Manipulation and analysis functions

3. Analytical functions

Analytical functions:

1. **Spatial operations** – localization part of information – issues of connectivity (buffer, network analysis) and contiguity
2. **Measurement function** – measuring distances, direction, etc.
3. **Statistical analyses**
4. Process **modelling**

Manipulation and analysis functions

3. Analytical functions with attribute queries

Analytical functions

= tools for finding information about the landscape from the modeled area:

1. **storage and search** functions = simple questions
2. **selective** function = selection by criterion
3. **modelling** function = description of the dynamics of phenomena in the landscape based on theoretical models

Manipulation and analysis functions

3. Analytical functions with attribute queries

A query language for analytical functions

System analysis of geoinformation = formulation of queries (questions) – special language – **SQL** (Structured Query language)

Information obtained in the form of answers – element classes can be created from the answers

Manipulation and analysis functions

3. Analytical functions with attribute queries

Communication with data – questions

Query – corresponds to functions:

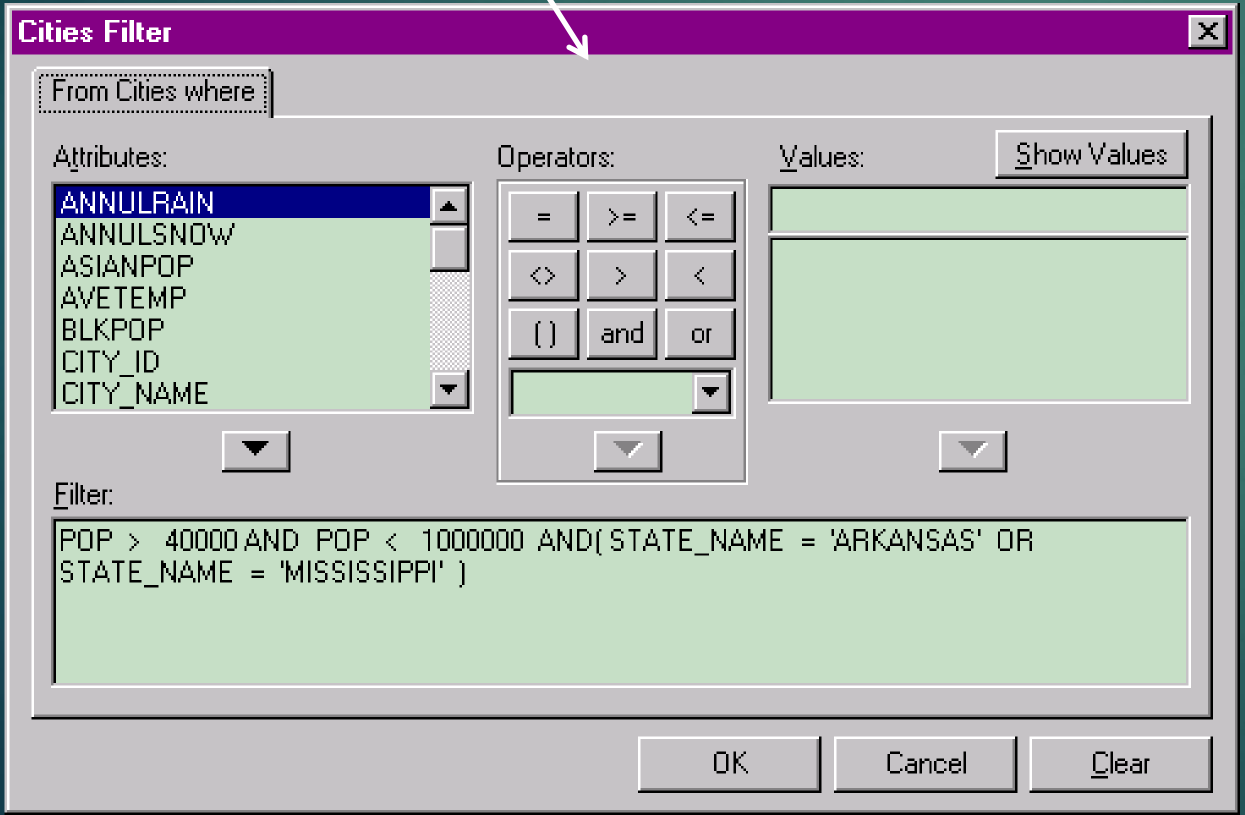
1. **searching** – query for existing data
2. **selective** – according to the specified property
3. **conditional** – asking what happens when

