Edmodo Code:fp3rtt

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Introduction to GIS

Vector Data Model

9th Lec.

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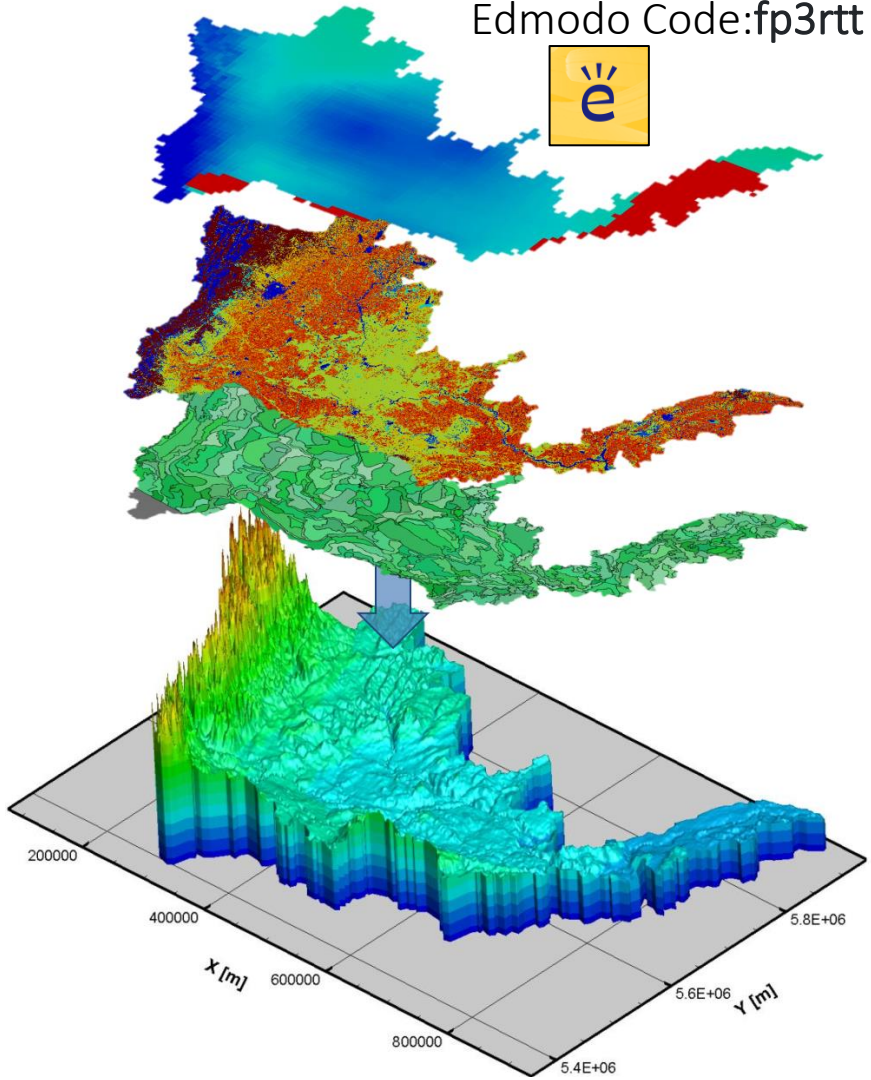


What we Learned in the Previouse class

Types of Vector Data

Point, Line, Polygon

Topology

Adjacency and Incidence

Outline

- Georelational Data Model
- Coverage
- Connectivity, Area definition, and Contiguity
- Shapefile

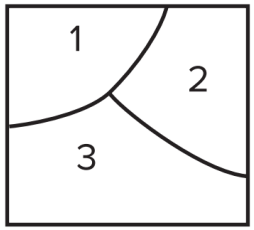
Georelational Data Model

The georelational data model stores geometries and attributes separately in a split system: geometries ("geo") in graphic files in a spatial subsystem and attributes ("relational") in a relational database.

The **coverage** and the **shapefile** are both examples of the georelational data model; however, the coverage is topological, and the shapefile is nontopological.

A georelational dataset uses a feature ID or label to link the spatial data with the attribute data.

