Image from NASA:
https://commons.wikimedia.org/wiki/File:Earth_Western_Hemisphere_transparent_background.png#filelinks

GIScience

Attribute Tables and Geodatabases

WV VIEW

AmericaView℠
Empowering Earth Observation Education
AmericaView.org - Est. 2003

Non-Spatial Data in GIS

Attributes = non-spatial characteristics associated with spatial data

Categorical
- Nominal = A unique identifier or unique types
- Ordinal = Ranked data

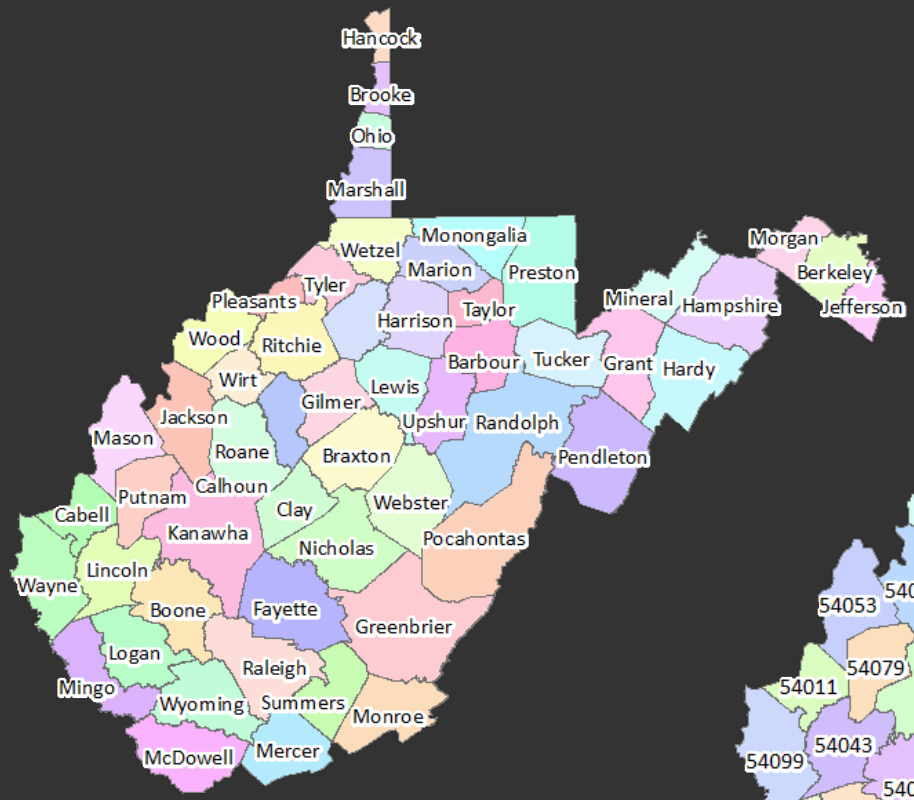
Numeric
- Interval = Difference between numbers is significant, but no fixed non-arbitrary zero point
- Ratio = Difference between numbers is significant, and there is a fixed non-arbitrary zero value

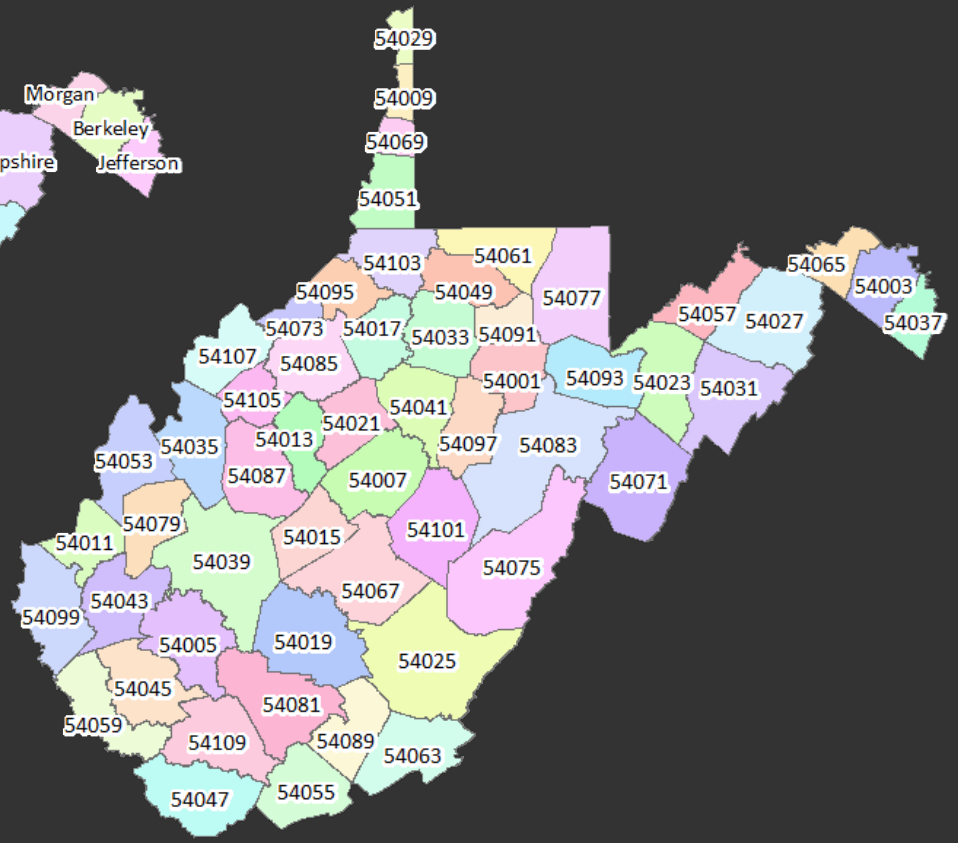
counties_detailed

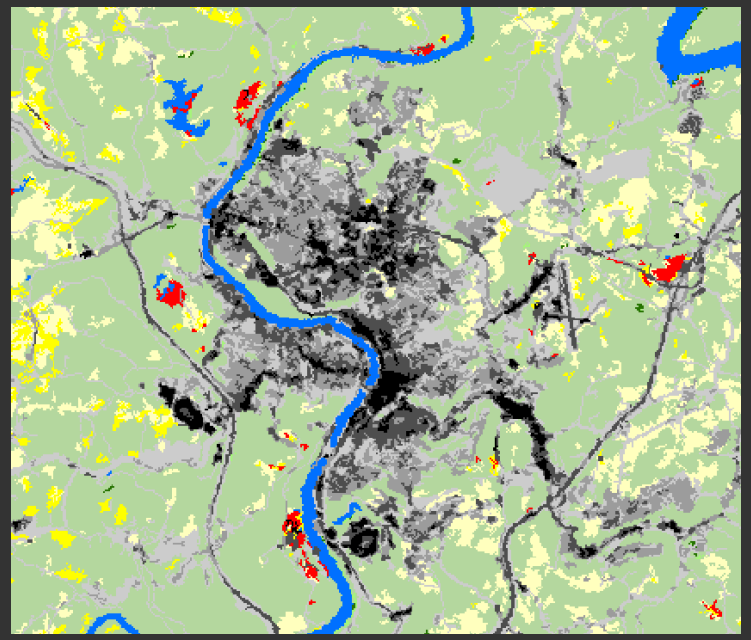
Field: Add Delete Calculate Selection: Zoom To Switch Clear Delete

FID	Shape	AREA	PERIMETER	NAME	STATE	FIPS	STATE_ABBR	SQUARE_MIL	POP2000	POP00SQMIL	MALE2000	FEMALE2000	MA
0	Polygon	281936384.193	69539.619328	Ohio	54	54069	WV	106.176	47427	446.7	22177	25250	
1	Polygon	807157354.71	125167.039523	Marshall	54	54051	WV	306.994	35519	115.7	17288	18231	
2	Polygon	1686168096.7	179373.536795	Preston	54	54077	WV	648.324	29334	45.2	14535	14799	

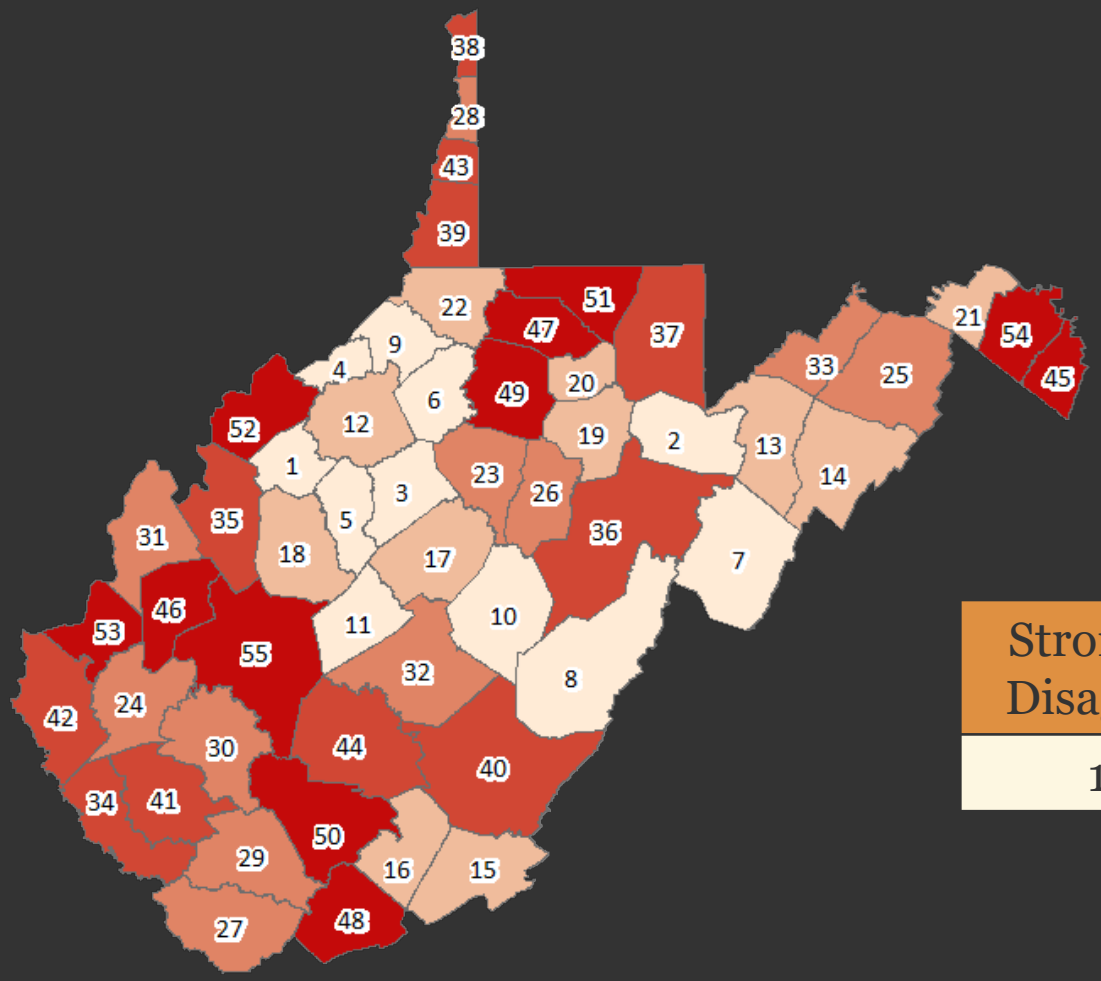
Nominal Data







Ordinal Data



Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Interval Data

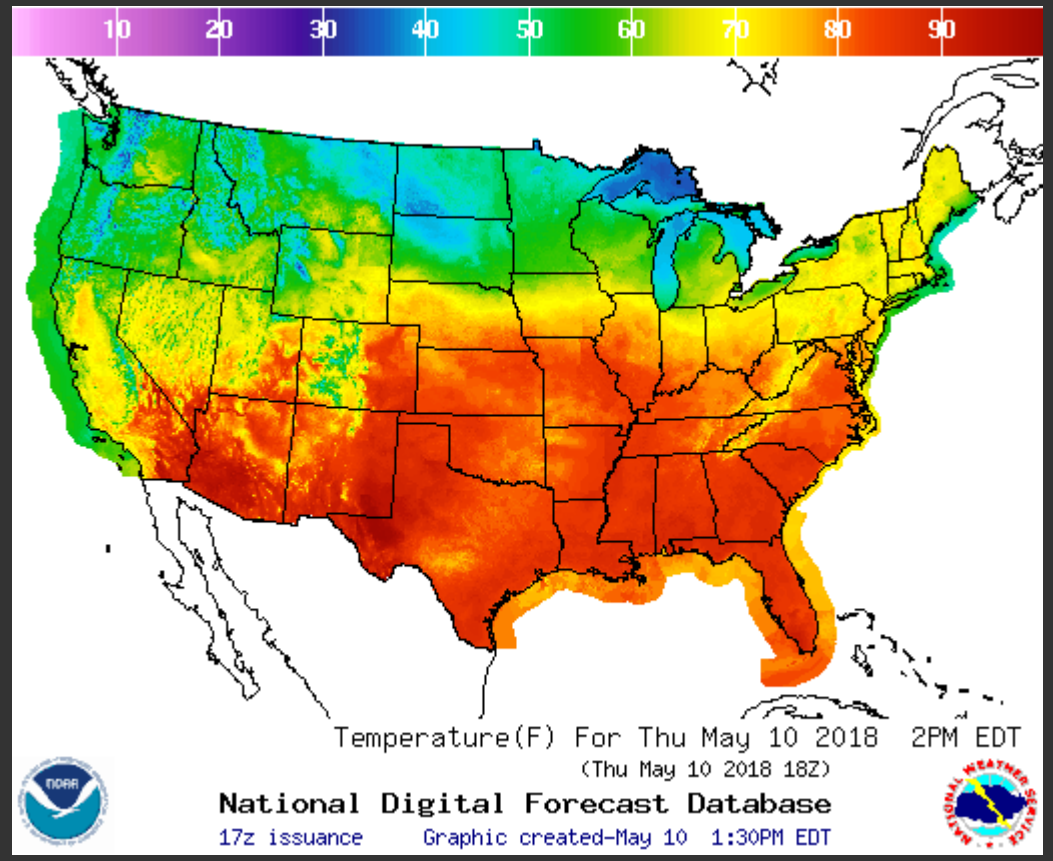
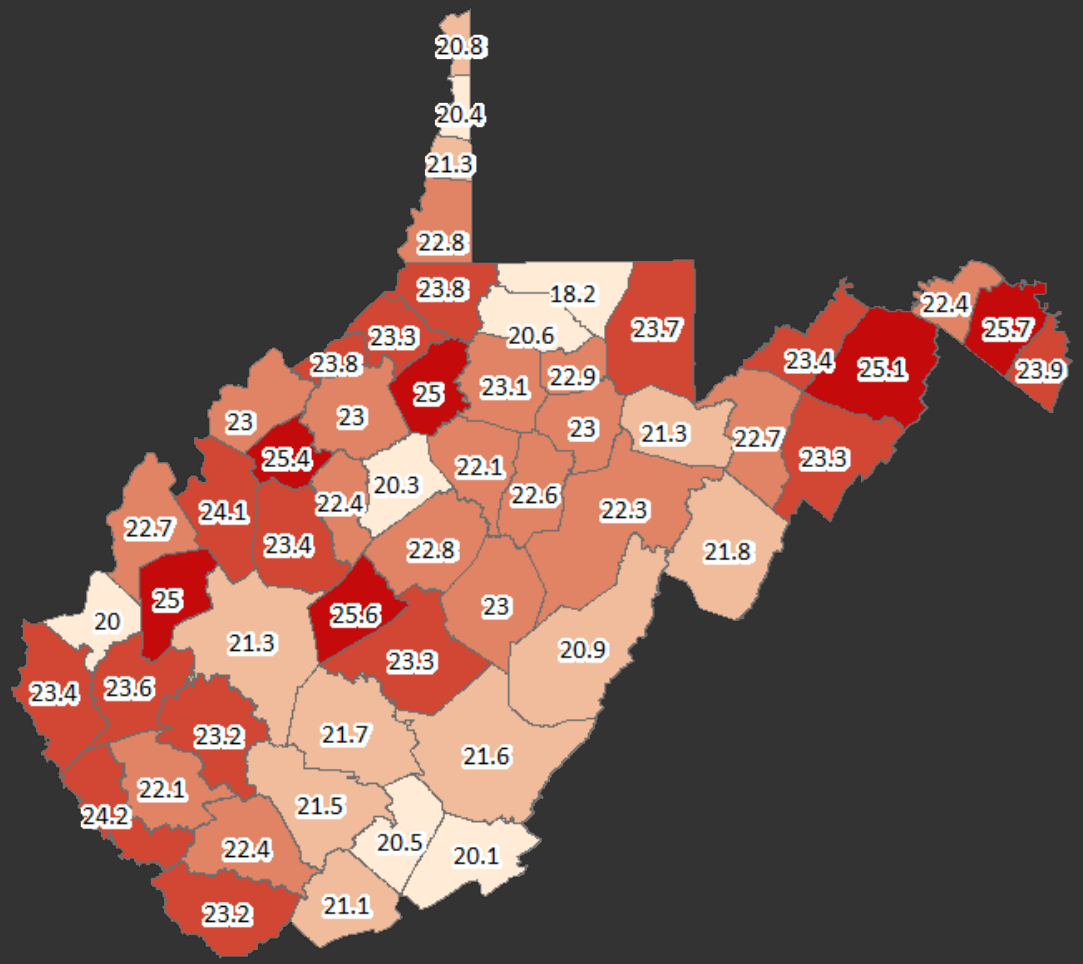
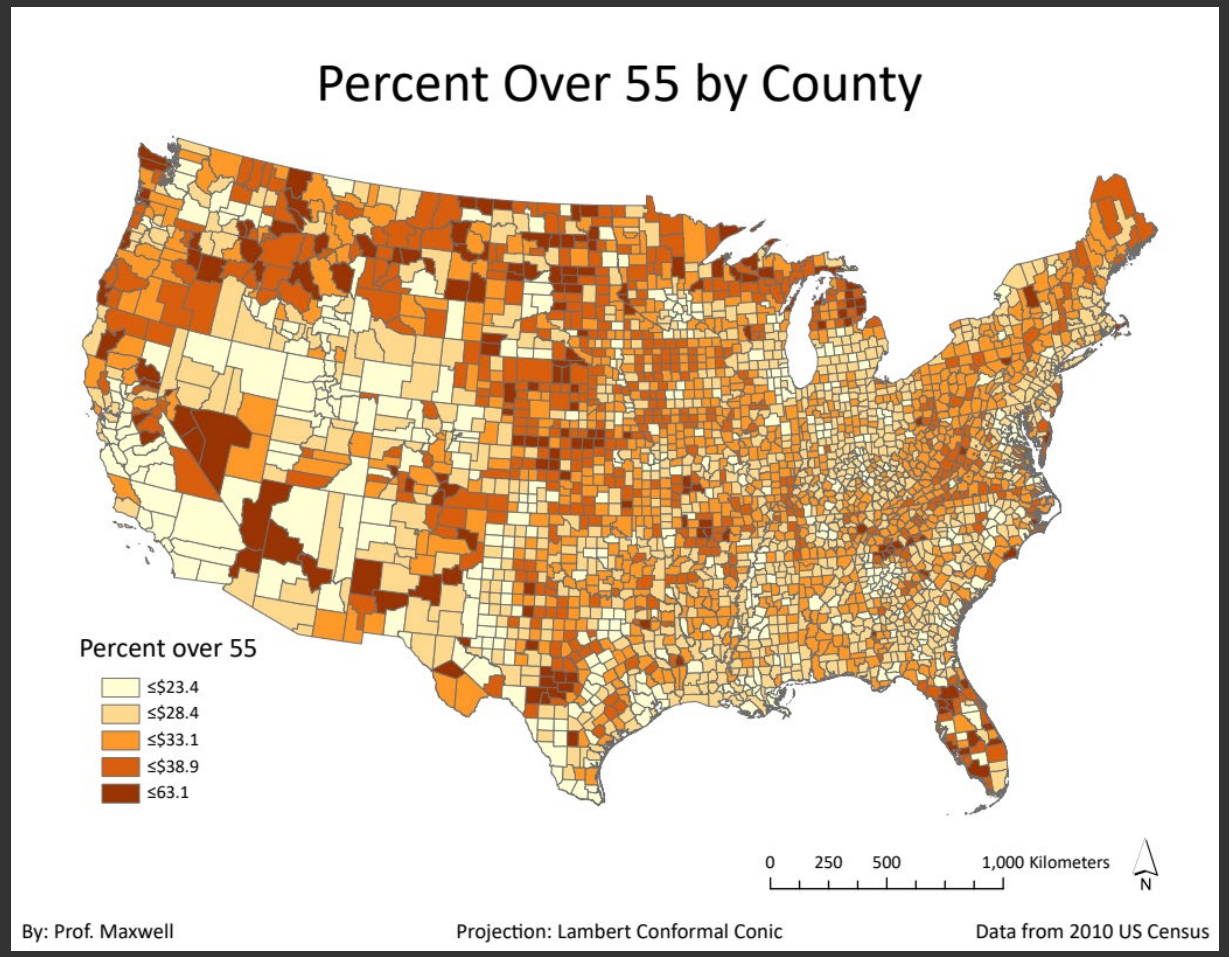