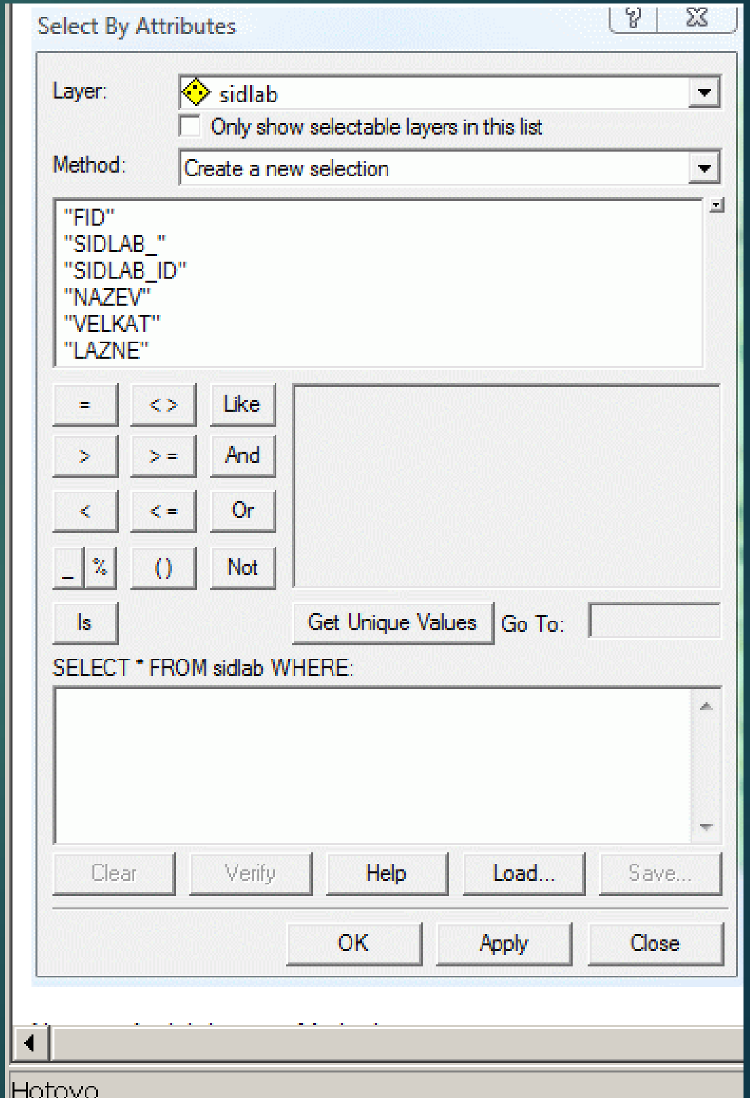
Manipulation and analysis functions

3. Analytical functions with attribute queries

Attribute query (=communication with data)

GeoMedia (Intergraph) ArcGIS (ESRI) →





Manipulation and analysis functions

3. Analytical functions with attribute queries

Communication with data – answers

Answers = the result of the use of functional tools according to data in the database

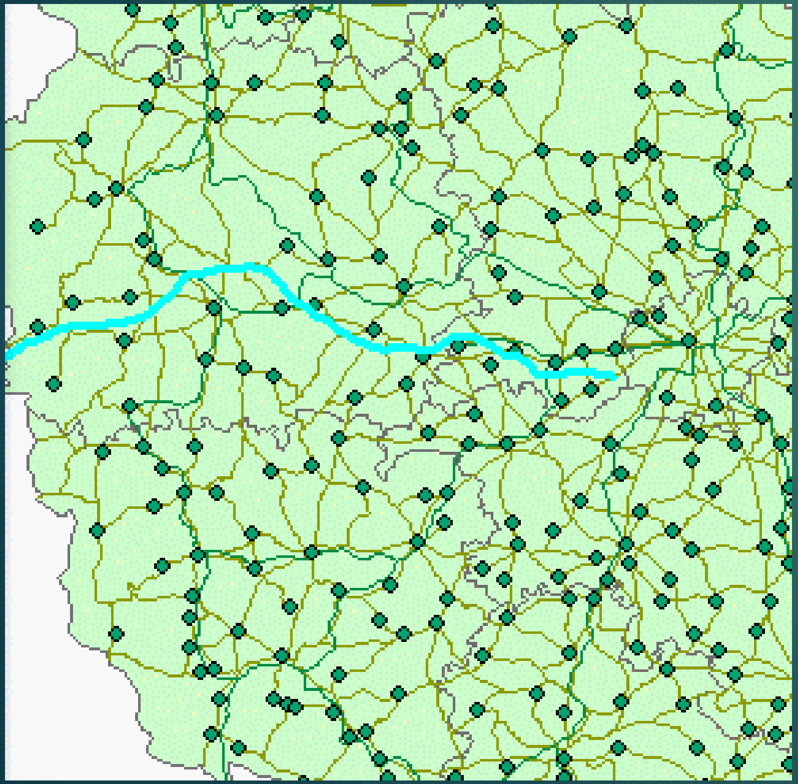
- **enumeration** (on a search query) shows the current data
- **selective** (for a selective query) selects based on the specified property value
- **predictive** (on a conditional question) – shows what happens when a section of the water supply in a given city is damaged

