimation

Range-graded scaling

- A group of data value

10-20

20-30

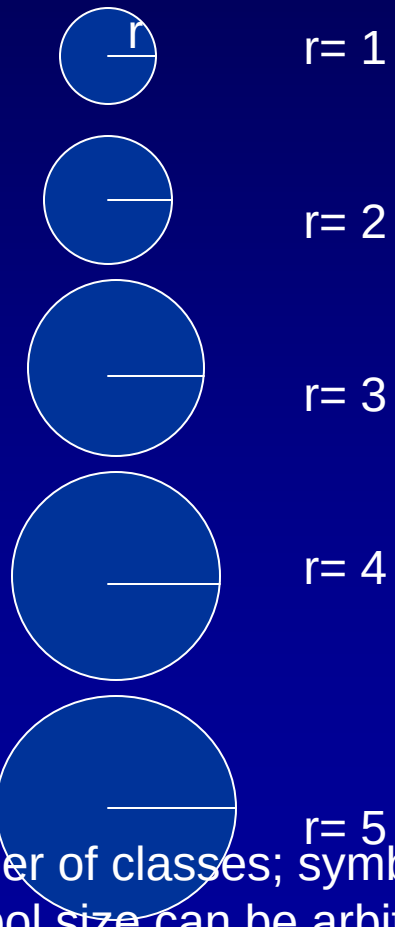
30-40

40-50

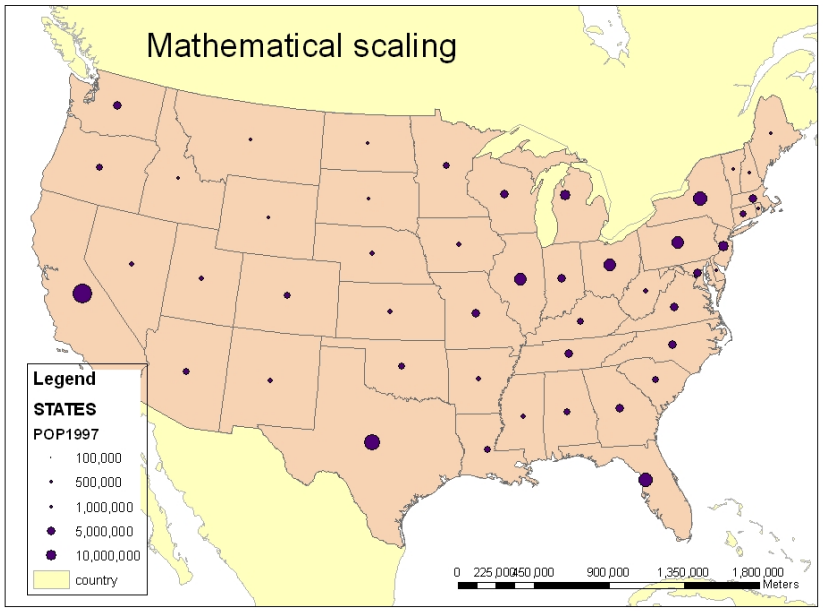
50-60

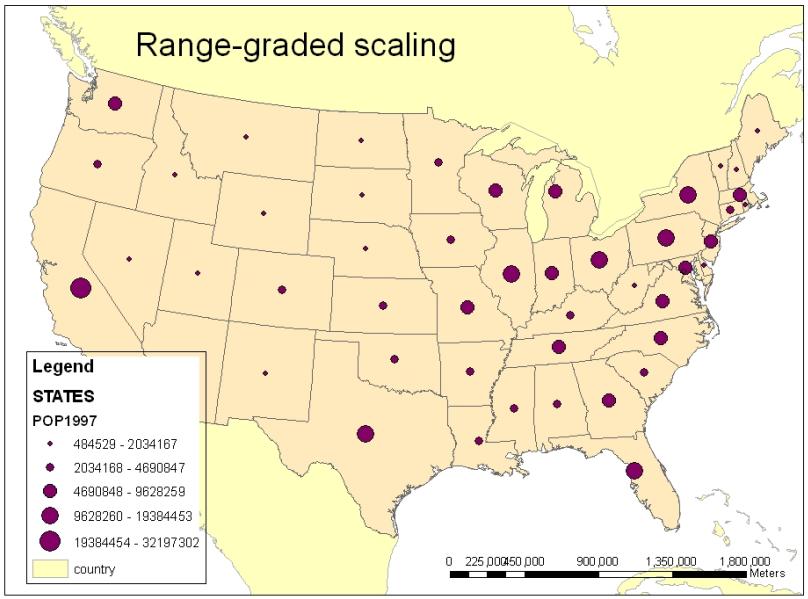
Can be grouped using different data classification methods

