

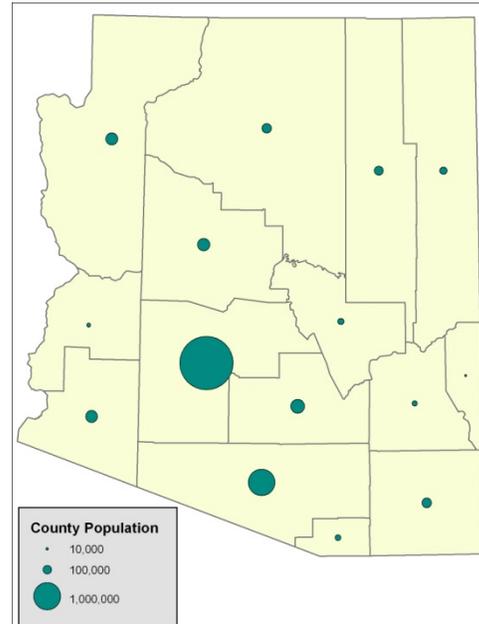
Mapping Quantities: Proportional or Graduated Symbols

This is the second lecture covering the topic of mapping quantities. In the previous lecture we looked at choropleth maps and today we will examine the use of proportional, or graduated symbols to represent quantities. In the following pages we will discuss the how, why, and when of proportional symbol maps.

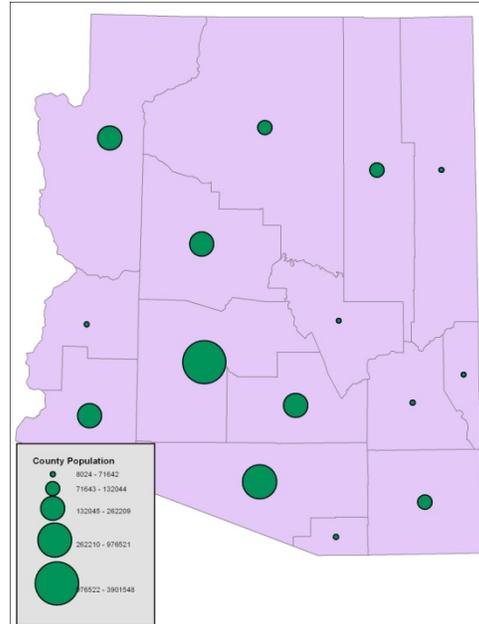
Introduction

A proportional symbol map has “symbols that change in size according to the value of the attribute they represent. For example, denser populations might be represented by larger circles, or larger rivers by thicker lines.” (GIS Dictionary, esri.com)

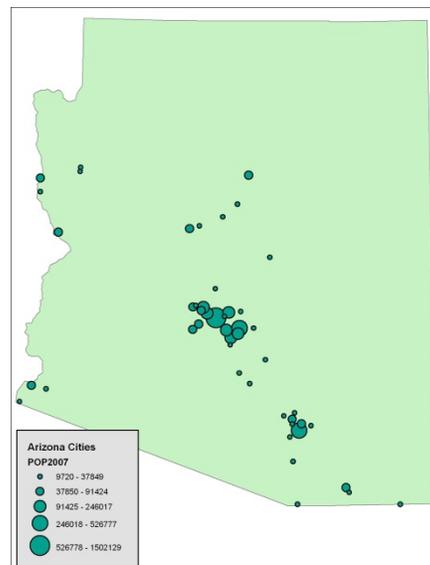
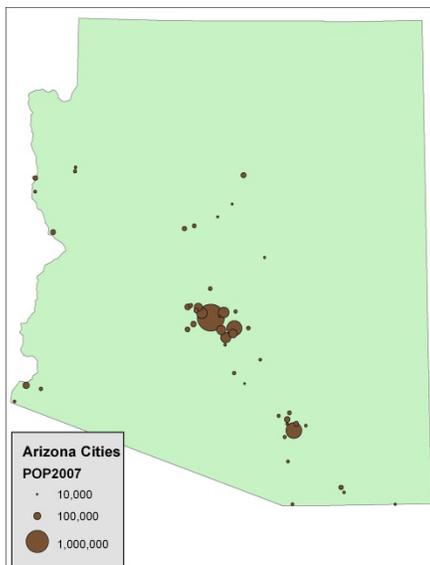
In proportional symbol maps, symbols vary in length, height, area, or volume from place to place in proportion to the quantity they represent. Although these most typically are used to represent point data, they can be also used with aggregated data for polygons, or for lines. For example, the map to the right represents aggregated population in Arizona counties as variable sized circles.