Manipulation and analysis functions

3. Analytical functions with attribute queries

Communication with data – answers

The resulting response to the **attribute** query



Selected Attributes of silnice

FID	Shape *	LENGTH	TRIDA_SIL	CISLO_SIL	E	CISLO2_SIL	J_PRUHY
723	Polyline	8737,757	D	D5	E50		2
729	Polyline	8117,299	D	D5	E50		2
747	Polyline	8642,245	D	D5	E50		2
749	Polyline	8100,853	D	D5	E50		2
798	Polyline	11773,61	D	D5	E50		2
799	Polyline	7303,857	D	D5	E50		2
819	Polyline	10770,81	D	D5	E50		2
828	Polyline	6676,177	D	D5	E50		2
853	Polyline	8929,384	D	D5	E50		2
854	Polyline	5547,383	D	D5	E50		2
859	Polyline	2457,414	D	D5	E50		2

Počet vybraných prvků

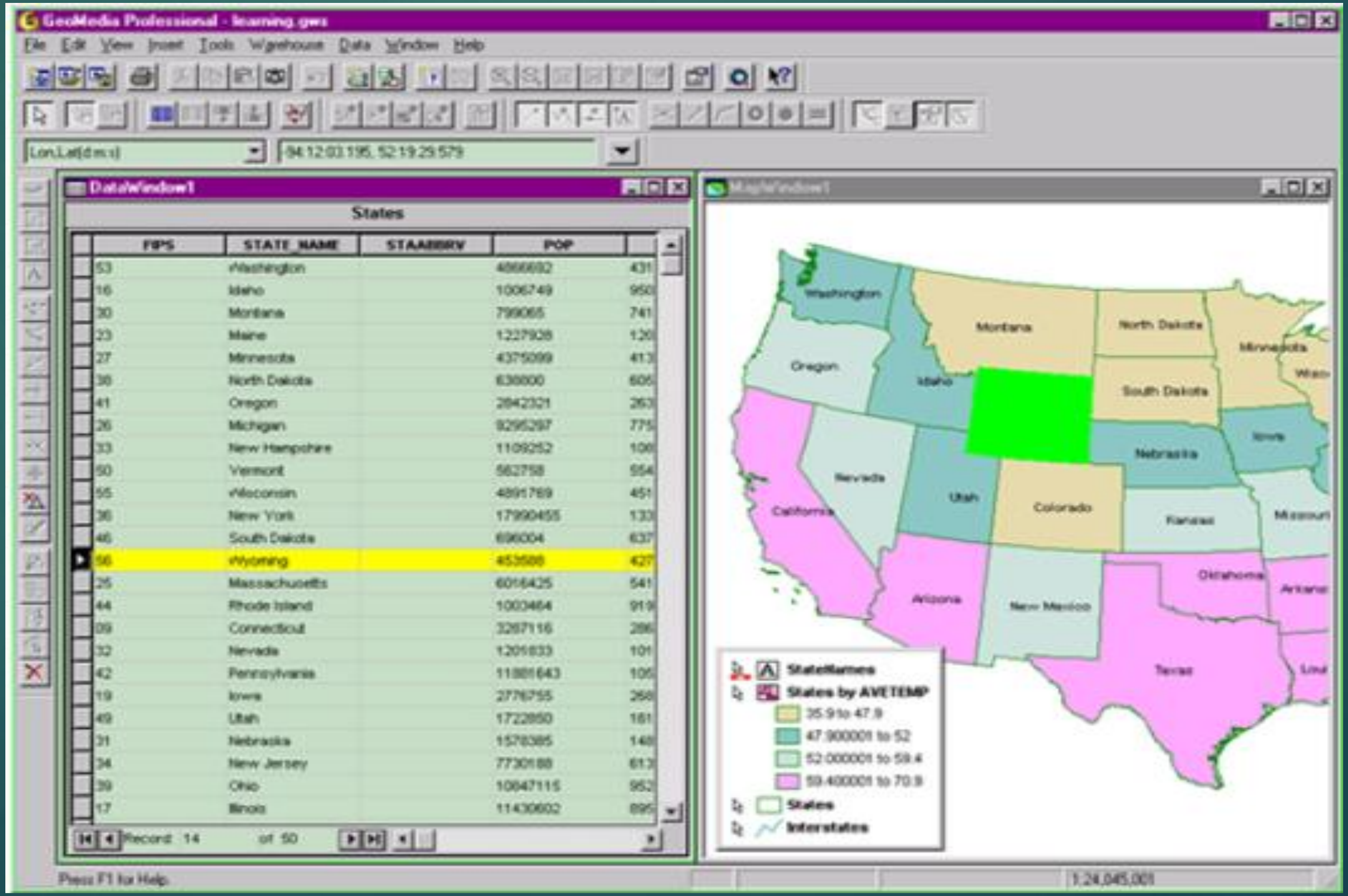
Record: 1 Show: All Selected Records (11 out of 1458 Selected) Options

