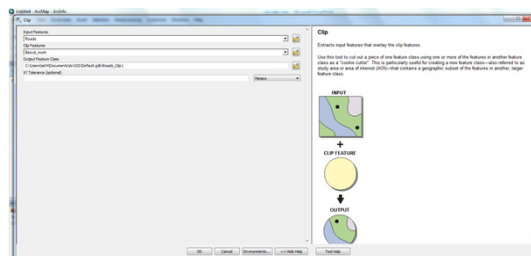


Vector GIS Analysis

- There are multiple ways of conducting geoprocessing in ArcGIS:
 - Tools → Dialog Box



Vector GIS Analysis

- There are multiple ways of conducting geoprocessing in ArcGIS:

– Command Line

```
Python
>>>
F1 show help for current cursor location.
F2 check the syntax of the current line (or code block if in multiple line mode).
ESC cancels the current operation.
Shift or Control Return will enter multiple line mode. To exit multiple line mode (execute the
```

Vector GIS Analysis

- There are multiple ways of conducting geoprocessing in ArcGIS:

– Script

```
10 import sys, string, os, arcgisscripting #IMPORT = KEYWORD
11
12 # Create the Geoprocessor object
13 gp = arcgisscripting.create() #SUBROUTINE CALL
14
15 # Check out any necessary licenses
16 gp.CheckOutExtension("3D")
17 gp.CheckOutExtension("spatial")
18
19 # Load required toolboxes...
20 gp.AddToolbox("C:/Program Files/ArcGIS/ArcToolbox/Toolboxes/Spatial Analyst Tools.tbx")
21 gp.AddToolbox("C:/Program Files/ArcGIS/ArcToolbox/Toolboxes/Conversion Tools.tbx")
22 gp.AddToolbox("C:/Program Files/ArcGIS/ArcToolbox/Toolboxes/Data Management Tools.tbx")
23 gp.AddToolbox("C:/Program Files/ArcGIS/ArcToolbox/Toolboxes/3D Analyst Tools.tbx")
24
25
26 # Local variables...
27 multipoint_shp = "C:\\NR533\\MB_HW\\multipoint.shp" #ASSIGNMENT STATEMENT & STRING LITERAL
28 multipoint_ft_shp = "C:\\NR533\\MB_HW\\multipoint_ft.shp"
29 lidar_rast = "C:\\NR533\\MB_HW\\lidar_rast"
30 Input = "C:\\NR533\\73921234\\MNC_Phase1d_36079a4d3\\MNC_Phase1d_36079a4d3.las"
31 view = "C:\\NR533\\MB_HW\\view"
32 observer = "multipoint_ft selection"
33
34 # Process: LAS to Multipoint...
35 gp.LASToMultipoint_3d(Input, multipoint_shp, "10", "", "ANY_RETURNS", "", "", "las")
36
37 # Process: Project...
38 gp.Project_management(multipoint_shp, multipoint_ft_shp, "PROJECTS\\MAD_1983_StatePlane_North_Carolina_FIPS_3200_Feet"
39
40 # Process: Point to Raster...
41 gp.PointToRaster_conversion(multipoint_ft_shp, "Shape", lidar_rast, "MOST_FREQUENT", "NONE", "")
42
43 # Process: Viewshed...
44 gp.Viewshed_m(lidar_rast, observer, view, "10", "FIRST PARTS", "")
```

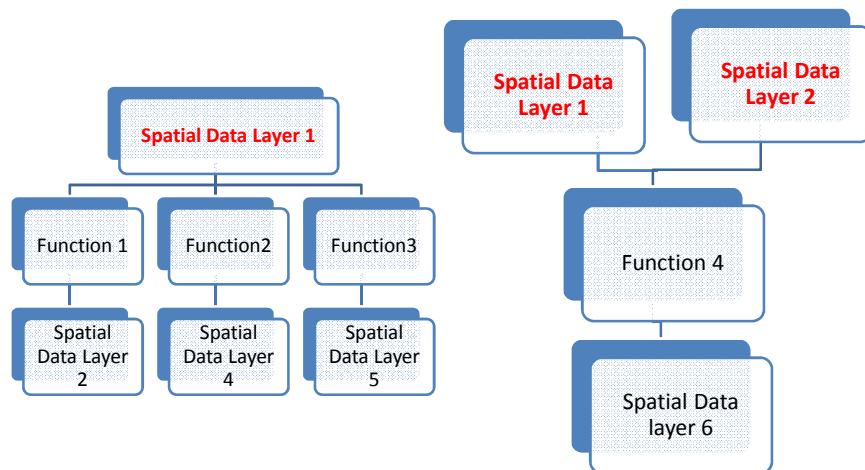
Vector GIS Analysis

- There are multiple ways of conducting geoprocessing in ArcGIS:

– Model builder

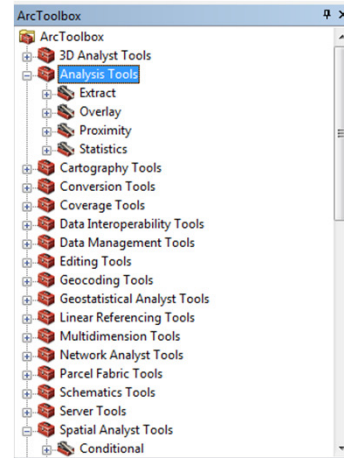


Vector GIS Analysis Process



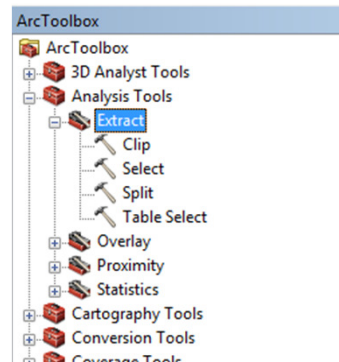
Geospatial Analysis: Features

- We will be working primarily with the **Analysis toolbox**
- It is a suite of geoprocessing tools used to solve spatial or statistical problems
- Four sub-toolsets:
 - **Extract**
 - **Overlay**
 - **Proximity**
 - **Statistics**



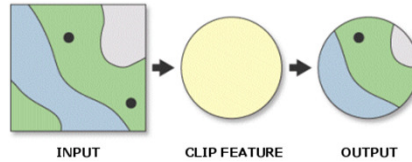
The Extract Toolset

- Contains tools used to manipulate data so that they contain only desired features and attributes → **Filtering spatially** and/or by **attribute**



Clip

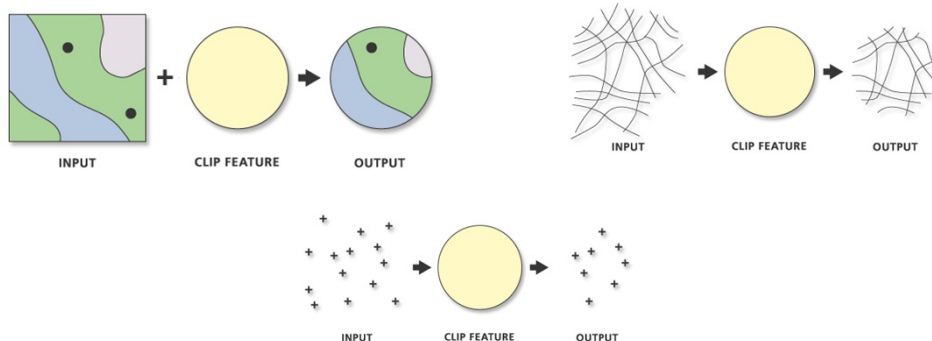
- Clip used for **extracting** features or parts of features from a feature class
- This tool uses a **polygon boundary** to cut features and their attributes from a feature class



- The output feature class will have the **attributes** of the input features
- The input features may be of any geometry type, but clip features **must have polygon geometry**

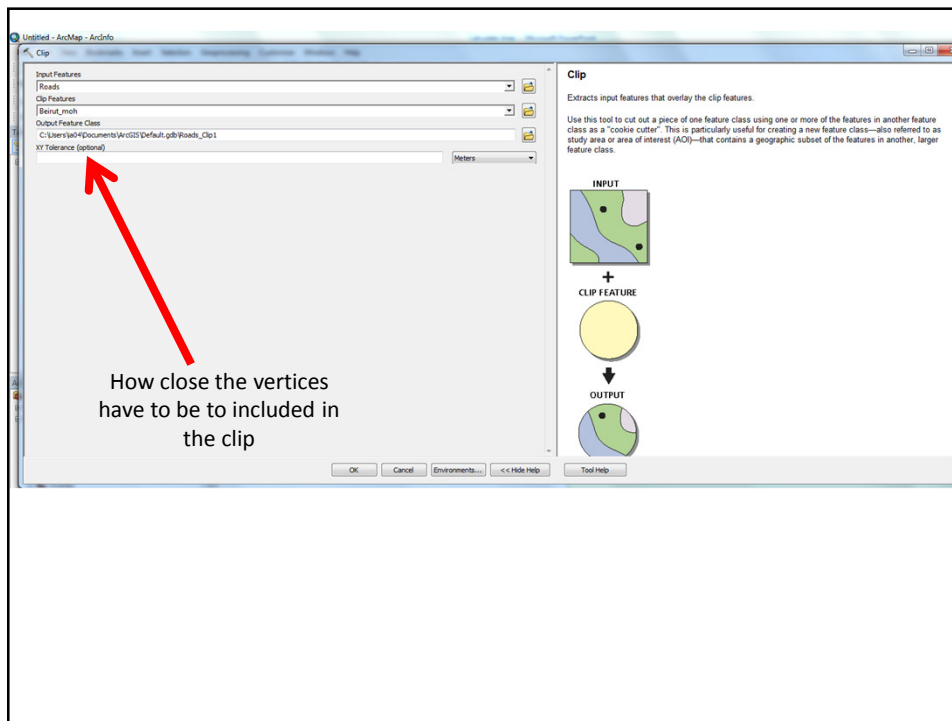
Clip

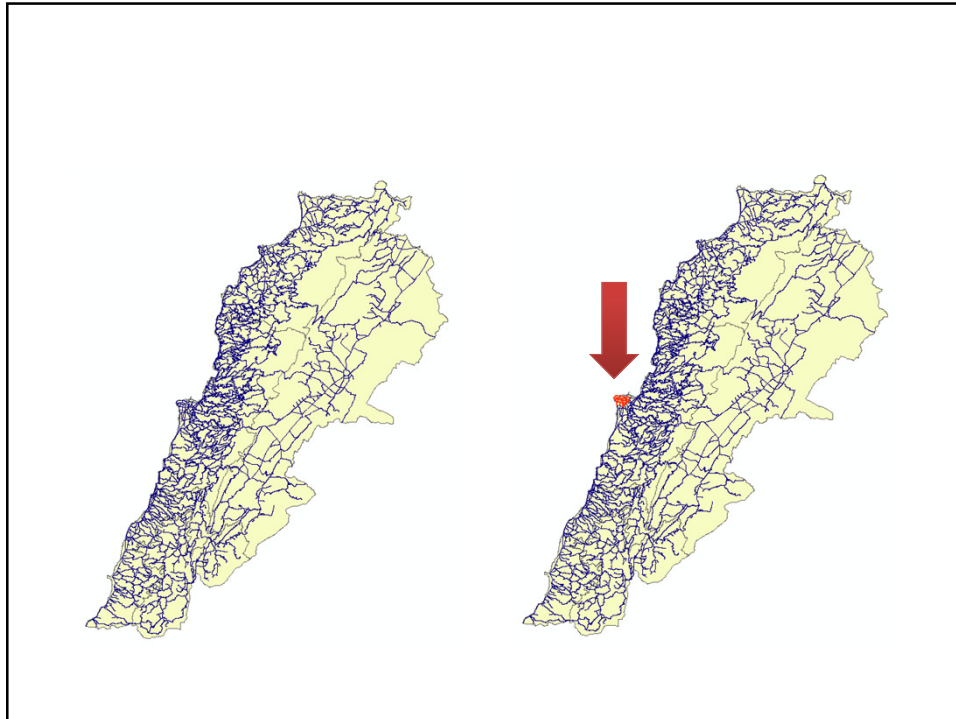
- If your cookie cutter includes many polygons what will happen?
 - It will take the first polygon according to ID



