

# Cartographic Conventions for Symbology and Color - Applications to Health Statistics Mapping

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Image: De Cola, Lee. 2002. "Spatial Forecasting of Disease Risk and Uncertainty." *Cartography and Geographic Information Science* 29(4).



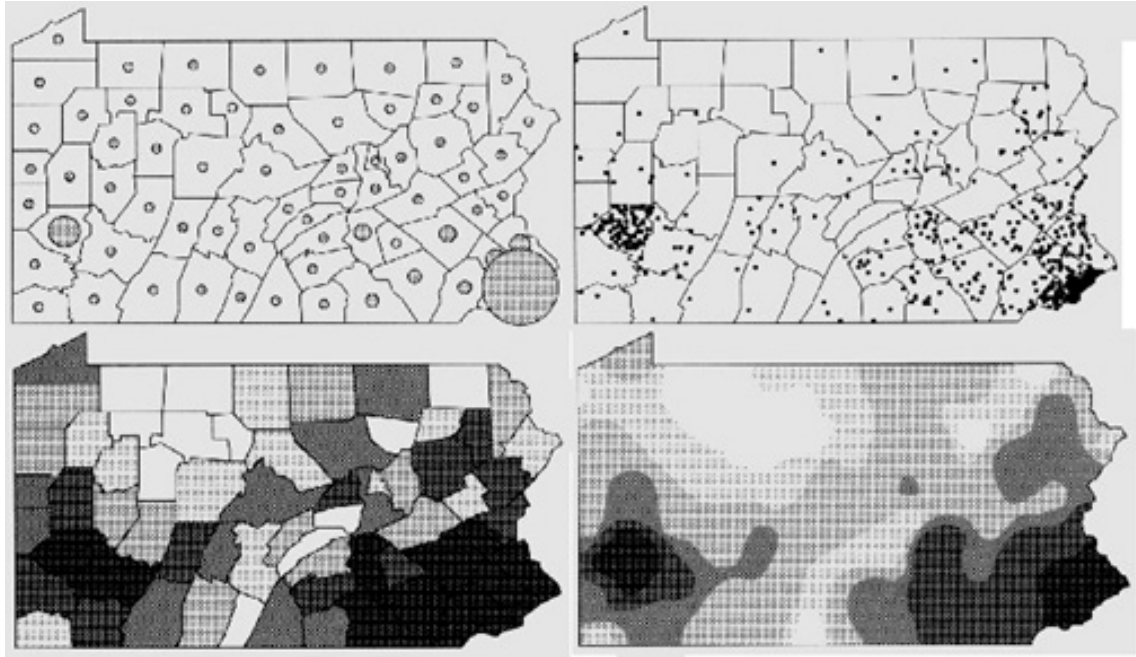
# Scope of webinar

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- The nature of geographic data
- Data models, cartographic models, and connotations
- Color: Dimensions of color and physiology of color perception
- Applying color theory and data models to the mapping of health statistics

# Thematic mapping: AIDS in Pennsylvania, 1988

counts,  
"numerousness"



boundaries matter

boundaries irrelevant

Different mapping techniques lead to  
different impressions of the phenomenon



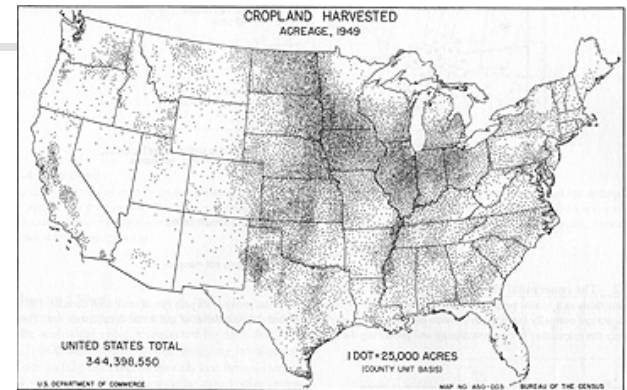
# Levels of measurement

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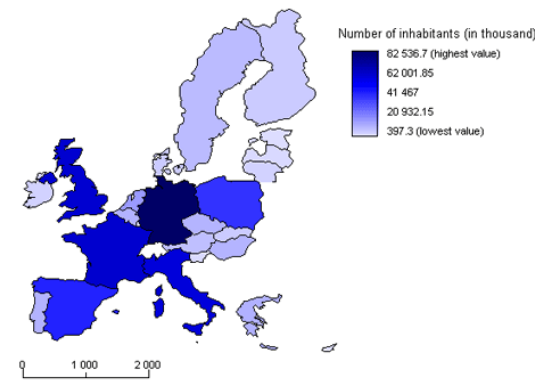
- Qualitative: difference in kind of thing
  - **nominal**: church types, race, gender, dog breeds, mortality causes
- Quantitative: difference in amount or intensity
  - **ordinal**: ranking of hazards, college basketball rankings
  - **interval**: temperature, time: “45° is not 3 times as hot as 15°, but it is 30° warmer”; arbitrary zero point (January 1; 0 Celsius)
  - **ratio**: most quantitative data: mortality rates, numerousness of people affected, intensity

# Spatial continuity

- What are the differences between the following data sets:
  - Locations of Wal-Marts
  - Dairy farms in Vermont
  - Aggregated census-based demographics
  - Temperature
- geographic data can be **discrete** or **continuous**
  - Does the data occur at points with undefined areas between the data points, or does a value exist at every location?

