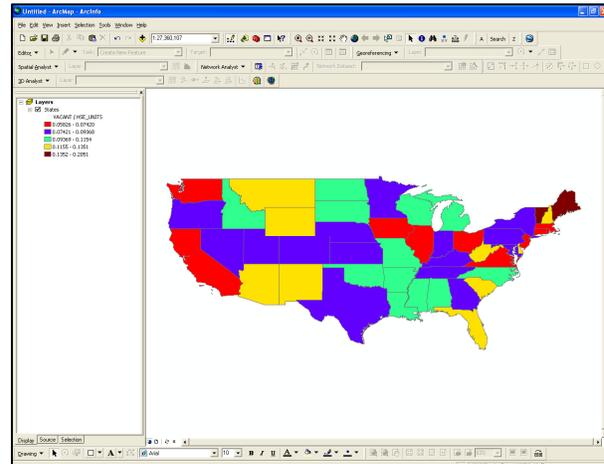
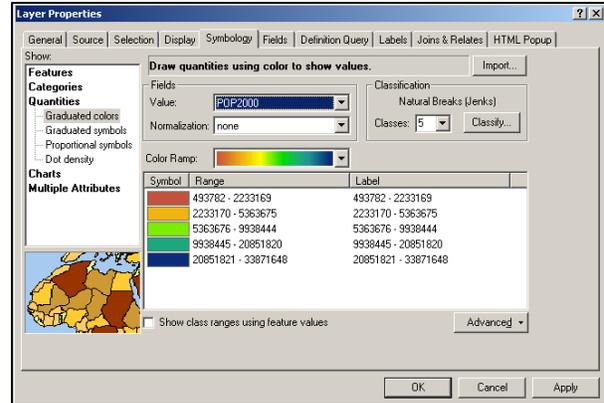
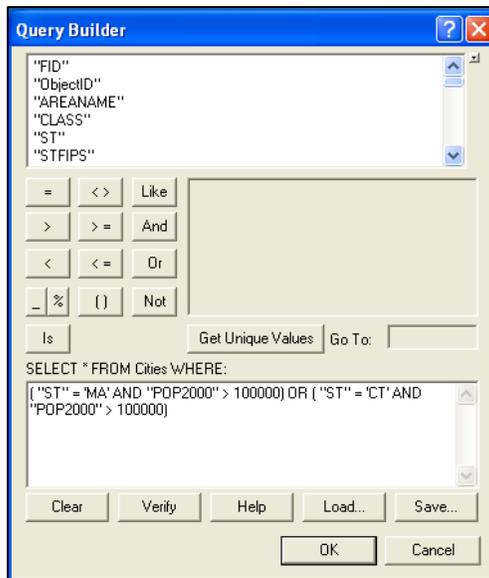


Week 5 Cookbook: GIS Tutorial Chapter 2

GIS Map Design: Choropleth Maps

Week 5 Overview

1. Introducing Choropleth Maps
2. Introducing Map Elements
3. First Hands-On Example
4. Your Turn: GIS Tutorial Chapter 2
5. Definition Queries
6. Second Hand-On Example



This is a big week! Choropleth maps, custom attribute scales, and definition queries – that’s a lot, all thrown together into Chapter 2 of the GIS Tutorial.

- On the plus side – those are the most important concepts and tools you will learn this semester.
- We will review and practice these things extensively over the coming weeks.

This cookbook contains two hands-on examples and you will work through Chapter 2 of the GIS Tutorial. The Week 5 assignment is on a separate sheet. There is also a short (optional!) quiz for you in the Week 5 folder to practice and reinforce the Week 4 content.

Consider printing this cookbook for your convenience

1) Introducing Choropleth Maps

What is a Choropleth Map?

- A choropleth map is simply a map in which the polygons are colored to represent certain attribute values.
- Or, where the size of symbols used for features is a function of the feature attributes.

For Example:

- A map showing the lower 48 states in different colors, depending on how many people lived in a given state in 2003.
- A map showing the location of the 48 state capitals as circles, with the diameter of each circle showing city population.

➔ We see and use choropleth maps all the time...without knowing the fancy word for it! Just look around and I'm sure you see a choropleth map somewhere.