Manipulation and analysis functions

3. Analytical functions with attribute queries

Communication with data – answers

The resulting response to the attribute query

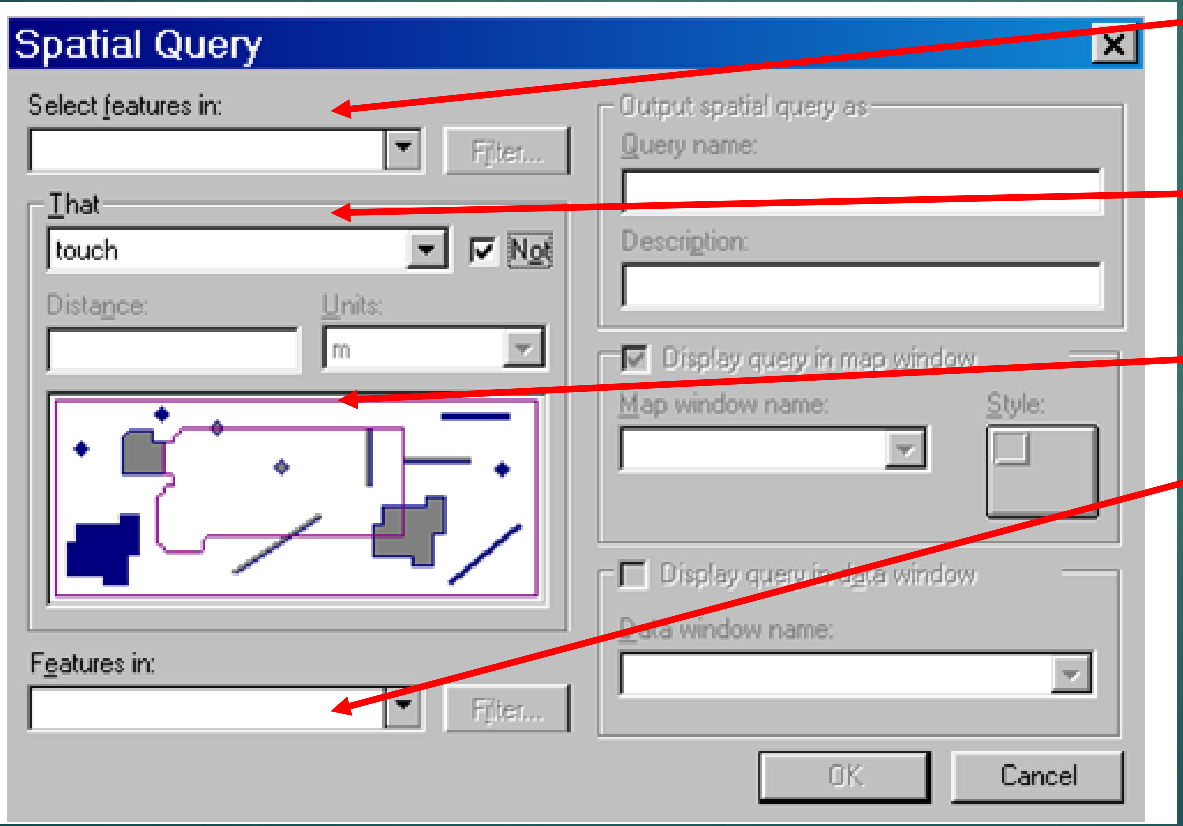


Manipulation and analysis functions

3. Analytical functions with spatial queries

Communication with data

spatial query – feasible only in GIS



the elements selected are from the first class that I select from

"That" spatial selection condition described verbally

and described with a picture

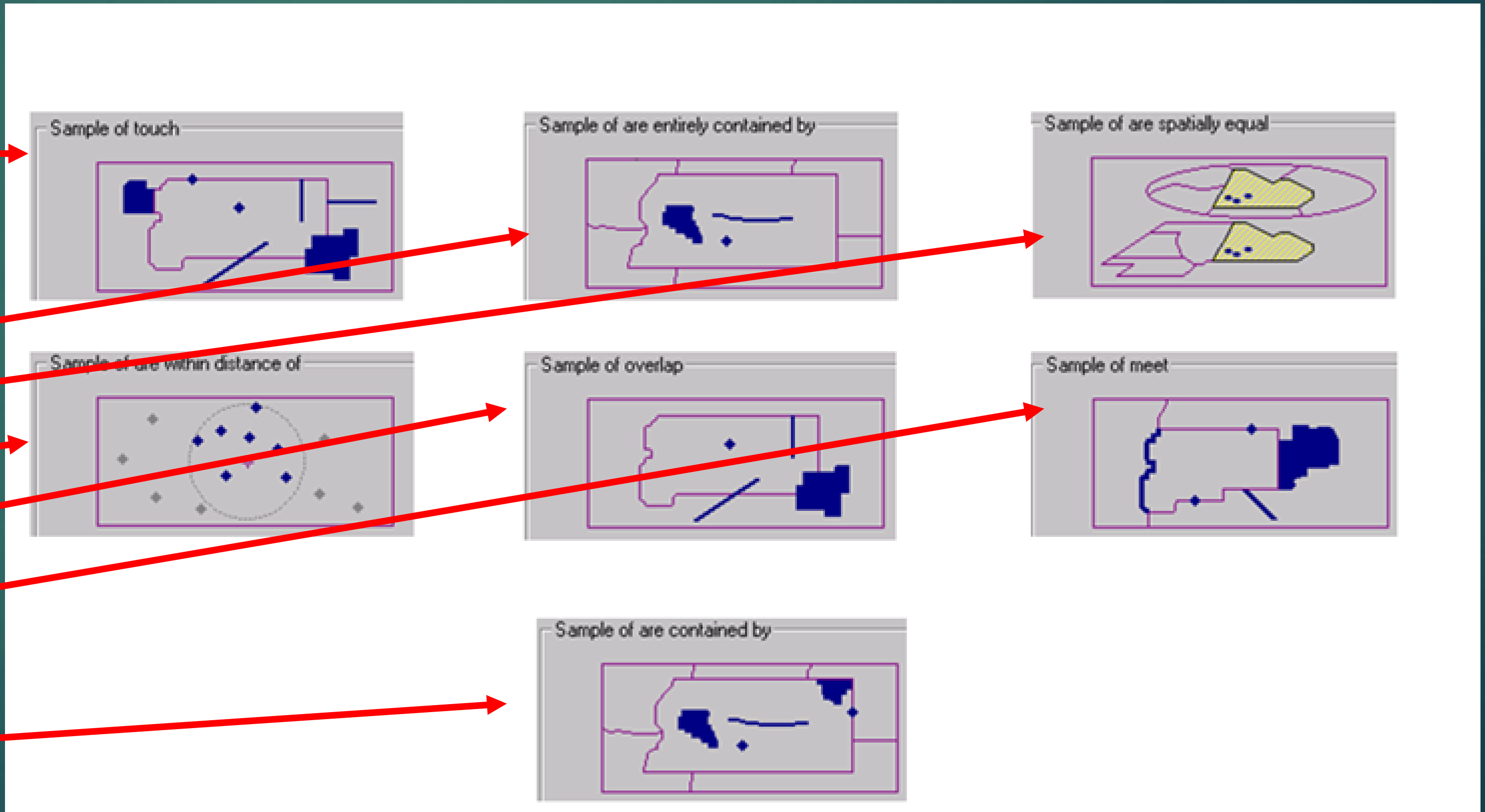
elements of the second class to determine the positional relationship to the classes of the first class

Manipulation and analysis functions

3. Analytical functions with spatial queries

Communication with data – spatial query

- touch
- contains
- are entirely contained by
- are spatially equal
- are within distance
- overlap
- meet
- are contained by
- entirely contain



Manipulation and analysis functions

4. Combined analysis of spatial data