Clip: An Example

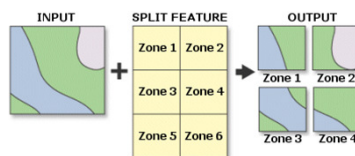
- I have the road network of Lebanon and I just want to select the roads in the Beirut Mohafaza
 - What is my Input Feature?
 - What is my Clip Feature?
 - What is my Output Feature?
 - What Attributes will my Output have?
- It is “**Cookie cutting**” of one layer using another layer





Split

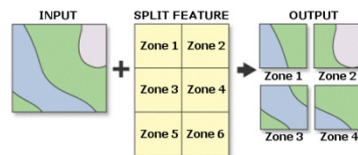
- Breaks the input features and stores them in **multiple** output datasets
- This tool breaks the features into **multiple features**



- The **boundary** of each unique value in the Split Field is used to split the Input Features
- The Split Features must be **polygon(s)**
- The feature attribute table for output → same as the Input Features attribute table

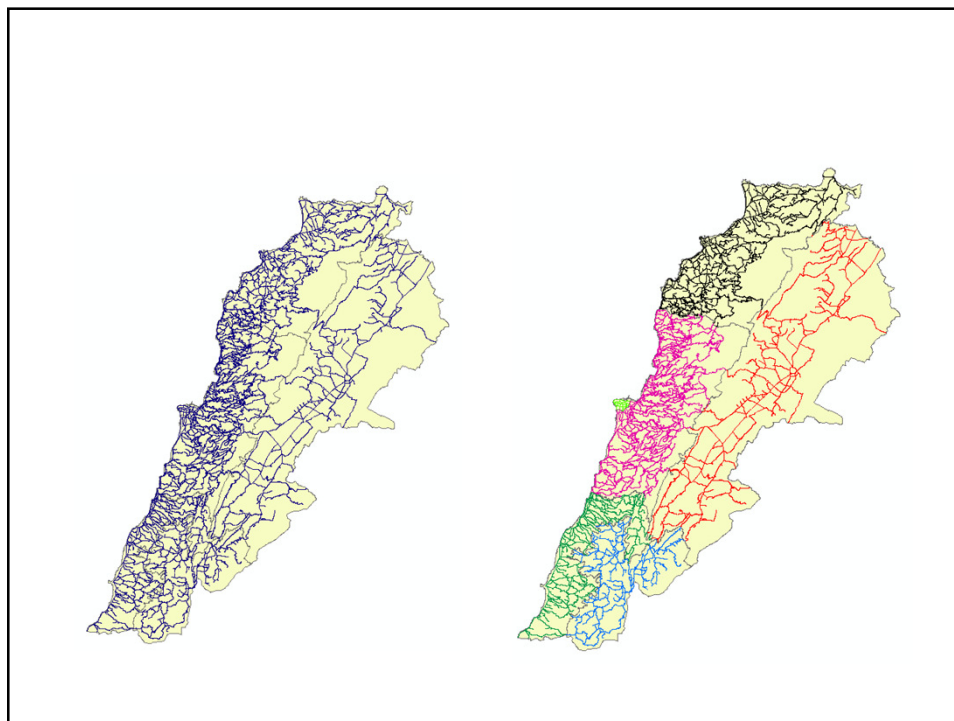
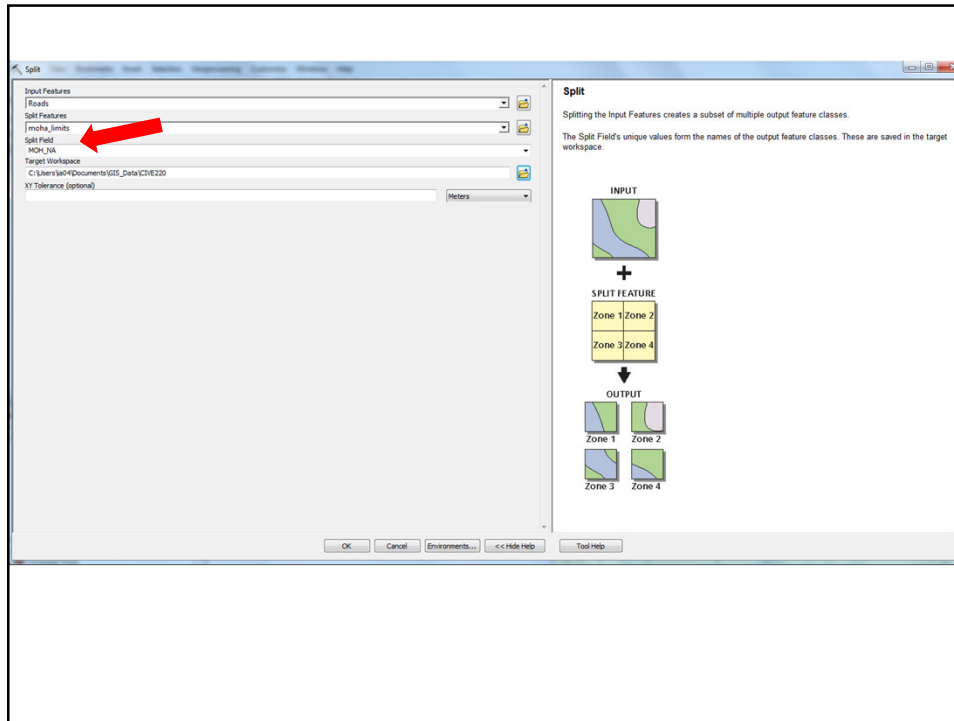
Split

- The split field data type must be of type **character**
- The output feature classes will be named for the split field values → They must start with a valid character
- The number of output feature classes equals the total number of unique values in the split field



Split: An Example

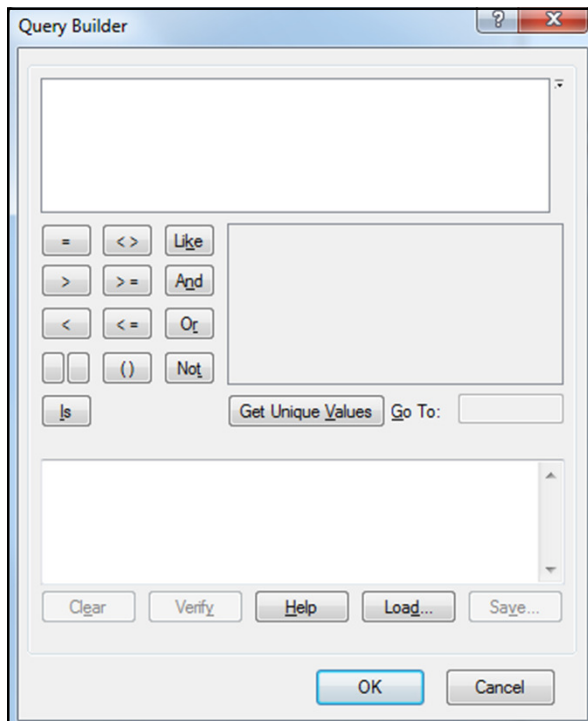
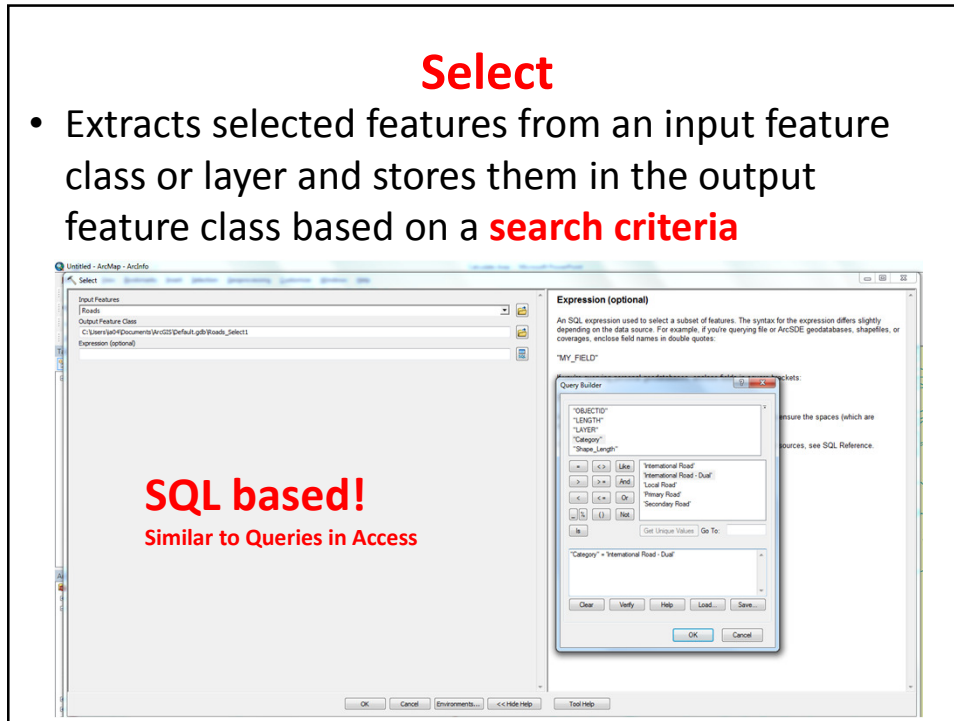
- I have the road network of Lebanon and I want to split the roads by Mohafaza
 - What is my Input Feature?
 - What is my Split Feature?
 - What type of files will I generate?
 - How many files will I generate?
 - Can I name each layer directly?
 - What attributes will my outputs have?



Select

- Extracts selected features from an input feature class or layer and stores them in the output feature class based on a **search criteria**

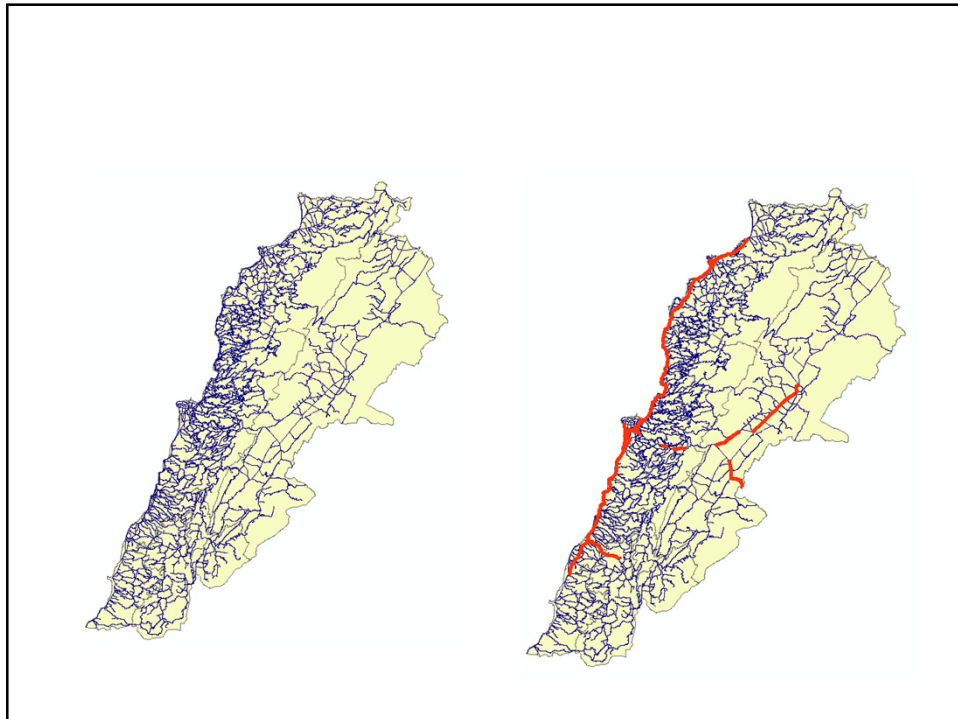
SQL based!
Similar to Queries in Access



- Mathematical operators such as +, -, *, / can also be used in queries
- Example:
 - Searching for large undeveloped properties
 - I would then use this expression that would find large properties and then restrict those to only properties that are undeveloped.
- **[acres]>= 10 AND [property] = "Undeveloped"**