Image from the National Weather Service

Ratio Data


20.8
20.4
21.3
22.8
23.8
18.2
23.3
20.6
23.7
23.8
25
23.1
22.9
23
23
23
21.3
25.4
22.1
20.3
22.7
22.6
24.1
22.4
22.3
23.4
22.8
21.8
25
25.6
23
20
21.3
23.3
20.9
23.4
23.6
23.2
21.7
21.6
22.1
24.2
21.5
22.4
20.5
20.1
23.2
21.1
22.4
25.7
23.4
25.1
23.9
22.7
23.3


Percent Over 55 by County
Percent over 55
≤$23.4
≤$28.4
≤$33.1
≤$38.9
≤63.1
0 250 500 1,000 Kilometers
N
By: Prof. Maxwell
Projection: Lambert Conformal Conic
Data from 2010 US Census

Attribute Tables

counties_detailed

Field: Add Delete Calculate Selection: Zoom To Switch Clear Delete

FID	Shape	AREA	PERIMETER	NAME	STATE	FIPS	STATE_ABBR	SQUARE_MIL	POP2000	POP00SQMIL	MALE2000	FEMALE
17	Polygon	1174558903.03	190866.47067	Ritchie	54	54085	WV	453.512	10343	22.8	5070	
18	Polygon	1243179000.53	205207.603298	Grant	54	54023	WV	477.209	11299	23.7	5585	
19	Polygon	887178857.707	146810.022398	Barbour	54	54001	WV	340.788	15557	45.6	7646	
20	Polygon	1090401465.58	162556.831726	Tucker	54	54093	WV	418.871	7321	17.5	3570	
21	Polygon	1513690918.56	207396.438169	Hardy	54	54031	WV	583.393	12669	21.7	6255	
22	Polygon	608205867.85	133536.114018	Wirt	54	54105	WV	232.987	5873	25.2	2939	
23	Polygon	1008177060.8	168255.380867	Lewis	54	54041	WV	382.142	16919	44.3	8206	
24	Polygon	2691753634.8	324281.73498	Randolph	54	54083	WV	1039.725	28262	27.2	14222	
25	Polygon	918241922.761	148989.496649	Upshur	54	54097	WV	354.758	23404	66	11354	
26	Polygon	878938845.427	157414.412621	Gilmer	54	54021	WV	340.045	7160	21.1	3600	
27	Polygon	1220556327.97	178691.609587	Jackson	54	54035	WV	465.792	28000	60.1	13623	
28	Polygon	725902912.067	164688.558169	Calhoun	54	54013	WV	280.623	7582	27	3786	
29	Polygon	1152234212.77	181232.373499	Mason	54	54053	WV	431.852	25957	60.1	12724	
30	Polygon	1807519120.32	197019.787819	Pendleton	54	54071	WV	697.871	8196	11.7	4125	
31	Polygon	1252066309.44	171703.11633	Roane	54	54087	WV	483.572	15446	31.9	7645	
32	Polygon	1337033182.79	172607.315752	Braxton	54	54007	WV	513.48	14702	28.6	7444	
33	Polygon	2437515275.93	269650.535179	Pocahontas	54	54075	WV	940.288	9131	9.7	4703	
34	Polygon	1439510921	167601.512884	Webster	54	54101	WV	555.968	9719	17.5	4783	
35	Polygon	906777879.744	142760.149326	Putnam	54	54079	WV	346.232	51589	149	25363	
36	Polygon	889922110.089	133636.623724	Clay	54	54015	WV	342.399	10330	30.2	5109	

Columns = fields or attributes; info stored for each record

Rows = Records; one record for each vector feature

- All shapefiles and feature classes have an attribute table
- Some categorical raster data can also have attribute tables

Creating a new field

- Must define field name (less than 10 characters)
- Can provide an alias
- Must define data type

polys_to_edit | Fields: polys_to_edit

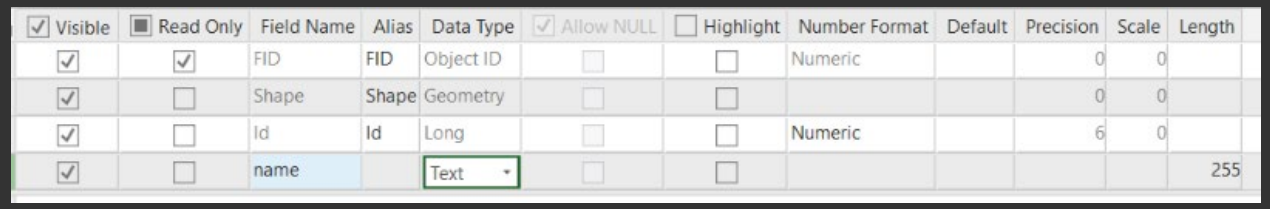
Current Layer: polys_to_edit

Visible	Read Only	Field Name	Alias	Data Type	Allow NULL	Highlight	Number Format	Default	Precision	Scale	Length
✓	✓	FID	FID	Object ID			Numeric		0	0	
✓		Shape	Shape	Geometry					0	0	
✓		Id	Id	Long			Numeric		6	0	
✓		Name	Name	Text					0	0	254
✓		Field		Long							

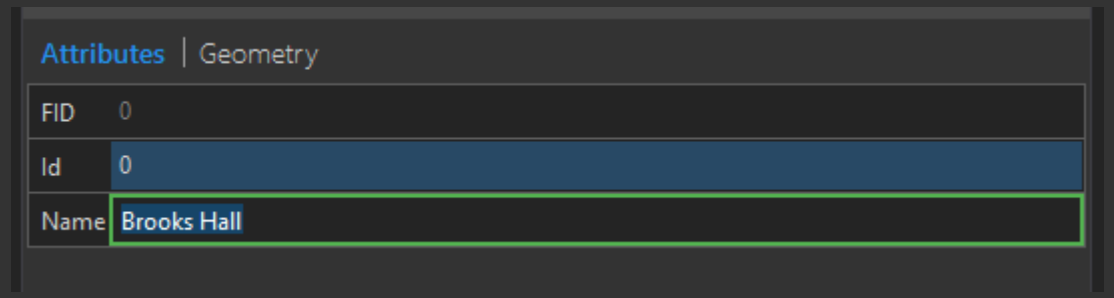
Click here to add a new field.

Adding Fields

- Make sure to define the correct type



Visible	Read Only	Field Name	Alias	Data Type	Allow NULL	Highlight	Number Format	Default	Precision	Scale	Length
☑	☑	FID	FID	Object ID		☐	Numeric		0	0	
☑	☐	Shape	Shape	Geometry		☐			0	0	
☑	☐	Id	Id	Long		☐	Numeric		6	0	
☑	☐	name		Text		☐					255

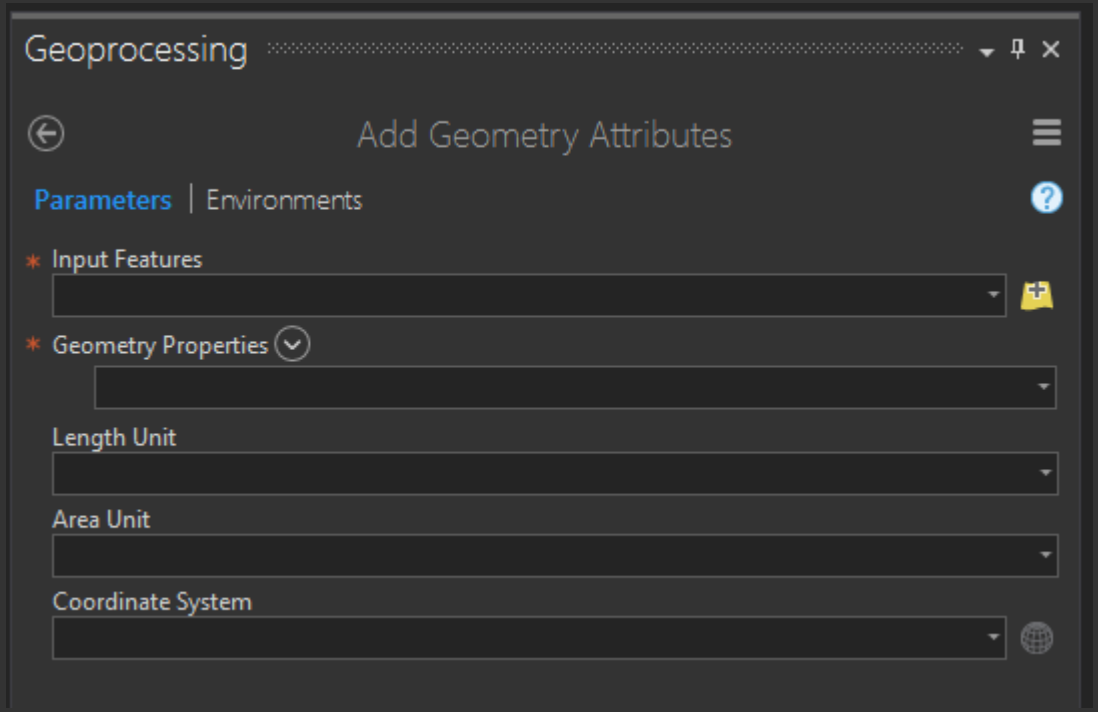


Data Type	Description
Short Integer	Integer values between -32,768 and 32,767
Long Integer	Integer values between -2,147,483,648 and 2,147,483,647
Float	Decimal values with 1-6 decimal places
Double	Decimal values with more the 6 decimal places
Text	Text strings
Date	Data info (mm/dd/yyyy)

Add Geometric Fields

- Use Add Geometry Attributes Tool

Points	Lines	Polygons
X-coordinate	Start-X	Area
Y-coordinate	Start-Y	Perimeter
Z-coordinate (if z-enabled)	End-X	Centroid-X
M-coordinate (if m-enabled)	End-Y	Centroid-Y
	Mid-X	
	Mid-Y	
	Length	
	Bearing	



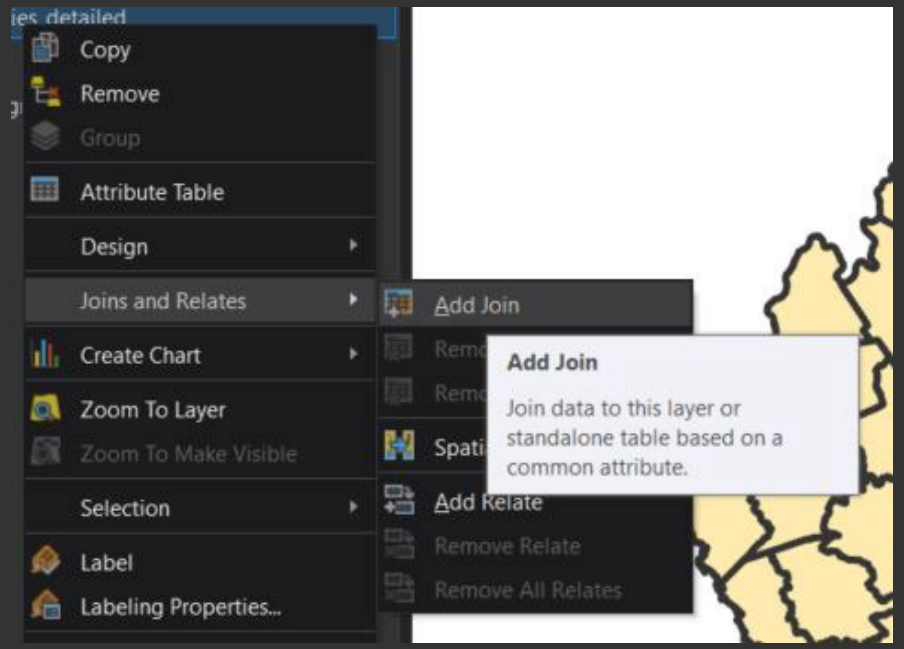
Joining non-spatial data and spatial data

Join

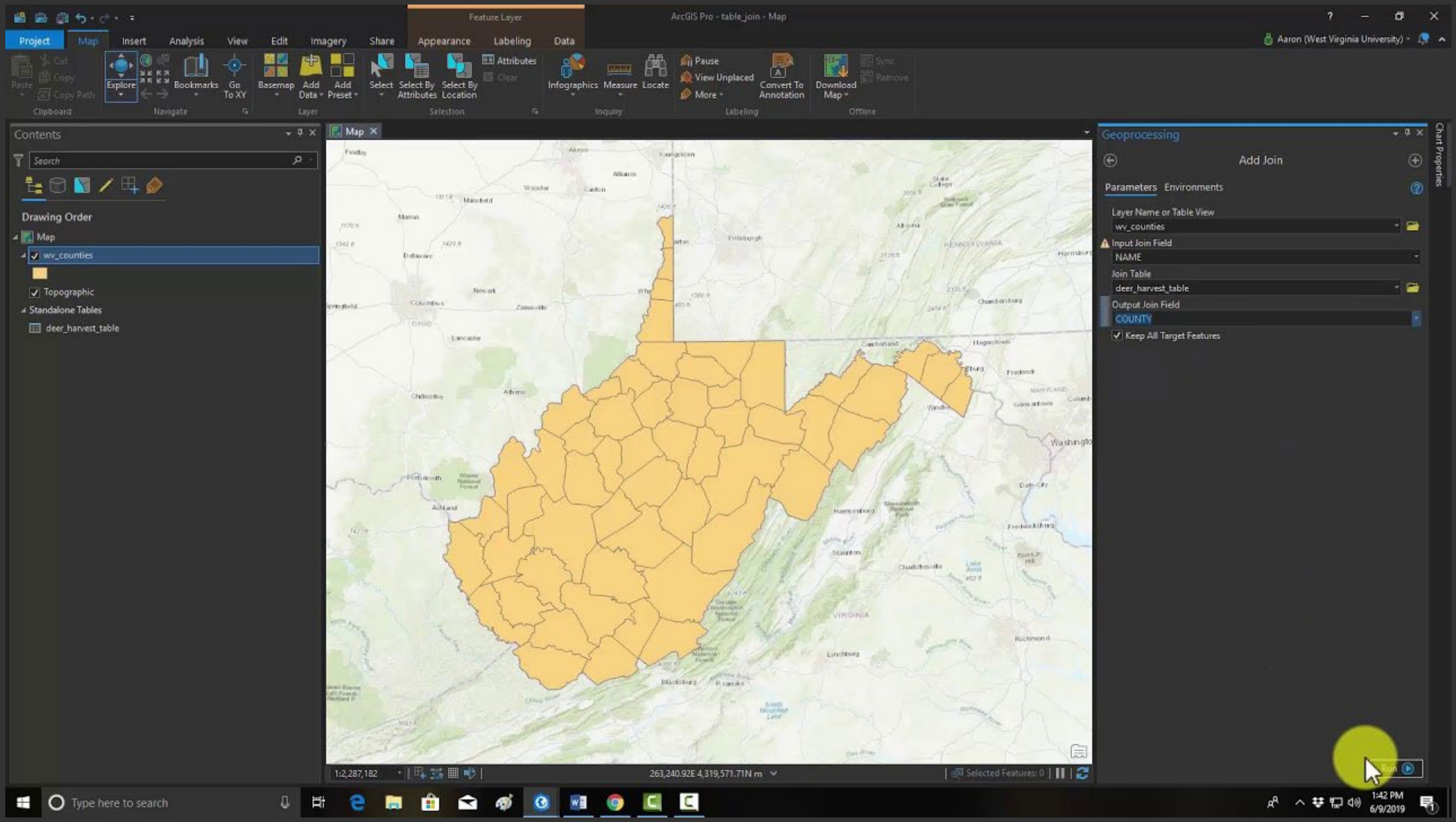
- Non-spatial data can be joined to spatial data as long as there is a common field between the data.
- Later, the joined fields can be used for analysis or to symbolize the features.

