

# Geodatabase Basics

## Querying Data

### Table Joins

# The Shapefile

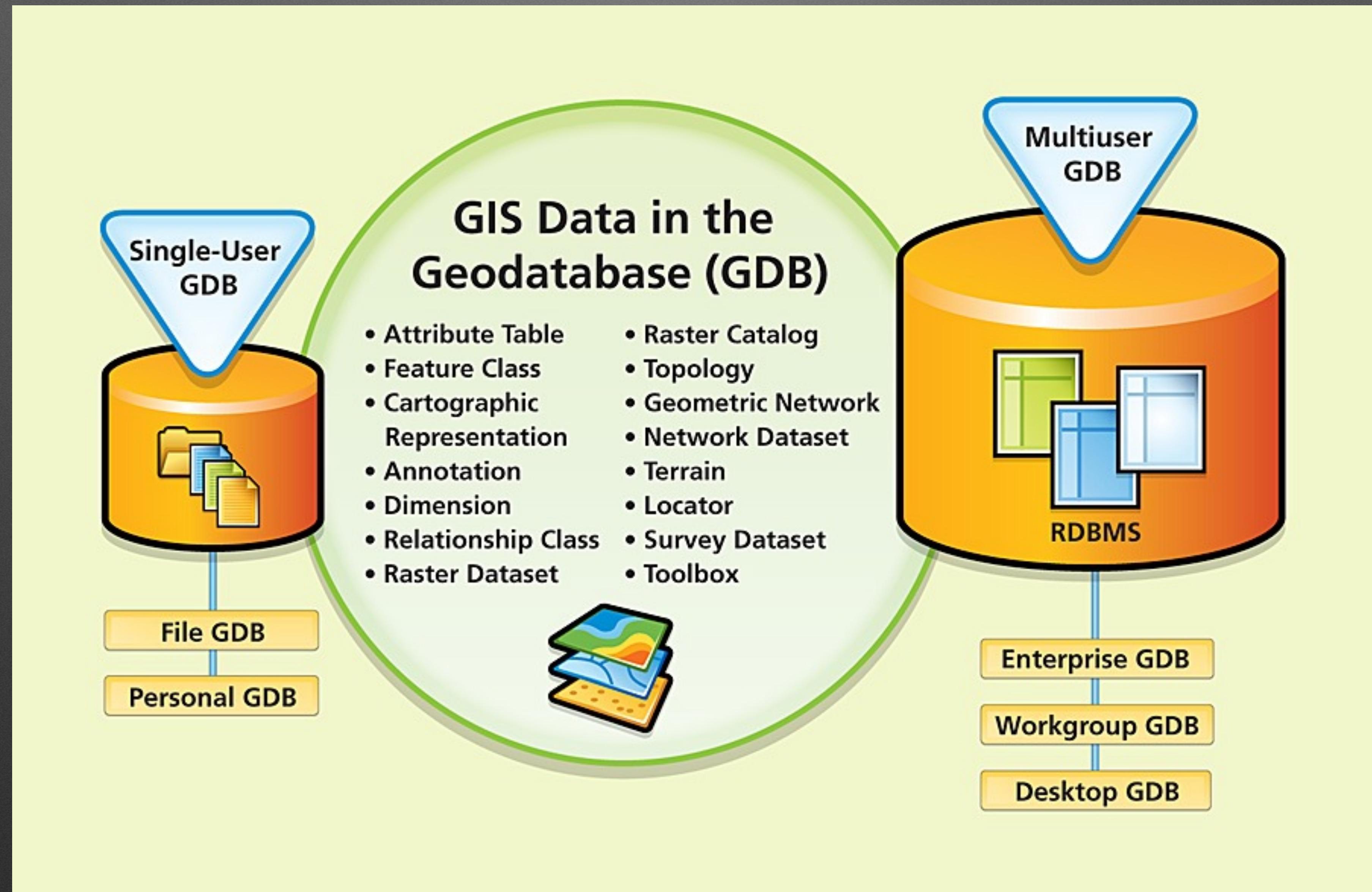
- We have been currently using shapefiles in class
- These are spatial datasets which predate the geodatabase, but are still widely used
- They only can store vector data
- Cannot store curves
- Made up of a lot of different pieces
- 2 Gigabyte Size Limit

Name	Type	Size	Modified
cntry08.shp	Shapefile	3.75 MB	8/26/2009 3:10:00 PM
cntry08.dbf	DBF File	110 KB	
cntry08.prj	PRJ File	1 KB	
cntry08.shp	SHP File	3,725 KB	8/26/2009 3:10 PM
cntry08.shp.xml	XML Document	181 KB	9/10/2014 7:02 PM
cntry08.shx	SHX File	3 KB	8/26/2009 3:10 PM

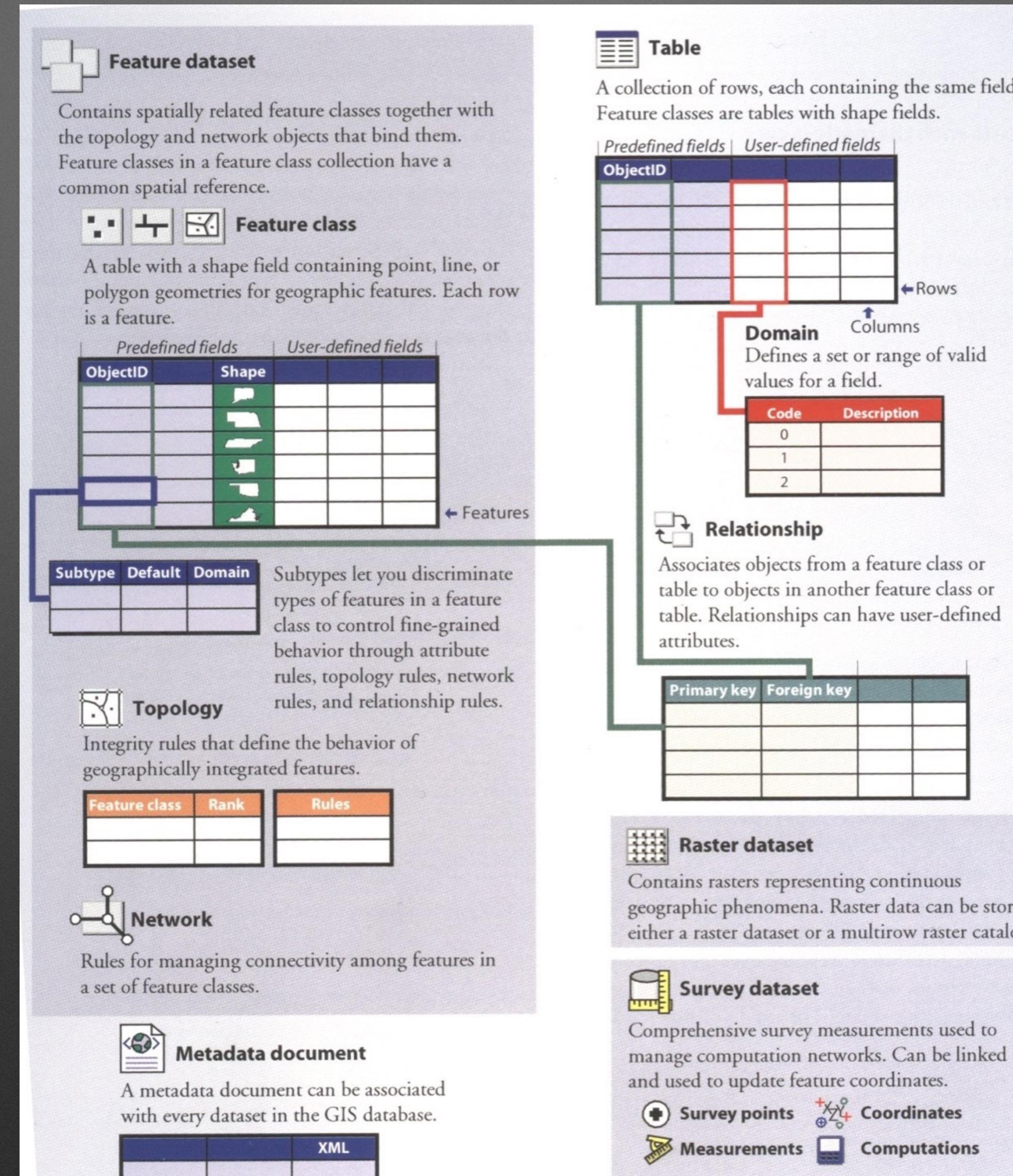
# Geodatabases

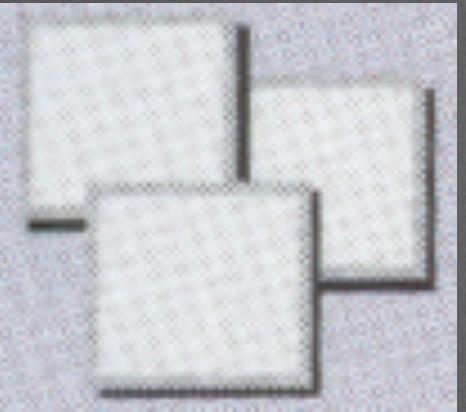
- Geodatabases allow for data to be stored in single database
- Can store tables, shapefiles, rasters, and annotation
- Allows for the storing of true curves
- In a file geodatabase there is a 2 terabyte limit per feature class
- Enterprise geodatabases have no limits
- Must be created in ArcGIS

# What is a Geodatabase?



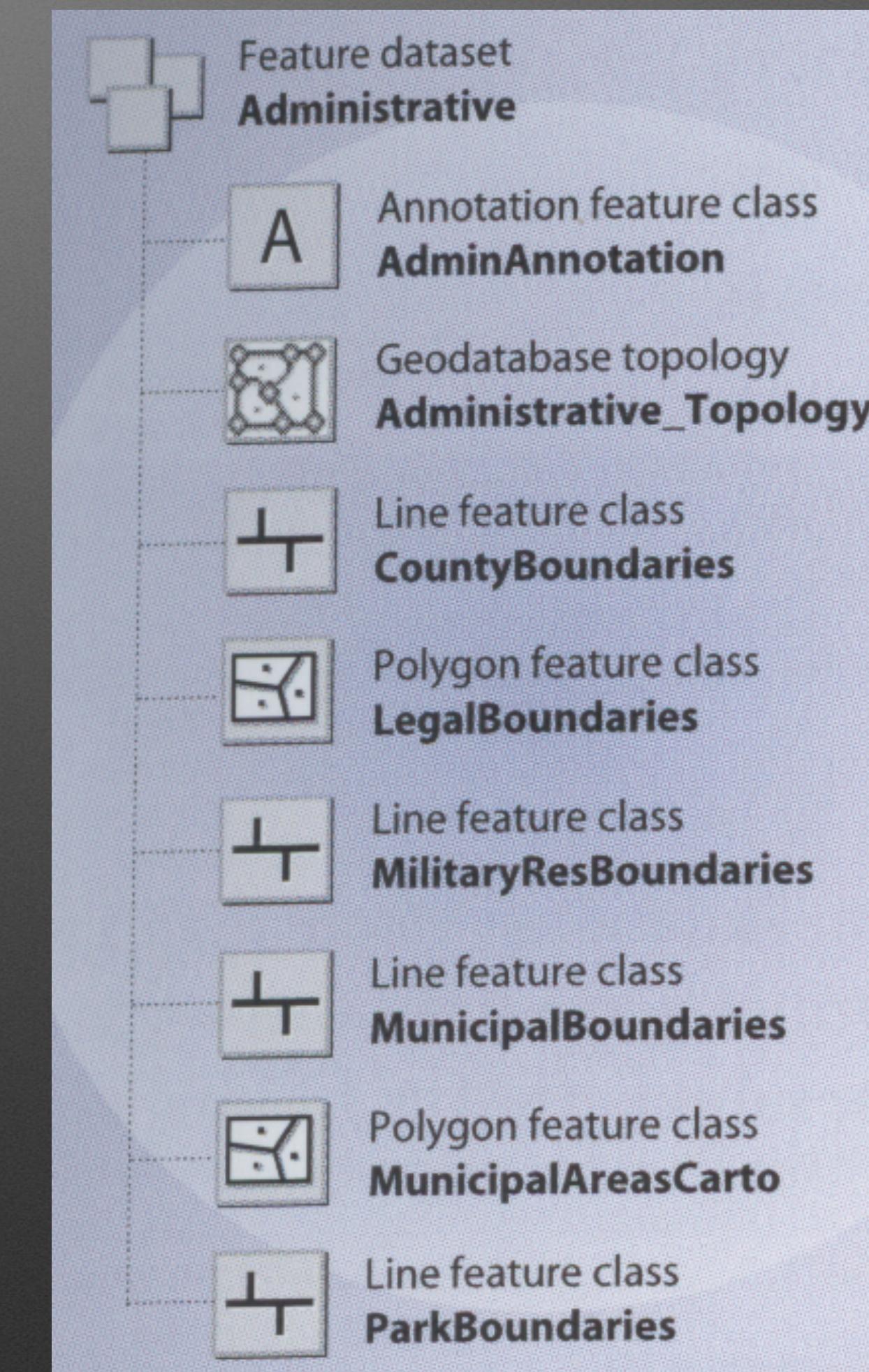
# Overview of Geodatabase Architecture





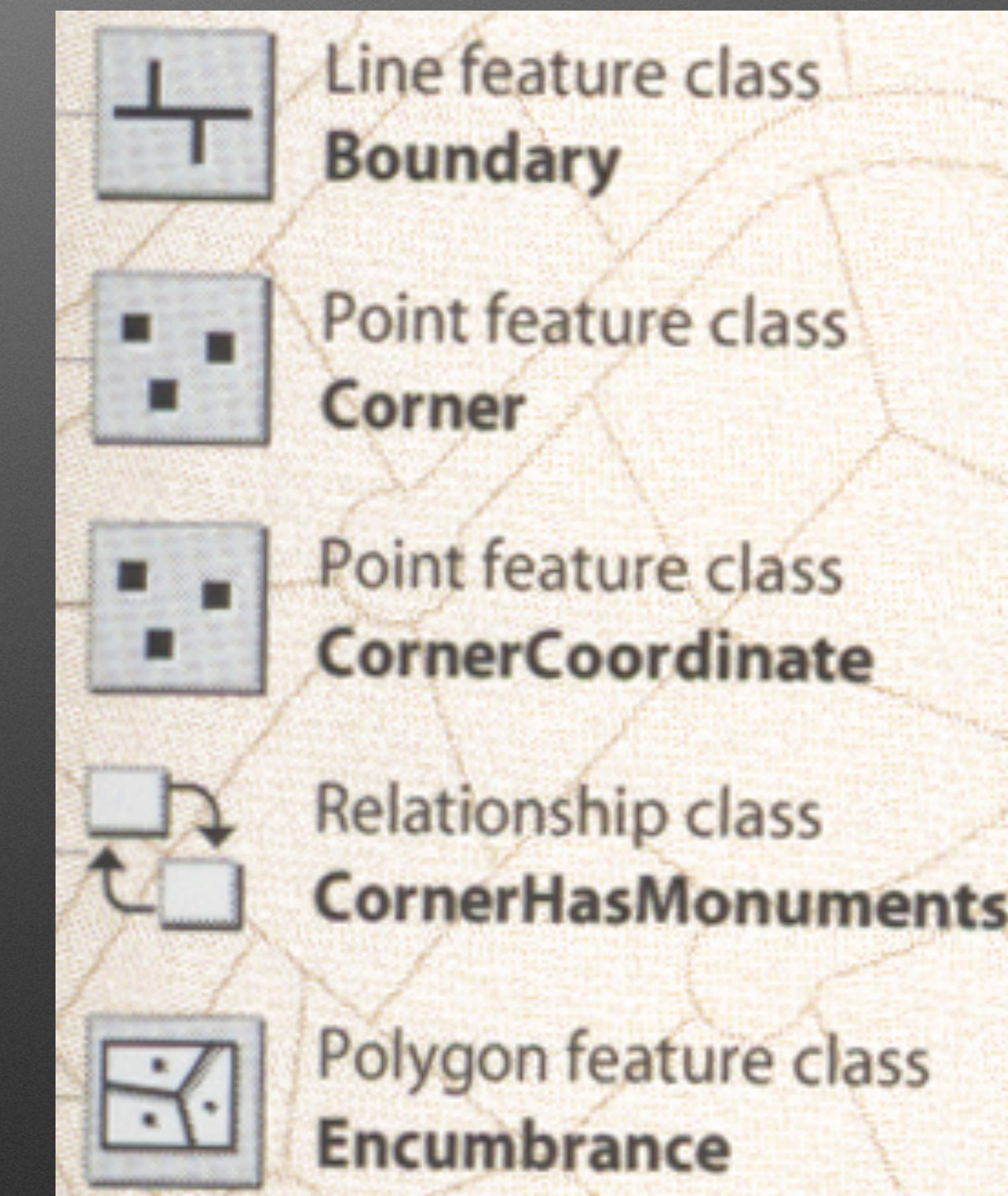
# Feature Dataset

- Contains spatially related features
- A logical organization container



# Feature Class

- The primary storage for spatial data
- Standalone and part of feature dataset



# Querying and Selecting Data

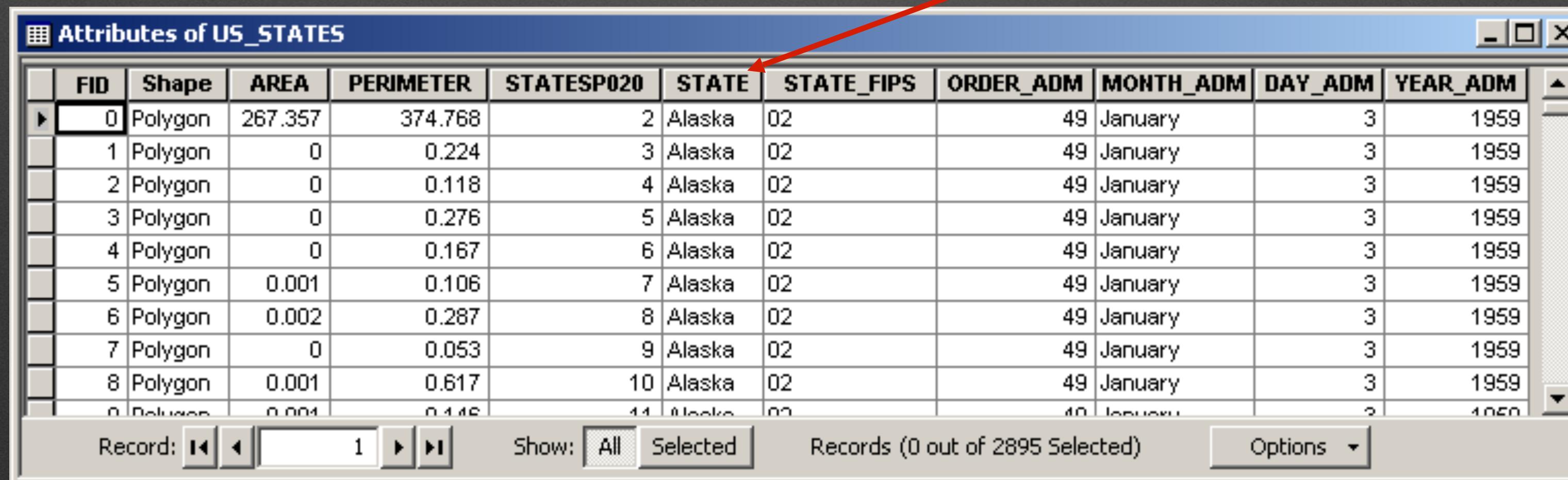
- Query – ask a question
- Many ways to query data in ArcMap
  - Identify tool
  - Using a graphic
  - Select by Location
  - Select by Attribute
  - Find tool