Analysis using geometric and non-geometric data

Usually two parts:

1) data selection
2) their analysis

Again, this task can only be done in GIS, because the analyses take place in space

Manipulation and analysis functions

4. Combined analysis of spatial data

4 feature categories for this analysis:

1. **Selection, classification and measurement functions**
2. **Overlay functions (spatial intersection / overlay, spatial difference)**
3. **Features in the neighborhood (buffer zone)**
4. **Connecting functions**

Combined Analysis of Spatial Data

4.1 Selection, classification and measurement functions

1. Selection, classification and measurement functions

selection functions – according to existing properties

classification – classification into classes – the class of watercourses divided into classes according to the orders of watercourses

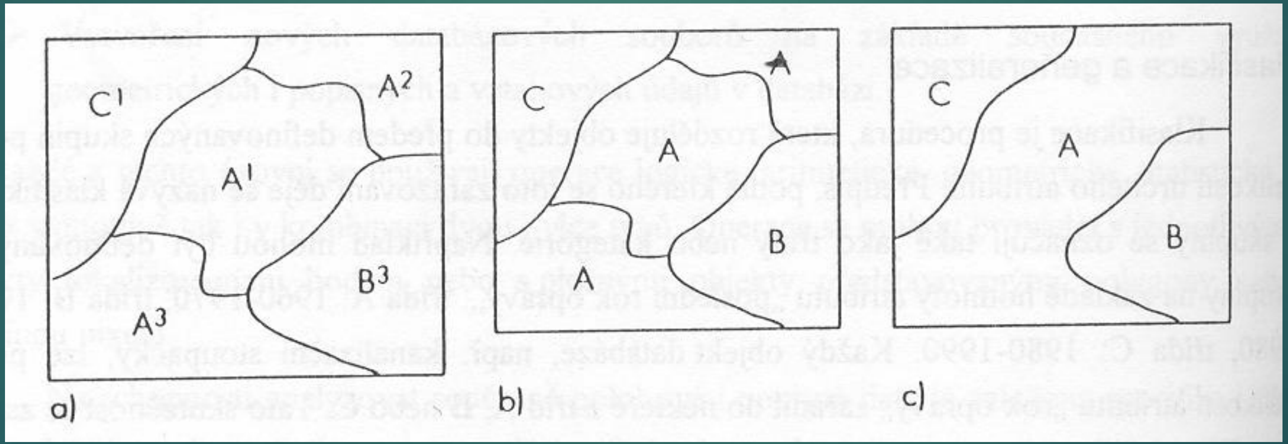
reclassification and subsequent **generalization** / **merger** / **abolition of internal boundaries**