The spatial features in the map layer are linked to the database via the ObjectID field in the database



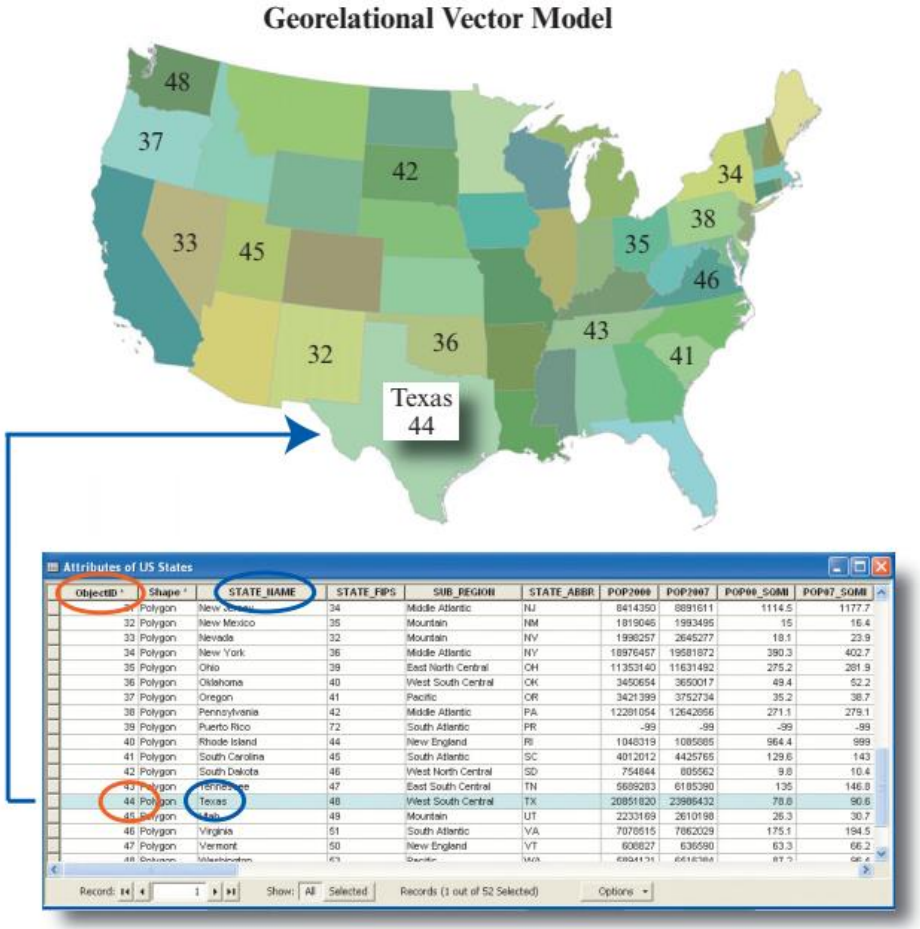
Graphic Files

Polygon/arc list
Arc-coordinate list
Left/right list
⋮

INFO File

Polygon-ID	Field 1	· · ·
1		
2		
3		

Georelational Data Model



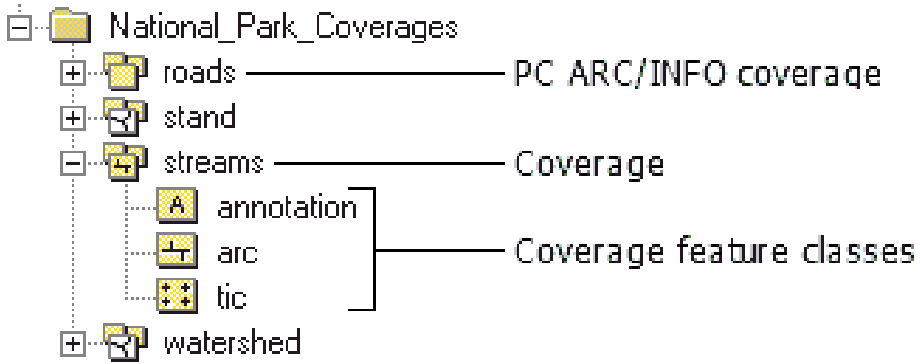
Coverage

ESRI (the Environmental Systems Research Institute) introduced the coverage and its built-in topology in the 1980s to separate GIS from CAD (computer-aided design) at the time.