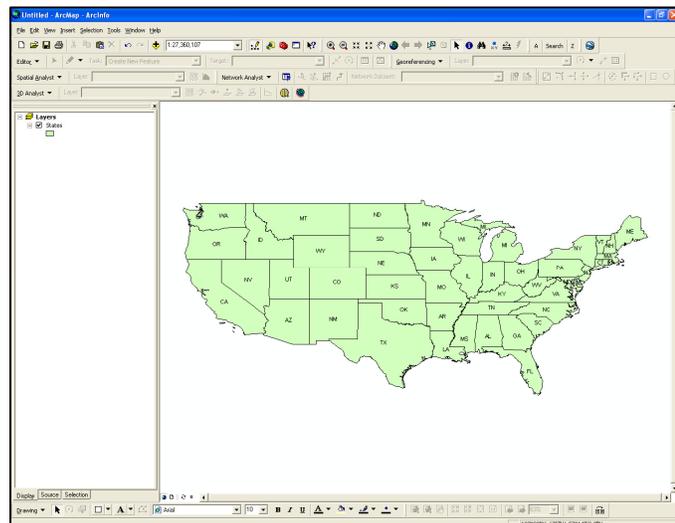
Consider the following map examples

Map 1

- Simple wireframe map of the USA.
- All states labeled with abbreviation.

This map is simple and 'boring' because it does not provide any content or meaning.

But – it is still useful – how else would you create a map to show the states and their abbreviations?

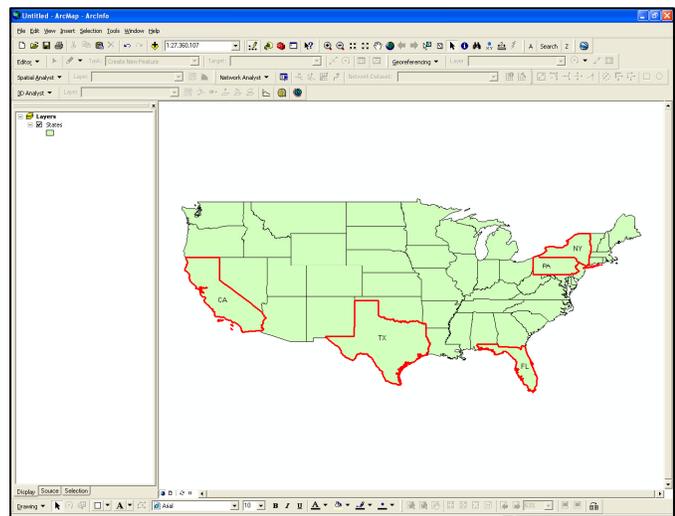


Map 2

- The 5 states with the highest number of vacant housing units are highlighted in red and labeled with their state abbreviation.

This map is more useful, since it has content and thus conveys information to the map user – in this case which states have the highest number of vacant housing units

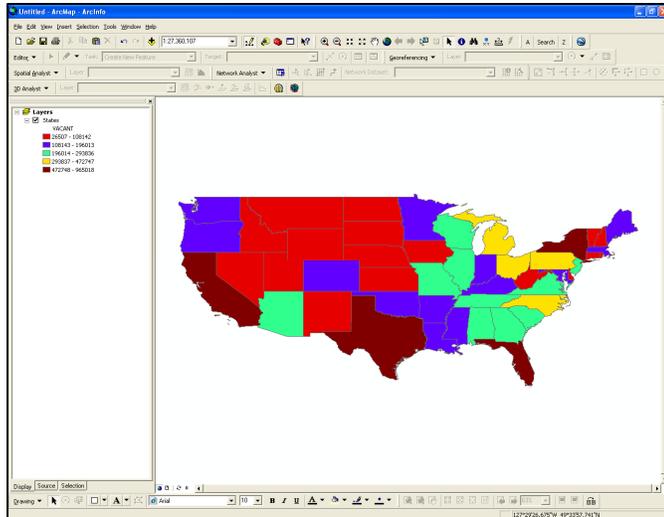
But, it's still only a simple wireframe map.



Map 3

- This is a classic choropleth map.
- The colors show the different absolute numbers of vacant housing units in 5 classes.

This map conveys real content – you can compare the different states using the colors and visualize spatial patterns. Now you can start to interpret these patterns – why do California and Texas have a lot of vacant housing units?



