



GEOG653 – Spatial Analysis

Lecture 3

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Outline

- Announcements and Updates
- Vector Analysis
 - Spatial Query
 - Spatial Join
 - Overlay Operations
 - Buffering
- Demos



Outline

- Announcements and Updates
 - Lab1
 - Due 9/16/2020
 - Exercises
 - ArcGIS Pro License



Overview

- The fundamental questions that spatial analysis tries to address:
 - Adjacency/Distance
 - What is near what?
 - Tobler's 1st law of geography: "Everything is related to everything else, but near things are more related than distant things."
 - Containment
 - What is in what?
- It is all about spatial relationships.



Overview

- Vector analysis is one of the most basic analytical functions.
- Methods:
 - Spatial Query
 - Spatial Join
 - Overlay Operations
 - Buffering



Overview

- Spatial Query and Spatial Join are vector analysis methods.
 - They can help locate features in one layer based on the location of other features in the same layer or in another layer.
 - This type of relationship is based on the spatial properties of the layers, including the spatial extent and location of features within layers, as well as the feature type of the layers.



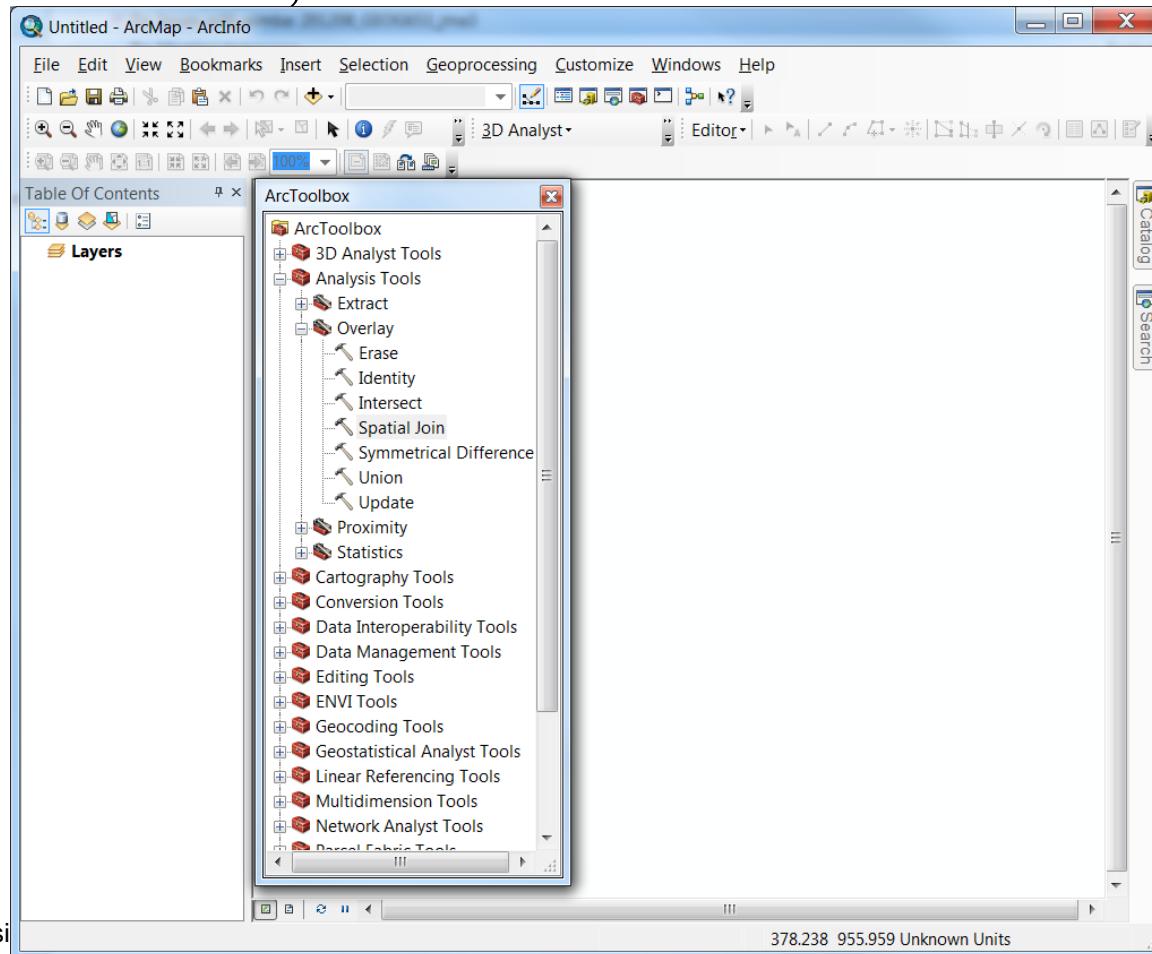
Overview

- Spatial Query is one of vector analysis methods.
 - Examples:
 - Which cities lie within Hillsborough county?
 - How many counties is passed through by Hillsborough River? And what counties are they?
 - What are those counties that share borders with Hillsborough County? Show me a map of them.
 - Where are the WalMart stores within 1 mile of Fletcher Ave.?



Overview

- Spatial Join is also part of vector analysis.
 - Based on spatial information such as distance, intersection, or containment.





Overview

- Overlay Operations
 - Core functions of ArcGIS Toolbox.
 - That's what GIS software was designed to do initially.
 - Provide much more powerful analytical capabilities than Spatial Query and Spatial Join.
 - Example: Where are the best habitat areas in Tampa Bay Watershed for the endangered Nine-Banded Armadillo, that are on the public lands and 100-meter away from major roads? And what is their percentage of area with respect to the entire watershed.



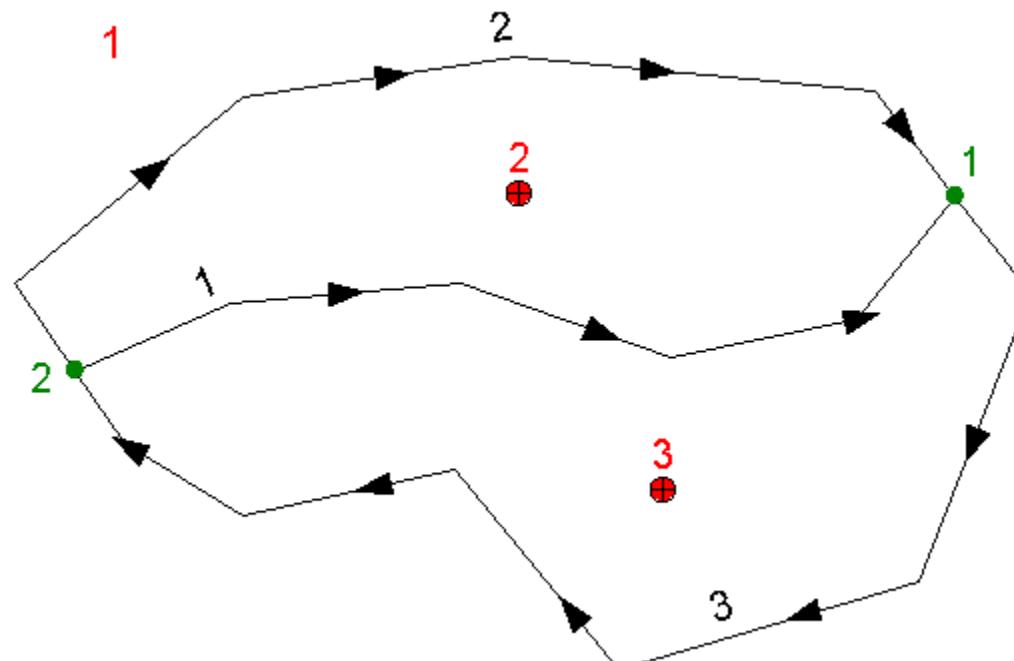
Overview

- Overlay Operations vs. Spatial Query
 - Spatial Query will create a new selected set within one of the two layers that have features overlapped. During this process, no new datasets are created and the attribute tables are not updated, either.
 - During the Overlay Operations process, new data layers will be created. The geometry and/or attribute tables are modified.



Overview

- “Overlay Operations” is sometime called “Topological Operations”
 - Because the overlay operations will rebuild/modify the topological relationships that make layers function.





Vector Analysis

- Spatial Query
 - The process of retrieving data from a map by working with map features, instead of tables.
 - One of the most basic analytical tasks in GIS:
 - locating features in one layer based on the location of other features in the same layer or in another layer.



Vector Analysis

- Spatial Query
 - What is Spatial Query?
 - A spatial query is a query expression used to select features based on their spatial relationships to other features.
 - Usually features from one layer are selected using features from another.
 - A spatial query requires that you construct a statement about how the selection will occur.
 - The result of a spatial query is a selection of features within a layer.



Vector Analysis

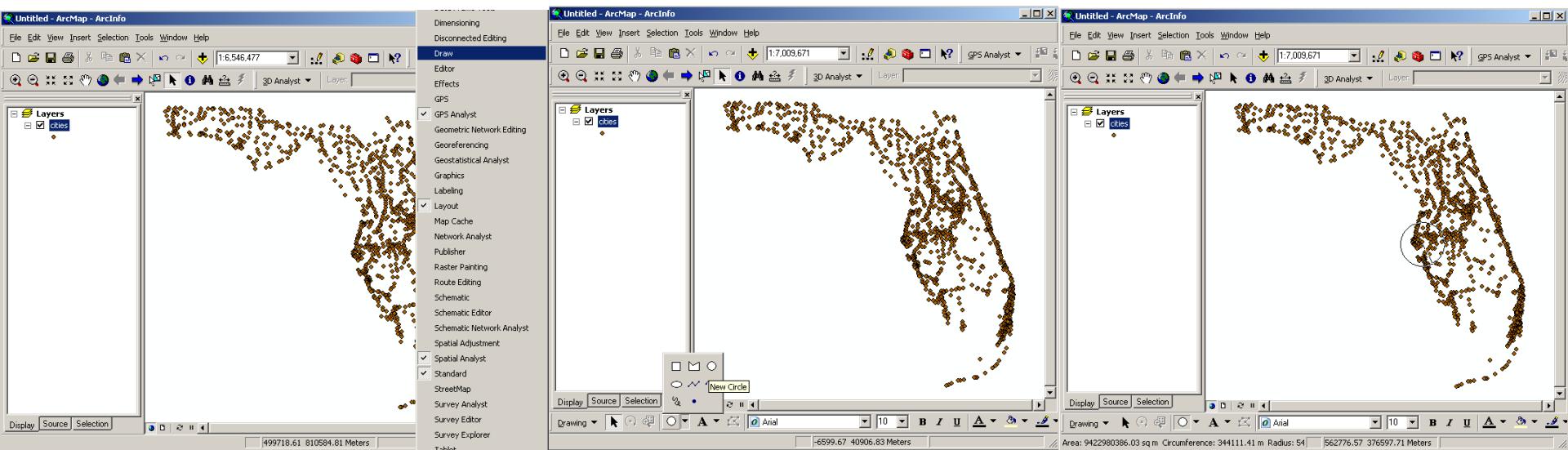
- Spatial Query
 - Selecting Features by Graphics
 - You can create, move and delete graphics.
 - Graphics can be points, lines, or circles.
 - You can also change the size, color, shape, and position of the graphics.
 - Select graphics with the Select Elements tool - 



Vector Analysis

- Spatial Query
 - Selecting Features by Graphics
 - To be able to select features by graphics, firstly you need to create graphics.
 - Turn on Draw tool bar
 - Draw a graphics

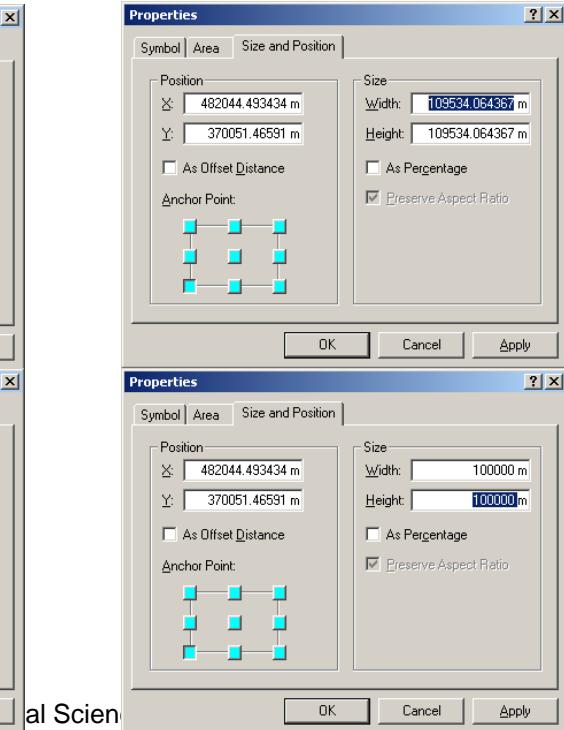
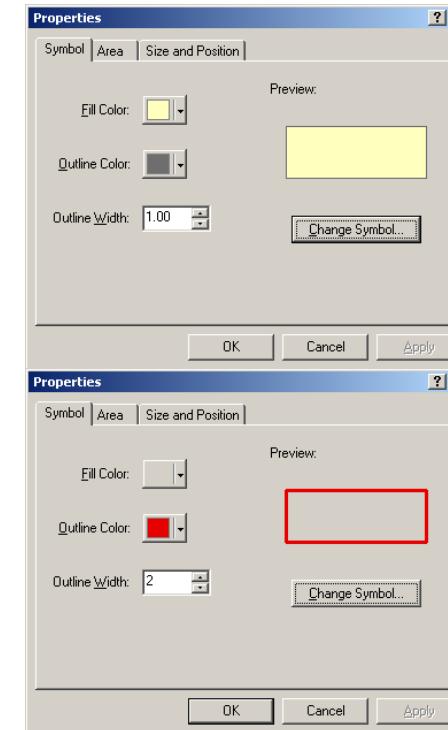
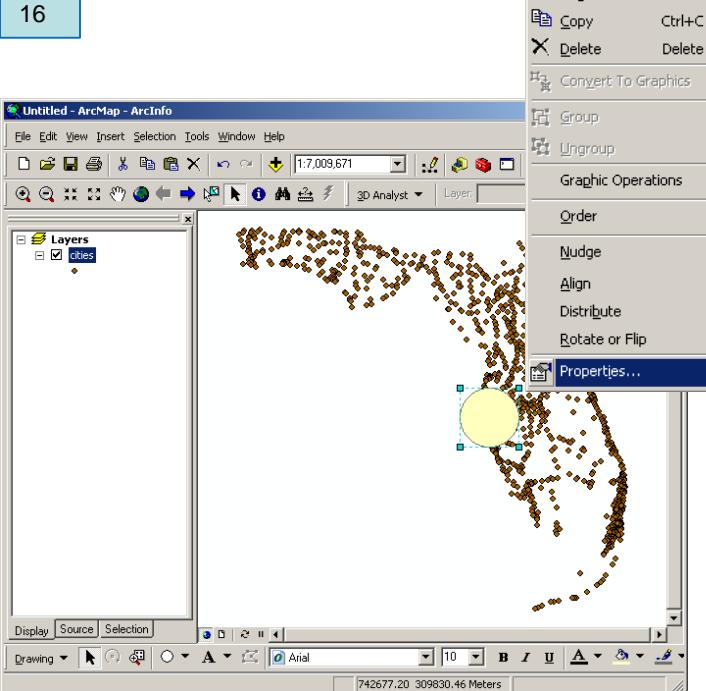
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Vector Analysis

- Spatial Query
 - Selecting Features by Graphics
 - To be able to select features by graphics, firstly you need to create graphics.
 - After a graphics is created, you can customize it.



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Vector Analysis

- Spatial Query
 - Selecting Features by Graphics
 - The **Select by Graphics** allows you to select features that intersect a graphic element from selectable layers.
 - This can be used with most graphics element except those containing text or curves.

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The screenshot shows two ArcMap windows and a table window. The left window displays a map of a coastal area with numerous brown point features. A red circle is drawn around a specific point feature. The right window shows the same map with a cyan circle drawn around the same point feature. The table window, titled 'Attributes of cities', lists 87 selected records out of 1113. The columns are FID, Shape*, FEATURE, and NAME. Some entries include MEDULLA, TEMPLE TERRACE, CARROLLWOOD VILLAGE, LAKELAND HIGHLANDS, CARRIOLWOOD, WEST LAKE WALES, DOVER, VERO BEACH, CRYSTAL BEACH, and PAMMWOOD.

FID	Shape*	FEATURE	NAME
656	Point	POPULATED PLACE	LAKE WALES
657	Point	POPULATED PLACE	MEDULLA
658	Point	POPULATED PLACE	TEMPLE TERRACE
659	Point	POPULATED PLACE	CARROLLWOOD VILLAGE
660	Point	POPULATED PLACE	LAKELAND HIGHLANDS
661	Point	POPULATED PLACE	CARRIOLWOOD
662	Point	POPULATED PLACE	WEST LAKE WALES
663	Point	POPULATED PLACE	DOVER
664	Point	COUNTY SEAT	VERO BEACH
665	Point	POPULATED PLACE	CRYSTAL BEACH
...



Vector Analysis

- Spatial Query
 - Selecting Feature by Spatial Relationship
 - Used to select features in one or more data layers on the spatial relationship to another layer. For example:
 - Which cities lie within Hillsborough county?
 - How many counties is passed through by Hillsborough River? And what counties are they?
 - What are those counties that share borders with Hillsborough County? Show me a map of them.
 - Where are the WalMart stores within 1 mile of Fletcher Ave.?



Vector Analysis

- Spatial Query
 - Selecting Feature by Spatial Relationship
 - The layers used in Select by Location are called **Target Layer(s)** and **Source Layer**.
 - The target layer(s) contain the features that we are interested in and will be selected.
 - The source layer contains features that are known and will be used to select features from the target layer.



Vector Analysis

- Spatial Query
 - Selecting Feature by Spatial Relationship

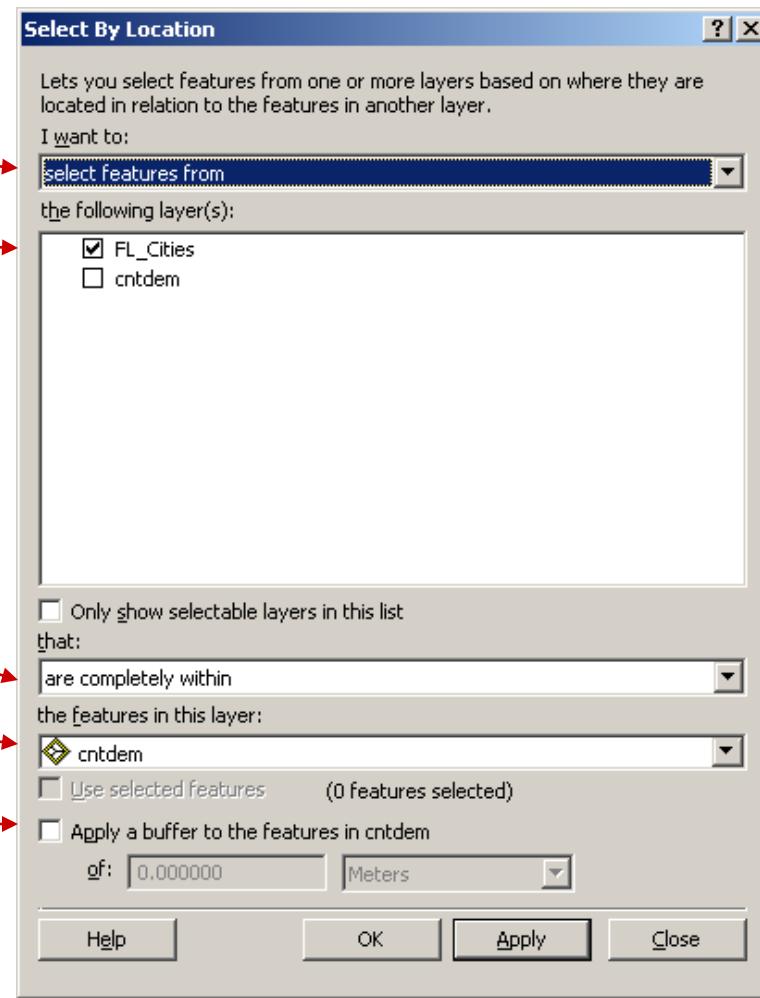
Selection Method

Target Layer

Spatial Relationship

Source Layer

Distance Buffer





Vector Analysis

- Spatial Query
 - Selecting Feature by Spatial Relationship
 - Four types of spatial relationship
 - Distance
 - » Example: select points within a distance of a feature
 - Containment
 - » Example: select points contained by a polygon
 - Intersection
 - » Example: select lines that intersect a feature
 - Adjacency
 - » Example: select polygons adjacent to a feature



Vector Analysis

- Spatial Query
 - Selecting Feature by Spatial Relationship
 - ArcGIS defines eleven specific spatial relationships
 - Containment
 - » “are completely within”
 - » “completely contain”
 - » “have their center in”
 - » “contain”
 - » “are contained by”



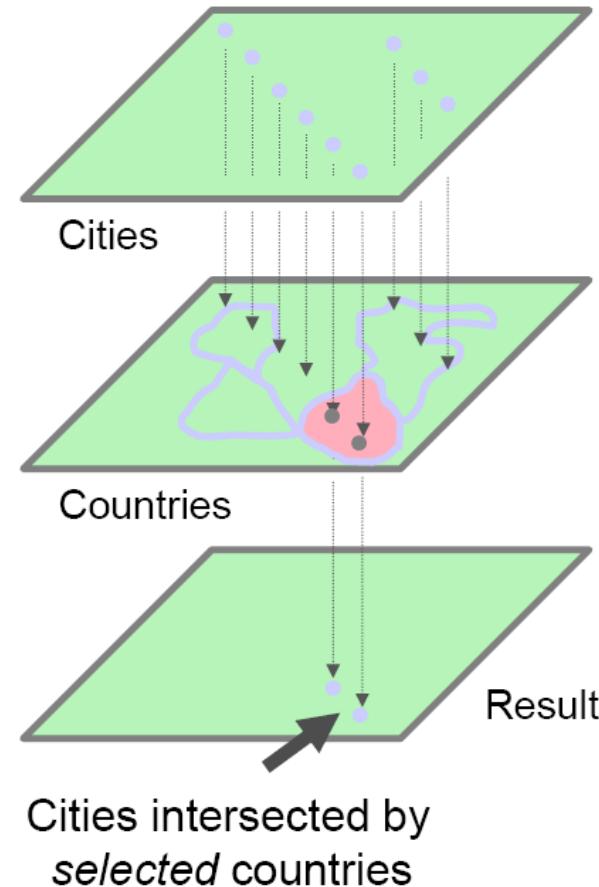
Vector Analysis

- Spatial Query
 - Selecting Feature by Spatial Relationship
 - ArcGIS defines eleven specific spatial relationships
 - Intersection
 - » “intersect”
 - » “are crossed by the outline of”
 - Distance/Adjacency
 - » “are within a distance of”
 - » “share a line segment with”
 - » “touch the boundary of”
 - » “are identical to”



Vector Analysis

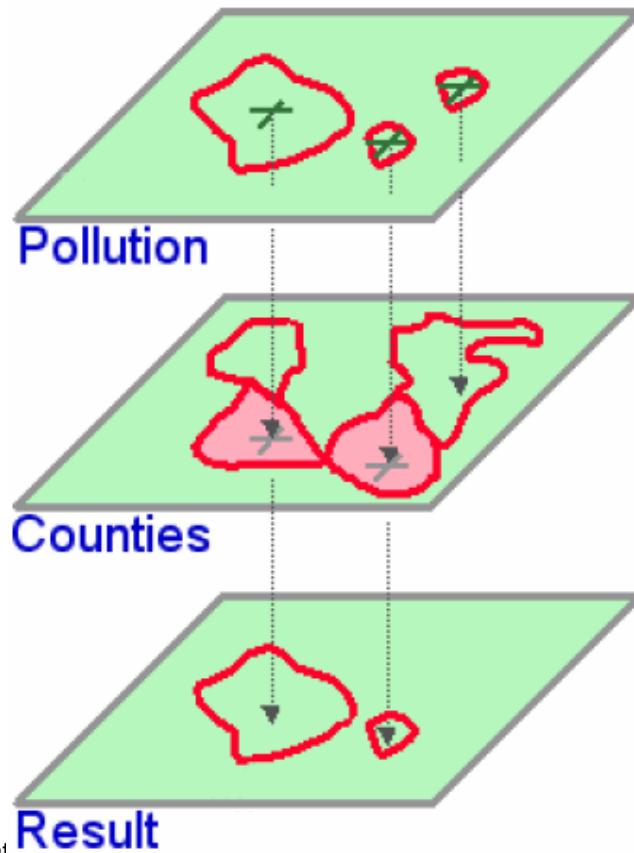
- Spatial Query
 - Selecting Feature by Spatial Relationship
 - Example: intersection





Vector Analysis

- Spatial Query
 - Selecting Feature by Spatial Relationship
 - Example: containment

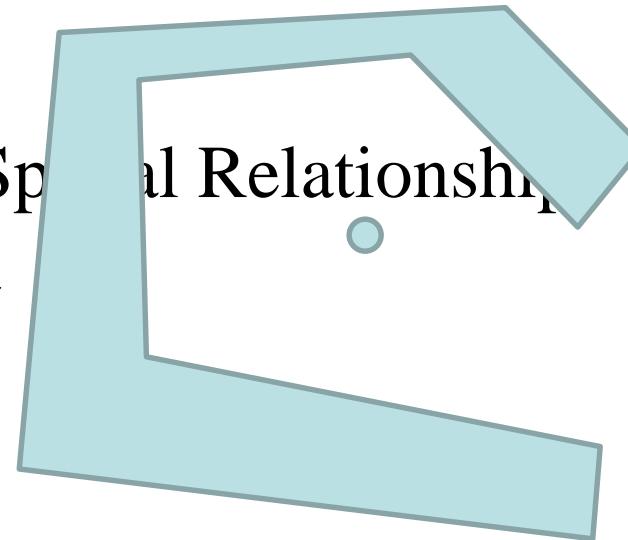
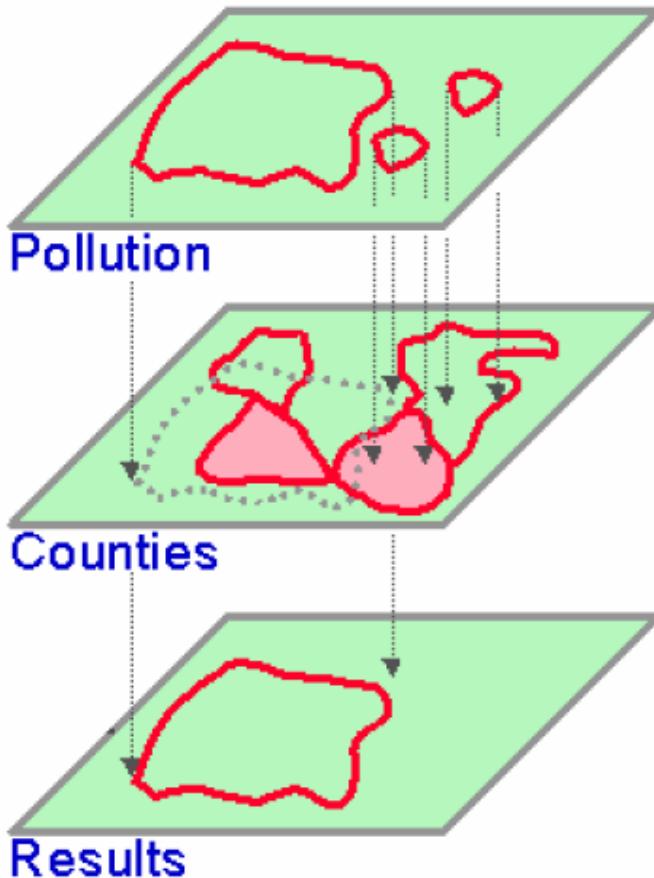


In this example, features in the Pollution dataset are selected if their centers fall inside the selected features in the Counties dataset.