A **coverage** is a georelational data model that stores vector data—it contains both the *spatial* (location) and *attribute* (descriptive) data for geographic features.

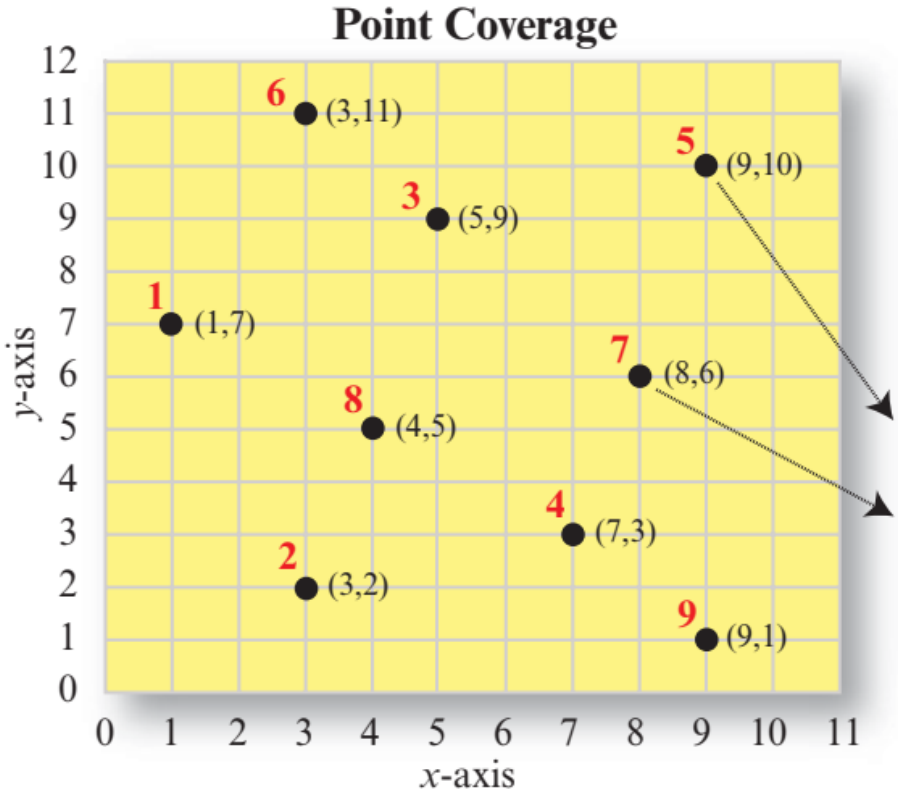
Coverages use a set of feature classes to represent geographic features. Each feature class stores a set of points, lines (arcs), polygons, or annotation (text).

A coverage is stored in the computer as a directory. The directory name is the coverage name



Coverage (Cont.)

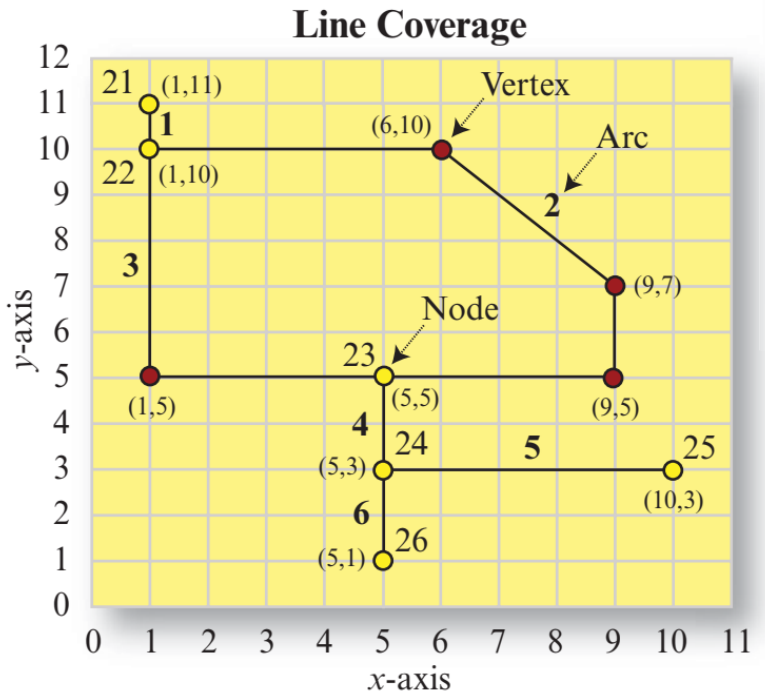
A point coverage is simple: It contains the feature IDs and pairs of *x*- and *y*-coordinates