Relate

- New fields are not added to table. However, a relationship is established.

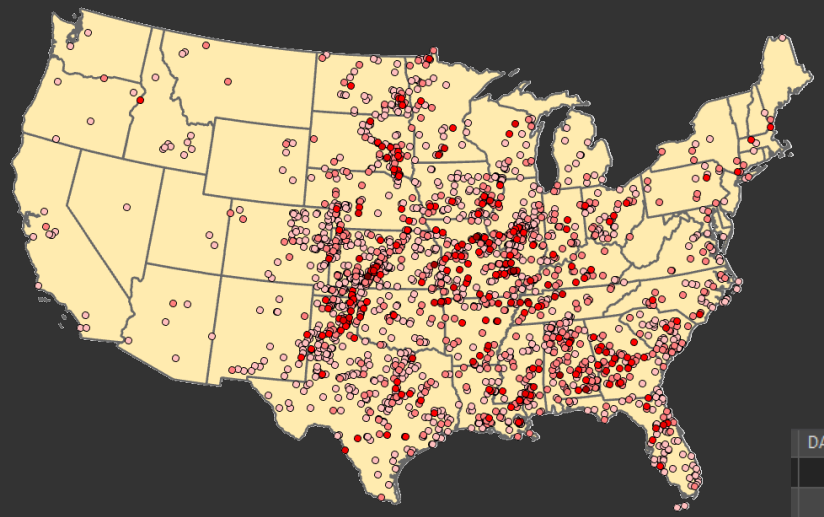


Video: Table Joins

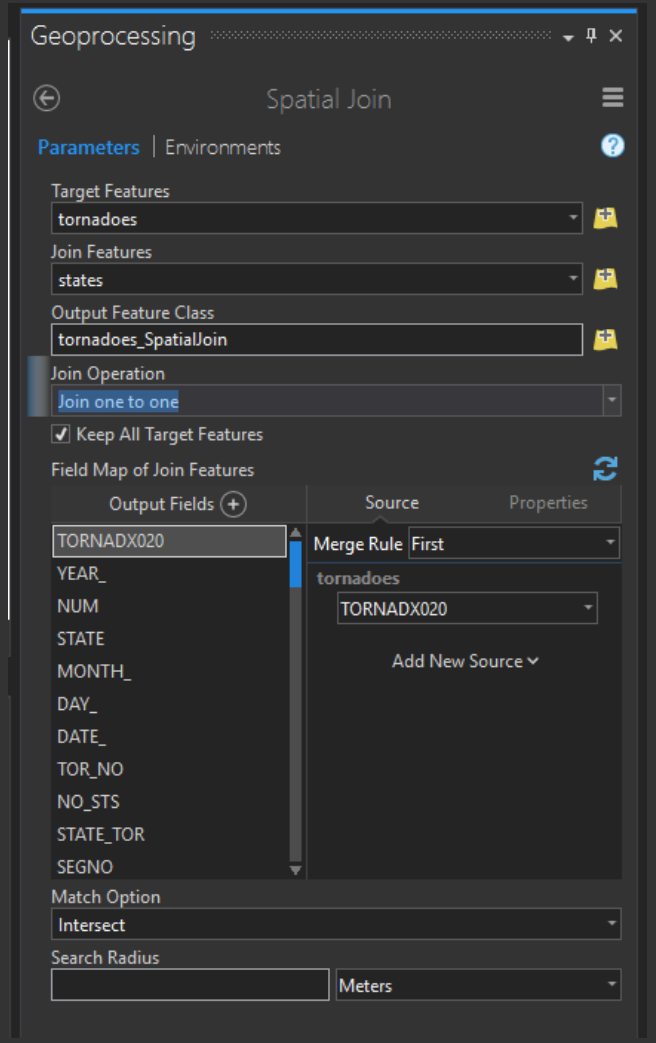


Spatial Joins

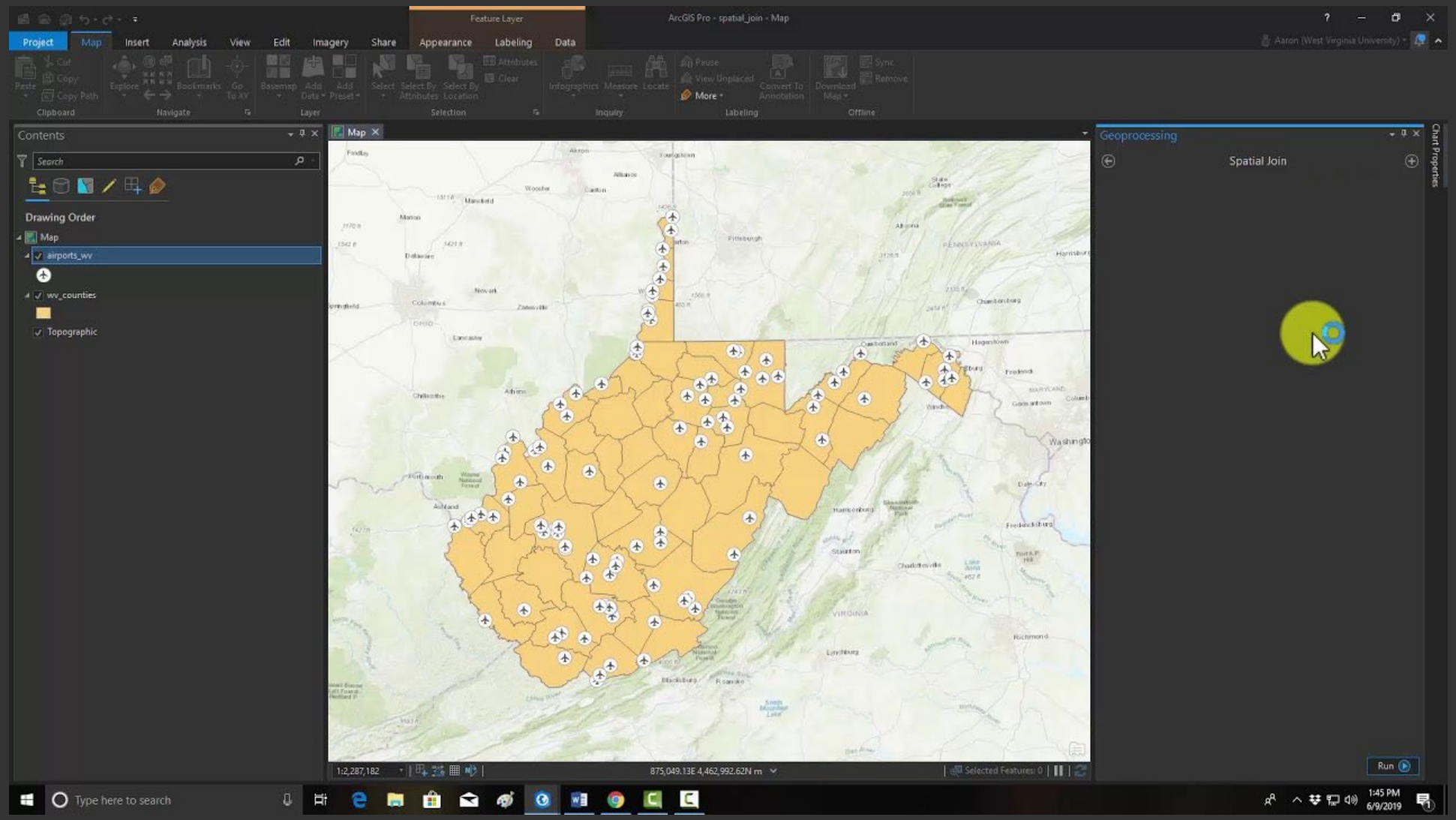
- Joins attributes based on spatial relationships



DAMAGE	F_SCALE	FID_	AREA	STATE_NAME	STATE_FIPS	SUB_REGION	STATE_ABBR
0	0	0	264435.873	Texas	48	W S Cen	TX
0	0	0	264435.873	Texas	48	W S Cen	TX
0	2	0	264435.873	Texas	48	W S Cen	TX
0	0	0	264435.873	Texas	48	W S Cen	TX
0	0	0	264435.873	Texas	48	W S Cen	TX
1	0	0	264435.873	Texas	48	W S Cen	TX
0	0	0	264435.873	Texas	48	W S Cen	TX
0	0	0	264435.873	Texas	48	W S Cen	TX
0	0	0	264435.873	Texas	48	W S Cen	TX
0	0	0	264435.873	Texas	48	W S Cen	TX
0	0	0	264435.873	Texas	48	W S Cen	TX
0	0	0	264435.873	Texas	48	W S Cen	TX
0	1	0	84520.49	Minnesota	27	W N Cen	MN
0	0	0	84520.49	Minnesota	27	W N Cen	MN