Vector Analysis

- Spatial Query
 - Selecting Feature by Spatial Relationship
 - Example: containment



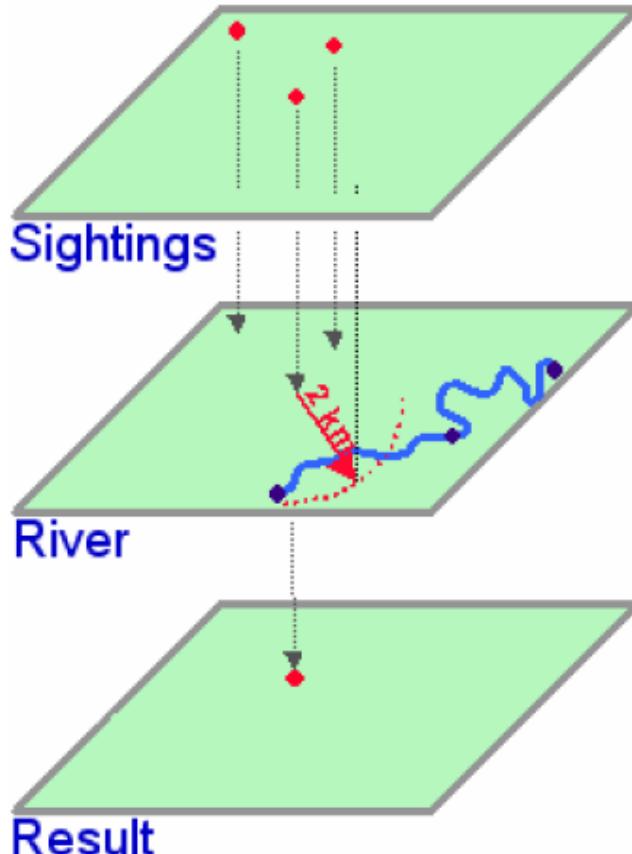
In this example, features in the Pollution dataset are selected if any selected features in the Counties dataset lie completely inside their boundaries.



Vector Analysis

- Spatial Query
 - Selecting Feature by Spatial Relationship
 - Example: distance

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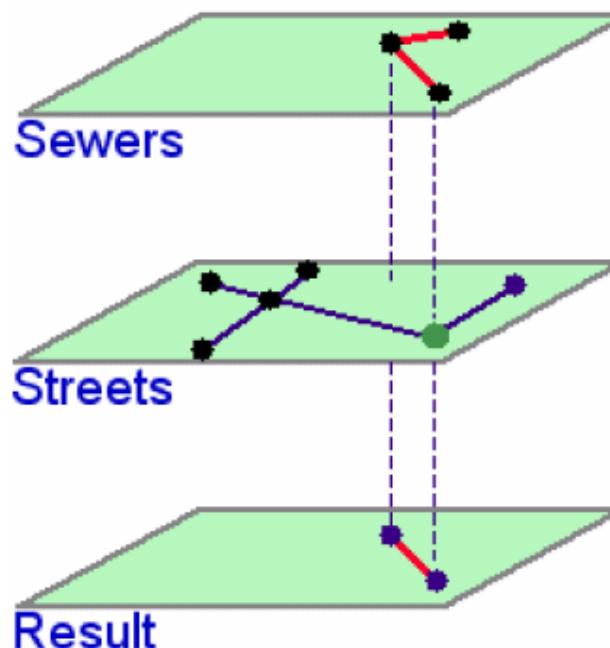


In this example, the locations where animals have been sighted are selected if they are within 2 kilometers of the features in the River dataset.



Vector Analysis

- Spatial Query
 - Selecting Feature by Spatial Relationship
 - Example: distance/adjacency



In this example, features in the Sewers dataset are selected if they share a point with features in the Streets dataset.



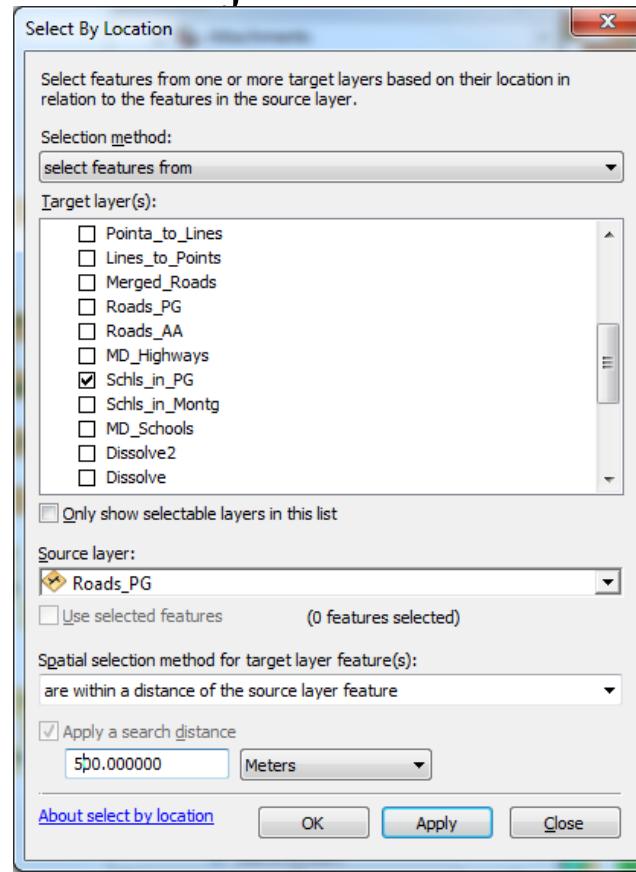
Vector Analysis

- Spatial Query
 - Selecting Feature by Spatial Relationship
 - “Select By Location” dialog window
 - It is often useful to combine Attribute Query and Spatial Data Query.



Vector Analysis

- Spatial Query
 - Selecting Feature by Spatial Relationship
 - Example: select all those schools that are within 500 meters from the major roads in Prince George's County.





Vector Analysis

- Spatial Query
 - Selecting Feature by Spatial Relationship
 - Example: select all those schools that are within 500 meters from the major roads in Prince George's County.

The screenshot shows an ArcMap interface with a map of Prince George's County, Maryland. The map displays several layers, including 'Roads_PG' (green lines), 'Schls_in_PG' (orange squares), and 'MD_Highways' (yellow lines). A table window titled 'Schls_in_PG' is open, showing a list of 215 selected school points. The table includes columns for FID, Shape, OBJECTID, Entity, Layer, Level, Color, Linetype, Text, Grid, grid_id, act_loc_x, and act_loc_y. The 'Entity' column shows values such as 'Cell', 'Point', and 'School'. The 'Text' column lists school names like 'Patuxent Element', 'Saint Marys of th', 'Heather Hills Eleme', etc. The 'Grid' column shows values like 'G12', 'F12', 'H12', etc. The 'act_loc_x' and 'act_loc_y' columns show coordinates. The bottom of the table window shows a status bar with '(56 out of 215 Selected)'.

FID	Shape *	OBJECTID	Entity	Layer	Level_	Color	Linetype	Text_	Grid	grid_id	act_loc_x	act_loc_y
0	Point	1125	Cell	0	0	0	Solid	SCHOOL	G12	G12	0	0
1	Point	1126	Cell	0	0	0	Solid	SCHOOL	G12	G12	0	0
2	Point	1453	Cell	0	0	0	Solid	SCHOOL	F12	F12	0	0
3	Point	1455	Cell	0	0	0	Solid	SCHOOL	F12	F12	0	0
4	Point	1457	Cell	0	0	0	Solid	SCHOOL	F12	F12	0	0
5	Point	1464	Cell	0	0	0	Solid	SCHOOL	F12	F12	0	0
6	Point	1465	Cell	0	0	0	Solid	SCHOOL	F12	F12	0	0
7	Point	1467	Cell	0	0	0	Solid	SCHOOL	F12	F12	0	0
8	Point	1469	Cell	0	0	0	Solid	SCHOOL	F12	F12	0	0
9	Point	1471	Cell	0	0	0	Solid	SCHOOL	F12	F12	0	0
10	Point	864	Cell	0	0	0	Solid	SCHOOL	H12	H12	0	0
11	Point	867	Cell	0	0	0	Solid	SCHOOL	H12	H12	0	0
12	Point	869	Cell	0	0	0	Solid	SCHOOL	H12	H12	0	0
13	Point	899	Cell	0	0	0	Solid	SCHOOL	H11	H11	0	0
14	Point	900	Cell	0	0	0	Solid	SCHOOL	H11	H11	0	0
15	Point	905	Cell	0	0	0	Solid	SCHOOL	G12	G12	0	0
16	Point	906	Cell	0	0	0	Solid	SCHOOL	G12	G12	0	0
17	Point	907	Cell	0	0	0	Solid	SCHOOL	G12	G12	0	0
18	Point	910	Cell	0	0	0	Solid	SCHOOL	G12	G12	0	0
46	Point	911	Cell	0	0	0	Solid	SCHOOL	G12	G12	0	0



Vector Analysis

- Spatial Join
 - Overview
 - A Spatial Join joins attributes from one layer to another based on feature location.
 - Spatial Join is a special case of tabular join. It uses the location of features, instead of a common field, to match the records in attribute tables.
 - Like tabular joins, spatial join will also append fields from a source table to the destination table.
 - It is based on spatial information such as distance, intersection, or containment.



Vector Analysis

- Spatial Join
 - Overview
 - There are two types of spatial relationship used to compare the locations of the features in the joined layers:
 - Proximity
 - Containment
 - The type of spatial join is dependent on the layer feature type.



Vector Analysis

- Spatial Join
 - Overview
 - Three different types:
 - Inside:
 - » Moves attributes of one theme to features of another based on location (one theme must be a polygon theme)
 - » Example: how many earthquakes fall within each county
 - Nearest:
 - » Determines the distance to the nearest feature of another theme (point/point, point/line)
 - » Example: which earthquake is the closest to each city
 - Intersect:
 - » Determines which features in another layer intersect the feature of another layer and summarizes the attributes of those features (line/line, line/polygon)
 - » Example: how many & which roads cross each river



Vector Analysis

- Spatial Join
 - Overview
 - The join feature class is the layer to make a selection on.
 - The source layer contains features that to be used for defining the selection on the destination layer.
 - In the proximity relationship, the record for the feature in the source table has the greatest proximity to the record for the feature in the join table is appended to the record in the destination table.



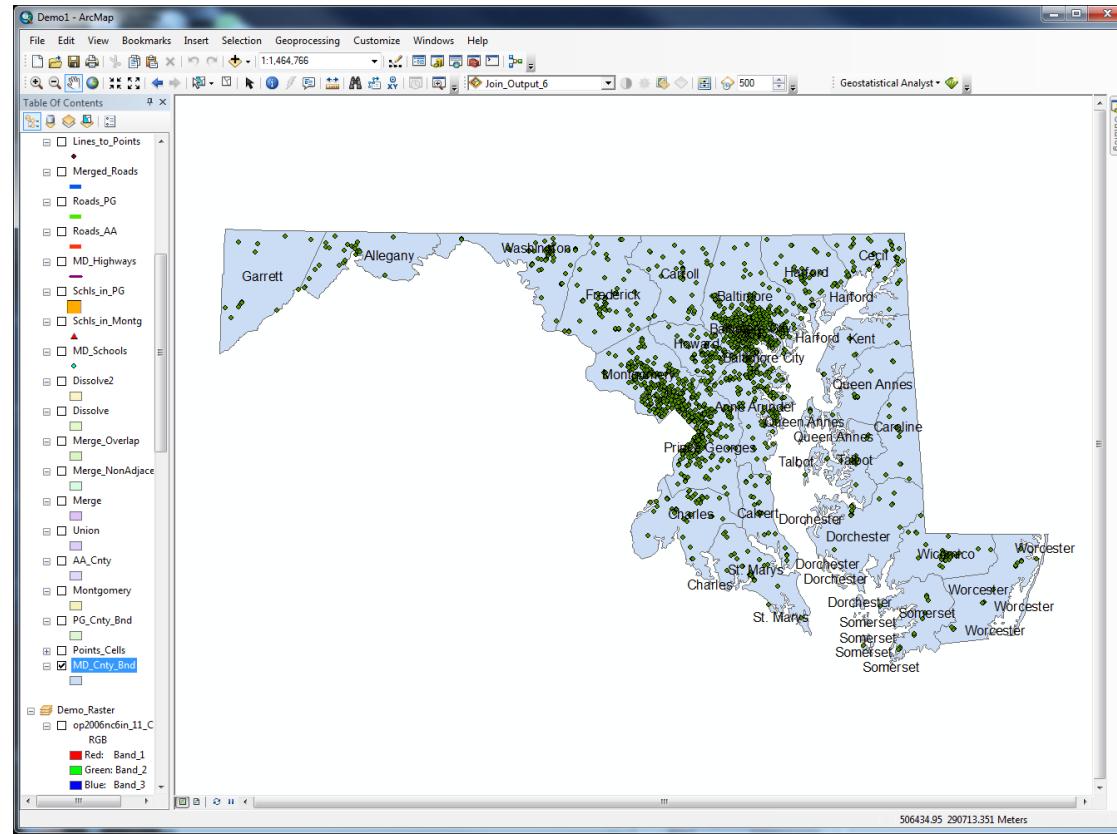
Vector Analysis

- Spatial Join
 - Overview
 - In the containment relationship, the record for the polygon (source) completely containing the line or point (destination) is appended to the destination table's record.



Vector Analysis

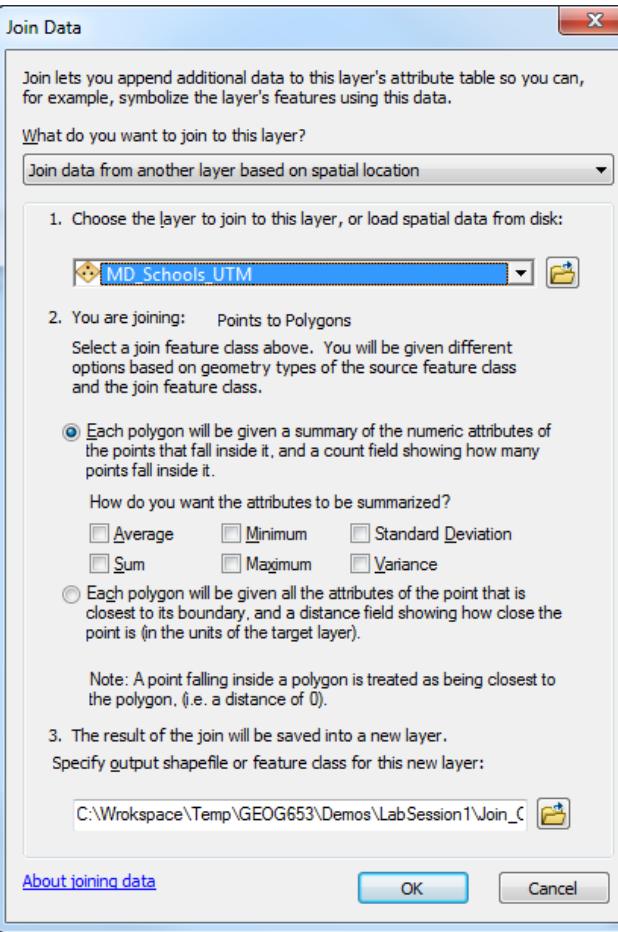
- Spatial Join
 - Containment
 - Example 1:
 - Append points to polygons.





Vector Analysis

- Spatial Join
 - Containment
 - Example 1: ('continued)



Table

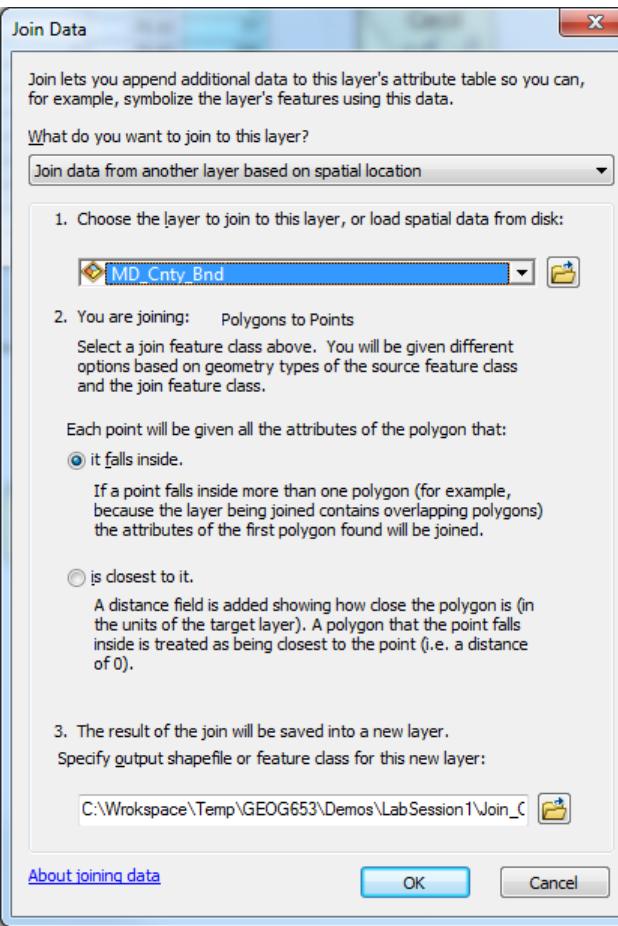
Join_Output_7

MD2CTY	MD2CTY_ID	STATE_FIPS	CNTY_FIPS	FIPS	STATE_NAME	CNTY_NAME	SUB_REGION	STAT_FLAG	X_Coord	Count_
2	1464	24	23	24023	Maryland	Garrett	S Atl	1	-79.28	14
3	1442	24	1	24001	Maryland	Allegany	S Atl	1	-78.7	25
4	1416	24	43	24043	Maryland	Washington	S Atl	1	-77.81	51
5	1408	24	21	24021	Maryland	Frederick	S Atl	1	-77.4	62
6	1389	24	13	24013	Maryland	Carroll	S Atl	1	-77.02	37
7	1381	24	5	24005	Maryland	Baltimore	S Atl	1	-76.65	209
8	1368	24	25	24025	Maryland	Harford	S Atl	1	-76.32	56
9	1357	24	15	24015	Maryland	Cecil	S Atl	1	-75.95	34
10	1421	24	25	24025	Maryland	Harford	S Atl	0	-76.08	0
11	1433	24	29	24029	Maryland	Kent	S Atl	1	-76.03	8
12	1488	24	27	24027	Maryland	Howard	S Atl	1	-76.93	77
13	1462	24	510	24510	Maryland	Baltimore City	S Atl	1	-76.62	189
14	1503	24	31	24031	Maryland	Montgomery	S Atl	1	-77.2	231
15	1469	24	25	24025	Maryland	Harford	S Atl	0	-76.27	0
16	1460	24	35	24035	Maryland	Queen Annes	S Atl	1	-75.98	9
17	1492	24	5	24005	Maryland	Baltimore	S Atl	0	-76.38	0
18	1517	24	3	24003	Maryland	Anne Arundel	S Atl	1	-76.61	131
19	1515	24	510	24510	Maryland	Baltimore City	S Atl	0	-76.55	0
20	1555	24	33	24033	Maryland	Prince Georges	S Atl	1	-76.85	215



Vector Analysis

- Spatial Join
 - Containment
 - Example 2: Append polygons to points.



Table

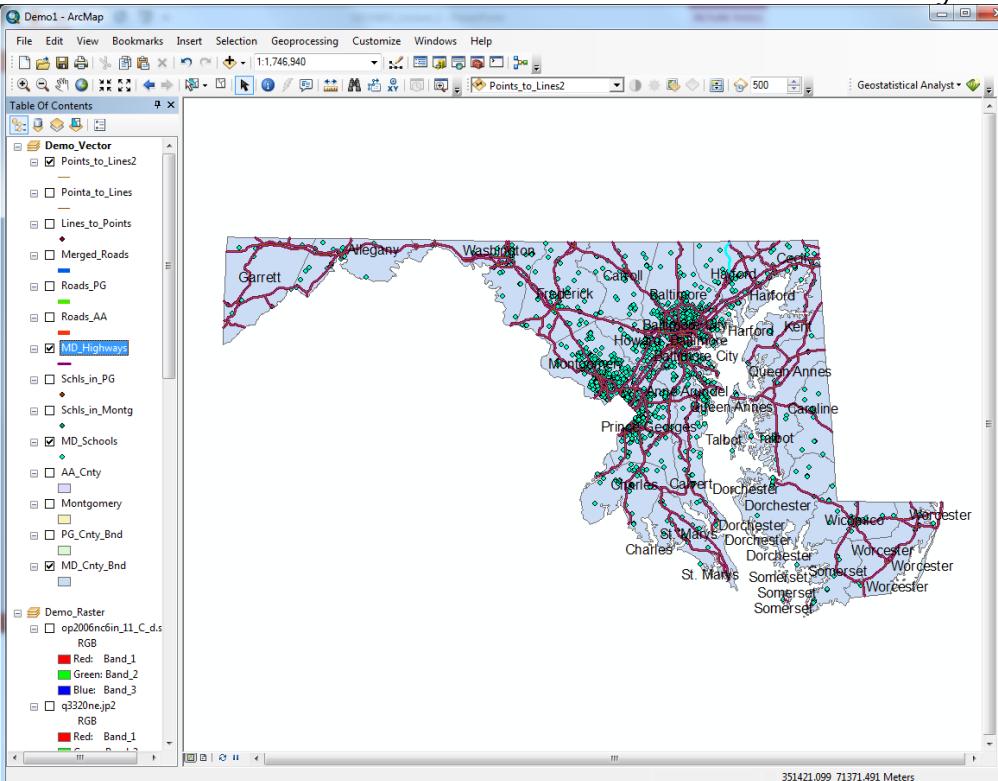
Join_Output_8

uid	Co_Num	State	X_Coord	Y_Coord	SHAUID	FID_2	AREA	PERIMETER	MD2CTY_	MD2CTY_ID	STATE_
429200390027AM	11	Maryland	211534.408488	193235.155595	4011	0	1725230000	191147	2	1464	
4282003112220AM	11	Maryland	187580.518162	194211.751563	4017	0	1725230000	191147	2	1464	
4282003112120AM	11	Maryland	190095.813396	189649.875591	4019	0	1725230000	191147	2	1464	
4282003120636PM	11	Maryland	194576.191257	195602.656909	4023	0	1725230000	191147	2	1464	
4282003120659PM	11	Maryland	194306.735896	195810.057869	4024	0	1725230000	191147	2	1464	
4282003120734PM	11	Maryland	195094.894361	196817.91963	4027	0	1725230000	191147	2	1464	
4282003120752PM	11	Maryland	195170.171673	196694.236814	4028	0	1725230000	191147	2	1464	
4282003120607PM	11	Maryland	193830.799128	194636.745356	4056	0	1725230000	191147	2	1464	
423200313710PM	11	Maryland	221573.125938	202800.347795	4930	0	1725230000	191147	2	1464	
2242003103543AM	11	Maryland	227561.078583	226084.394665	5763	0	1725230000	191147	2	1464	
422200314839PM	11	Maryland	202451.540768	224215.241383	5829	0	1725230000	191147	2	1464	
422200320643PM	11	Maryland	201620.329247	220065.801891	5831	0	1725230000	191147	2	1464	
423200392136AM	11	Maryland	215317.622527	227349.743274	5865	0	1725230000	191147	2	1464	
4222003115203AM	11	Maryland	193649.163032	224682.344104	5882	0	1725230000	191147	2	1464	
4282003101911AM	1	Maryland	261773.229911	209320.117913	4867	1	1116430000	212173	3	1442	
425200395606AM	1	Maryland	242660.371269	214983.166623	4875	1	1116430000	212173	3	1442	
425200394947AM	1	Maryland	240765.205316	213865.019038	4877	1	1116430000	212173	3	1442	
425200392335AM	1	Maryland	231308.105531	214049.110686	4881	1	1116430000	212173	3	1442	
425200391529AM	1	Maryland	229199.326009	212135.377564	4885	1	1116430000	212173	3	1442	
425200390777AM	4	Maryland	200000.000000	207545.010552	4890	1	1116430000	212173	3	1442	

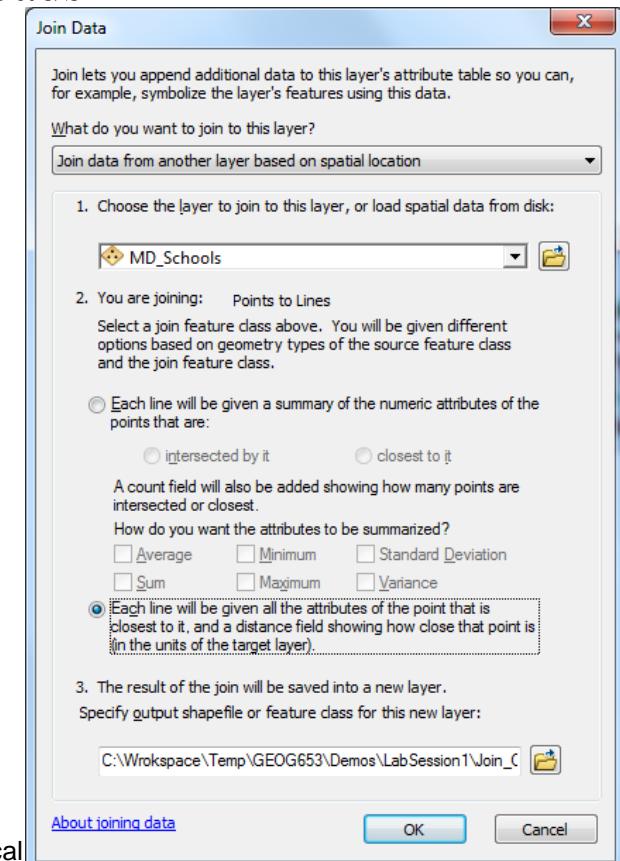


Vector Analysis

- Spatial Join
 - Proximity
 - Example 3:
 - Source feature class: Maryland major roads
 - Join feature class: Maryland schools



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Vector Analysis

- Spatial Join
 - Proximity
 - Example 3: ('continued)

- The source table attributes will be appended to the destination table.
- In addition, a field called “Distance” will be automatically added to the table, representing the distance between the source (roads) and the join (cities) features.