Combined Analysis of Spatial Data

4.1 Selection, **classification** and measurement functions

reclassification and subsequent connection (merge, dissolve)

- original classes × new classes: dropping boundaries between reclassification areas of the same classes



Reclassification : I create class A from classes A^1, A^2, A^3

The same classes are separated by the boundary = possible topological error

a spatial connection / merge, dissolve
I will remove the error

Combined Analysis of Spatial Data

4.1 Selection, classification and **measurement** functions

measuring function – measurement of distances, lengths and areas

The user can make a selection:

surfaces **greater** than, **less** than

of line objects **longer** than, **shorter** than

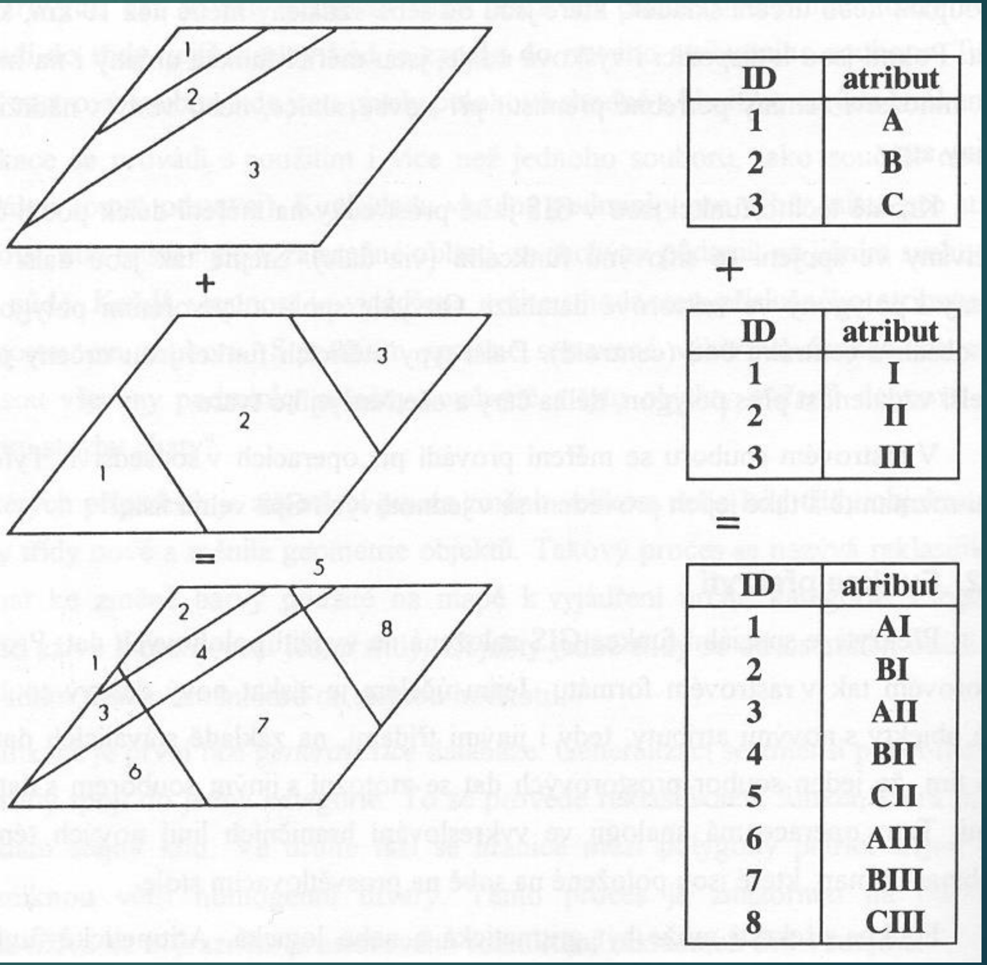
Combined Analysis of Spatial Data

4.2 Overlay function – **vector data**

2a. Overlap of two areal classes

input layers (classes)

output layer (class)