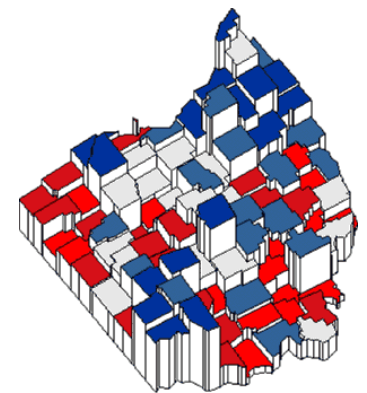
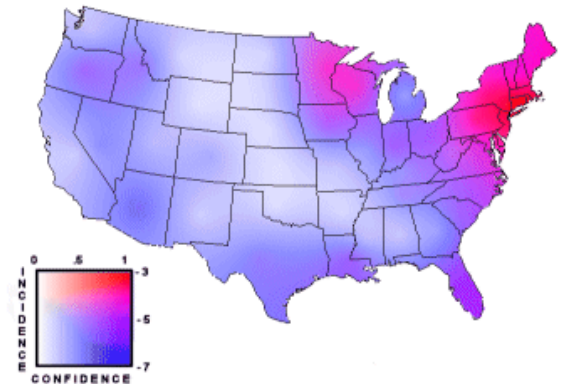


Distribution of the EU Population in 2003



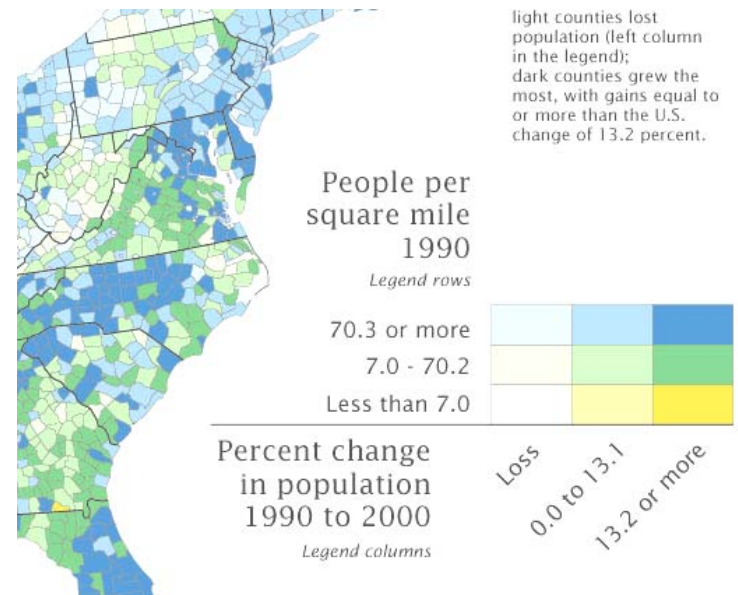
# Spatial variation

- What is the primary difference between these data sets:
  - Sales tax rates
  - Electoral college results for 1992
  - Raccoon density
  - CO concentration near a factory
- Geographic data can vary abruptly or smoothly
  - Are there boundaries (natural or cultural) that exist that govern the distribution of the data?



# Color on maps

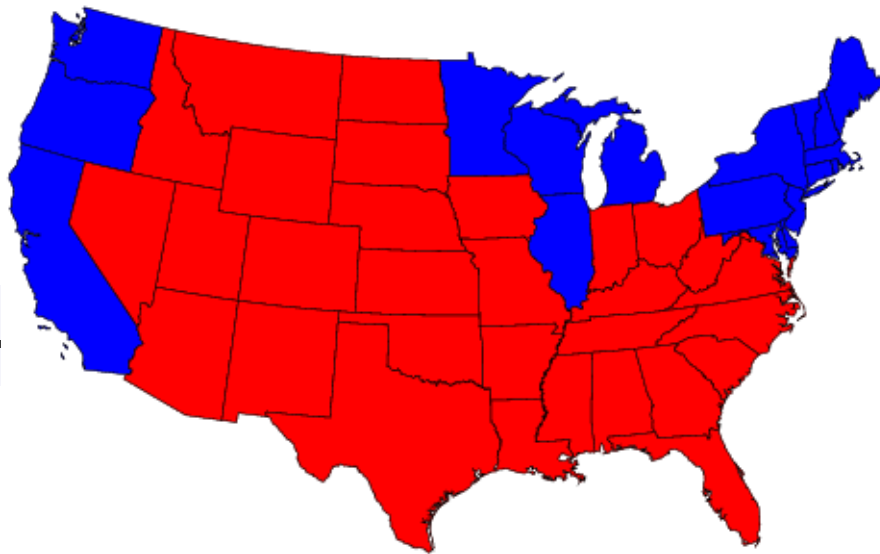
- advent of computer maps (GIS, Internet, etc.) affords use of color on maps like never before
- map interpretation and color perception intimately linked
- factors in color perception:
  - medium of presentation
  - color blindness
  - psychophysical effects
  - cultural factors and connotations
  - cartographic conventions and mental models



# LAND ELEVATION Conterminous United States







2004 election:

Red = Bush

Blue = Kerry

Choropleth map, discrete binary color scheme

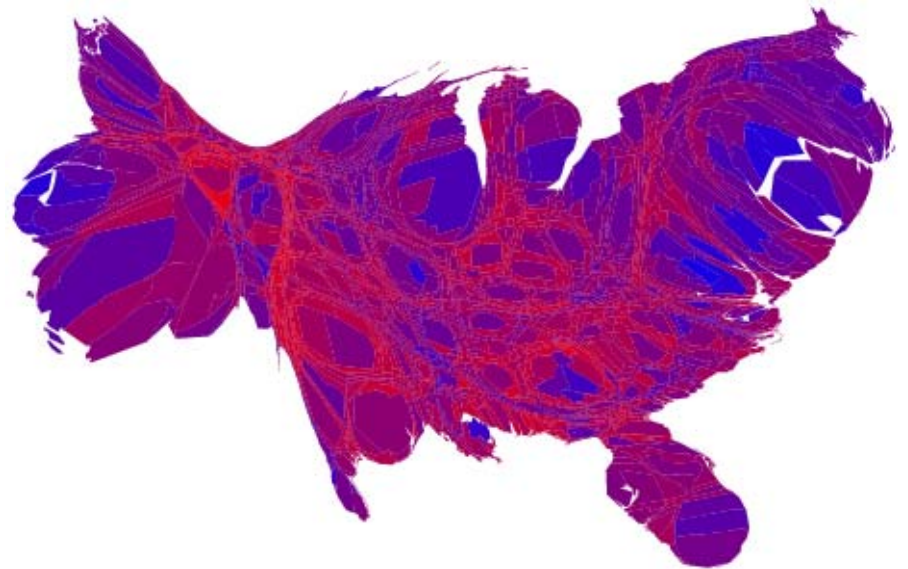
Same data, different impression:

Red = strongly Bush

Purple = close to even

Blue = strongly Kerry

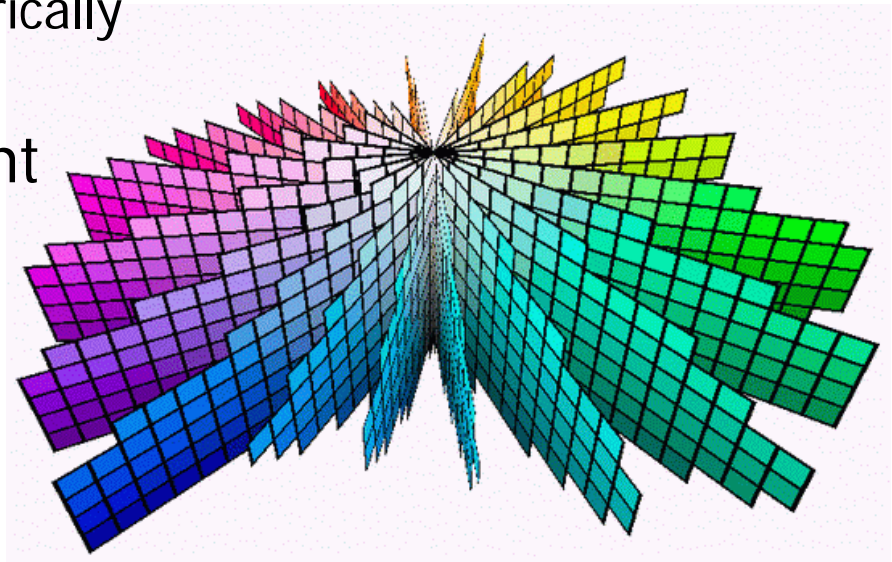
Cartogram (size based on population), continuous diverging hue transition



Michael Gastner, M., C. Shalizi, and M. Newman (2004). "Maps and cartograms of the 2004 US presidential election results," <http://www.cscs.umich.edu/~crshalizi/election/>

# The dimensions of color

- color has three dimensions
  - colors can be described numerically by a triple (a, b, c) of values
- different models use different "axes"
  - RGB, CMY(K), HCV, Munsell, Pantone, CIE
  - each uses slightly different definitions
- most common to describe mapping color techniques: HSB

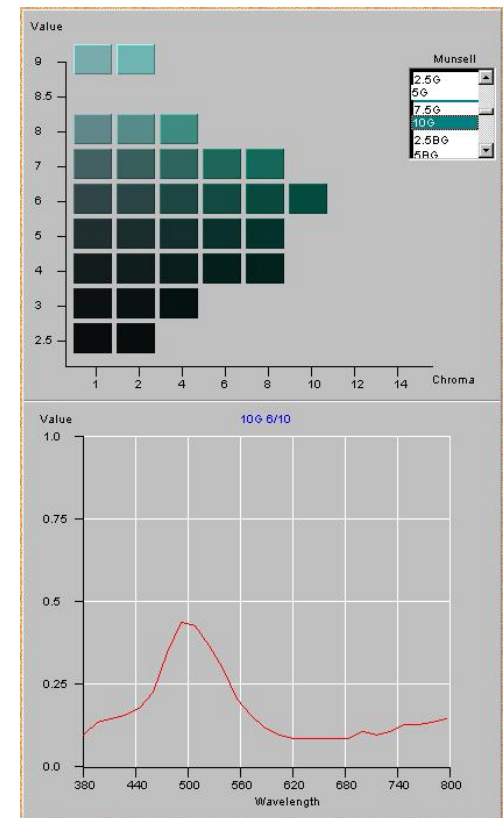


HSB java applet: <http://people.ucsc.edu/~mlz/hue/>

Flash color model explorer: <http://www.tech.purdue.edu/cg/facstaff/jlmohler/dcm.html>

# Hue, saturation, brightness

- hue – colors of the rainbow – ROYGBIV
- saturation – amount of other hues other than dominant hue
  - gray is **desaturated** – **electric blue** is **saturated**
  - a.k.a. chroma, intensity
- brightness – amount of white or black
  - **light green** through **forest green** to **dark green**
  - a.k.a. value, lightness



<http://www.it.lut.fi/ip/research/color/demonstration/demonstration.html>



# Psychophysical effects of color perception

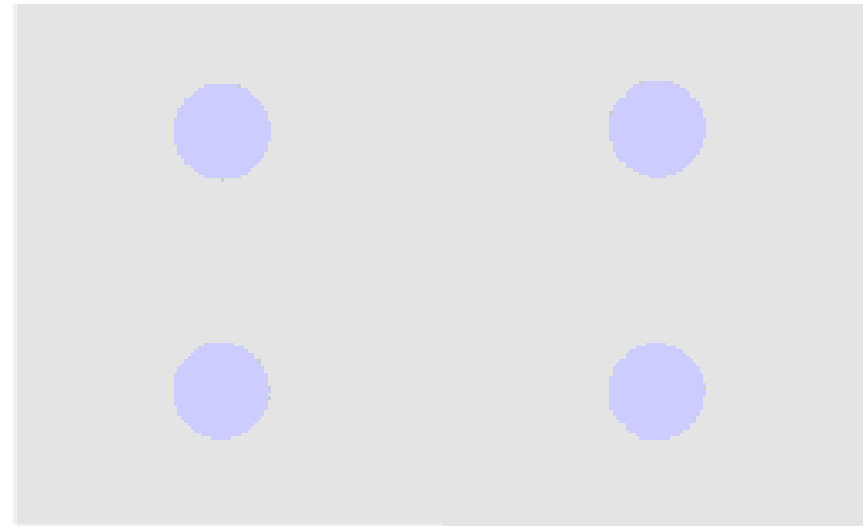
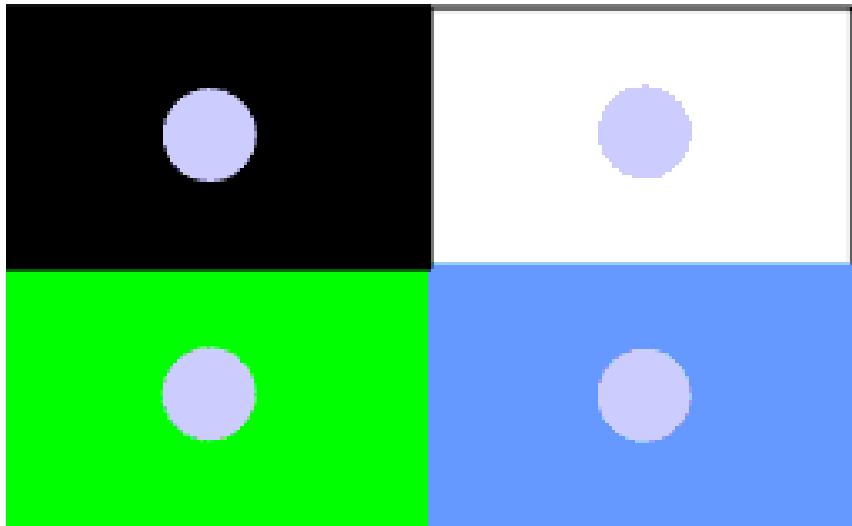
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- simultaneous contrast
  - perceived brightness and color of area is influenced by surrounding color
  - darker background makes colors look lighter
  - implications for mapping
- chromostereopsis
  - “advance-and-retreat”
  - longer wavelength light appears closer than shorter wavelength
  - implications for mapping



