INTRODUCTION TO GIS

presented by:
Timothy L. Haithcoat
University of Missouri
Columbia

A Simple Definition of GIS

A computer system which can hold and use data describing places on the earth's surface.

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This definition leaves out the most important component of the GIS…the **people** who administrate, use, and manage the GIS.

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GIS is BIG Business Now

- GIS is the primary driver for its very own, ever greater, acceptability and use.
- Everyone likes maps and graphics and the computer makes it easier for you to visualize your data.
- GIS growth feeds on its own successes and builds new and more complex applications as it permeates society.
- It is projected that $75 to $95 BILLION dollars will be spent in the United States alone on GIS implementations through the year 2000.
- The market has grown over 40% per year with no stopping for several years now.

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There are literally thousands of applications of GIS!!

Why?

Because no project is ever started without first asking:

Where??

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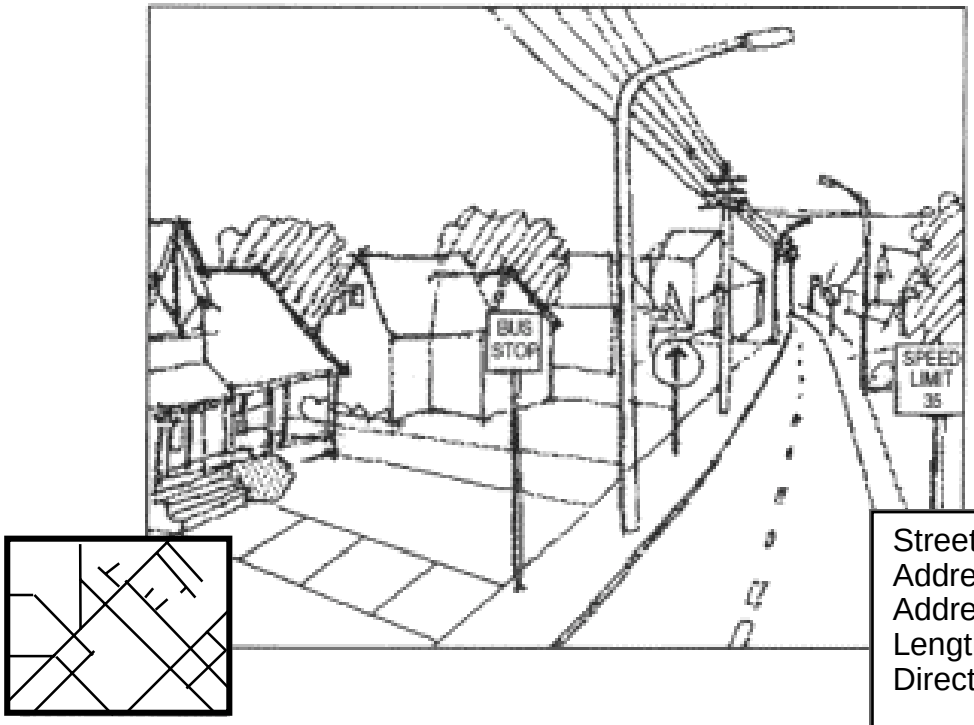
Geographic Features

Geographic features are represented by two types of data.



Street Name
Address range on left
Address range on right
Length to travel
Directions to travel

SPATIAL DATA **ATTRIBUTE DATA**

Questions a GIS can Answer

A comprehensive GIS can answer all of the following questions...

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LOCATION: What is at...?

Here we are seeking to find out what exists at a particular location.

A location can be described in many different ways using, for example, place name, zip code, or latitude and longitude coordinates.

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CONDITION: Where is it?

Instead of identifying what exists at a given location, you want to find a location where certain conditions are satisfied.

For example, you wish to find a house assessed at less than $120,000 with 4 bedrooms and made of wood or stucco.

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TRENDS:
What has changed since…?

This seeks to discover the differences between an area as the result of the passing of time.

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PATTERNS:
What spatial patterns exist?

This seeks to discover what types of patterns may exist in the newly created data file that were not visible before. For example you may wish to know where motor vehicle accidents occur and at what times.

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MODELING: What if...?

This seeks to determine what happens if something is changed within an area. For example a new subdivision is added to a school district, or a toxic substance seeps into the local ground water supply, or you want to locate a new business.

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What a GIS is NOT.

A GIS is not simply a computer system for making pretty maps.
More importantly a GIS...

...is an **analysis tool**.

...**links** spatial data with geographic information about a particular feature on a map.

...can use the **stored** attributes to compute **new information** about map features.

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Geographic Query/Reporting

Use of database query and tabular report generation tools to perform special geographic queries and generate hard copy reports, displays, or maps.

Examples:

- Display and produce tabular summary of all water quality permit sites exceeding discharge standards
- Identify and display all water lines of a specified age and diameter

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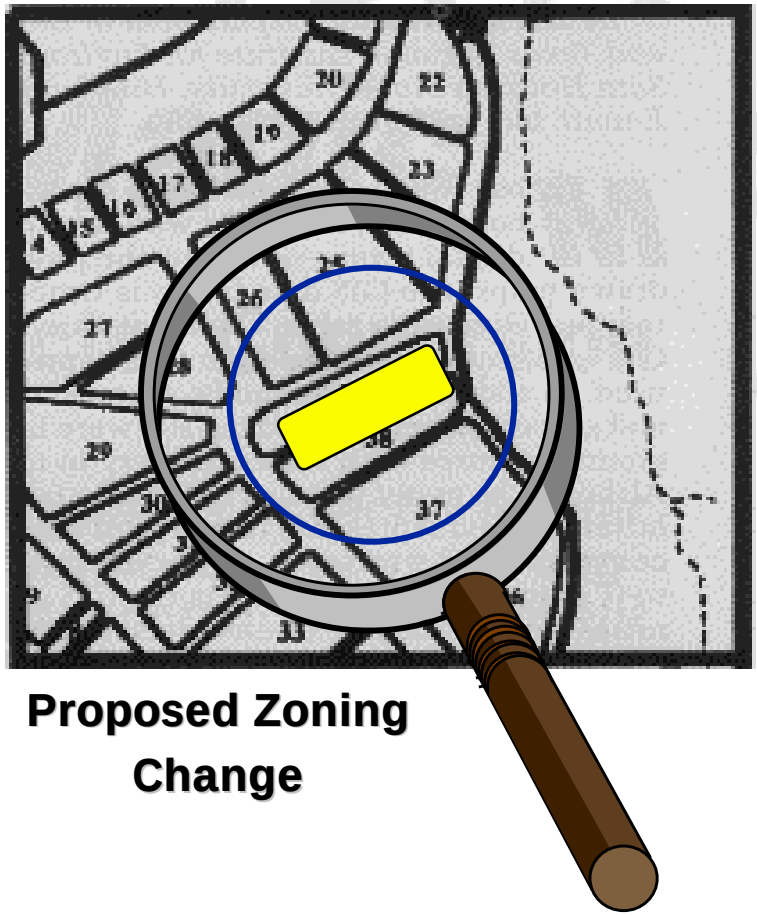
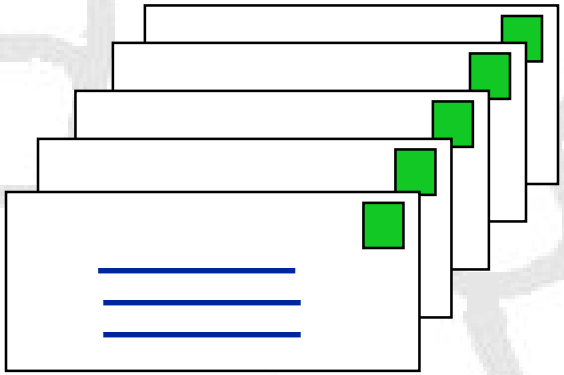
Using a GIS to Query a Geographic Database



