

# Leveraging the *Where* of Geographic Data

GIS II Data Management



- **Explore fundamental GIS methods to take advantage of the spatial characteristics of geographic data**
- **Unleash the power of spatial operations:**
  - **Spatial data basics**
  - **Introduction to spatial selections/queries**
  - **Introduction to spatial joins**



With multiple layers in your maps - are you interested in the relationships between these layers?

How many hospitals are located within a selected geography?

Where is the closest hospital with a primary stroke center classification?

What are the underlying demographics for a selected Hospital Service area?

Also how do you enumerate individual spatial records to a larger geography?

Consider some useful tools:

Spatial Selection

Spatial Join

## Components

- Spatial (where?)
  - *Geometry or shape of an object*
  - *Where it is located*
- Attributes (what?)
  - *Tabular data*
  - *Describes an object*



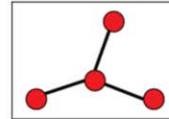
OWNER	LANDUSE	DE	PHYS ADD	CONSTTYP	YEARBULT	R
MD	VAC ADJ 10 ACRES OR >		0 OLD OXFORD RD			0
NC	VAC ADJ 10 ACRES OR >		0 RES MOUNTAIN RD			0
NC	PRESENT USE/AGRICULTUR		0 COUNTY LINE RD			0
NC	VAC ADJ TMBR 20 ACRES &		0 COUNTY LINE RD			0
NC	RES/ RURAL RES W/ ACRES	011	COUNTY LINE RD	R/S/D/C/L D/SH/2/AV		1985
NC	RES/ RURAL RES W/ ACRES	0721	COUNTY LINE RD	R/S/D/C/L D B/SH/2/AV		1985

Review components of geographic data

### A brief discussion of topology in a GIS

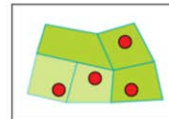
#### Connectivity

Connections between objects



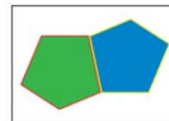
#### Containment

Maintenance of boundaries and closed areas to define relationships with other objects



#### Adjacency

Relationships between objects that are next to each other



For the purposes of this discussion we will limit of definition of topology to: how points lines and polygons relate to each other.

Along with explicit spatial definition (i.e. coordinates) your geographic data includes topological information that helps define relationships to objects in space:

- What is connected to what?
- What is within what?
- What is beside what?

GIS software keeps track of this information allowing you to use it for a number of spatial operations and queries; indeed this very information allows for spatial join and spatial query functionality we will discuss in this module.

The arrangement that constrains how point, line, and polygon features share geometry. For example, street centerlines and census blocks share geometry, and adjacent soil polygons share geometry.

Topology defines and enforces data integrity rules (for example, there should be no gaps between polygons).

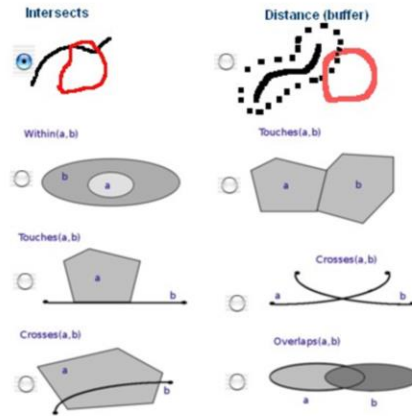
It supports topological relationship queries and navigation (for example, navigating feature adjacency or connectivity), supports sophisticated editing tools, and allows feature construction from unstructured geometry (for example, constructing polygons from lines).