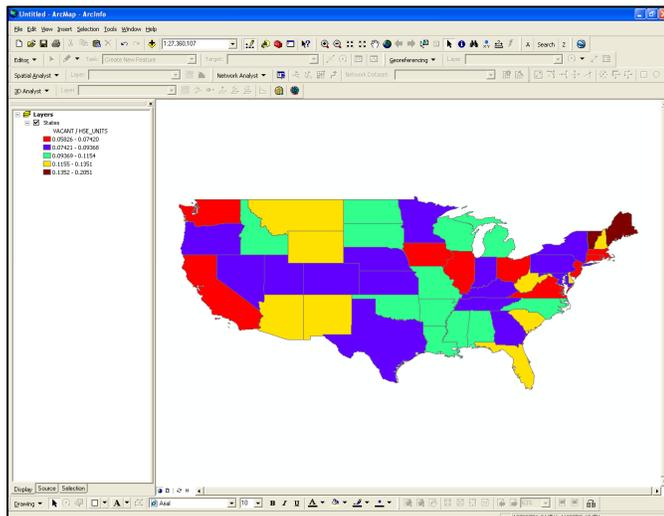
But: Is this a meaningful map? Is this a meaningful spatial pattern?

Map 4

- This is also a classic choropleth map.
- The colors here show the different relative numbers of vacant housing units in 5 classes.
- Here, we show the percentage of vacant housing units relative to total housing units.

This map has real meaning!

In Map 3: of course Texas and California have a high number of vacant housing units...they also have a high number of people and housing units overall



It makes much more sense to show the percentage of vacant housing units, relative to the total number of housing units as done in Map 4 – now Maine stands out.

Things to think about when creating colorful choropleth maps

1. Are the colors meaningful?
2. Is the color scale appropriate? (dark colors suggest high, many, intense, etc.)
3. Printing color is expensive!
4. Color-blind people!

➔ If in doubt...use grey scale in your maps...with white/light grey representing low/small/little/weak and the black/dark grey representing high/many/intense. It may not look as cool as color, but has a lot of advantages.

2) Introducing Map Elements

The following are mandatory map elements that have to be included on any map.

1. **Map Title**
A short and meaningful description of the map, usually located above the map.
2. **Your name, affiliation, and date.**
Example: Map prepared by Carsten Braun, Westfield State College, 09/21/2009.
3. **Data Credits.** That's extremely important: You have to cite the source(s) of the data you use in a map.
4. **Scale Bar.** Use meaningful units and meaningful ranges depending on the size and scale of your map. For example, the scale bar for a driving map is probably best shown in miles.
5. **North Arrow.** That's your classic map element...you need to orient your map in space by providing a North Arrow.
6. **Map Legend.** Meaningful, comprehensive, and well-designed. Good legend are the key to a good map – we will practice legend making extensively.

Optional map elements that can be included on map:

- Neat Lines (= a frame around all map elements) to tie all map elements together.
- Logos of your company, business, or agency. For example, you could add the Westfield State College logo to your maps.

In ArcGIS, you can work on your map in two different views:

Click on View – Data View in ArcGIS

This 'view' of your map is best for data analysis and map making.

Click on View – Layout View

This 'view' of your map is best for defining the map/page size, map layout, adding map elements, and printing, but you can also perform the data analysis in the Layout View.

Let's try a few of these concepts from Part 1 and Part 2 as a hands-on example: We'll be making a simple choropleth map of the United States in the Data View and then add the required map elements in the Layout View. This map you could print and have a professional map!

Note: There is a narrated two-part Jing in the Week 5 folder that you can play as you create your map.