# Query Basics

“give me everything from  
the table US\_STATES”

“where the value of the  
STATE column is equal to  
the value ‘Alaska’”

**SELECT \* FROM US\_STATES WHERE STATE =  
‘Alaska’**



	FID	Shape	AREA	PERIMETER	STATESP020	STATE	STATE_FIPS	ORDER_ADM	MONTH_ADM	DAY_ADM	YEAR_ADM
▶	0	Polygon	267.357	374.768		2	Alaska	02		49	January
	1	Polygon	0	0.224		3	Alaska	02		49	January
	2	Polygon	0	0.118		4	Alaska	02		49	January
	3	Polygon	0	0.276		5	Alaska	02		49	January
	4	Polygon	0	0.167		6	Alaska	02		49	January
	5	Polygon	0.001	0.106		7	Alaska	02		49	January
	6	Polygon	0.002	0.287		8	Alaska	02		49	January
	7	Polygon	0	0.053		9	Alaska	02		49	January
	8	Polygon	0.001	0.617		10	Alaska	02		49	January
...	...	...	...	...		...	...				...

# SQL

```
SELECT Book.title,
       count(*) AS Authors
  FROM Book
  JOIN Book_author ON Book.isbn = Book_author.isbn
 GROUP BY Book.title
```

Example output might resemble the following:

Title	Authors
SQL Examples and Guide	3
The Joy of SQL	1
How to use Wikipedia	2
Pitfalls of SQL	1

- Structured Query Language
- Used Implicitly and Explicitly in ArcGIS
- Combine tables, fields, operators, much more..

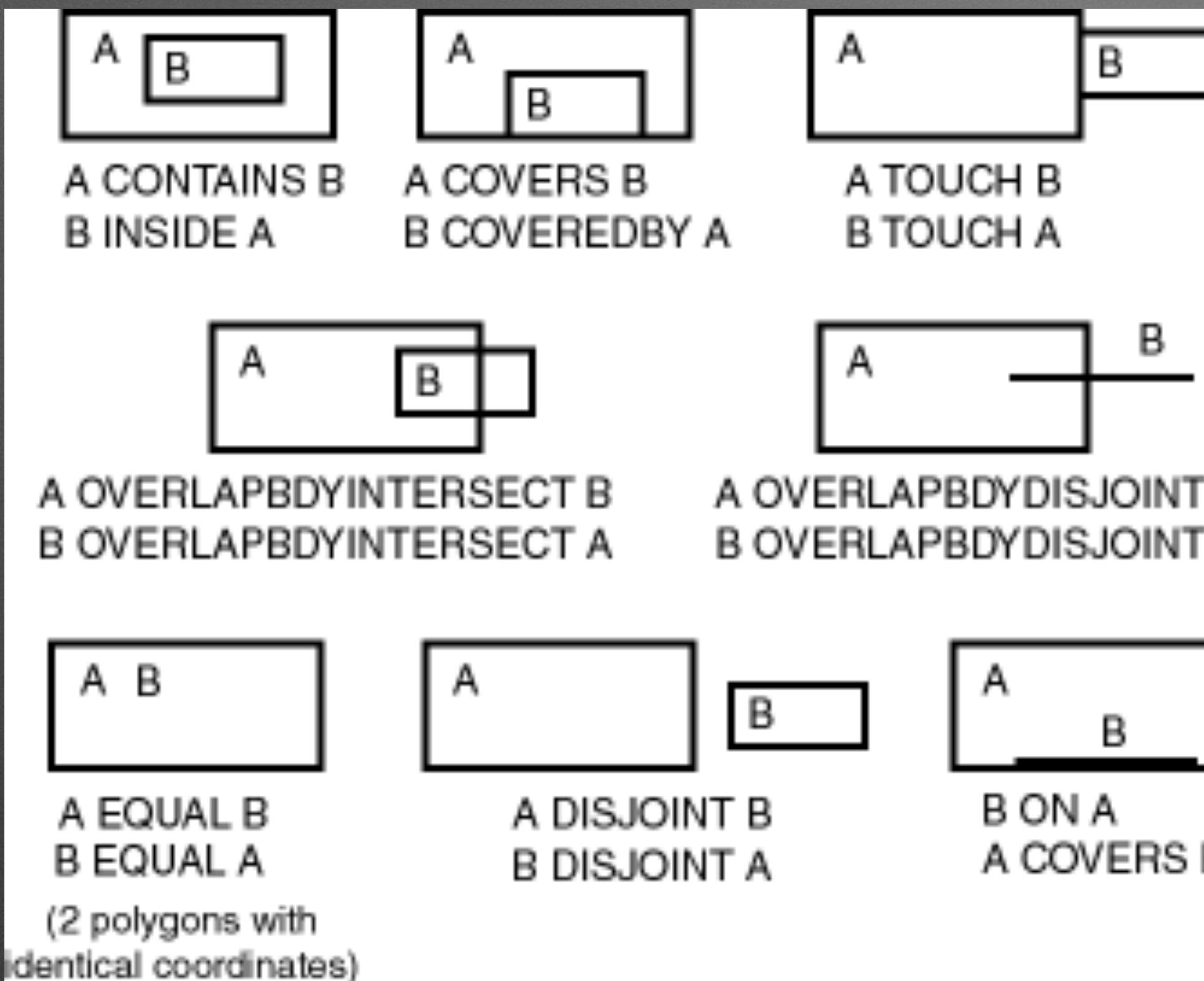
```
SELECT title,
       count(*) AS Authors
  FROM Book
 NATURAL JOIN Book_author
 GROUP BY title
```

# SQL WHERE Operators

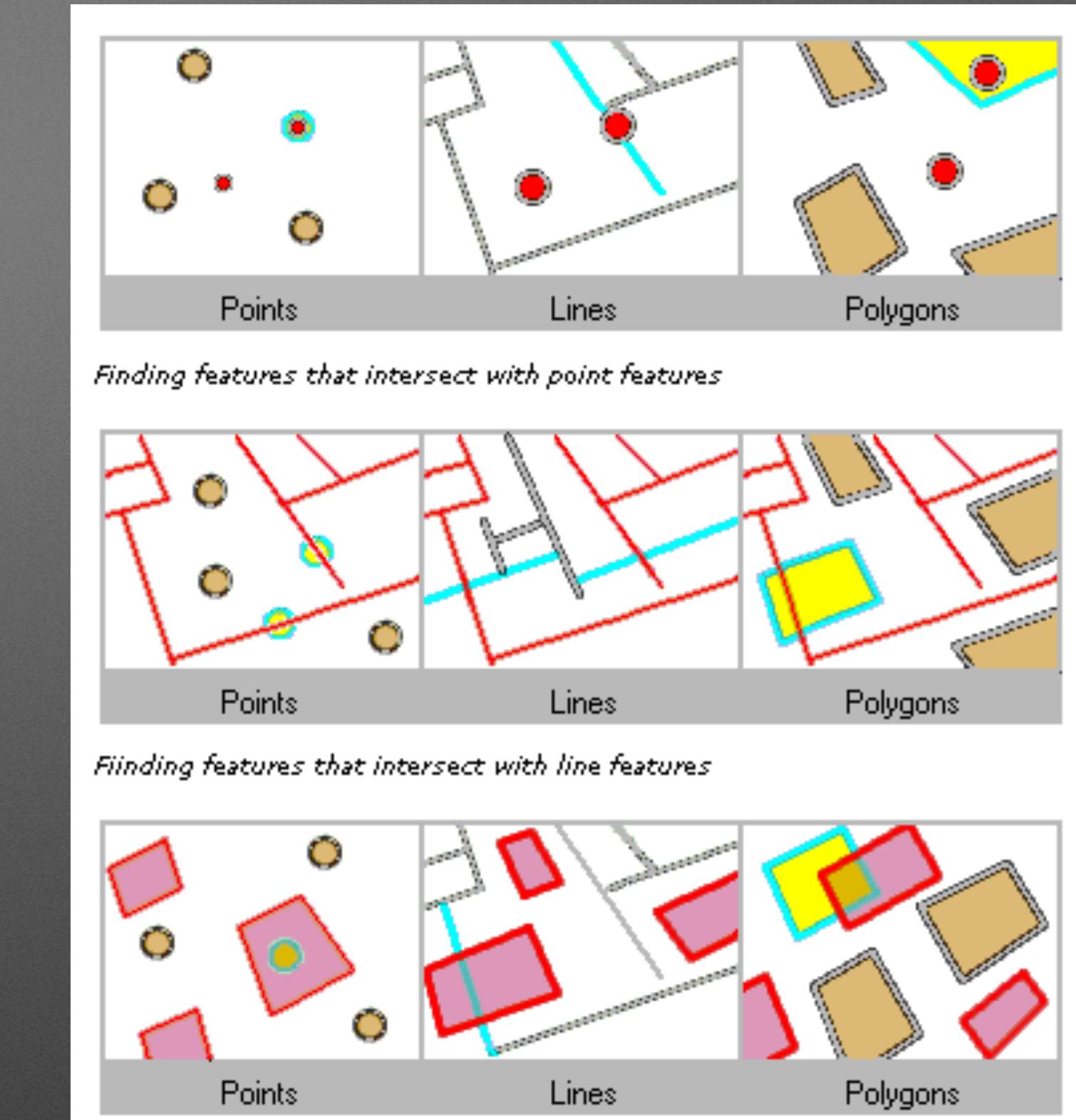
Operators	Usage
<b>Comparison operators</b>	
=	Equal
<>	Not equal
<	Less than
>	Greater than
<=	Less than or equal to
>=	Greater than or equal to
<b>Logical operators</b>	
AND	Joins two conditions and returns results when both are true
OR	Joins two conditions and returns results when either is true
NOT	Negates any logical expression or keywords such as like, null, between, in, and exists
<b>Arithmetic operators</b>	
+	Addition
-	Subtraction
/	Division
*	Multiplication

\* <http://iuedocs.oes.indiana.edu/images/operators.png>

# Spatial Operators for Querying



[http://www.stanford.edu/dept/itss/docs/oracle/10g/appdev.101/b10826/top\\_rel.gif](http://www.stanford.edu/dept/itss/docs/oracle/10g/appdev.101/b10826/top_rel.gif)