## Spatial selections/queries: Asking questions of your data

Select features in one or more layers based on relationship to other features

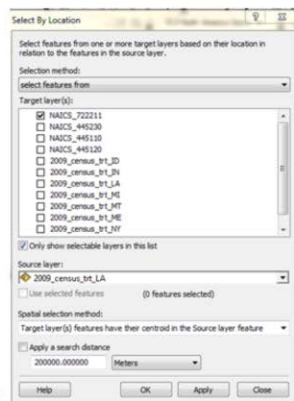
## Spatial Joins: Connecting your data

Uses spatial associations between layers to append fields from one layer to another



Spatial operations take advantage of the spatial information associated with your geographic data; they are one of the many things that make GIS pretty cool

- **Select features based on location relative to other features**
- **Number of methods to select features within a layer or another layer**
  - **Point**
  - **Line**
  - **Polygon**
- **Not permanent**



Spatial relationships covered:

+Geoprocessing tool

Selection\Select By Location...

INTERSECT Target layer(s) features intersect the Source layer feature

WITHIN\_A\_DISTANCE Target layer(s) features are within a distance of the Source layer feature

CONTAINS Target layer(s) features contains the Source layer feature

COMPLETELY\_CONTAINS Target layer(s) features completely contains the Source layer feature

CONTAINS\_CLEMENTINI Target layer(s) features contains (Clementini) the Source layer feature

WITHIN Target layer(s) features are within the Source layer feature

COMPLETELY\_WITHIN Target layer(s) features are completely within the Source layer feature

WITHIN\_CLEMENTINI Target layer(s) features are within (Clementini) the Source layer feature

ARE\_IDENTICAL\_TO Target layer(s) features are identical to the Source layer feature

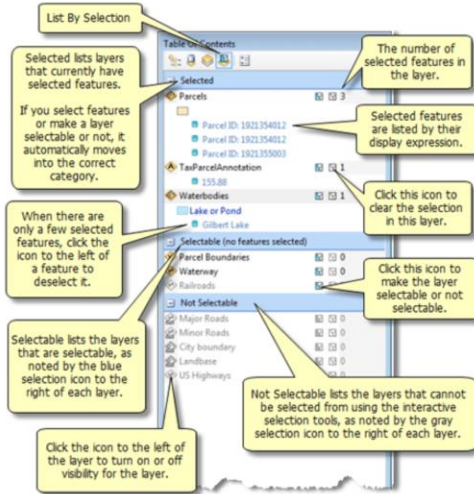
BOUNDARY\_TOUCHES Target layer(s) features touch the boundary of the Source layer feature

SHARE\_A\_LINE\_SEGMENT\_WITH Target layer(s) features share a line segment with the Source layer feature

CROSSED\_BY\_THE\_OUTLINE\_OF Target layer(s) features are crossed by the outline of the Source layer feature

HAVE\_THEIR\_CENTER\_IN Target layer(s) features have their centroid in the Source layer feature

- **Determine which layers can be selected**
- **Good if you have many layers in one project**
- **Displays number of selected features and display expression**



**List By Selection**

Selected lists layers that currently have selected features.

If you select features or make a layer selectable or not, it automatically moves into the correct category.

When there are only a few selected features, click the icon to the left of a feature to deselect it.

Selectable lists the layers that are selectable, as noted by the blue selection icon to the right of each layer.

Click the icon to the left of the layer to turn on or off visibility for the layer.

The number of selected features in the layer.

Selected features are listed by their display expression.

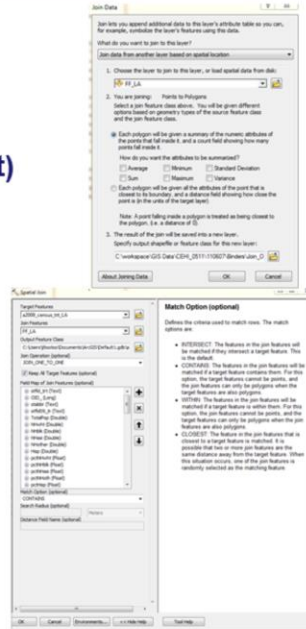
Click this icon to clear the selection in this layer.

Click this icon to make the layer selectable or not selectable.

Not Selectable lists the layers that cannot be selected from using the interactive selection tools, as noted by the gray selection icon to the right of each layer.