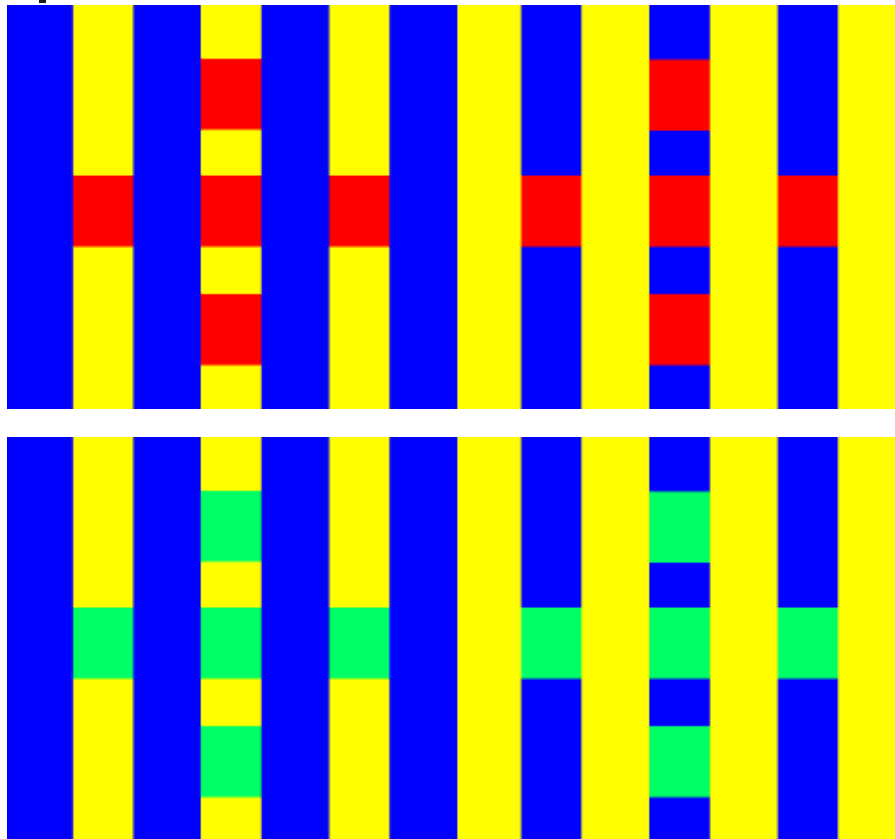
# Simultaneous contrast

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The Munker-White Illusion: [http://www.michaelbach.de/ot/lum\\_white-illusion/index.html](http://www.michaelbach.de/ot/lum_white-illusion/index.html)

# Simultaneous contrast

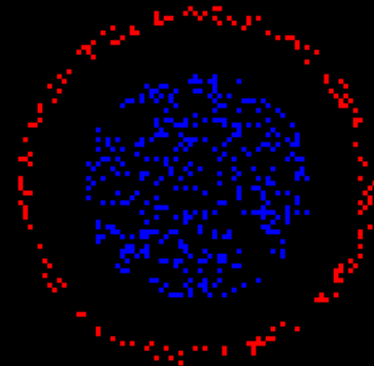
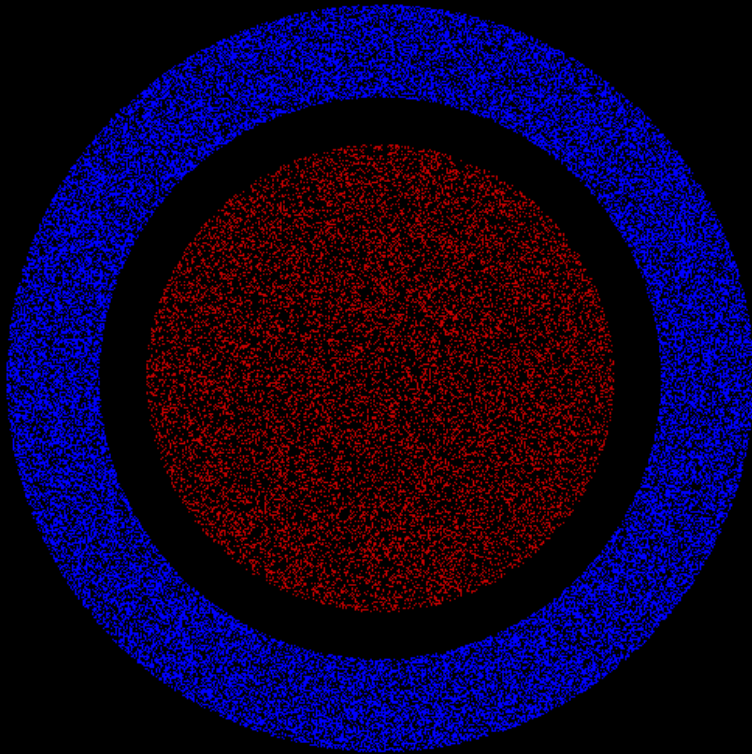


<http://www.colorcube.com/illusions/scstripe.htm>



# Chromostereopsis

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Most see the red as closer to the eye than the blue