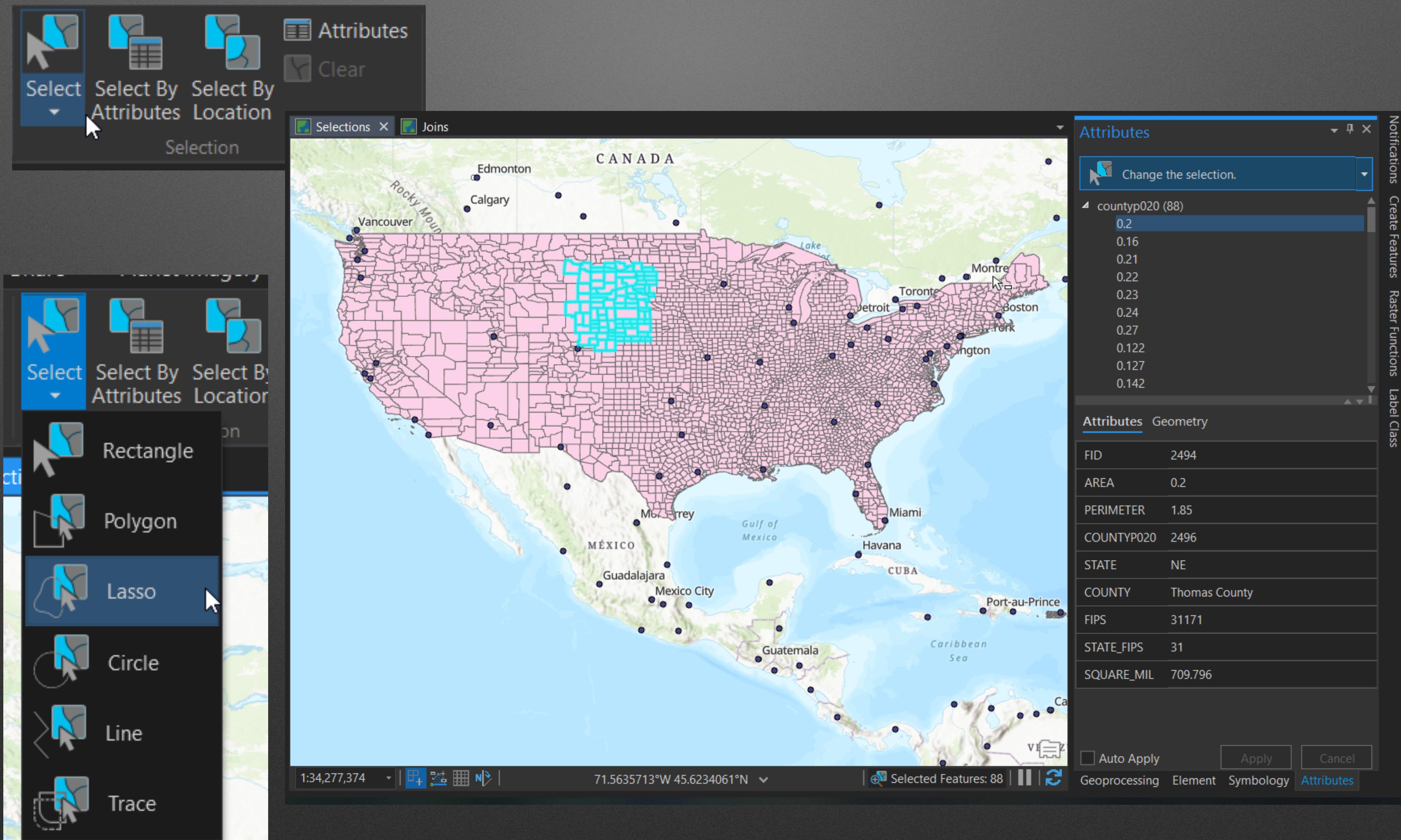
Intersect Example

Non-exhaustive list

See ArcGIS Help Topic “Select By Location dialog” for more info

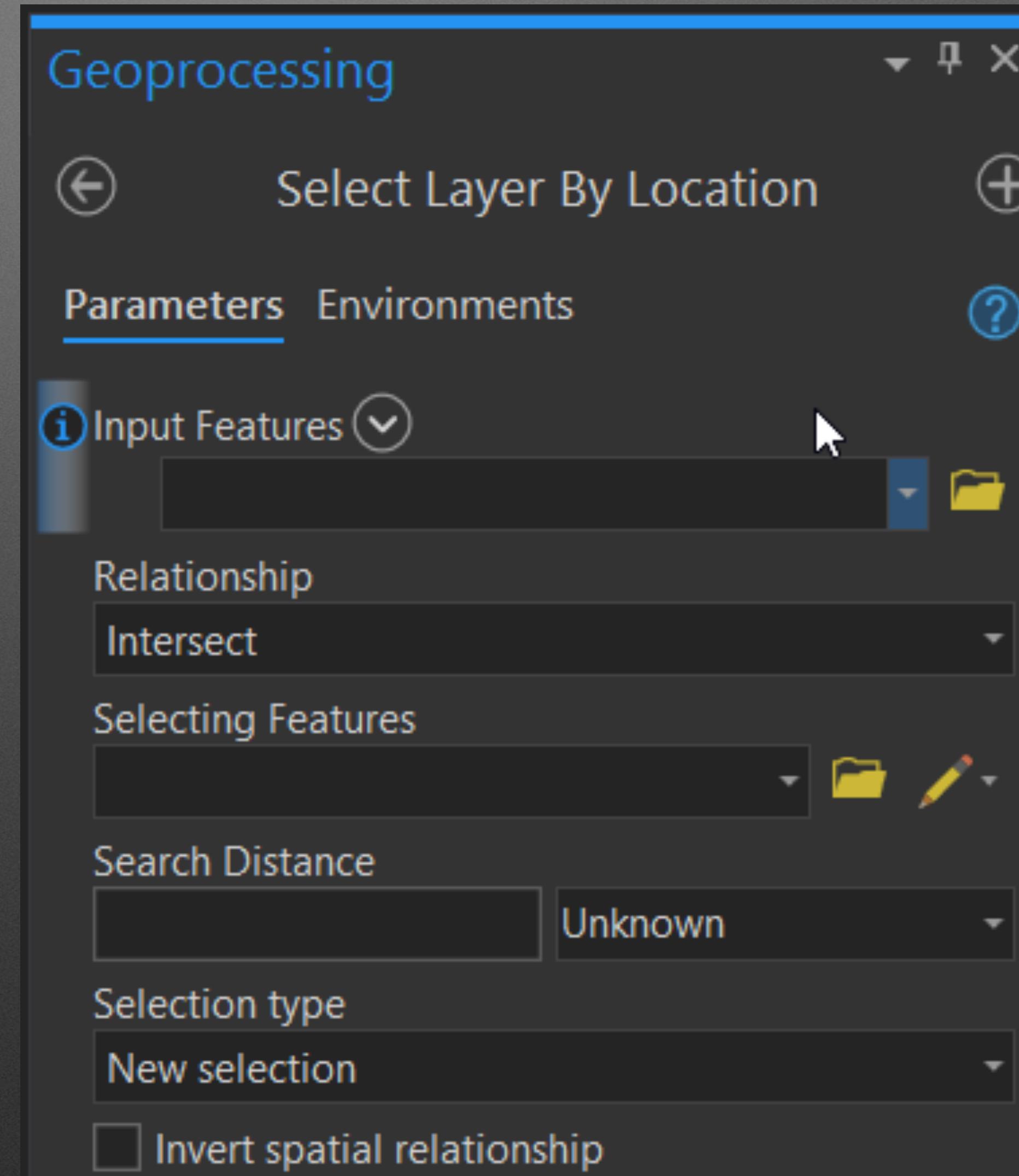
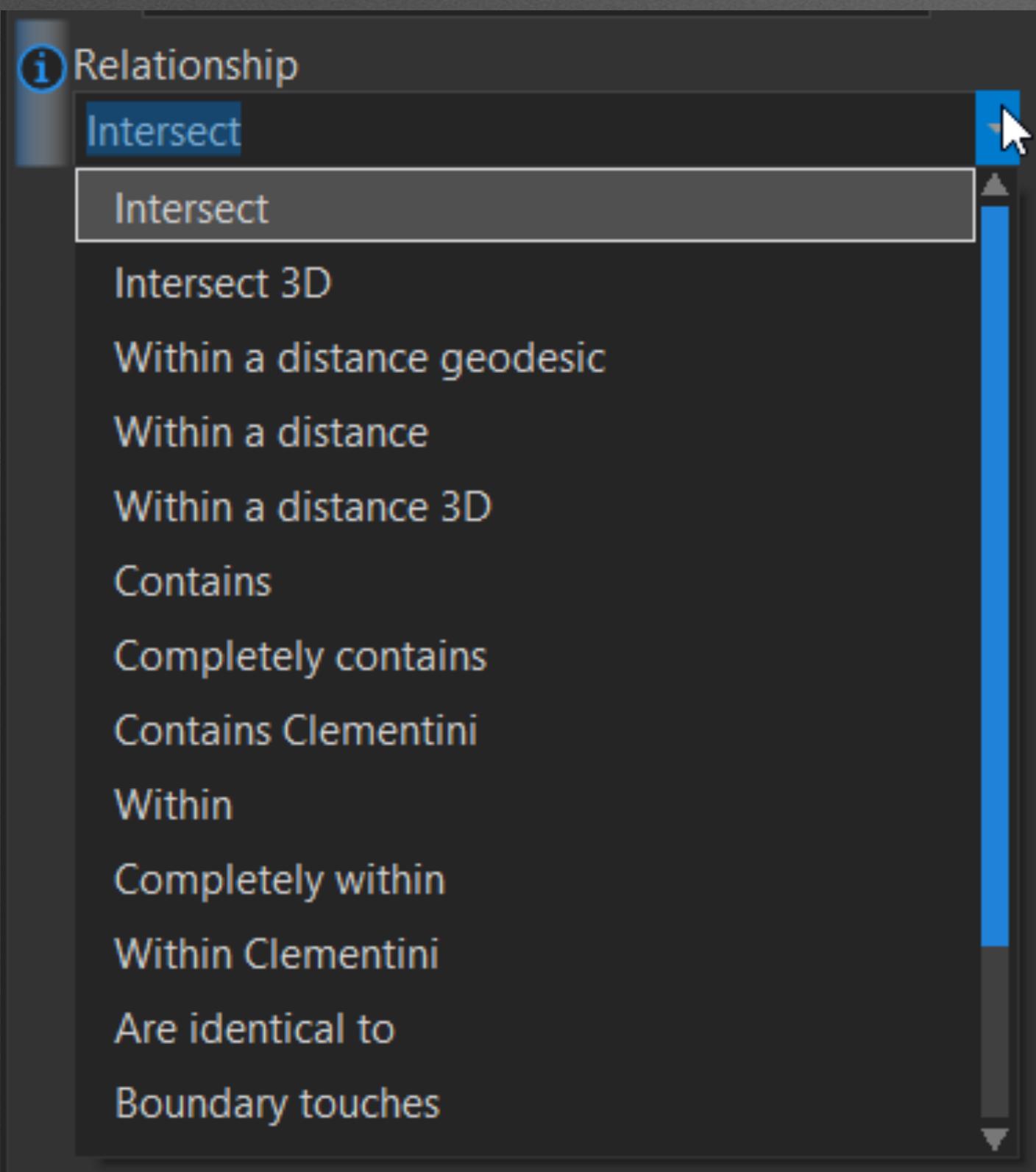
Used as a “spatial” WHERE clause

# Interactive Selection Tool



# Select by Location

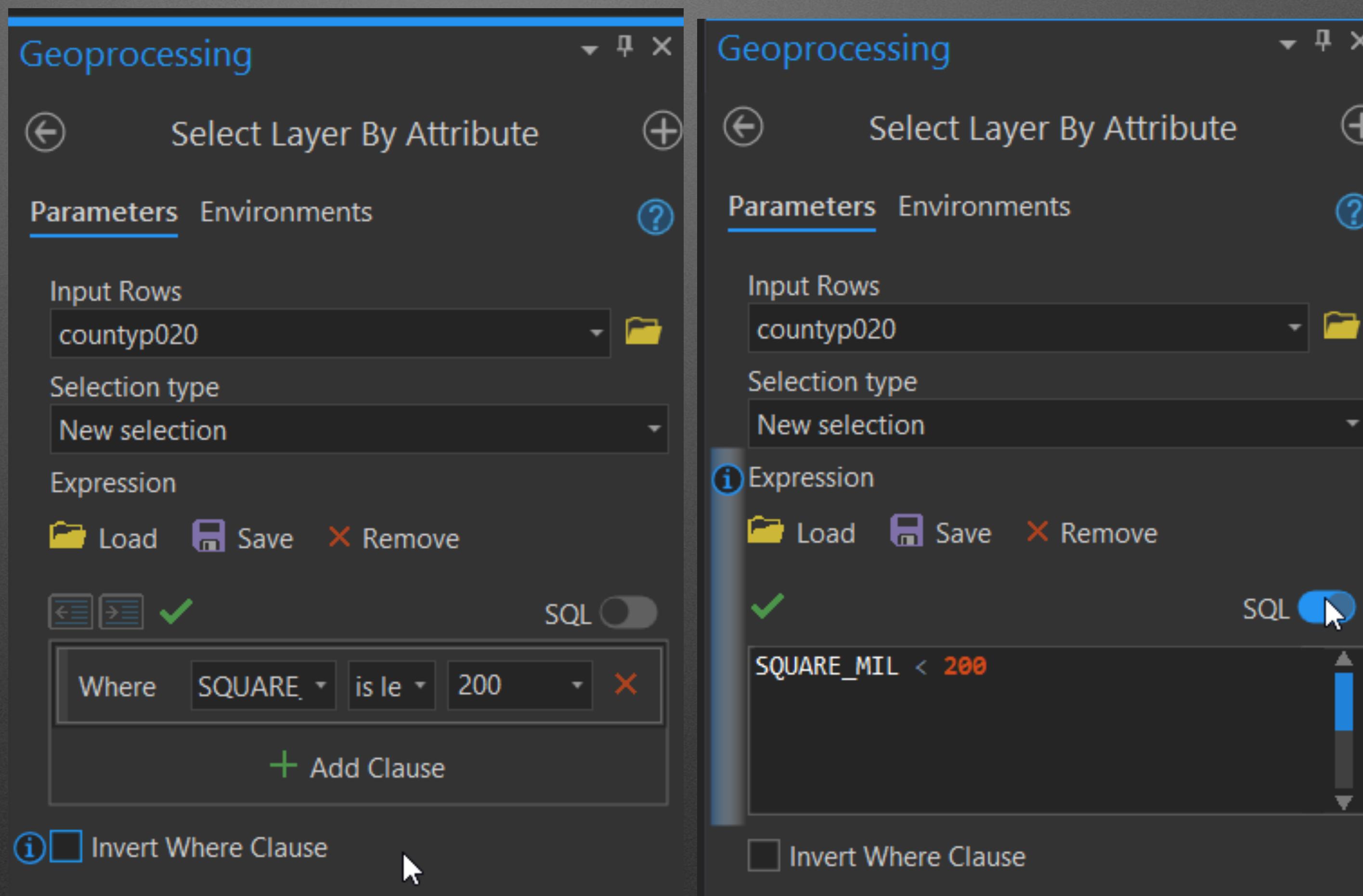
- Uses  
Spatial  
Operators



# Select by Attribute

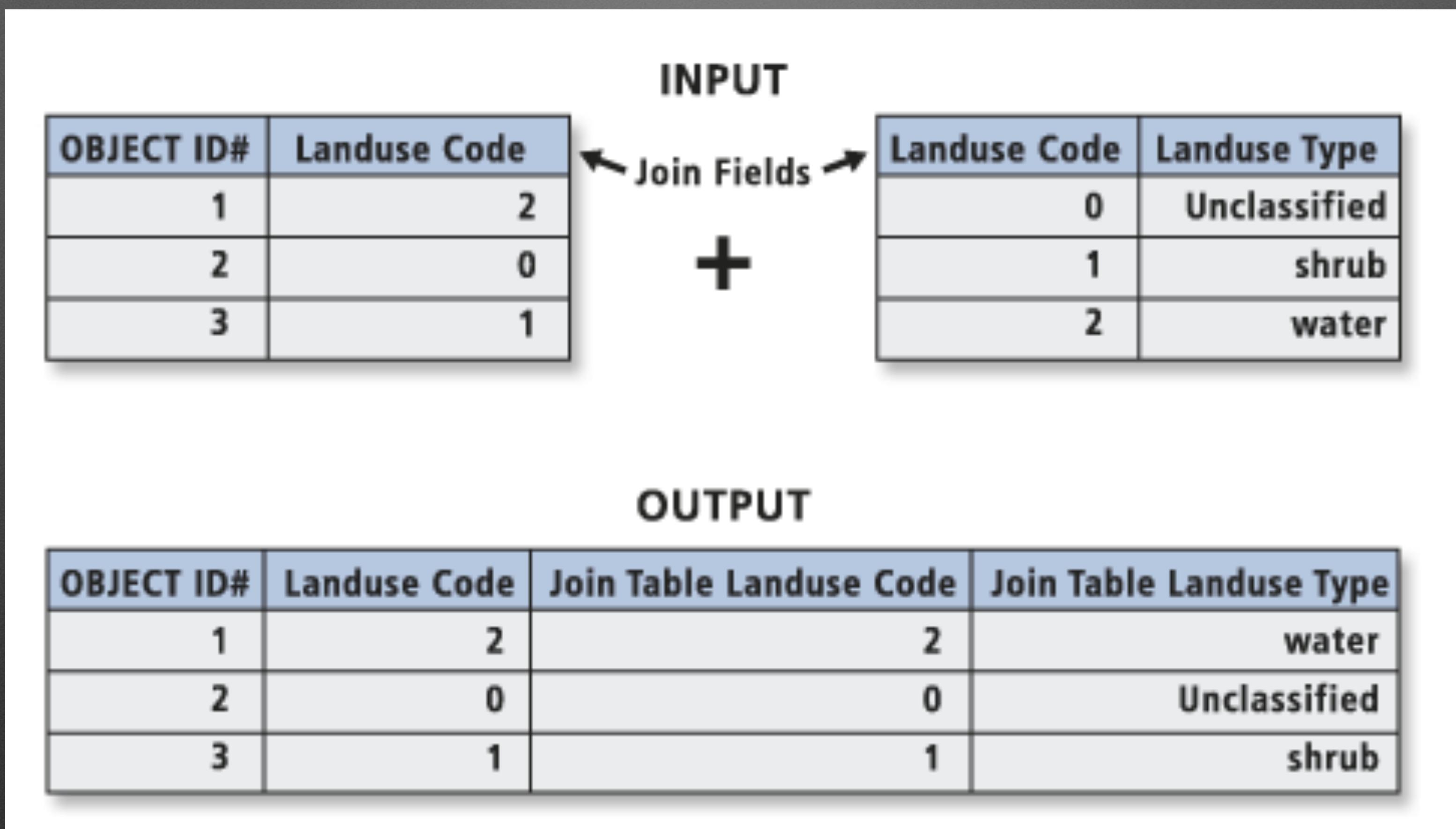
- Build the WHERE part of query

Full query being built



# Table Join

“Appending the fields of one table to those of another through an attribute or field common to both tables. A join is usually used to attach more attributes to the attribute table of a geographic layer.”



Shape	FID	LU_Code	LU-Code	Description
Polygon	1	2	1	Single Family
Polygon	2	1	2	Agriculture
Polygon	3	1	3	Commercial

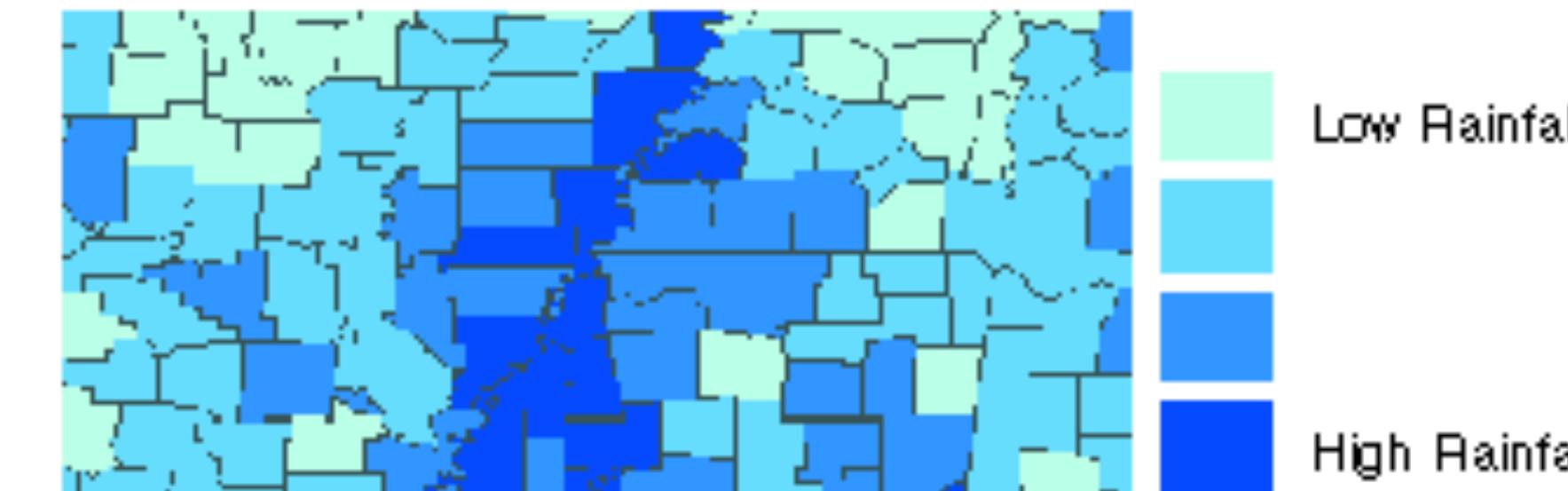


## Join on number

Shape	FID	County
Polygon	1	Atoka
Polygon	2	Kiowa
Polygon	3	Nowata

County	Rain	Total
Atoka	1.80	10.16
Kiowa	2.34	13.67
Nowata	1.62	11.90

## Join on string (text)



**US Counties**

FID *	Name	ID
190	Canyon County	16027
256	Caribou County	16029
208	Cassia County	16031
225	Clark County	16033
226	Clearwater County	16035
227	Custer County	16037
228	Elmore County	16039

**Population\_Data**

ID	% Population Change
16027	+3.9
16029	+0.5
16031	+0.9
16033	+3
16035	+0.5
16037	+0.5
16039	+3.2