Layer Name	Selection Icon	Number of Selected Features
Selected	Blue selection icon	3
Parcels	Blue selection icon	3
Parcel ID: 1821354012	Blue selection icon	
Parcel ID: 1821354012	Blue selection icon	
Parcel ID: 1821355003	Blue selection icon	
TaxParcelAnnotation	Blue selection icon	1
155.88	Blue selection icon	
Waterbodies	Blue selection icon	1
Lake or Pond	Blue selection icon	
Gilbert Lake	Blue selection icon	
Selectable (no features selected)	Blue selection icon	0
Parcel Boundaries	Blue selection icon	0
Waterway	Blue selection icon	0
Railroads	Blue selection icon	0
Not Selectable	Gray selection icon	0
Major Roads	Gray selection icon	0
Minor Roads	Gray selection icon	0
City boundary	Gray selection icon	0
Landbase	Gray selection icon	0
US Highways	Gray selection icon	0

- **Join based on location of two layers**
  - **Creates new layer**
  - **Appends tables (join to target)**
  
- **Based on the relationship(s) between the two participating layers**
  - **Intersection**
  - **Containment/Within**
  - **Closest**



A spatial join joins the attributes of two layers based on the location of the features in the layers.

A new layer is created Like joining two tables by matching attribute values in a field, a spatial join appends the attributes of one layer to another.

Match join options:

- +Intersect-matches join features with intersect target features
- +Contains-target feature contains a join feature (points cannot be set as target feature and polygons can only be set as join features when target feature is polygon)
- +Is within-target features within join features matched (points cannot be set as join features and polygons may only be target features when join fields are also polygons)
- +Closest- target features matched to closest join feature

*Wont' work with number leading on target for GDB*

## Join by location (spatial join)

Join by location or spatial join uses spatial associations between the layers involved to append fields from one layer to another. Spatial joins are different from attribute and relationship class joins in that they are not dynamic and require the results to be saved to a new output layer.

1. **Match each feature to the closest feature or features** - In this association, you can either append the attributes of the nearest feature or append an



aggregate (i.e. min, max etc.) of the numeric attributes of the closest features.

**2. Match each feature to the feature that it is part of** - In this case, the attributes of the feature for which the current feature makes up a portion are appended.

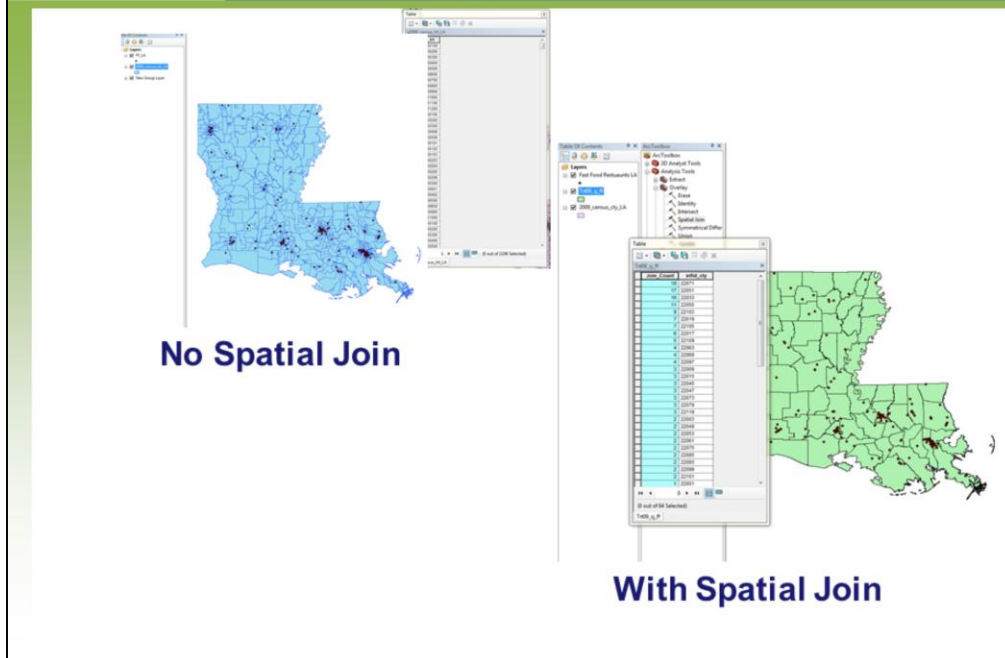
**3. Match each feature to the feature or features that it intersects** - Like with the closest feature(s) association above, you can either append the attributes of a single intersecting feature or an aggregate of the numeric attributes of the intersecting features.

