

Vector Analysis

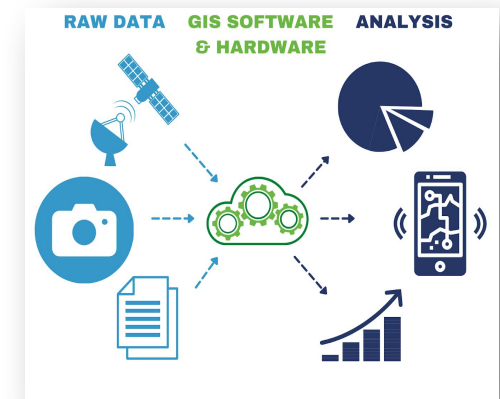
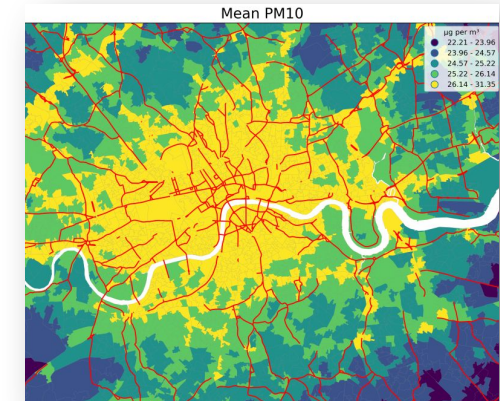
Spatial Data Analysis

ADAPTED FROM MATERIAL DEVELOPED BY Francis C. Onyambu

Spatial Analysis

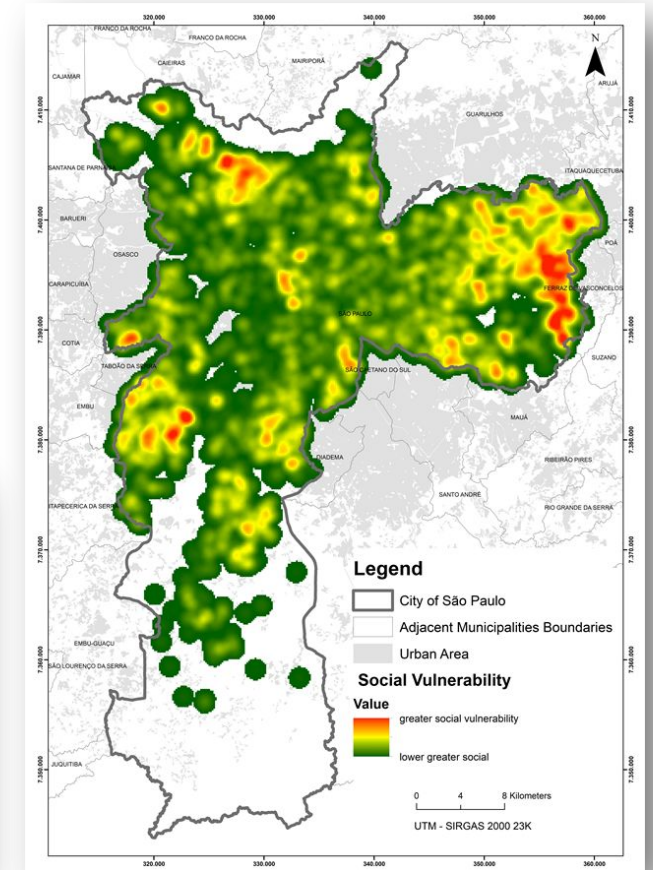
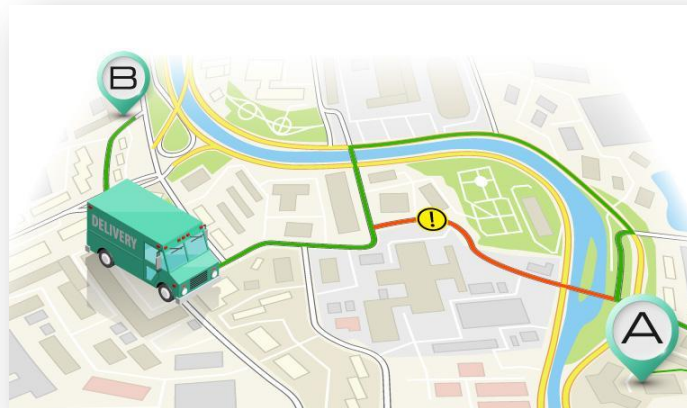
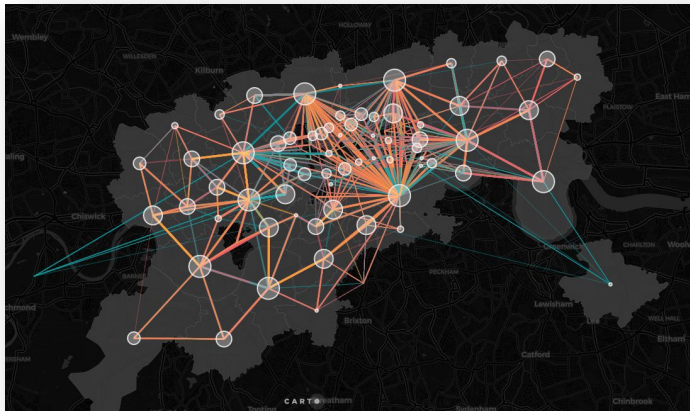
Spatial analysis is a fundamental component of a GIS that allows for an in-depth study of the topological and geometric properties of a dataset or datasets