**One to One**

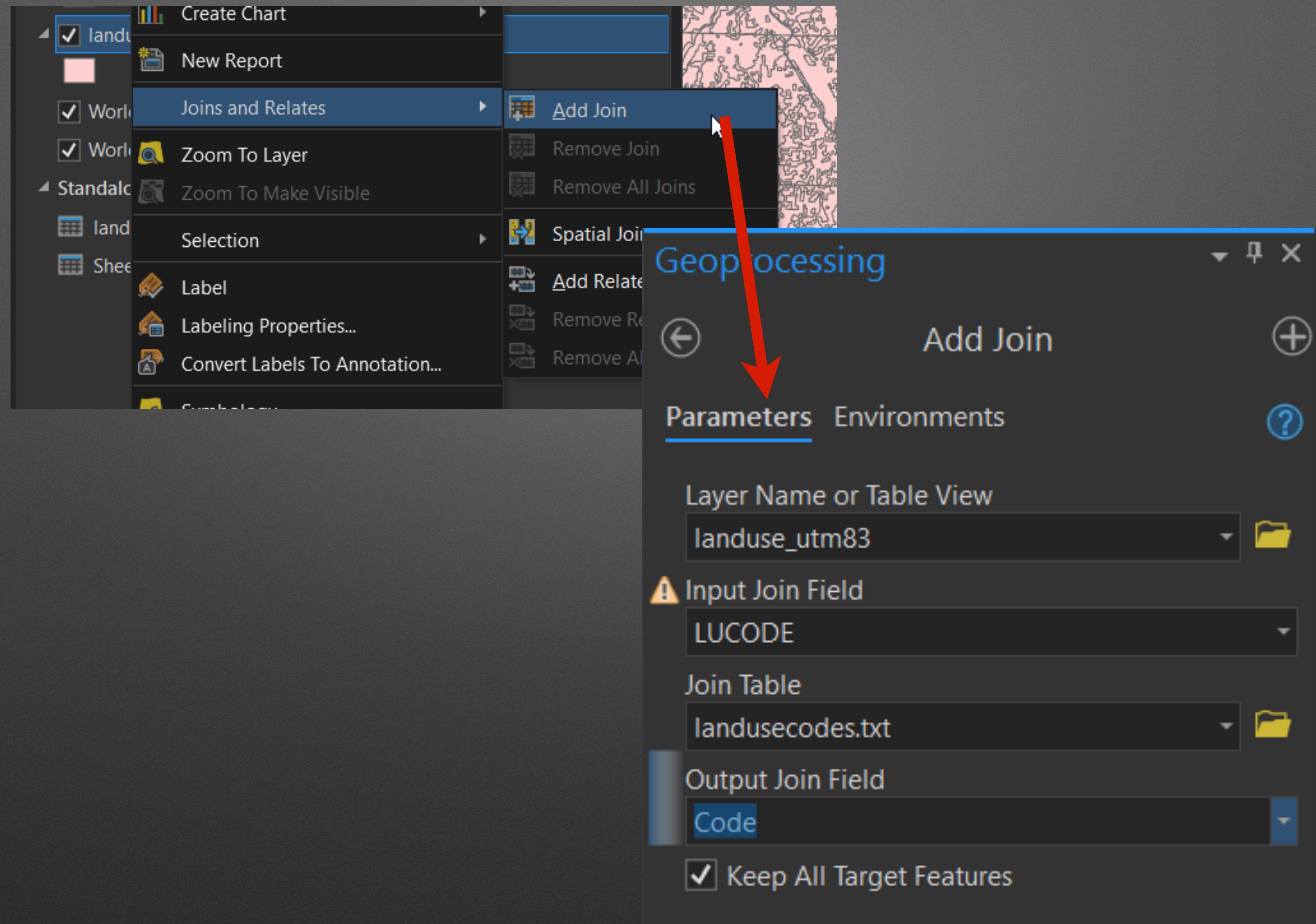
# One to Many

**Landuse**

OBJECTID *	Shape *	ZONE_CODE
384	Polygon	MDR
385	Polygon	VAC
386	Polygon	LDR
387	Polygon	MDR
388	Polygon	MDR

**Zone\_Code**

FID *	ZONE_CODE	DESCRIPTION
10	SDP	Special Development Plan
11	TNS	Transitional
12	MDR	Medium-density Residential
13	LDR	Low-density Residential
14	VAC	Vacant



# Hands-on – Querying and Table Joins

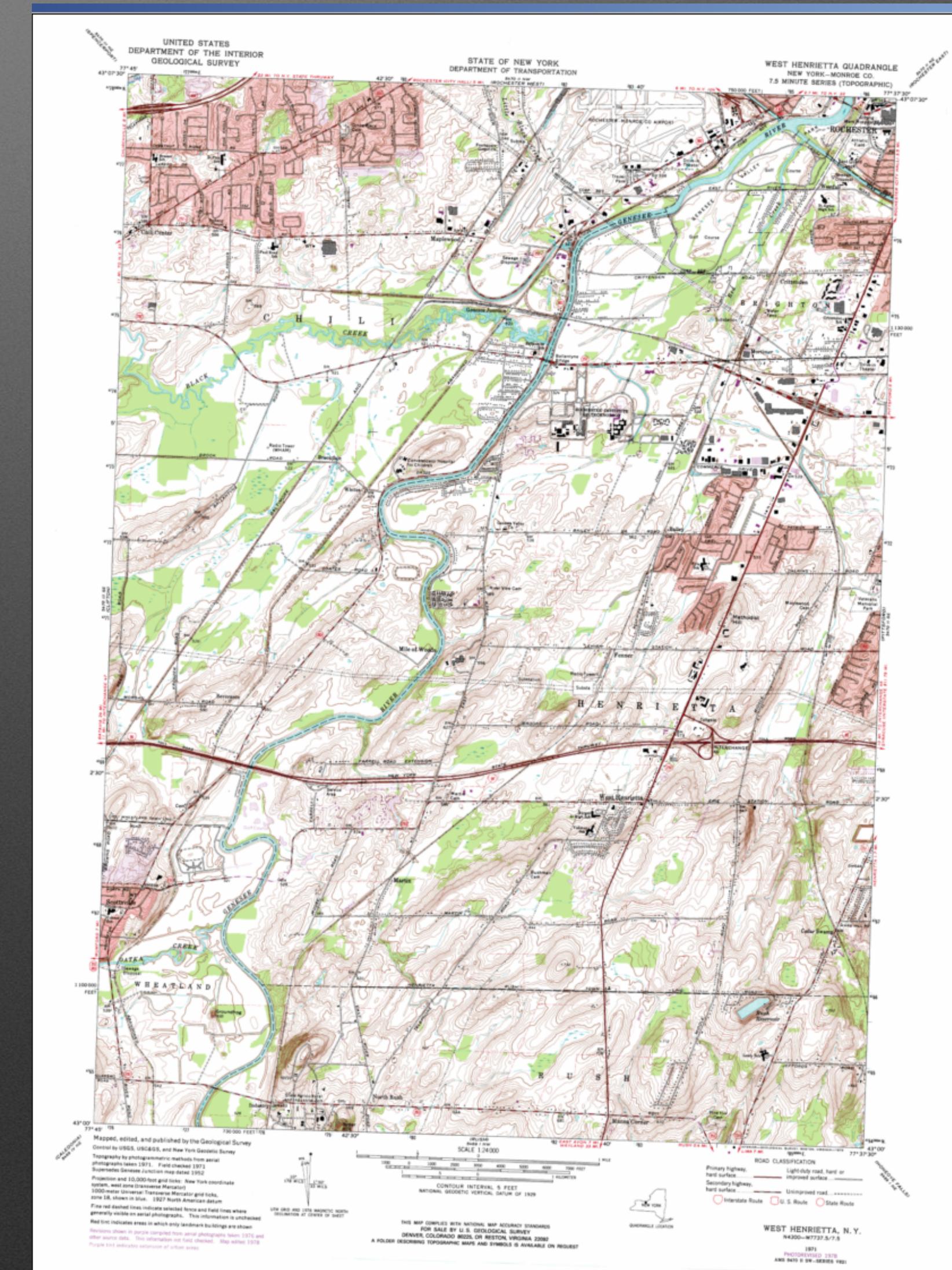
- Please do not do these steps until told to do so by the instructor (i.e. no skipping ahead)
- Download and unzip locally the file `Week4_hands_on_materials.zip` from myCourses under Content Week 4
- Look at a File Geodatabase
- Select by location (counties/cities) (All cities within NY counties)
- Table join (observe different data types)

# Cartography

# Basic map making

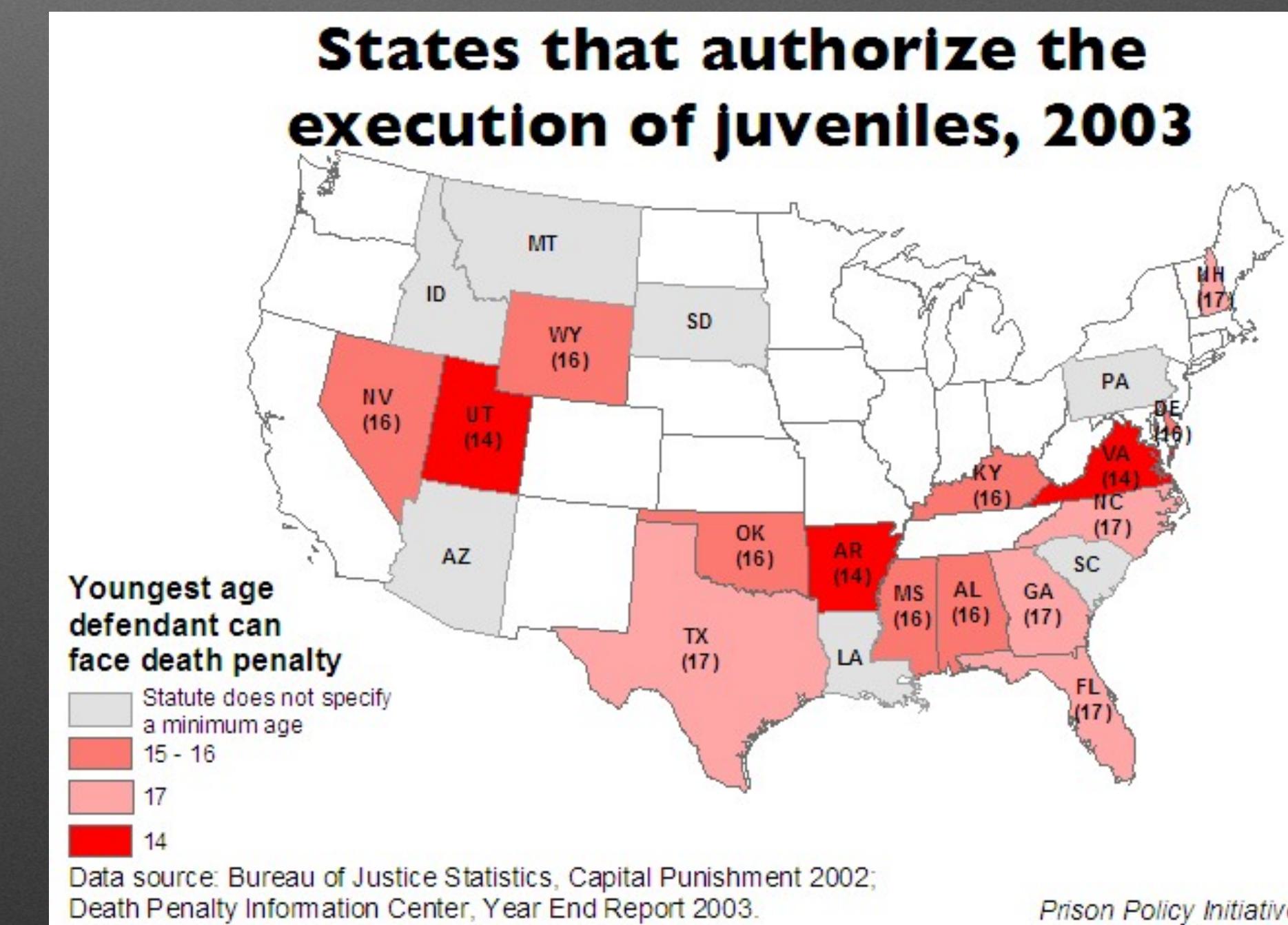
# Review - Reference Map

- Numerous features
- No specific information being shown
- Good for a base map to show other information



# Review - Thematic Map

- Distributions of a single attribute
- Relationships among several attributes



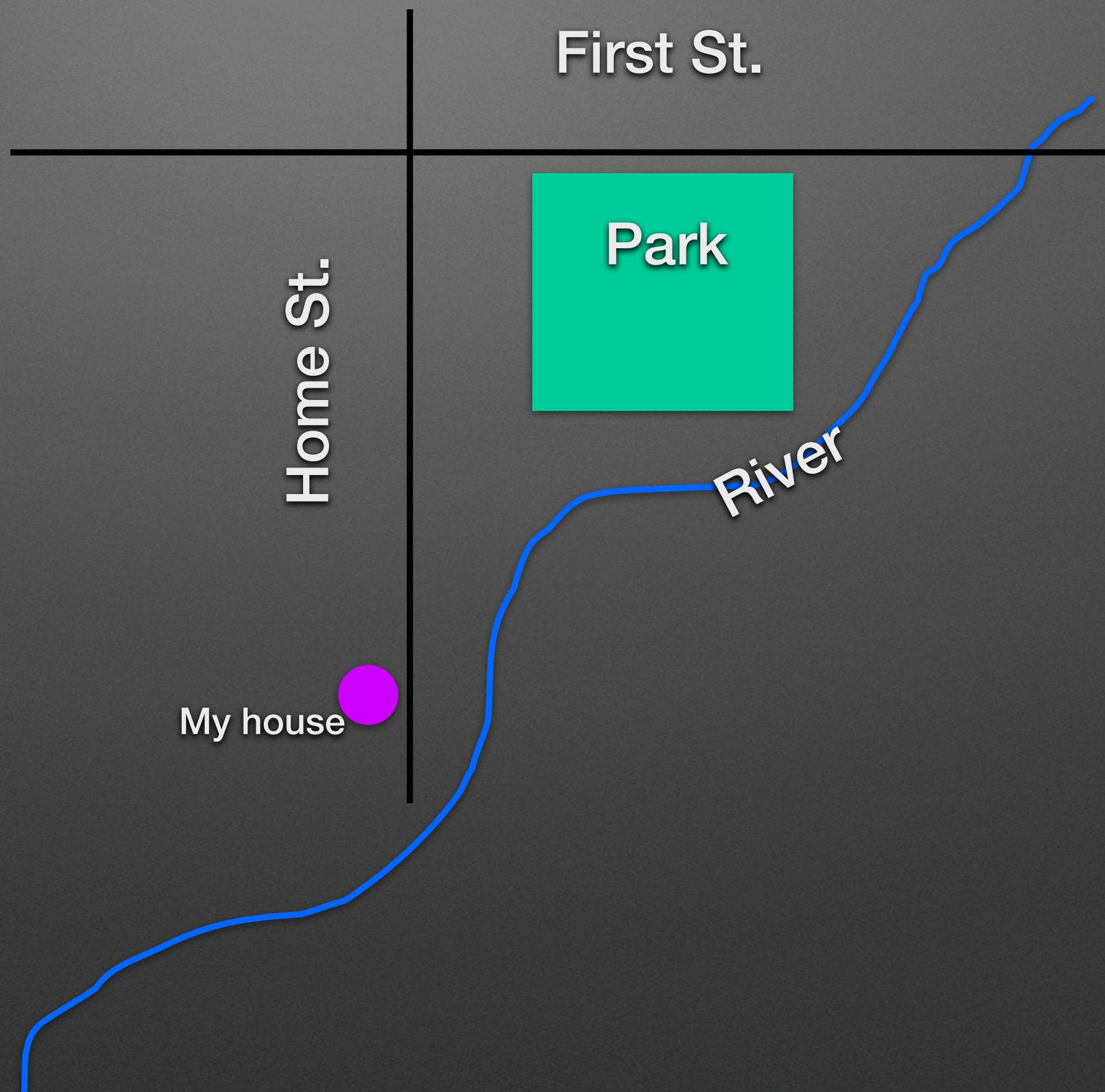
[http://www.prisonpolicy.org/images/juvenile\\_dp\\_laws\\_us.jpg](http://www.prisonpolicy.org/images/juvenile_dp_laws_us.jpg)