For each point, polygon and line combination, only the most commonly used of these associations are available in the join dialog. With VBA, however, it is possible to perform a join based on any association and with any combination of point, line or polygon feature layers.

For the best results, it is recommended that both layers have the same coordinate system. If the layers have different coordinate systems, the following rules apply:

- The spatial join will be calculated in the target layer's (the select layer in the table of contents) coordinate system.
- If the type of join performed involves adding a field to show the distance between joined features, the distance will be in a unit of measure associated with the target layer's coordinate system.
- If one of the layers has an unknown coordinate system and the other a defined coordinate system, an error message will appear. If both layers have an unknown coordinate system, the join will proceed and the resulting layer will have an unknown coordinate system.
- The coordinate system used to display data in ArcMap has no effect on how the data is joined. ArcMap allows data to be stored in one coordinate system and displayed in another. The analysis is always performed using the stored coordinate system.

Note: Use the Spatial Join geoprocessing tool in ArcToolbox (Analysis Tools > Overlay > Spatial Join tool) instead of this dialog if you are performing spatial join with large or complex datasets. The Spatial Join tool will in these cases give you dramatically better performance and reliability, and you can use the geoprocessing framework to easily automate repetitive or frequently performed joins with the tool as part of a model or script, or simply by entering the parameters for the tool in the geoprocessing command line. For example, you may wish to perform several similar spatial joins to compare the results.

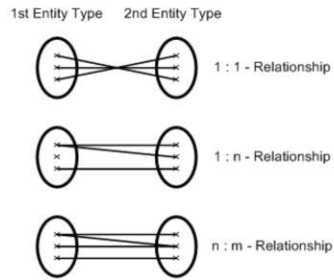


Spatial join involves matching rows from the join layer to the target layer based on a spatial relationship and writing to an output feature class

Many to one counts from the join layer (LA fast food restaurants NAICS 722211) are appended to the target layer (LA Census 2009 tracts) in a new shapefile that contains a count field for restaurants

This is a many to one join.

- **Cardinality**



- **What is the spatial relationship you are leveraging?**



Cardinality rules:

Is the join a one to one?

Is the join one to many?

Many to many joins will not work

Does the relationship make sense?

- Valid spatial relationships for joins are determined by the geometry types of the input layers as well as the chosen match option

Target Features	Join Features	CONTAINS	COMPLETELY_CONTAINS	CONTAINS_CLEMENTINI	WITHIN	COMPLETELY_WITHIN	WITHIN_CLEMENTINI	ARE_IDENTICAL_TO	BOUNDARY_TOUCHES	SHARE_A_LINE_SEGMENT_WITH	CROSSED_BY_THE_OUTLINE_OF	HAVE_THEIR_CENTER_IN
[Point]	[Point]	✓										
	[Line]					✓	✓					
	[Area]						✓	✓				✓
[Line]	[Point]	✓	✓									✓
	[Line]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	[Area]				✓	✓	✓		✓	✓	✓	✓
[Area]	[Point]	✓	✓	✓								✓
	[Line]	✓	✓	✓					✓	✓	✓	✓
	[Area]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

relationships of INTERSECT, INTERSECT\_3D, WITHIN\_A\_DISTANCE, WITHIN\_A\_DISTANCE\_3D, and CLOSEST are not shown in the table, they are valid for any combination of geometry type.