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MD_Highways											
FID	Shape *	FNODE	TNODE	LPOLY	RPOLY	LENGTH	MD2RDS_	MD2RDS_ID	ESRI_CLASS	ROAD_CLASS	CLASS
0	Polyline	2	1	2	2	10520.3	1	10395	5	State secondary highway	2
1	Polyline	3	4	2	2	250.62	2	10399	8	Parallel highway	1
2	Polyline	7	8	2	2	2385.74	3	10458	1	Interstate	
3	Polyline	8	6	2	2	3272.27	4	10459	8	Parallel highway	2
4	Polyline	10	9	2	2	686.288	5	10476	5	State secondary highway	2
5	Polyline	11	4	2	2	13022.3	6	10511	8	Parallel highway	2
6	Polyline	5	11	2	2	6248.67	7	10512	3	Other U.S. highway	1
7	Polyline	13	11	2	2	1574.12	8	10568	8	Parallel highway	2
8	Polyline	14	12	2	2	4569.81	9	10591	8	Parallel highway	2

Points_to_Lines2											
source	operator_i	updated_da	progress	uid	Co_Num	State	X_Coord	Y_Coord	SHAUID	Distance	
16	ibarnes	3/18/2003	Complete	3182003104623AM	17	Maryland	470480.838682	144060.957277	1434	8780.440286	
16	ibarnes	4/21/2003	Complete	4212003100041AM	10	Maryland	359578.357682	182850.559617	2969	6578.068387	
16	ibarnes	3/21/2003	Complete	3212003111942AM	23	Maryland	565354.01381	77159.280158	358	6500.980578	
16	ibarnes	4/11/2003	Complete	411200393016AM	18	Maryland	444701.255682	64483.587603	232	6311.0155	
16	ibarnes	4/11/2003	Complete	411200393016AM	18	Maryland	444701.255682	64483.587603	232	6311.0155	
16	ibarnes	3/21/2003	Complete	3212003111942AM	23	Maryland	565354.01381	77159.280158	358	6250.580281	
16	ibarnes	3/21/2003	Complete	3212003111942AM	23	Maryland	565354.01381	77159.280158	358	6237.597624	
16	ibarnes	3/11/2003	Complete	311200315018PM	12	Maryland	4514200.072968	223224.93815	5980	6201.59477	
16	ibarnes	3/21/2003	Complete	3212003111942AM	23	Maryland	565354.01381	77159.280158	358	5898.033102	



Vector Analysis

- Overlay Operations
 - One of the original functions when GIS was designed
 - Geoprocessing is a broader term.
 - Geoprocessing essentially deals with automating GIS tasks, modeling and analysis.
 - More than overlaying
 - Manipulating tables
 - Changing projections



Vector Analysis

- Overlay Operations
 - Most common tools
 - Extract
 - Overlay
 - Proximity
 - Data Management



Vector Analysis

- Overlay Operations
 - Know what they are
 - Major characteristics
 - Restrictions
 - Know how to use
 - Geometry
 - Table attributes
 - Know when to use
 - Pay attention to the subtle differences between some similar operations
 - Integrate different tools



Vector Analysis

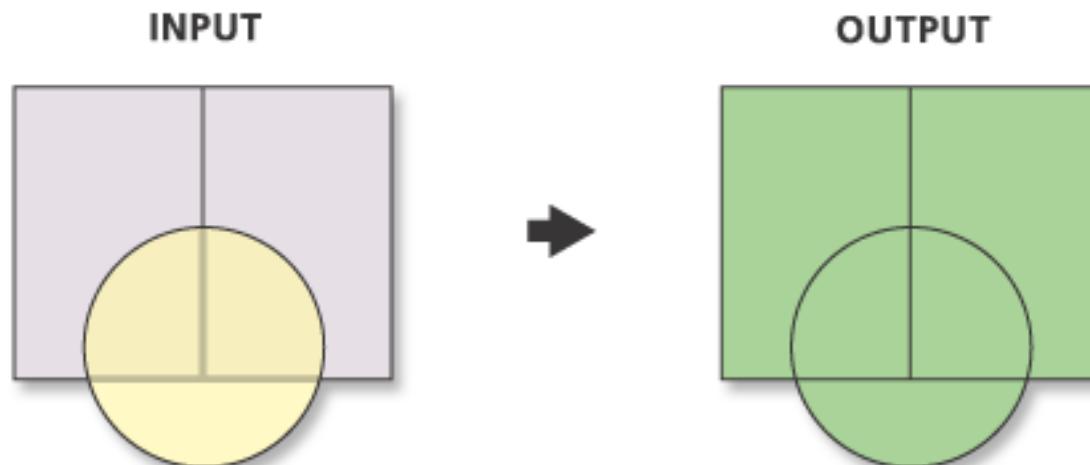
- Overlay Operations
 - Union

- Combines two or more feature layers into a single new feature layer. All features and the attributes are written to the output feature class.
- It is the Boolean operation: OR
- In the vector analysis it allows to extend the boundary of any single layer.



Vector Analysis

- Overlay Operations
 - Union





Vector Analysis

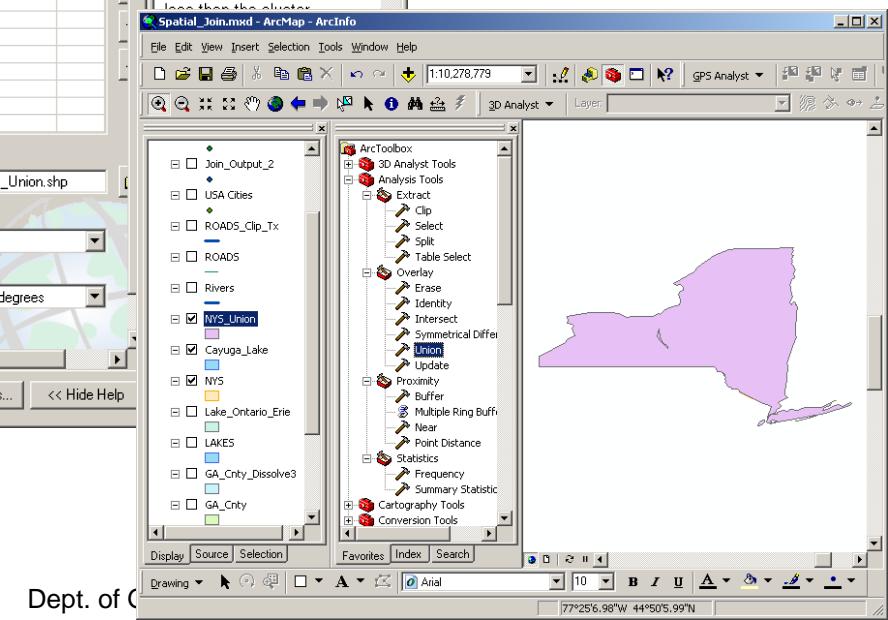
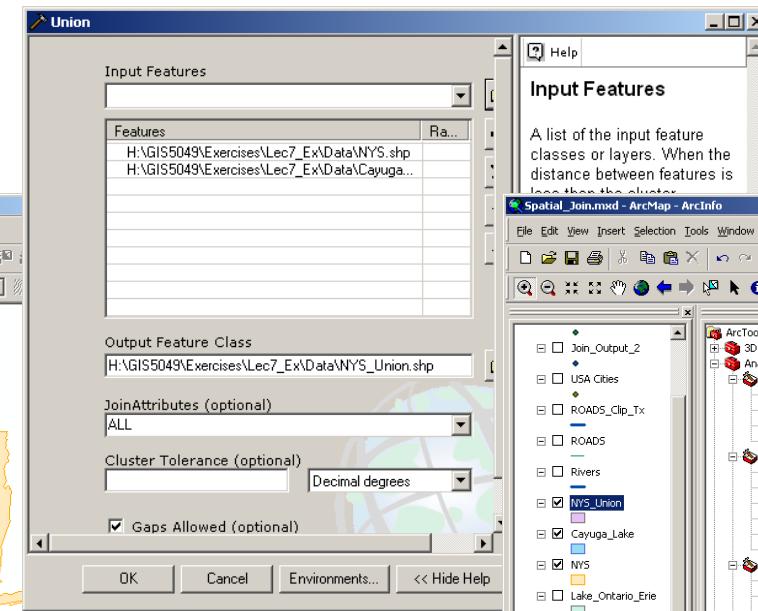
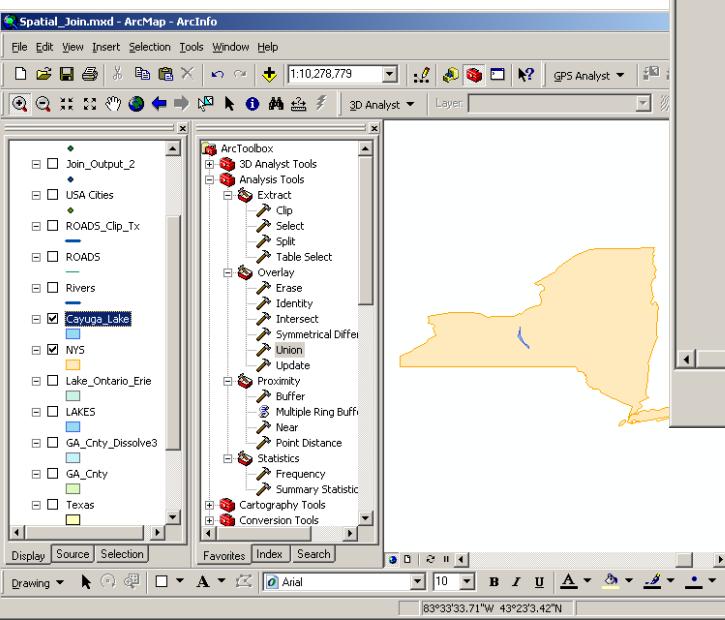
- Overlay Operations
 - Union
 - Characteristics of Union:
 - All inputs must be of polygon feature type.
 - The output features will have the attributes of all the input features that they overlap.
 - Multiple polygon feature layer and feature layers can be unioned together at a time.
 - The sequence of adding inputs does not matter.



Vector Analysis

- Overlay Operations
 - Union (ArcMap)
 - Example: (one input feature is inside the other one)
 - Question: What will be the number of records in the output attribute table?

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Vector Analysis

- Overlay Operations
 - Union (ArcMap)
 - Example: ('continued)
 - All attributes from the input layers are included in the output.

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The image displays three overlapping windows showing attribute tables for different layers. The top window is titled "Attributes of Cayuga_Lake" and contains one record: FID 0, Shape^ Polygon, AREA 54.765, and NAME Gayuga Lake. The middle window is titled "Attributes of NYS" and contains one record: FID 0, Shape^ Polygon, AREA 48561.751, STATE_NAME New York, STATE_FIPS 36, SUB_REGION Mid Atl, and STATE_ABBR NY. The bottom window is titled "Attributes of NYS_Union" and contains two records. The first record has FID_Cayuga -1, AREA 0, NAME Gayuga Lake, FID_NYS 0, AREA_1 48561.751, STATE_NAME New York, STATE_FIPS 36, and SUB_REGI Mid Atl. The second record has FID_Cayuga 0, AREA 54.765, NAME Gayuga Lake, FID_NYS 0, AREA_1 48561.751, STATE_NAME New York, STATE_FIPS 36, and SUB_REGI Mid Atl.

FID	Shape [*]	AREA	NAME
0	Polygon	54.765	Gayuga Lake

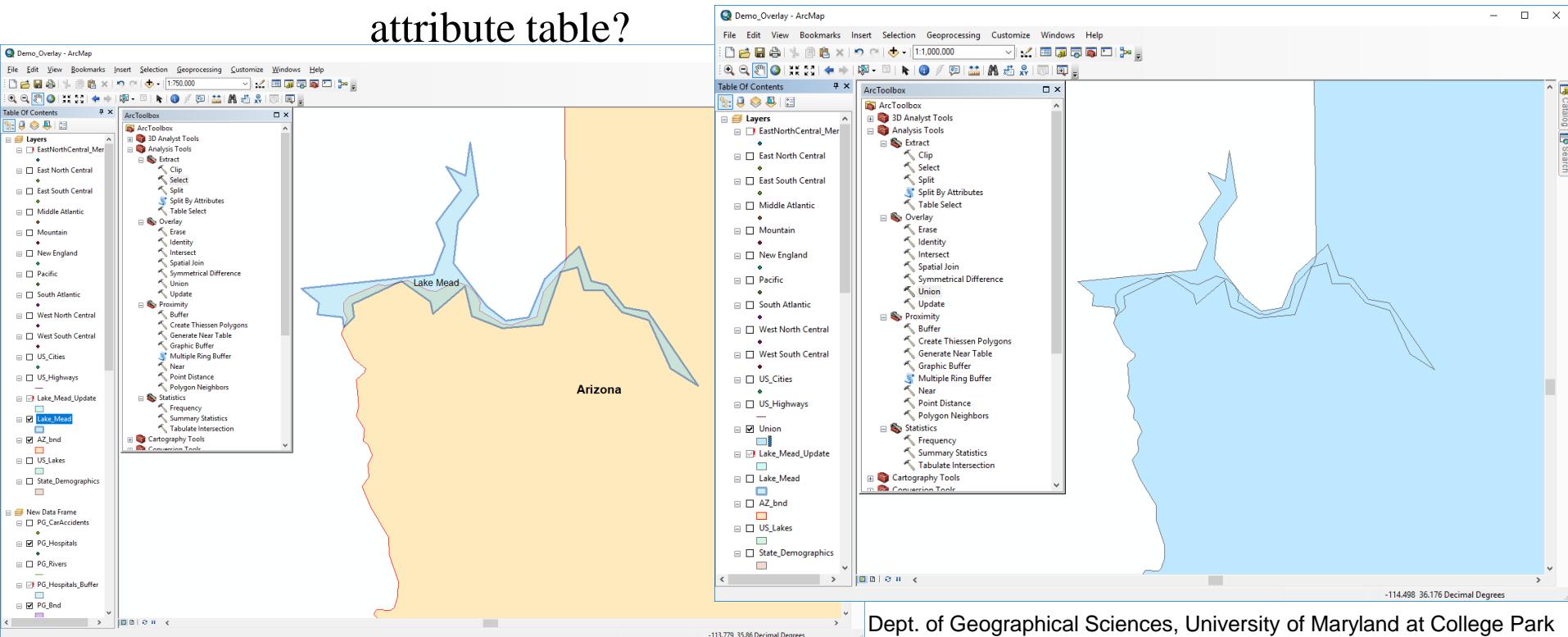
FID	Shape [*]	AREA	STATE_NAME	STATE_FIPS	SUB_REGION	STATE_ABBR
0	Polygon	48561.751	New York	36	Mid Atl	NY

FID_Cayuga	AREA	NAME	FID_NYS	AREA_1	STATE_NAME	STATE_FIPS	SUB_REGI
-1	0		0	48561.751	New York	36	Mid Atl
0	54.765	Gayuga Lake	0	48561.751	New York	36	Mid Atl



Vector Analysis

- Overlay Operations
 - Union (ArcGIS Pro)
 - Example: (one input feature is partially overlapped with the other one)
 - Question: What will be the number of records in the output attribute table?





Vector Analysis

- Overlay Operations
 - Union (ArcGIS Pro)
 - Example:

The screenshot shows the ArcGIS Pro interface with three tables open:

- Lake_Mead** (Top Table):

FID	Shape *	ObjectID	AREA	NAME
0	Polygon	5	317.56	Lake Mead
- AZ_bnd** (Middle Table):

FID	Shape *	ObjectID	STATE_NAME	STATE_FIPS	SUB_REGION	STATE_ABBR	POP2000	POP2007
0	Polygon	36	Arizona	04	Mountain	AZ	5130632	6363799
- Union** (Bottom Table):

FID	Shape *	FID_Lake_M	ObjectID	AREA	NAME	FID_AZ_bnd	ObjectID_1	STATE_NAME
0	Polygon	0	5	317.56	Lake Mead	-1	0	
1	Polygon	-1	0	0		0	36	Arizona
2	Polygon	0	5	317.56	Lake Mead	0	36	Arizona

The bottom table, Union, shows the result of the spatial join between Lake_Mead and AZ_bnd. It includes columns for FID, Shape, FID_Lake_M, ObjectID, AREA, NAME, FID_AZ_bnd, ObjectID_1, and STATE_NAME. The first two rows represent the union of the single feature from each table, while the third row represents the original Lake Mead feature.



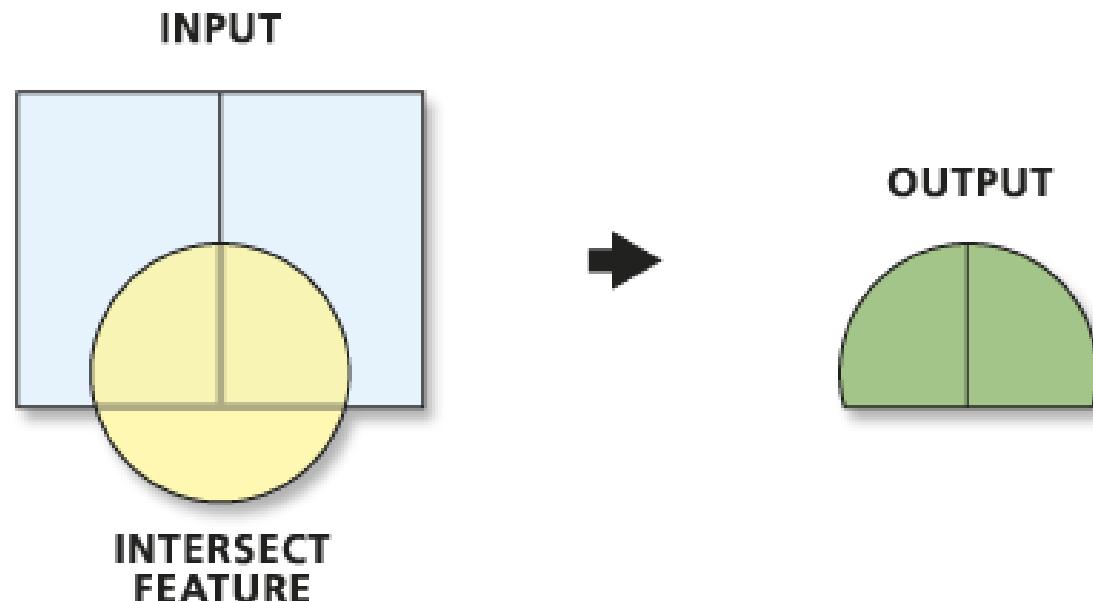
Vector Analysis

- Overlay Operations
 - Intersect
 - Computes a geometric intersection of the input features.
 - Features or portion of features common to all layers will be written to the output layer.
 - It is the Boolean operation: AND
 - In vector analysis it allows to narrow down the boundary of interest.



Vector Analysis

- Overlay Operations
 - Intersect





Vector Analysis

- Overlay Operations
 - Intersect
 - Characteristics of Intersect
 - The inputs can be any combination of feature types (point, multipoint, line, polygon).
 - » They cannot be complex features such as annotation features, dimension features, or network features.
 - The attribute table of the output feature layer will contain attribute information from both input features.
 - The output geometry type can only be of the same geometry or a geometry of lower dimension as the input feature layer with the lowest dimension geometry.
 - The sequence of adding inputs does not matter.



Vector Analysis

- Overlay Operations
 - Intersect (ArcGIS Pro)

The screenshot shows the ArcGIS Pro interface with a map titled "ArcGIS Pro - Overlay_2 - Map". The map displays a blue polygon representing "Lake_Mead_Intersect", which is the result of intersecting two other features: "Lake_Mead" (blue) and "AZ_bnd" (orange). The map also includes a base layer for "Esri World Topographic Map". The "Analysis" tab is selected in the ribbon. The "Geoprocessing" pane on the right shows an "Intersect" tool is currently running, with parameters set to input features "Lake_Mead" and "AZ_bnd", and output feature class "Lake_Mead_Intersect". The "Contents" pane lists the layers: "Lake_Mead_Intersect" (selected), "Lake_Mead", "AZ_bnd", and "Esri World Topographic Map". The "Table" pane shows the attribute table for "Lake_Mead_Intersect", which contains one record:

OBJECTID_12	Shape	FID_Lake_Mead	ObjectID	AREA	NAME	FID_AZ_bnd	ObjectID	STATE_NAME	STATE_FIPS	SUB_I
1	Polygon	0	5	317.56	Lake Mead	0	36	Arizona	04	Mountains

The status bar at the bottom indicates the operation completed successfully.



Vector Analysis

- Overlay Operations
 - Clip

- This operation will extract input features that overlay the clip features.
- The output feature will be a portion of the input feature.
- The attributes of the output feature layer are the same as those of the input feature layer.



Vector Analysis

- Overlay Operations
 - Clip

- Characteristics of Clip:

- The input feature layer can be any feature type: points, lines, or polygons.
- The clip feature restrictions have changed.
 - » It must be a polygon before V10.0.
 - » Starting from 10.0, the clip feature can be points, lines, and polygons, depending on the feature types of the input.



Vector Analysis

- Overlay Operations
 - Clip

- Characteristics of Clip:

- The clip feature restrictions have changed. (since 10.0)
 - » When the Input Features are polygons, the Clip Features must also be polygons.
 - » When the Input Features are lines, the Clip Features can be lines or polygons. When clipping line features with line features, only the coincident lines or line segments are written to the output, as shown in the graphic below.
 - » When the Input Features are points, the Clip Features can be points, lines, or polygons. When clipping point features with point features, only the coincident points are written to the output. When clipping point features with line features, only the points that are coincident with the line features are written to the output.



Vector Analysis

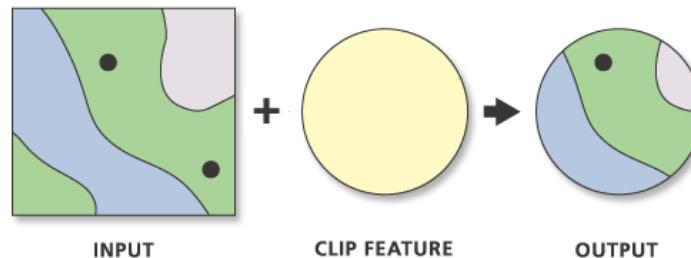
- Overlay Operations
 - Clip
 - Characteristics of Clip:
 - The output feature layer will have the same coordinate system as the input feature layer.
 - Particularly useful for creating a new feature layer that contains a geographic subset of the features in another, larger feature layer.



Vector Analysis

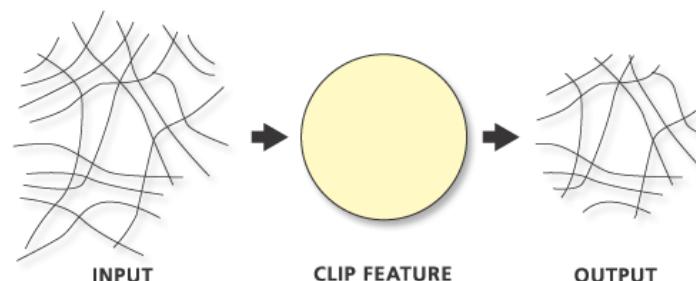
- Overlay Operations
 - Clip

- Polygon features clipped by polygon features

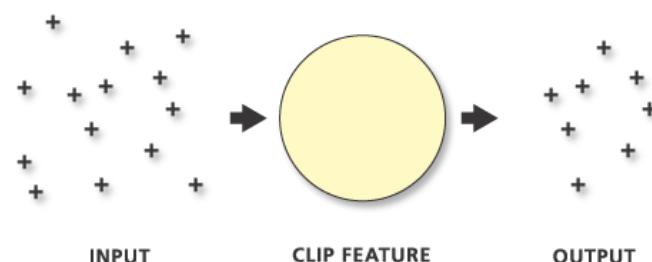


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- Line features clipped by polygon features



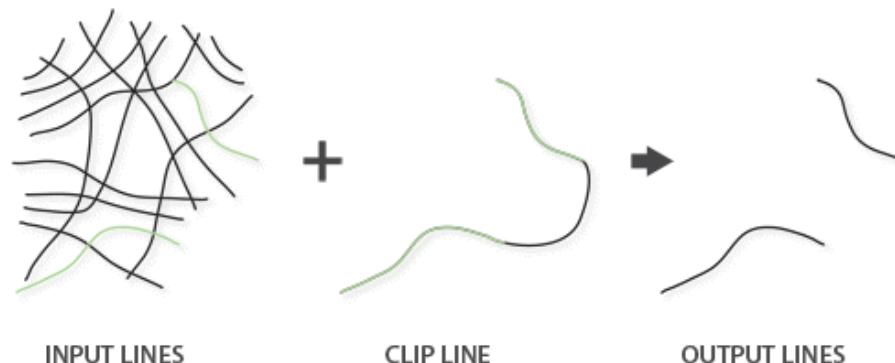
- Point features clipped by polygon features





Vector Analysis

- Overlay Operations
 - Clip
 - Both the input and clip features are lines.



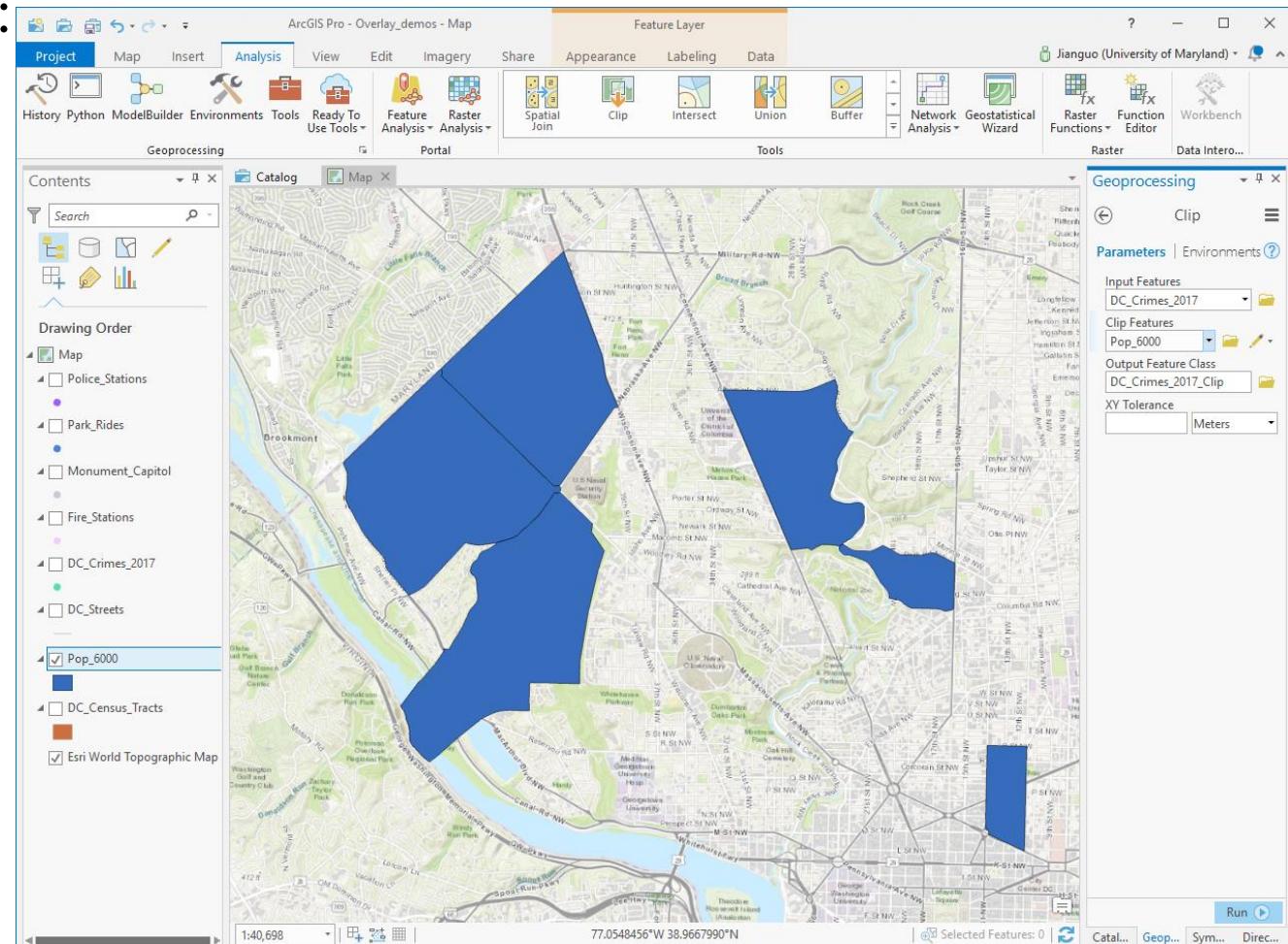
- Both the input and clip features are points.