Analysis of spatial data can be defined as computing new information to provide new insights from existing spatial data, Which help to answer questions and solve problems that are of spatial relevance.



Spatial Analysis

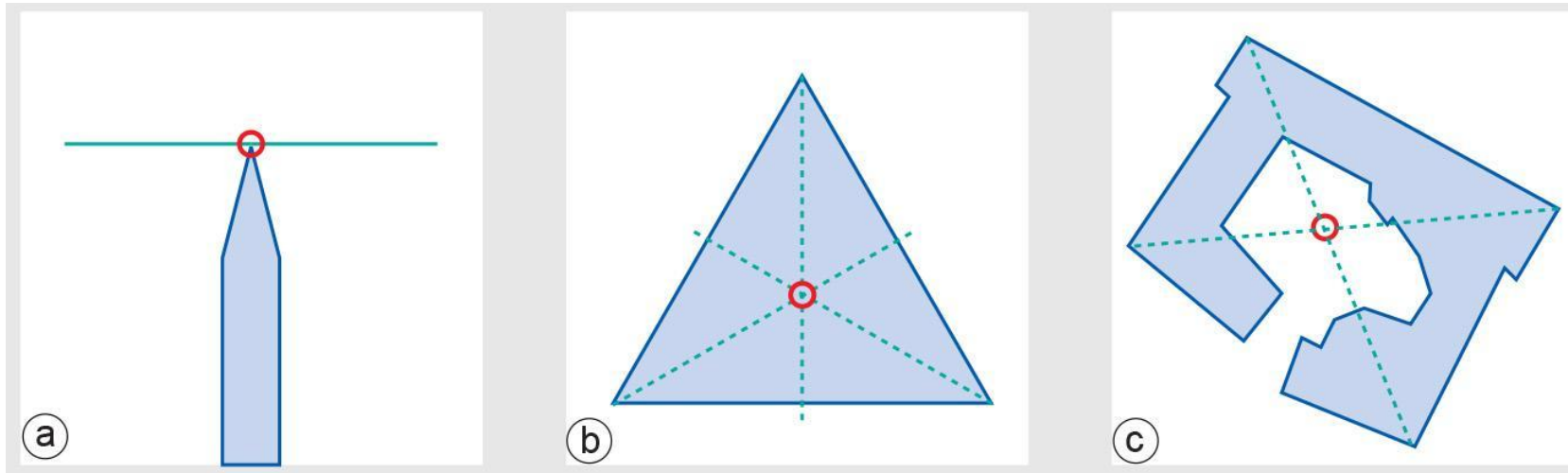
The exact nature of the analysis will depend on the application requirements, but computations and analytical functions can operate on both spatial and non-spatial data.