Proposed Zoning Change



Neighbors must be notified

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Selecting Records

		TYPE
		30
		30
		27
		16
		30
		27

		TYPE
		30
		30
		27
		16
		30
		27

		TYPE
		30
		30
		27
		16
		30
		27

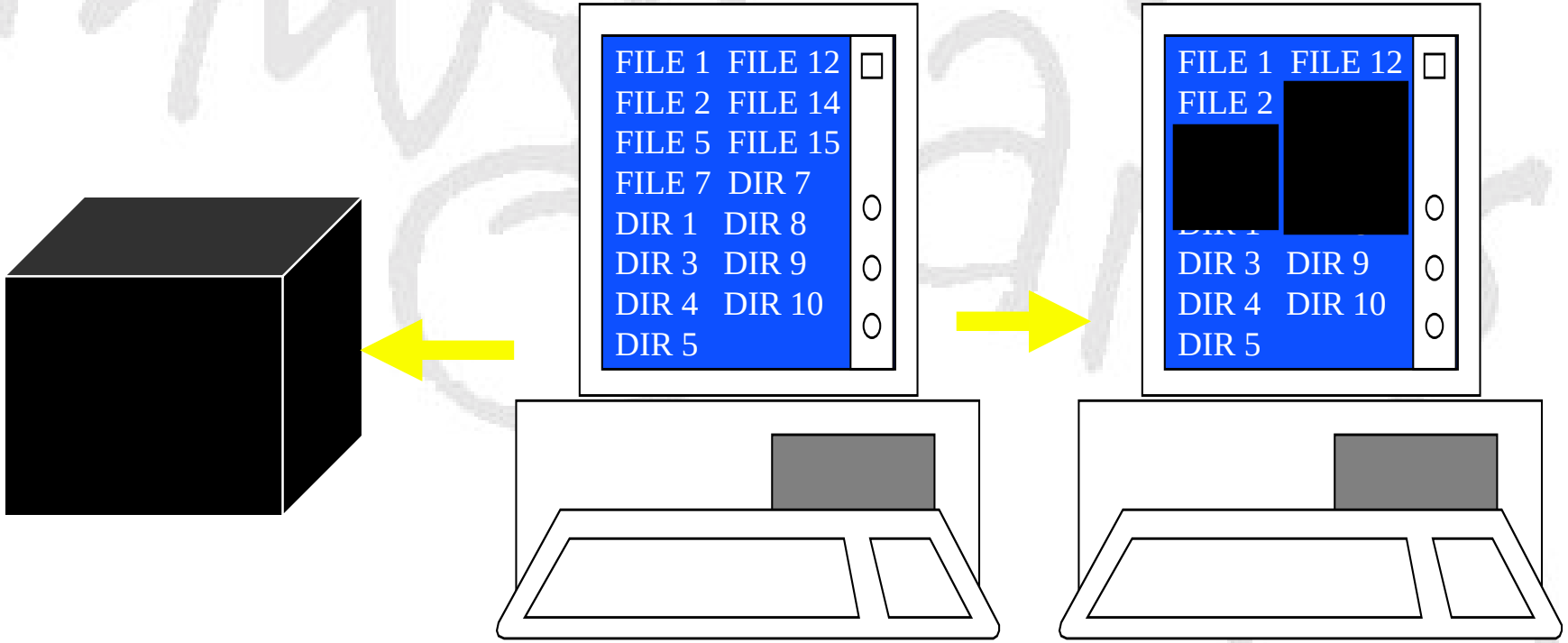
		TYPE
		30
		30
		27
		16
		30
		27

RESELECT
Reselect Type = 30
3 records selected

ASELECT
Aselect Type = 16
4 records selected
or
ASELECT
6 records selected

NSELECT
2 records selected

GIS Functions - Data Management



ARCHIVED DATA

ON-LINE STORAGE

DELETED FROM SYSTEM

Thematic Mapping

Production of maps in which a shading pattern is used to differentiate between categories of a geographic "theme" for a defined map or feature.

Examples:

- Shaded land use maps
- Population density maps

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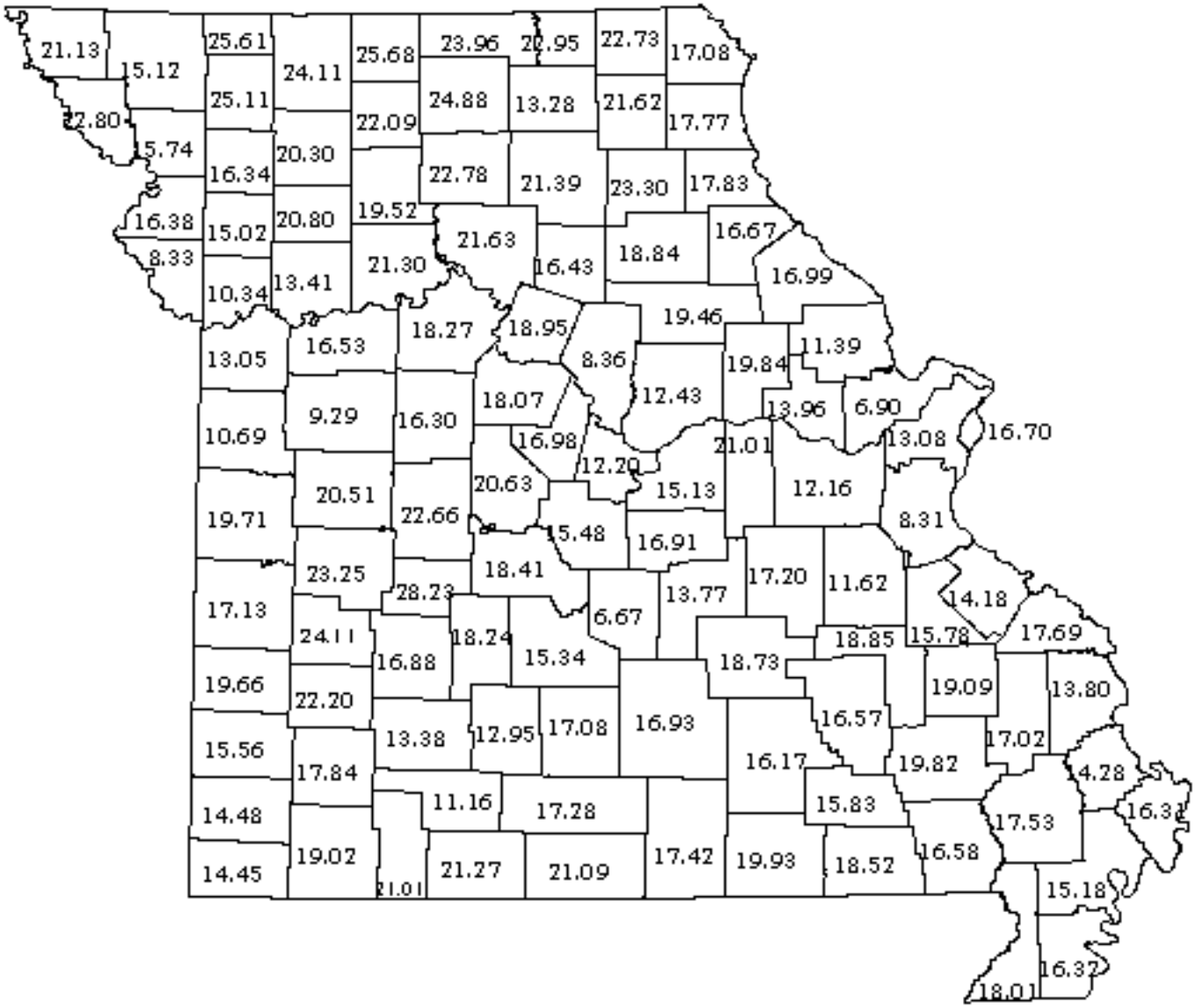

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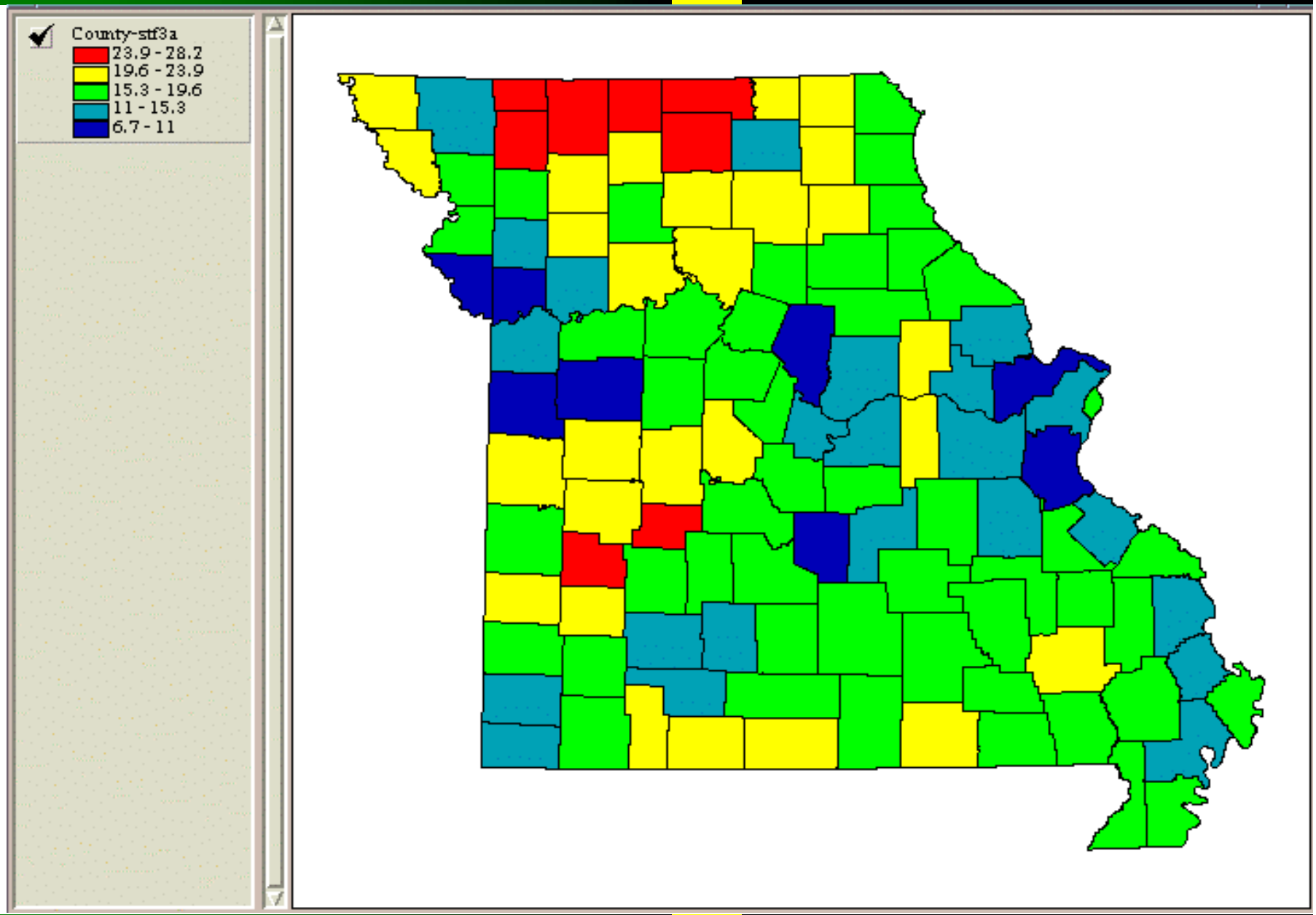