Symbols in these maps can either represent actual values, or classes of values. Also called absolute scaling and range graded values. In the previous map, absolute scaling of each symbol represents the actual population value of the particular county. Thus there are fifteen different sized symbols in the map. The example to the right represents population divided into 5 different range graded classes. Because each class is a range of values, any particular symbol can appear more than once in the map.



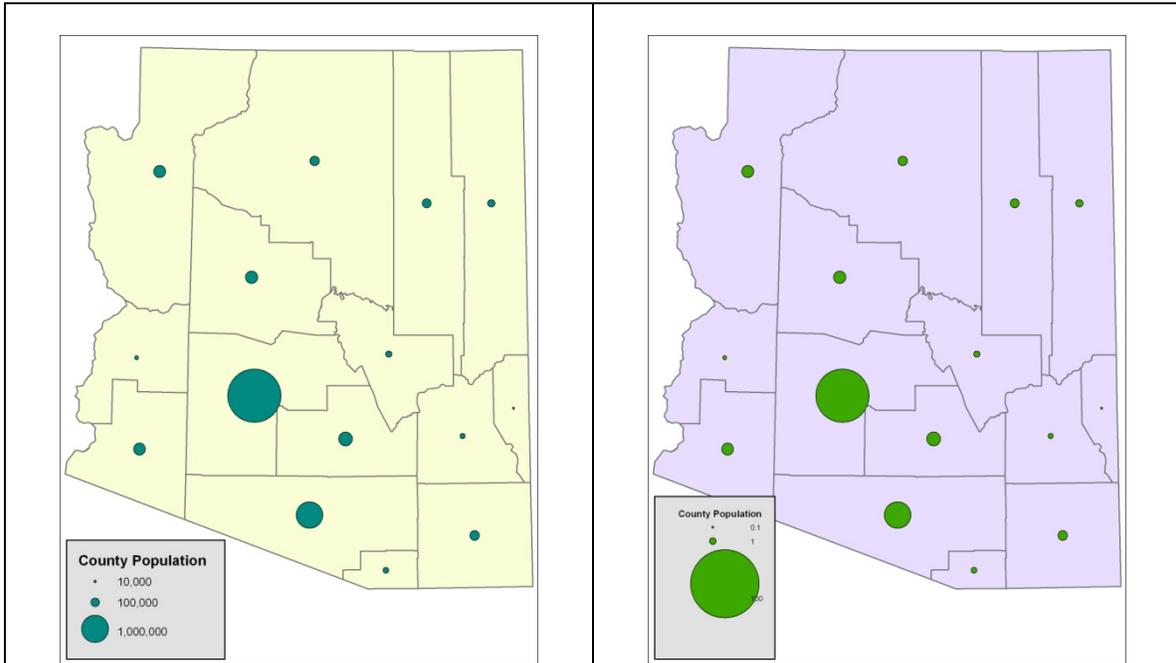
Below are examples of proportional symbol maps representing discrete points. The map on the left shows symbols representing populations for each city using absolute scaled symbols. The map on the right shows these same data put into 5 range graded classes.



Data Types and Restrictions

Proportional symbol maps are limited to particular data types. For example ratio scale data can be used, but not interval scale data because it is difficult to symbolize the value zero and impossible to symbolize negative values using proportional sizes. Within ratio scale data, you can symbolize either raw values or derived data describing percents or

proportions. For example county population, below left, or county population as percent of state population, below right.