# Color use issues

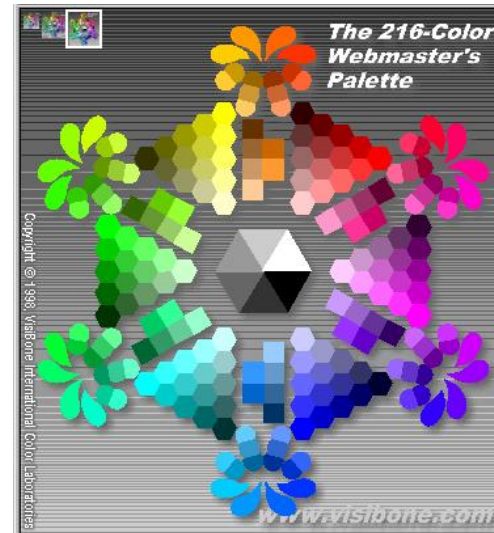
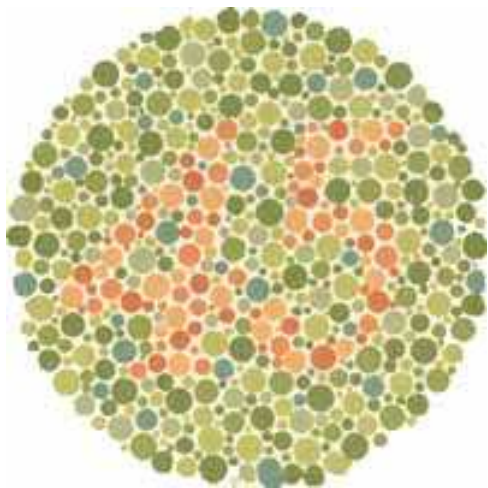
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- color blindness
- color variations among media types



# Color blindness

- maps need to be designed with color deficiencies of users in mind



Simulate color blindness: <http://colorlab.wickline.org/colorblind/colorlab/>

# Color schemes for the color blind

- certain color schemes not discernable for the color blind
- most color impairment is red-green; also blue-yellow



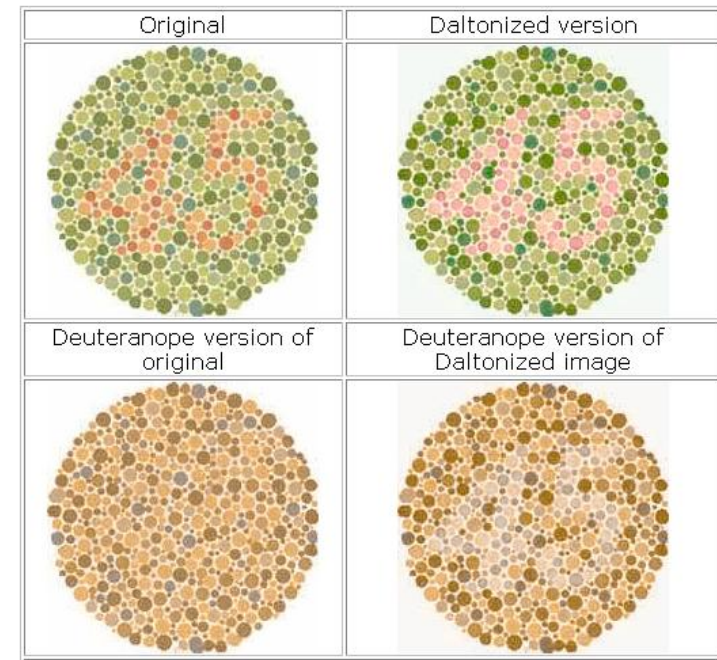
# Color schemes for the color blind

- from [usability.gov](http://usability.gov) :

**Guideline:** Do not rely on color alone to communicate a message.

**Comments:** Ensure that text and graphics are understandable when viewed without color. If designers depend on color to convey information, colorblind users and users with devices that have noncolor or nonvisual displays cannot receive the information.

- use [vischeck](http://vischeck.com) to see how your map or graphic will look to the color blind



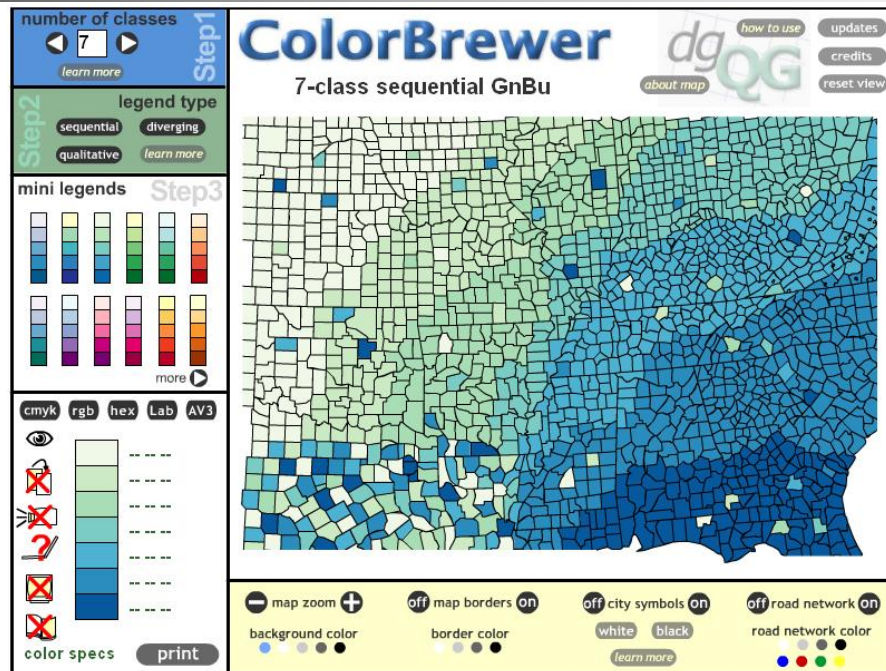
vischeck: <http://www.vischeck.com/>

# Media issues

- graphics for b&w photocopying
  - is there enough of a lightness difference?
- graphics for LCD/RGB projectors
  - projectors tend to wash out saturated colors, making bright colors look pastel and making pastel look white
- graphics for color printing
  - color printers vary; use CMYK as color specs for color printing