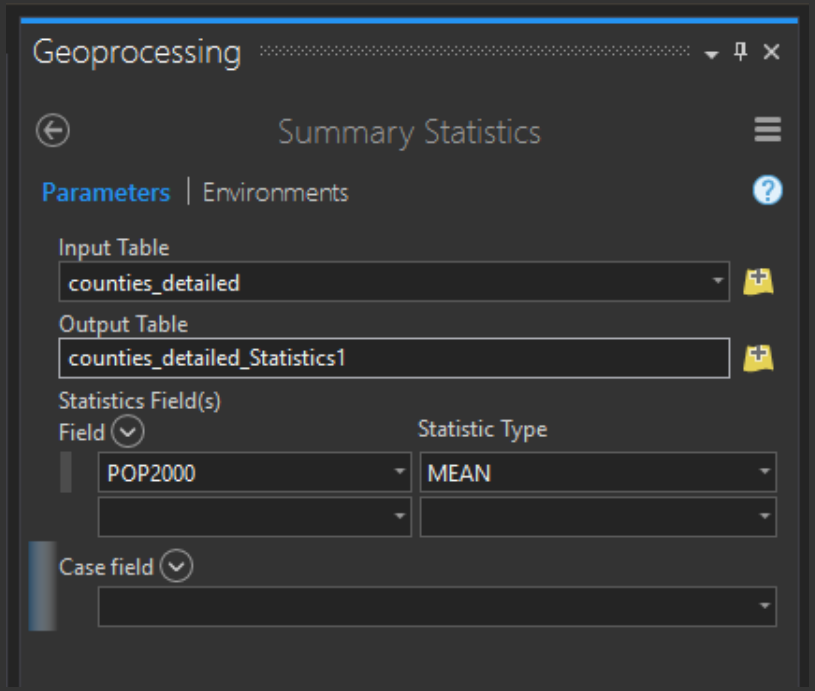


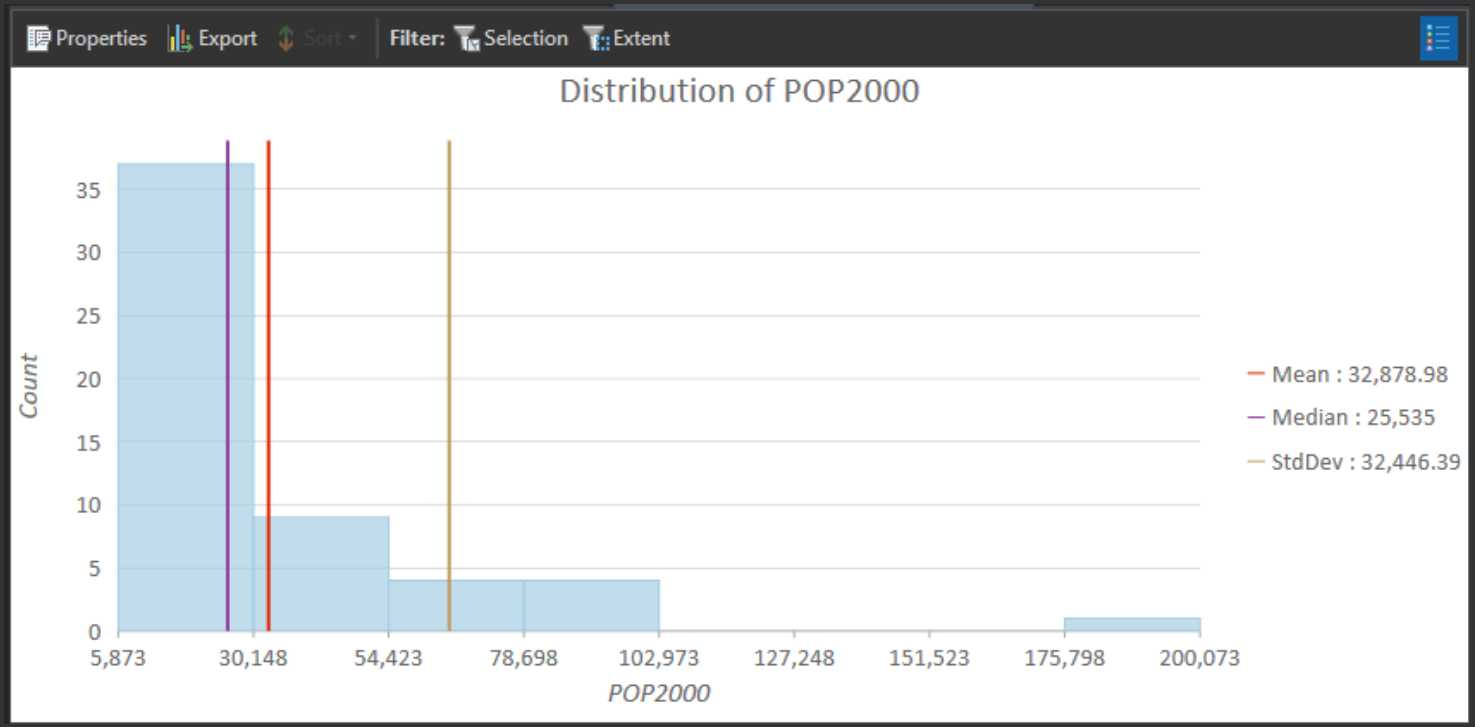
Video: Spatial Joins



Field Summary Statistics

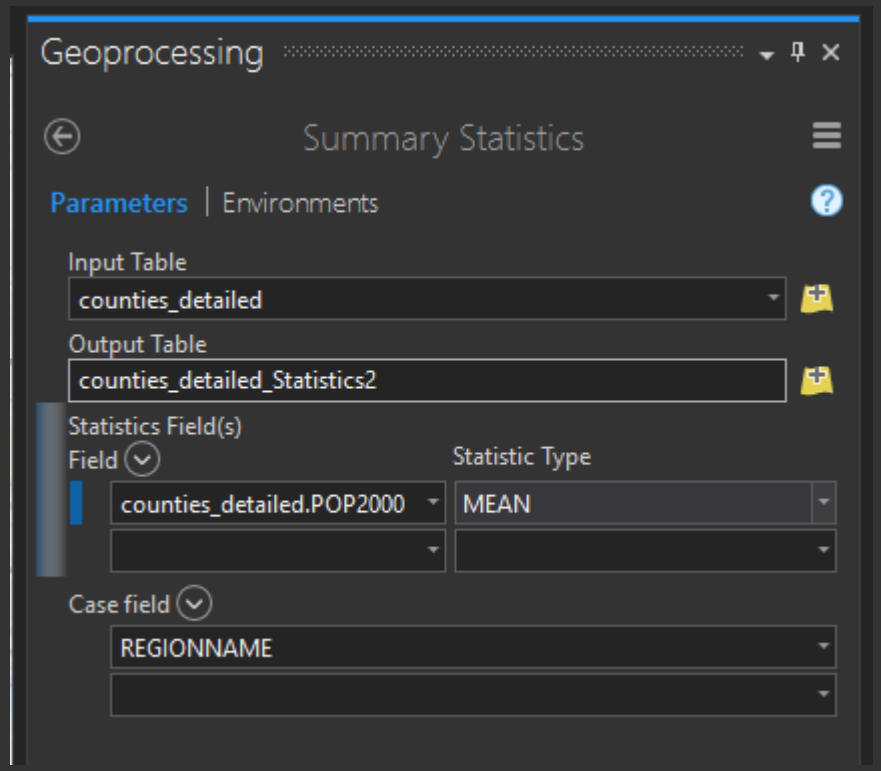
- Statistics for numeric fields





Field Summary Statistics

- Statistics for numeric fields

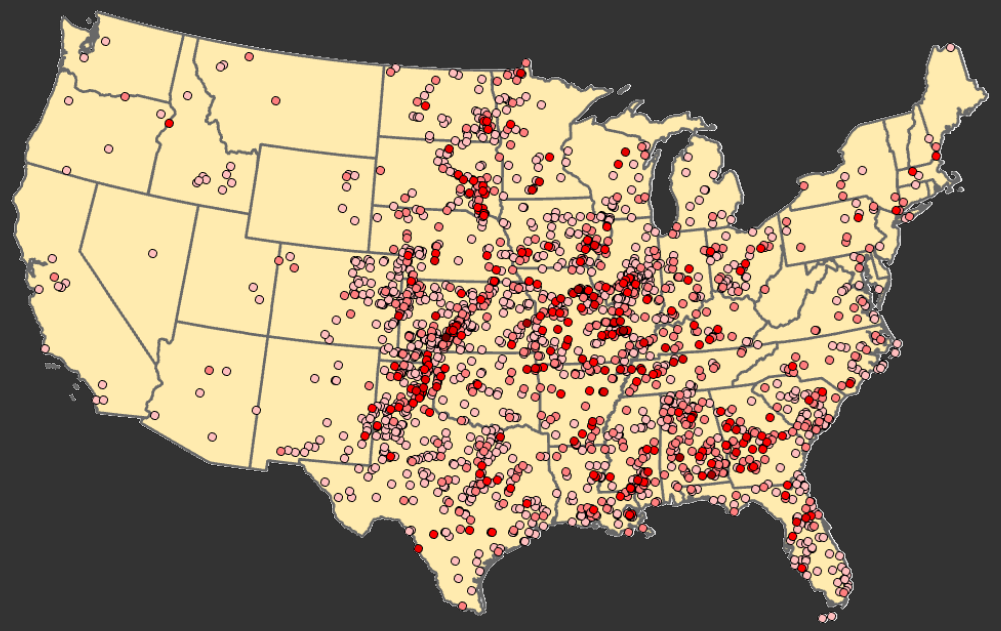


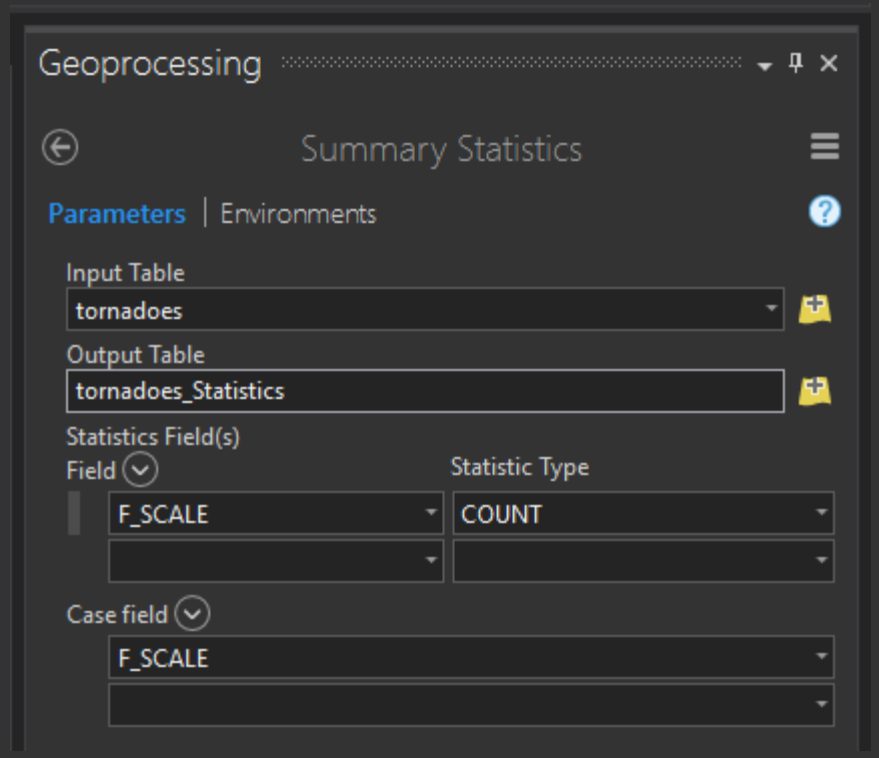
Field: Add Delete Calculate Selection: Zoom To Switch Clear

OBJECTID	WV_Deer_Harvest200	FREQUENCY	MEAN_counties_detailed.POP2000
1	Eastern Panhandle	3	44346
2	Hatfield-McCoy Mo...	5	31301.8
3	Metro Valley	4	93600.75
4	Mid-Ohio Valley	7	23249.142857
5	Mountain Lakes	7	15542.285714
6	Mountaineer Country	7	39357
7	New River/Greenbrie...	8	38106.375
8	Northern Panhandle	6	28057.5
9	Potomac Highlands	8	15519.875

Click to add new row.

Summarize Fields





Field: Add Delete Calculate Selection:

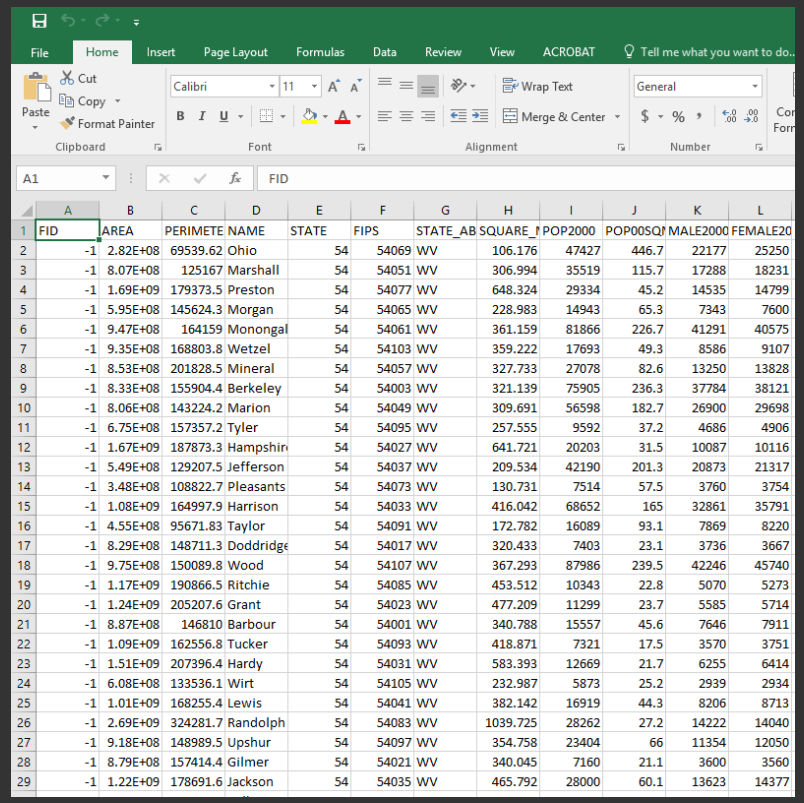
OBJECTID	F_SCALE	FREQUENCY	COUNT_F_SCALE
1	0	1236	1236
2	1	531	531
3	2	168	168
4	3	58	58
5	4	6	6
6	5	1	1

Tornadoes
by Fujita scale (severity)

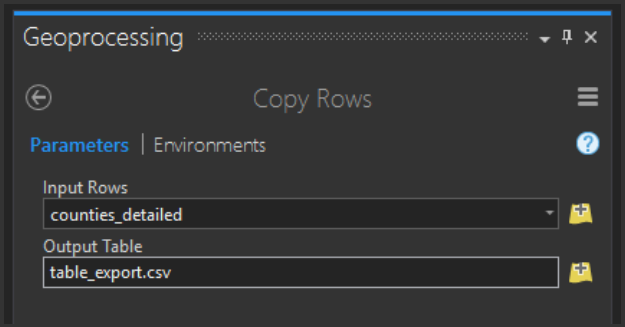
F_SCALE
- 0
- 1
- 2
- 3
- 4
- 5

Export an Attribute Data

- Types include text files, comma separated values (CSV), geodatabase tables, and dBASE tables
- Can analyze aspatial or tabulated data outside of GIS software



FID	AREA	PERIMETE	NAME	STATE	FIPS	STATE_AB	SQUARE_M	POP2000	POP00SQM	MALE2000	FEMALE20
-1	2.82E+08	69539.62	Ohio	54	54069	WV	106.176	47427	446.7	22177	25250
-1	8.07E+08	125167	Marshall	54	54051	WV	306.994	35519	115.7	17288	18231
-1	1.69E+09	179373.5	Preston	54	54077	WV	648.324	29334	45.2	14535	14799
-1	5.95E+08	145624.3	Morgan	54	54065	WV	228.983	14943	65.3	7343	7600
-1	9.47E+08	164159	Monongal	54	54061	WV	361.159	81866	226.7	41291	40575
-1	9.35E+08	168803.8	Wetzel	54	54103	WV	359.222	17693	49.3	8586	9107
-1	8.53E+08	201828.5	Mineral	54	54057	WV	327.733	27078	82.6	13250	13828
-1	8.33E+08	155904.4	Berkeley	54	54003	WV	321.139	75905	236.3	37784	38121
-1	8.06E+08	143224.2	Marion	54	54049	WV	309.691	56598	182.7	26900	29698
-1	6.75E+08	157357.2	Tyler	54	54095	WV	257.555	9592	37.2	4686	4906
-1	1.67E+09	187873.3	Hampshir	54	54027	WV	641.721	20203	31.5	10087	10116
-1	5.49E+08	129207.5	Jefferson	54	54037	WV	209.534	42190	201.3	20873	21317
-1	3.48E+08	108822.7	Pleasants	54	54073	WV	130.731	7514	57.5	3760	3754
-1	1.08E+09	164997.9	Harrison	54	54033	WV	416.042	68652	165	32861	35791
-1	4.55E+08	95671.83	Taylor	54	54091	WV	172.782	16089	93.1	7869	8220
-1	8.29E+08	148711.3	Doddridge	54	54017	WV	320.433	7403	23.1	3736	3667
-1	9.75E+08	150089.8	Wood	54	54107	WV	367.293	87986	239.5	42246	45740
-1	1.17E+09	190866.5	Ritchie	54	54085	WV	453.512	10343	22.8	5070	5273
-1	1.24E+09	205207.6	Grant	54	54023	WV	477.209	11299	23.7	5585	5714
-1	8.87E+08	146810	Barbour	54	54001	WV	340.788	15557	45.6	7646	7911
-1	1.09E+09	162556.8	Tucker	54	54093	WV	418.871	7321	17.5	3570	3751
-1	1.51E+09	207396.4	Hardy	54	54031	WV	583.393	12669	21.7	6255	6414
-1	6.08E+08	133536.1	Wirt	54	54105	WV	232.987	5873	25.2	2939	2934
-1	1.01E+09	168255.4	Lewis	54	54041	WV	382.142	16919	44.3	8206	8713
-1	2.69E+09	324281.7	Randolph	54	54083	WV	1039.725	28262	27.2	14222	14040
-1	9.18E+08	148989.5	Upshur	54	54097	WV	354.758	23404	66	11354	12050
-1	8.79E+08	157414.4	Gilmer	54	54021	WV	340.045	7160	21.1	3600	3560
-1	1.22E+09	178691.6	Jackson	54	54035	WV	465.792	28000	60.1	13623	14377



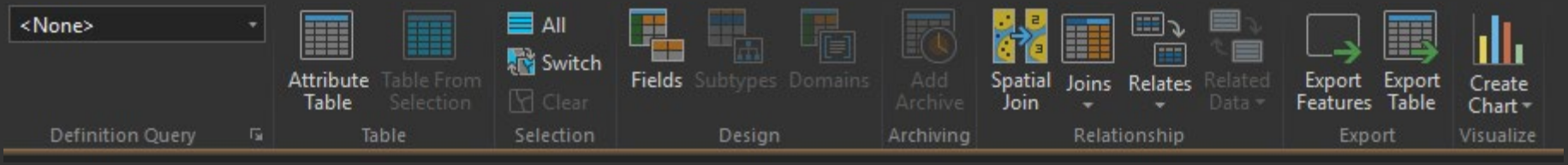


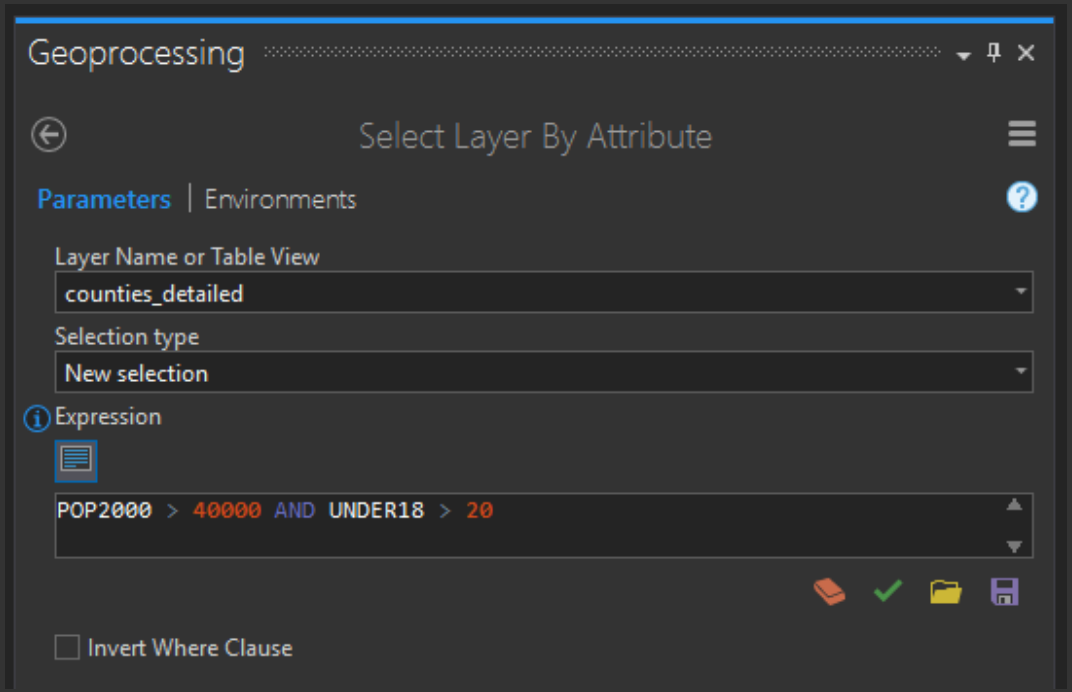
Table or Aspatial Queries

Logical Operators

Equal: =
Not Equal: <>
Greater Than: >
Greater Than or Equal To: >=
Less Than: <
Less Than or Equal To: <=

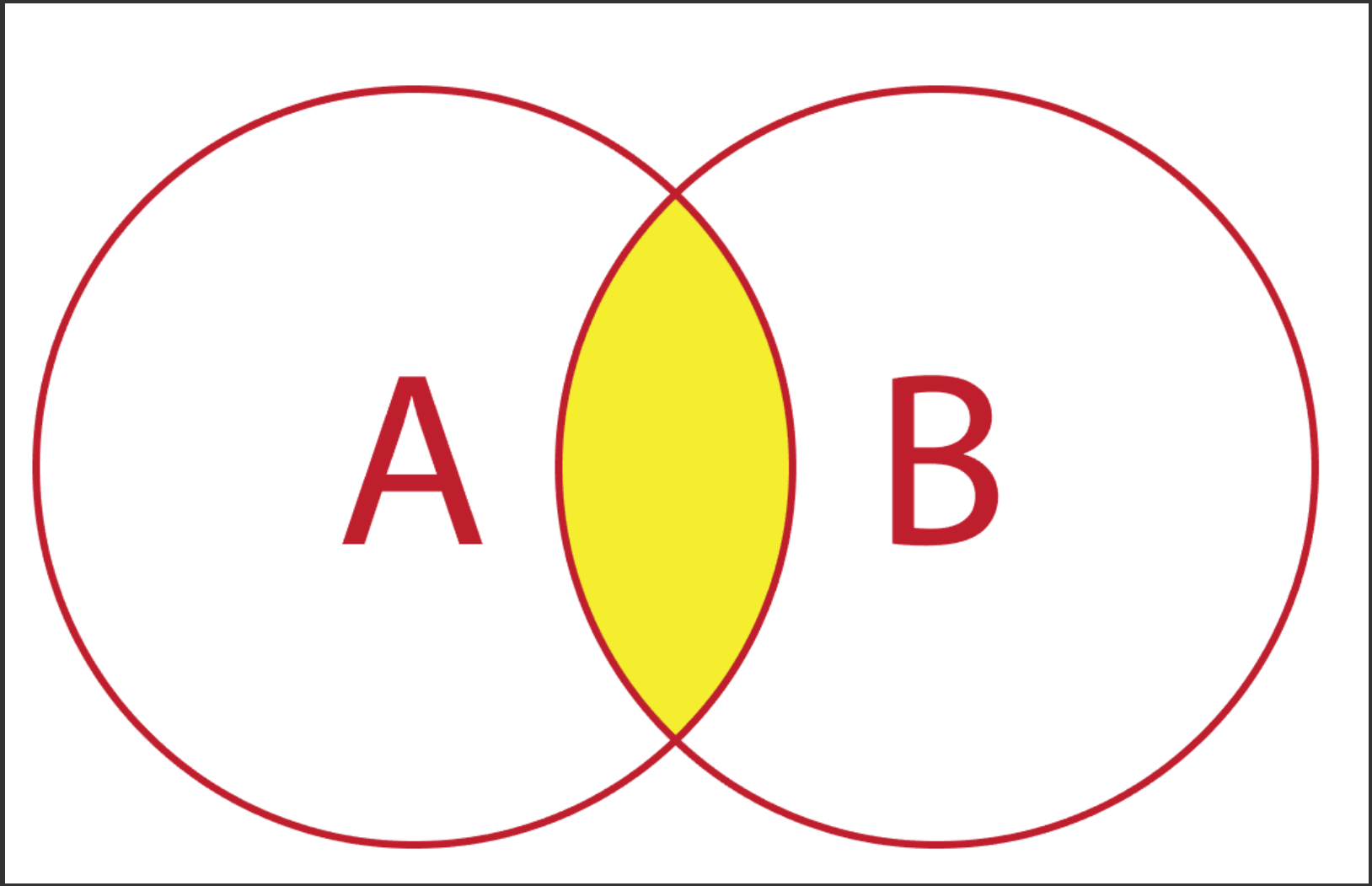
Boolean Connectors

AND (A and B)
OR (A or B, including A and B)
NOT (A but not B)
XOR (A or B, but not A and B)