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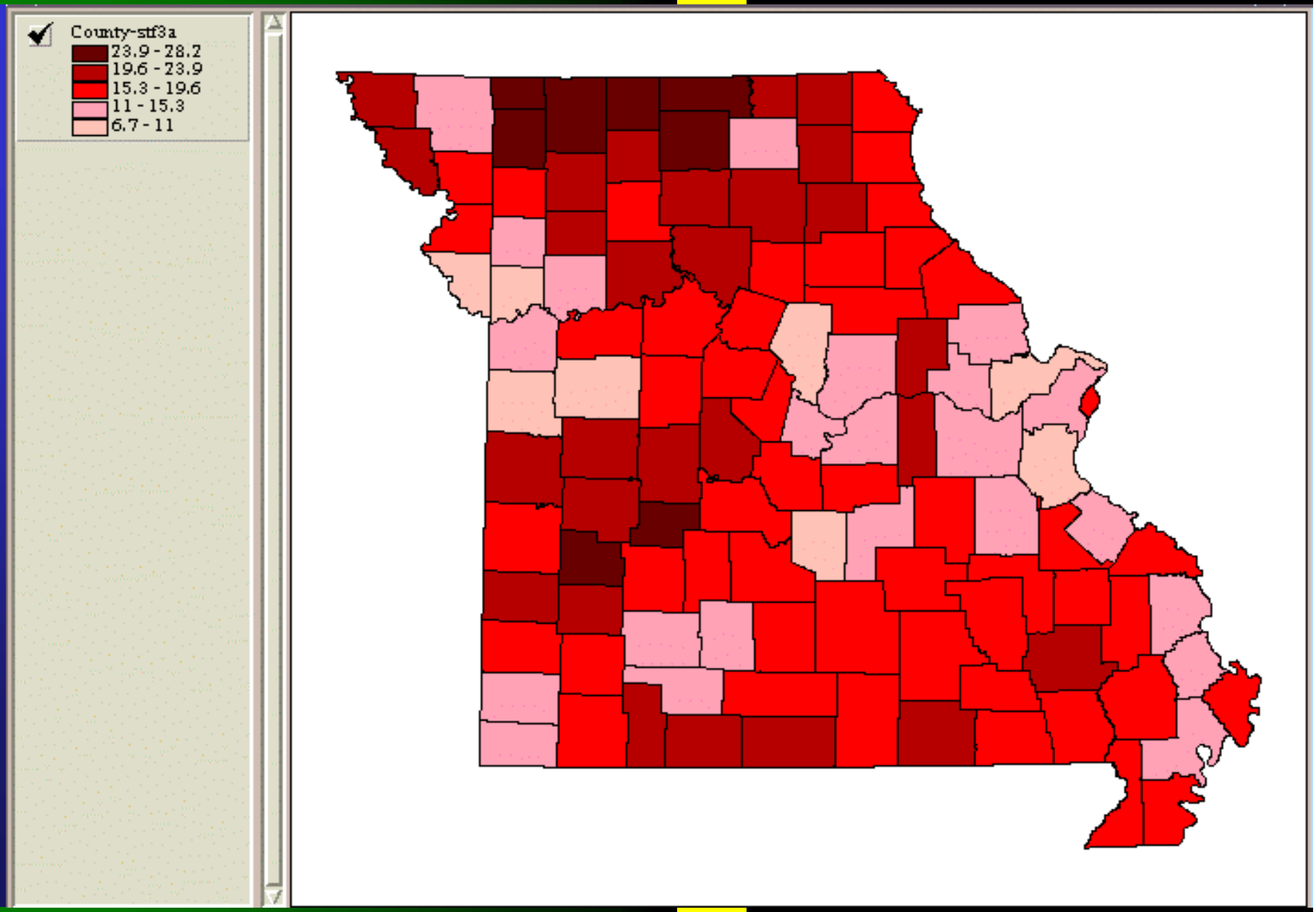

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Spatial Aggregation

The retrieval and tabulation of map features or occurrences that are encompassed by a user-defined area.

Examples:

- **Summary of crime incidents by police reporting district**
- **Calculation of newly paved road mileage within a state highway maintenance district**

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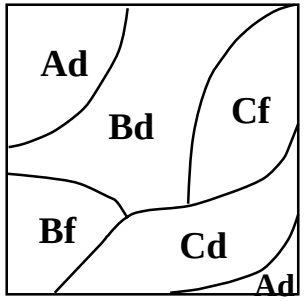
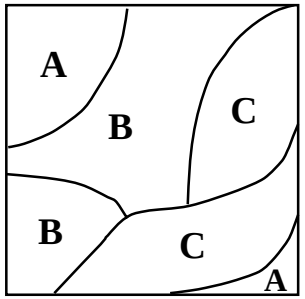
Steps:

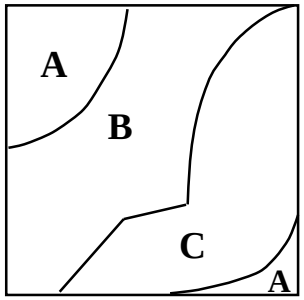
1. **Reclassify** soil areas by soil type only.
2. **Dissolve** boundaries between areas of same soil type.
3. **Merge** polygons into large objects.



Soil Types A, B and C with growth potentials d and f



Soil Types A, B and C



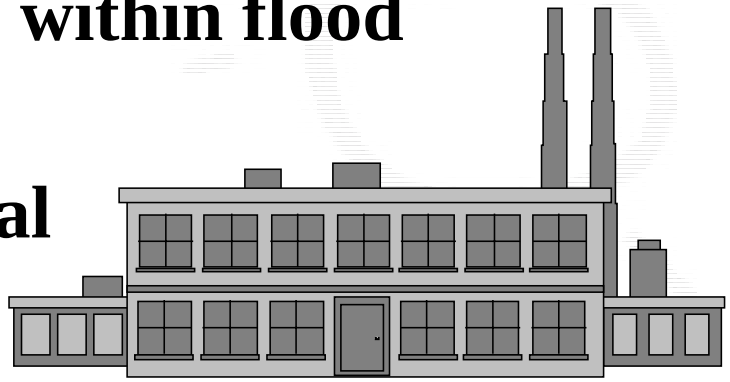
Soil Types A, B, and C

Polygon Overlay

The vertical overlay of multiple map layers to derive a resulting layer based on some logical combination of attributes.

Examples:

- **Erosion analysis based on overlay of soil, slope, and land cover layer;**
- **Determine parcels that fall within flood prone areas**
- **Site suitability for industrial development**