Symbols

In general, circles are the easiest symbols to use, and to understand. This is important because studies have made it clear that map readers are unable to distinguish proportional change in symbols correctly. They consistently underestimate the area or volume of symbols, so being able to distinguish a symbol that is twice as large as another is difficult, if not impossible for most map users. It is possible to use symbols other than circles (more below), replicative symbols can make for dramatic maps, but it is even more difficult to judge proportional size for symbols with more complex shape than circles.

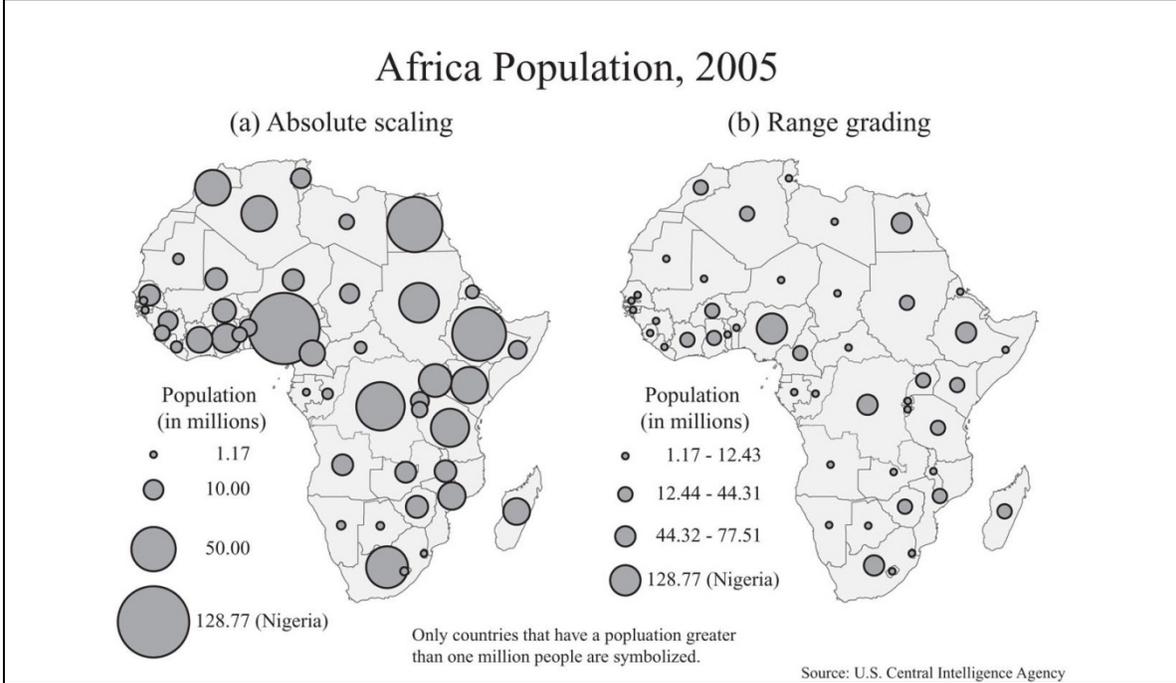
Symbol Scaling

This has led to a variety of approaches to symbolization, most commonly absolute scaling, range grading, and apparent magnitude scaling. Two of these we have already seen, absolute scaling and range grading.