Point Attribute Table	
ID	*x*,*y* Coordinates
1	1,7
2	3,2
3	5,9
4	7,3
5	9,10
6	3,11
7	8,6
8	4,5
9	9,1

Coverage (Cont.)

data structure of a line coverage; the starting point of an arc is the from node, and the end point is the to-node.

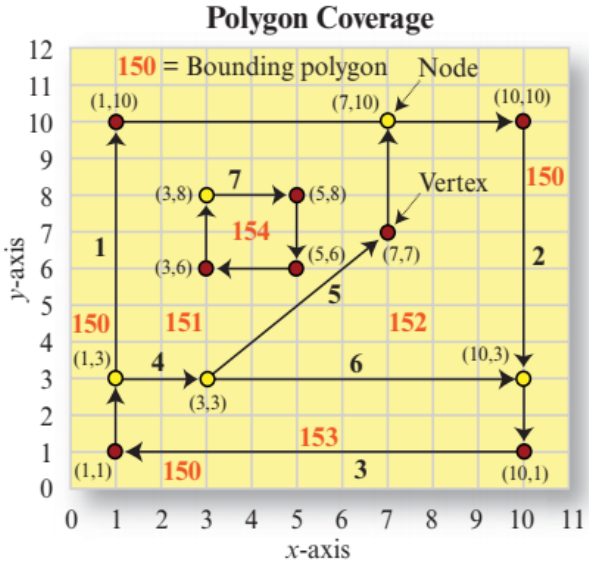


Arc Nodes		
Arc	*From* node	*To* node
1	21	22
2	22	23
3	23	22
4	23	24
5	24	25
6	24	26

Arc Coordinates	
Arc	*x,y* Coordinates
1	(1,11) (1,10)
2	(1,10) (6,10) (9,7) (9,5) (5,5)
3	(5,5) (1,5) (1,10)
4	(5,5) (5,3)
5	(5,3) (10,3)
6	(5,3) (5,1)

Coverage (Cont.)

Polygon data-structure coverages contain a polygon Left-Right list for each arc. This information allows for studies of adjacency. Arcs that make up each polygon are found in the Polygon-Arc list. All points (nodes and vertices) that define the arcs are found in the Arc-Coordinate list.



Left-Right Polygons		
Arc	Left Polygon	Right Polygon
1	150	151
2	150	152
3	150	153
4	151	153
5	151	152
6	152	153
7	151	154

Polygon Arcs	
Polygon	Arc
151	1,4,5,0,7
152	5,2,6
153	6,3,4
154	7

Arc Coordinates	
Arc	*x,y* Coordinates
1	(1,3) (1,10) (7,10)
2	(7,10) (10,10) (10,3)
3	(10,3) (10,1) (1,1) (1,3)
4	(1,3) (3,3)
5	(3,3) (7,7) (7,10)
6	(3,3) (10,3)
7	(3,8) (5,8) (5,6) (3,6) (3,8)

To show that polygon 154 is a *hole* within polygon 151, the arc list for polygon 151contains a **zero** to separate the external and internal boundaries

Coverage (Cont.)

The coverage supports three basic topological relationships:

- **Connectivity:** Arcs connect to each other at nodes.
- **Area definition:** An area is defined by a series of connected arcs.
- **Contiguity:** Arcs have directions and left and right polygons.