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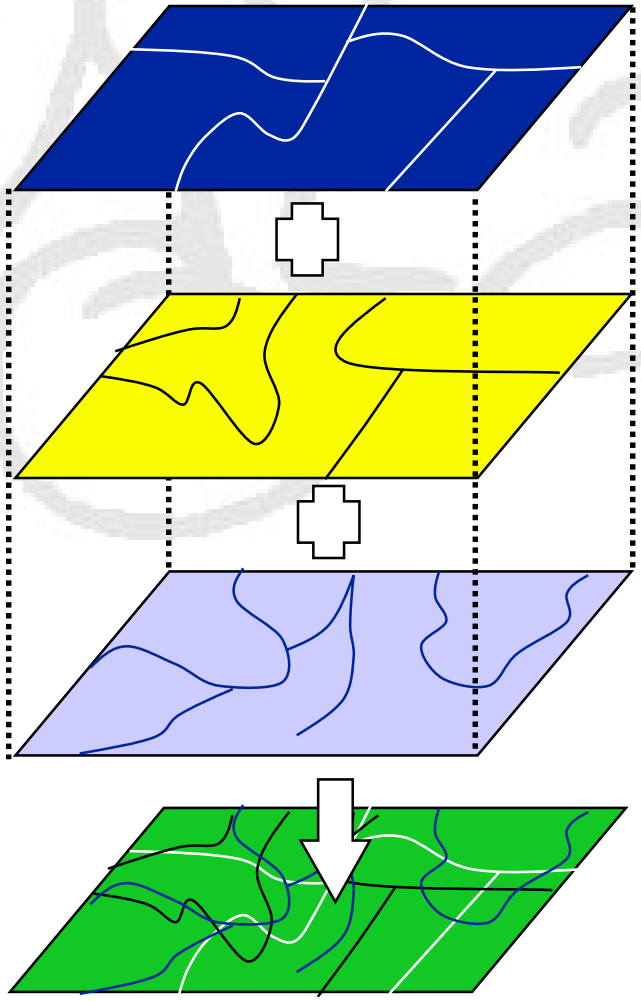
Suitability Analysis Using Map Overlays

Governmental Administrative Units

Land Use

Soils

Suitability for Industrial Development



Analysis of these interrelated maps

Produces

Application (Result)

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Point in Polygon

- Overlay point objects on areas, compute "is contained in" relationship
- Result is a new attribute for each point
  - Example: combine wells and planning districts, find district containing each well

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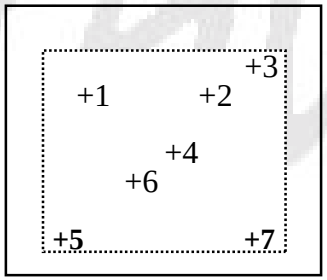
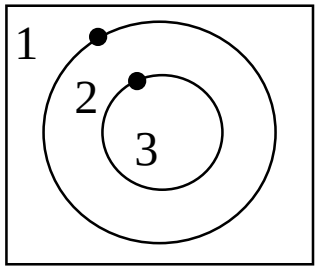
Identity - Point Option

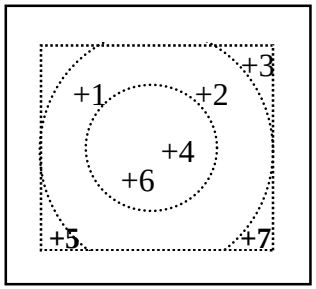
Input Coverage



Identity Coverage



Output Coverage



INPUT COVERAG	
#	Attribut
1	A
2	B
3	C
4	D
5	E
6	F
7	G

IDENTITY COVERAG	
#	Attribut
1	
2	102
3	103

OUTPUT COVERAG	INPUT COVERAG		IDENTITY COVERAG	
#	#	Attribut	#	Attribut
1	1	A	2	102
2	2	B	2	102
3	3	C	1	
4	4	D	3	103
5	5	E	1	
6	6	F	3	103
7	7	G	1	

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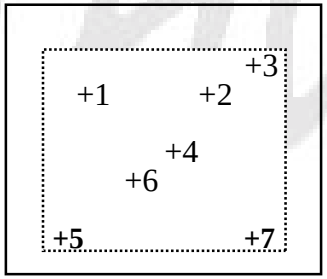
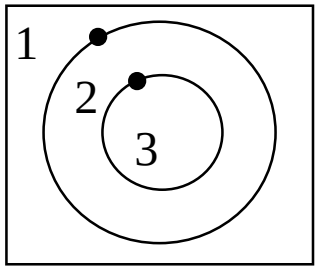
Intersect - Point Option

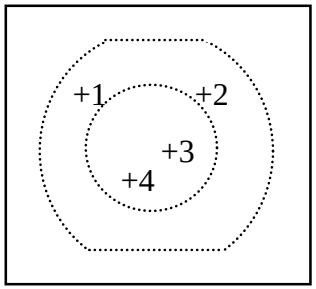
Input Coverage



Intersect Coverage



Output Coverage



INPUT COVERAG	
#	Attribute
1	A
2	B
3	C
4	D
5	E
6	F
7	G

INTERSEC COVERAG	
#	Attribut
1	
2	102
3	103

OUTPUT COVERAG	INPUT COVERAG		INTERSECT COVERAG	
#	#	Attribute	#	Attribute
1	1	A	2	102
2	2	B	2	102
3	4	D	3	103
4	6	F	3	103

Line on Polygon

- Overlay line objects on area objects, compute "is contained in" relationships
- Lines are broken at each area object boundary
  - Number of output lines is greater than number of input lines
- Containing area is new attribute of each output line
  - Example: combine roads and counties, find county containing each road segment

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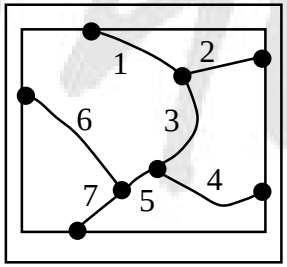
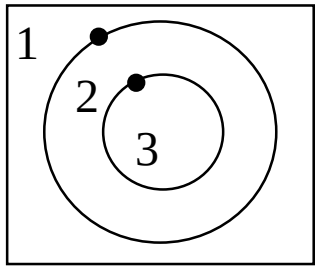
Identity - Line Option

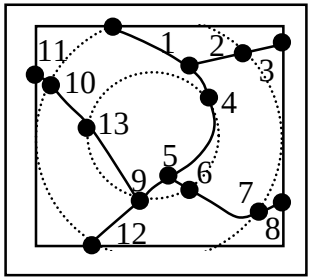
Input Coverage



Identity Coverage



Output Coverage



INPUT COVERA	
#	Attribu
1	A
2	B
3	A
4	C
5	A
6	D
7	A

UNION COVERA	
#	Attribu
1	
2	102
3	103

OUTPUT COVERA	INPUT COVERA		UNION COVERA	
#	#	Attribut	#	Attribut
1	1	A	2	102
2	2	B	2	102
3	2	B	1	
4	3	A	2	102
5	3	A	3	103
6	4	C	3	103
7	4	C	2	102
8	4	C	1	
9	5	A	3	103
10	6	D	2	102
11	6	D	1	
12	7	A	2	102
13	6	D	3	103

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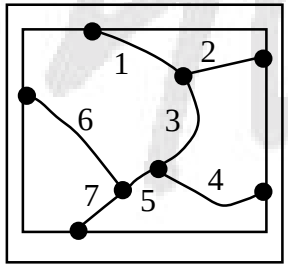
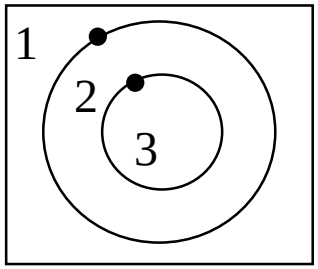
Intersect - Line Option