# Basics of Map Design

- Graphic Elements
- Figure/Ground
- Visual Variables

# Graphic Elements

- Point
- Line
- Area



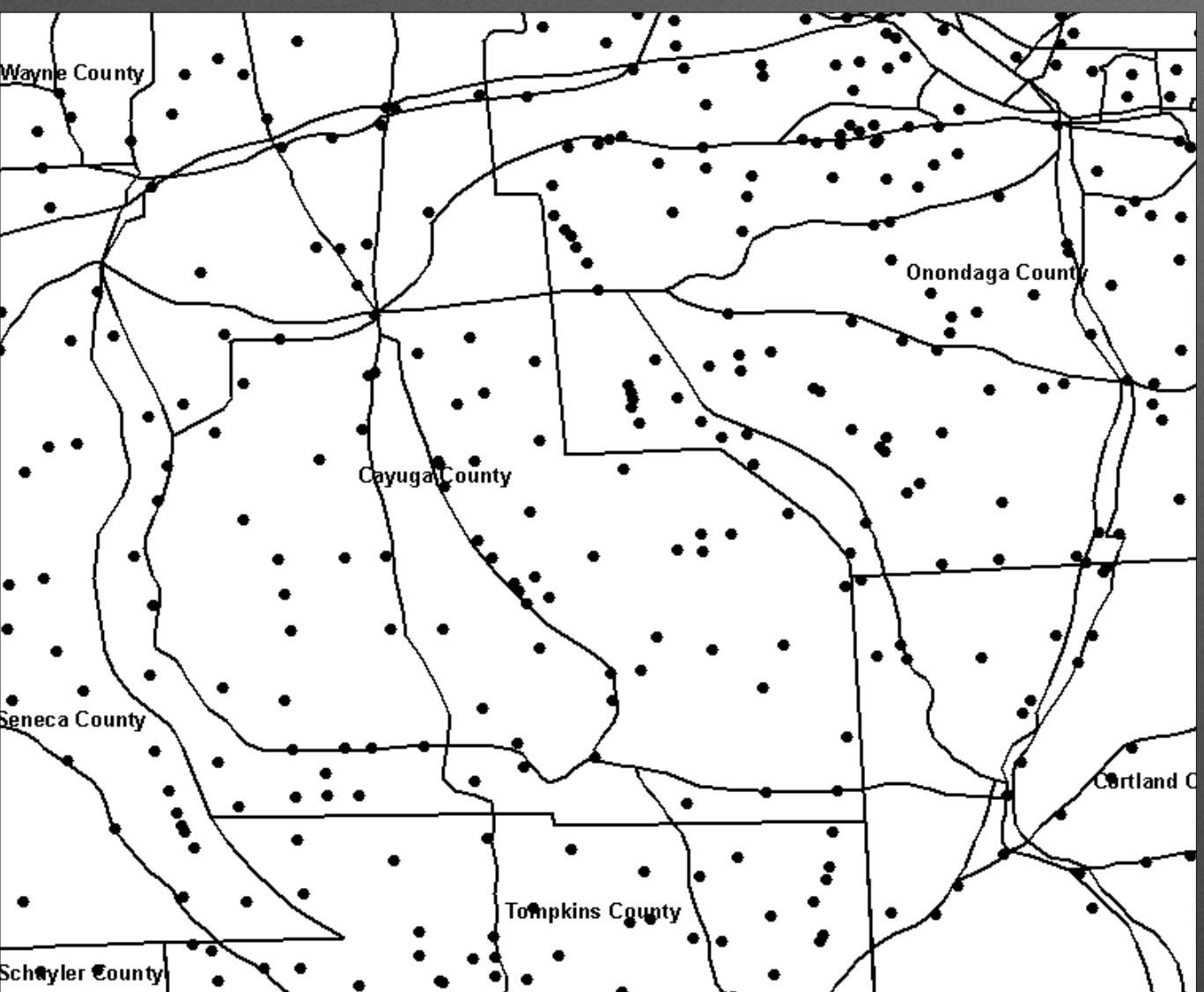
# Figure/Ground

- Main figure on the map vs. background

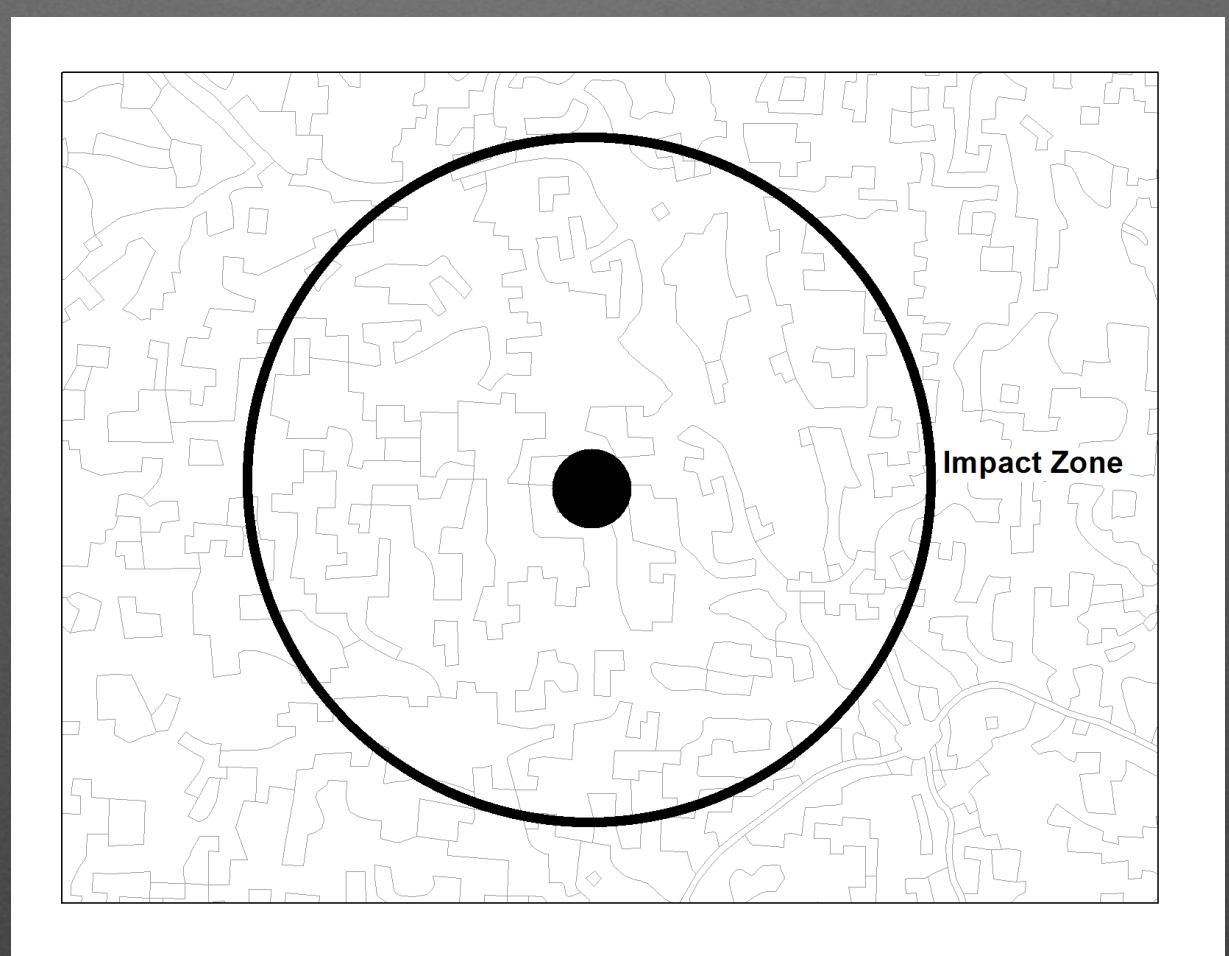


Ambiguous FG – vase or faces?

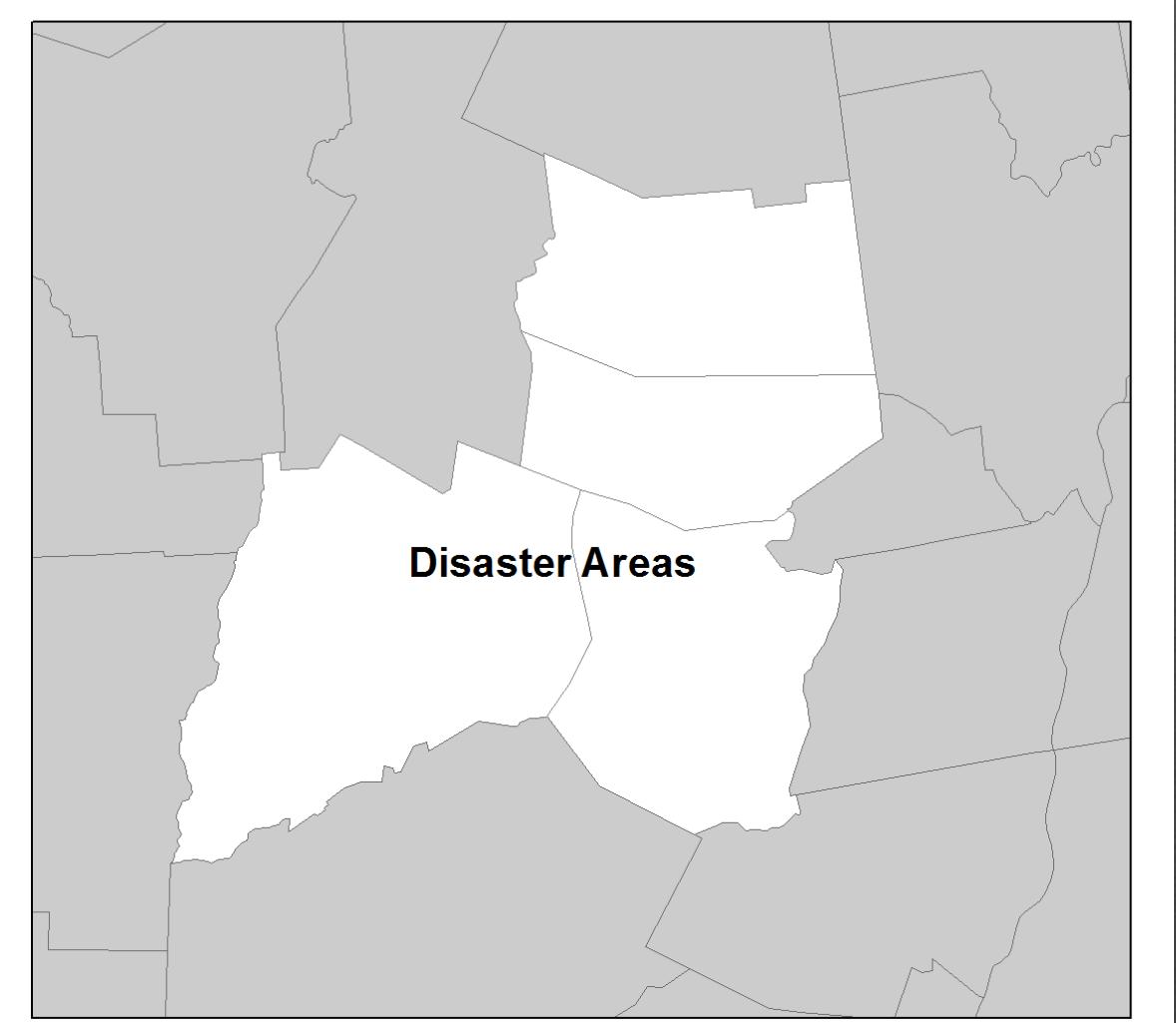
# Figure/Ground



Ambiguous FG



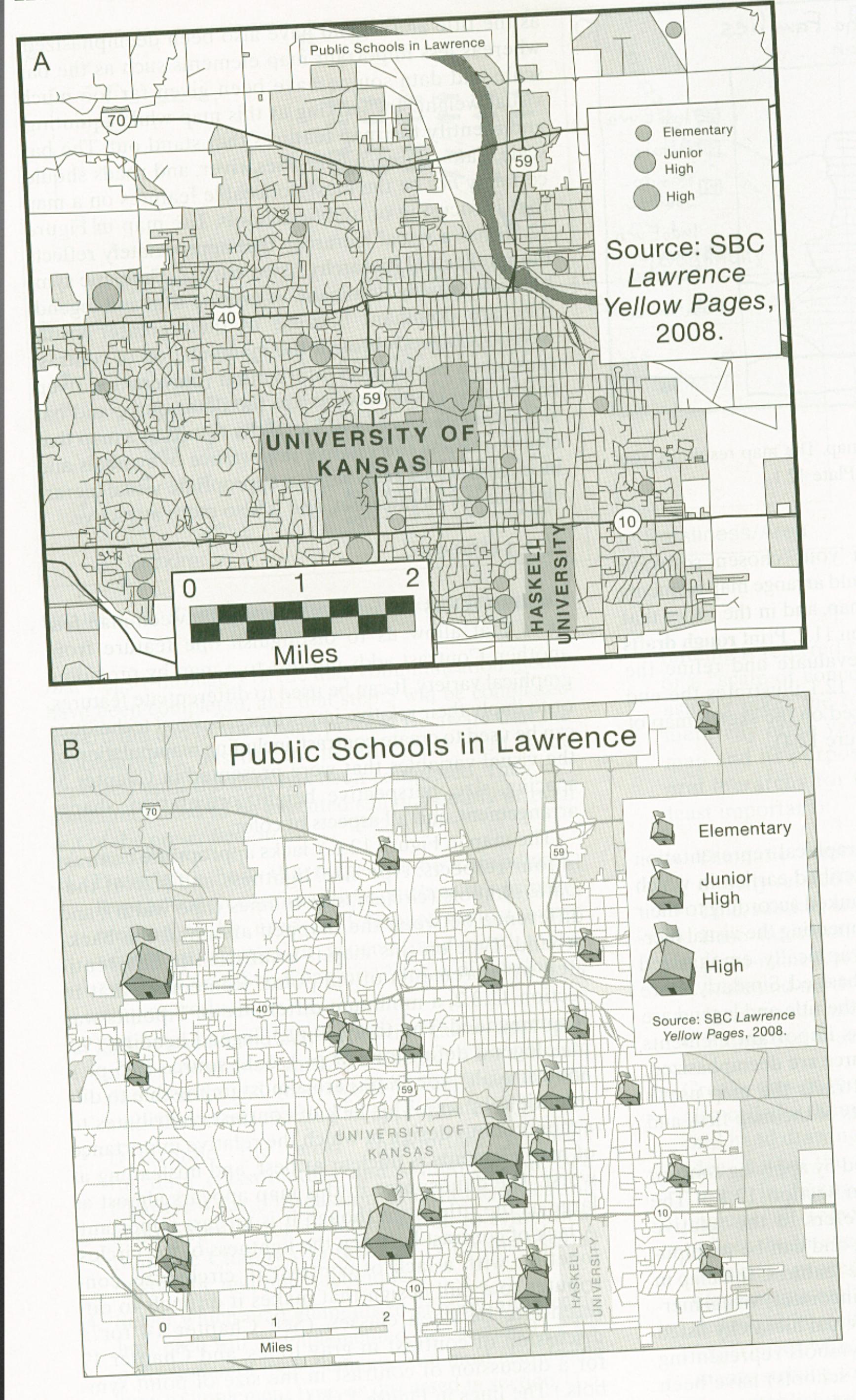
Dark – Figures  
Light - Ground



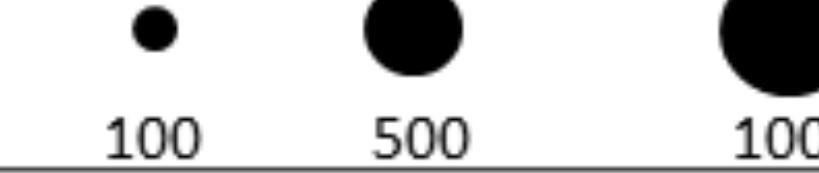
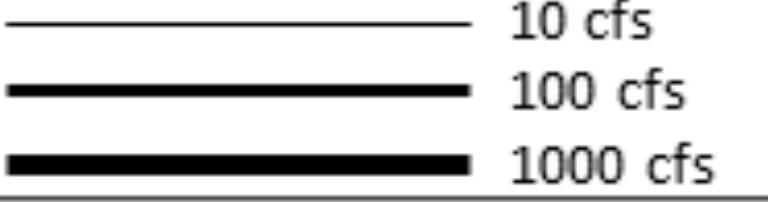
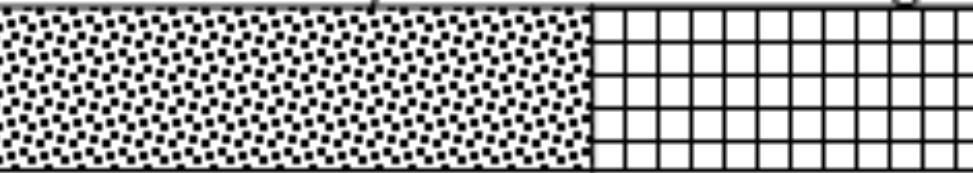
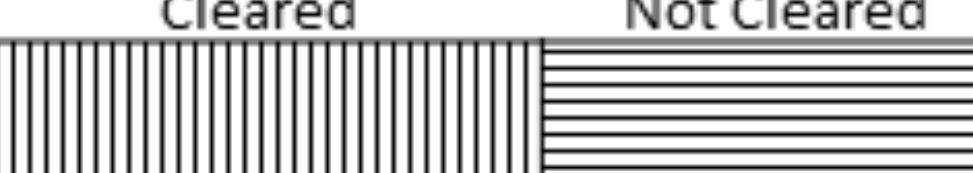
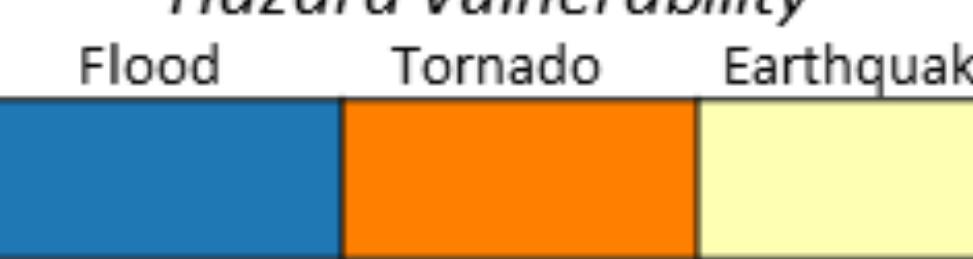
Dark – Ground  
Light - Figure