3) A Hands-On Example

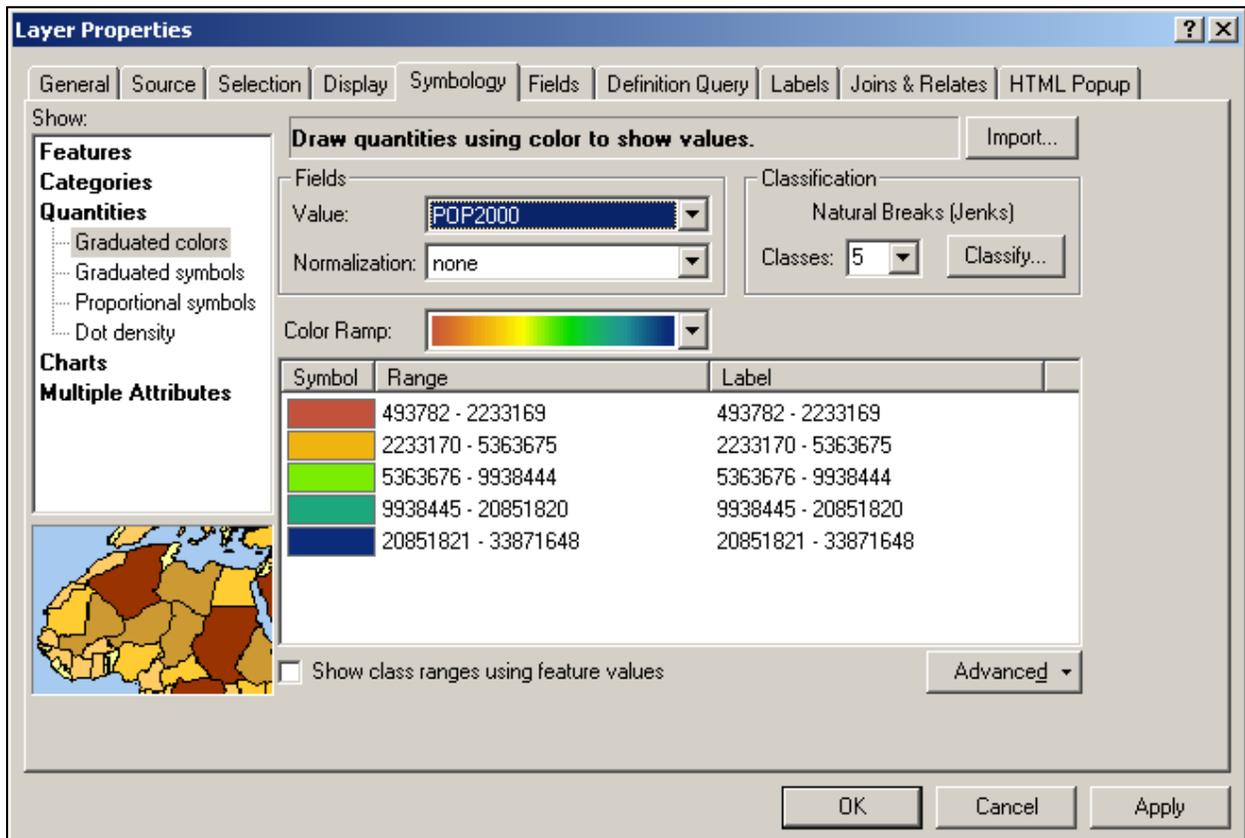
Note: There is a narrated two-part Jing in the Week 5 folder that you can play as you create your map.

1. If necessary, create a folder on your USB flash-drive (inside the \garp0244 folder) called week5.
2. Start ArcMap – A new empty map.
3. Add the States.shp shape file from C:\GISTutorial\UnitedStates\.

You get a simple wireframe map of the lower 48 states (and DC), with all states shown in the same identical color (ArcGIS picks a random color for you).

Mapping Task: Change the map so the states are shown in different colors, depending on their Population in 2000. This turns the simple wireframe map into a simple choropleth map.

4. Double-click on the map layer States to open the Layer Properties.
5. Select the Symbology Tab.
Here you control how the spatial features of the map layer (in this case States) are displayed on your map. You are **NOT** changing the underlying data! You are **ONLY** changing the way the data are displayed as a map layer on your map.



6. Select Quantities – Graduated Colors.
7. Select Value: POP2000.
8. Select a panchromatic color bar – that is a color bar with different colors.
Is this a good color choice for your map?
9. Select a monochromatic color bar – that is a color bar with different shades of the same color, for example red.
Is this a good color choice for your map?
10. Select grey scale.
Is this a good color choice for your map?
11. Reverse the grey scale by clicking on Range and selecting Reverse Sorting.
Is this a good color choice for your map?

Your choice of color bar and sorting is a deliberate decision you make.

Don't just accept whatever ArcGIS gives you as a default. Think about (1) what you want to show with your map and (2) who will be the audience for your map.

You can create very misleading maps by choosing an inappropriate color bar...in fact we will practice this in a few weeks with the *Lying with Maps* Project.

12. Add the Cities.shp shape file from C:\GISTutorial\UnitedStates\.

Okay, now you have a simple choropleth map – nothing fancy, but let's explore how we can turn this map into a professional map that we can print and publish.