Vector Analysis

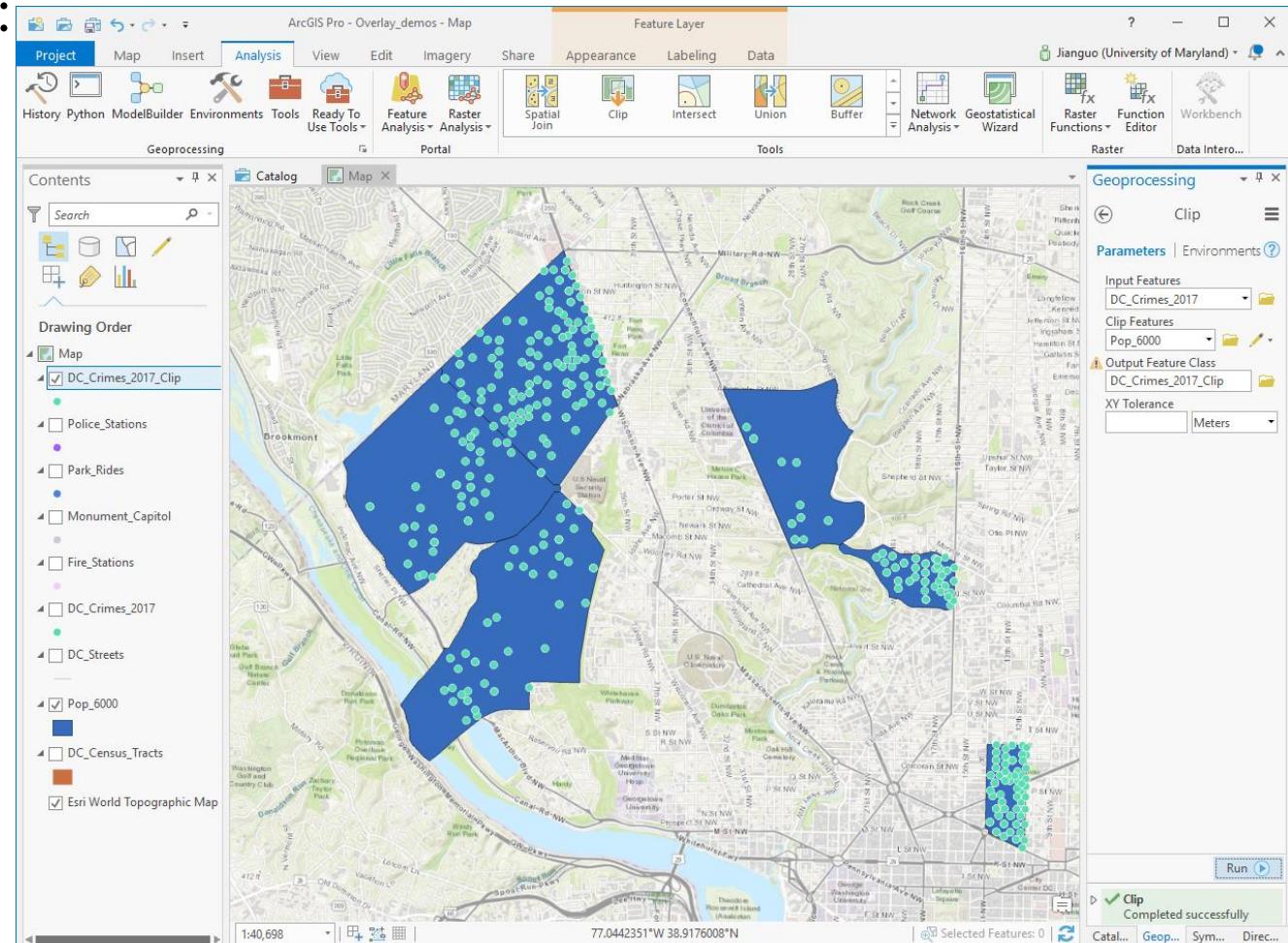
- Overlay Operations
 - Clip (ArcGIS Pro)
 - Example:





Vector Analysis

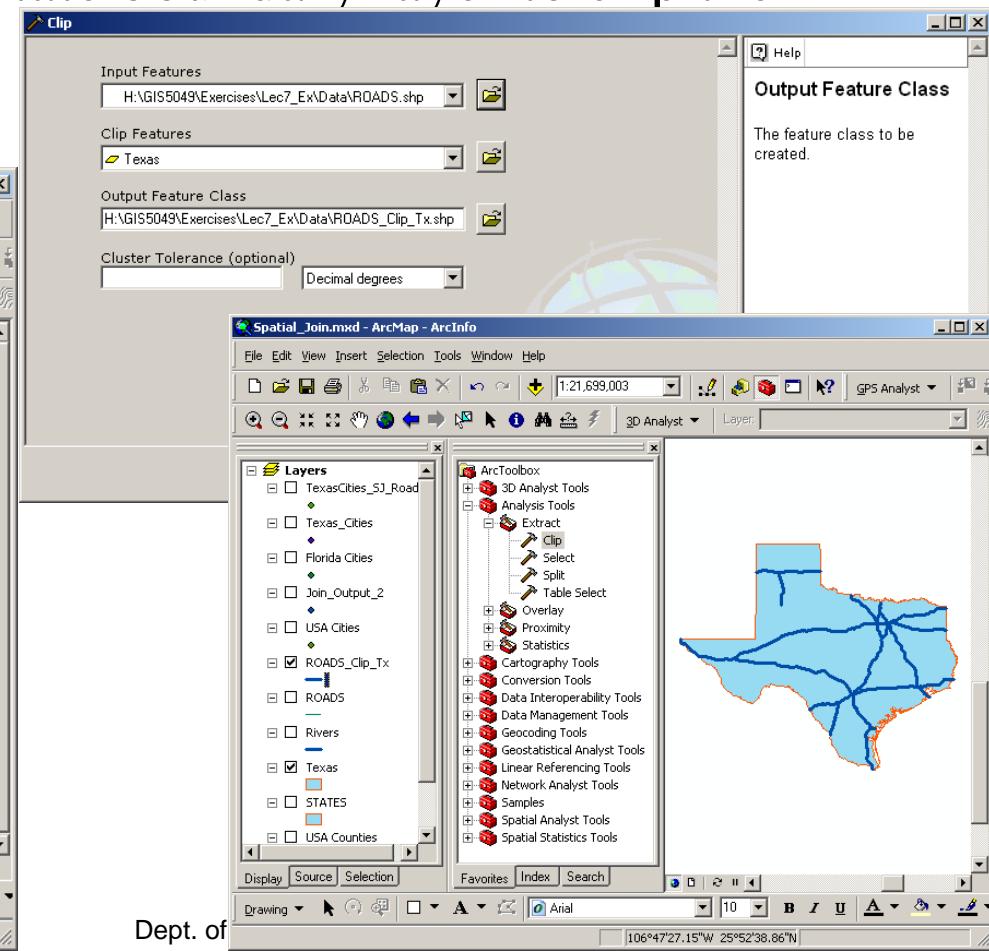
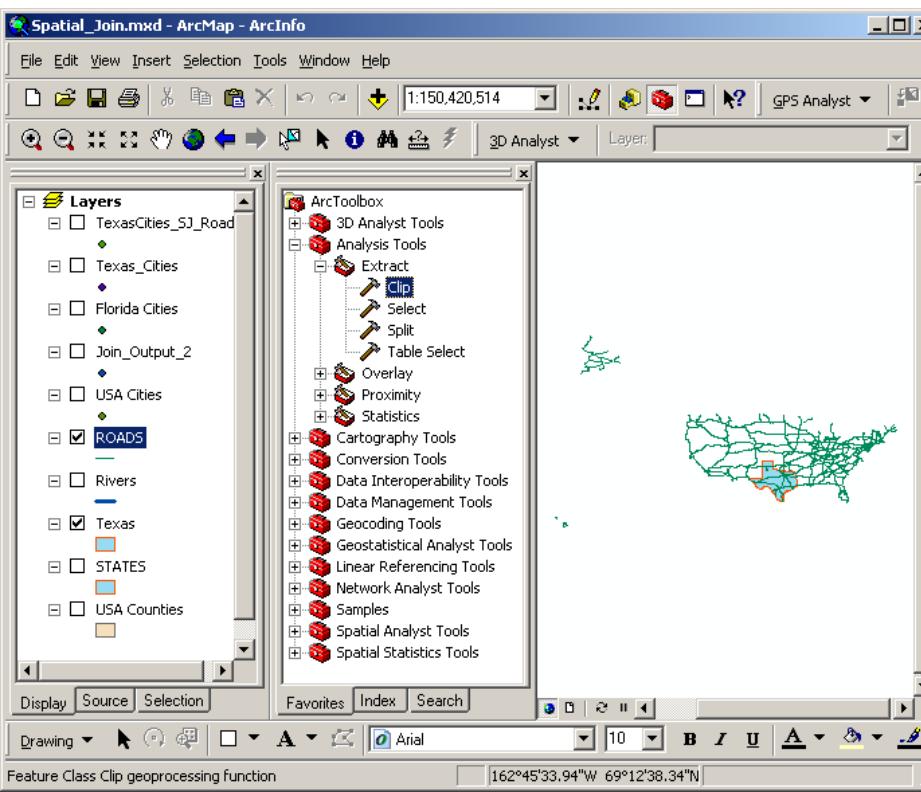
- Overlay Operations
 - Clip (ArcGIS Pro)
 - Example:





Vector Analysis

- Overlay Operations
 - Clip (ArcMap)
 - Example: Use Texas State boundary layer to clip the USA Roads layer.





Vector Analysis

- Overlay Operations

- Clip (ArcMap)

- Example: ('continued)
 - The output layer will have the same attributes as that of the input layer – “Roads”.

FID	Shape*	LENGTH	TYPE	AD
0	Polyline	140.931	Multi-Lane Divided	Interstate
1	Polyline	186.06	Multi-Lane Divided	Interstate
2	Polyline	8.642	Multi-Lane Divided	Interstate
3	Polyline	9.439	Multi-Lane Divided	Interstate
4	Polyline	8.208	Multi-Lane Divided	Interstate
5	Polyline	22.106	Multi-Lane Divided	Interstate
6	Polyline	18.154	Multi-Lane Divided	Interstate
7	Polyline	8.297	Multi-Lane Divided	Interstate
8	Polyline	156.827	Multi-Lane Divided	Interstate
9	Polyline	74.106	Multi-Lane Divided	Interstate

Record: [Navigation Buttons] 1 [Next] Show: All Selected Records (0 out of 679 Selected.) Options

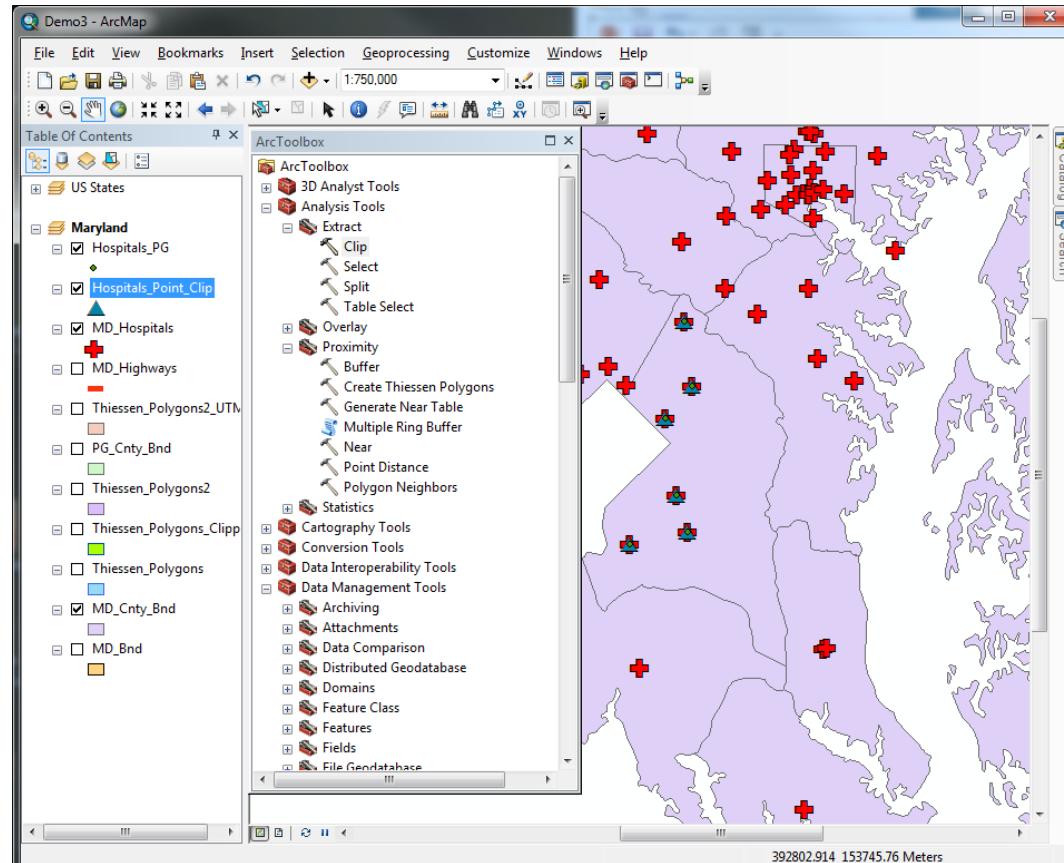
FID	Shape*	LENGTH	TYPE	AD
0	Polyline	255.966	Multi-Lane Divided	Interstate
1	Polyline	279.954	Multi-Lane Divided	Interstate
2	Polyline	116.399	Multi-Lane Divided	Interstate
3	Polyline	163.622	Multi-Lane Divided	Interstate
4	Polyline	23.212	Multi-Lane Divided	Interstate
5	Polyline	306.303	Multi-Lane Divided	Interstate
6	Polyline	10.473	Multi-Lane Divided	Interstate
7	Polyline	38.135	Multi-Lane Divided	Interstate
8	Polyline	30.52	Multi-Lane Divided	Interstate
9	Polyline	11.3	Multi-Lane Divided	Interstate

Record: [Navigation Buttons] 1 [Next] Show: All Selected Records (0 out of 32 Selected.) Options



Vector Analysis

- Overlay Operations
 - Clip (ArcMap)
 - Example: (both Input and Clip features are points)
 - Only the coincident points are written to the output.





Vector Analysis

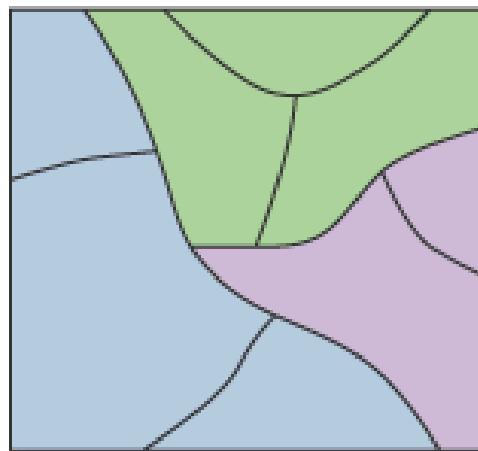
- Overlay Operations
 - Dissolve
 - Generalization toolset.
 - This operation aggregates features based on specified attributes.
 - It will create a new layer by merging layers that have the same value for a specified item.
 - It is often used to create a simplified coverage from one that is more complex.



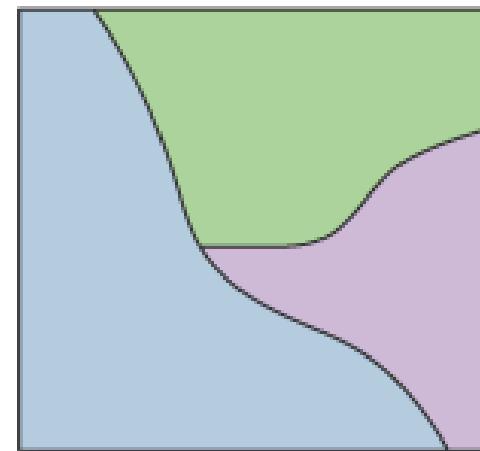
Vector Analysis

- Overlay Operations
 - Dissolve

INPUT COVERAGE



OUTPUT COVERAGE

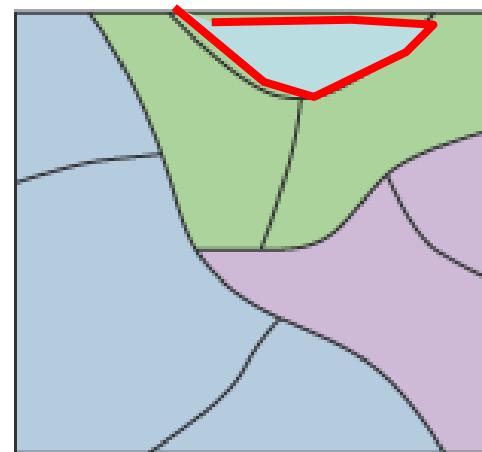




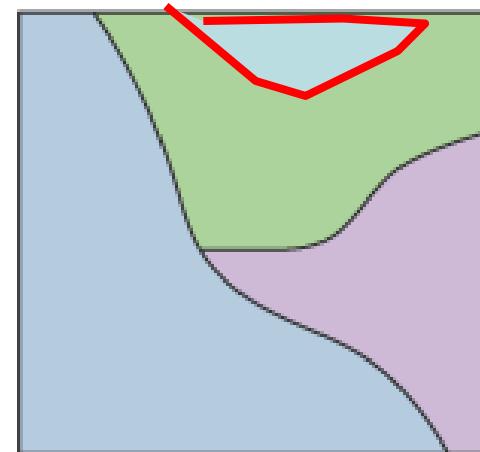
Vector Analysis

- Overlay Operations
 - Dissolve
 - Defined by “zones” (attributes)

INPUT COVERAGE



OUTPUT COVERAGE





Vector Analysis

- Overlay Operations
 - Dissolve
 - Characteristics of Dissolve:
 - The input layer can be any feature types (point, line , or polygon).
 - A dissolve field must be identified/defined.
 - The features to be aggregated do NOT have to be adjacent to each other.
 - » “Zone” vs. “region”
 - » “Zone” is defined by attributes, not by location.



Vector Analysis

- Overlay Operations
 - Dissolve
 - The attributes of the aggregated features may be summarized using a statistic type.
 - Text attribute fields may be summarized using the statistics First or Last.
 - The record that is ranked as the first or last one with same value (based on dissolve field) of each group in the table.
 - Numeric attribute fields may be summarized using any statistic: Sum, Mean, Max, Min, Range, Std, First, or Last.



Vector Analysis

- Overlay Operations
 - Dissolve
 - The attributes of the aggregated features may be summarized using a statistic type.

The screenshot shows two instances of the ArcGIS 'Dissolve' tool dialog box side-by-side. Both dialogs have the following settings:

- Input Features:** USA_States
- Output Feature Class:** C:\WorkSpace\Temp\Dissolve.shp
- Dissolve_Field(s) (optional):** Sub_REGION (checkbox checked)
- Statistics Field(s) (optional):** POP1999 (checkbox checked)
- Create multipart features:** Checked

The right-hand dialog box also shows a dropdown menu for the Statistic Type, with MEAN selected.

Field	Statistic Type
POP1999	MEAN



Vector Analysis

- Overlay Operations
 - Dissolve
 - The statistic type used to summarize attributes is added to attribute table of the output feature as a field.

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Attributes of Dissolve

FID	Shape *	SUB_REGION	MEAN_POP19
0	Polygon	E N Cen	8882006.4
1	Polygon	E S Cen	4153858.75
2	Polygon	Mid Atl	12787758.3333
3	Polygon	Mtn	2145487.25
4	Polygon	N Eng	2248007.5
5	Polygon	Pacific	8801677.4
6	Polygon	S Atl	5514351.44444
7	Polygon	W N Cen	2686266.71429
8	Polygon	W S Cen	7611667

Record: Show: All Selected

Attributes of Dissolve5

FID	Shape *	SUB_REGION	FIRST_STAT
0	Polygon	E N Cen	Wisconsin
1	Polygon	E S Cen	Kentucky
2	Polygon	Mid Atl	New York
3	Polygon	Mtn	Montana
4	Polygon	N Eng	Maine
5	Polygon	Pacific	Washington
6	Polygon	S Atl	District of Columbia
7	Polygon	W N Cen	North Dakota
8	Polygon	W S Cen	Oklahoma

Record: Show: All Selected

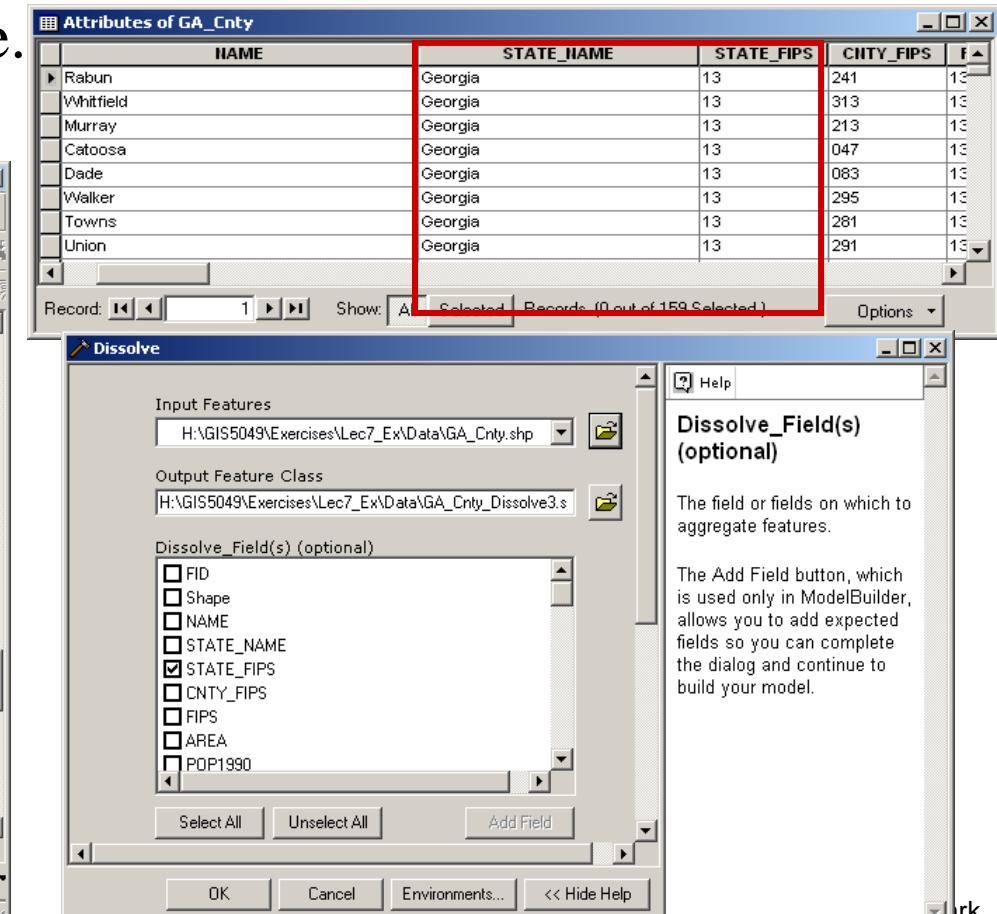
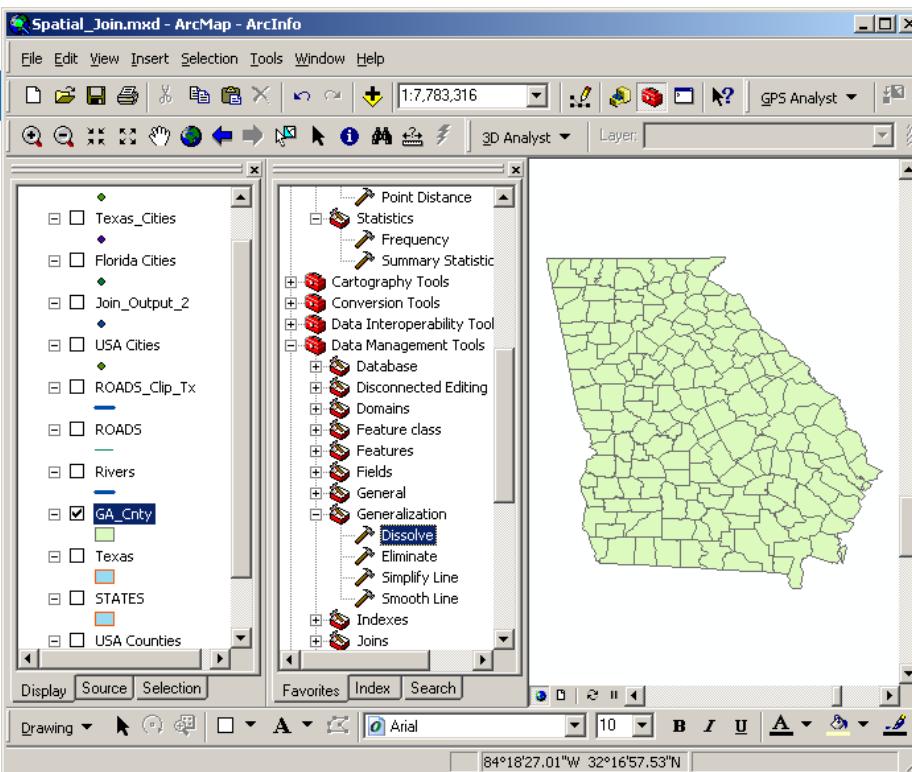


Vector Analysis

- Overlay Operations

- Dissolve

- Example: Dissolve the counties in Georgia to create a single polygon feature.