Vector measurements

Locational measurements

- ✓ A single coordinate pair for a point.
- ✓ A list of pairs for a polyline or polygon boundary.
- ✓ The centroid of a polygon.



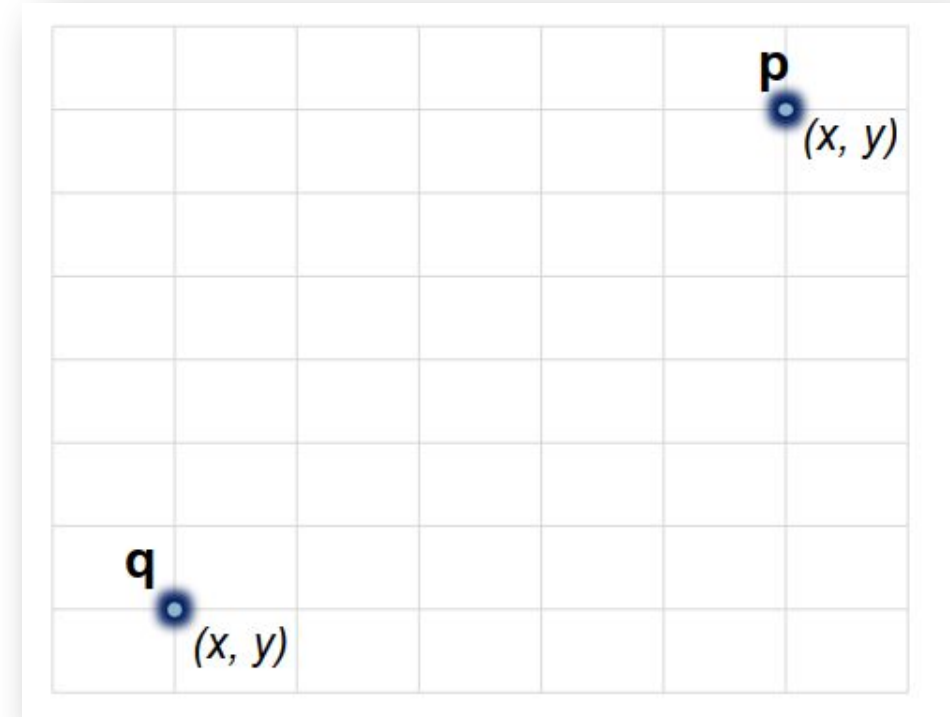
Vector measurements

Length measurements

- ✓ Associated with polylines or in their function as polygon boundaries

Distance measurements

- ✓ Distance between two points can be given by Pythagorean distance function



$$dist(p, q) = \sqrt{(x_p - x_q)^2 + (y_p - y_q)^2}$$

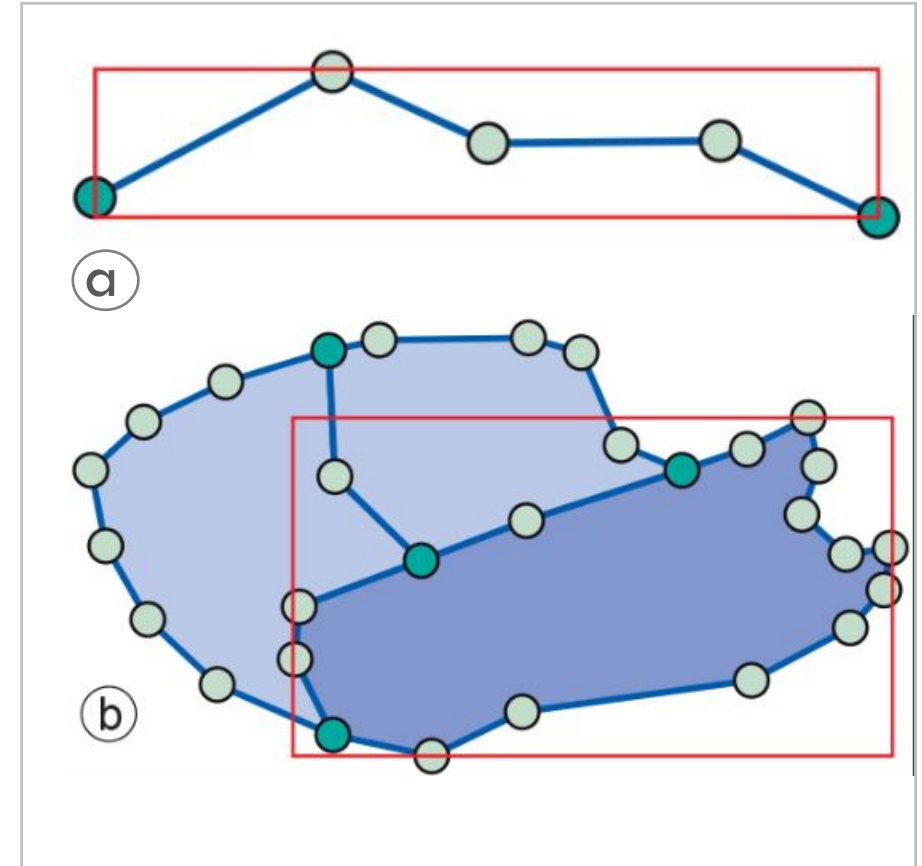
Vector measurements

Area size measurement

- ✓ Area size is associated with polygon features
- ✓ It can be computed, but it is usually stored with the polygon as an extra attribute value. This speeds up the computation of other functions that
- ✓ require area size values

Minimal bounding box