ID	atribut
1	A
2	B
3	C

ID	atribut
1	I
2	II
3	III

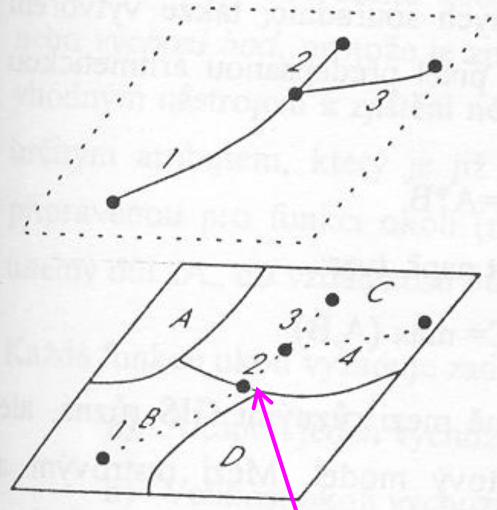
ID	atribut
1	AI
2	BI
3	AII
4	BII
5	CII
6	AIII
7	BIII
8	CIII

The process involves calculating all newly created intersections

Combined Analysis of Spatial Data

4.2 Overlay function – **vector data**

2.b Overlap of linear and surface classes



ID	spoj	silnice číslo	okres
1	1	410	B
2	1	410	C
3	2	9	C
4	3	18	C

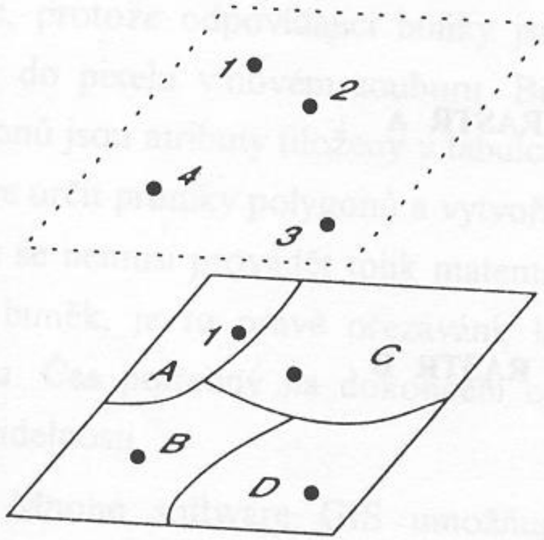
intersection (*2*) of the line and the boundary of the area is calculated

– this is the task that elevates GIS above CAD and databases

Combined Analysis of Spatial Data

4.2 Overlay function – **vector data**

2.c Overlap of point and area class



ID	budova číslo	obvod
1	660	A
2	659	C
3	610	D
4	665	B

Combined Analysis of Spatial Data

4.2 Overlay function – **vector data**

2.d **Spatial difference** (spatial difference)

allows to perform spatial masking, that is to perform operation difference for two surfaces

input = two area feature classes:

1) elements which have to be masked or cleared away (from-feature) from red classes

2) elements which they have be used like a mask (subtract-feature) of features of the yellow class

Combined Analysis of Spatial Data

4.2 Overlay function – raster **data**

2. Overlay function for raster GIS = map algebra problem

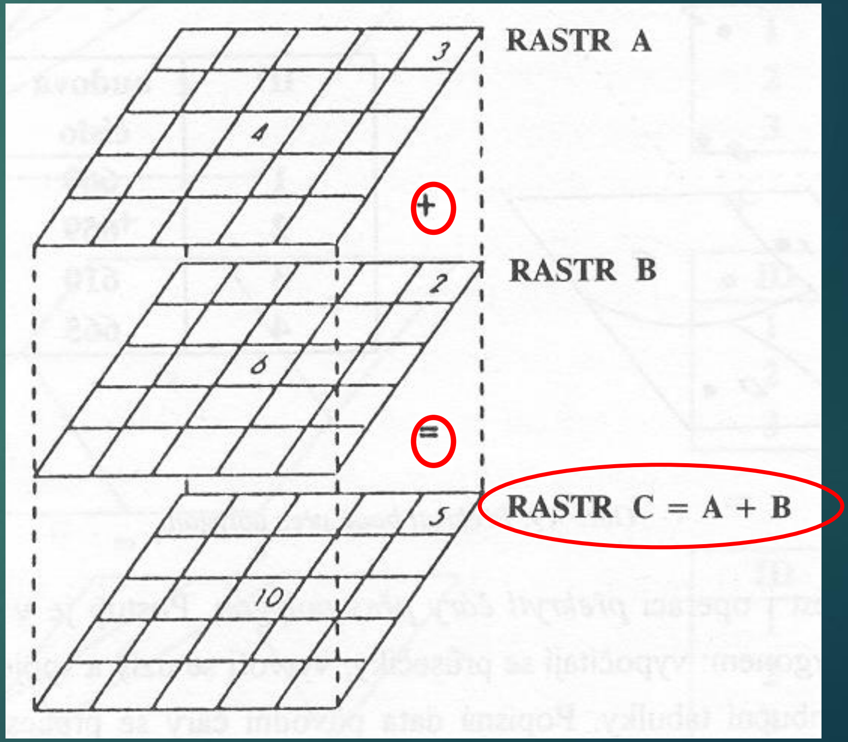
overlap of 2 area classes in

vector GIS – frequent formation of **cracks**

overlay function – easier in **raster GIS**

Here is an example for the sum, that is, the classic one overlap

This role can be extended to use other operators.
The principle is the same, these are calculations between corresponding pixels