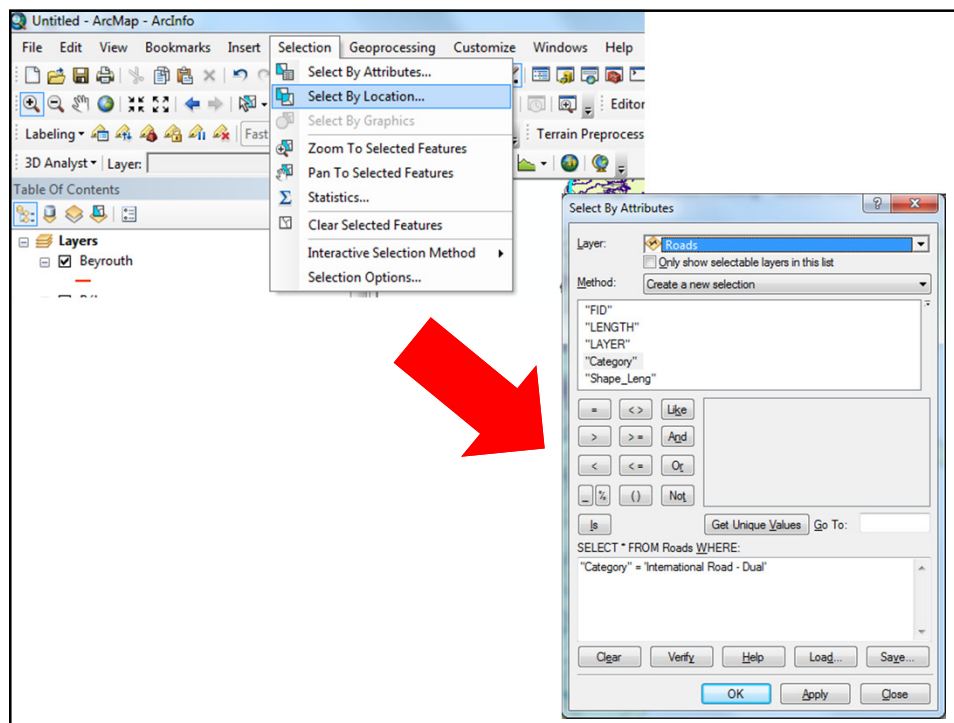
Select: An Example

- I have the road network of Lebanon and I want to select only the roads that can be classified as “International-Dual” → Select by attribute!
 - What is my Input Feature?
 - How many files will I generate?
 - What Attributes will my outputs have?



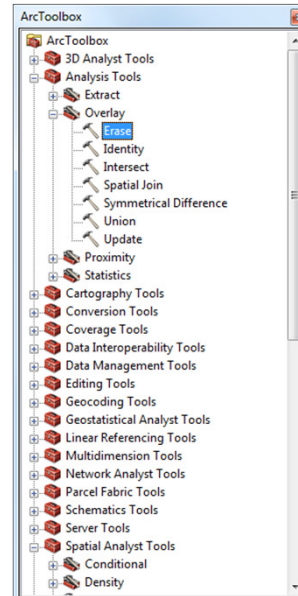
Select By Attribute

- You can use the “Select by Attribute” from the Select menu in ArcGIS
 - It does the selection
 - Does not create a new file directly from your selection



Overlay Toolset

- Contains tools for topological integration of features based on symmetry
- Has many tools:
 - Erase
 - Identify
 - Intersect
 - Spatial Join
 - Symmetrical Difference
 - Union
 - Update

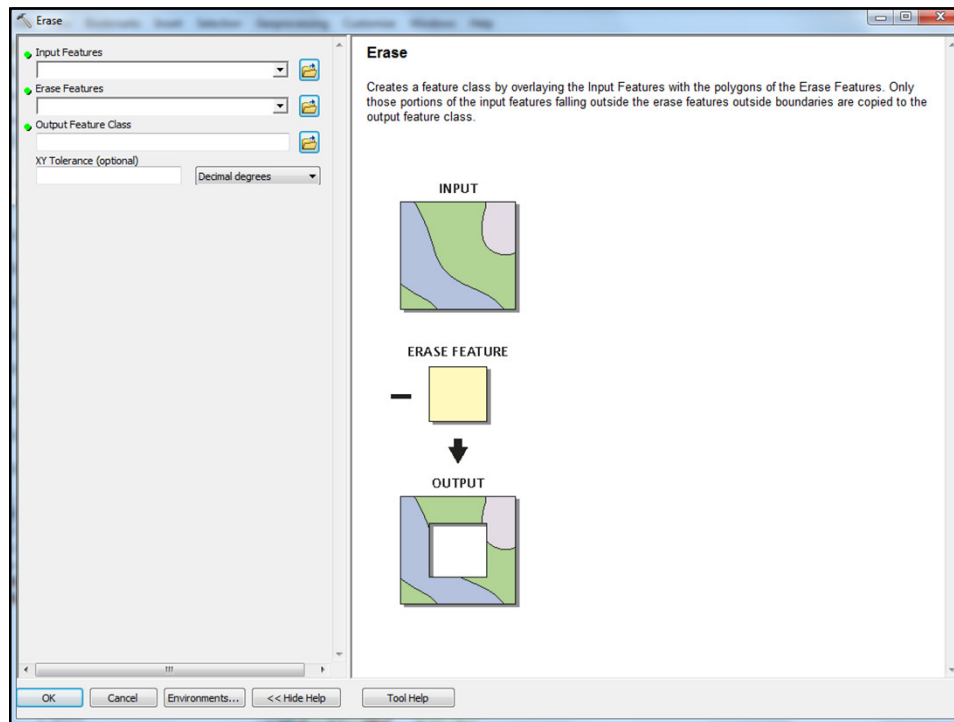


Erase

- Erase: creates a feature class from those features or portions of features **outside** the erase feature class

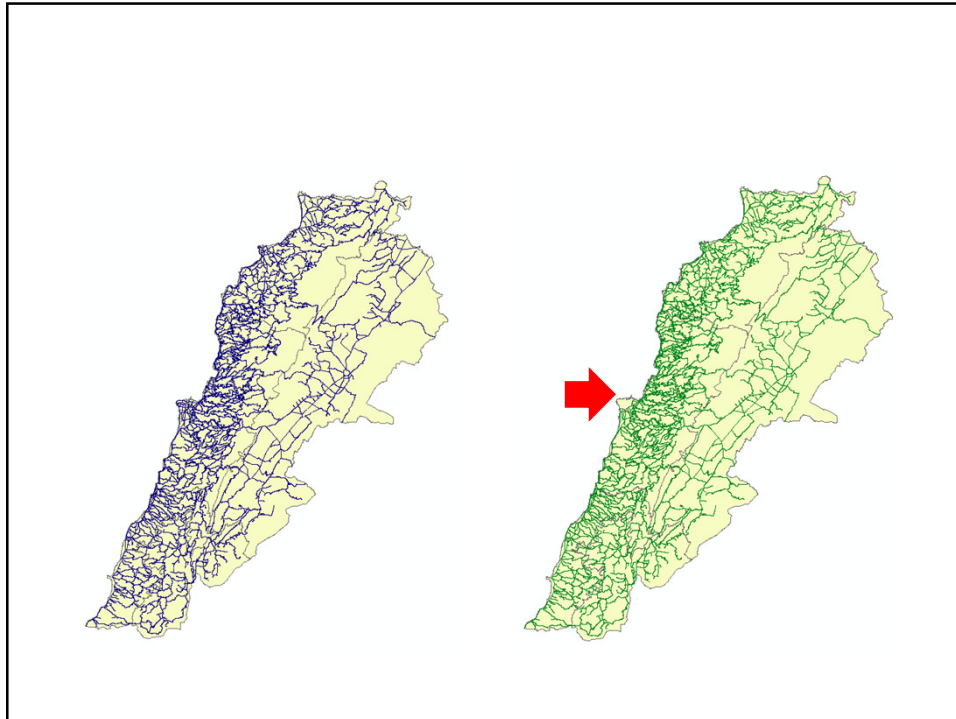


- Input feature polygons that are coincident with erase feature polygons will be **removed**
- The erase features must be polygons



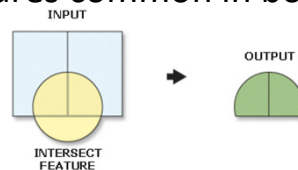
Erase: An Example

- Let us assume that I want to keep all the roads except for the roads in Beirut
 - What is my Input Feature?
 - What is my Erase Feature?
 - How many files will I generate?
 - What Attributes will my output have?

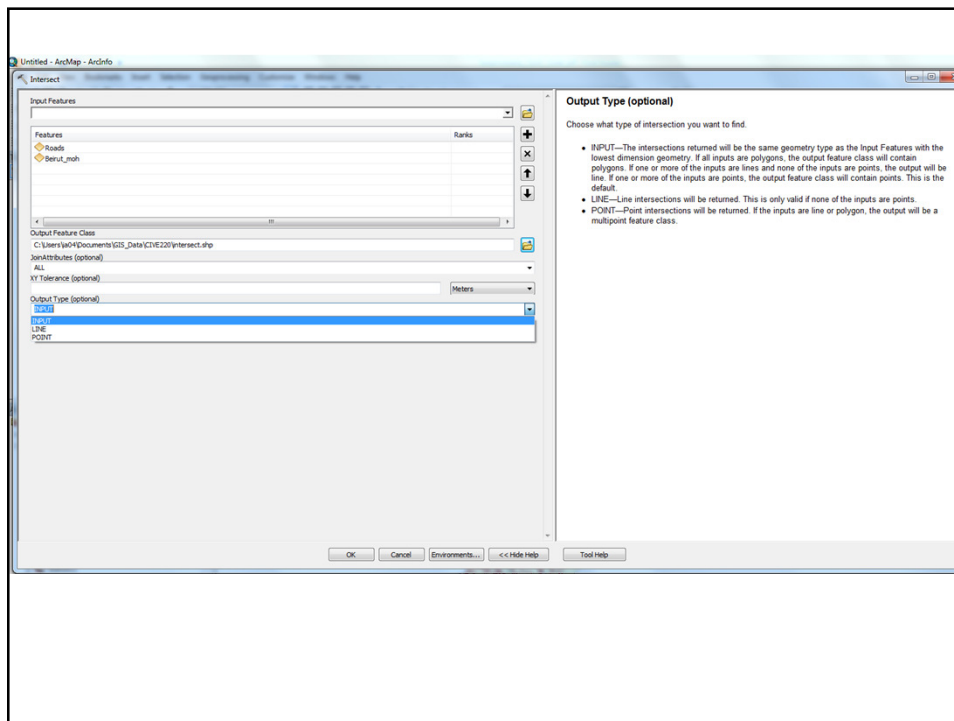
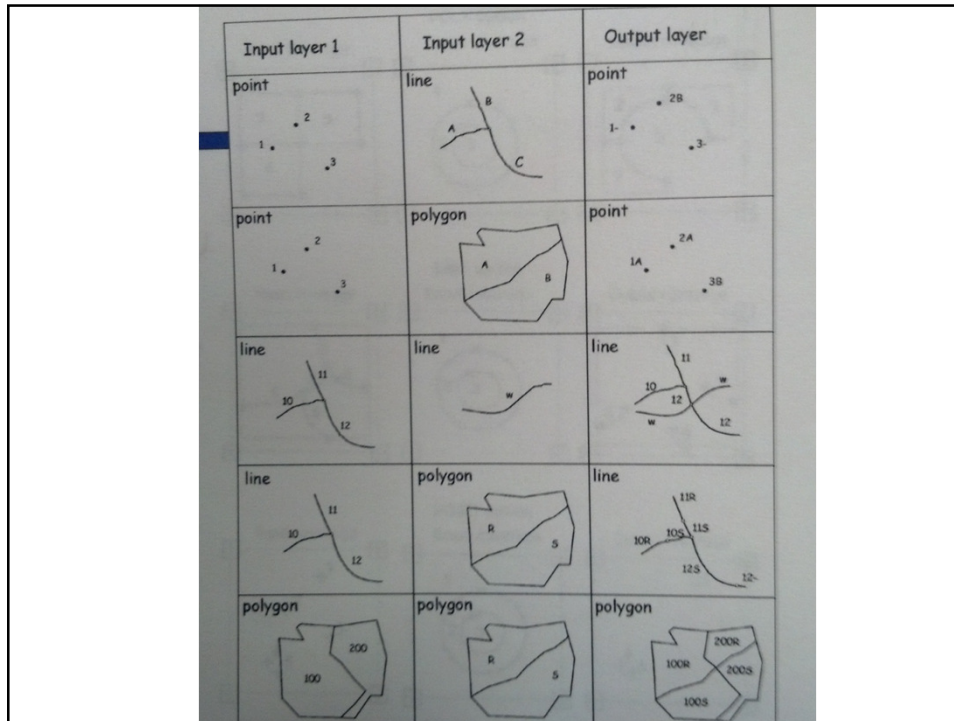


Intersect

- Intersect: builds a new feature class from the intersecting features common in both feature classes



- The **input features** can be point, multipoint, line, or polygon
- If the inputs have different geometry types → the output feature class geometry type will default to the same as the input features with the lowest dimension geometry!