Vector Analysis

- Overlay Operations
 - Dissolve
 - Example: ('continued)

The screenshot shows the ArcMap interface with the following components:

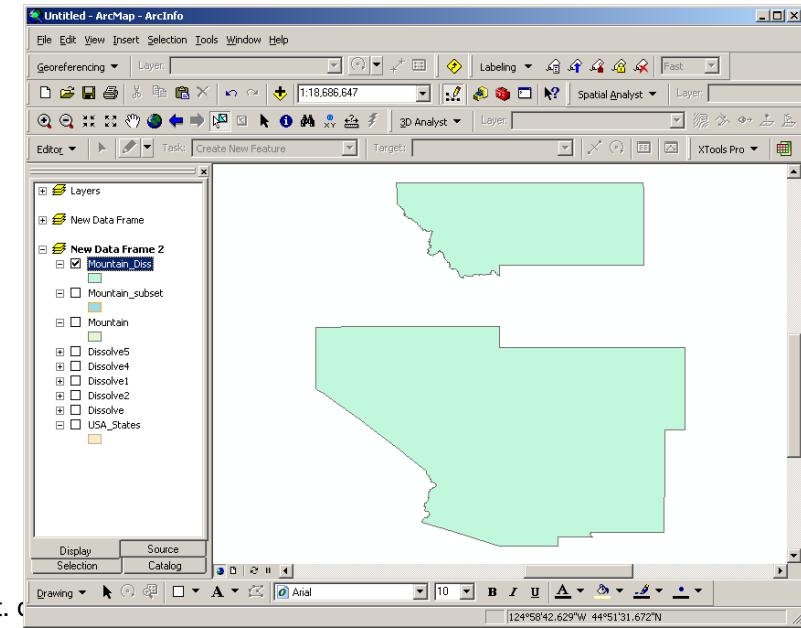
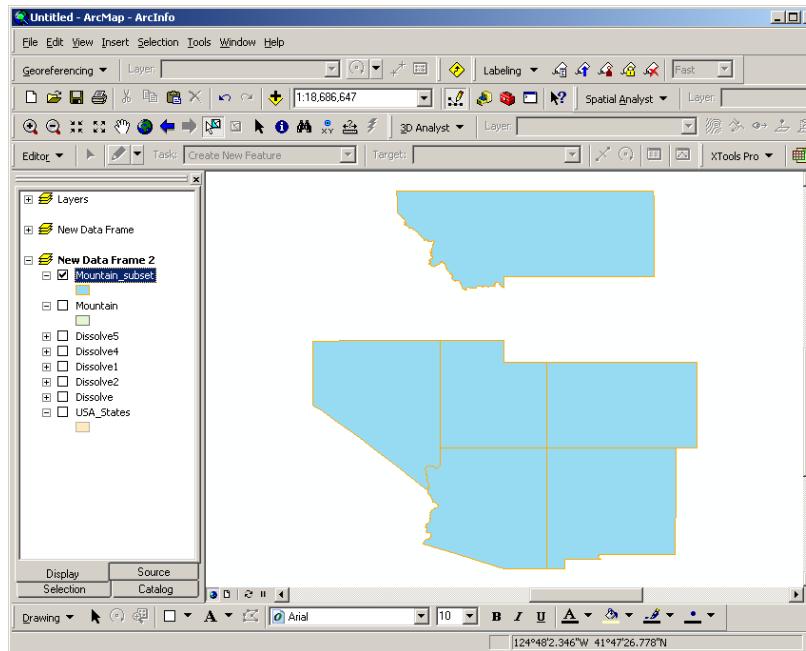
- Table of Contents (left):** Shows layers including "Florida Cities", "Join_Output_2", "USA Cities", "ROADS_Clip_Tx", "ROADS", "Rivers", "GA_Cnty_Dissolve3" (selected), "GA_Cnty", "Texas", "STATES", and "USA Counties".
- Toolbars and Menus:** Standard ArcMap menus like File, Edit, View, Insert, Selection, Tools, Window, Help, and toolbars for Selection, Layer, and 3D Analyst.
- Map View (center):** Displays a map of Georgia with a light blue dissolved county boundary.
- Attributes Table (right):** Titled "Attributes of GA_Cnty_Dissolve3", it shows one record:

FID	Shape'	STATE_FIPS
0	Polygon	13
- Message Bar (bottom):** Shows coordinates "85°20'40.66"W 35°44'45.26"N".



Vector Analysis

- Overlay Operations
 - Dissolve
 - Example: non-adjacent features



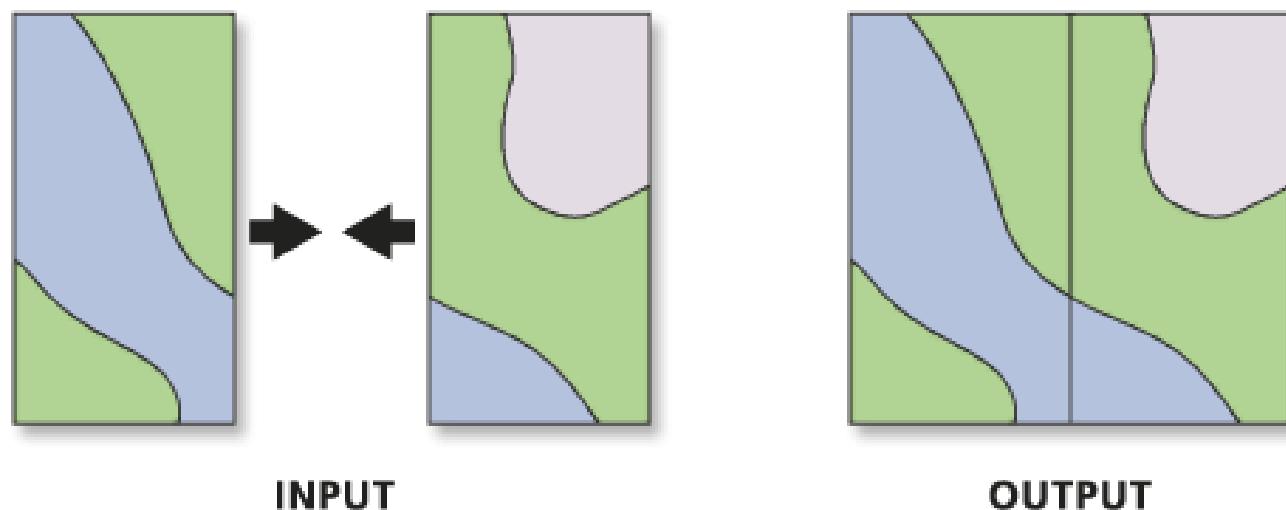


Vector Analysis

- Overlay Operations
 - Merge

- Combines input features from multiple input sources (of the same data type) into a single, new, output feature layer.
- ArcToolbox: Data Management Tools > General > Merge

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Vector Analysis

- Overlay Operations

- Merge

- Characteristics of Merge:

- The input layer can be of any feature types (point, line, or polygon).
 - » However, given a specific operation, the input features must be the same type.
 - Input data sources need not be adjacent.
 - Overlap of the input layers is allowed.
 - Can merge multiple layers at a time.
 - Can't use multiple input layers of the same name.



Vector Analysis

- Overlay Operations
 - Merge

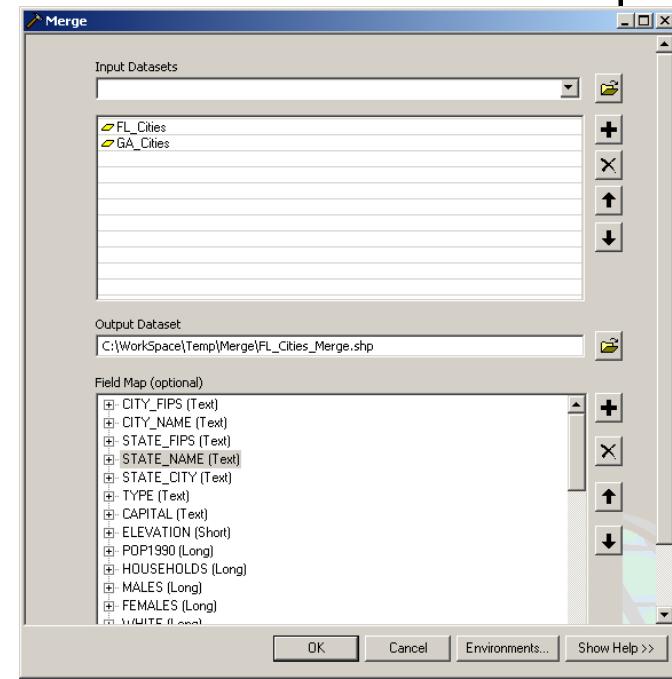
- Characteristics of Merge: ('continued)
 - This tool will not split or alter the geometries from the input datasets. All features from the input datasets will remain intact in the output dataset, even if the features overlap.
 - If no coordinate system is specified in the Environment Settings, the output feature class will be in the coordinate system of the first feature layer in the input features list.



Vector Analysis

- Overlay Operations
 - Merge

- Characteristics of Merge: ('continued)
 - The order in which you select fields determines the order in which their values will be displayed in the output field. When joining several input fields into a single output field, the output fields' values will be generated based on the order the input fields were chosen.
 - The order can be modified.





Vector Analysis

- Overlay Operations
 - Merge
 - Example: merge adjacent features

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The screenshot shows two ArcMap windows. The left window displays a map of the western United States with state boundaries. The 'Merge' tool is selected in the 'Editor' toolbar, and the 'Merge' dialog is open in the center-left pane. It lists several states: USA_Cities, ROADS, Pacific, TX, FL, WA, OR, CA, and USA_States. The 'WA' and 'OR' checkboxes are checked. The right window shows a detailed view of the Pacific Northwest states (Washington, Oregon, and California) with their respective state names labeled. A smaller window titled 'Attributes of Pacific' is open at the bottom right, showing a table of attributes for the merged feature.

FID	Shape *	AREA	STATE_NAME	STATE_FIPS	SUB_REGION
0	Polygon	157776.31	California	06	Pacific
1	Polygon	97073.594	Oregon	41	Pacific
2	Polygon	67290.061	Washington	53	Pacific



Vector Analysis

- Overlay Operations
 - Merge
 - Example: merge non-adjacent features

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The screenshot shows two ArcMap sessions side-by-side. The left session displays a map of the western United States with states Washington, Oregon, California, Texas, Florida, and others colored in various shades of blue and purple. A legend on the left lists 'Merge' operations for USA_Cities, ROADS, and several states (TX, FL, WA, OR, CA). The right session shows a similar map with a 'Merge' operation for 'FL_Merge' selected. The 'Attributes of FL_Merge' table is open, listing the following data:

FID	Shape *	AREA	STATE_NAME	STATE_FIPS	SUB_REGION	S
0	Polygon	55814.731	Florida	12	S Atl	FL
1	Polygon	264435.873	Texas	48	W S Cen	TX
2	Polygon	97073.594	Oregon	41	Pacific	OF
3	Polygon	67290.061	Washington	53	Pacific	WA
4	Polygon	157776.31	California	06	Pacific	CA

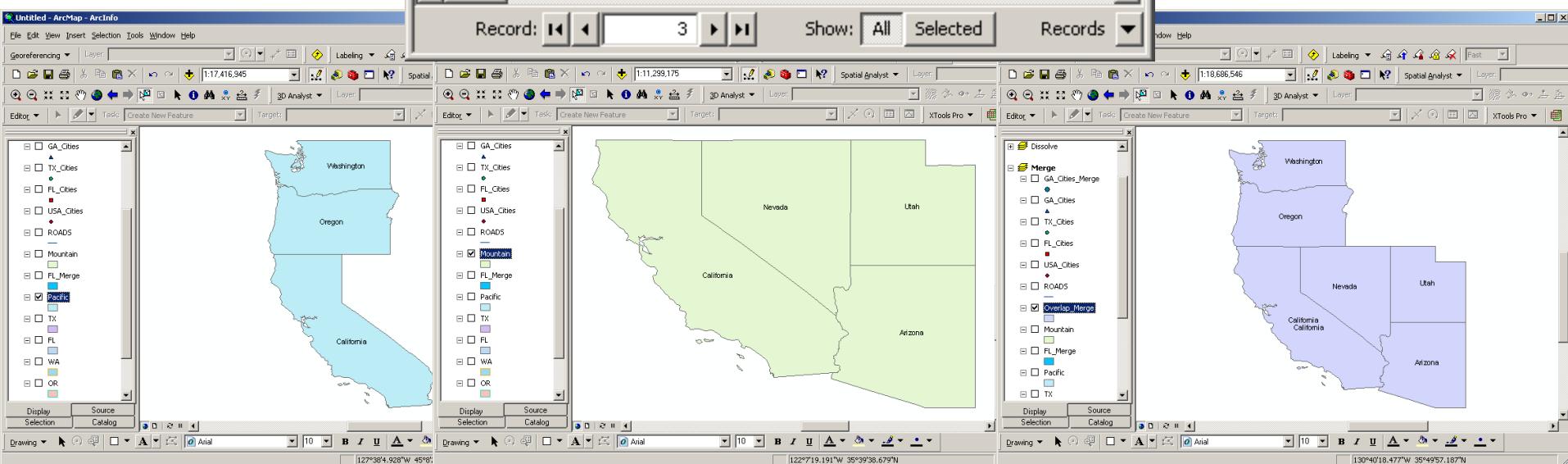


Vector Analysis

- Overlay Operations
 - Merge
 - Example: merge overlapped features

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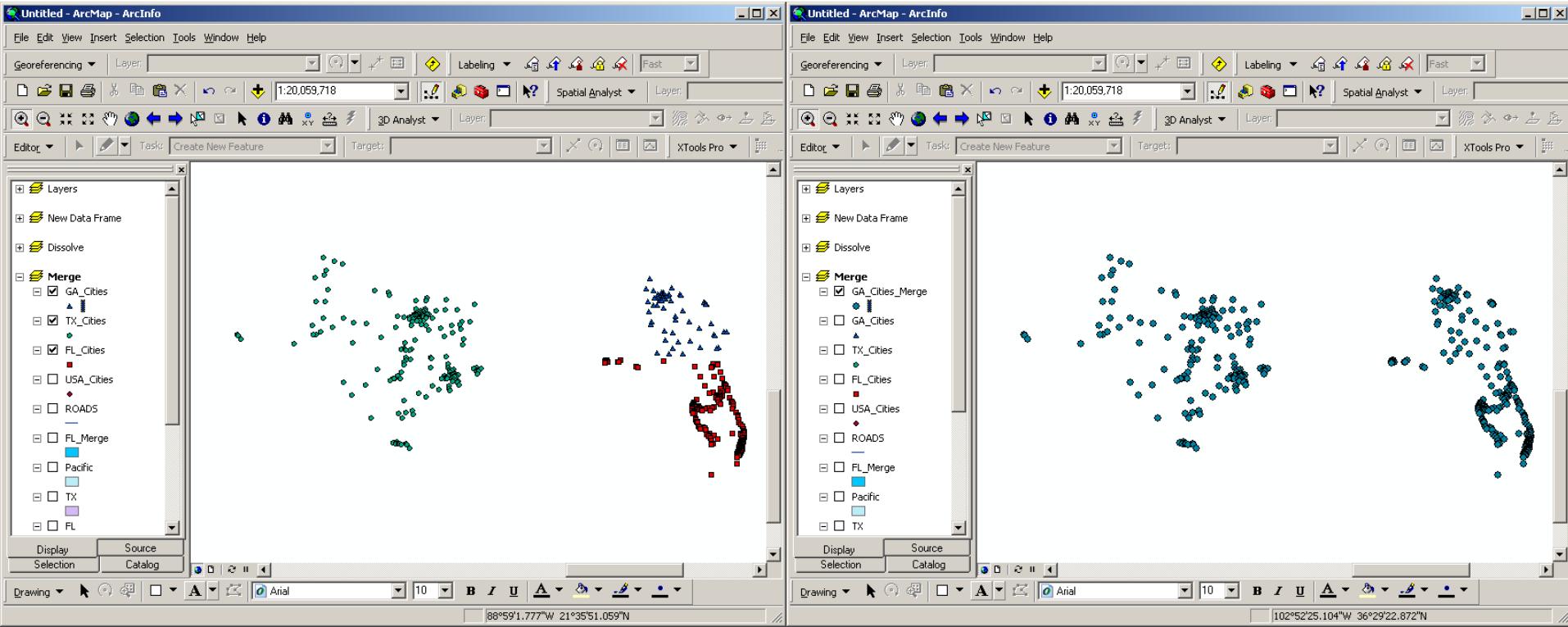
FID	Shape *	AREA	STATE_NAME	STATE_FIPS	SUB_REGION
0	Polygon	110669.975	Nevada	32	Mtn
1	Polygon	84871.909	Utah	49	Mtn
2	Polygon	157776.31	California	06	Pacific
3	Polygon	113712.679	Arizona	04	Mtn
4	Polygon	157776.31	California	06	Pacific
5	Polygon	97073.594	Oregon	41	Pacific
6	Polygon	67290.061	Washington	53	Pacific





Vector Analysis

- Overlay Operations
 - Merge
 - Example: merge point features





Vector Analysis

- Overlay Operations

- Erase

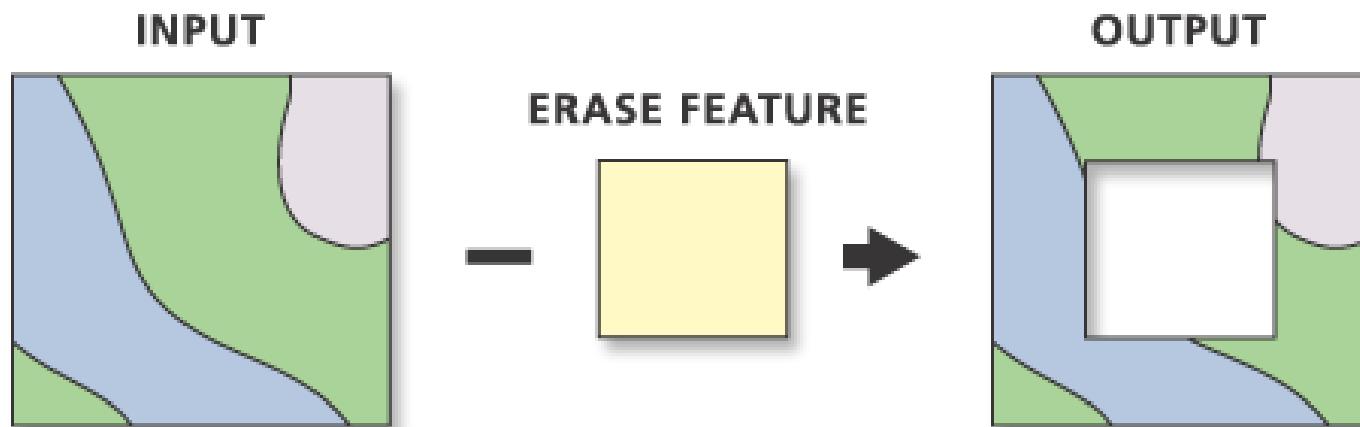
- Overlaying the Input Features with the Erase Feature which defines the erasing area.
 - Input features or portions of input features that do not overlap erase features are written to the output feature layer.
 - Input Features or portions of input features that overlap the Erase Features are not written to the output feature layer.
 - The output feature has the same attributes as that of the input feature.



Vector Analysis

- Overlay Operations
 - Erase
 - Just like a cookie cutter.

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Vector Analysis

- Overlay Operations

- Erase

- Characteristics of Erase:

- Input Features can be points, lines, or polygons.
 - Typically the Erase Feature is smaller than the Input Feature in terms of spatial extent.
 - The restrictions on the types of Erase Features have changed.
 - » Before 10.0, the Erase Features must be polygons.
 - » After 10.0, the Erase Features can be point, lines, and polygons.



Vector Analysis

- Overlay Operations

- Erase

- Characteristics of Erase: ('continued)

- A polygon erase feature can be used to erase polygons, lines, or points from the input features
 - A line erase feature can be used to erase lines or points from the input features.
 - » **Exercise 1:** coincident vs. non-coincident?
 - » **Exercise 2:** Line Erase Feature + Point Input Feature?
 - A point erase feature can be used to erase points from the input features.
 - Output Features will be of the same geometry type as Input Features.
 - Input Feature polygons that are coincident with Erase Feature polygons will be removed.



Vector Analysis

- Overlay Operations
 - Erase
 - Example:

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The screenshot shows the ArcMap interface with several windows open. In the main map window, a road network is displayed over a background of state boundaries. A legend on the left identifies various layers, including 'ROADS' (selected), 'Mountain', and 'Overlap_Merge'. An 'Erase' dialog box is prominently displayed, showing 'ROADS' as the 'Input Features' and 'Mountain' as the 'Erase Features'. The 'Output Feature Class' is set to 'C:\WorkSpace\Temp\Erase.shp'. To the right of the dialog is a 'Attributes of Erase' table listing seven records of Polyline features. Below the dialog is a 'Layers' list showing a hierarchy of data frames, merges, and specific layers like 'GA_Cities_Merge' and 'Mountain'. Another 'Layers' list is visible at the bottom right.

FID	Shape *	LENGTH	TYPE	ADMN_CLASS	TOLL_RD	RTE
0	Polyline	140.931	Multi-Lane Divided	Interstate	N	82
1	Polyline	186.06	Multi-Lane Divided	Interstate	N	84
2	Polyline	8.642	Multi-Lane Divided	Interstate	N	94
3	Polyline	9.439	Multi-Lane Divided	Interstate	N	94
4	Polyline	8.208	Multi-Lane Divided	Interstate	N	35
5	Polyline	22.106	Multi-Lane Divided	Interstate	N	494
6	Polyline	18.154	Multi-Lane Divided	Interstate	N	35



Vector Analysis

- Overlay Operations
 - Erase
 - What if the input layer is coincident with the erase feature?
 - Example:

90

The screenshot shows the ArcGIS interface with the 'Erase' tool open. The 'Erase' dialog box is in the foreground, displaying settings for erasing 'TX_Cities' features from 'TX'. The output feature class is set to 'C:\WorkSpace\Temp\Merge\TX_Cities_Erase.shp'. A map view in the background shows a map of Texas with city locations. An 'Attributes of TX_Cities_Erase' table window is also visible, showing a single record for the erased feature.

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Erase

Input Features: TX_Cities

Erase Features: TX

Output Feature Class: C:\WorkSpace\Temp\Merge\TX_Cities_Erase.shp

XY Tolerance (optional): Decimal degrees

OK Cancel Environments... Show Help >

Attributes of TX_Cities_Erase

FID	Shape *	CITY_FIPS	CITY_NAME	ST

Layers

- New Data Frame
- Dissolve
- Merge
 - TX_Cities_Erase
 - GA_Cities_Merge
 - TX_Cities
 - FL_Cities
 - USA_Cities
 - Erase
 - ROADS
 - Overlap_Merge
- Proximity
 - Buffer
 - Create Thiessen F
 - Multiple Ring Buff
 - Near
 - Point Distance
- Statistics
- Cartography Tools
- Conversion Tools
- Data Interoperability Tool
- Data Management Tools
 - Data Comparison
 - Database

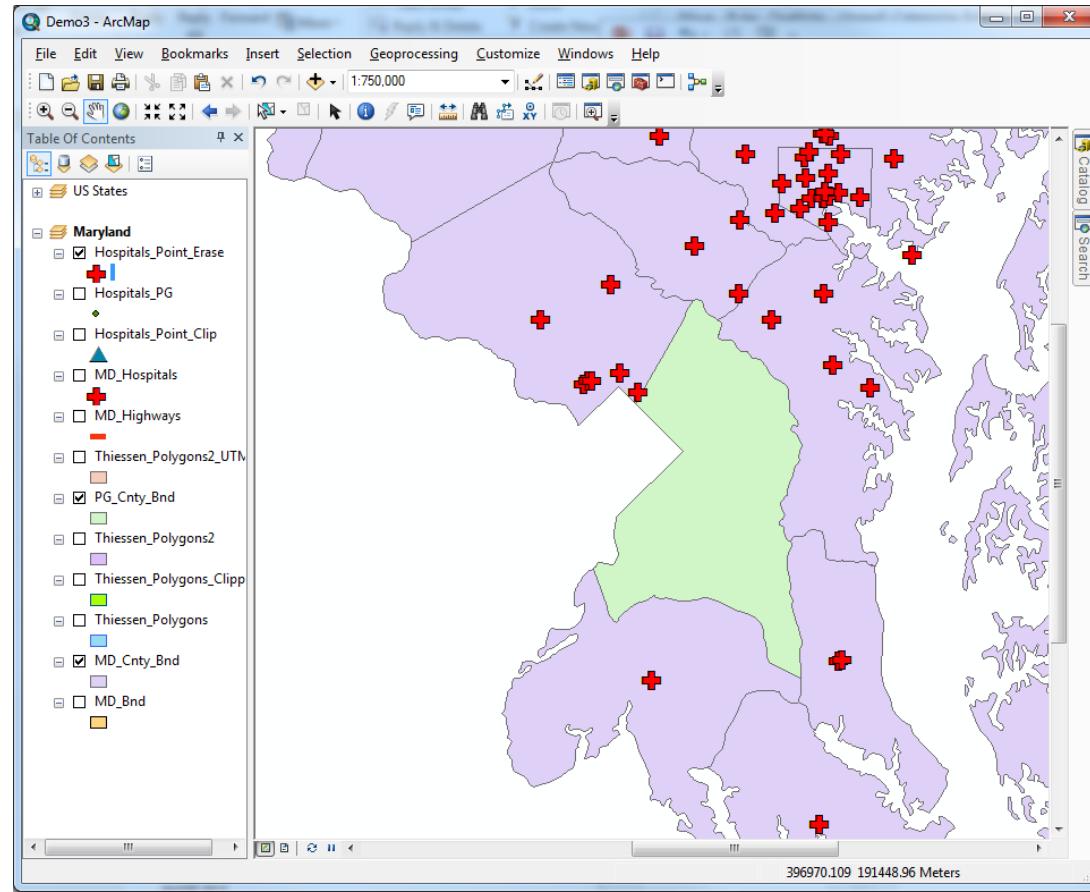
Dept.

Drawing Selection Catalog Favorites Index Search E Drawing 10 B I U Aerial 124°38'37.725"W 51°18'54.218"N



Vector Analysis

- Overlay Operations
 - Erase
 - Example: (both the input and erase features are points)





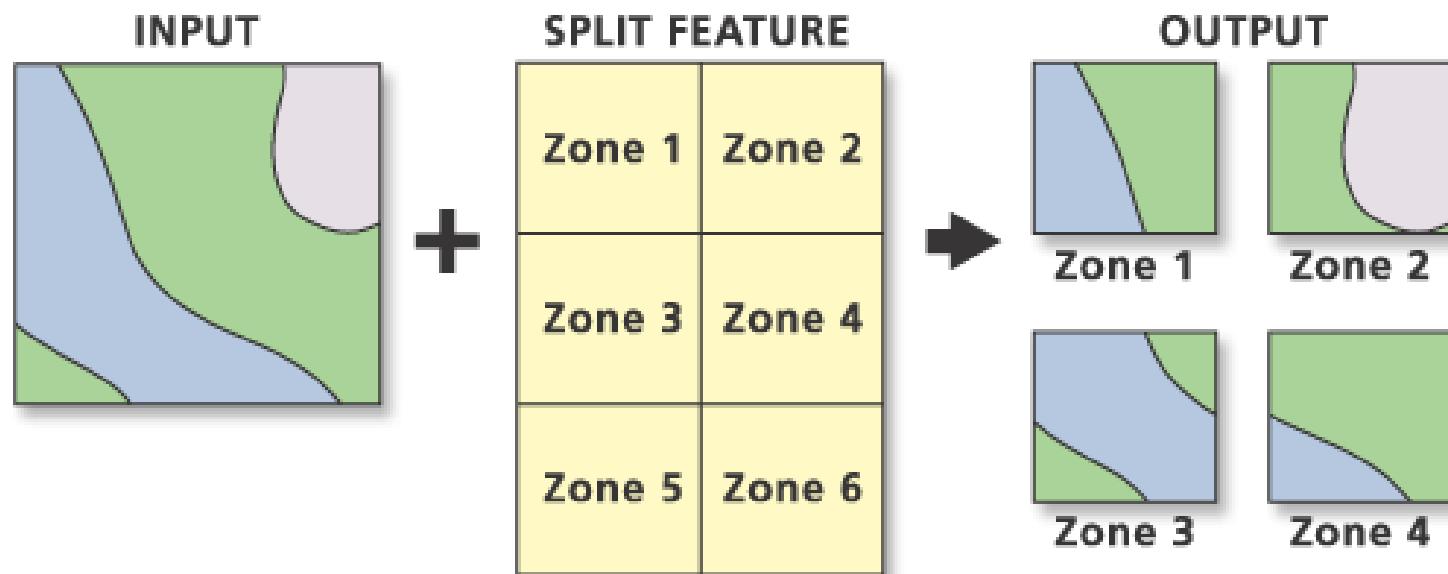
Vector Analysis

- Overlay Operations
 - Split
 - Breaks the Input Features into multiple output feature layers.
 - The boundary of each unique value in the Split Field is used to split the Input Features.
 - The feature attribute table for output feature layers contains the same items as the Input Features attribute table.