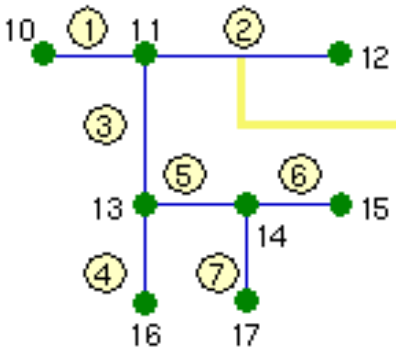
Connectivity

Connectivity is defined through arc-node topology. Connectivity allows to identify a route to the airport, connect streams to rivers, or follow a path from the water treatment plant to a house.

Arc-node topology is supported through an arc-node list. The list identifies the from- and to-nodes for each arc. Connected arcs are determined by searching through the list for common node numbers.

In the example, the **arcs 1**, **2**, and **3** all intersect because they share **node 11.** The computer can determine that it is possible to travel along **arc 1** and turn onto **arc 3** because they share a common **node (11)**, but it's not possible to turn directly from **arc 1** onto **arc 5** because they don't share a common node.

Arc-Node Topology



Arc-Node List

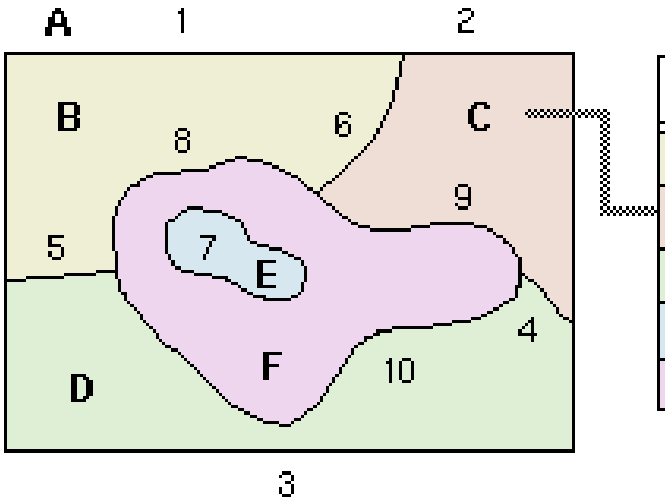
Arc	From Node	To Node
1	10	11
2	11	12
3	11	13
4	13	16
5	13	14
6	14	15
7	14	17

Area Definition

An area such as lakes, and parcels of land, is represented in the vector model by one or more boundaries defining a polygon.

consider a lake (**F**) with an island in the middle. The lake actually has two boundaries: **one** that defines its <u>outer edge</u> (arc 8, 9, and 10) and **the island** that defines its <u>inner edge</u> (arc 7).

In the terminology of the vector model, an island defines an inner boundary (or **hole**) of a polygon.



Polygon-Arc Topology

Polygon	Arc List
B	1, 6, 8, 5
C	2, 4, 9, 6
D	3, 5, 10, 4
E	7
F	8, 9, 10, 0, 7

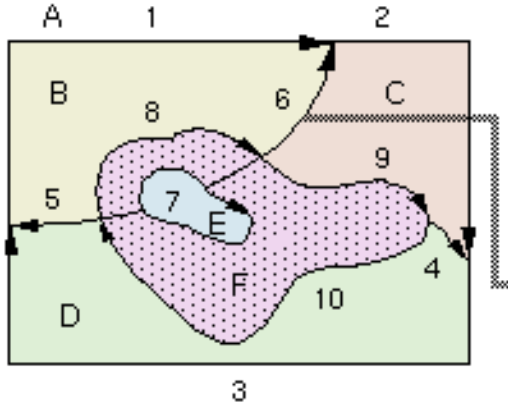
Contiguity

Two geographic features that share a boundary are called **adjacent**. Contiguity is the topological concept that allows the vector data model to determine adjacency.

Polygons are contiguous to each other if they share a common arc. This is the basis for many neighbor and overlay operations.

polygon **B** is on the left of **arc 6**, and polygon **C** is on the right. Thus we know that polygons **B** and **C** are adjacent.

Notice that the label for polygon **A** is outside the boundary of the area. This polygon is called the **external**, or **universe,** polygon and represents the world outside the study area.