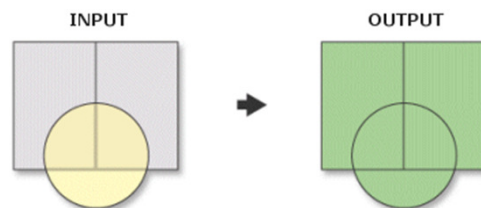


Intersect: An Example

- Somehow similar to Identify?
- But allows me to intersect multiple layers (>2) at once and the layers NEED NOT be of the same geometry!

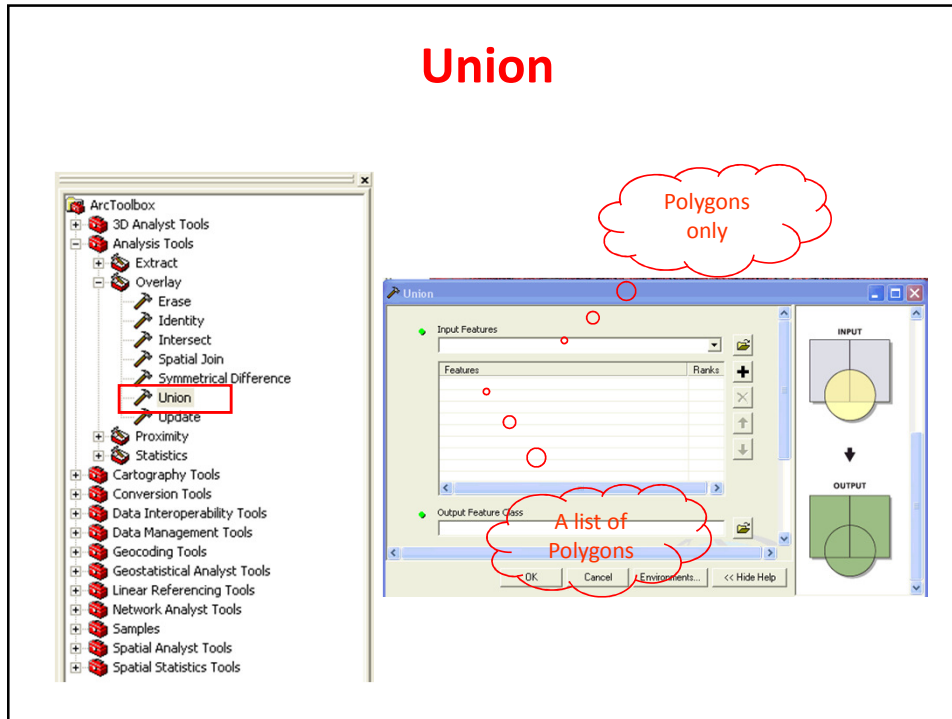
Union

- Union: builds a new feature class by combining the features and attributes of each feature class



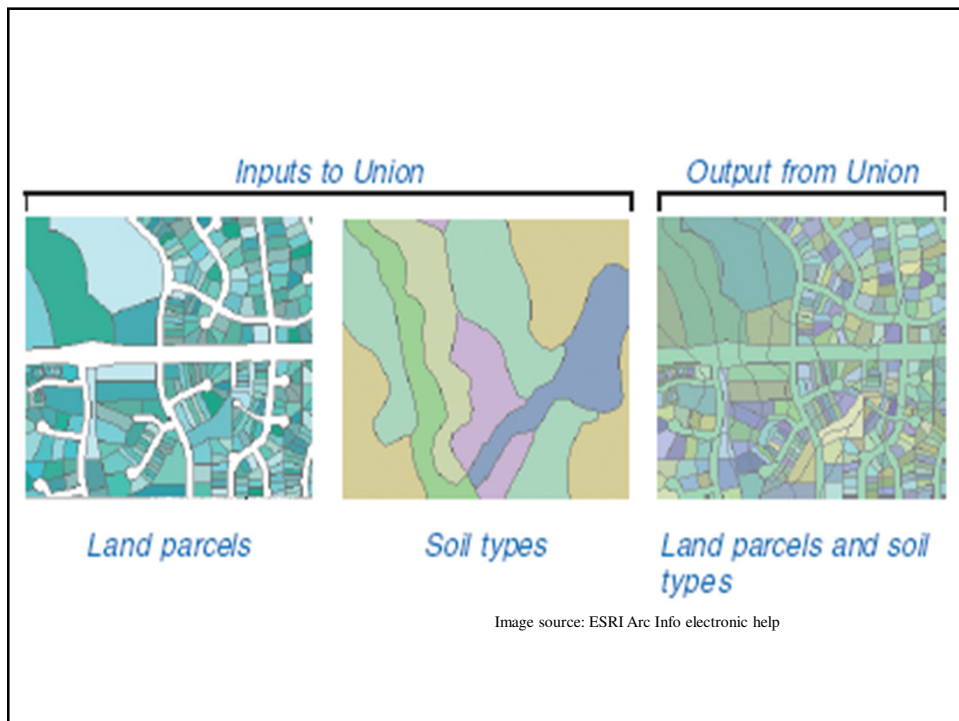
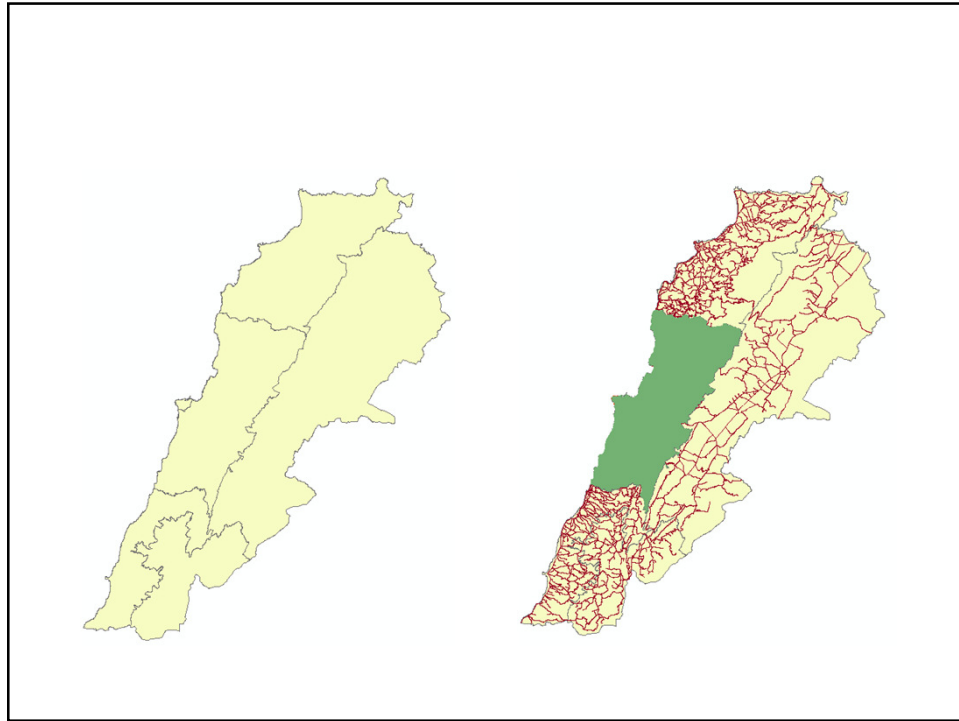
- All input feature classes and feature layers must have polygon geometry
- Can have more than 2 features at the same time

Union



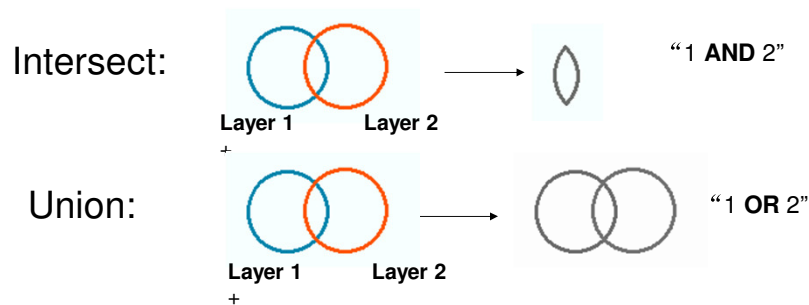
Union: An Example

- Let us assume I have a project that stretches over Beirut and Mount Lebanon
- I want to combine the two shapefiles into one file
- Attribute Information from which layer?



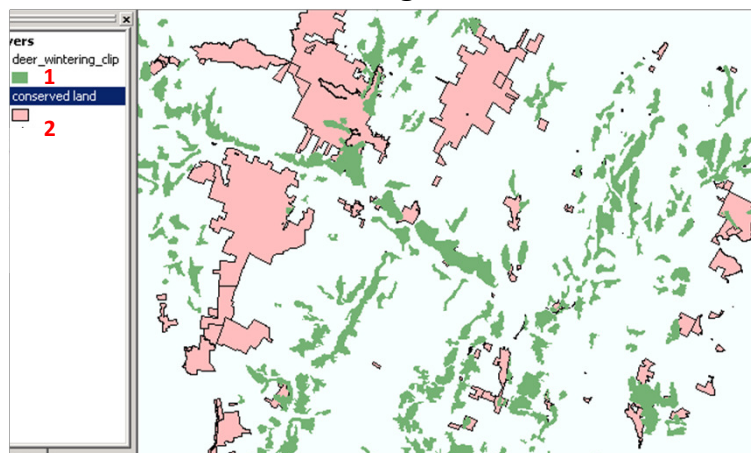
Union vs. Intersection

- Union is the union of two overlapping set of features and intersection is the intersection



Union vs. Intersection: Example

- Here's an example. Say we have one layer that shows us where the forest cover (1) is and another that shows us the location of government owned land (2)



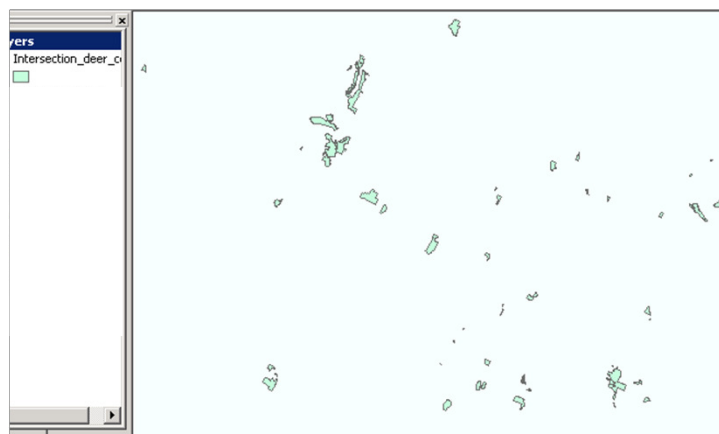
Union vs. Intersection: Example

- Union gives us land that is **EITHER** forested **OR** that is a government owned



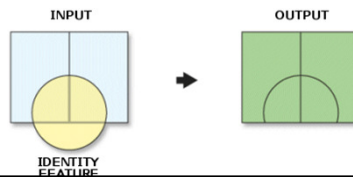
Union vs. Intersection: Example

- Intersect gives us land that is **BOTH**, and preserves all polygon boundaries within that common extent



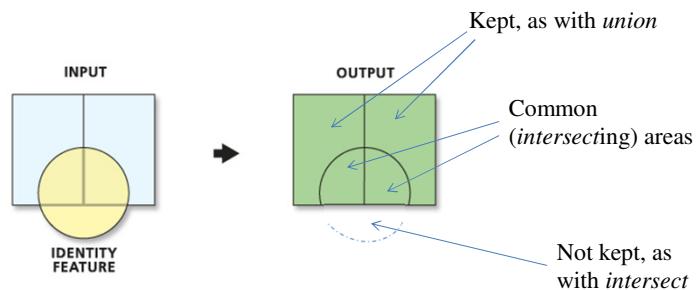
Identity

- Identity: Intersects two feature classes
- The output contains **ALL** the input features as well as those **overlapping features** of the identity feature class
 - The order of the layers makes a difference!
- The input features can be a point, multipoint, line, or polygon
- The identity feature must be polygon