13. Switch to the Layout View (View – Layout View).
14. Click on Insert – and add the required map elements:
 - Map Title
 - Text: Enter your name, affiliation, and date
 - North Arrow (many types to choose from)
15. Click on Insert – Scale Bar to add a scale bar.
Adjust to meaningful units and a meaningful range.
16. Click on Insert – Legend and add a simple map legend using the Legend Wizard (just click Next> until the wizard is finished and a legend is added to your map).
17. Arrange the Map Elements appropriately.
You can move the map elements around using the mouse. Double-clicking on a map element brings up the Properties dialog box. For example, double-click on a text box to edit the text, change the font size, alignment, etc.
18. Save the map to your USB flash drive, into the \garp0244\week5 folder, using the map name: week5example.mxd.

Let's review the basic sequence. You start with a blank map and add shapefiles which are displayed as map layers. Then you change the Symbology of each map layer to make them visualize the information that you want, for example population in 2000. Then you switch to the Layout View and add the mandatory map elements. Then you print the map and export it as a PDF file or JPG image.

- The single most important map element is the legend – we will practice making good legends all throughout the semester. For now you can make decent legend simply by using the defaults of the Legend Wizard.

For Fun (and practice) – Try this:

Change the symbology of your map layer Cities so that the diameter of the circle becomes a function of the city population in 2000 and change the color of the circles to green.

→ We'll use this map again later on to explore Definition Queries.

4) Your Turn: GIS Tutorial Chapter 2

Chapter 2 is a bit of a 'kitchen-sink' chapter, introducing many important concepts and skills, albeit rather briefly and not all that well organized in my opinion. The key here is to work slowly and methodically – many of the steps build on one another...thus skipping steps or making mistakes will cost you later!

- As always – whenever prompted to save a map, layer, file, etc.
→ Save to your USB flash drive, into the \garp0244\week5 folder.

Page 42 to 51: Choropleth Maps and Group Layers

- Choropleth Maps and Group Layers. We have already covered choropleth maps. Group Layers are great to 'bundle' map layers and help with the map organization.
- Complete the important 'Your Turn' Box on Page 50.
- Save the layer file as described on Page 51, but to your USB flash drive, into the \garp0244\week5 folder.

→ Skip Pages 52 to 56 (about threshold scales, do that later, time permitting).

Page 57 to 61: Choropleth Maps with Custom Attribute Scales

- The single most important thing you will learn all semester!
- There is a narrated multi-part Jing in the Week 5 folder explaining custom attribute scales.
- Complete the important 'Your Turn' Box on Page 59.
- Save the layer file as described on Page 60, but to your USB flash drive, into the \garp0244\week5 folder.

Page 62 to 69: Pin (point) Maps and Definition Queries

- Page 62 is crucial! Remember – you have to change the actual break points using the "Classify" button and then change the legend labels.
- Pages 66 and 68 describe Definitions Queries. More about that later, but this is the second most important thing you will learn all semester.
- Save the map as described on Page 62, but to your USB flash drive, into the \garp0244\week5 folder.

Page 70 to 72: Create Hyperlinks and MapTips

- Complete the 'Your Turn' boxes on Page 71 and Page 72.
- Save the map as described on Page 71, but to your USB flash drive, into the \garp0244\week5 folder.

This is a long and difficult chapter, no question about it.

But, on the plus side, you will learn the two most important things this semester: Custom Attribute Scales and Definition Queries. We will repeat and practice both many times this semester.

5) Definition Queries (Page 62 – 69)

Definition Queries are the single most important concept and tool you will learn all semester.

- Also important (and very similar): Select by Attribute; Select by Location
- Also important (and complementary): Custom Attribute Scales