- Symbol size

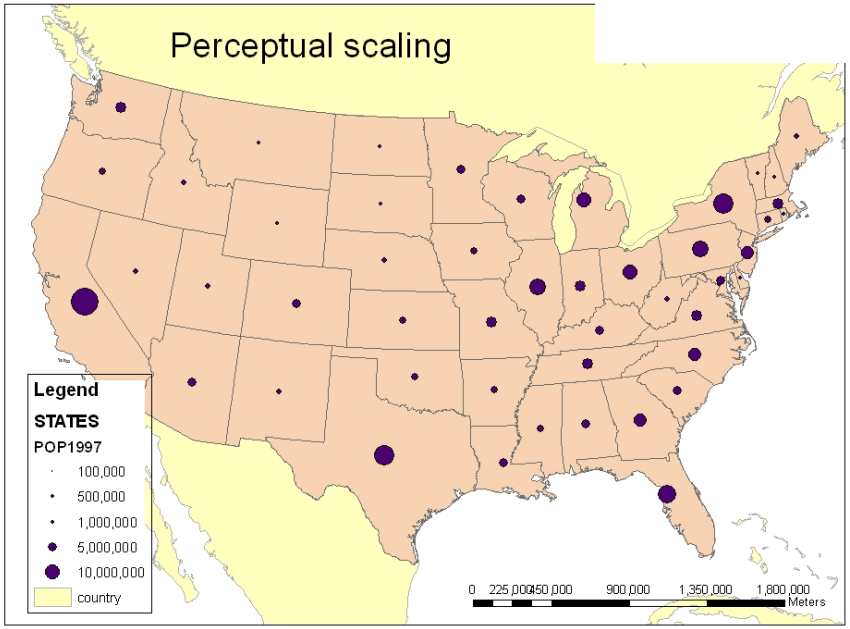


Data values are grouped into a certain number of classes; symbol size is proportional to relative rank of classes; symbol size can be arbitrarily chosen as well





Unclassed



Classed

- ArcGIS Demo: USPop_ProportionalSymbolMap.mxd

Design considerations

- Does the map fit into the appropriate model of geographic phenomenon?
- What kinds of proportional symbols?
- Which scaling methods?
- How much to overlap?
- Handling symbol overlap
- Does the map embody the principle of visual hierarchy?

What kinds of point symbol?

- Figure 16.1 A: geometric symbols
- Figure 16.3: pictographic symbols
- Advantage and limitations?
- Geometric: 2D vs. 3D? (Figure 16.4)

Which scaling methods?

- Classed or not? Advantage/limitations of each?
  - Compare four maps in Figure 16.11 (p. 321)
- If unclassed, which scaling?
  - What if you can correctly estimate size unlike the way in which Flannery argued?
- Consider distribution of data and how maps look
  - Variation of data is very small, unclassed method would usually yield monotonous pattern
  - Variation of data is very large, unclassed method would usually yield clustered pattern
  - If you use classed method, it will hide the fact that data varies very little by symbol size
  - If data distribution has outliers, map by unclassed method will be hard to read

How much to overlap?

- Compare http://130.166.124.2/chiatlas/chi151.GIF
- and ImagePool\circle_symbol.wmf
- Compare Figure 16.15
- Map should appear neither ‘too full’ nor ‘too empty’
- Too monotonous pattern is not good
  - Lack of distinguishing power
- Too clustered pattern is not good either
  - Lowers readability, lack of accuracy

Handling symbol overload

- See Figure 16.16 (p. 325)
  - Transparent symbols
  - Opaque symbols
- Advantage/limitations?

Tips for proportional symbol map design

- Symbols should be made to appear as strong figures in perception
  - Enhance visual hierarchies
    - Contrast, Edge, Proximity, Layering,…
- Symbols should be clear and unambiguous in meaning
  - Symbol size should be distinguishable from neighboring symbols
  - Do not overload symbols; it lowers readability

Proportional symbol & Diverging color scheme