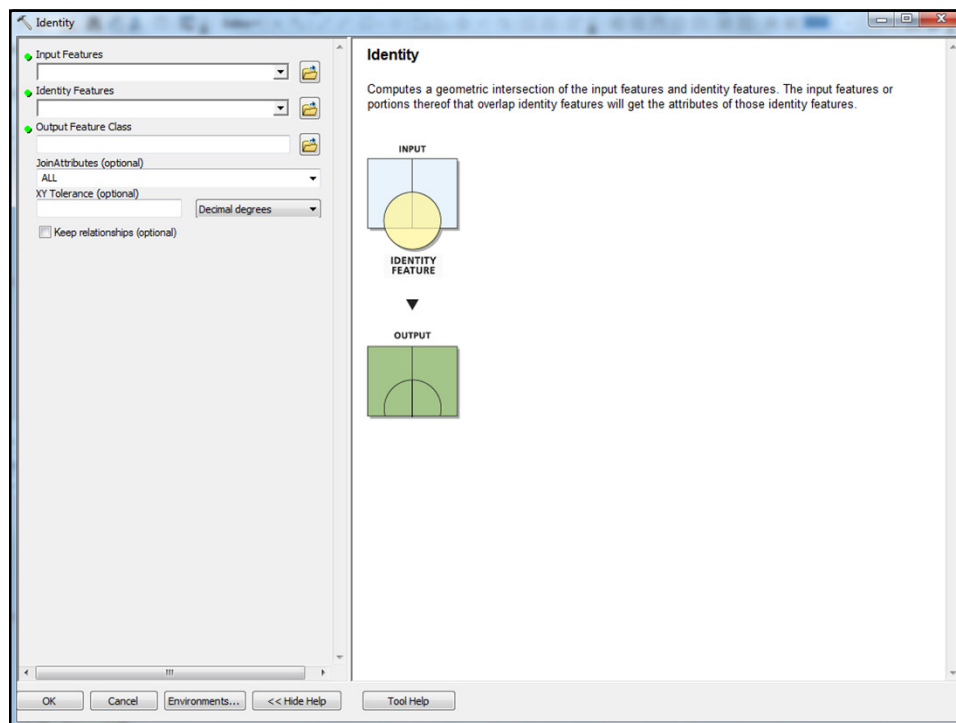
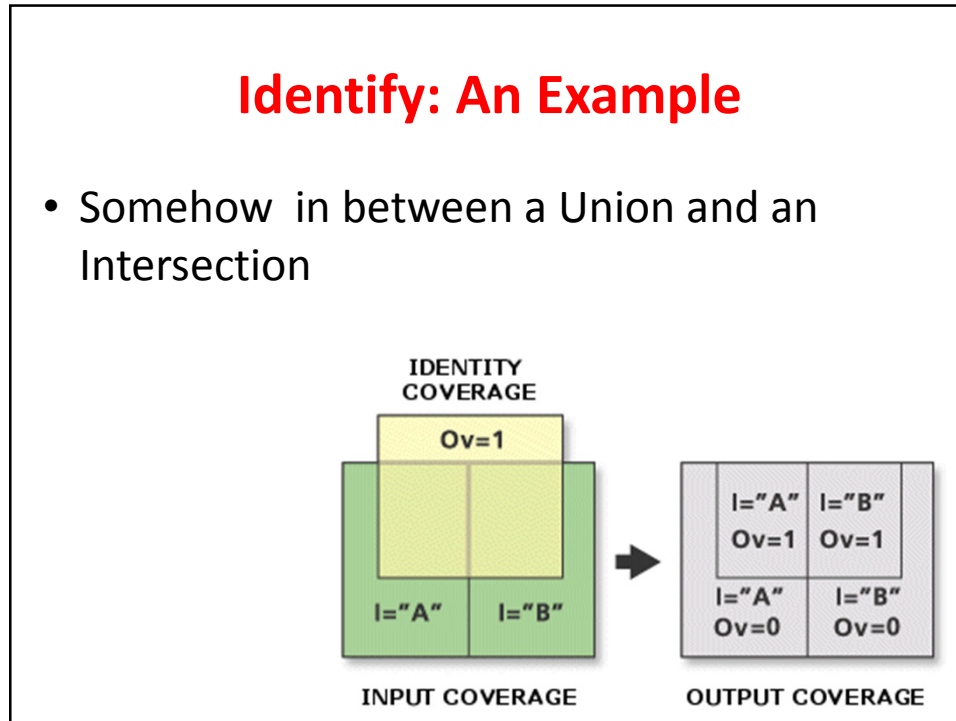
Identity

- Identity performs an intersection but doesn't retain ALL features
 - Keeps all "input" layer features
 - Keeps/creates only overlapping "identity" features and their attributes



Identify: An Example

- Somehow in between a Union and an Intersection



Table

FID	Shape *	FID_roads	LENGTH	LAYER	Category	Shape_Leng	FID_Beirut	AREA	PERIMETER	MOHA_LIMIT	MOHA_LIM_1	MOH_NA	MOH_CODE	
0	Polyline		13843.967	BOUND	Primary Road	13843.96689	0	2123590	34082	5		1	Beyrouth	1
1	Polyline	1	1335.114	BOUND	Primary Road	1335.114088	0	2123590	34082	5		1	Beyrouth	1
2	Polyline	2	3692.174	BOUND	Primary Road	3692.174202	0	2123590	34082	5		1	Beyrouth	1
3	Polyline	3	10000.091	BOUND	Primary Road	10000.091348	0	2123590	34082	5		1	Beyrouth	1
4	Polyline	4	690.041	BOUND	Primary Road	690.041121	0	2123590	34082	5		1	Beyrouth	1
5	Polyline	5	1430.61	BOUND	Primary Road	1430.609923	0	2123590	34082	5		1	Beyrouth	1
6	Polyline	6	1066.578	BOUND	Primary Road	1066.5779	0	2123590	34082	5		1	Beyrouth	1
7	Polyline	7	2933.701	BOUND	Primary Road	2933.701196	0	2123590	34082	5		1	Beyrouth	1
8	Polyline	8	3320.974	BOUND	Primary Road	3320.973669	0	2123590	34082	5		1	Beyrouth	1
9	Polyline	9	995.503	BOUND	Primary Road	995.503449	0	2123590	34082	5		1	Beyrouth	1
10	Polyline	10	4822.971	32\$05SEC032	Secondary Road	4822.970686	0	2123590	34082	5		1	Beyrouth	1
11	Polyline	11	2452.524	33\$05PRI042	Primary Road	2452.523714	0	2123590	34082	5		1	Beyrouth	1
12	Polyline	12	4339.824	INT01-DUAL	International Road - Dual	4339.823545	0	2123590	34082	5		1	Beyrouth	1
13	Polyline	13	10749.195	34\$05INT003	International Road - Dual	10749.194592	0	2123590	34082	5		1	Beyrouth	1
14	Polyline	14	74732.009	INT02-DUAL	International Road - Dual	74732.008486	0	2123590	34082	5		1	Beyrouth	1

Identify

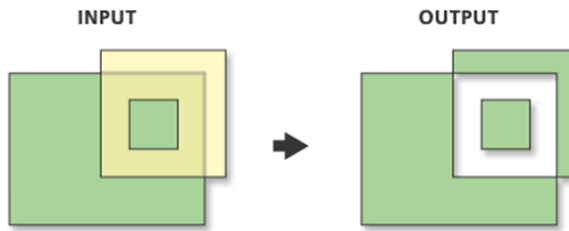
Clip

Table

FID	Shape *	LENGTH	LAYER	Category	Shape_Leng
0	Polyline	13843.967	BOUND	Primary Road	13843.96689
1	Polyline	1335.114	BOUND	Primary Road	1335.114088
2	Polyline	3692.174	BOUND	Primary Road	3692.174202
3	Polyline	10000.091	BOUND	Primary Road	10000.091348
4	Polyline	690.041	BOUND	Primary Road	690.041121
5	Polyline	1430.61	BOUND	Primary Road	1430.609923
6	Polyline	1066.578	BOUND	Primary Road	1066.5779
7	Polyline	2933.701	BOUND	Primary Road	2933.701196
8	Polyline	3320.974	BOUND	Primary Road	3320.973669
9	Polyline	995.503	BOUND	Primary Road	995.503449
10	Polyline	4822.971	32\$05SEC032	Secondary Road	4822.970686
11	Polyline	2452.524	33\$05PRI042	Primary Road	2452.523714
12	Polyline	4339.824	INT01-DUAL	International Road - Dual	4339.823545
13	Polyline	10749.195	34\$05INT003	International Road - Dual	10749.194592
14	Polyline	74732.009	INT02-DUAL	International Road - Dual	74732.008486

Symmetrical Difference

- The opposite of intersection: Removes the areas in common and keeps the features that do not overlap
- Uses the boolean operation of XOR
- Like Union, layers have to be of the same type

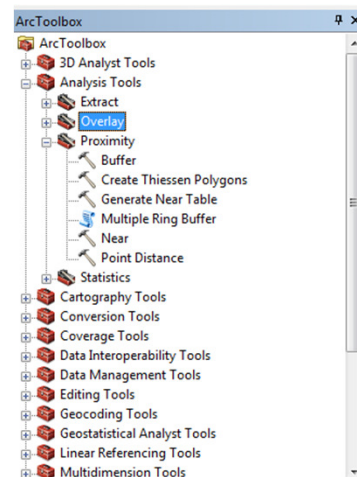


Proximity Toolset

- Helps answer one of the most basic questions asked of a GIS
 - **“What's near what?”**
- For example:
 - How close is this well to the landfill?
 - Do any roads pass within 1,000 meters of a stream?
 - What is the distance between two locations?
 - What is the nearest or farthest building from the epicenter of an earthquake?
 - What is the distance between each feature in a layer and the features in another layer?
 - What is the shortest street network route from some location to another?

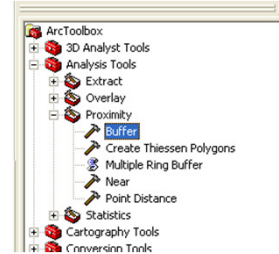
Proximity Toolset

- Has many tools:
 - **Buffer**
 - **Multiple Ring Buffer**
 - **Point Distance**
 - **Near**
 - Generate Near table
 - **Create Thiessen Polygons**

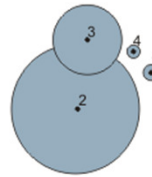


Buffer

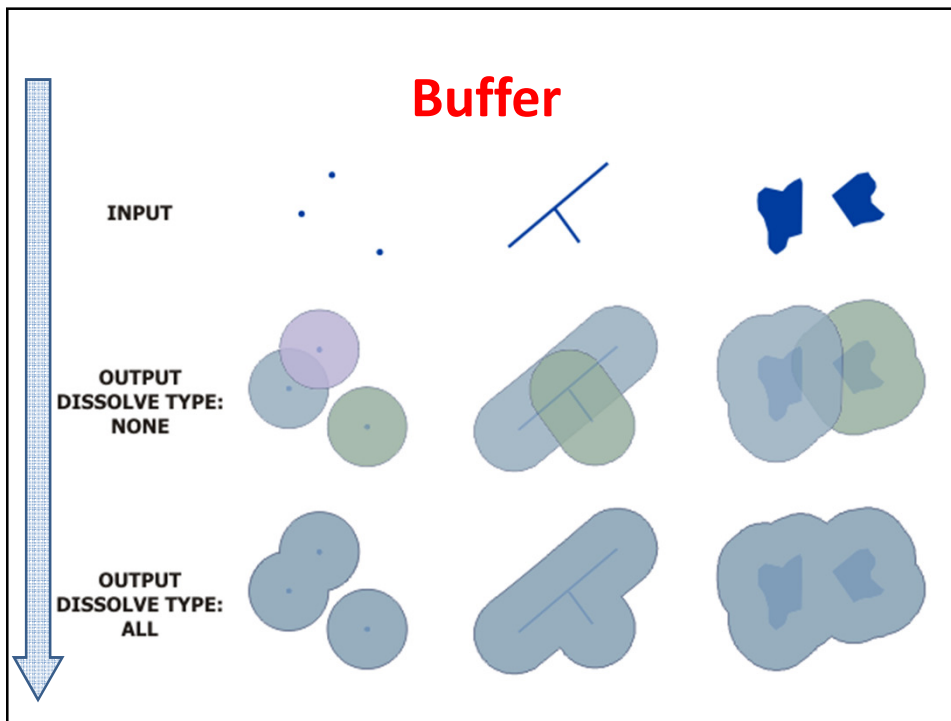
- Creates buffer polygons around input features to a specified distance
- Input can be point, line, or polygon
- Output is always a polygon
- Distance:
 - The distance can be specified by the user
 - The distance can be specified in the attribute table
 - ➔ variable buffer distance