Vector Analysis

- Overlay Operations
 - Split





Vector Analysis

- Overlay Operations

- Split

- Characteristics of Split:

- The Split Features must be polygons.
 - The Split Field data type must be character.
 - The output feature layers will be named for Split Field values.
 - The number of output feature layers equals the total number of unique values in the Split Field.
 - The Target Workspace must already exist.
 - The Target Workspace for saving those multiple output layers can not be overwritten.



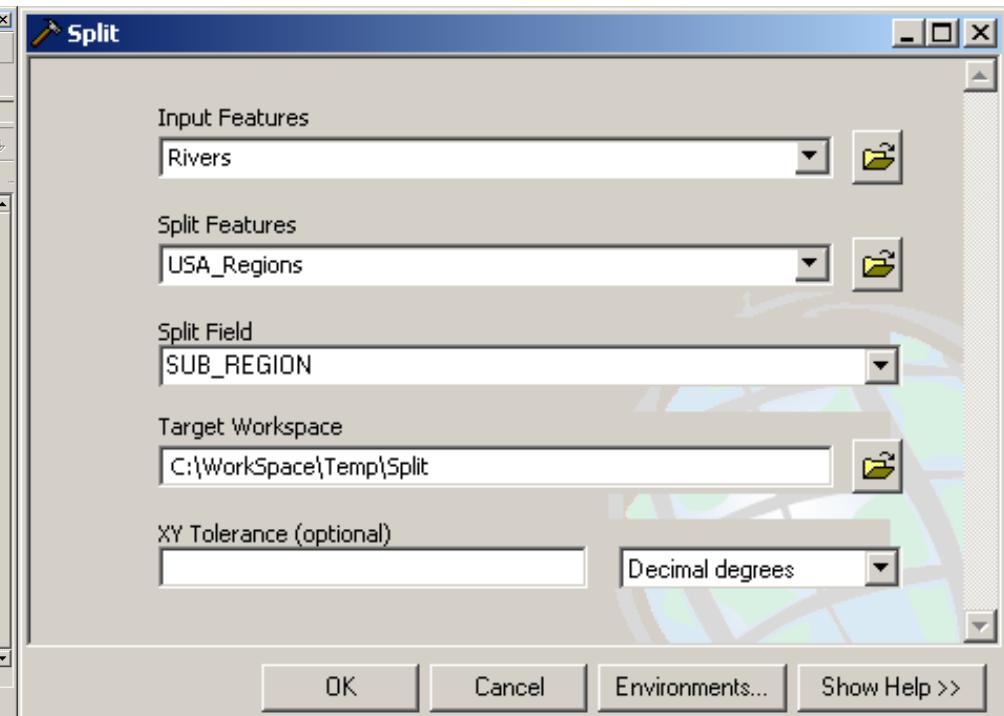
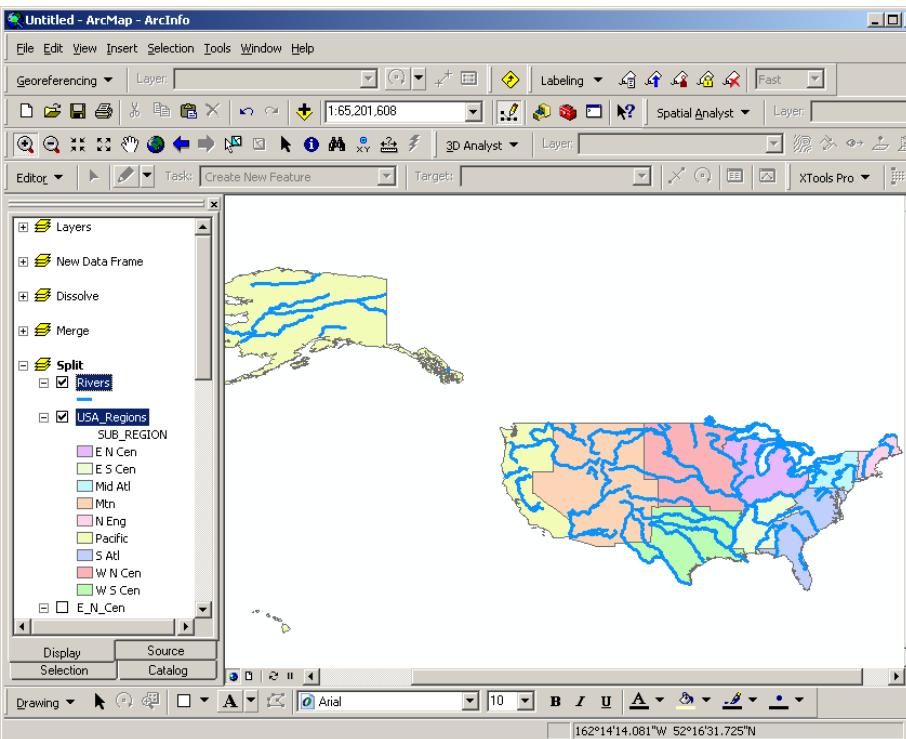
Vector Analysis

- Overlay Operations
 - Split
 - Characteristics of Split: ('continued)
 - The split field's unique values must start with a valid character. If the target workspace is a file, personal, or ArcSDE geodatabase, the field's values must begin with a letter.
 - » Exception: Shapefile names can begin with a number, and a folder target workspace allows field values that begin with a number.
 - » Example: using State FIPs which are numbers but can be defined as text/string data type.
 - **Exercise:** use a dataset to test and verify these restrictions.



Vector Analysis

- Overlay Operations
 - Split
 - Example:

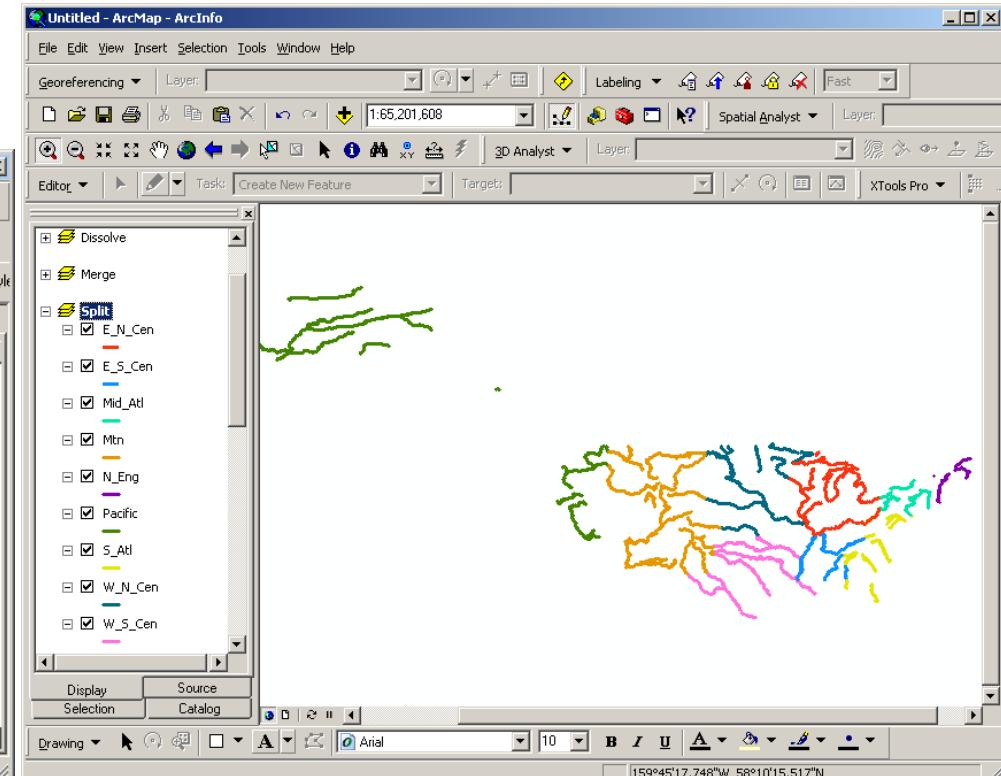
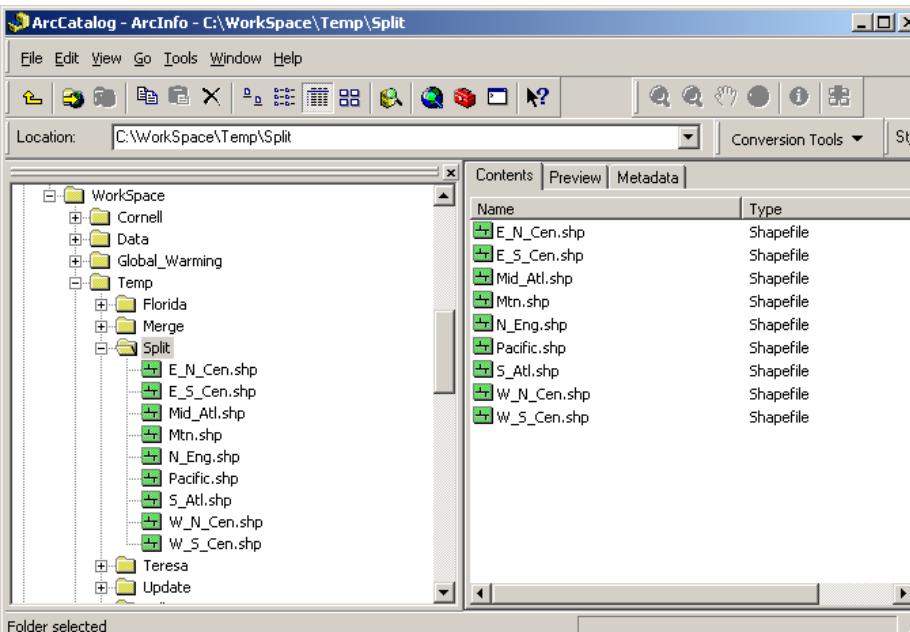




Vector Analysis

- Overlay Operations
 - Split
 - Example: ('continued)

97





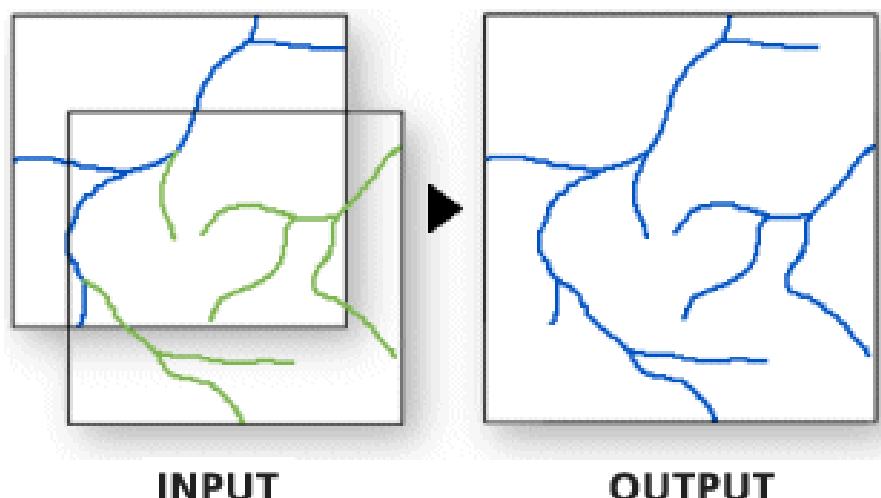
Vector Analysis

- Overlay Operations
 - Append
 - Appends multiple input dataset into an already existing target dataset.
 - Input datasets can be point, line or polygon feature classes, tables, rasters or raster catalogs.



Vector Analysis

- Overlay Operations
 - Append





Vector Analysis

- Overlay Operations

- Append

- Characteristics of Append:

- When the inputs are features, all input features must be of the same feature type as the features of the target dataset.
 - » For example, if the target feature class contains polygon features, the input features types must be polygon as well.
 - Input datasets may overlap one another and/or the target dataset.
 - All features from both the input feature class and the target feature class will remain intact after the append, even if the features overlap.
 - Input datasets in a different coordinate system from the target feature class will be projected into the coordinate system of the target feature class.

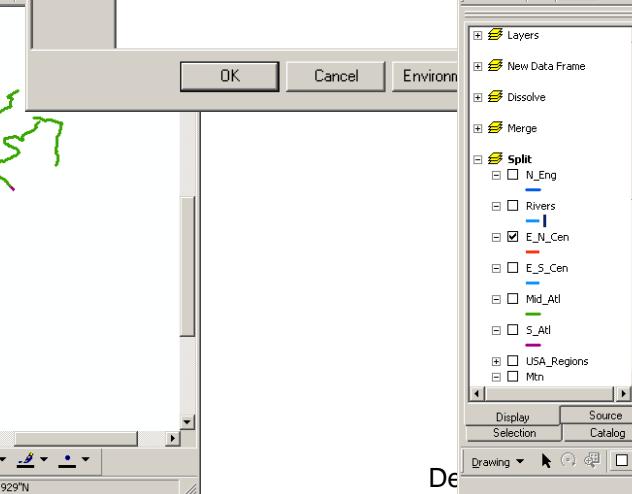
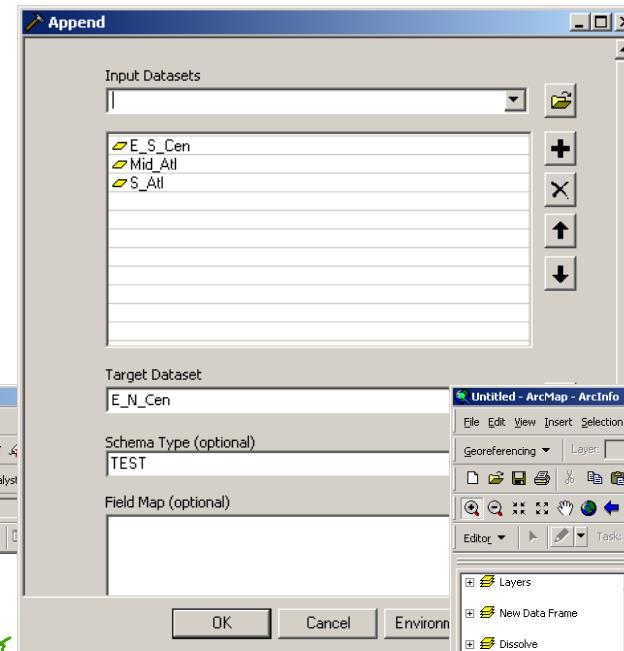
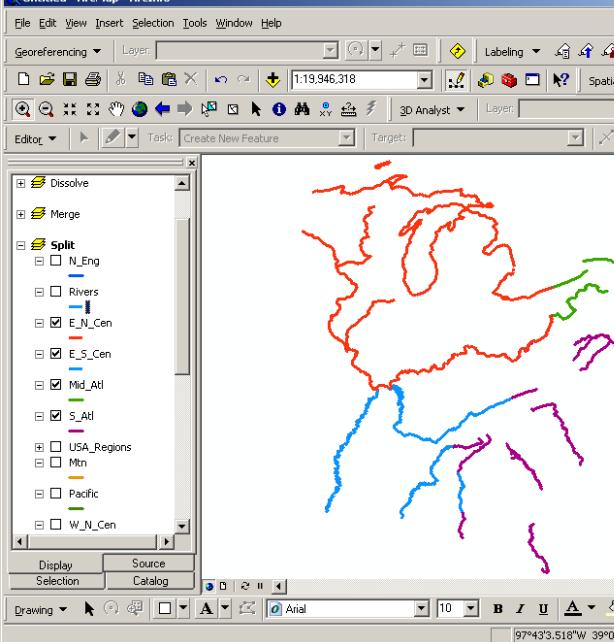


Vector Analysis

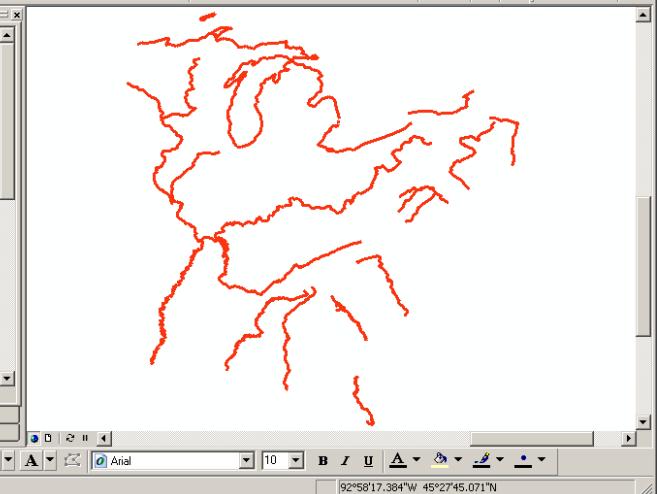
- Overlay Operations
 - Append
 - Example:

101

Untitled - ArcMap - ArcInfo



De



92°58'17.384"W 45°27'45.071"N



Vector Analysis

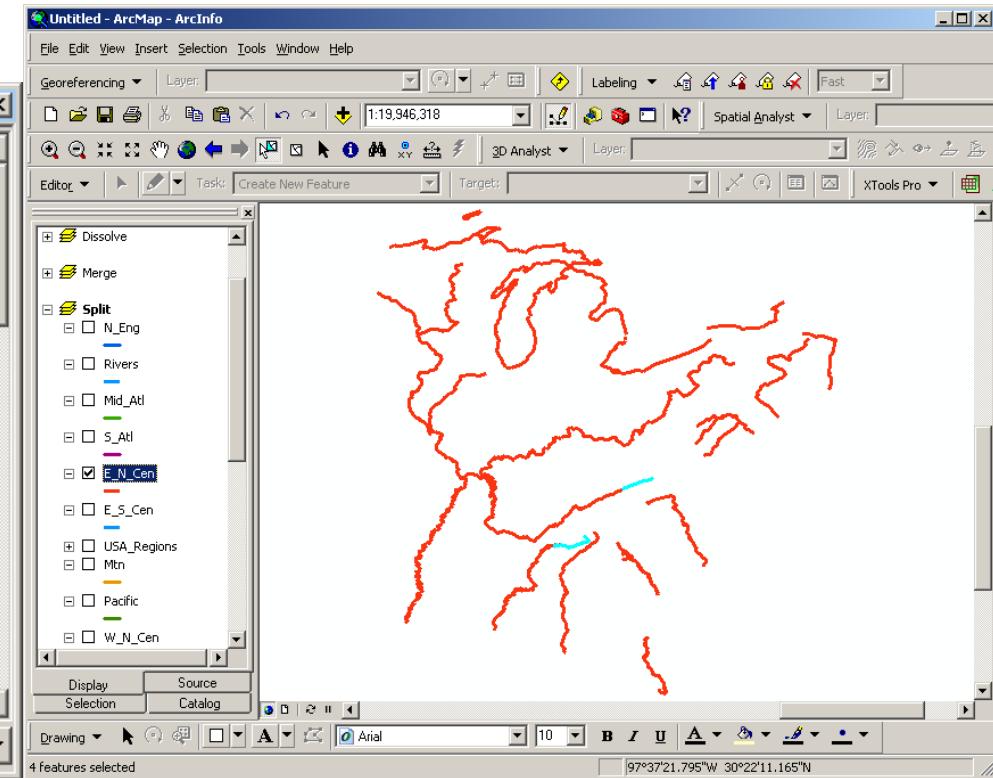
- Overlay Operations
 - Append
 - Example:

- Input features from all the input feature classes remain intact in the target feature class, i.e. not planarized.

Attributes of E_N_Cen

FID	Shape *	NAME	SYSTEM
0	Polyline	Niagara	St. Lawrence
1	Polyline	Niagara	St. Lawrence
2	Polyline	St. Clair	St. Lawrence
3	Polyline	St. Clair	St. Lawrence
4	Polyline	Illinois	Mississippi
5	Polyline	Illinois	Mississippi
6	Polyline	Mississippi	Mississippi
7	Polyline	Mississippi	Mississippi
8	Polyline	Mississippi	Mississippi
9	Polyline	Missouri	Mississippi
10	Polyline	Missouri	Mississippi
11	Polyline	Niagara	St. Lawrence
12	Polyline	Niagara	St. Lawrence
13	Polyline	Ohio	Mississippi
14	Polyline	Ohio	Mississippi
15	Polyline	St. Clair	St. Lawrence
16	Polyline	St. Clair	St. Lawrence
17	Polyline	Wisconsin	Mississippi
18	Polyline	Wisconsin	Mississippi

Record: 1 Show: All Selected Records (0 out of 61)





Vector Analysis

- Overlay Operations
 - Update
 - It computes a geometric intersection of the Input Features and Update Features.
 - The attributes and geometry of the Input Features are updated by the Update Features.
 - The Input Features or portions of input features that do not overlap Update Features will be written to the Output Feature Class.
 - The Input Features or portions of Input Features that overlap update features **will be erased**, and the update features will be written to the Output Feature Class.



Vector Analysis

- Overlay Operations
 - Update



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Vector Analysis

- Overlay Operations
 - Update

- Characteristics of Update:

- The original input will not be modified by this operation.
- The Input Features and Update Features must be polygon.
- The Input Features and Update Features field names must match.
 - » If the update feature class is missing one (or many) of the fields that are present in the input feature class, the input feature class field value for the missing fields will be removed from the output feature class.



Vector Analysis

- Overlay Operations
 - Update
 - Example: (ArcGIS Pro)
 - Input Features: AZ; Update Feature: Lake Mead

The Input Features or portions of input features that do not overlap Update Features will be written to the Output Feature Class.

The Input Features or portions of Input Features that overlap update features will be erased, and the update features will be written to the Output Feature Class.

ArcGIS Pro - Overlay_2 - Map

Feature Layer

Analysis

Contents

Catalog

Map

Geoprocessing

Project

Map

Insert

Analysis

View

Edit

Imagery

Share

Appearance

Labeling

Data

Jianguo (University of Maryland)

History Python ModelBuilder Environments Tools Ready To Use Tools Portal

Geoprocessing

Spatial Join

Intersect

Union

Buffer

Network Analysis

Geostatistical Wizard

Raster Functions

Function Editor

Workbench

Tools

Raster

Data Inter...

Geoprocessing

Catalog

Map

Geoprocessing

Update

Parameters | Environments

Input Features: AZ_bnd

Update Features: Lake_Mead

Output Feature Class: AZ_bnd_Update

Borders

XY Tolerance: Decimal Deg

Drawing Order

Map

Lake_Mead_Intersect

Lake_Mead

AZ_bnd

Esri World Topographic Map

1:3,223,115 113.1448255°W 35.1943065°N

AZ_bnd_Update

Field	Add	Delete	Calculate	Selections	Zoom To	Switch	Clear	Delete
OBJECTID_1								
1	Polygon	36	Arizona	04	Mountain	AZ	5130632	6363799
2	Polygon	5					0	0

Click to add new row.

0 of 2 selected

Run

Completed successfully

Catal... Geop... Sym... Direc...

Dept. of Geographical Sciences, University of Maryland at College Park



Vector Analysis

- Overlay Operations
 - Update
 - Example: (ArcGIS Pro)
 - Input Features: Lake Mead; Update Feature: AZ

The Input Features or portions of input features that do not overlap Update Features will be written to the Output Feature Class.

The Input Features or portions of Input Features that overlap update features will be erased, and the update features will be written to the Output Feature Class.

The screenshot shows the ArcGIS Pro interface with a spatial analysis process named "Overlay_2 - LakeMead_bnd_Update".

Contents View: Displays a map of Lake Mead and surrounding areas. A large blue polygon representing the "AZ.bnd" update feature covers most of the lake. Other layers include "Lake_Mead_Intersect" (light green), "Lake_Mead" (dark green), and "AZ.bnd" (orange).

Geoprocessing Tab: Shows the "Update" tool selected under the "Geoprocessing" tab. The "Parameters" pane shows:

- Input Features: AZ.bnd
- Update Features: Lake_Mead
- Output Feature Class: AZ_Update
- Borders: checked
- XY Tolerance: Decimal Deg

Map View: Shows the resulting output features. The "LakeMead_bnd_Update" layer contains two features: one blue polygon representing the portion of the lake not overlapping AZ.bnd, and one orange polygon representing the portion that does overlap.

Table View: Shows the attribute table for the "LakeMead_bnd_Update" layer.

OBJECTID	Shape	ObjectID	AREA	NAME	Shape_Length	Shape_Area
1	Polygon	5	317.56	Lake Mead	3.11835	0.04596
2	Polygon	36	0		23.25727	28.85909

Status Bar: Shows "Completed successfully" for the update operation.



Vector Analysis

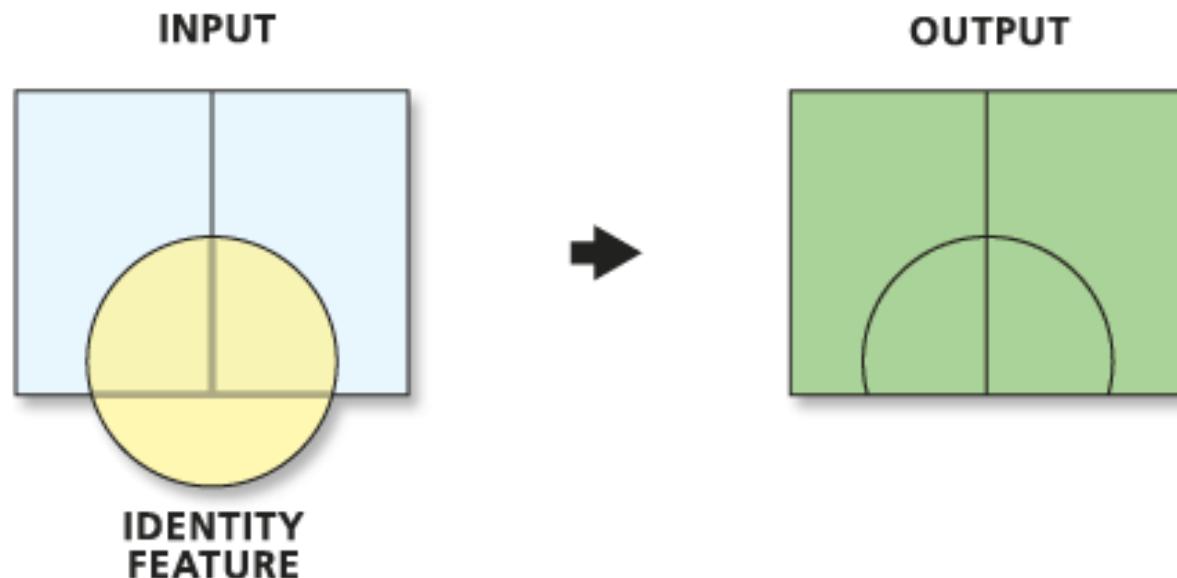
- Overlay Operations
 - Identity

- Computes a geometric intersection of the Input Features and Identity Features.
- Input Features or portions of Input Features that do not overlap Identity Features are written to the output.
- Input features or portions of Input Features that overlap Identity Features get the attribute information from the Identity Feature and are written to the output.



Vector Analysis

- Overlay Operations
 - Identity





Vector Analysis

- Overlay Operations
 - Identity

- Characteristics of Identity:

- The input features can be points, lines or polygons.
- The inputs cannot be annotation features, dimension features, or network features.
- The Identity Features must be polygons or have the same geometry type as the Input Features.
 - » Before 10.0, the Identity Features must be polygons.