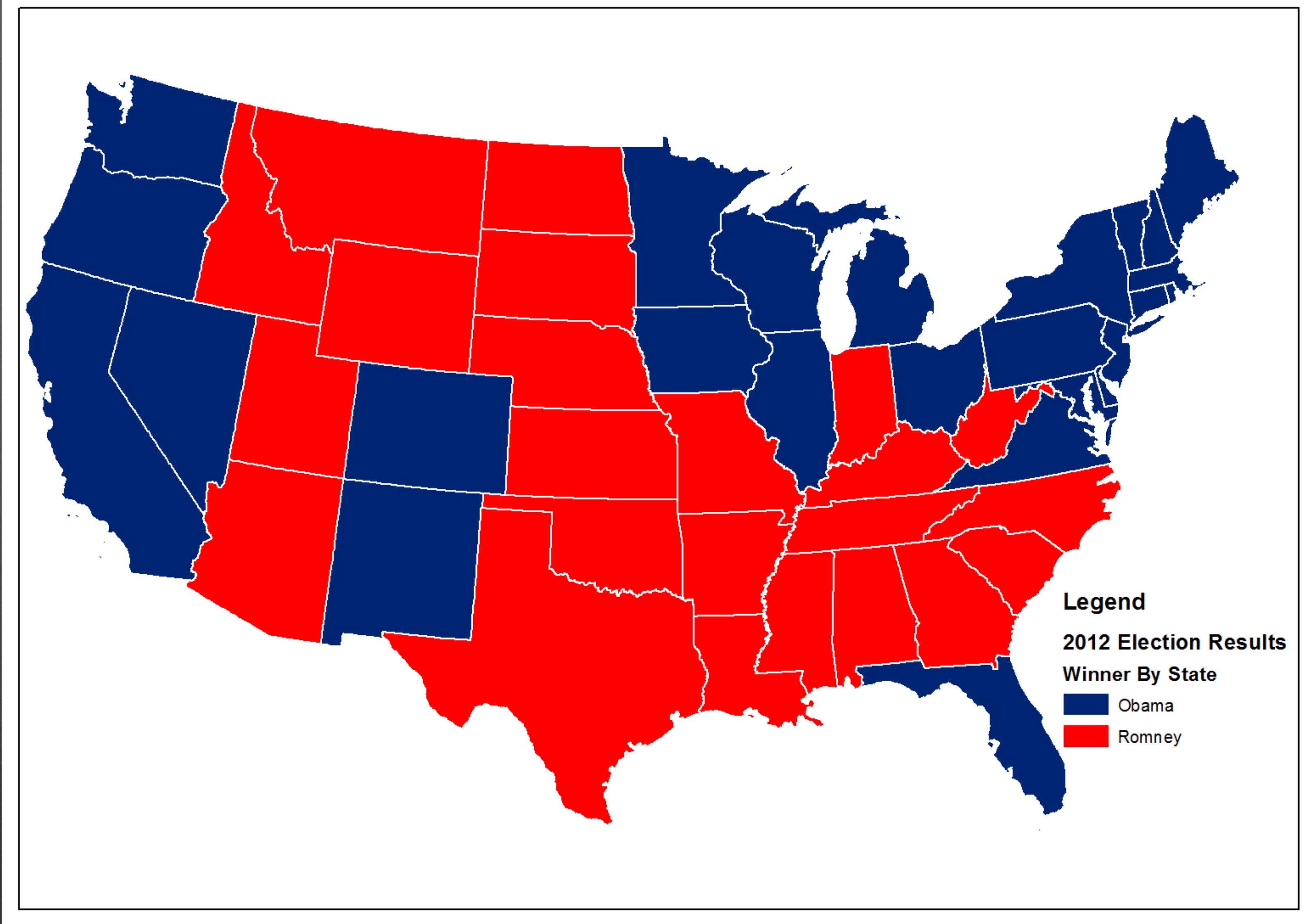
# Visual Hierarchy

Slocum et. al. 2005

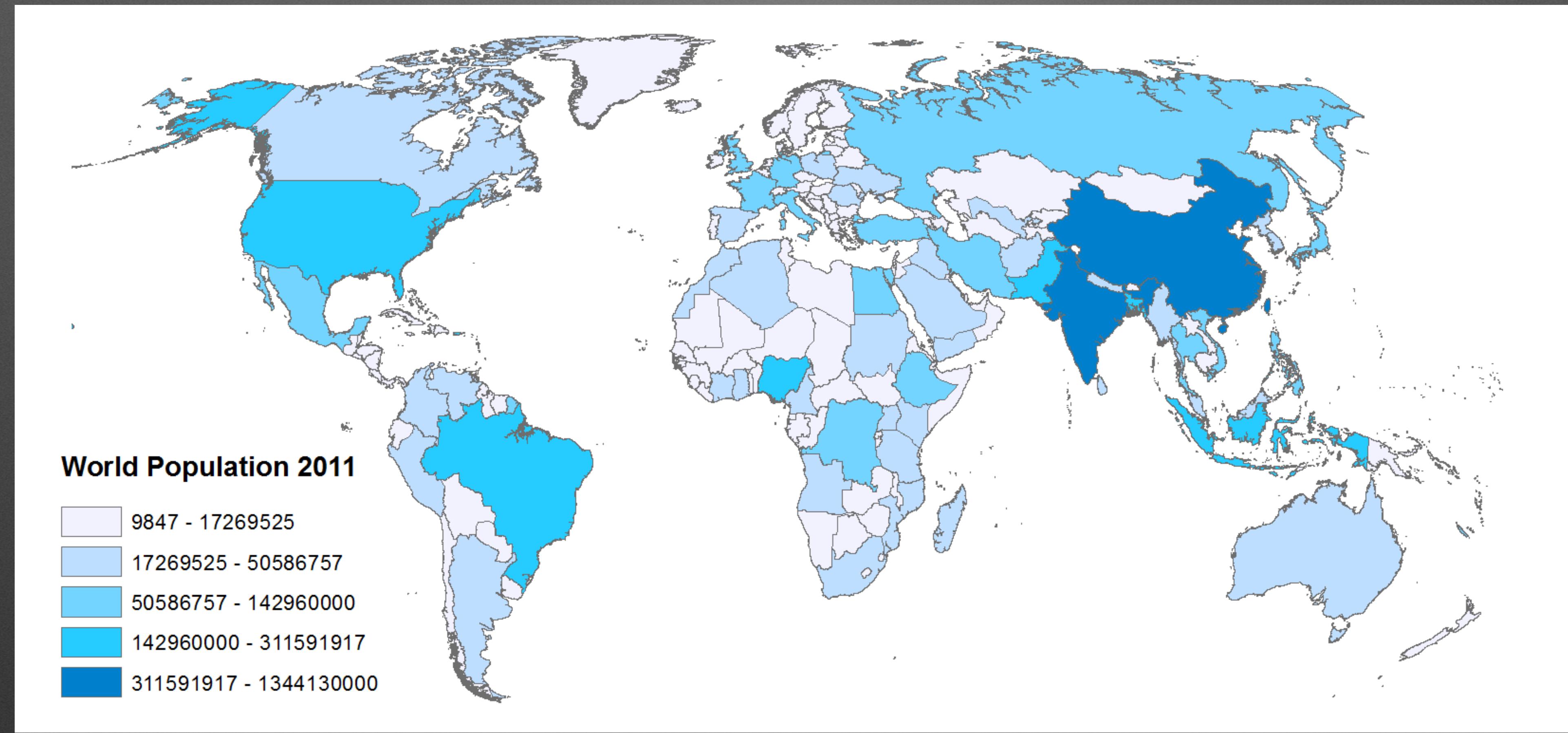


# Visual Variables

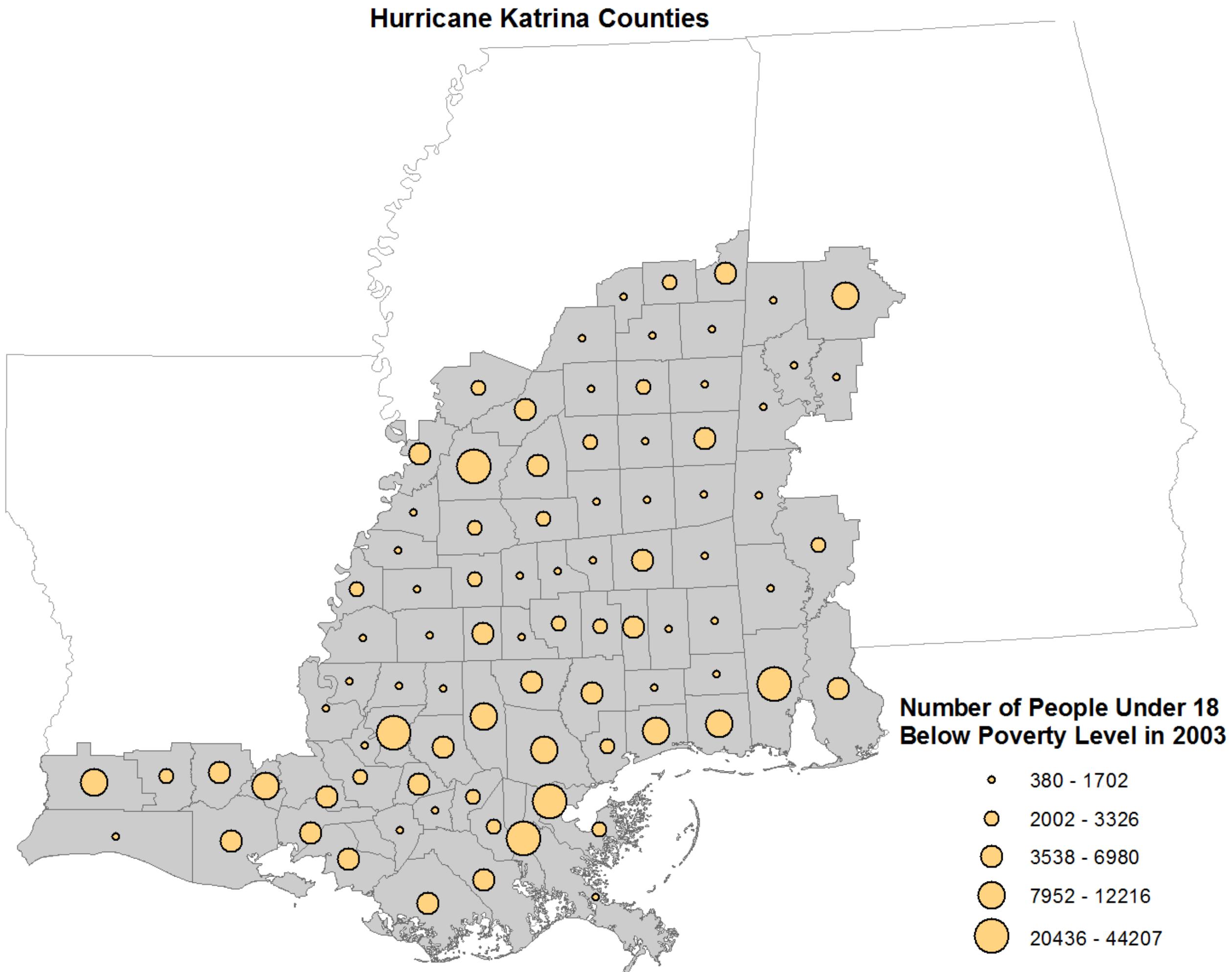
Visual Variable	Graphical Element		
	Point	Line	Area
<b>Size</b> Qualitative? – Ordinal Quantitative? – Yes	<i>Disaster Effected Population</i>  100      500      1000	<i>Flooding River Flow Rate</i>  10 cfs      100 cfs      1000 cfs	<i>Crop Area Drought Impacts</i> 
<b>Shape</b> Qualitative? – Yes Quantitative? – No	<i>Disaster Relief Stations</i>  medical      food      shelter	<i>Relief Access Road Types</i>  Paved road      Dirt road	<i>Earthquake Damage Status</i>  Destroyed      Undamaged
<b>Orientation</b> Qualitative? – Yes Quantitative? – No	<i>Water Well Status</i>  clean      treatable      contaminated	<i>Evacuation Road Status</i>  open      closed	<i>Landmine Inspection Status</i>  Cleared      Not Cleared
<b>Color Hue</b> Qualitative? – Yes Quantitative? – No	<i>Building Damage Status</i>  none      partial      destroyed	<i>Refugee Camp Boundaries</i>  food      medical	<i>Hazard Vulnerability</i>  Flood      Tornado      Earthquake
<b>Lightness</b> Qualitative? – No Quantitative? – Yes	<i>Hazard Risk Index</i>  low      → high	<i>Gas Plume Volume</i>  10ppm      100ppm	<i>Disaster Counts per District</i>  10      100      1000