OBJECTID *	SHAPE *	buffer_field
1	Point	200 Meters
2	Point	1 Miles
3	Point	1 Kilometers
4	Point	500 Feet

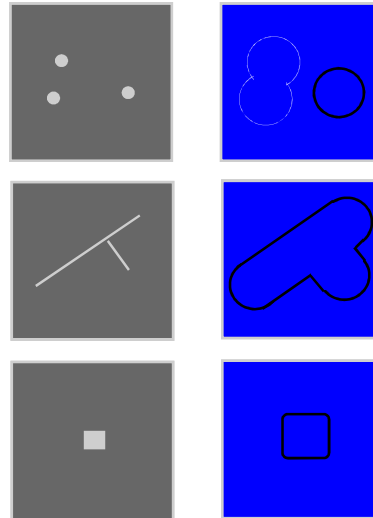


Buffer

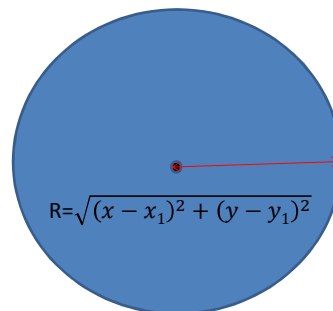


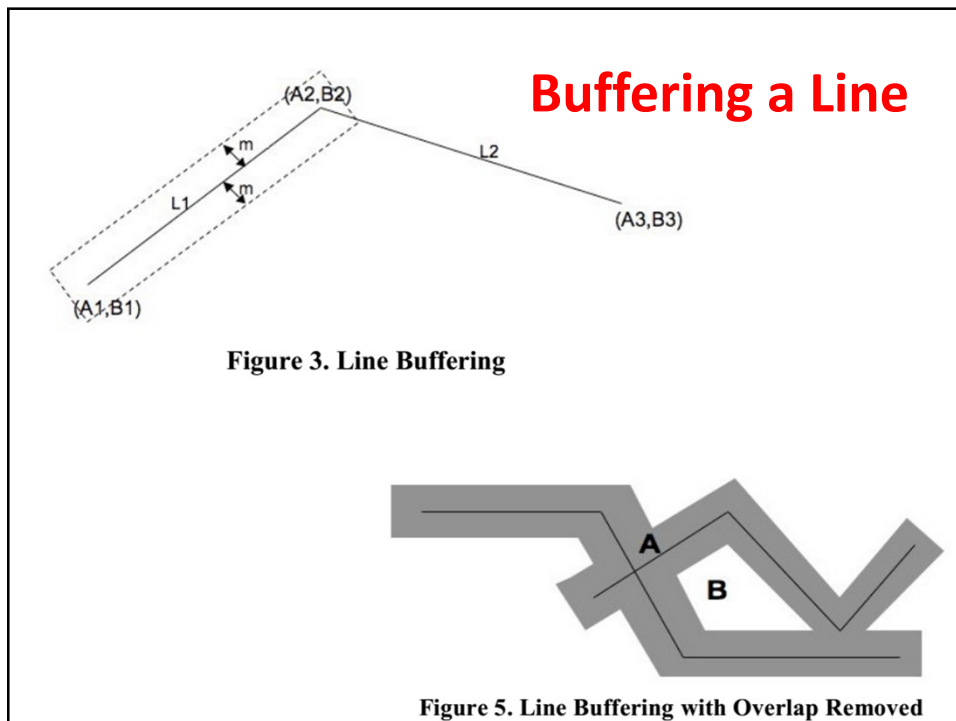
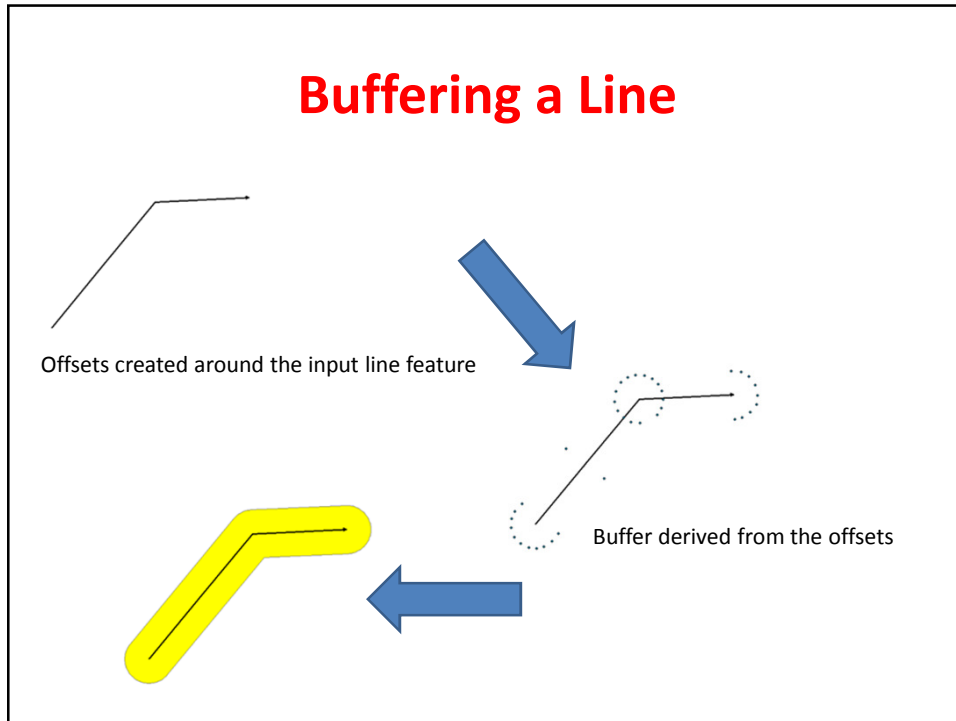
Buffers

- Buffers are great for determining areas of influence
- It will create:
 - Circular regions around your points
 - Corridors around your lines
 - Wider regions around your polygons



Buffering a Point





Line Buffer Example

Street Study
- Polygon buffer created 2 Km around selected streets



Buffering a Polygon

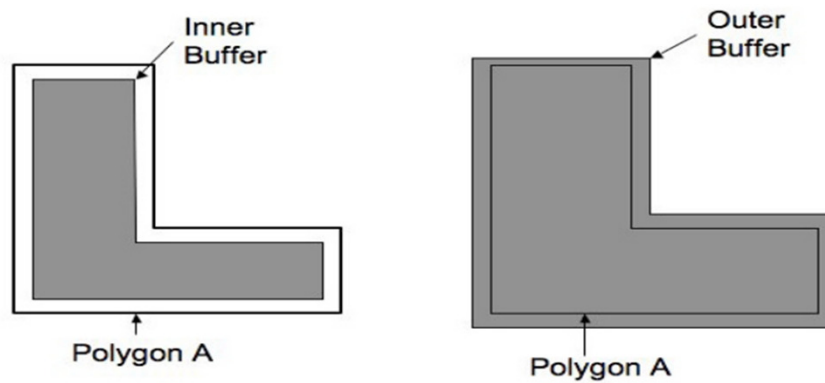
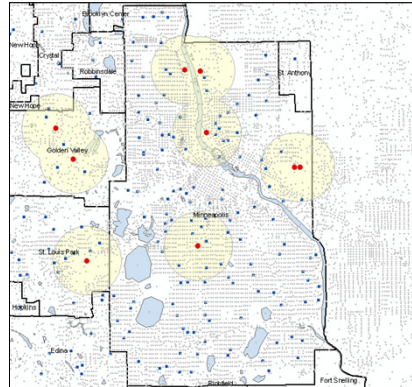
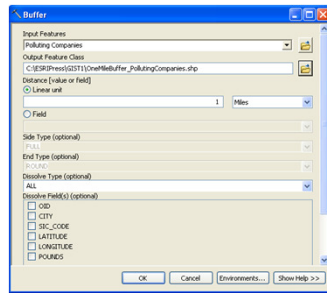


Figure 6. Polygon Buffering

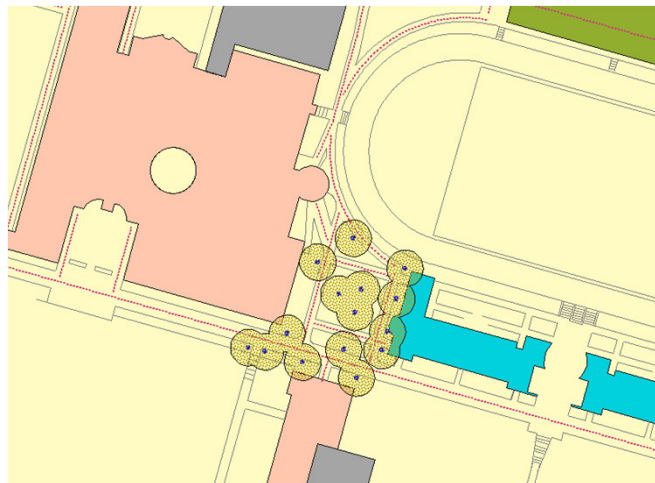
Point Buffer Example

- Polluting company buffers
 - Added schools
 - Added population



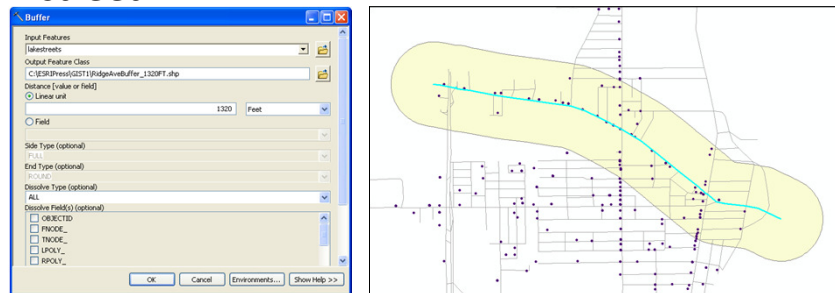
Campus Safety

Polygon buffer 20' around lights in a parking lot



Line buffer example

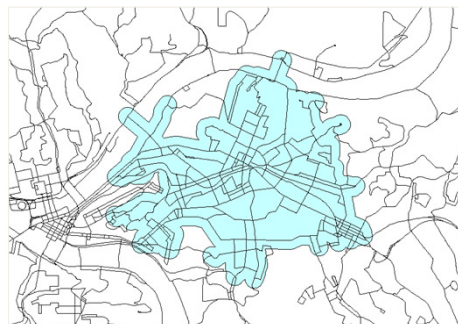
- Businesses within .25 miles of a selected street

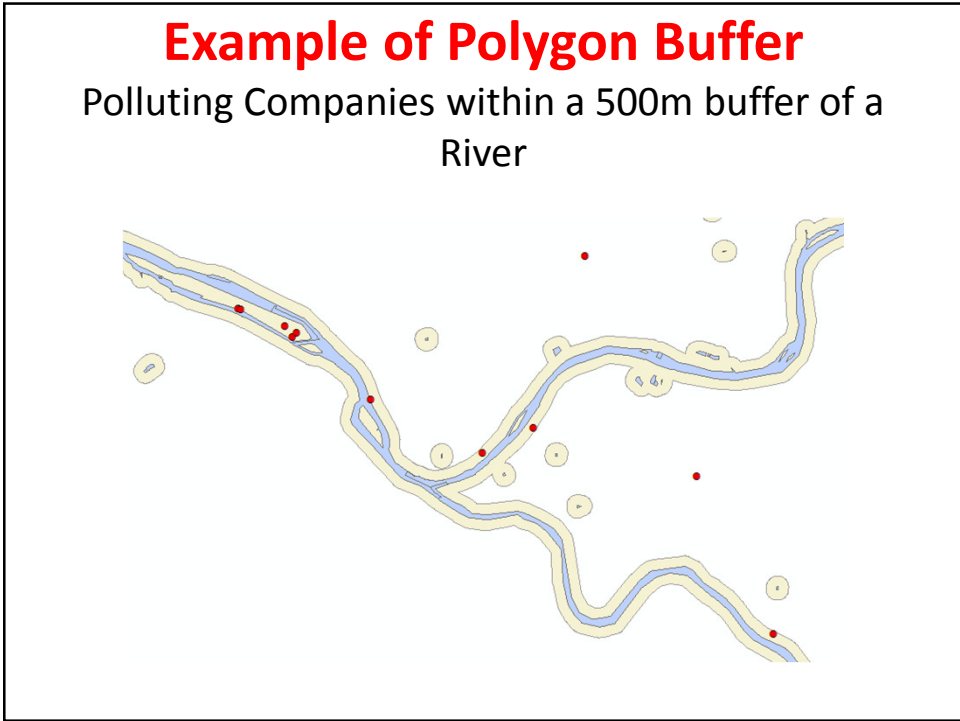


Line Buffer Example

Access to public transportation

- Polygon buffer created around Bus Routes
- Shows areas within 15 minute walking distance from routes





Buffer
Creates buffer polygons around input features to a specified distance. An optional dissolve can be performed to combine overlapping buffers.