Vector Analysis

- Overlay Operations
 - Identity
 - Example: Input: AZ; Identity Feature: Lake Mead

Input Features or portions of Input Features that do not overlap Identity Features are written to the output. Input features or portions of Input Features that overlap Identity Features get the attribute information from the Identity Feature and are written to the output.

ArcGIS Pro - Overlay_2 - AZ_bnd_Identity

Contents

- Map
- AZ_bnd_Identity
- AZ_Update
- LakeMead_bnd_Update
- Lake_Mead_Intersect
- Lake_Mead
- AZ_bnd
- Esri World Topographic Map

Map

1:1,223,115 111.7336788°W 37.5257664°N

AZ_bnd_Identity

Field	Add	Delete	Calculate	Selection:	Zoom To	Switch	Clear	Delete
OBJECTID_12				36	Arizona	04	Mountain	AZ
Shape				0				5130632
ObjectID								6363799
STATE_NAME								
STATE_FIPS								
SUB_REGION								
STATE_ABBR								
POP2000								
POP2007								
POP00								



Vector Analysis

- Overlay Operations
 - Identity

- Example: Input: Lake Mead; Identity Feature: AZ

Input Features or portions of Input Features that do not overlap Identity Features are written to the output. Input features or portions of Input Features that overlap Identity Features get the attribute information from the Identity Feature and are written to the output.

The screenshot shows the ArcGIS Pro interface with the 'Analysis' tab selected. The map view displays the Colorado River and Lake Mead. The 'Geoprocessing' pane on the right shows the 'Identity' tool is currently running. The 'Parameters' section specifies 'Input Features' as 'Lake_Mead' and 'Identity Features' as 'AZ_bnd'. The 'Table' view at the bottom shows the resulting feature class 'LakeMead_identity' with two entries:

OBJECTID_12	Shape	FID_Lake_Mead	ObjectID	AREA	NAME	FID_AZ_bnd	ObjectID	STATE_NAME	STATE_FIPS	SUB_I
1	Polygon	0	5	317.56	Lake Mead	-1	0			
2	Polygon	0	5	317.56	Lake Mead	0	36	Arizona	04	Mount



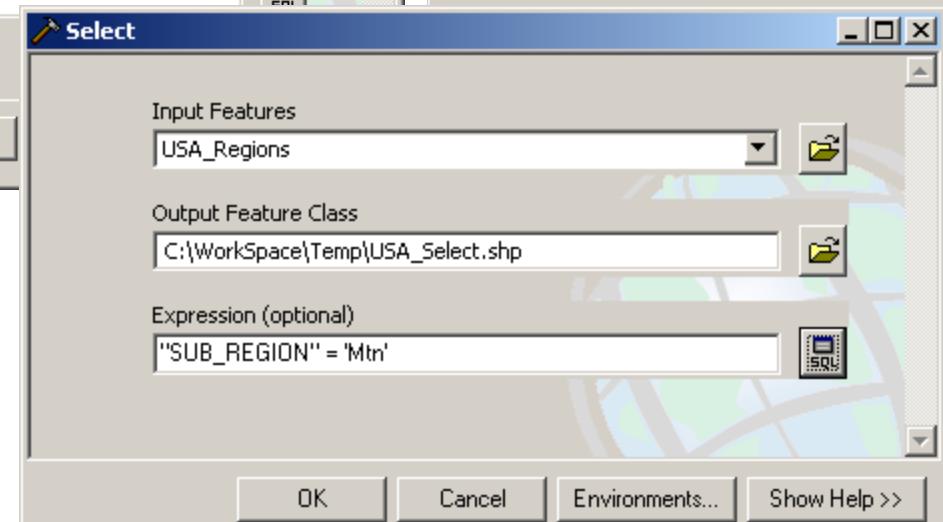
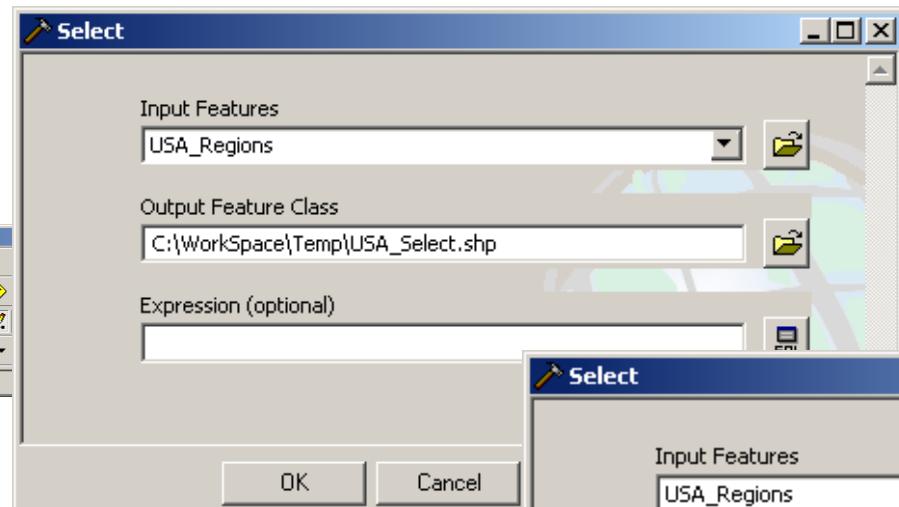
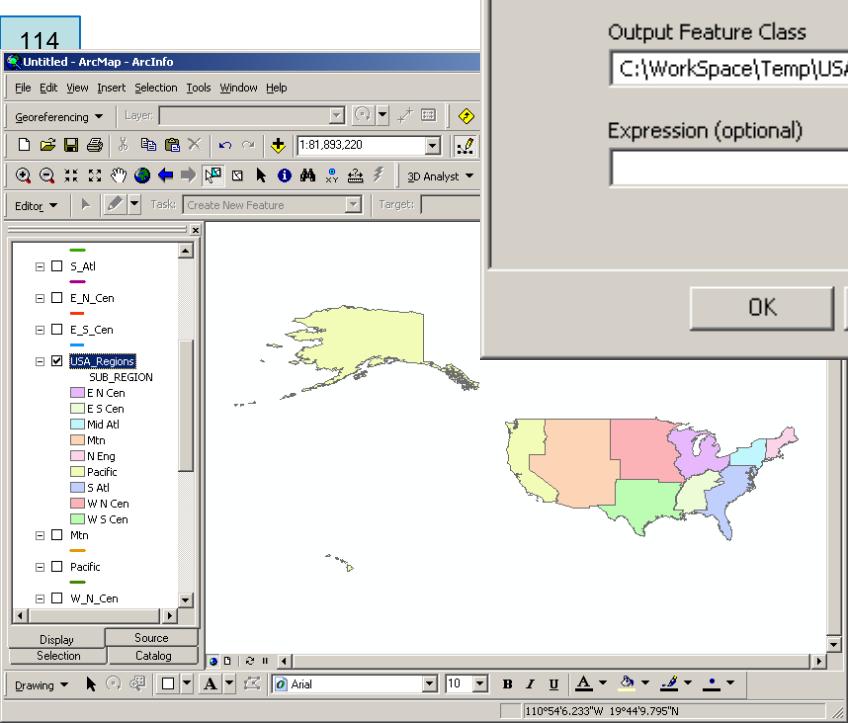
Vector Analysis

- Overlay Operations
 - Select
 - Extracts features from an input feature class or input feature layer and stores them in a new output feature class.
 - The output feature class may be created with a subset of features based on a Structured Query Language (SQL) expression.
 - If no SQL expression is included, then all features will be included in the output feature class.
 - If a SQL expression is used but returns nothing, the output feature class will be empty.



Vector Analysis

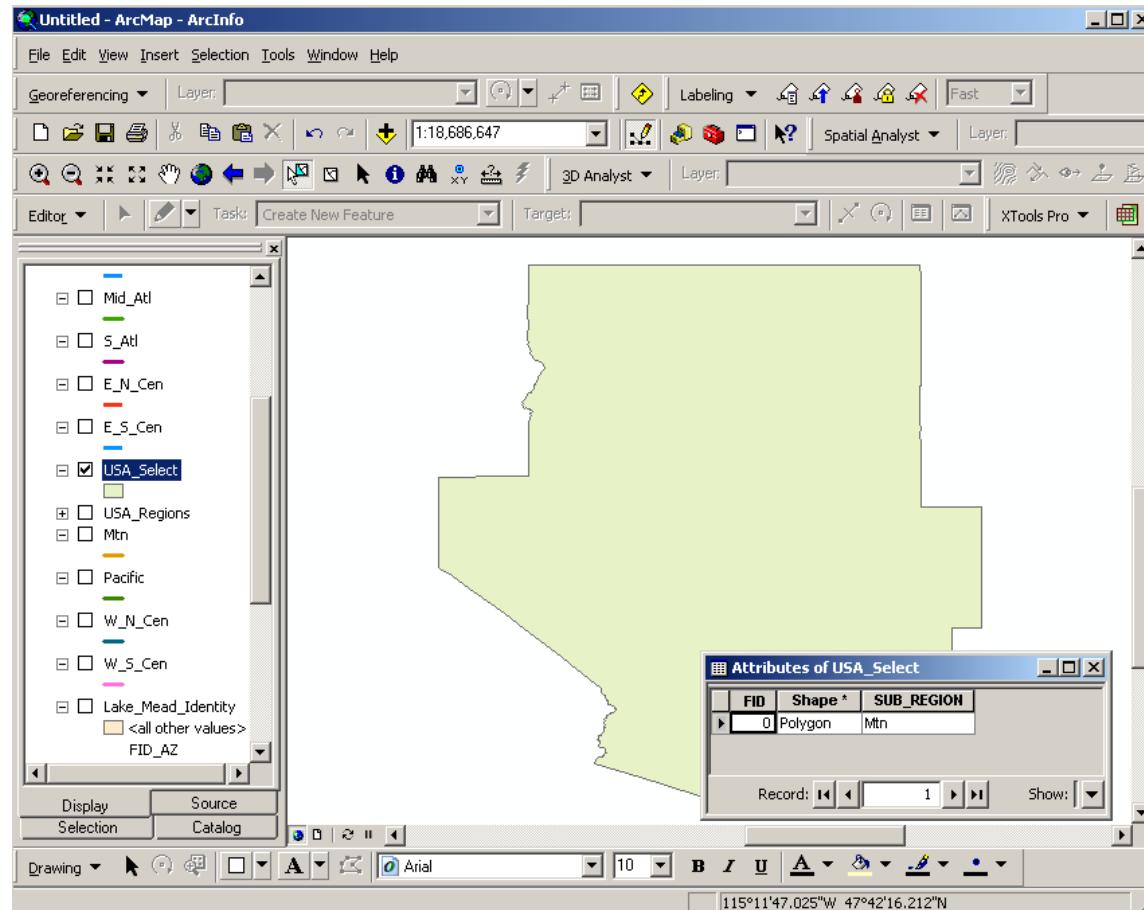
- Overlay Operations
 - Select
 - Example:





Vector Analysis

- Overlay Operations
 - Select
 - Example:





Vector Analysis

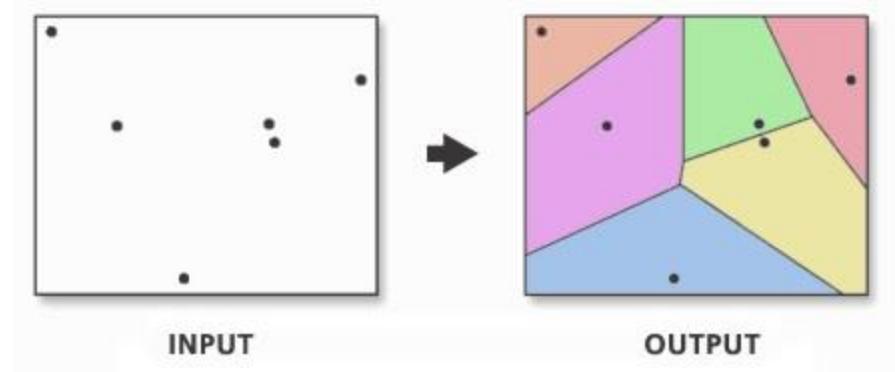
- Overlay Operations
 - Create Thiessen Polygons
 - This tool creates Thiessen polygons from point input features.
 - Each Thiessen polygon contains only a single point input feature. Any location within a Thiessen polygon is closer to its associated point than to any other point input feature.



Vector Analysis

- Overlay Operations
 - Create Thiessen Polygons
 - This tool is used to divide the area covered by the point input features into Thiessen or proximal zones. These zones represent full areas where any location within the zone is closer to its associated input point than to any other input point.

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Vector Analysis

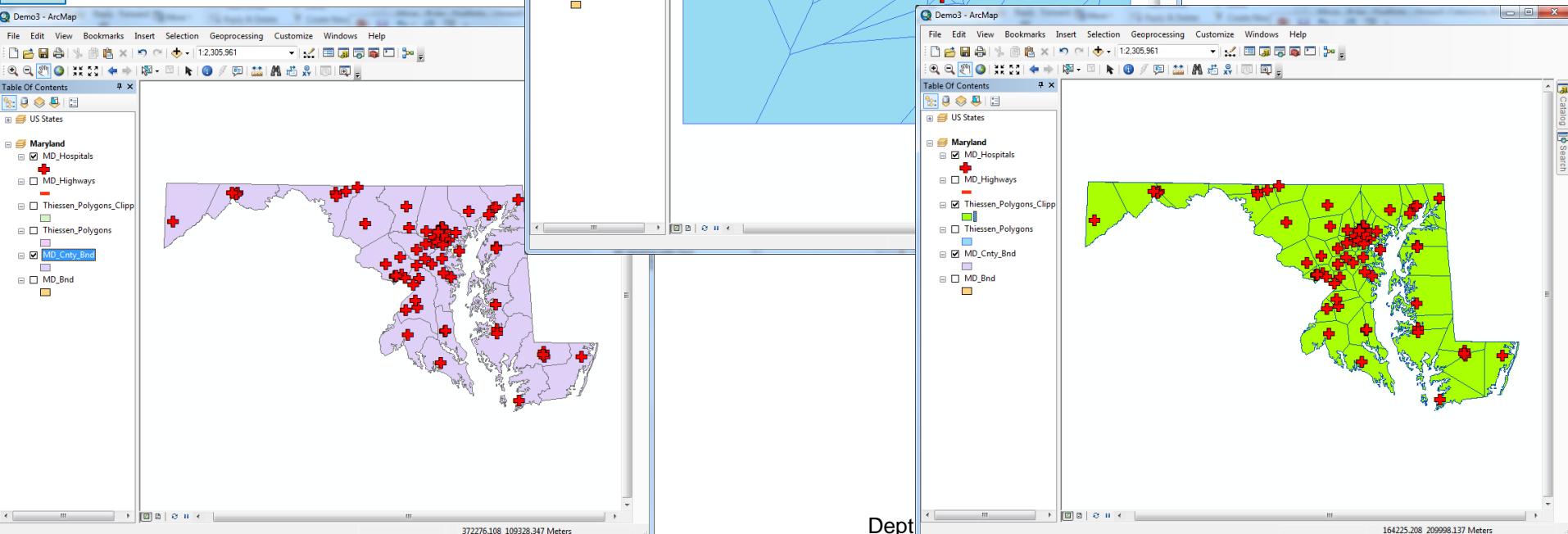
- Overlay Operations
 - Create Thiessen Polygons
 - Characteristics:
 - The outside boundary of the output Thiessen polygon feature class is the extent of the point input features plus an additional 10%. If the Extent environment is set to a specific extent window, this tool will use the environment setting to set its outside boundary.
 - » **Exercise:** Use a dataset to verify it. (Make sure the data is projected and that the spatial extents are compared based on the same coordinate system.)
 - This tool may produce unexpected results with data in a geographic coordinate system since the Delaunay triangulation method used by the tool works best with data in a projected coordinate system.



Vector Analysis

- Overlay Operations
 - Create Thiessen Polygons
 - Example:

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Dept

164225.208 209998.137 Meters



Vector Analysis

- Overlay Operations
 - Create Thiessen Polygons
 - Example:

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The figure consists of three side-by-side screenshots of the ArcGIS Pro interface, illustrating the process of creating Thiessen Polygons.

Screenshot 1 (Left): Shows a map of Washington, D.C. with numerous red location markers representing fire stations. A large green polygon, representing a Thiessen Polygon, is drawn around a specific cluster of stations in the northern part of the city. The map also displays roads, rivers, and other geographical features. The ArcGIS Pro ribbon at the top includes tabs for Project, Map, Insert, Analysis, View, Edit, Imagery, Share, Appearance, Labeling, and Data. The Analysis tab is selected. The ribbon bar also has icons for History, Python, ModelBuilder, Environments, Tools, Ready To Use Tools, Feature Analysis, Raster Analysis, and Portal.

Screenshot 2 (Middle): Shows the "Create Thiessen Polygons" tool dialog box. It lists the "Input Features" as "Fire_Stations" and the "Output Feature Class" as "Fire_Stations_CreateThiessen". Other options like "Only Feature ID" are visible. Below the dialog is a preview window showing the Thiessen polygons overlaid on the map. The map shows the same red station markers and green polygon as the first screenshot.

Screenshot 3 (Right): Shows the final result where the Thiessen polygons have been created. The map now displays a complex network of blue polygons, each encompassing a group of red station markers. The map includes labels for neighborhoods like McLean, Falls Church, and Arlington. The ArcGIS Pro ribbon and toolbars are visible at the top and bottom of the interface.



Vector Analysis

- Overlay Operations
 - Overlay tools that accept polygons only:
 - Union
 - Update
 - All other overlay tools accept a variety of geometry types.



Vector Analysis

- Overlay Operations

- Merge vs. Append

- Similarities:

- They both will create a single output feature layer from multiple input layers.
 - Two or more of the input layers can not have the same name.
 - The input features do not have to be adjacent to each other.
 - Input features from all the input feature classes remain intact in the output layer or the target layer.

- Differences:

- For Append, the target feature must already exist.
 - » This target layer will be modified.
 - » This target layer will define the geometry type, attribute structure, and coordinate system.
 - For Merge, all the input layers are equal in terms of priority.



Vector Analysis

- Overlay Operations
 - Union vs. Append
 - Similarities
 - Both methods will expand the extent of any individual input layer.
 - Differences:
 - Unlike the Union function, Append does not planarize the input features into a single output.
 - » Input features from all the input feature classes remain intact in the target feature class.



Vector Analysis

- Overlay Operations
 - Clip vs. Erase
 - Similarities:
 - They both will define a new boundary (often smaller) for the input layers.
 - The output layer will have the same attribute structure and feature type as that of the input layer.
 - Differences:
 - For Clip, the input features that overlap with the clipping feature are preserved instead of erased.



Vector Analysis

- Overlay Operations
 - Clip vs. Intersect
 - Similarities:
 - They both will define a new boundary (often smaller) for the input layers.
 - Differences:
 - For Intersect, the output layer will have the attributes from all input layers. Also the feature type of the output will be determined by the lowest dimension of the input layer.
 - For Clip, the output layer will have the same attribute structure and feature type as that of the input layer.



Vector Analysis

- Overlay Operations
 - Overlaying large datasets is CPU and RAM intensive.
 - Schedule large overlays accordingly.
 - Shut down all other applications.
 - Use powerful computers with lots of memory.
 - Use file geodatabases for outputs
 - Result dataset may be too large for shapefiles or personal geodatabases.



Vector Analysis

- Buffering
 - Proximity is always one of the most basic GIS questions.
 - Buffering will identify or define an area within a specified distance around a feature.
 - Input features can be polygons, lines, or points.
 - Buffers are usually used to delineate protected zones around features or to show areas of influence.



Vector Analysis

- Buffering
 - Three types of buffers:
 - Buffers based on constant distance
 - Buffers based on variable distance
 - Multiple Ring Buffers



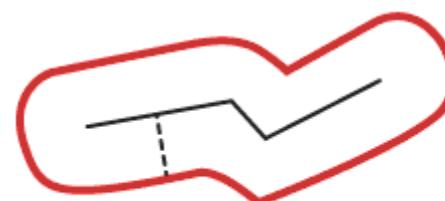
Vector Analysis

- Buffering
 - Buffers based on constant distance
 - Buffering around points creates circular zones.
 - Buffering around lines creates a series of elongated zones.
 - Buffering around polygons creates buffer zones extending outward from the polygon boundaries.

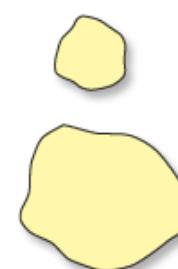
129



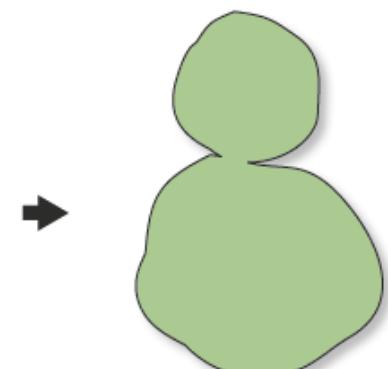
Buffering a point



Buffering a linestring



INPUT

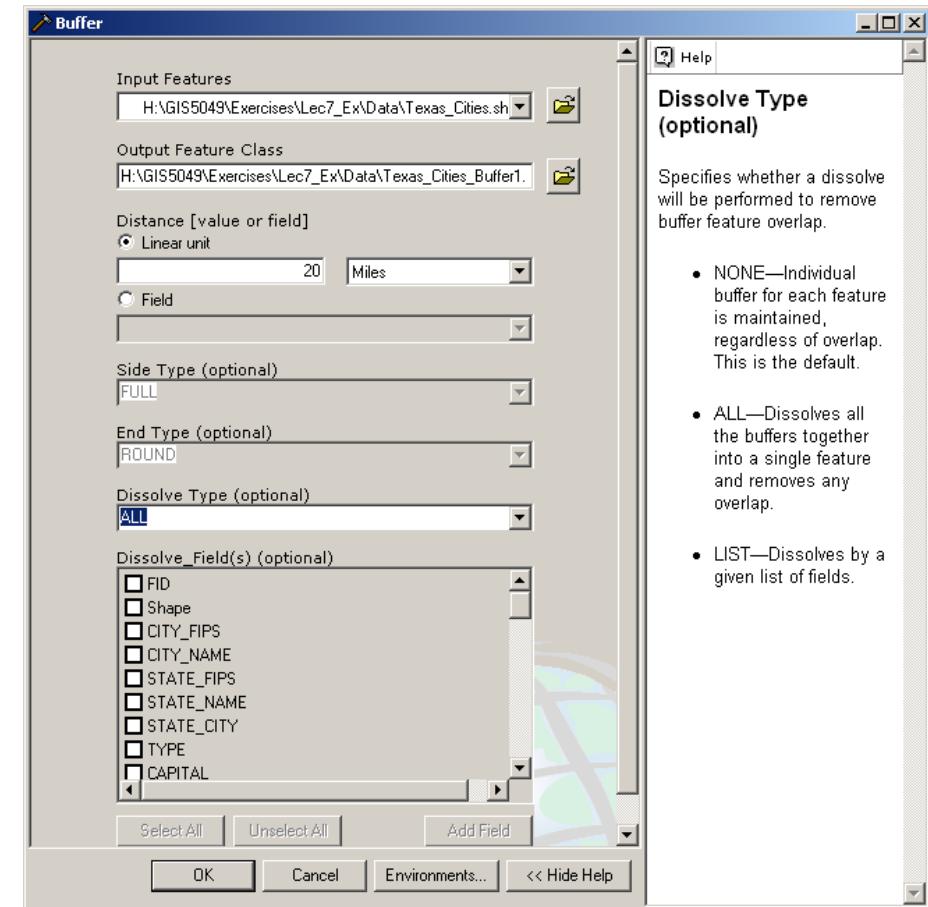
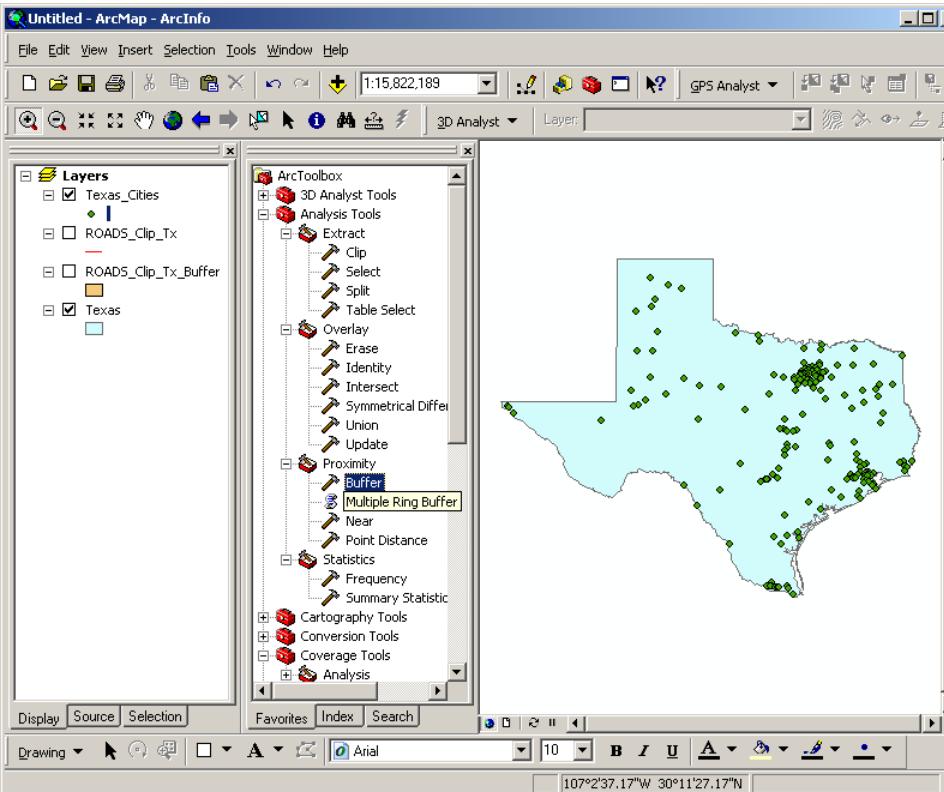


OUTPUT



Vector Analysis

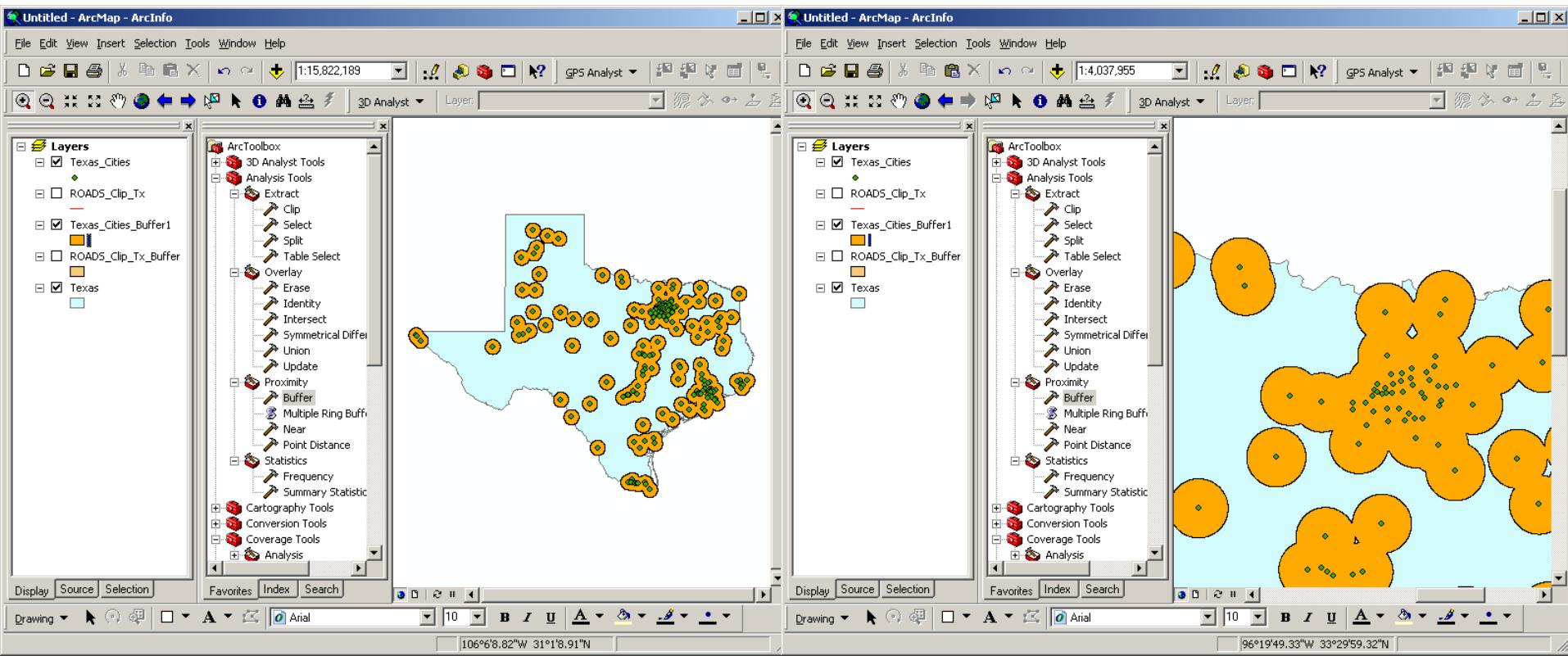
- Buffering
 - Buffers based on constant distance
 - Example: make a 20-mile buffer zone around cities in Texas.