- ✓ It applies to polylines and polygons and determines the minimal rectangle.



The minimal bounding box of (a) a polyline, and (b) a polygon

Vector Operations

Single Layer Operation

single layer analyses are those that are undertaken on an individual feature dataset

Example of Single Layer Operation:

- Buffering
- Dissolve
- Select

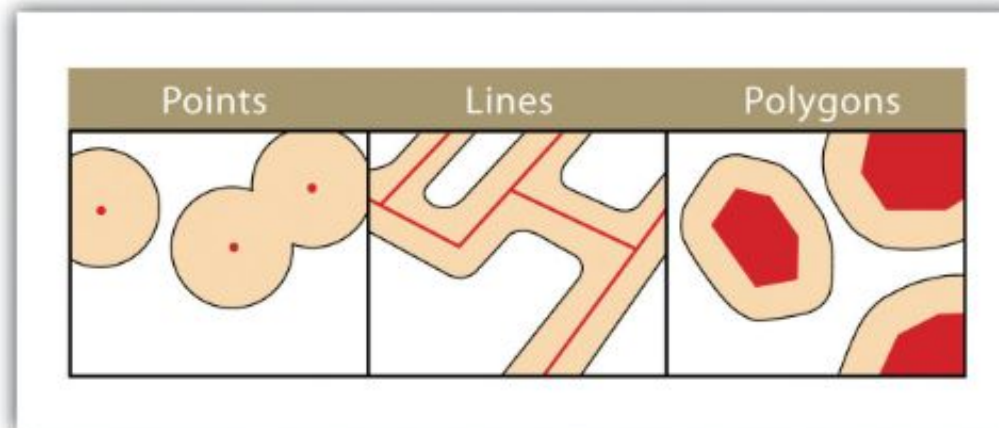
Vector Operations

Buffering

Buffers are common vector analysis tools used to address questions of proximity in a GIS.

“is the process of creating an output polygon layer containing a zone (or zones) of a specified width around an input point, line, or polygon feature”

**Neighborhood
Operations**



Vector Operations

Buffering

Buffers are particularly suited for determining the area of influence around features of interest.