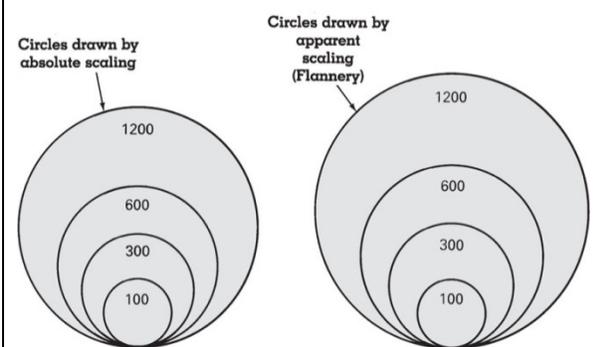
Absolute scaling takes a strict proportional approach. If a symbol is twice as large as another, this indicates that it represents a value that is twice as large. This approach is easy to calculate and makes logical sense, but as we have already mentioned a couple of times leads

Range scaling puts data into classes. This makes it relatively easy to match a symbol size to a range of values, but actual values are lost. In the graphic below, the map on the right uses range scaling.

to incorrect proportional estimates by map readers. In the graphic below, the map to the left uses absolute scaling.



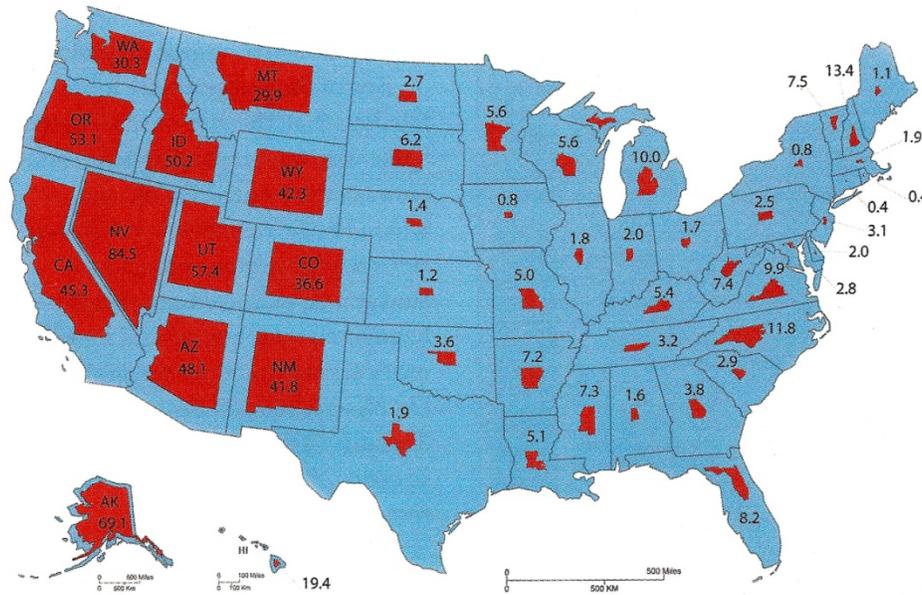
Apparent Magnitude Scaling adjusts symbol size to account for misinterpretation of symbols. There are a variety of schemes for accomplishing this, all based on experimental values leading to inconsistent results. But these results are often easier for the map reader to interpret than symbols created using absolute scaling.



A clever exception to the problems with replicative symbols can be seen below. Here symbols are used to represent the amount of federal land in each state. This map is successful, because the replicative symbols are easily recognizable as states; the comparison is more within each state than across states, numeric values help the user understand the proportional relationship between symbols, and because the use of red and blue creates a dramatic color differentiation.

WHO OWNS THE WEST?

Federal Land as a Percentage of Total State Land Area



Data source: U.S. General Services Administration, *Federal Real Property Profile 2004*, excludes trust properties.

Conclusions

Today's lecture looked at proportional symbol maps. The basic idea is that symbol size varies based on ratio scale values at point locations or aggregated across polygons. The symbol size can be based on either actual values or classed values. Although map readers consistently underestimate the size of symbols, these maps do give the user a quick, comparative understanding of data.

Students should be aware that there is some confusion introduced by the software we use in this course. In ArcMap, proportional and graduated symbol maps are defined differently. In ArcMap, when the user selects proportional symbols from the list of different types of maps, the software creates a map using absolute scaling or apparent magnitude scaling symbols; when they select graduated symbols from the list, the software creates a map of range graded values. Just be aware that this distinction is specific to the software, and is not necessarily reflective of the larger cartographic community's understanding of the terms proportional and graduated.