Vector Analysis

- Buffering
 - Buffers based on constant distance
 - Example: ('continued)





Vector Analysis

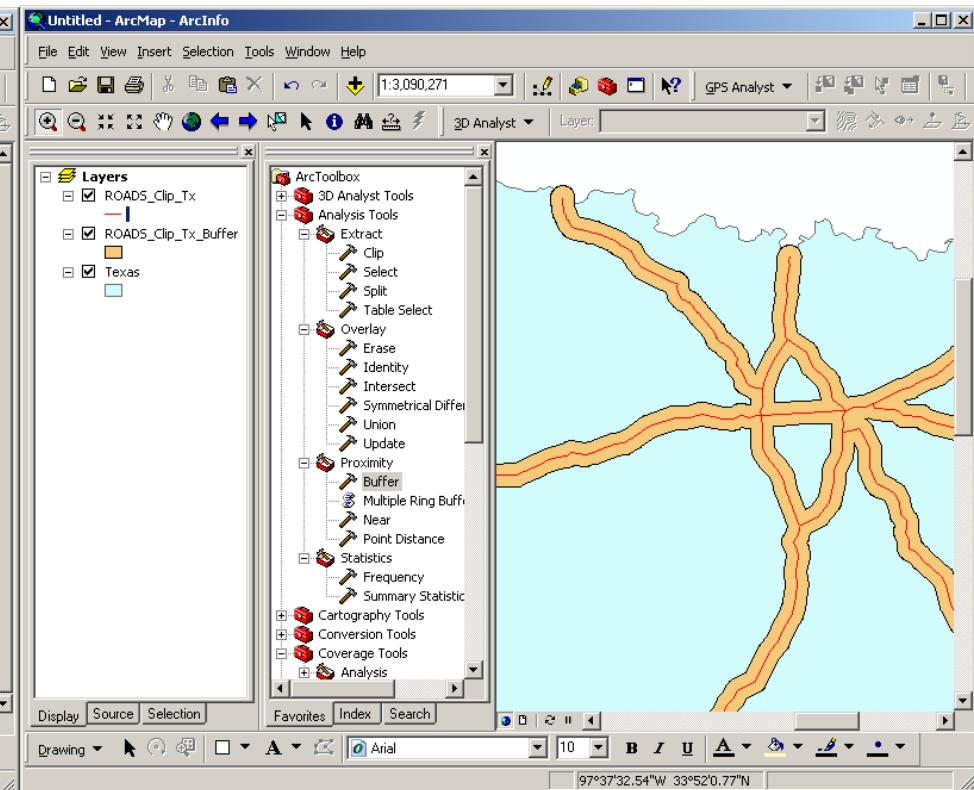
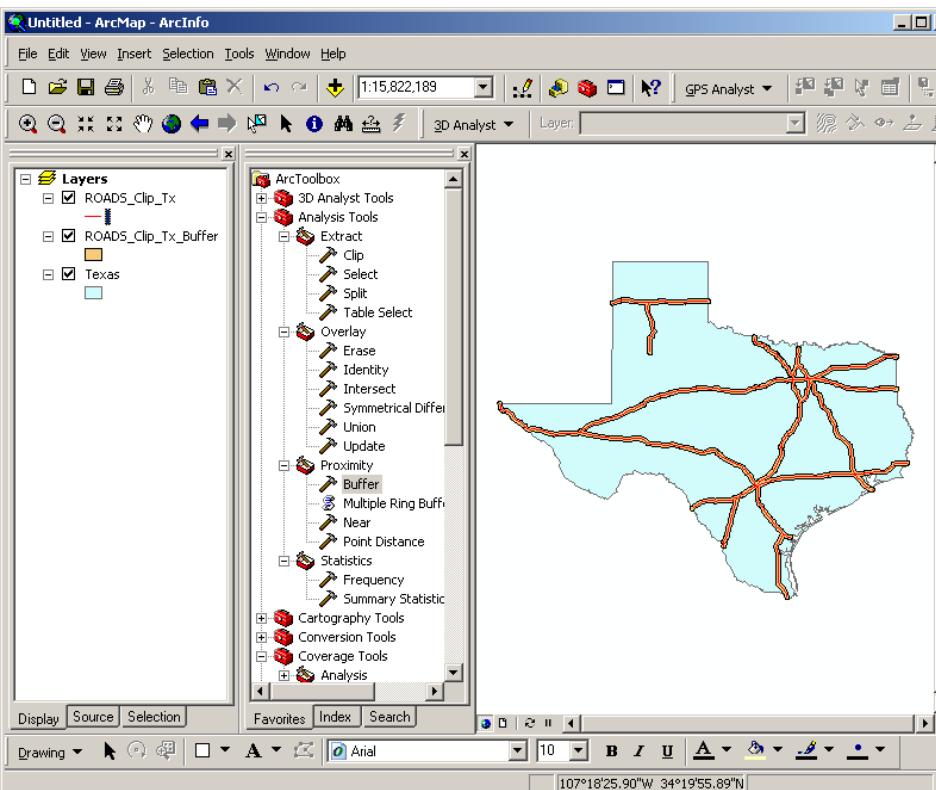
- Buffering
 - Buffers based on constant distance
 - Example: Make a 5-mile buffer zone around the major roads in Texas.

The screenshot shows the ArcMap interface with a map of Texas. A buffer analysis tool dialog box is open on the right side of the screen, titled "Buffer". The "Input Features" field contains "H:\GIS5049\Exercises\Lec7_Ex\Data\ROADS_Clip_T". The "Output Feature Class" field contains "H:\GIS5049\Exercises\Lec7_Ex\Data\ROADS_Clip_Tx_Buff". The "Distance [value or field]" section has "5 Miles" selected under "Linear unit". The "Dissolve Type (optional)" section includes a detailed description: "Specifies whether a dissolve will be performed to remove buffer feature overlap." It lists three options: "NONE—Individual buffer for each feature is maintained, regardless of overlap. This is the default.", "ALL—Dissolves all the buffers together into a single feature and removes any overlap.", and "LIST—Dissolves by a given list of fields." The "Dissolve_Field(s) (optional)" list includes checkboxes for FID, Shape, LENGTH, TYPE, ADMN_CLASS, TOLL_RD, RTE_NUM1, RTE_NUM2, and ROUTE. At the bottom of the dialog are "OK", "Cancel", "Environments...", and "<< Hide Help" buttons.



Vector Analysis

- Buffering
 - Buffers based on constant distance
 - Example ('continued)





Vector Analysis

- Buffering
 - Buffers based on variable distance
 - You can create buffers of various distances depending on the types of objects in the feature class.
 - Example: For the single dataset of turtle habitats in Florida, you can create larger buffers for those most endangered turtle species while creating smaller buffer zones for those less endangered turtle species.
 - Needs a new field which stores the variable distance in the attribute table of the input layer.



Vector Analysis

- Buffering
 - Buffers based on variable distance
 - Needs a new field which stores the variable distance

The screenshot shows the ArcMap interface with a map of the United States. A blue polygon layer labeled "Lower48_ST" covers the continental US, while a thin blue line layer labeled "Roads_Lower48" shows the road network. Two attribute tables are displayed side-by-side.

Left Table: Attributes of Roads_Lower48_UTM83_15N

FID	Shape *	LENGTH	TYPE	ADMN_CLASS
340	Polyline	174.174	Paved Divided	US Highway
341	Polyline	188.724	Multi-Lane Divided	Interstate
342	Polyline	115.707	Multi-Lane Divided	Interstate
343	Polyline	144.167	Paved Undivided	State Highway
344	Polyline	52.244	Paved Divided	US Highway
345	Polyline	116.949	Multi-Lane Divided	Interstate
346	Polyline	262.315	Multi-Lane Divided	Interstate
347	Polyline	8.828	Multi-Lane Divided	Interstate
348	Polyline	288.293	Multi-Lane Divided	Interstate
349	Polyline	224.271	Multi-Lane Divided	Interstate
350	Polyline	167.206	Multi-Lane Divided	Interstate
351	Polyline	217.863	Multi-Lane Divided	Interstate

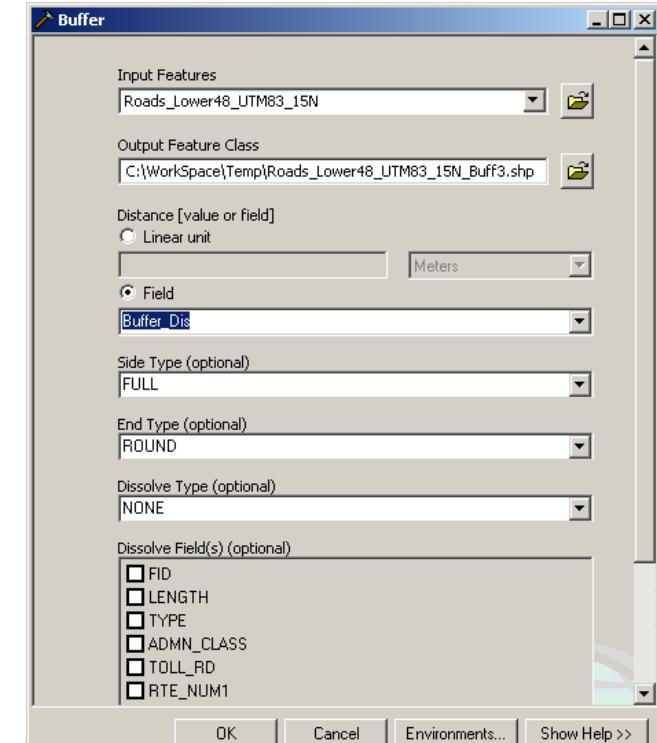
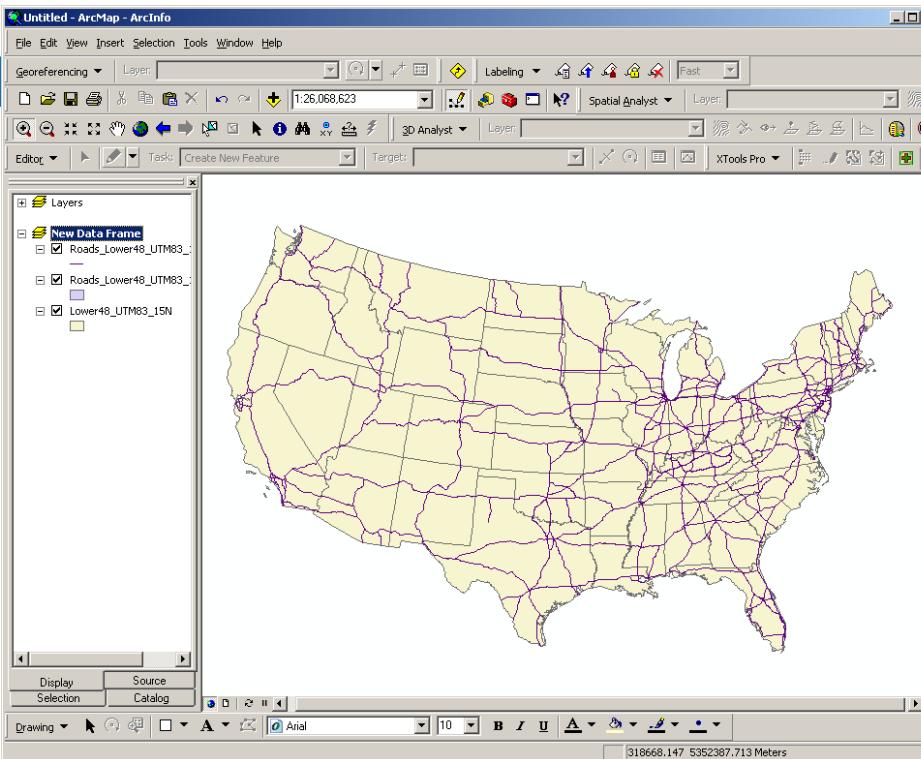
Right Table: Attributes of Roads_Lower48_UTM83_15N

FID	Shape *	LENGTH	TYPE	ADMN_CLASS	Buffer_Dis
340	Polyline	174.174	Paved Divided	US Highway	10000
341	Polyline	188.724	Multi-Lane Divided	Interstate	20000
342	Polyline	115.707	Multi-Lane Divided	Interstate	20000
343	Polyline	144.167	Paved Undivided	State Highway	3000
344	Polyline	52.244	Paved Divided	US Highway	10000
345	Polyline	116.949	Multi-Lane Divided	Interstate	20000
346	Polyline	262.315	Multi-Lane Divided	Interstate	20000
347	Polyline	8.828	Multi-Lane Divided	Interstate	20000
348	Polyline	288.293	Multi-Lane Divided	Interstate	20000
349	Polyline	224.271	Multi-Lane Divided	Interstate	20000
350	Polyline	167.206	Multi-Lane Divided	Interstate	20000
351	Polyline	217.863	Multi-Lane Divided	Interstate	20000



Vector Analysis

- Buffering
 - Buffers based on variable distance
 - **Note:** The unit of distance is very important.
 - Re-project the datasets.
 - Changing the coordinate system of data frame does not work.

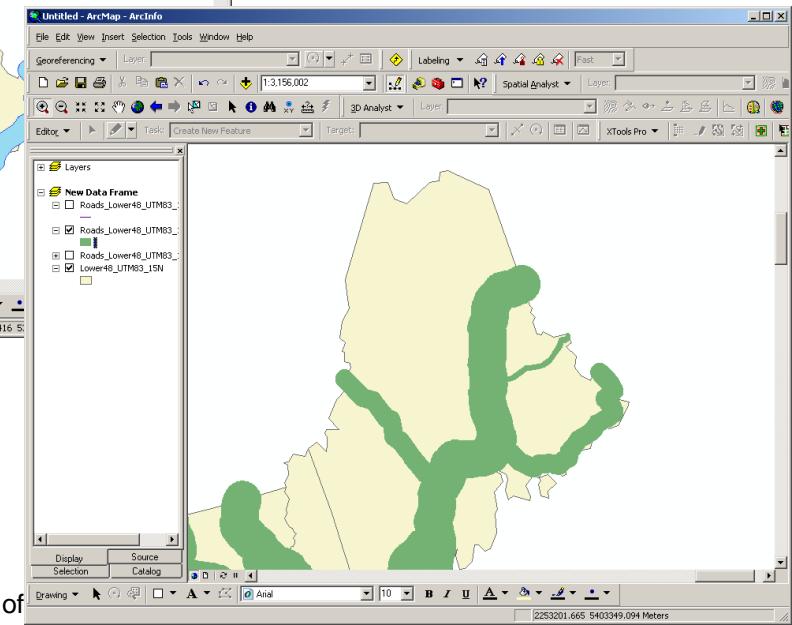
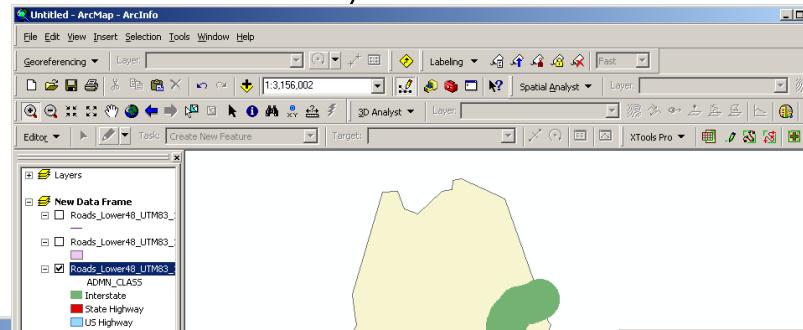
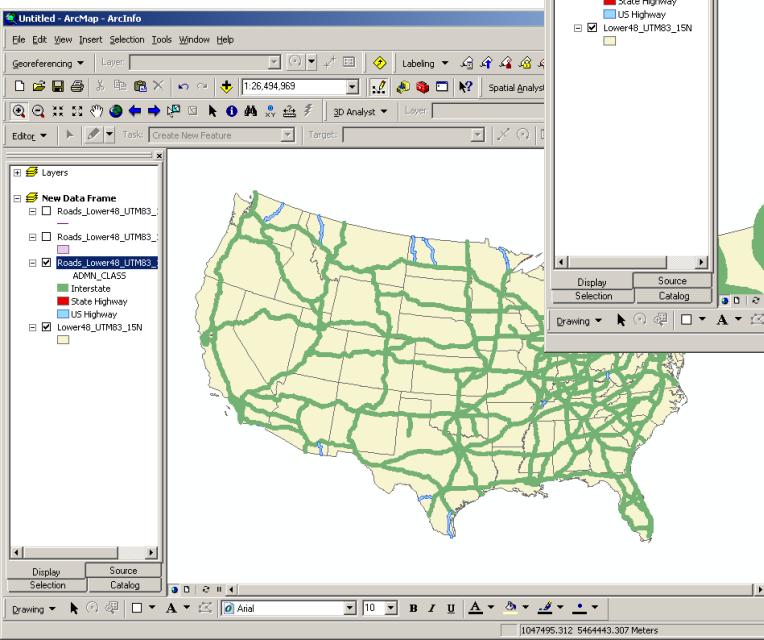




Vector Analysis

- Buffering
 - Buffers based on variable distance
 - Dissolve is necessary to remove overlapping buffers.

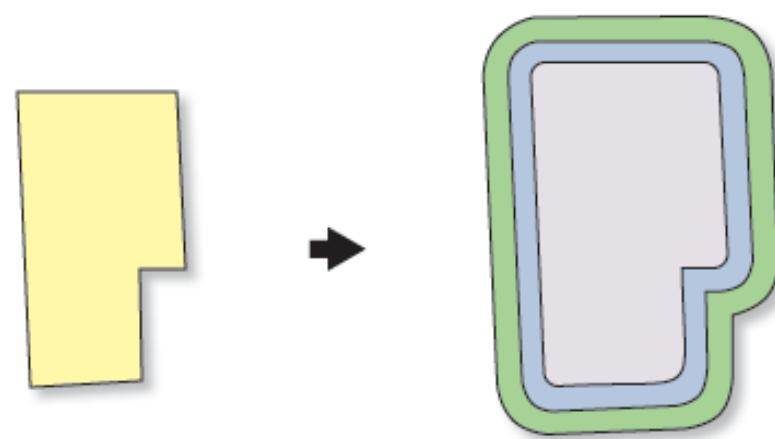
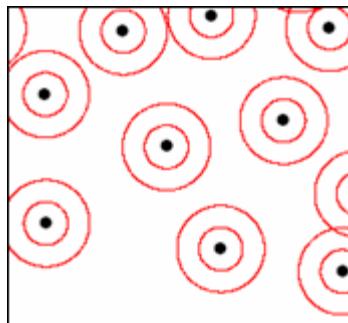
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Vector Analysis

- Buffering
 - Multiple Ring Buffer
 - Creates a new feature class of buffer features using a set of buffer distances.
 - You could use the multi-ring buffer tool to classify the areas around a feature into near, moderate distance, and long distance classes for an analysis.





Vector Analysis

- Buffering
 - Multiple Ring Buffer

The screenshot illustrates the process of creating a multiple ring buffer in ArcMap. On the left, the ArcMap interface shows a map of Lake Mead and its surroundings. A legend on the left side lists various regions and features, including USA_Select, USA_Regions, and LAKES. In the center, the "Multiple Ring Buffer" dialog box is open, showing the input feature ("Lake_Mead"), the output feature class ("C:\Workspace\Temp\Lake_Mead_MB.shp"), and three buffer distances (5, 10, and 50) listed in the "Distances" field. Below these fields are optional settings: "Buffer Unit (optional)" set to "Miles", "Field Name (optional)" left blank, and "Dissolve Option (optional)" set to "ALL". On the right, two windows show the results: the "Attributes of Lake_Mead..." table displays three records corresponding to the buffer distances, and the "Untitled - ArcMap - ArcInfo" window shows the final multiple ring buffer polygon overlaid on the original lake shape.

Multiple Ring Buffer

- Input Features: Lake_Mead
- Output Feature class: C:\Workspace\Temp\Lake_Mead_MB.shp
- Distances:
 - 5
 - 10
 - 50
- Buffer Unit (optional): Miles
- Field Name (optional):
- Dissolve Option (optional): ALL

Attributes of Lake_Mead...

FID	Shape *	distance
0	Polygon	5
1	Polygon	10
2	Polygon	50

Untitled - ArcMap - ArcInfo

Lake_Mead_MB

distance
5
10
50

Untitled - ArcMap - ArcInfo



Vector Analysis

- Buffering
 - Features will not be buffered if their buffer distance is zero.
 - Negative distances can be used when buffering polygon features, to create buffers on the inside of the polygon features.
 - Using a negative value will shrink the output polygon feature by the distance specified.



Vector Analysis

- Buffering
 - Using a negative value will shrink the output polygon feature by the distance specified.

The screenshot shows two ArcMap windows. The left window displays a map of Texas with a blue buffer layer applied to its state boundary. The right window shows the 'Buffer' dialog box with the following settings:

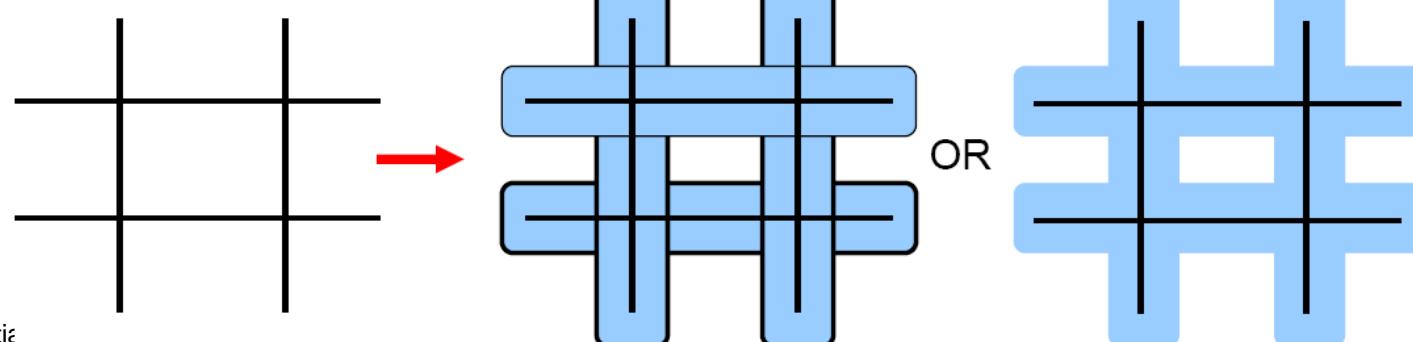
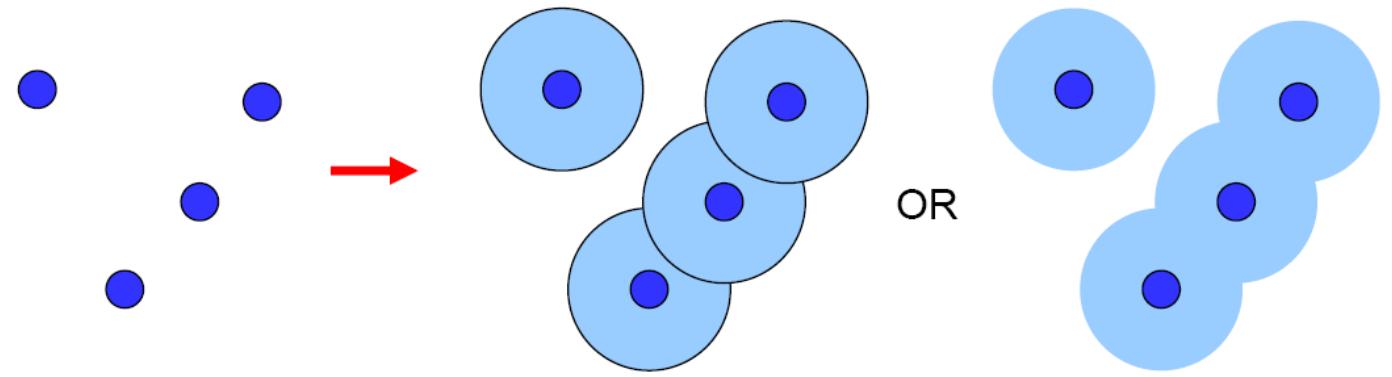
- Input Features:** TX
- Output Feature Class:** C:\WorkSpace\Temp\Merge\TX_Buffer2.shp
- Distance [value or field]:** 50000 Meters (radio button selected)
- Field:** (unchecked)
- Side Type (optional):** FULL
- End Type (optional):** ROUND
- Dissolve Type (optional):** NONE

Below the dialog box, the ArcMap interface shows the 'Layers' pane with the 'New Data Frame' folder expanded, containing layers such as 'Roads_Lower48_UTM83_15N' and 'TX_Buffer_Inward'. The right window also shows a map of Texas with a red buffer layer applied to its state boundary, which is inward relative to the original boundary.



Vector Analysis

- Buffering
 - An optional dissolve is often performed to remove overlapping buffers. It is called “coalescing”.





Vector Analysis

- Buffering
 - Coalescing can be important.
 - When using the results of Buffer as input to an overlay operation such as Union or Intersect, it is recommended that Buffer output be dissolved in order to reduce the number of features and overlap.
 - This will reduce the number of spatial relationships between the input features being processed, thereby reducing the amount of memory the tool requires and the amount of time required for processing.



Vector Analysis

- Buffering
 - Buffer with overlay will provide portions of features within a distance.
 - Spatial Join and Select Layer By Location all capable of selecting within a distance, but not portions of features.



Vector Analysis

- Demos

- Union
- Intersect
- Dissolve
- Split
- Clip
- Erase
- Merge
- Append
- Update
- Identity
- Create Thiessen Polygons
- Selection
- Buffer based on constant distance
- Buffering based on variable distance
- Multiple Ring Buffer
- Spatial Query
- Spatial Join



THE END

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