Two primary types of buffers are available to the GIS users:

Constant width Buffers

Constant width buffers require users to input a value by which features are buffered

Variable width buffers

call on a premade buffer field within the attribute table to determine the buffer width for each specific feature in the dataset

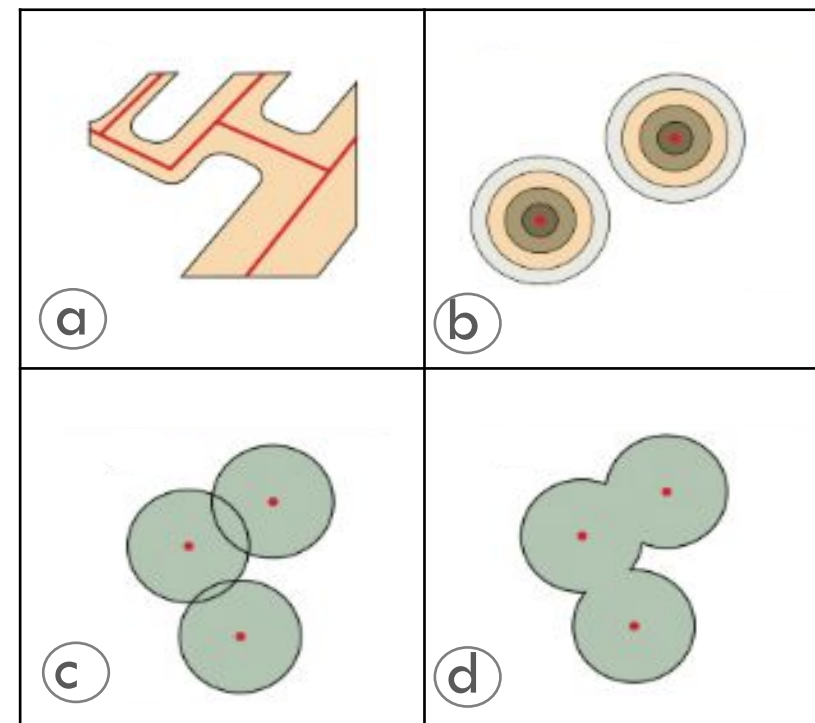
Vector Operations

Buffering

Additional Buffer Options

In addition, users can choose to **dissolve** or **not dissolve** the boundaries between overlapping, coincident buffer areas.

Multiple ring buffers can be made such that a series of concentric buffer zones (much like an archery target) are created around the originating feature at user-specified distances



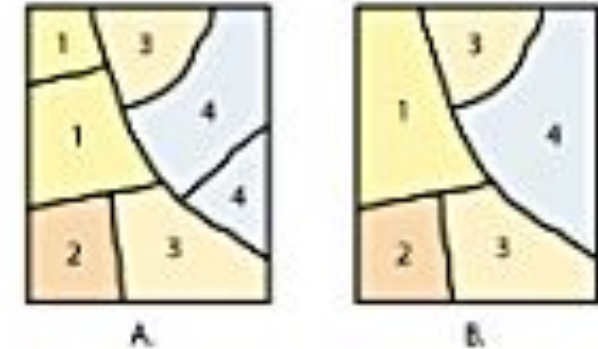
Additional Buffer Options around Red Features: (a) Variable Width Buffers, (b) Multiple Ring Buffers, (c) Non-dissolved (d) Dissolved Buffer

Vector Operations

Dissolve

The dissolve operation combines adjacent polygon features in a single feature dataset based on a single predetermined attribute

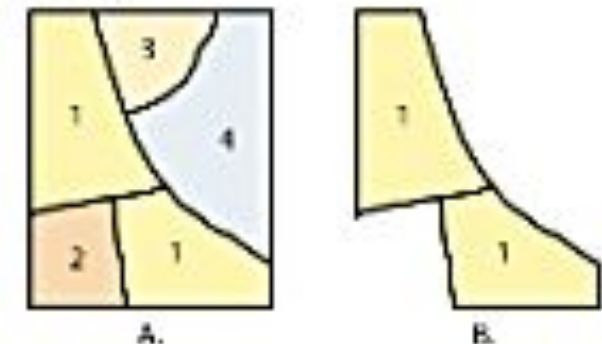
Dissolve



Select

The select operation creates an output layer based on a user-defined query that selects particular features from the input layer.