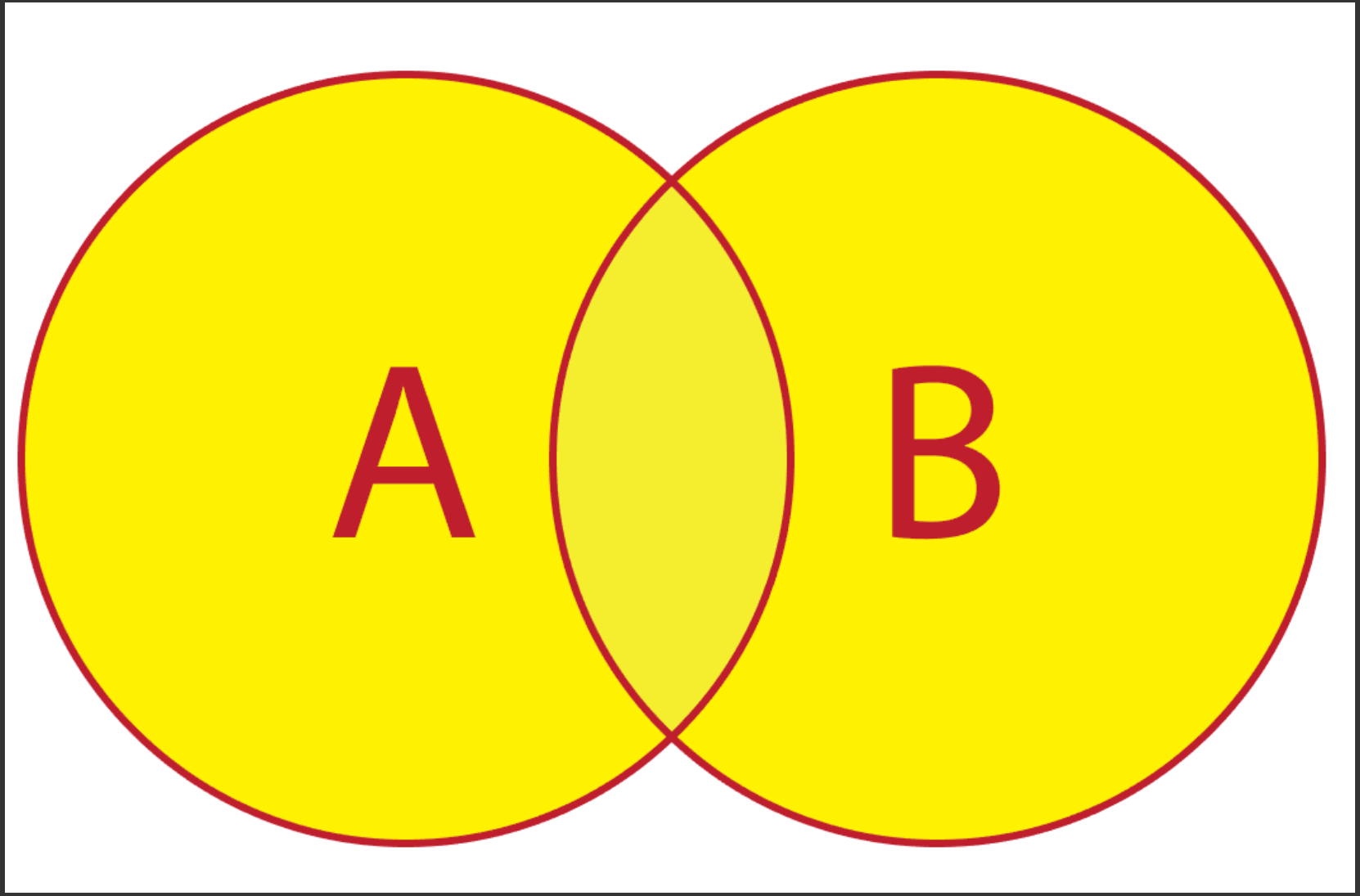


Population >= 20,000 AND Region = Midwest

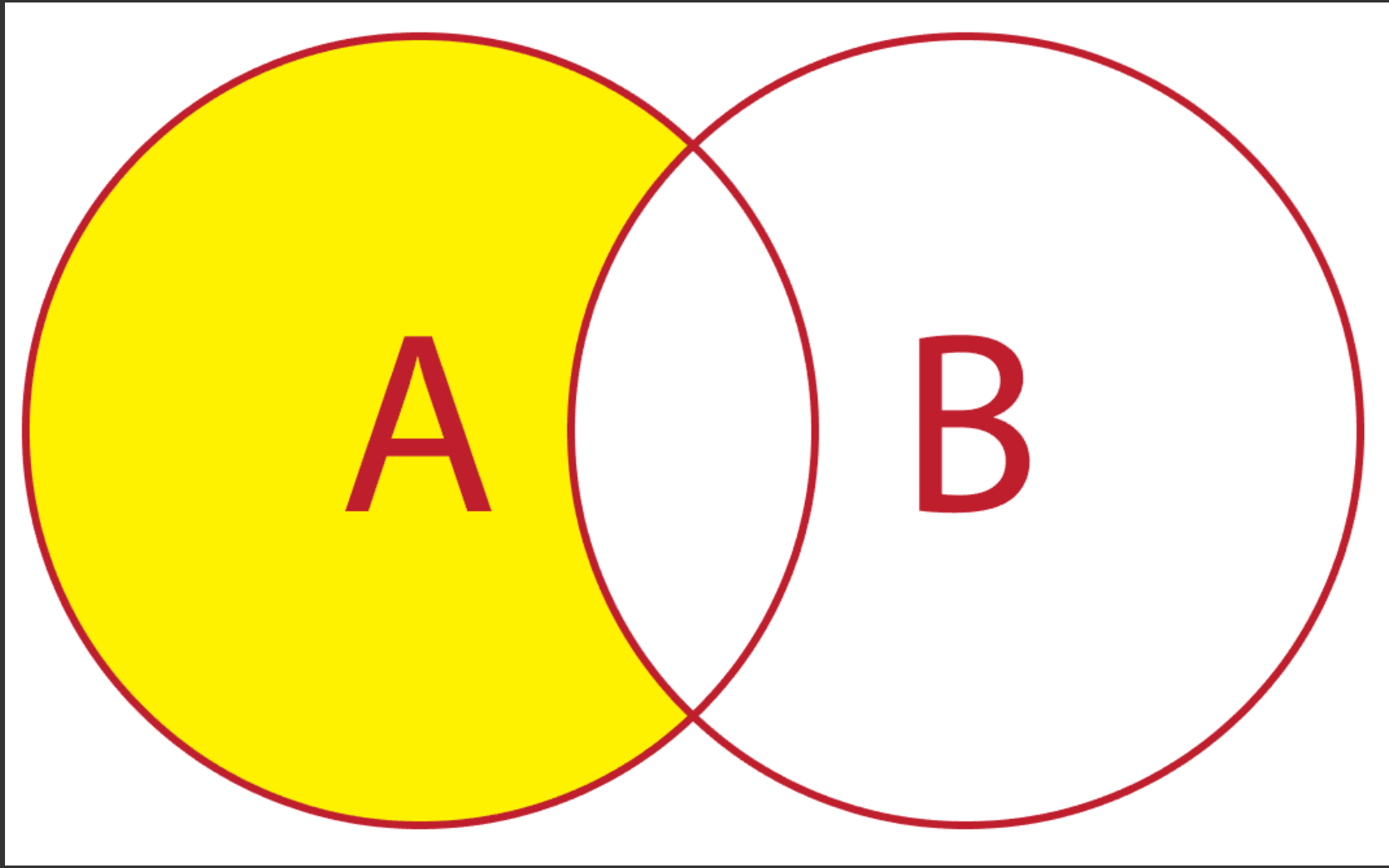
A AND B



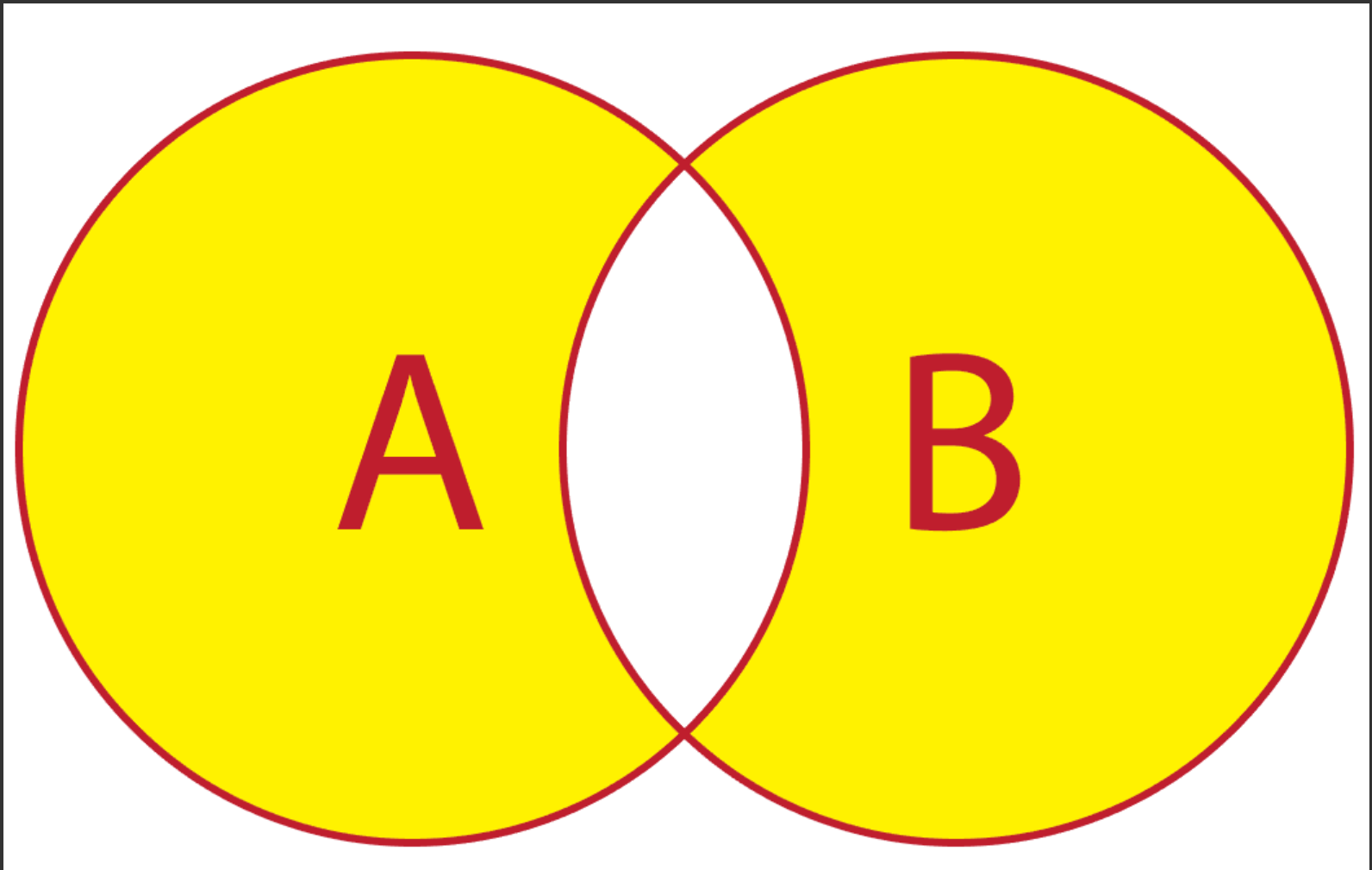
A OR B



A NOT B

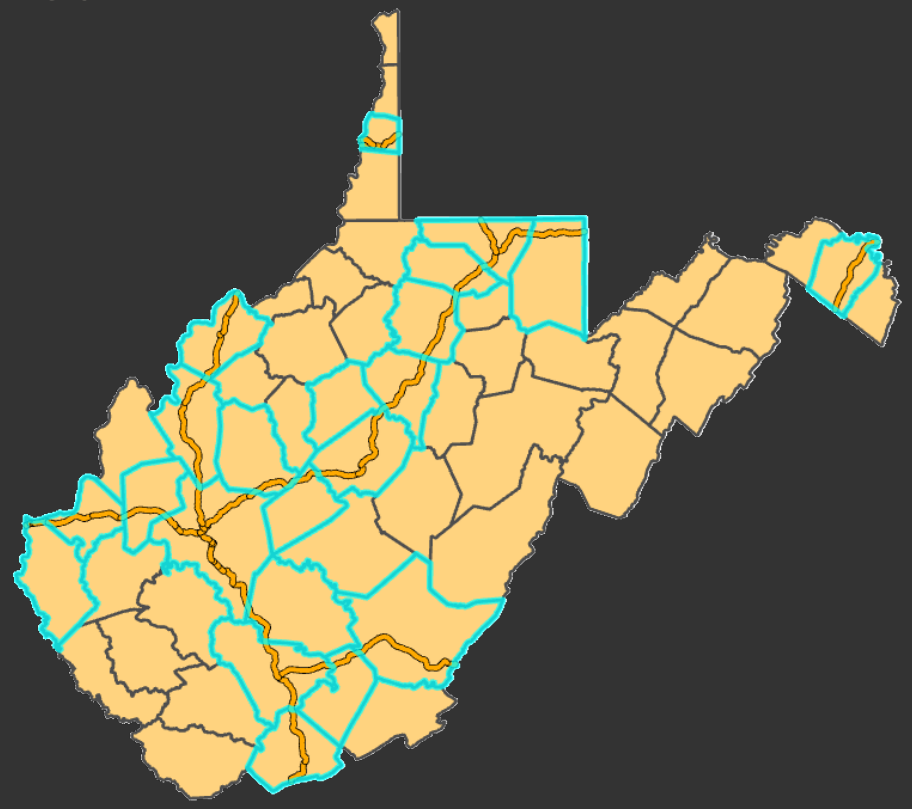


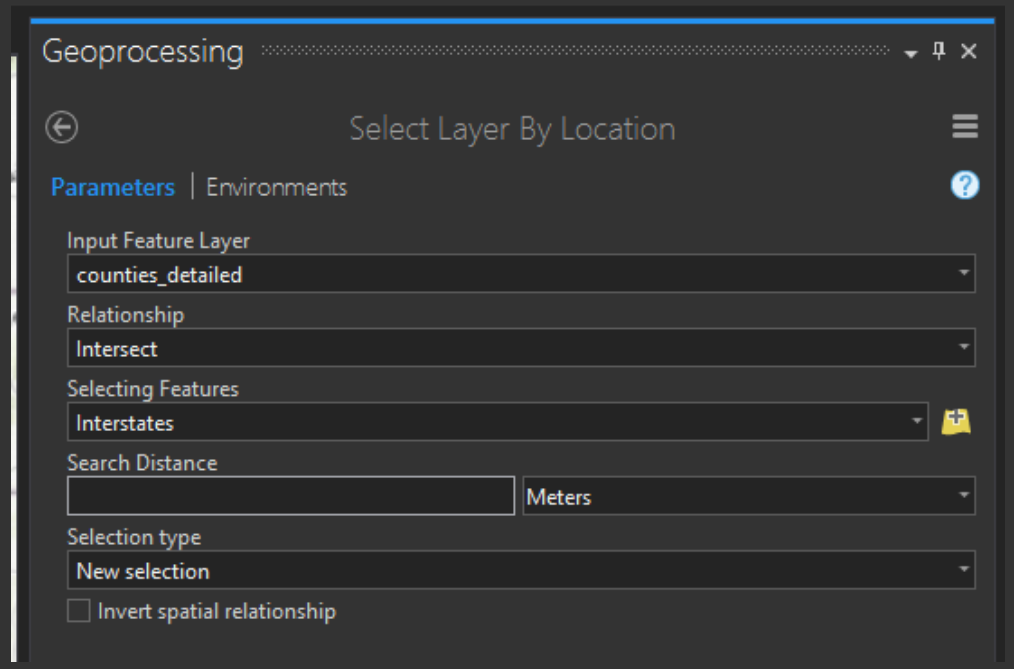
A XOR B



Select by Location

- Select based on spatial relationships to other geographic features





Select by Location

- Intersect = select input features that intersect the selecting features. This is the default.
- Within a Distance = select input features that are within the specified Euclidean distance of the selecting features.
- Contains = select any input feature that contains, even partially, a selecting feature.
- Completely Contains = select any input feature that completely contains a selecting feature.
- Within = select any input feature that is within, even partially, a selecting feature.
- Completely Within = select any input feature that is completely within a selecting feature.