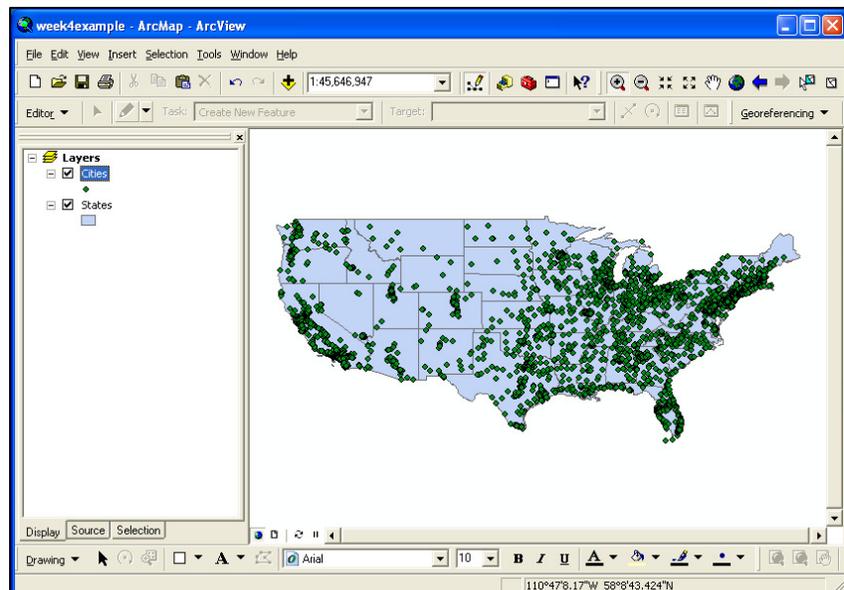
Definition Queries (and Select by Attribute) allow you to select sub-sets of spatial features, depending on their attributes. Select by Location allows you to do the same thing, but based on the location of your spatial features.

Example

You have a map layer, displaying a shape file that consists of 3533 circles, each showing the location of a city in the USA.

The associated attribute table contains demographic data for each city.

Arguably – this is an interesting map if you are interested in all 3533 cities in the USA.



How about if you are only interested in a certain sub-set of these cities? For example:

- Cities in Massachusetts?
- Cities in Connecticut?
- Cities in Massachusetts and in Connecticut?
- Cities in Massachusetts and in Connecticut, but only if they have more than 100,000 people?

6) A Hands-On Example

Note: There is a narrated three-part Jing in the Week 5 folder that you can play as you create your map.

Open the map you created in Step 3, showing states and cities. Or, create a new map as follows:

1. Start ArcCatalog.
2. Start ArcMap – New Empty Map.
3. Add States.shp and Cities.shp from the C:\GIS\Tutorial\United States folder.
4. Save your map to your USB flash drive, into the \garp0244\week5 folder, using a meaningful file name.

Now we are ready to explore Definition Queries.

5. Double-click on the map layer Cities to open the Layer Properties, select the Definition Query tab, and click on Query Builder. Now you are ready to create a query.
6. Use the buttons and scroll windows to create the following expression:

“ST” = ‘MA’ Here is how:

Double-click on “ST”
 Single-click on the equal sign
 Click on Get Unique Values
 Double-click on ‘MA’ (you will need to scroll down a bit)
 Click the OK twice

Do NOT even attempt to type this expression using the keyboard!
 ALWAYS use ONLY the buttons and scroll windows – trust me!

Your map layer now only shows the cities located in MA. Open the attribute table to confirm – you should only see the cities located in MA listed in the attribute table.

7. Go back into the Query Builder, highlight and delete the old expression, and create the following new expression:

“ST” = ‘CT’

Your map layer now only shows the cities located in CT. Open the attribute table to confirm – you should only see the cities located in CT listed in the attribute table.

8. Go back into the Query Builder, highlight and delete the old expression, and create the following new expression:

(“ST” = ‘MA’ AND “POP2000” > 100000)

Here, ONLY use the keyboard to enter the value 100000
 Make sure that you include the parentheses!
 Click the OK twice

Your map layer now shows the 5 cities in MA with more than 100,000 people in 2000 (Springfield, Worcester, Lowell, Cambridge, and Boston). Open the attribute table to confirm – you should only see five cities listed in the attribute table.

- Go back into the Query Builder, delete the old expression and create a new expression to only show the cities in CT with more than 100,000 people in 2000.

Your map layer now shows the 5 cities in CT with more than 100,000 people in 2000. Open the attribute table to confirm – you should only see five cities listed in the attribute table.

- Go back into the Query Builder, delete the old expression and create a new expression to only show the cities in CT and MA with more than 100,000 people in 2000.

("ST" = 'MA' AND "POP2000" > 100000) OR

("ST" = 'CT' AND "POP2000" > 100000)

Make sure that you include the parentheses!