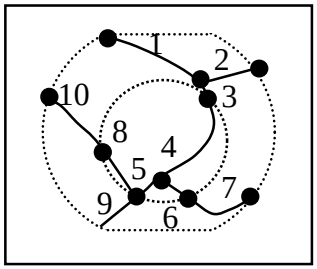
Input Coverage



Intersect Coverage



Output Coverage



INPUT COVERAG	
#	Attribut
1	A
2	B
3	A
4	C
5	A
6	D
7	A

INTERSEC COVERAG	
#	Attribut
1	
2	102
3	103

OUTPUT COVERAG	INPUT COVERAG		INTERSECT COVERAG	
#	#	Attribut	#	Attribut
1	1	A	2	102
2	2	B	2	102
3	3	A	2	102
4	3	A	3	103
5	5	A	3	103
6	4	C	3	103
7	4	C	2	102
8	6	D	3	103
9	7	A	2	102
10	6	D	2	102

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Polygon on Polygon
("Polygon Overlay")

- Overlay two layers of area objects
- Boundaries are broken at each intersection
- Number of output areas likely greater than the total number of input areas
  - Example: input watershed boundaries, county boundaries, output map of watershed/county combinations
  - After overlay we can recreate either of the input layers by dissolving and merging based on the attributes contributed by the input layer

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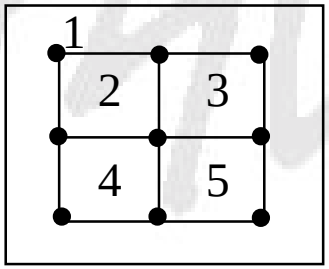
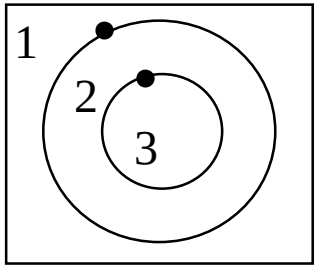
Identity - Poly Option

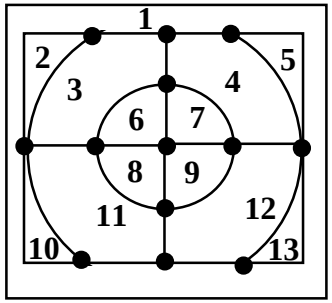
Input Coverage



Identity Coverage



Output Coverage



INPUT COVERAG	
#	Attribute
1	
2	A
3	B
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IDENTITY COVERAG	
#	Attribute
1	
2	102
3	103

OUTPUT COVERAG	INPUT COVERAG		IDENTITY COVERAG	
#	#	Attribute	#	Attribute
1	1		1	
2	2	A	1	
3	2	A	2	102
4	3	B	2	102
5	3	B	1	
6	2	A	3	103
7	3	B	3	103
8	4	C	3	103
9	5	D	3	103
10	4	C	1	
11	4	C	2	102
12	5	D	2	102
13	5	D	1	

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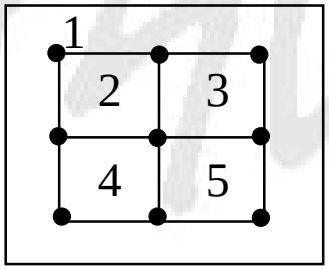
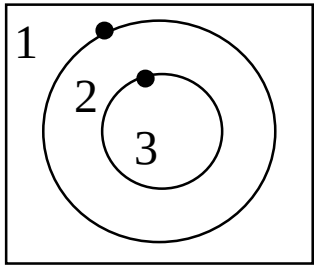
Intersect - Poly Option

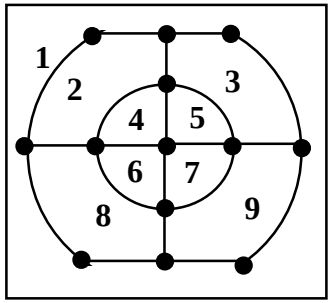
Input Coverage



Intersect Coverage



Output Coverage



INPUT COVERAG	
#	Attribute
1	
2	A
3	B
4	C
5	D

INTERSEC COVERAG	
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1	
2	102
3	103

OUTPUT COVERAG	INPUT COVERAG		INTERSECT COVERAG	
#	#	Attribute	#	Attribute
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3	3	B	2	102
4	2	A	3	103
5	3	B	3	103
6	4	C	3	103
7	5	D	3	103
8	4	C	2	102
9	5	D	2	102

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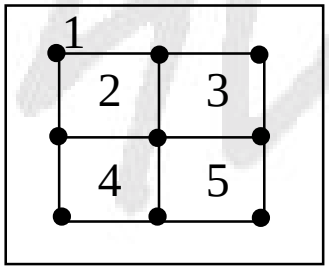
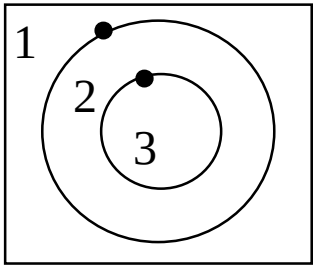
Union

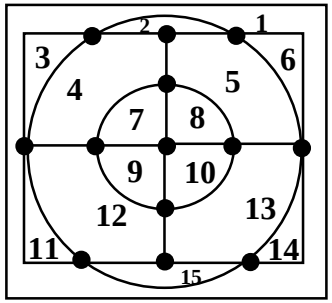
Input Coverage



Union Coverage



Output Coverage



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#	Attribut
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UNION COVERA	
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1	
2	102
3	103

OUTPUT COVERA	INPUT COVERAG		UNION COVERAG	
#	#	Attribut	#	Attribut
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2	1		2	102
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4	2	A	2	102
5	3	B	2	102
6	3	B	1	
7	2	A	3	103
8	3	B	3	103
9	4	C	3	103
10	5	D	3	103
11	4	C	1	
12	4	C	2	102
13	5	D	2	102
14	5	D	1	
15	1		2	102

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Proximity/Buffer Analysis

Generation and selection of map data within specified distance around a point, line, or polygon feature

Examples:

- **Property search to find all parcels within a specified distance of a target parcel**
- **Environmental impact analysis requiring delineation of a buffer zone around a stream**

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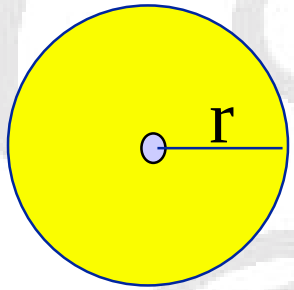
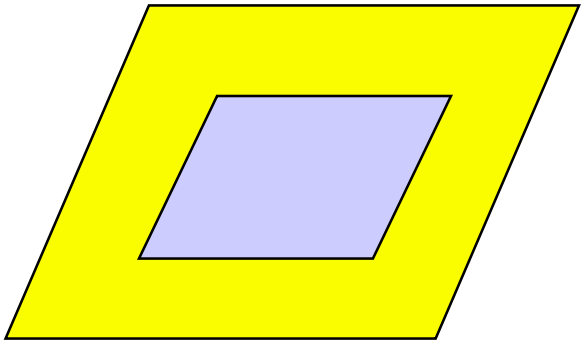
Buffering





Buffering a Point

example: All area within one mile of the city.