Select by Location

Are identical To = select any input feature that has identical geometry to a selecting feature.

Boundary Touch = select any input feature that has a boundary that touches a selecting feature.

Share a Line Segment With = select any input feature that shares a line segment with a selecting feature.

Crossed by Outline Of = select any input feature that is crossed by the outline of a selecting feature.

Have Their Center In = select any input feature that has its center in the selecting features. The center for lines is defined as the midpoint and the center for polygons is defined as the centroid.

gid integer	postgis_fi bigint	lat_y_dd numeric	long_x_dd numeric	status character varying (254)	nest_id bigint	geom geometry
1	1	2999999999	546999999995	ACTIVE NEST	1	0101000020E6100000DAACFA5C6D335AC02E39EE940E224440
2	35	3000000001	141000000001	INACTIVE LOCATION	35	0101000020E61000001EE1B4E045235AC04E62105839144440
3	36	0999999999	619999999997	ACTIVE NEST	36	0101000020E6100000FC3559A31E3E5AC03BC780ECF5F64340
4	37	8000000001	663000000007	ACTIVE NEST	37	0101000020E61000000A2E56D4603E5AC017BCE82B48474440
5	46	9000000000	635999999996	ACTIVE NEST	46	0101000020E6100000A94D9CDCEF405AC0B3075A8121074440
6	47	4999999999	231000000001	ACTIVE NEST	47	0101000020E6100000E92B4833162B5AC039622D3E052C4440

Geodatabases

Why use a Geodatabase?

1. Organize and manage data
2. Make use of database management systems
3. Make use of structured query language (SQL)
4. On-the-fly topology
5. Topology between features
6. Use domains and subtypes
7. Migrate to an enterprise database

The Relational Model

- Collection of interrelated tables in digital format
- Tables are connected via keys
- Primary Key = one or more attributes whose values can uniquely identify a record in a table
- Foreign Key = one or more attributes that refer to a primary key in another table
- Each table can be prepared, maintained, and edited separately
- Tables can be related

The Geodatabase

Personal and File Geodatabases

- Edited by a single user and do not support versioning
- Usually hosted and used on a local machine

Enterprise Geodatabase

- Edited by multiple users and supports versioning
- Host locally or in an enterprise database system (Oracle, Microsoft SQL Server, IBM DB2, Informix, PostgreSQL)

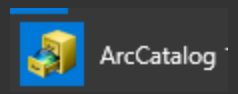
ESRI Geodatabases

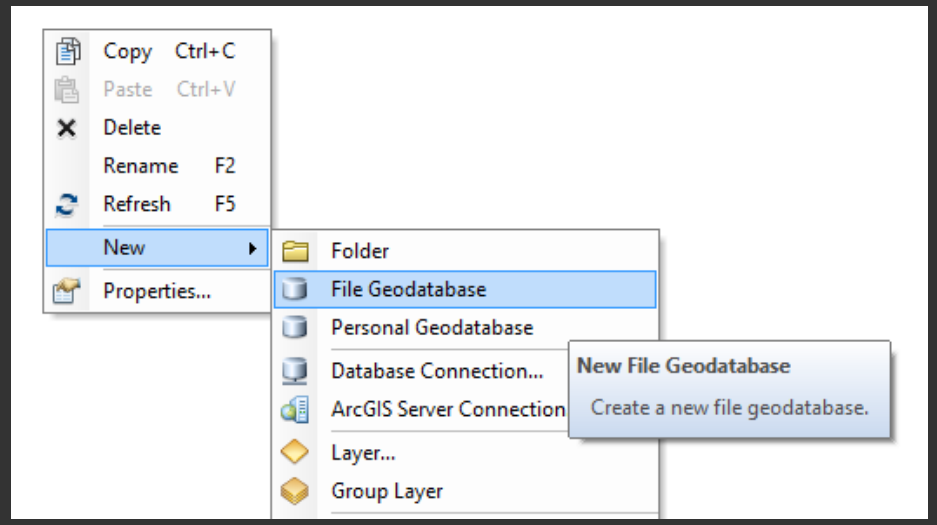
	Personal GDB	File GDB	Enterprise GDB
Storage Format	Microsoft Access	Folder of binary files	Database management system (Oracle, Microsoft SQL Server, IBM DB2, Informix)
Storage Capacity	2 GB	1 TB per table	Depends
Supported OS	Windows	Any platform	Depends
Number of users	Single editor, multiple users	Single editor, multiple users	Multiple editors, multiple readers

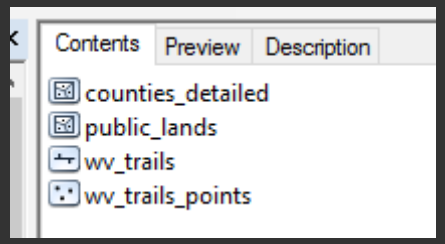
https://pro.arcgis.com/en/pro-app/help/data/geodatabases/overview/types-of-geodatabases.htm

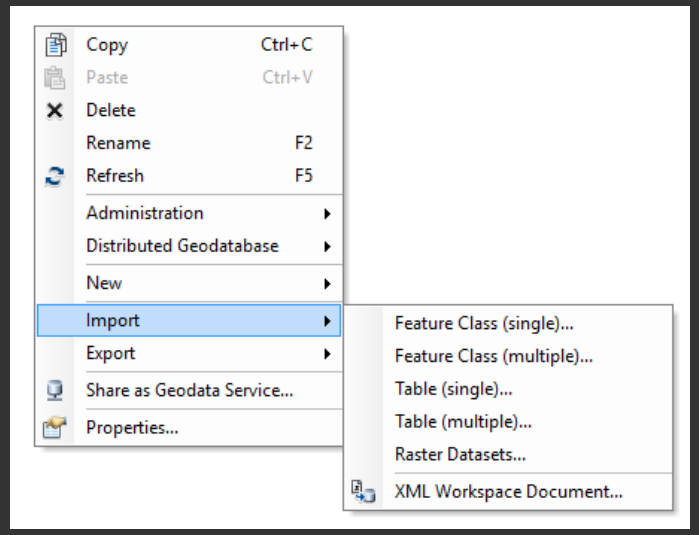
Creating a New Geodatabase

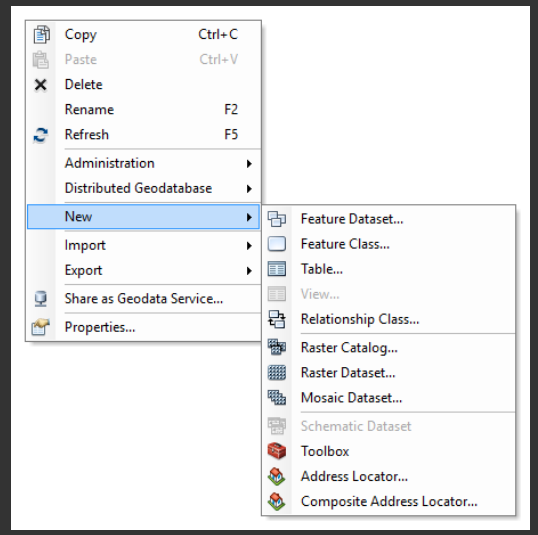
- Use ArcGIS Pro or ArcCatalog
- Can import data into the geodatabase
- Can also create new features

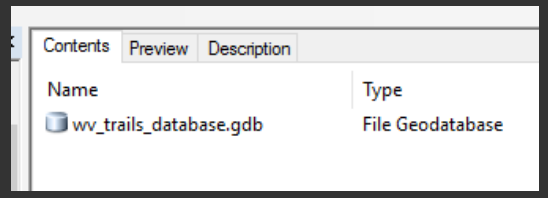










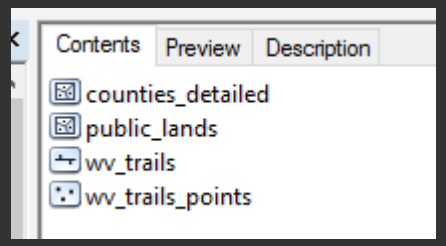


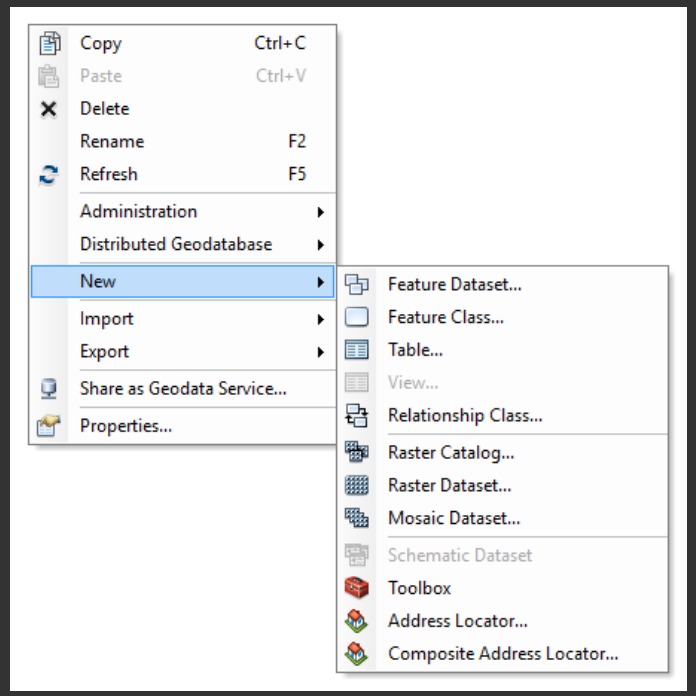
Geodatabase Components

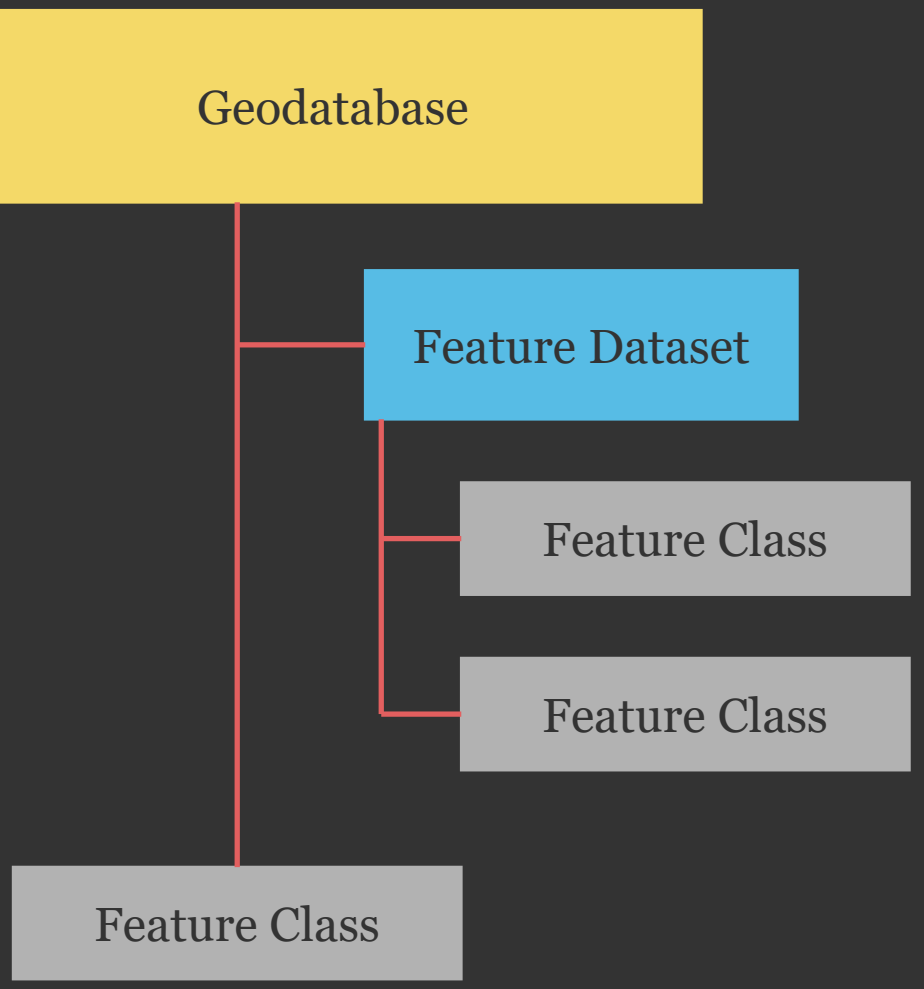
- Feature classes
- Feature datasets
- Mosaic datasets
- Raster catalog
- Raster dataset
- Schematic dataset
- Tables
- Toolboxes
- Attachments
- Feature-lines annotations
- Geometric networks
- Network datasets
- Parcel fabrics
- Relationship classes
- Terrains
- Topologies

Feature Class

- Collection of features that share the same geometry (points, lines, or polygons) and spatial reference

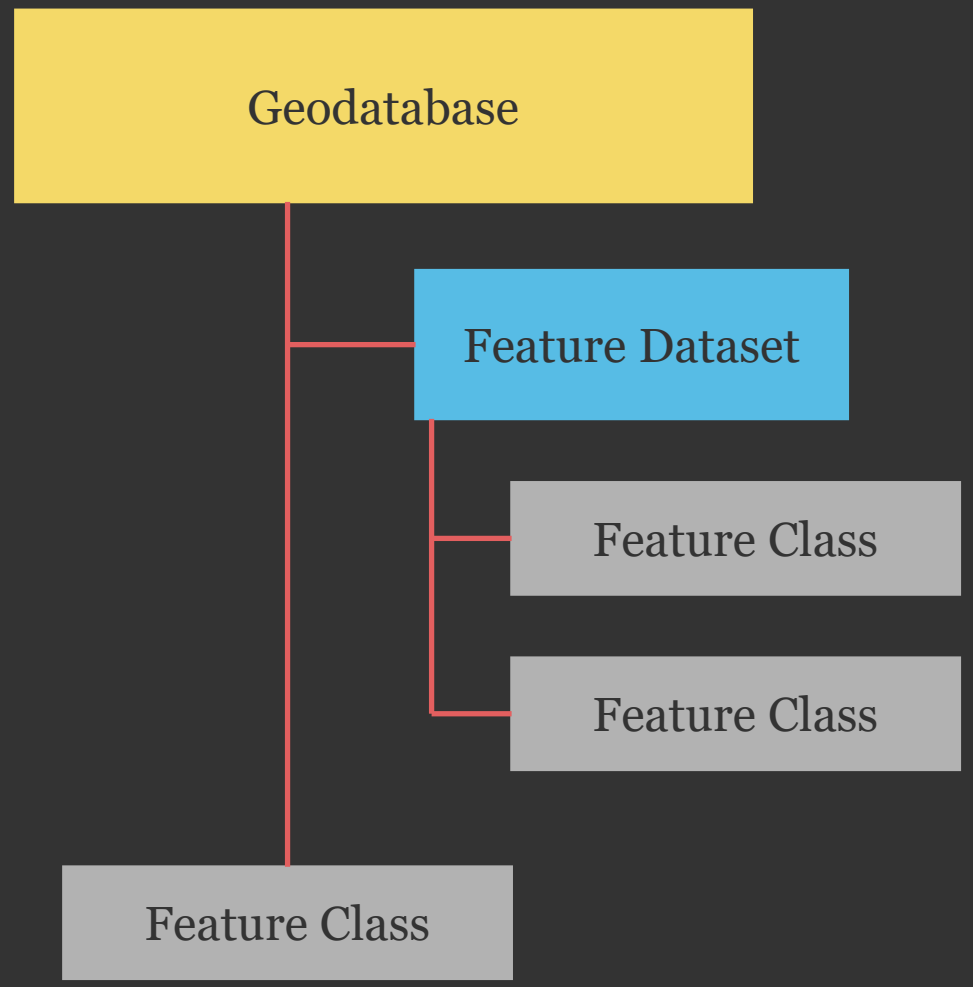






Feature Datasets

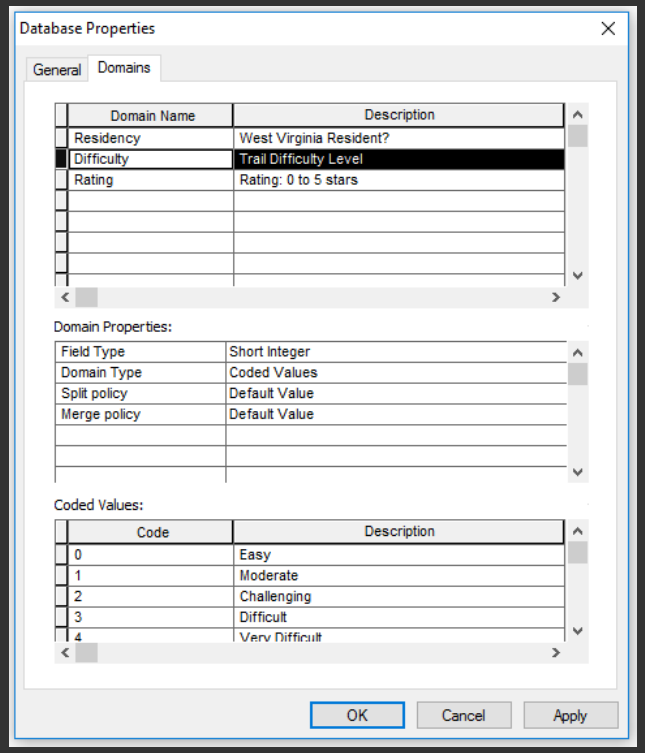
- Collection of feature classes that have the same spatial reference
- Can be used to organize the geodatabase
- Can control data access and editing privileges
- Can organize data for sharing
- May be necessary
  - Build topology between features
  - Create a network dataset
  - Create a terrain dataset
- Must define spatial reference upfront