# Color Brewer



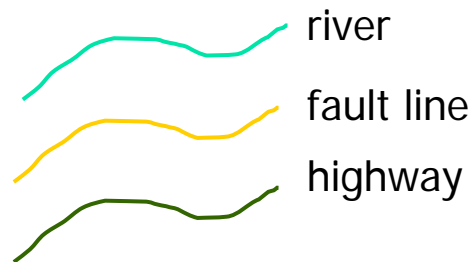
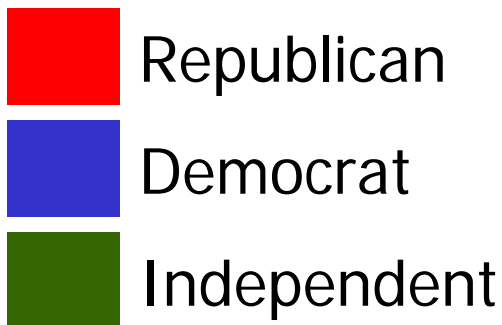
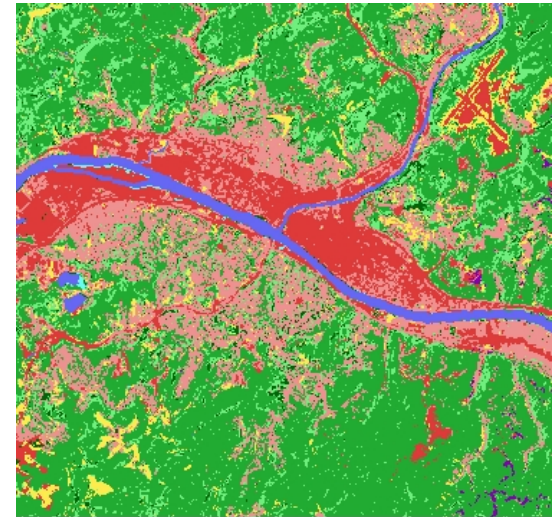
Learn much more and play with color schemes at

[Color Brewer](http://www.personal.psu.edu/faculty/c/a/cab38/ColorBrewerBeta.html)

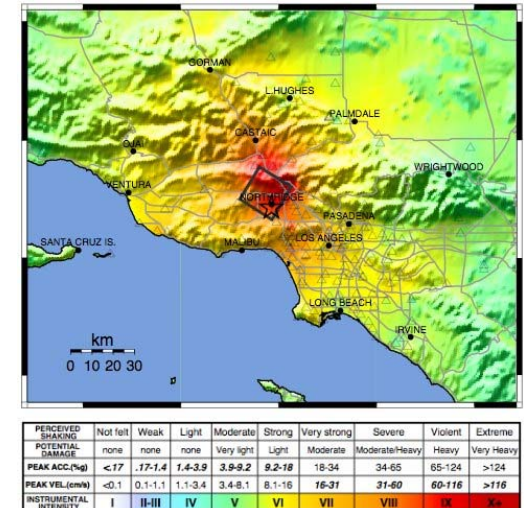
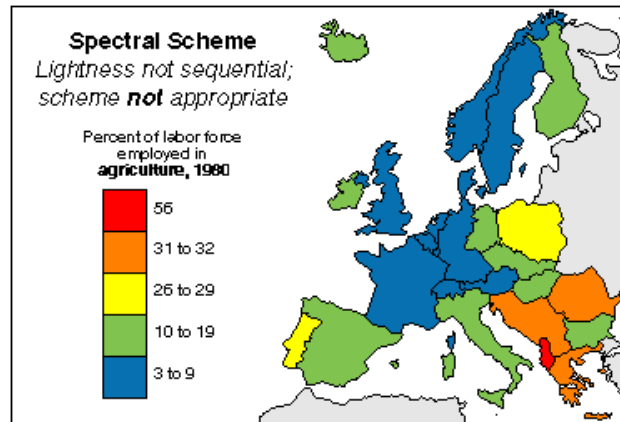
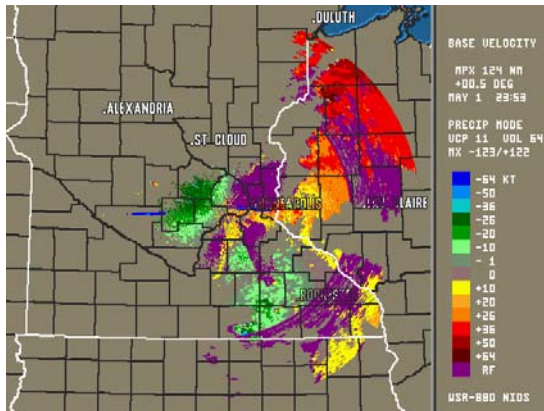
Color Brewer: <http://www.personal.psu.edu/faculty/c/a/cab38/ColorBrewerBeta.html>