Input Features

Output Feature Class

Distance [value or field]

- Linear unit
- Field

Side Type (optional)

- FULL
- LEFT
- RIGHT
- OUTSIDE_ONLY

End Type (optional)

- ROUND
- SQUARE
- MITER

Dissolve Type (optional)

- NONE
- ALL

Dissolve Field(s) (optional)

Select All Unselect All Add Field

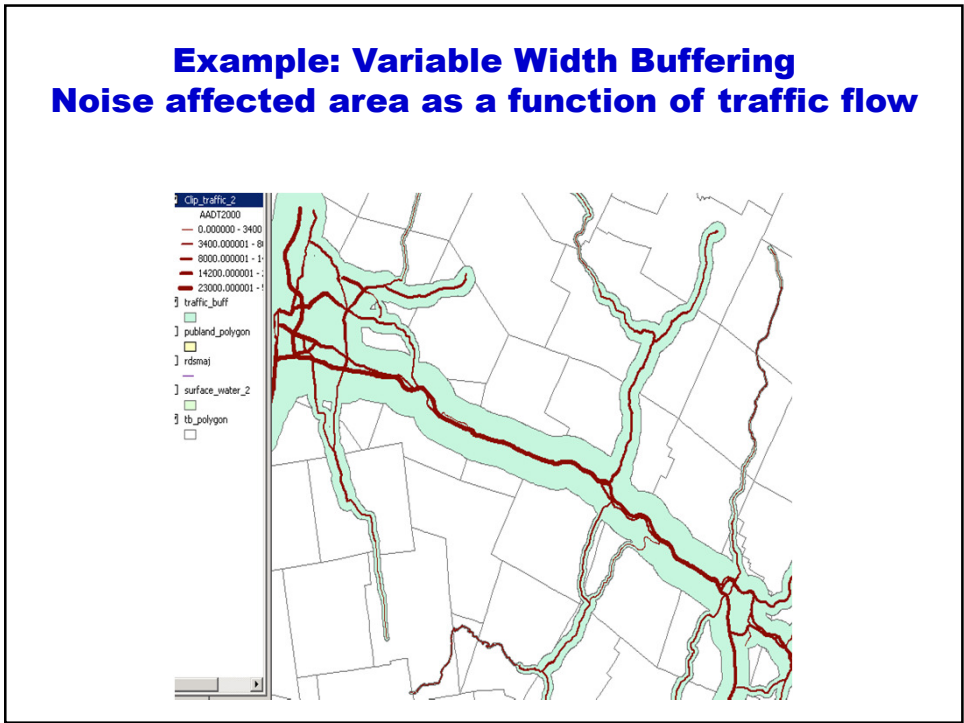
OK Cancel Environments... << Hide Help Tool Help

Fixed line

Variable distance (field)

What kind of a buffer?
FULL: buffers will be generated on both sides. This is the default.
LEFT: For line input features, buffers will be generated on the left of the line. This option is not valid for polygon input features
RIGHT: For line input features, buffers will be generated on the right of the line. This option is not valid for polygon input features
OUTSIDE_ONLY: For polygon, buffers will be generated only outside the input polygon (the area inside the input polygon will be erased from the output buffer)

Example: Variable Width Buffering Noise affected area as a function of traffic flow



Buffer

Creates buffer polygons around input features to a specified distance. An optional dissolve can be performed to combine overlapping buffers.

Input Features: []

Output Feature Class: []

Distance [value or field]: []

Linear unit

Field

Side Type (optional): []

End Type (optional): []

Dissolve Type (optional): []

Dissolve Field(s) (optional): []

Fixed line

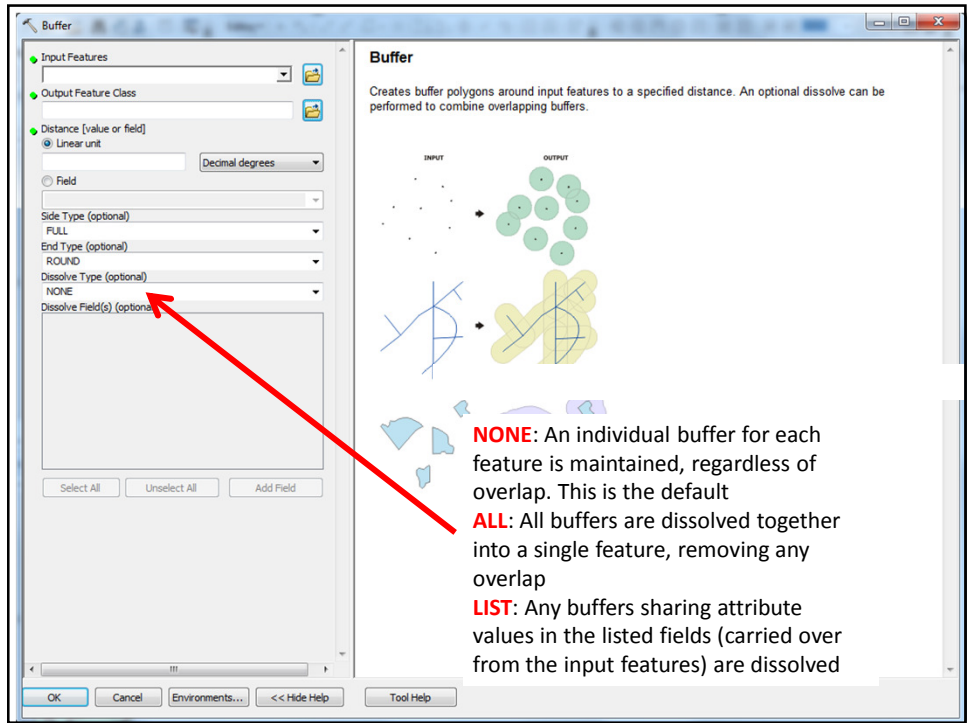
Variable distance (field)

What kind of a buffer?

- FULL: buffers will be generated on both sides. This is the default.
- LEFT: For line input features, buffers will be generated on the left of the line. This option is not valid for polygon input features
- RIGHT: For line input features, buffers will be generated on the right of the line. This option is not valid for polygon input features
- OUTSIDE_ONLY: For polygon, buffers will be generated only outside the input polygon (the area inside the input polygon will be erased from the output buffer)

How can I get the inside of a polygon?

OK Cancel Environments... << Hide Help Tool Help



Buffer

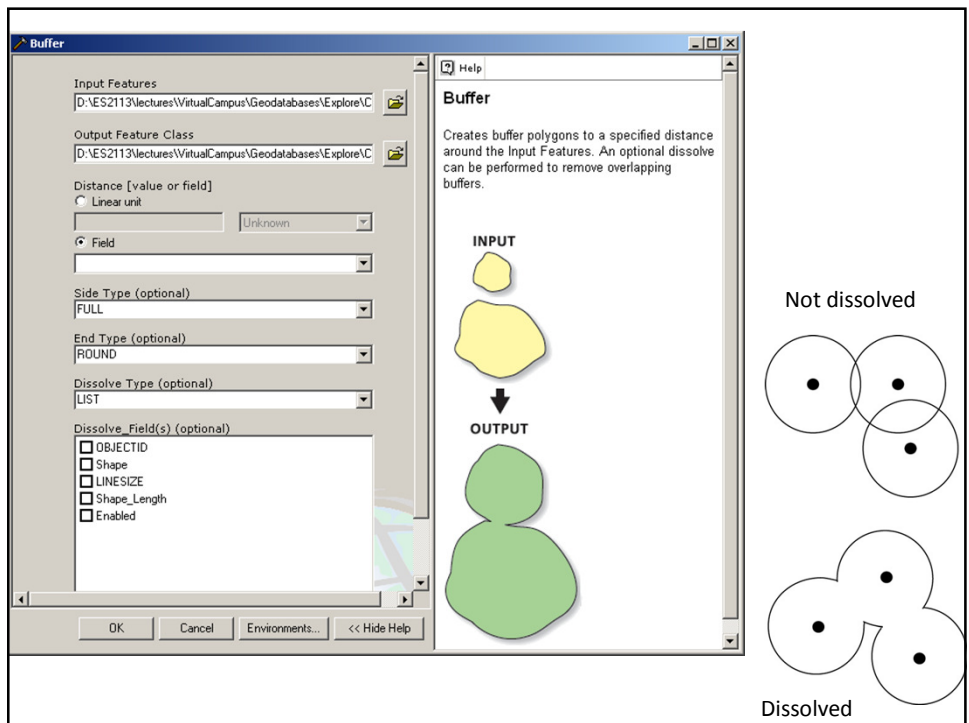
Creates buffer polygons around input features to a specified distance. An optional dissolve can be performed to combine overlapping buffers.

INPUT → **OUTPUT**

NONE: An individual buffer for each feature is maintained, regardless of overlap. This is the default

ALL: All buffers are dissolved together into a single feature, removing any overlap

LIST: Any buffers sharing attribute values in the listed fields (carried over from the input features) are dissolved



Buffer

Input Features: D:\ES2113\lectures\VirtualCampus\Geodatabases\Explore\C

Output Feature Class: D:\ES2113\lectures\VirtualCampus\Geodatabases\Explore\C

Distance [value or field]: Linear unit

Side Type (optional): FULL

End Type (optional): ROUND

Dissolve Type (optional): LIST

Dissolve_Field(s) (optional):
 OBJECTID
 Shape
 LINESIZE
 Shape_Length
 Enabled

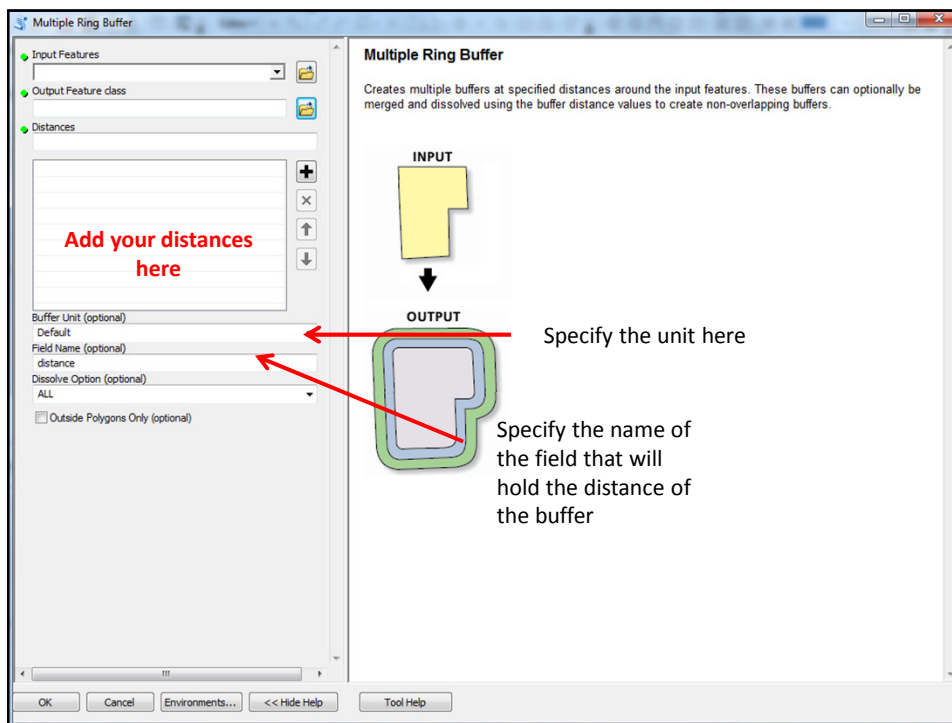
INPUT → **OUTPUT**

Not dissolved

Dissolved

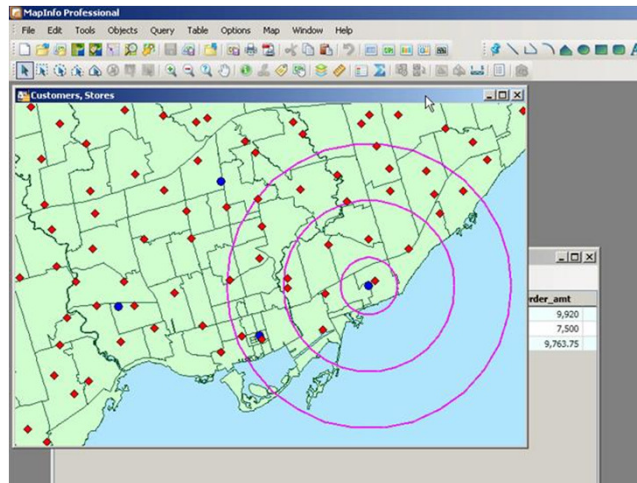
Multiple Buffers

- Creates multiple ring buffers at specified distances around the input features
- These buffers can optionally be merged and dissolved