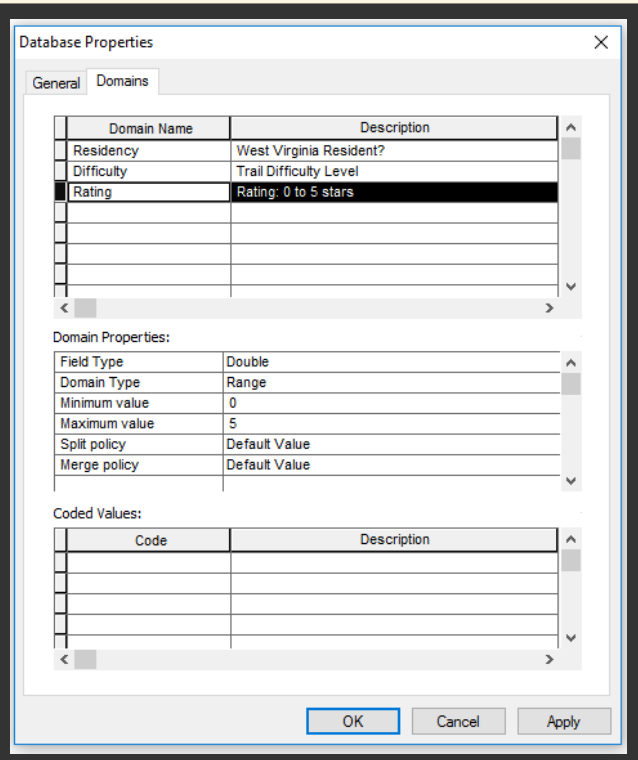


Domains

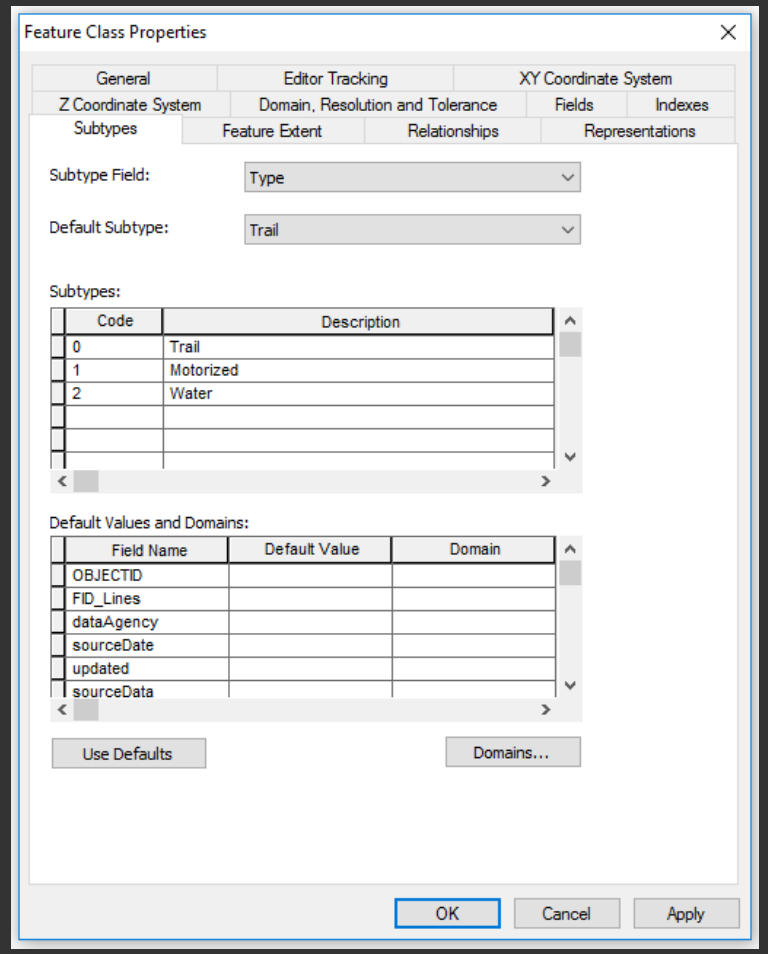
- A property of a geodatabase shared by the individual datasets
- Created at the geodatabase level
- Can be used to specify allowed values or entries to a field
- Coded Values = discrete values that represent allowed entries
- Ranged Values = stipulates that values can only be entered within a given range

Code	Description
1	Poor
2	Fair
3	Average
4	Good
5	Excellent





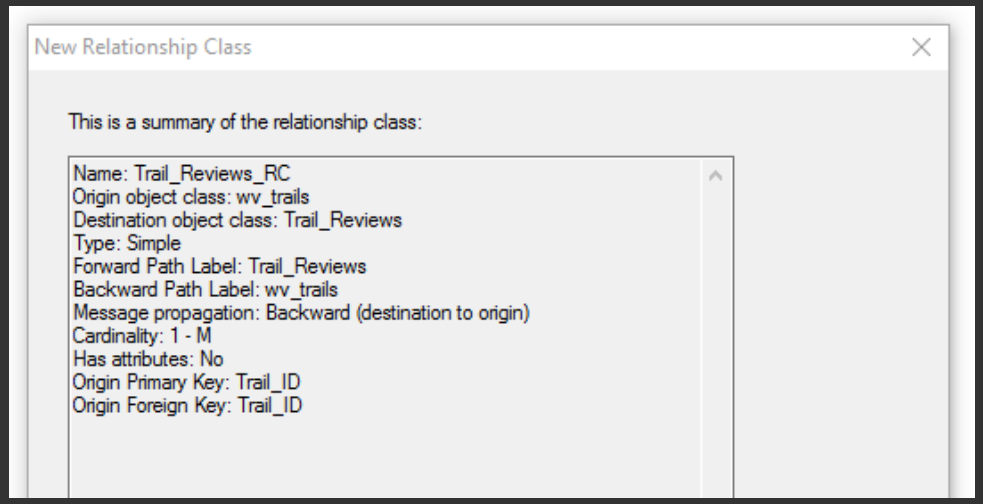
Subtypes

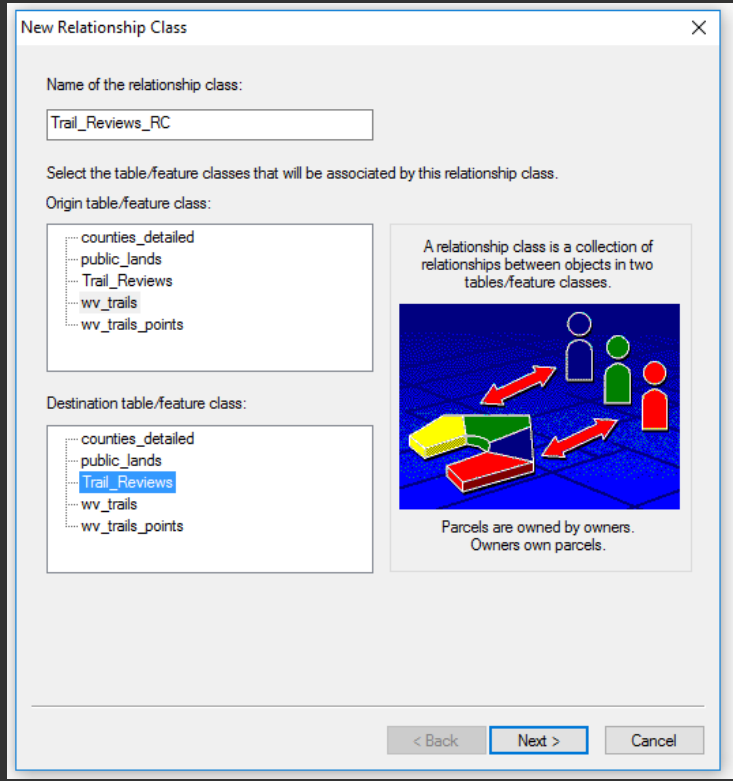


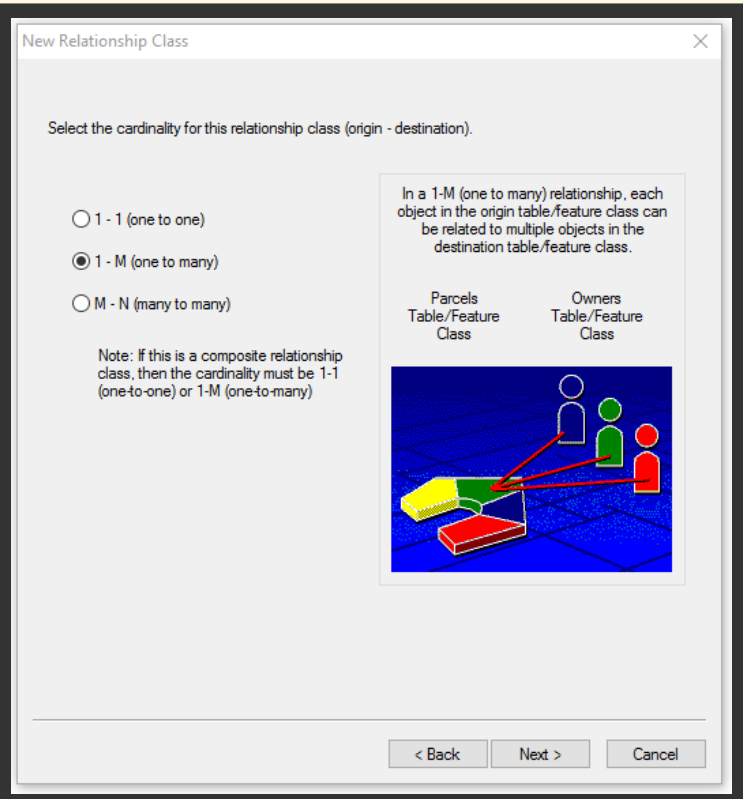
- Subsets of features in a feature class or table that share the same attribute
- Used to categorize data
- Use coded values

Relationship Class

- Establishes a relationship between features in a geodatabase
- Define relationship using primary and foreign keys



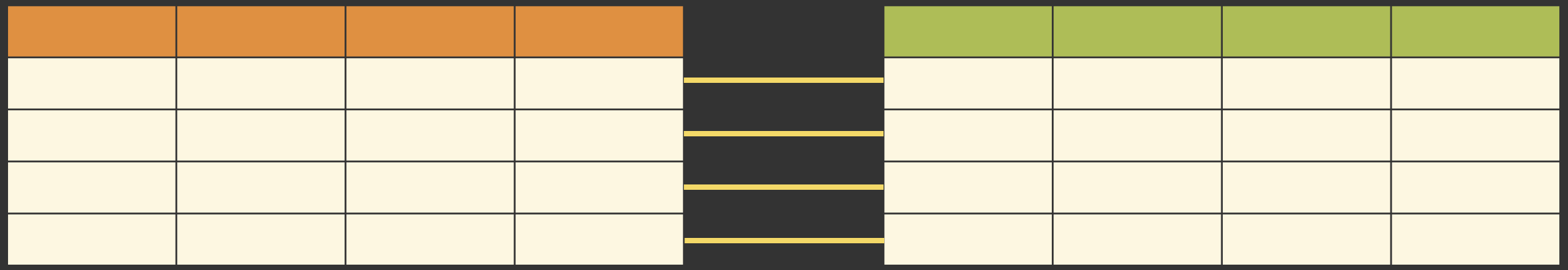




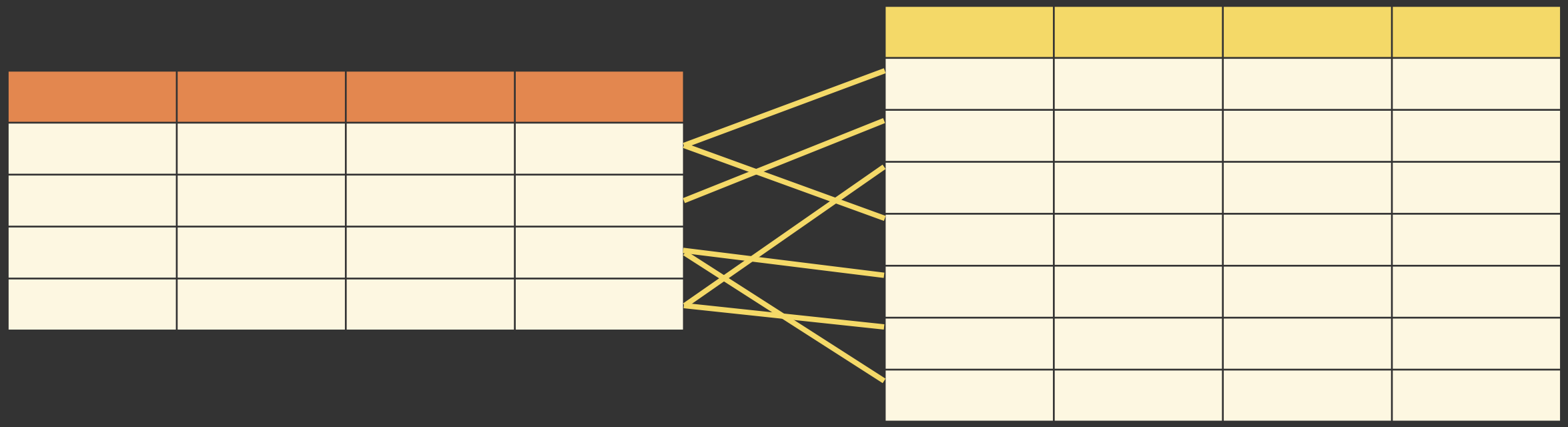
Types of Relationships

- One-to-One = one record in Table 1 is related to 1 record in Table 2
- One-to-Many = one record in Table 1 is related to many records in Table 2
- Many-to-One = multiple record in Table 1 is related to the same record in Table 2
- Many-to-Many = multiple records in Table 1 is related to multiple records in Table 2