# Color schemes for thematic mapping

- qualitative mapping
  - if difference in kind, colors should vary by hue



# Hue scheme – quantitative data?

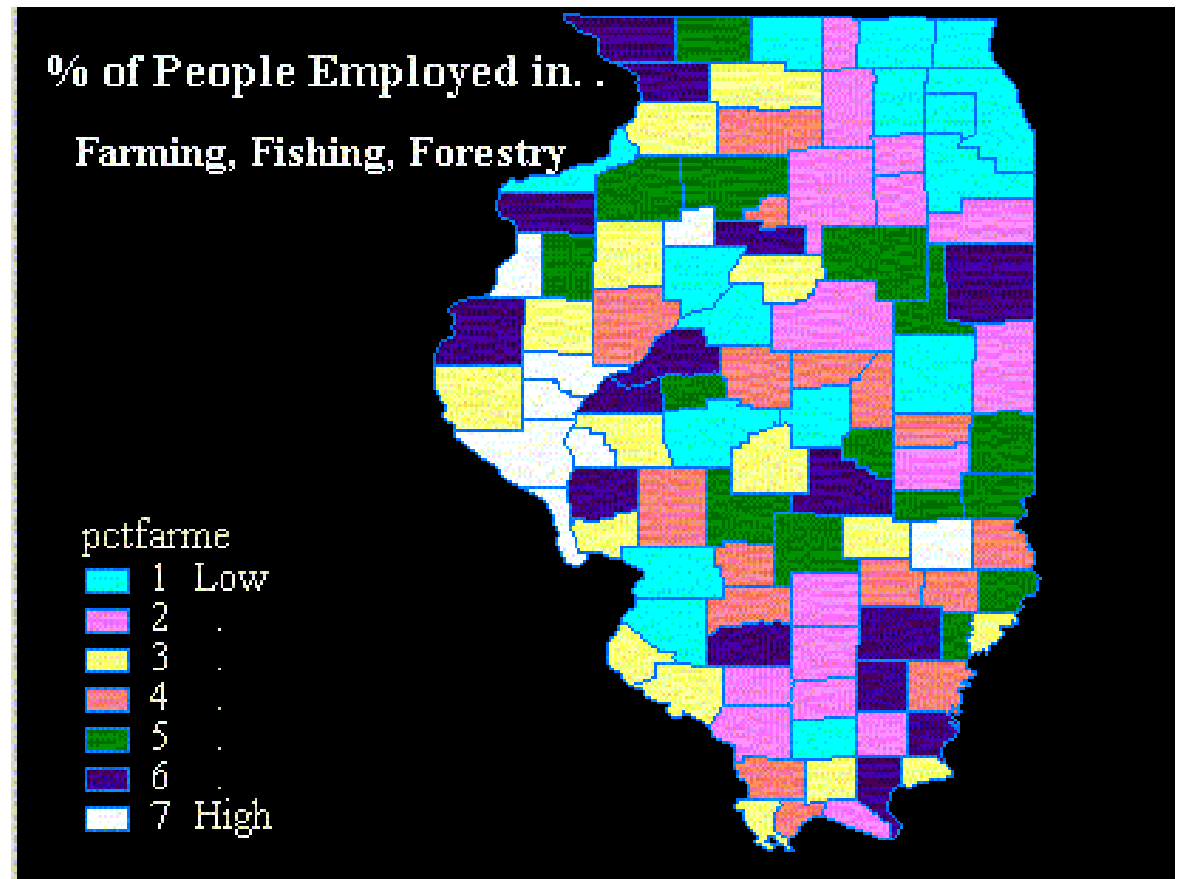


hue differences are confusing for quantitative data – which color is least / greatest?

possible exception:  
intensity/heat –  
connotations of  
temperature symbols:  
red = hot, blue = cold

# Choropleth maps: traps

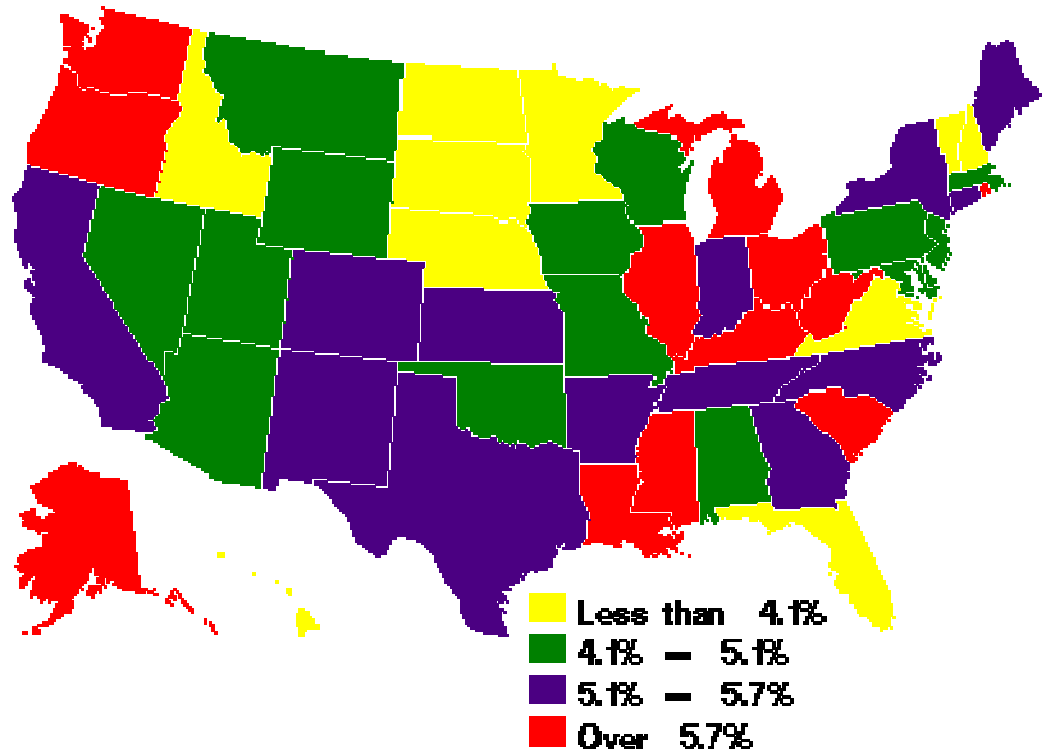
Appropriate match to data model (abrupt, continuous data), but color scheme is not logically ordered





# Choropleth maps: traps

Appropriate match to data model (abrupt, continuous data), but color scheme is not logically ordered



# Color schemes for thematic mapping

- quantitative mapping
  - if difference in count or degree, use **sequential** color scheme
    - lightness variations: darker = more



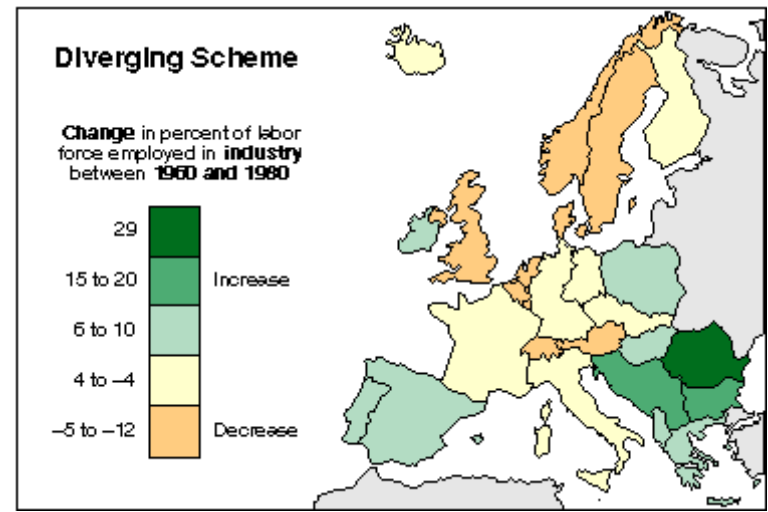
Water Use by Parcel



Color and map design: [http://www.personal.psu.edu/faculty/c/a/cab38/GEOG321/04\\_color02/color5.html](http://www.personal.psu.edu/faculty/c/a/cab38/GEOG321/04_color02/color5.html)