Select



Vector Operations

Multiple Layer Analysis

Overlay is the process of taking two or more different thematic maps of the same area and placing them on top of one another to form a new map

The principle of spatial overlay is to compare the characteristics of the same location in both data layers and to produce a result for each location in the output data layer

**Overlay
Analysis**

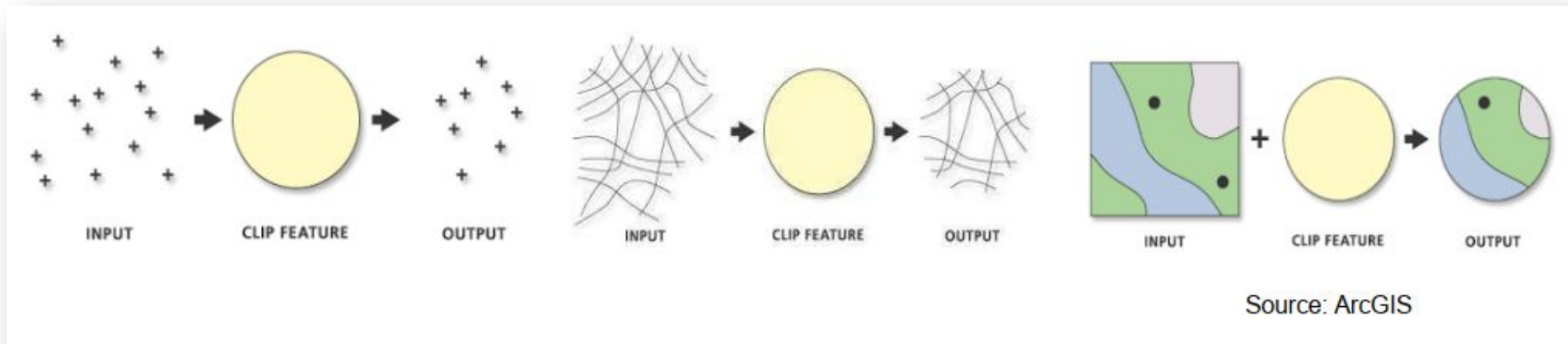
Example of Single Layer Operation:

- Clipping
- Union
- Intersect
- Symmetrical difference
- Identity
- Split

Vector Operations

Clipping

- ✓ It takes a data layer and restricts its spatial extent to the generalized outer boundary obtained from the selected polygon in a second input layer.
- ✓ Besides this generalized outer boundary, no other polygon boundaries from the second layer play a role in the result



Vector Operations

Union

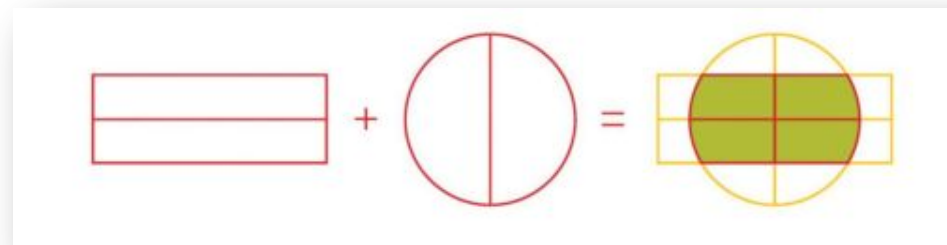
- ✓ A union is an analytical process in which the features from two or more map layers are combined into a single, composite layer.
- ✓ Union includes the data from all the included layers, meaning that overlapping and non-overlapping areas are included in a new polygon



Vector Operations

Intersect

- ✓ Intersect is an analytical operation that can be used to select any part of a feature that intersects with one or more other features.
- ✓ The areas of the map where all the input features intersect will create a feature as the intersect output