Buffering a Line

example: All areas within 1000 meters of a road.

Buffering an Area

example: All areas within 500 meters of a wetlands area.

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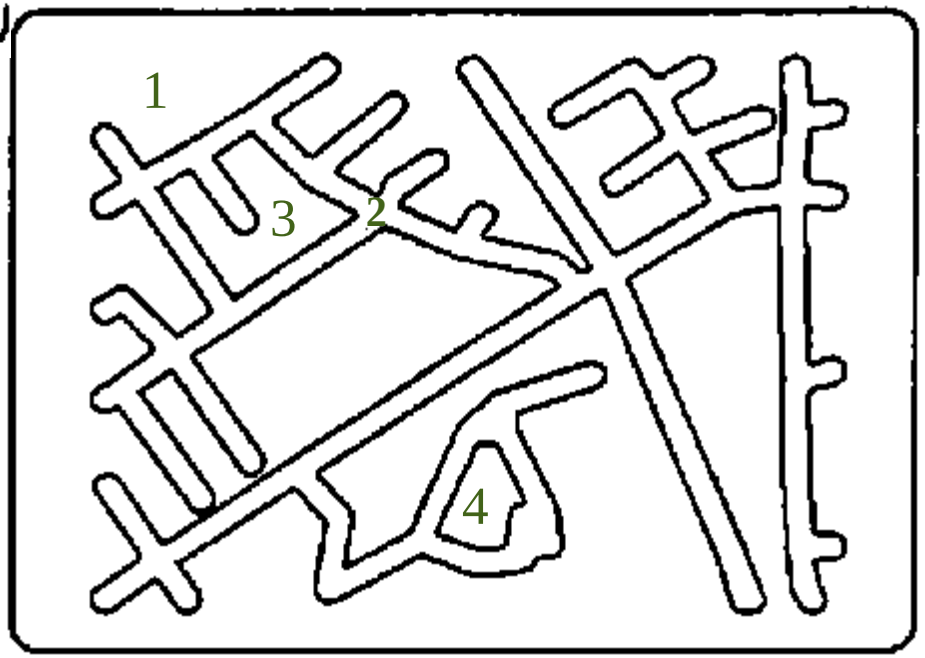
Buffer



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Network Analysis

Analytical technique to evaluate flow or paths through a defined linear network.

Examples:

- **Analysis of optimal routes through road network**
- **Analysis of flow in a water distribution system**

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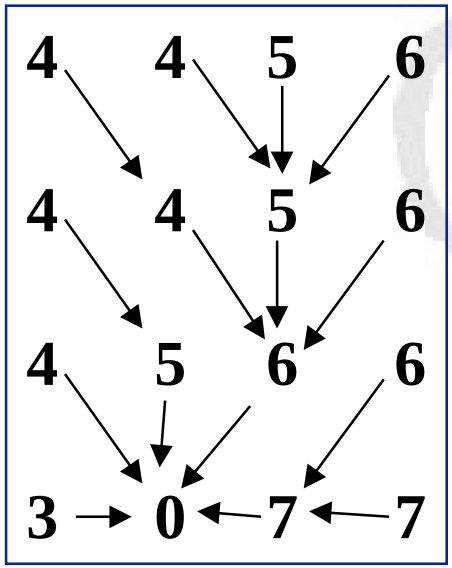
Determining the Network

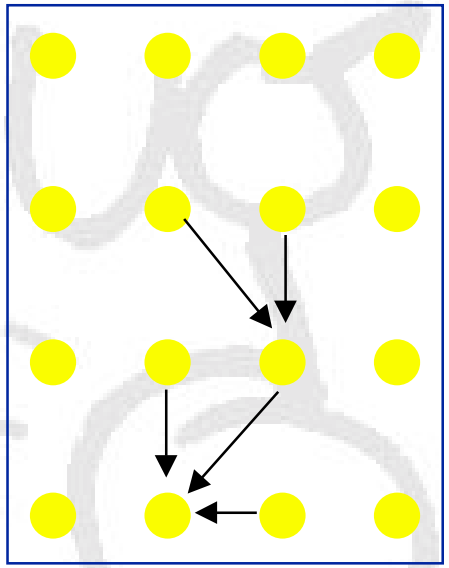
Flow Directions



Accumulating Flow

1	1	1	1
1	2	4	1
1	2	8	1
1	16	3	1

Critical Flow Level 2



Address Matching and Incident Mapping

Generation of maps showing the point location of features or phenomena on a suitable base map. Incident locations may be defined by x, y coordinates, street addresses, or other locational identifiers.

Examples:

- **Mapping of water sampling points**
- **Police incident mapping**

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Terrain Analysis

Use of three-dimensional data to perform landscape or terrain evaluation.

Examples:

- Use of digital elevation models to generate contour maps and perform slope analysis
- Civil engineering calculations to determine cut-and-fill volumes and generate vertical profile drawings

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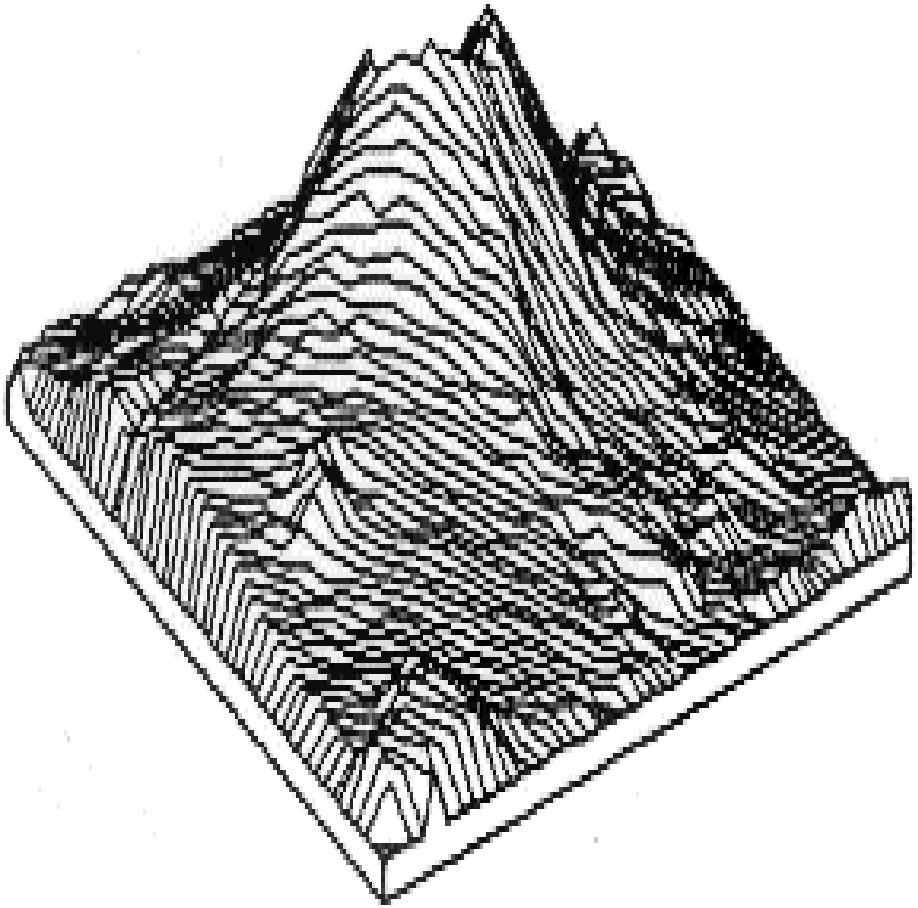
What is a Surface?