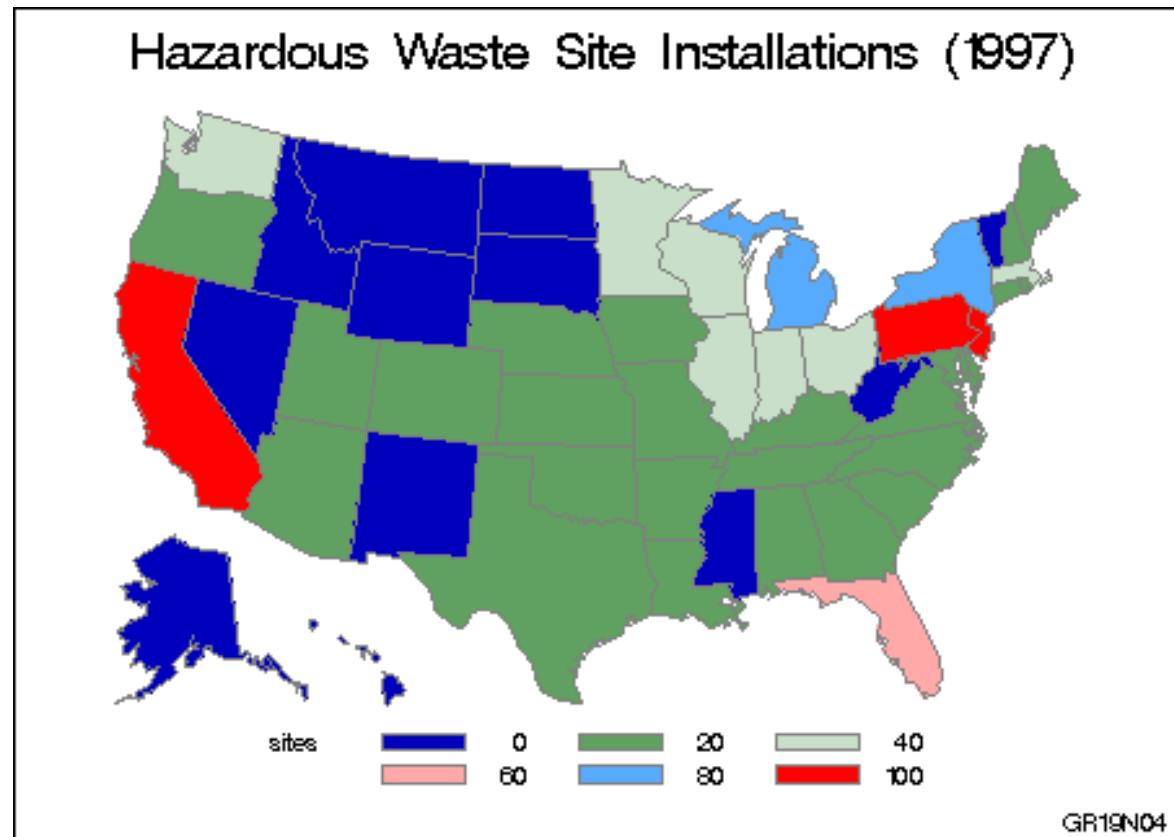
# Color schemes for thematic mapping

- quantitative mapping
  - if there is a critical class or critical class break, use **diverging** color scheme



# Choropleth maps: traps

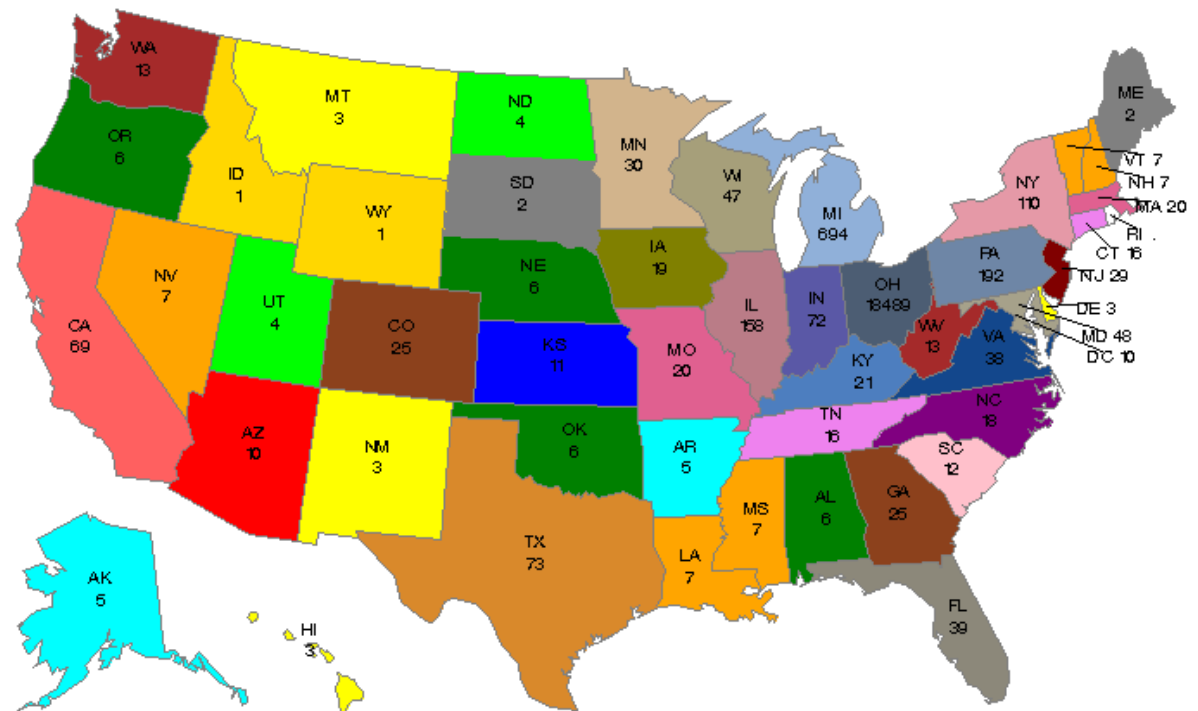
Inappropriate cartographic model for data model (abrupt, discrete) – data are not normalized to account for area, population differences



# Choropleth maps: traps

Inappropriate match to data model (abrupt, discrete data), AND color scheme is not logically ordered

HEADCOUNT ENROLLMENT BY STATE & US TERRITORY



Fall 2005