# Color Hue - Qualitative Distinction

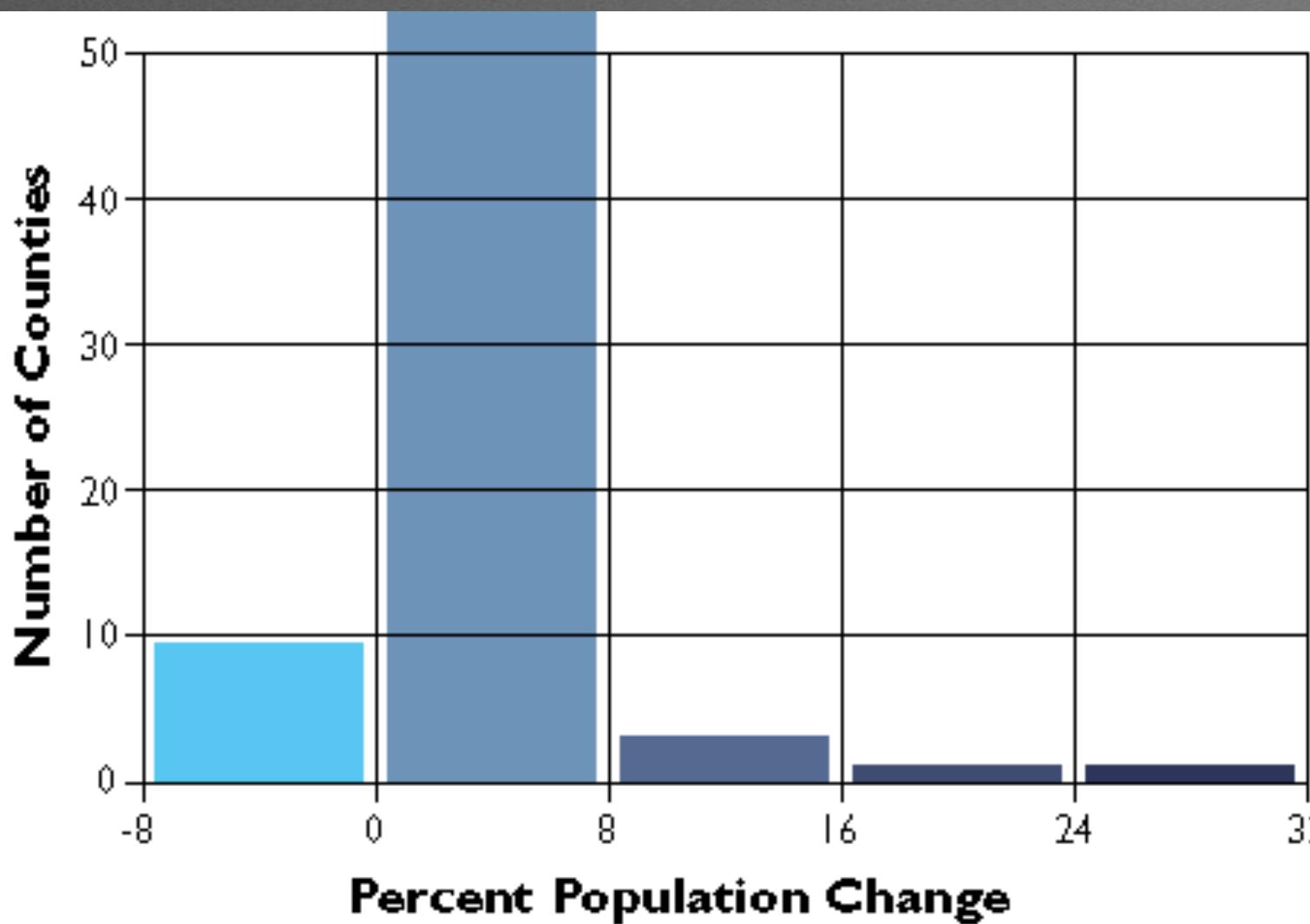


# Lightness - Quantitative Distinction

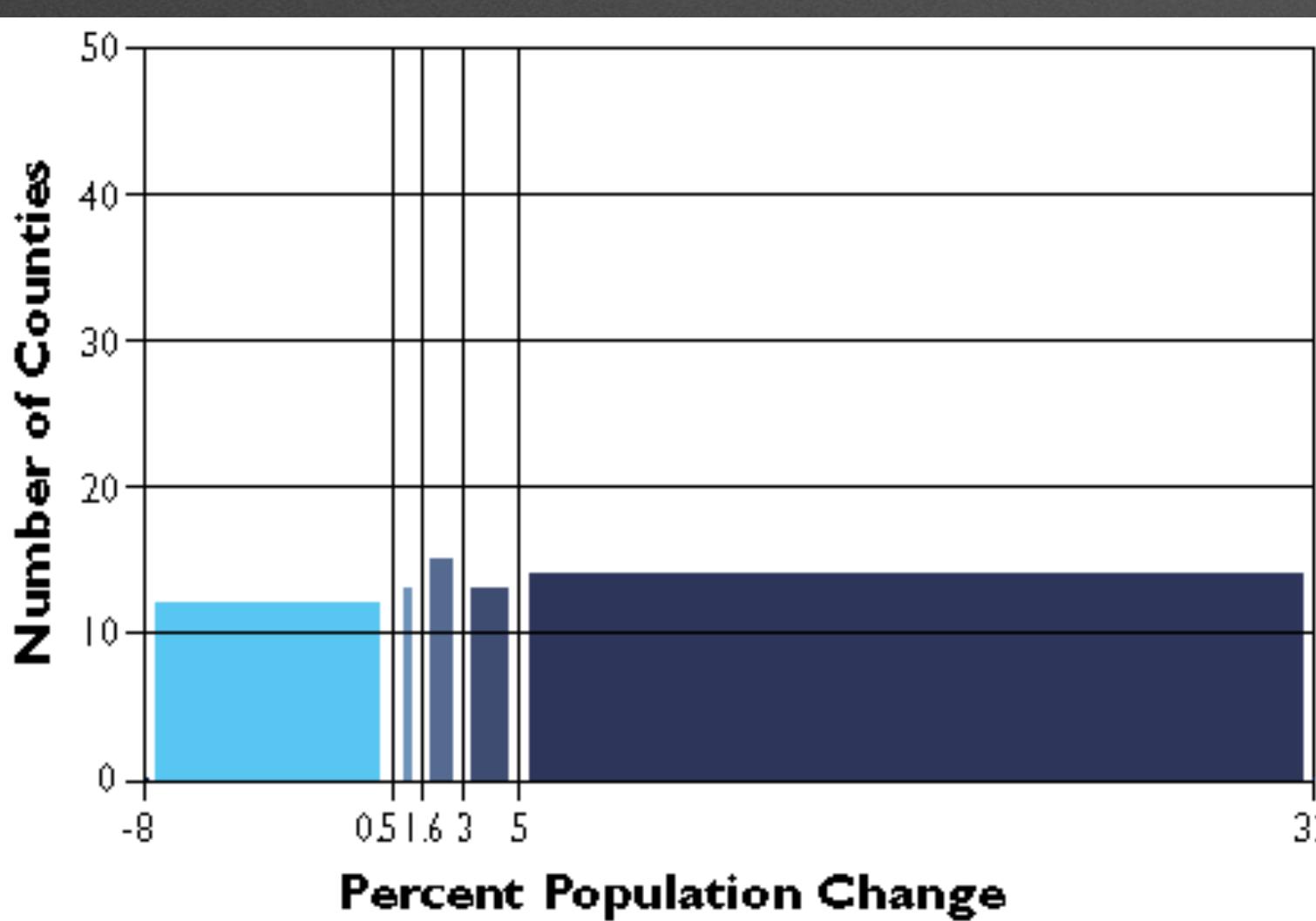


# Size - Quantitative Distinction

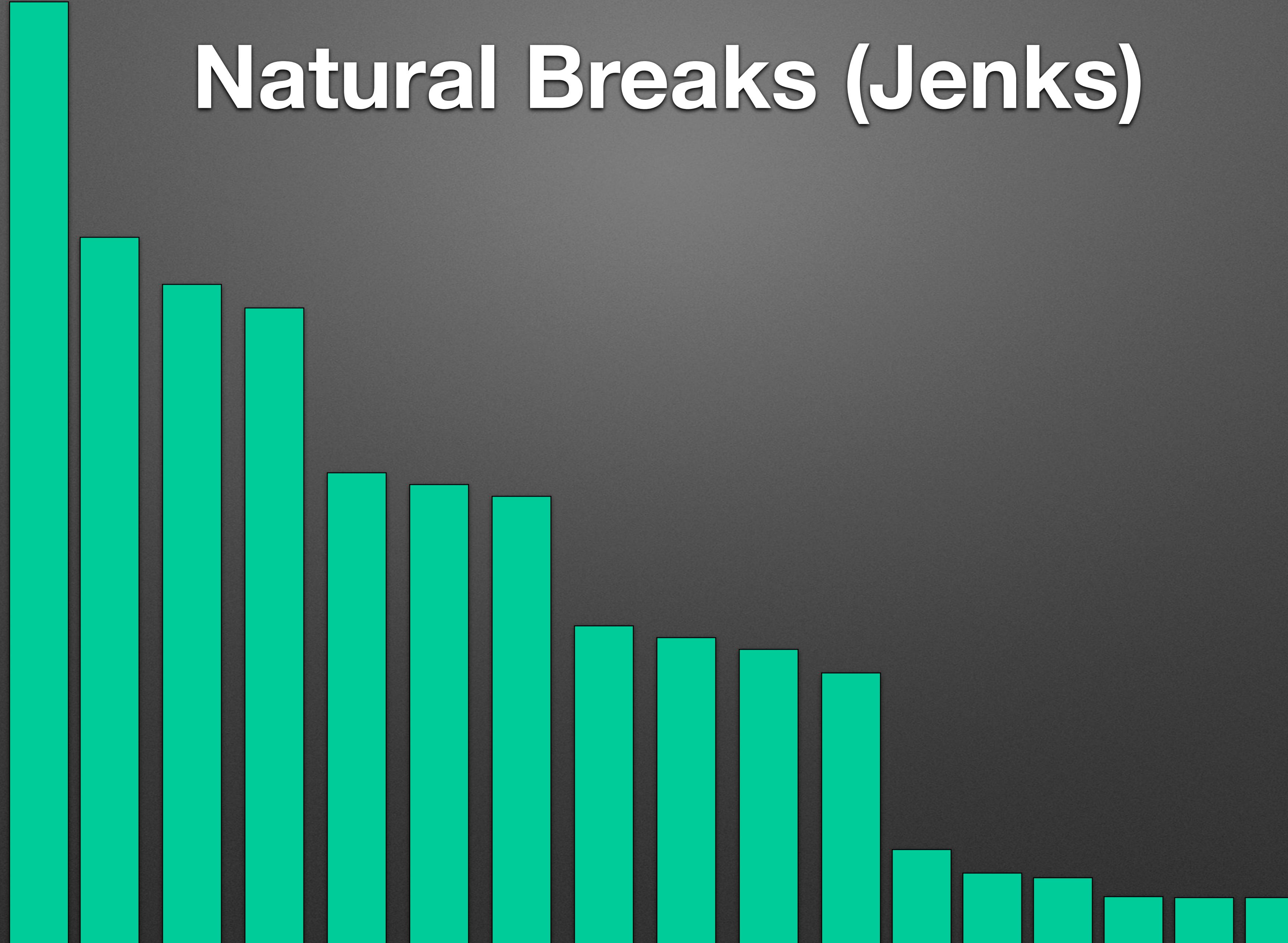
# Thematic Mapping



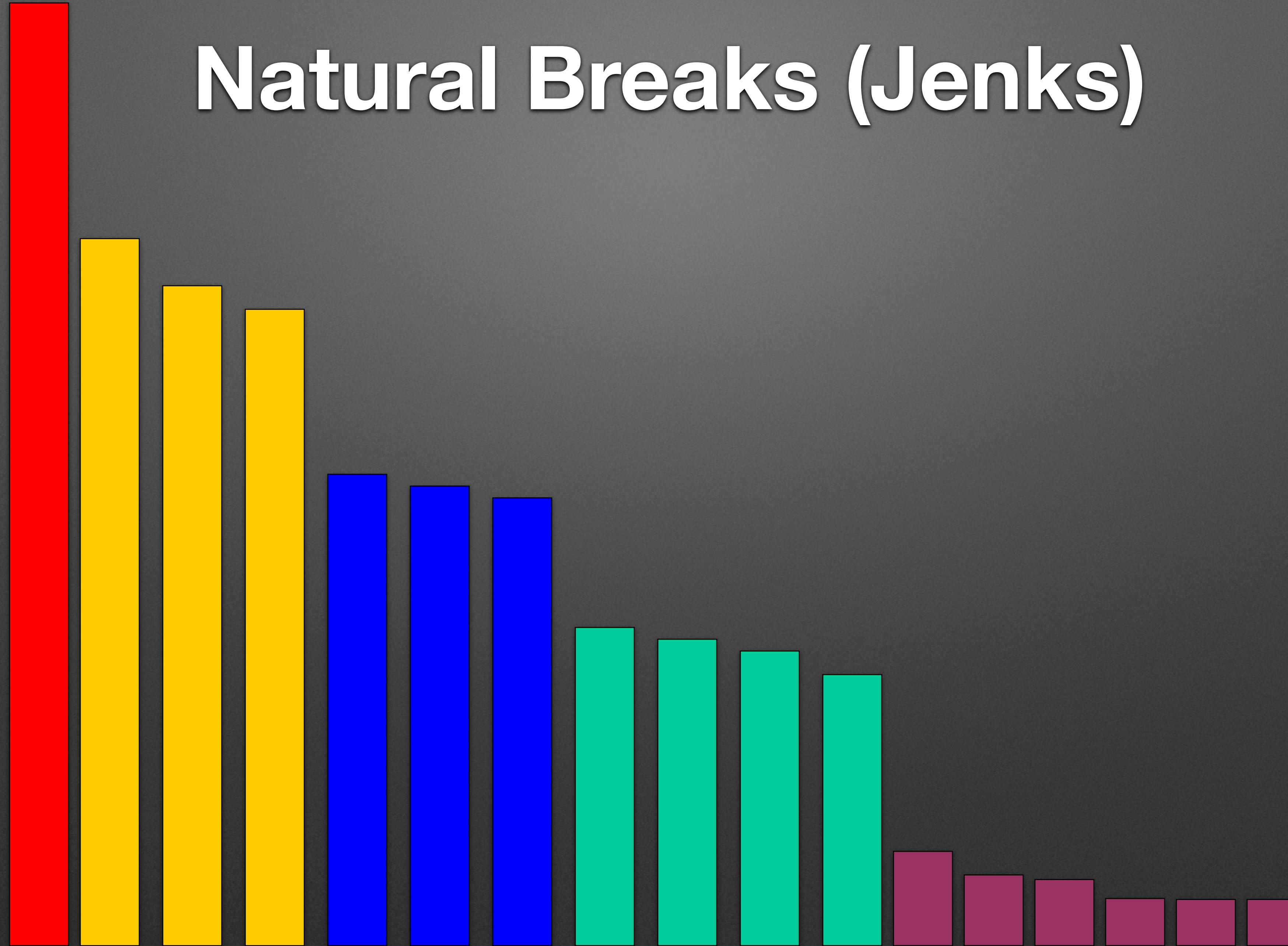
- **Equal Interval**
  - Equal range of values in each class
  - Each class will likely contain a different number of features
  - Divide the total range of values by the number of classes (in our case, 5)
    - this gives you the value range of each class
- **Quantile (percentile)**
  - Equal number of features in each class



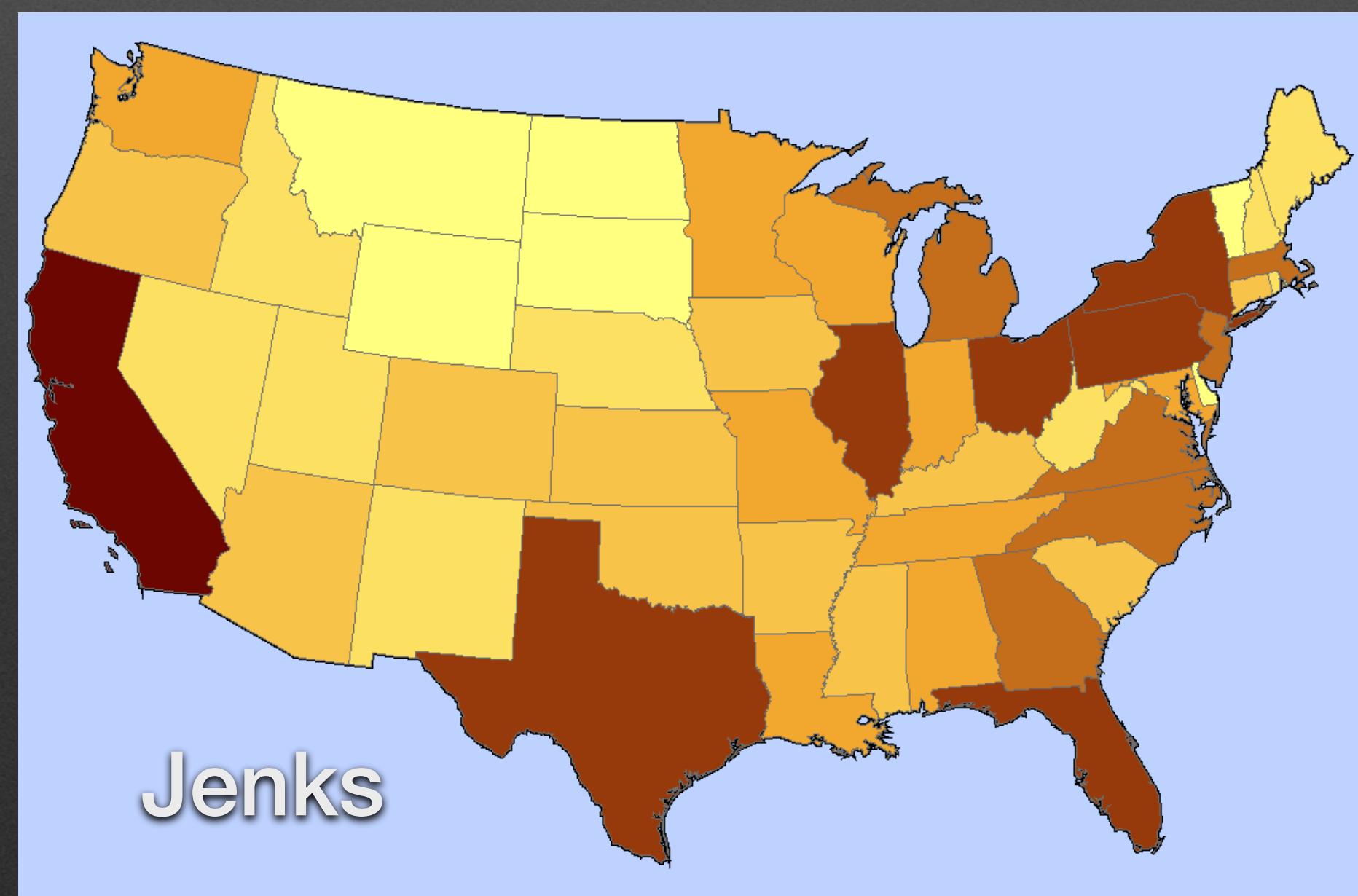
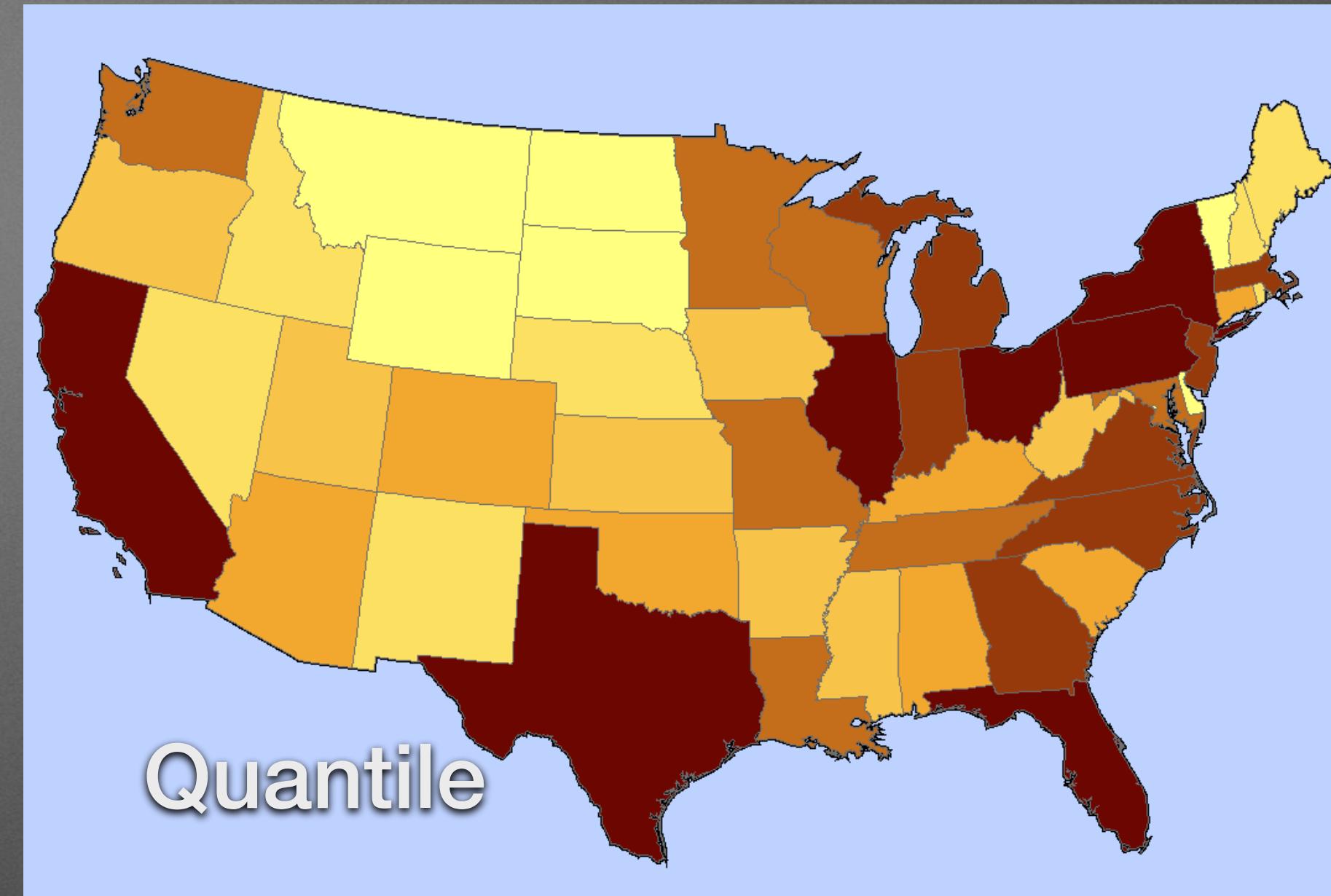
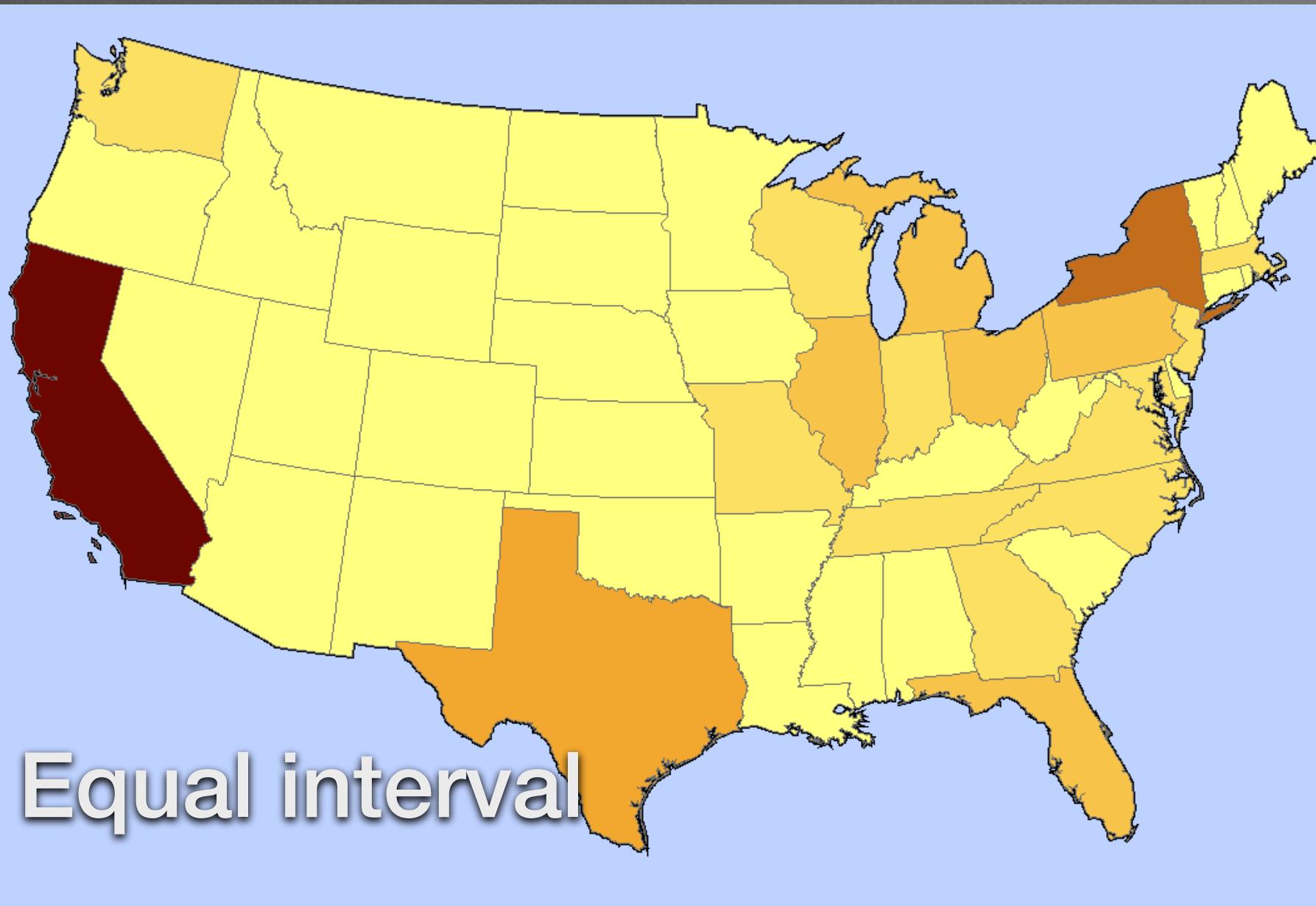
# Natural Breaks (Jenks)