A surface is a continuous feature, without discrete intervals.

There is no way to store all the information about a surface.

We must **approximate** a surface with **samples**.

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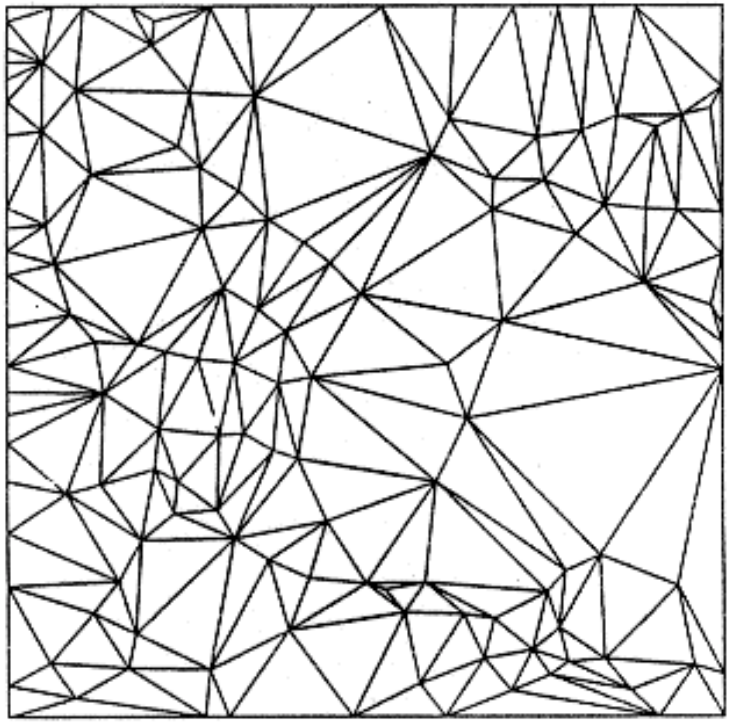
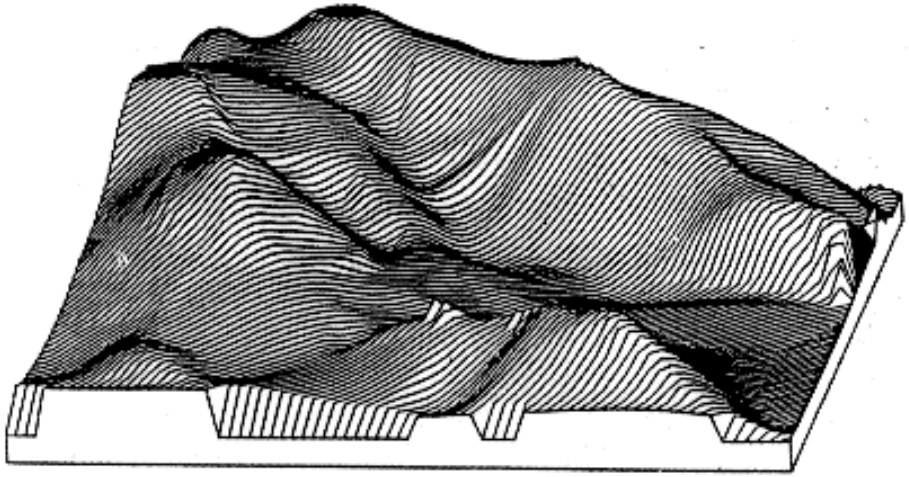
Elevation Represented as Areas

Tiefort Mountains, California





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Document Management/Hypermedia

Storage and retrieval of geographically referenced documents (often optically scanned) in geographic query and analysis.

Examples:

- **Use of GIS as pointer to scanned engineering drawings, site photographs, building permit forms, or deeds**

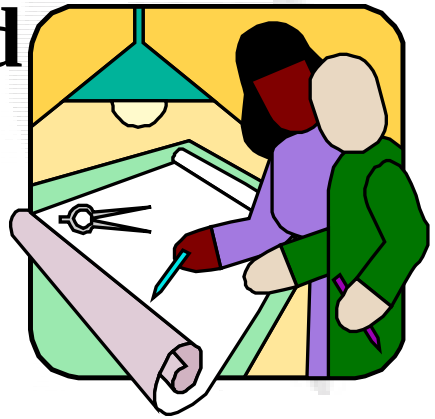

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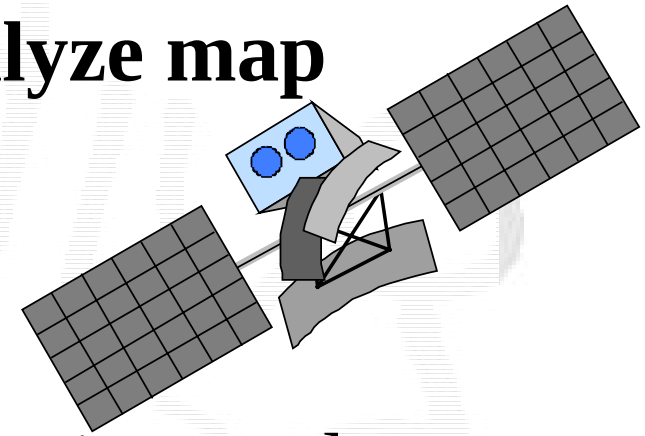
Image Processing

Analysis of raster images from scanners to interpret, display, and analyze map features.



Examples:

- Mapping of land cover using image data from the SPOT or Landsat satellite
- Display and manipulation of scanned facility drawings.

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This image map combines the parcel map with one-meter black and white imagery. The picture tells the user that the parcels have been zoned for development but that indeed many of them have not been developed as of yet.

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THE END

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