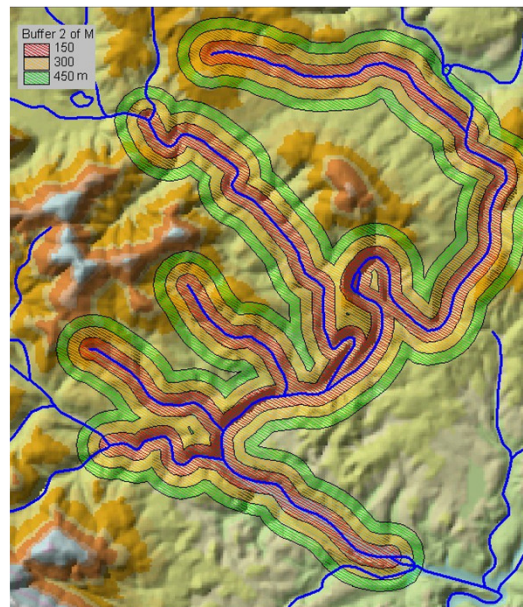
Example

- Areas affected if I have a blast at the Dora Petroleum Hub
 - 1 tank
 - 2 tanks
 - 3 tanks



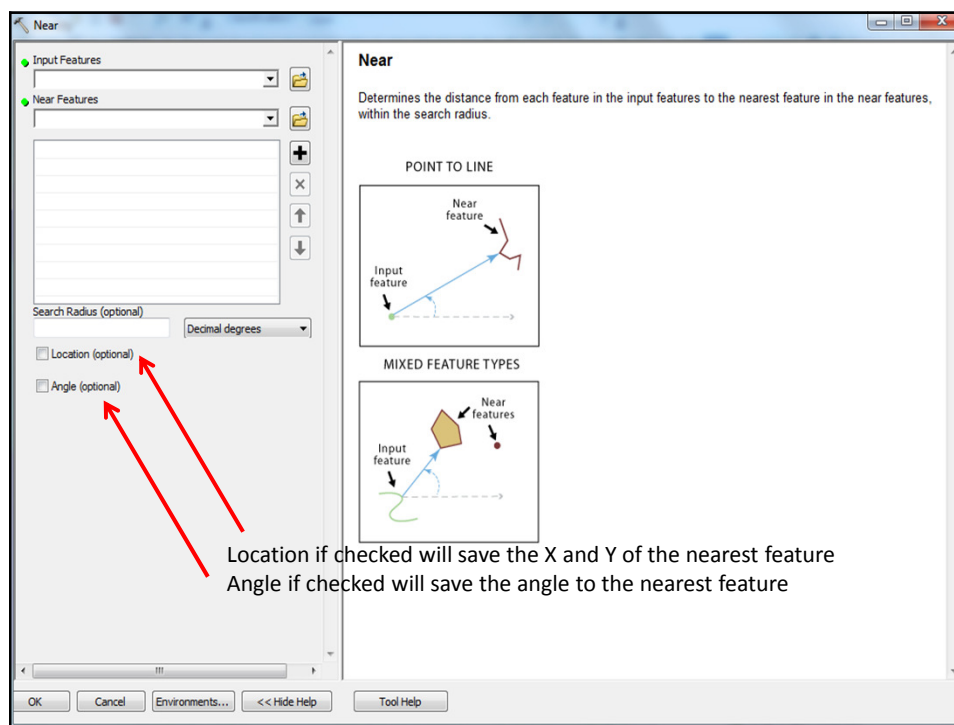
Example

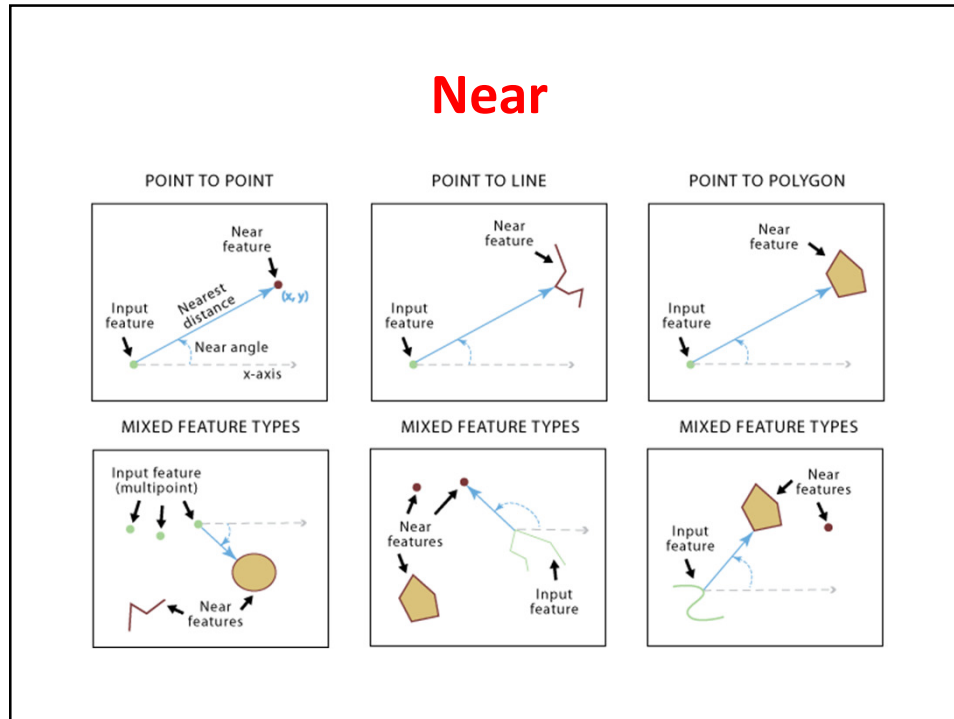
- Buffering around a river in case of a flood
 - Different flood intensities → different flood maps



Near

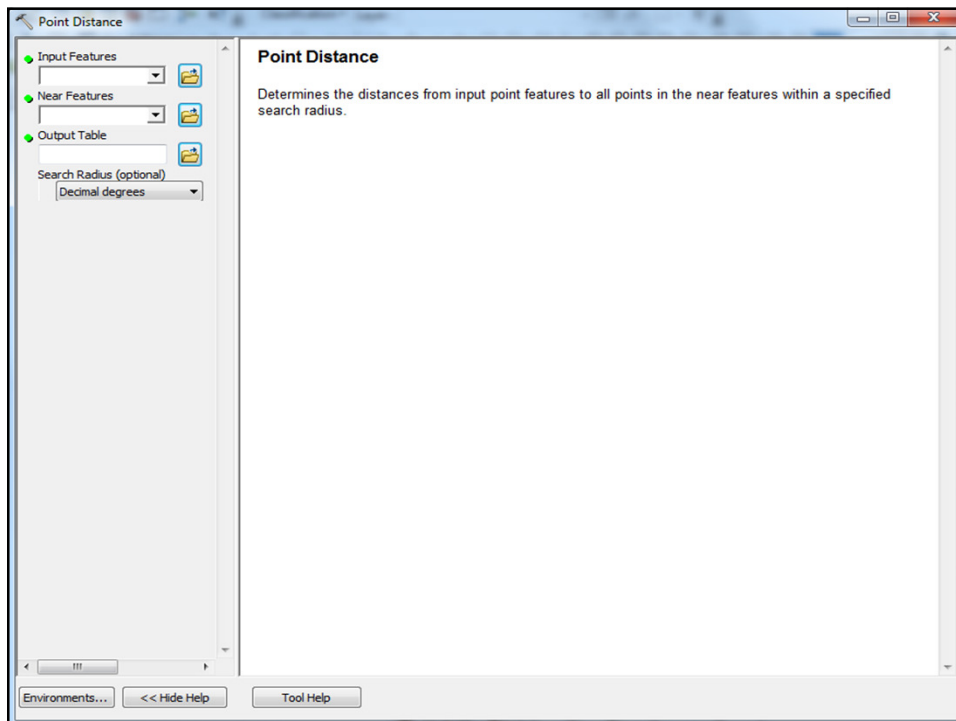
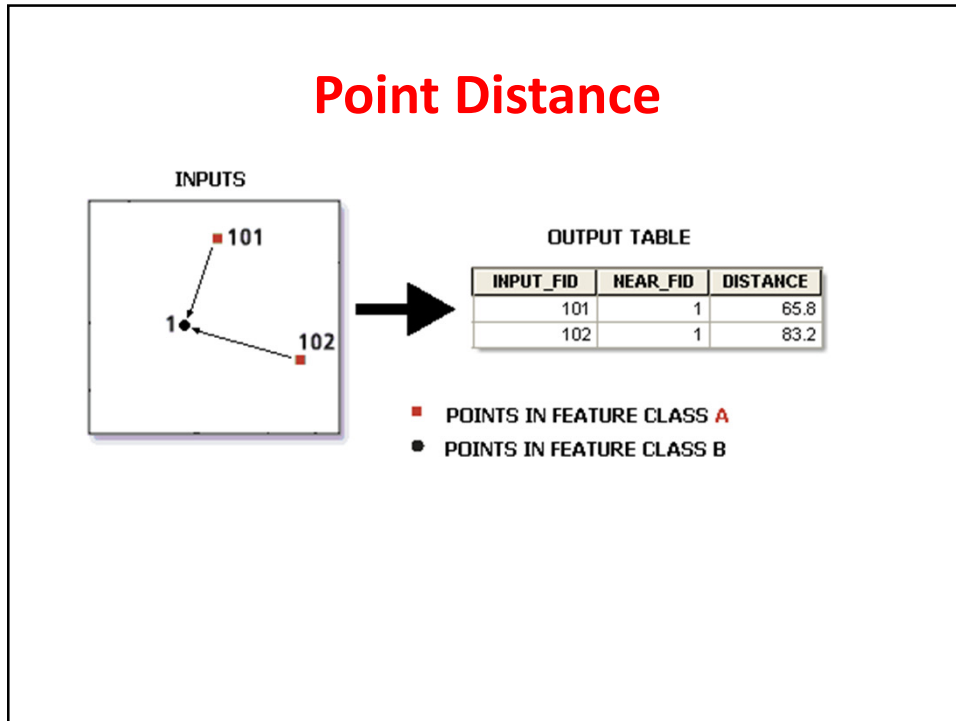
- For each feature in the **Input Layer**, the **Near** tool finds the nearest feature **in same or other layer(s)**
- Adds attributes such as distance to attributes of the input table → You **DO NOT** create a new file
- Works with points, lines, and polygons
- There can be one or more entries of near features
- You can specify a search radius





Point Distance

- Works **ONLY** with point layers
- For each point in the input layer, this tool finds the distance to **EVERY OTHER** point in the same or in another point layer
- Results are recorded in a new table
- To limit the number of calculations, using a **Search Radius** is recommended for large datasets because the output table can get really BIG!



Create Thiessen Polygons

- 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
- Used a lot to assign monitoring stations (e.g. weather stations)