Left-Right Topology

Arc	Left Polygon	Right Polygon
1	A	B
2	A	C
3	A	D
4	C	D
5	D	B
6	B	C
7	F	E
8	B	F
9	C	F
10	D	F

Shapefile

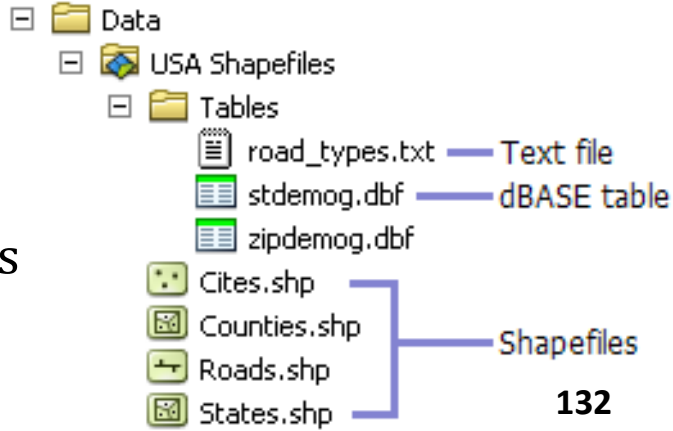
In less than one decade after GIS companies introduced topology to separate GIS from CAD, the same companies adopted nontopological data format.

A shapefile is a simple, nontopological format for storing the geometric location and attribute information of geographic features.

Geographic features in a shapefile can be represented by points, lines, or polygons (areas). The workspace containing shapefiles may also contain dBASE tables, which can store additional attributes that can be joined to a shapefile's features.

Shapefile polygons actually have duplicate arcs for the shared boundaries and can overlap one another.

The shapefile is stored in three basic files: The *.*shp* file stores the feature geometry, the *.*shx* file maintains the spatial index of the feature geometry, and *.*dbf* the dBASE table that stores feature attributes

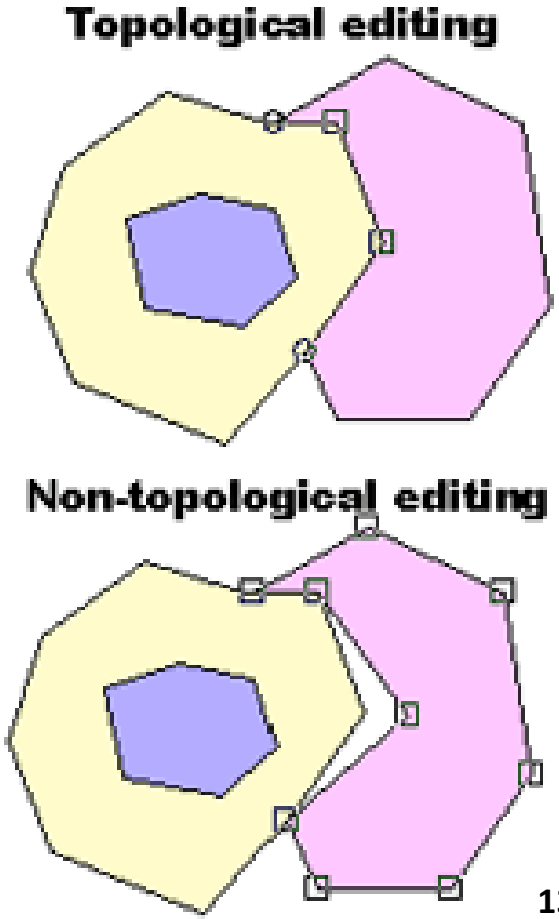


Shapefile

Nontopological data such as shapefiles have **two** main advantages:

First, they can display more rapidly on the computer monitor than topology based data. This advantage is particularly important for people who use, rather than produce GIS data.

Second, they can be used across different software packages .



Basic Comparison between Coverage and Shapefile

Developed:	1980s	1990s
Same data:		
Data format:	Coverage	Shapefile
	Topology required	Topology absent
	Complicated	Simple
	Hard to use	Easy to use
	Efficient data	Inefficient data