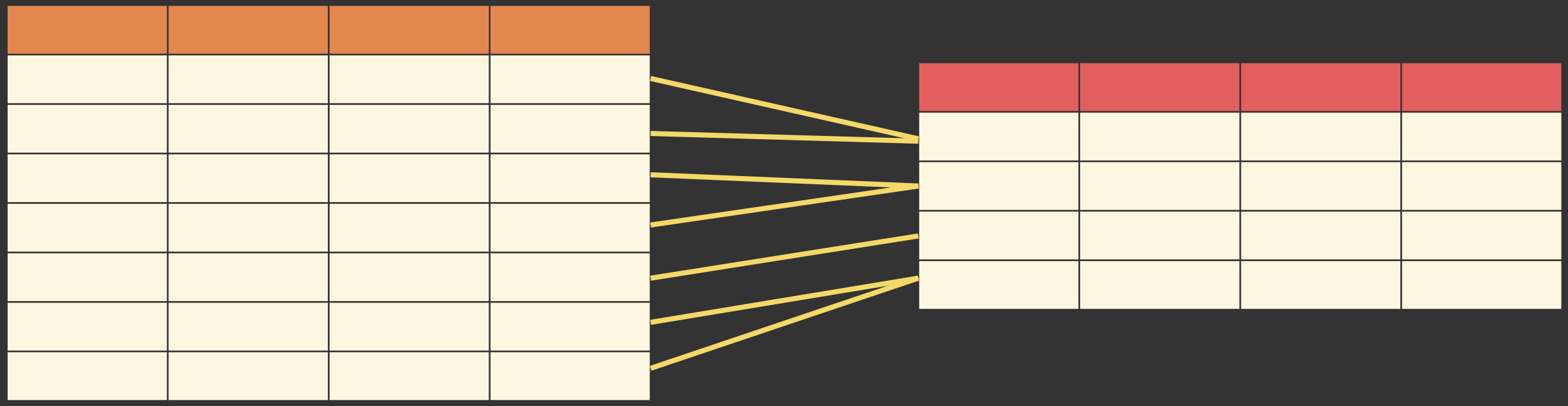
One-to-One



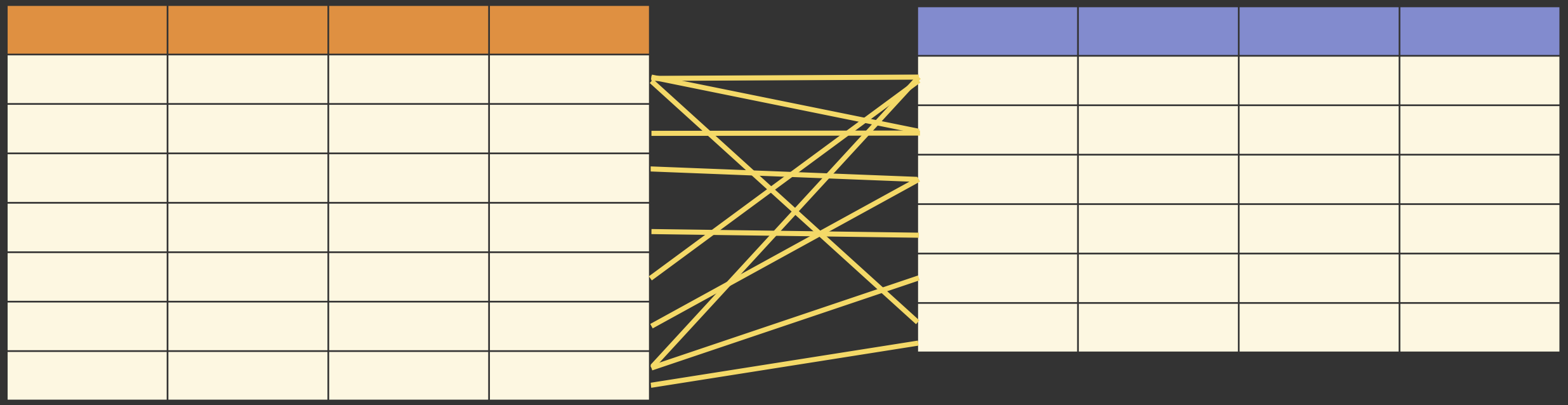
One-to-Many



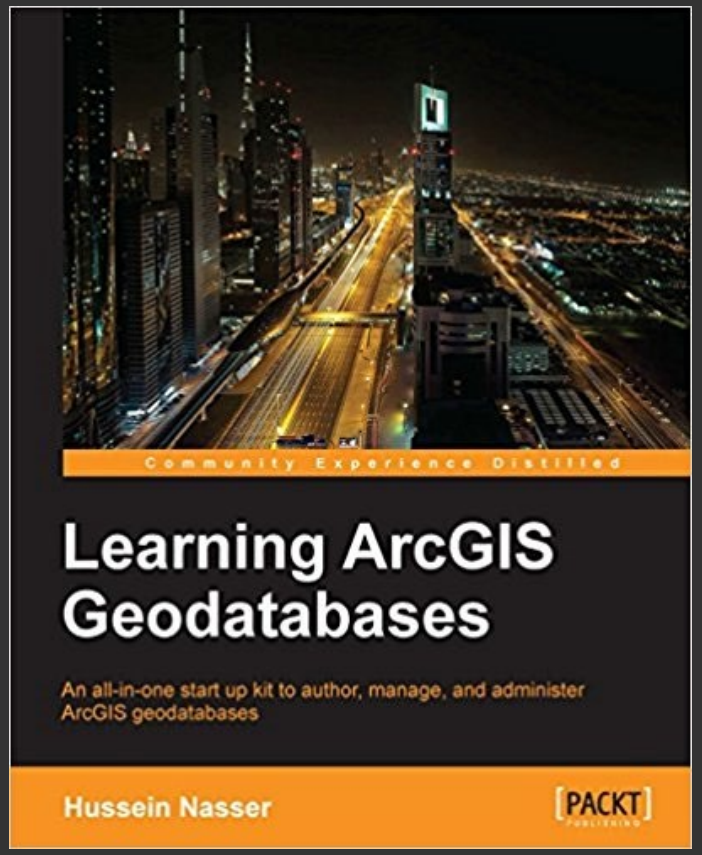
Many-to-One



Many-to-Many

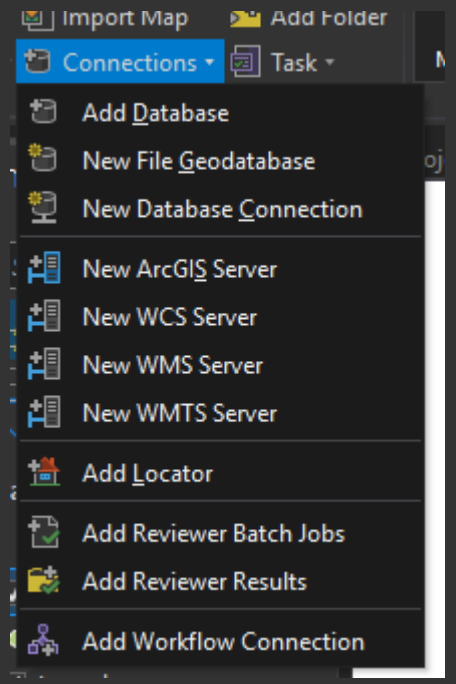


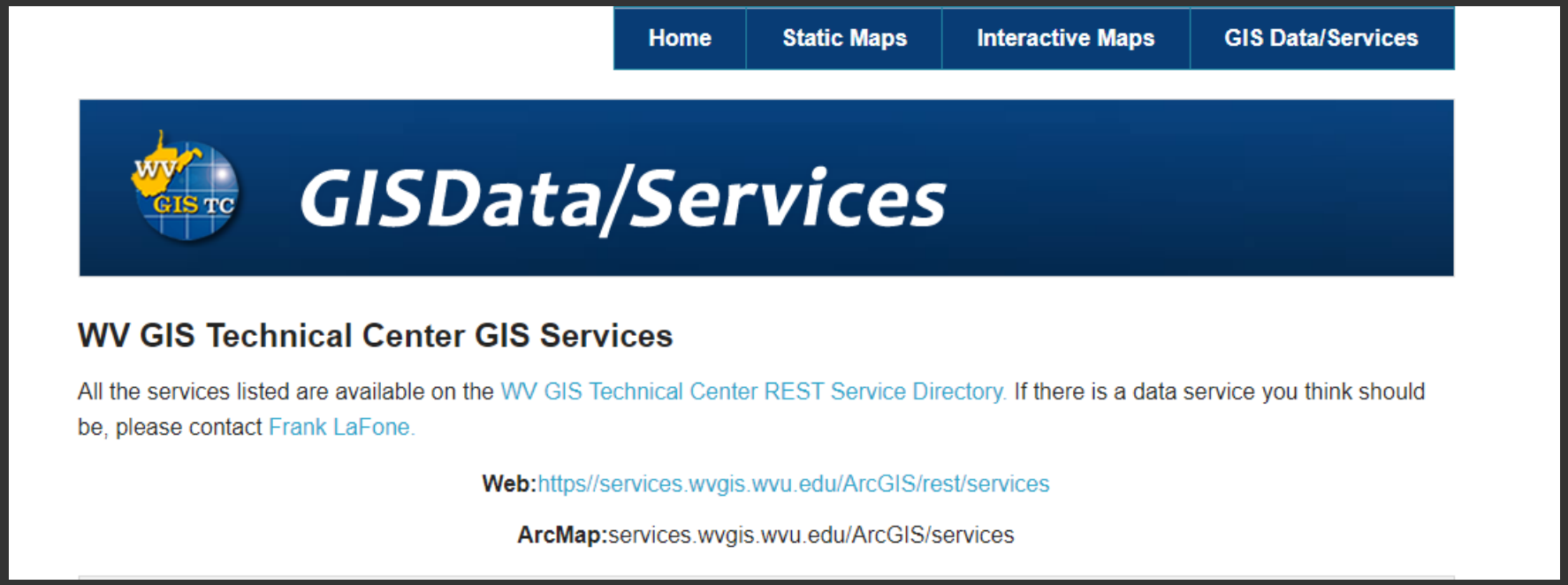
Book Recommendation



https://www.packtpub.com/application-development/learning-arcgis-geodatabases

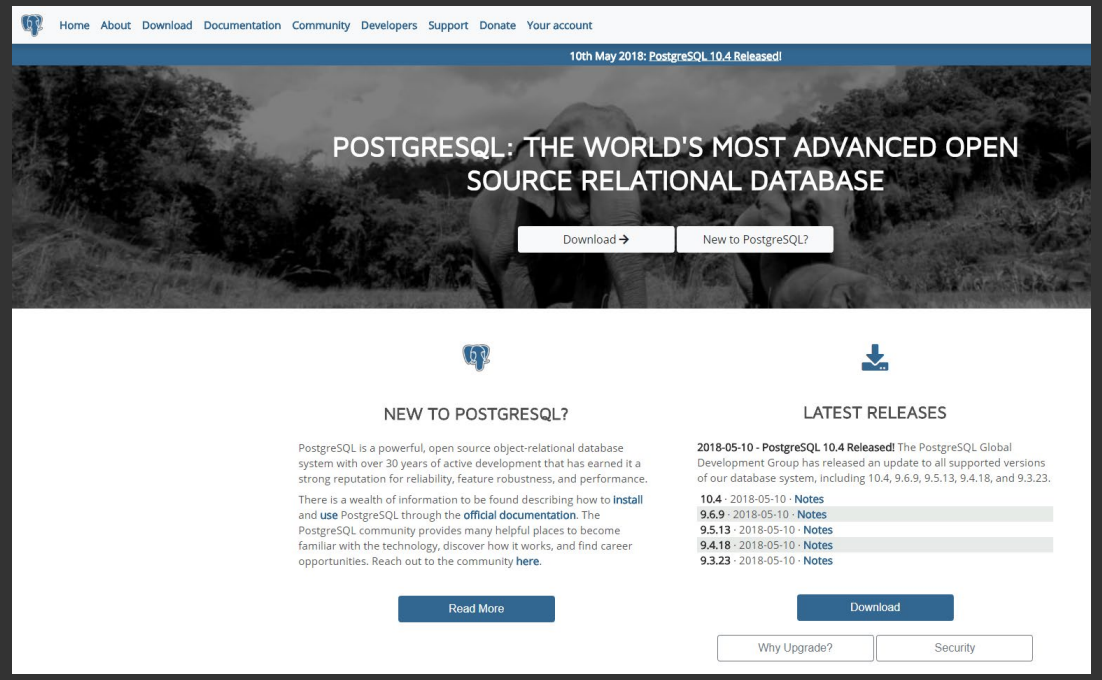
Connecting to Servers in ArcGIS Pro





https://www.mapwv.gov/gis_services.html

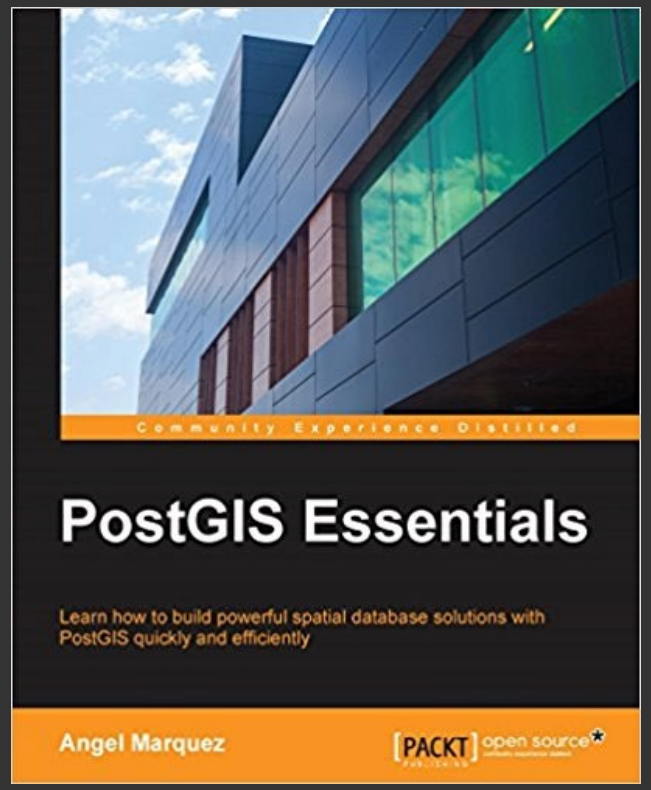
PostgreSQL and PostGIS

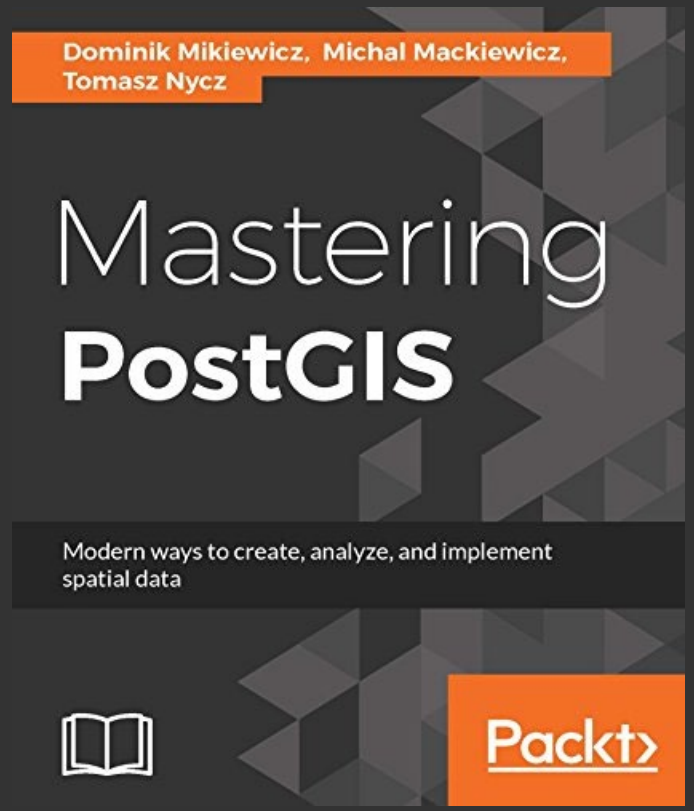


https://www.postgresql.org/

https://postgis.net/

PostgreSQL and PostGIS

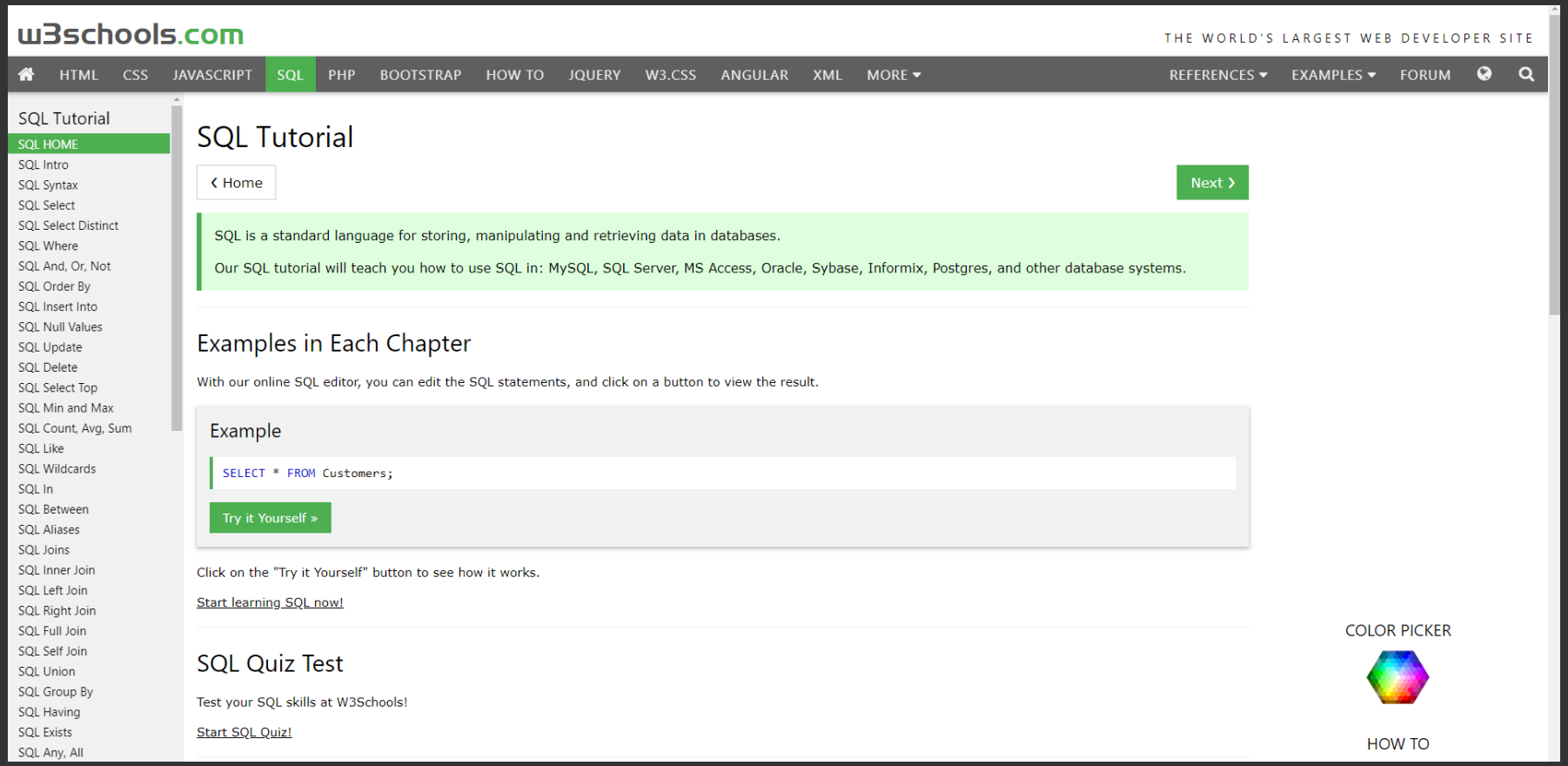




https://www.packtpub.com/big-data-and-business-intelligence/postgis-essentials

https://www.packtpub.com/big-data-and-business-intelligence/mastering-postgis

Learn SQL



https://www.w3schools.com/sql/default.asp

This is the end of this lecture module.

Please return to the West Virginia View Webpage for additional content.