Vector Operations

Symmetrical difference

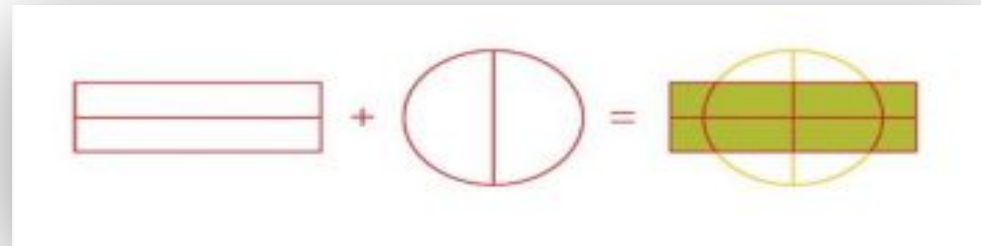
- ✓ This analysis process creates a new layer with the features of either one of the original layers, but the new layer does not include the areas where both of the layers existed.
- ✓ The symmetrical difference operation performs the opposite task of the intersect tool, and must use two polygon features in its analysis



Vector Operations

Identity

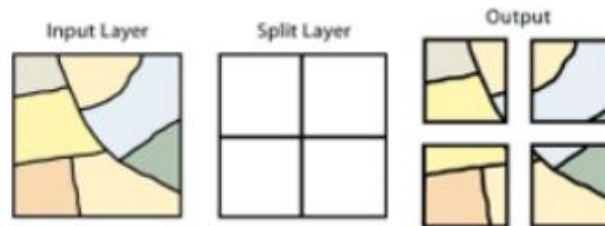
- ✓ It allows the user to combine the attributes of one overlapping feature into another. The Identity overlay takes two or more layers and gives any intersecting areas of layers with a target or "identity" layer, the characteristics of the identity layer.