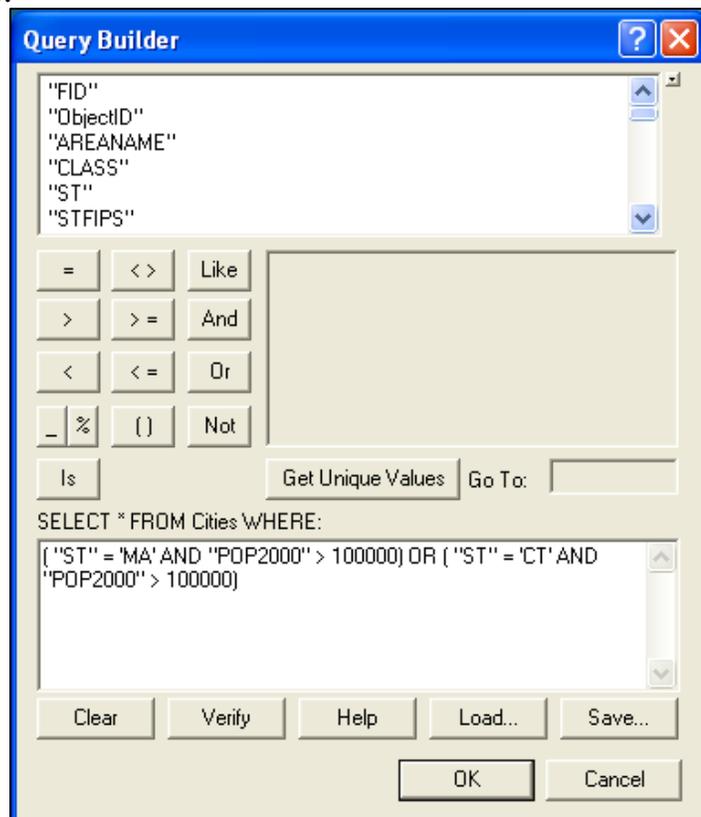
Click OK twice

Your map layer now shows the 5 cities in MA and the 5 cities in CT with more than 100,000 people in 2000. Open the attribute table to confirm – you should only see ten cities listed in the attribute table.

The possibilities for data analysis are endless!

- You can combine selection criteria using logical operators (Like, And, Or, Not) – which is classic Boolean Algebra.
- Be careful and use parentheses in your selection statement to combine or separate your logical expressions.
- Always check your Definition Query results by looking at the attribute table.

Did your Definition Query produce the desired results?



| Week | Date | Topics, Themes, and Tasks | | Assignment |
|-------------|---------------|----------------------------------|--|-------------------|
| Week 1 | 9/2 – 9/8 | Welcome to GARP 0244-Online | Getting Started with Online Learning and GIS | HW #1 |
| Week 2 | 9/9 – 9/15 | What is GIS? Part I | Hardware, software, concepts, data, analysis, and people = GIS | HW #2 |
| Week 3 | 9/16 – 9/22 | What is GIS? Part II | Simple GIS: Web Mapping Applications | HW #3 |
| Week 4 | 9/23 – 9/29 | GIS Tutorial Ch. 1 | Introduction to ArcGIS 9.3.1: ArcMap and ArcCatalog | HW #4 |
| Week 5 | 9/30 – 10/6 | GIS Tutorial Ch. 2 | GIS Map Design: Classification and Choropleth Maps | HW #5 |
| Week 6 | 10/7 – 10/13 | GIS Tutorial Ch. 3 | GIS Outputs = Maps: Creating Meaningful Maps | HW #6 |
| Week 7 | 10/14 – 10/20 | Project 1 | 'Lying with Maps' | Project 1 |
| Week 8 | 10/21 – 10/27 | Review and Reflection | Basic GIS: Intelligent and Meaningful Maps | |
| Week 9 | 10/28 – 11/03 | What is MassGIS? | Online Sources of GIS Data: MassGIS and More | HW #7 |
| Week 10 | 11/04 – 11/10 | GIS Tutorial Ch. 6 | Spatial Analysis Part I: Creating GIS Data | HW #8 |
| Week 11 | 11/11 – 11/17 | GIS Tutorial Ch. 8 | Spatial Analysis Part II: The ArcGIS Toolbox | HW #9 |
| Week 12 | 11/18 – 11/24 | Project 2 | MassGIS Project | Project 2 |
| Week 13 | 11/25 – 12/01 | Project 2 | MassGIS Project | Project 2 |
| Week 14 | 12/02 – 12/08 | Project 2 | Mass GIS Project | Project 2 |
| Week 15 | 12/09 – 12/15 | Project 3 | Zoning for Westfield and Holyoke | Project 3 |