# Natural Breaks (Jenks)



# Comparison of equal interval, quantile and Jenks



# Picking Colors

- Lots of things to take into consideration with your map color schemes
- Main one is the audience and what you are trying to tell
- ArcGIS Symbology Templates are a good place to start
- For more advanced ideas there is the [colorbrewer2.org](http://colorbrewer2.org) web site
  - Gives you colors and ramps to fit a variety of different use cases
  - Can pick colorblind safe, print friendly, or photocopy safe schemes

# Working With Layouts

- What maps do?
  - maps convey geographic information
  - highlight geographic relationships
  - present analysis results
  - guide people to a location

# Working With Layouts

- Things to consider when making a map
  - how and where it will be presented
  - who is the intended audience
  - reality and the need to generalize
  - scale and technical limits

# Gretchen Peterson's Map Evaluation Checklist

## GENERAL

- The purpose of the map is clear
- Authorship is indicated

## SPECIFICATIONS

- Final file size is not too large for distribution
- Resolution of final file is adequate for quality printing and/or viewing
- If printing, the file type is admissible by your printing personnel and/or software and hardware
- If printing, the colors are specified in the necessary formula (e.g., Pantone, HEX, CMYK)

## LOCATION

- The reader is able to discern the location's larger context
- Projection is satisfactory
- The scale is appropriate for the data (e.g. data are not jagged or pixelated)

## READABILITY

- All symbols are clearly defined
- Eyes can sweep from map colors to legend colors for deciphering
- All labels are readable
- All words are spelled correctly
- All abbreviations are defined

## LOOK AND FEEL

- Aesthetic is cohesive
- Marginal elements fit in with the overall look and feel
- Marginal elements (e.g., the legend) are anchored in a logical position
- There is a clear foreground
- There is a clear background

## CLUTTER

- All elements in the map are necessary
- No elements need to or can be removed
- All map layers that are needed are presented
- The viewer is not distracted from the central purpose
- Elements have been de-inked as much as possible

## COLOR

- The colors are a logical representation of features
- The colors enhance, rather than detract from, the central purpose
- No colors misrepresent features (e.g., red is not used to indicate a good location)

# GIS Cartography

**1 LAYOUT**

When planning your layout, first consider all possible elements to include on it like: north arrow, legend, authorship and so on. Question every element's purpose: is it necessary? **Say no to clutter.** Logos can be garish. The map title should state your main point. Consider including metadata like date and network path; use small gray italic text for them. **To arrange elements, start with a sketch or emphasis map.** Don't dumb-down your map but do make it readable. Balance is still in but blocky is out.

**2 FONTS**

The intended viewing distance is the key to choosing a letter point size. Long-range viewing guidelines: 18 point minimum for body text; 90-120 point for title text; 12-14 point for metadata elements. Expanded character spacing provides emphasis. **Use script or italics for hydrographic feature labels.** Red text connotes poor, bad or important. Mountain range labels should be in upper case and follow the range. The distance between a point and its label should be about half the size of the lettering. **Posters for long-range viewing need left-justified text and double-spacing.**

**3 COLOR**

Everyone will have something to say about your color choices – don't take it personally. **Analogous colors create a subdued, quiet effect.** Complementary colors are ostentatious and attention grabbing. Polychrome colors need to be chosen carefully to make sure they don't clash. Neutrals are in right now. Seek color palette inspiration in unique places: book covers, website designs, photographs, painter's leaflets and so on. Our eyes can't distinguish more than 5 shades of the same hue.

**4 FEATURES**

Learn the conventions for your most-displayed features and then **decide whether those conventions need innovation.** Water-related features are usually, but not always, blue. Population center points are displayed using symbol levels: **larger, more prominent symbols for the bigger cities.** Features with non-static geographic boundaries can be displayed with **squiggly lines, colors that fade toward the edges or dotted lines.** **Use thicker lines for every fifth or tenth contour on contour maps.** Hypsometric tinting creates a color gradient that follows contours. Look up standard symbols for land use, land cover, soils, and geology features before creating your own.

**5 MEDIA**

**Avoid clutter** on slides under most circumstances. **Research the latest slide presentation styles prior to giving a presentation if it has been a while.** Text in reports should flow around maps. Report maps don't need borders unless they are full page maps. Always place the map on the same page as the text that references it unless it is a full page map. Web maps range from static images to full information systems. JPEGs use a compression algorithm that **lowers the file size but also lowers to image quality.** TIFF and EPS files have **high image quality but also have large file sizes.**

>>

FIND THESE PLUS OTHER GREAT MAPPING TIPS IN:

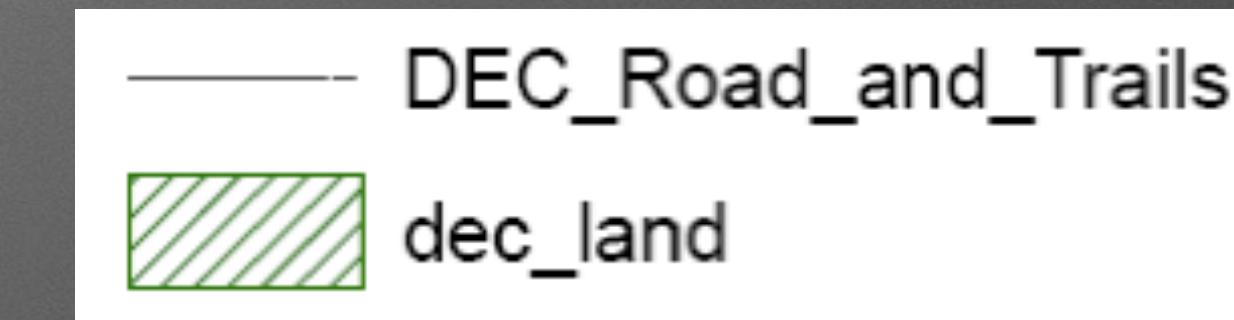
**GIS Cartography: A Guide to Effective Map Design**  
by Gretchen N. Peterson, GISP  
2009, CRC Press

*"If those of us in the geographic information system (GIS) realm have disregarded design in the past, we are now coming to realize that the elegant display of geographic data is as important as the data itself."*

<http://www.gretchenpeterson.com>

# Things to Watch For

remove\_underscores\_from\_titles\_they\_look\_funny

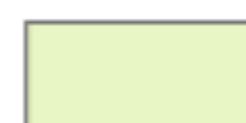


## Hillshade of DEMToRa\_I36e4

### <VALUE>



222.8999939 - 284.2000122



284.2000123 - 318



318.0000001 - 350



350.0000001 - 379

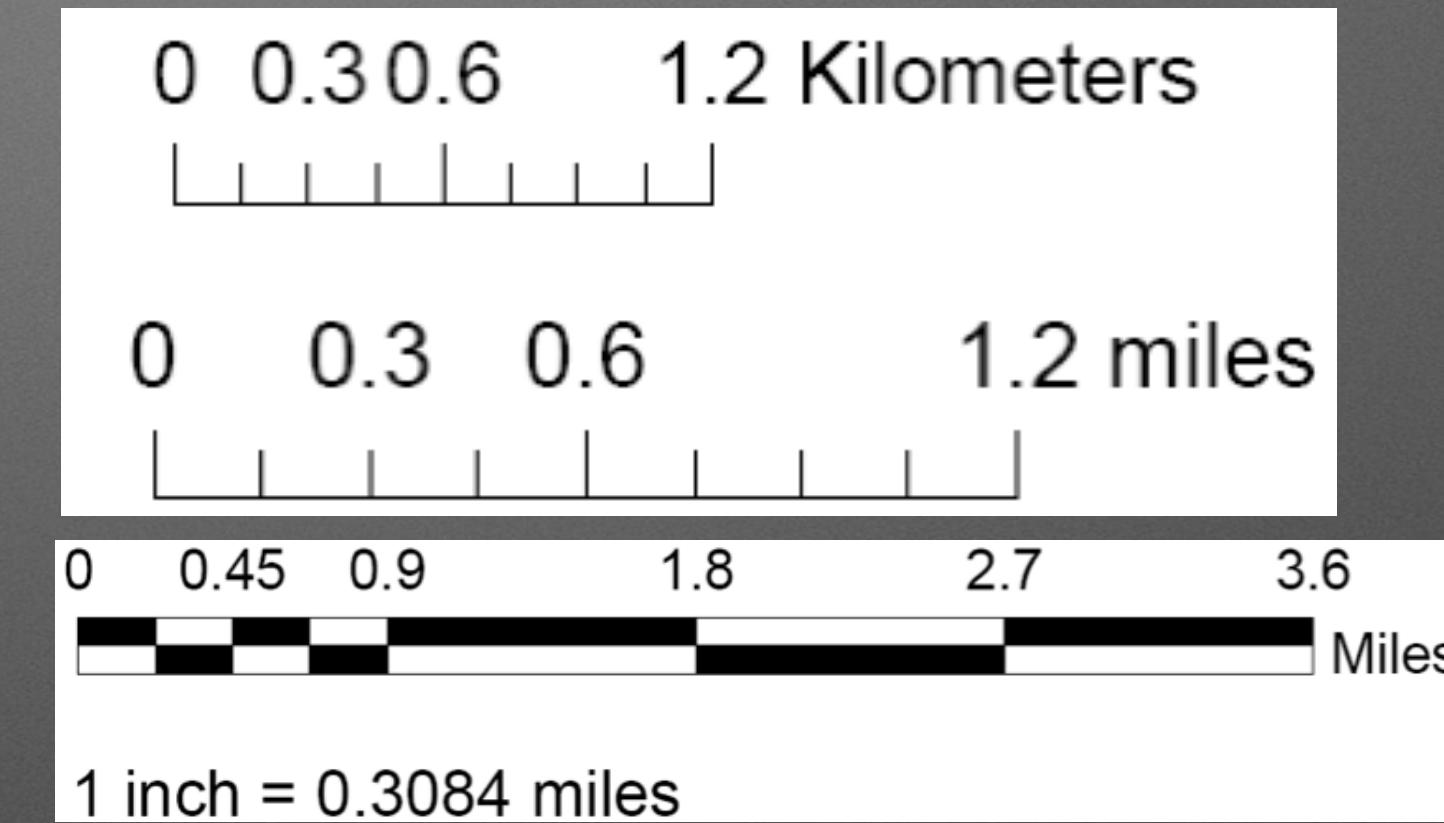


379.0000001 - 416.5

round numbers so there aren't as many decimal places

# Things to Watch For

use even rounded numbers for scale bar increments. for example, end the graphic scale at 5 miles or 2.5 miles

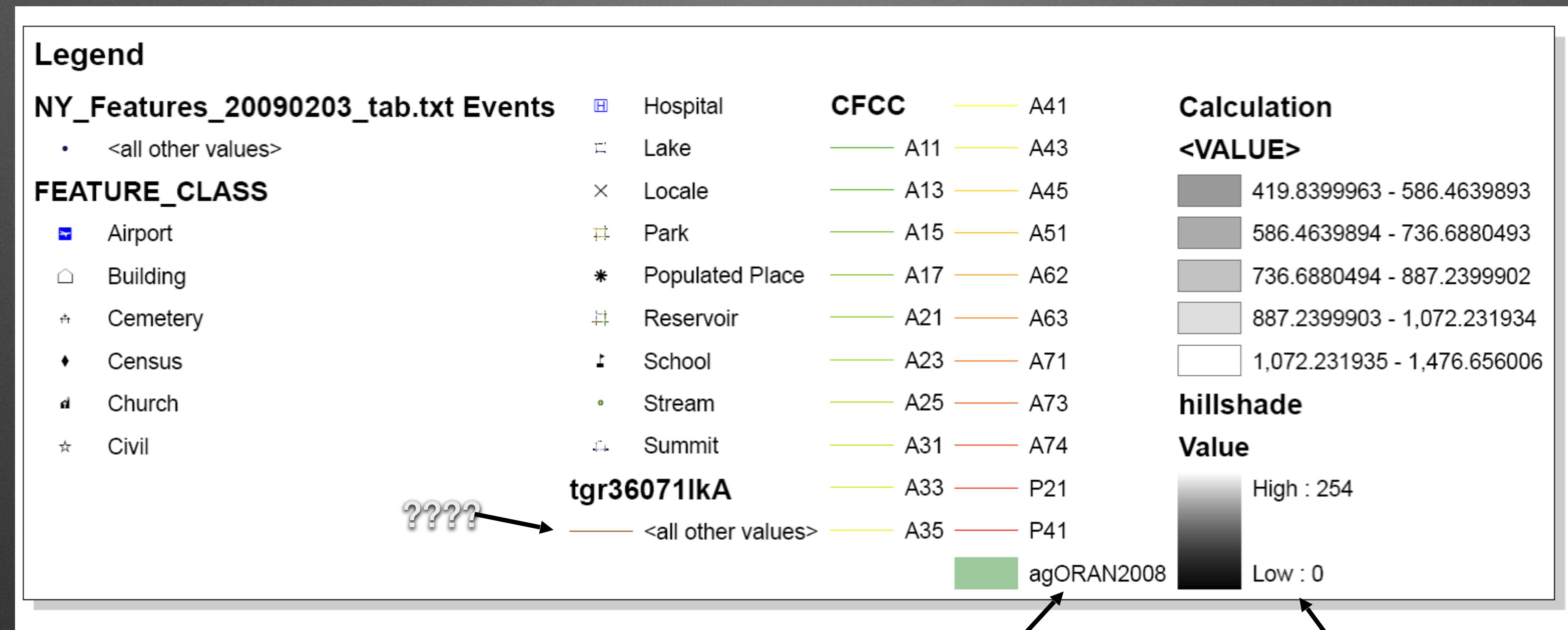


make sure your legend titles are meaningful and will be understood by someone other than you

CFCC2
Road, unseparated
Road, unseparated, in tunnel
Road w/ underpass
Road w/ rail
Road, separated
Road, separated, tunnel
Road, separated, underpass
Road, separated, rail

use different sizes as well as colors to discern the various feature types (roads in this example), especially when you showing many classes, in this example, they are hard to understand. Also, make sure labels are intuitive – in this example, what does "road, unseparated" really mean? better classification would be "interstates, county roads etc"

# Things to Watch For



make sure all legend items  
are relevant

?????  
Is this needed?

**Lab - GIS and Basic Map Making**  
**Due Date: October 7th 11:59 PM**  
**Delivery Format: Word file in drop**  
**box**

**Reminders:**  
**Data is Lab4Data.zip**

**Next Class Readings**

# Readings

- Brewer\_Designing\_Better\_Maps\_Ch\_1
- GIS cartography poster by Gretchen Peterson
- Map Evaluation Checklist
- MacEachren\_1995\_c1
- GPS-Posterweb
- Difference between recreational and professional grade gps receivers
- why-postprocess