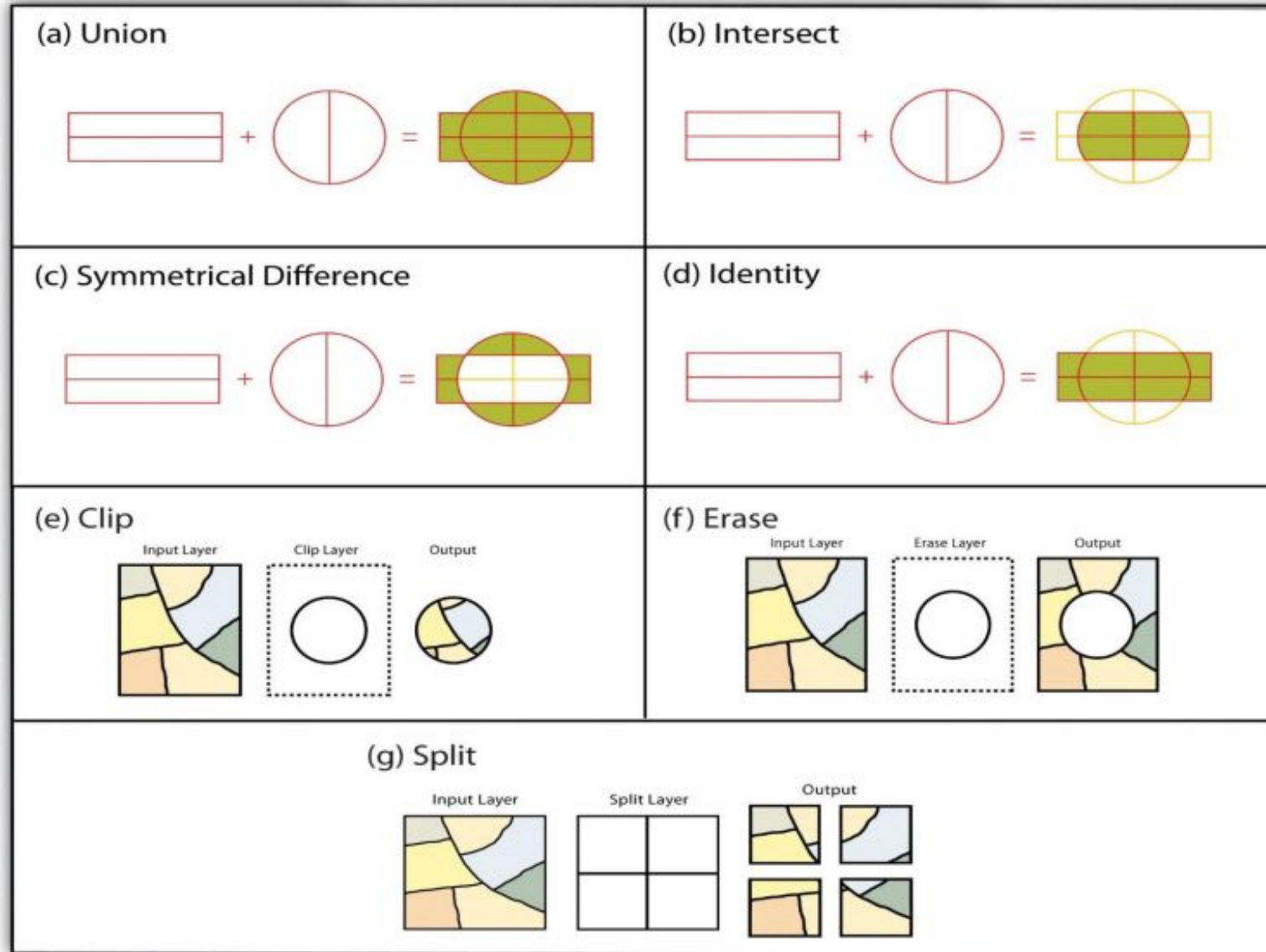
Vector Operations

Split

- ✓ Splits an input Layer with overlaying features to create a subset of output feature classes.



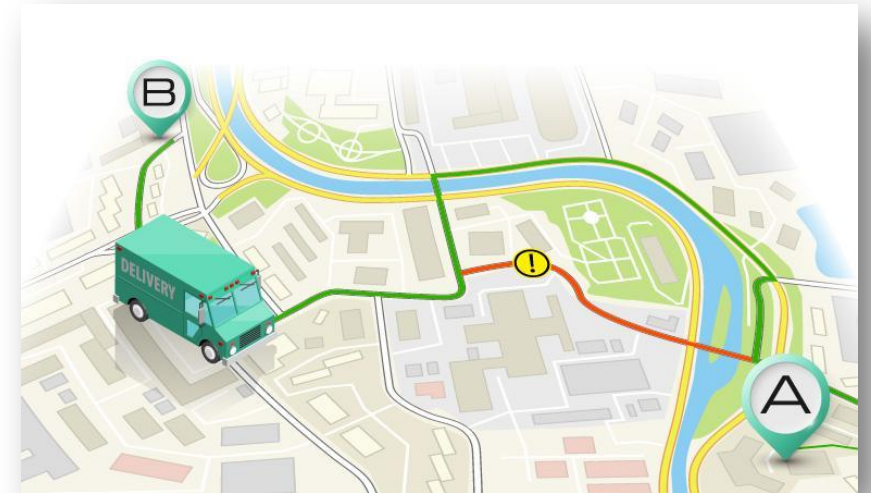
Vector Operations



Vector Operations

Network

- ✓ A network is a connected set of lines representing some geographic phenomenon, typically to do with transportation.
- ✓ The “goods” transported can be almost anything: people, cars and other vehicles along a road network, commercial goods along a logistic network, phone calls along a telephone network, or water pollution along a stream/river network.



References:

<https://lrb.itc.utwente.nl/page/491/concept/79812>

https://saylordotorg.github.io/text_essentials-of-geographic-information-systems/s11-geospatial-analysis-i-vector-o.html



Exercise

<https://principles-and-applications-of-rs-and-gis.readthedocs.io/en/latest/vector-analysis.html>