Combined Analysis of Spatial Data

4.3 Nearby functions for **vector** GIS

3. Features in the neighbourhood

Finding properties around the object (default object)

It is necessary to enter:

1. **size** of the surroundings
2. at least one **default object**
3. **type of function** applied to the surrounding territory

Combined Analysis of Spatial Data

4.3 Functions in the vicinity

3.a Search function

– they work with numerical or thematic data

search area = the area where it is searched according to the request:

- **for numerical data**: mean, variance, majority
- **for thematic data**: majority, maximum, minimum, diversity.

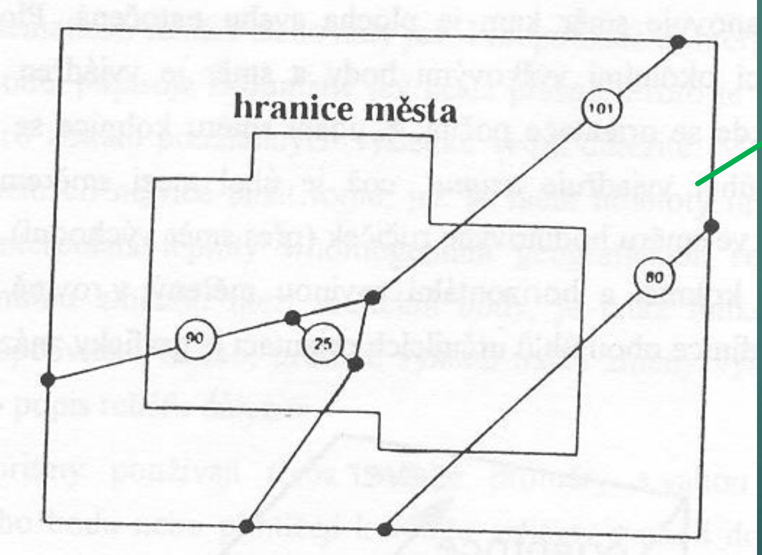
- the result is an attribute assigned to the **default object**
- **the neighborhood** (search area) may be irregularly shaped, may be entered interactively, or may arise as a result of other functions.

- A specific example is searching for the nomenclature of the map sheet containing the specified point.

Combined analysis of spatial data
4.3 Features in the vicinity in vector GIS

3.b Reverse search function

Searches for points and lines that are located in a defined neighborhood



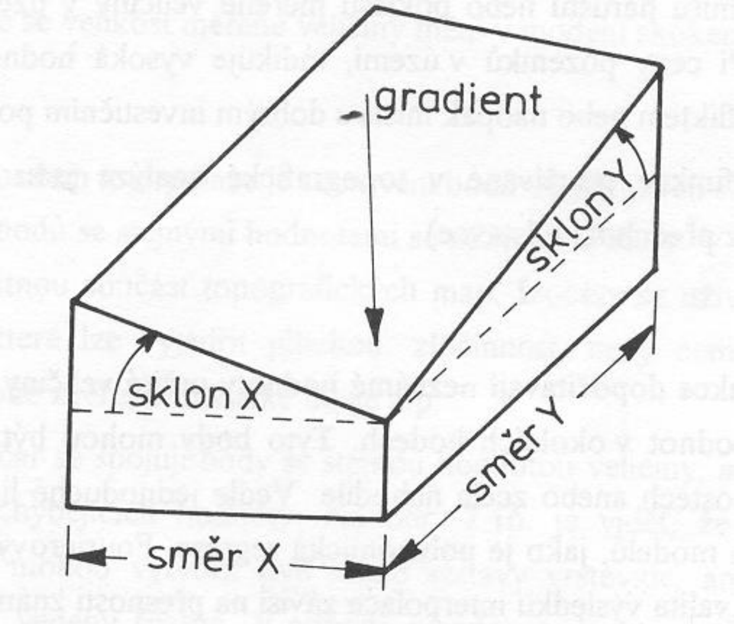
This function object will not find (80) unless there exist intersections with the border of the area, since no node of the object lies inside the city.

To determine that this object also passes through the city, it is necessary to calculate the intersections with the city boundary and then search using contained by or other poplars. functions that take into account points on the boundary of the polygon (intersections)

3.c Topographic functions (see DMT)

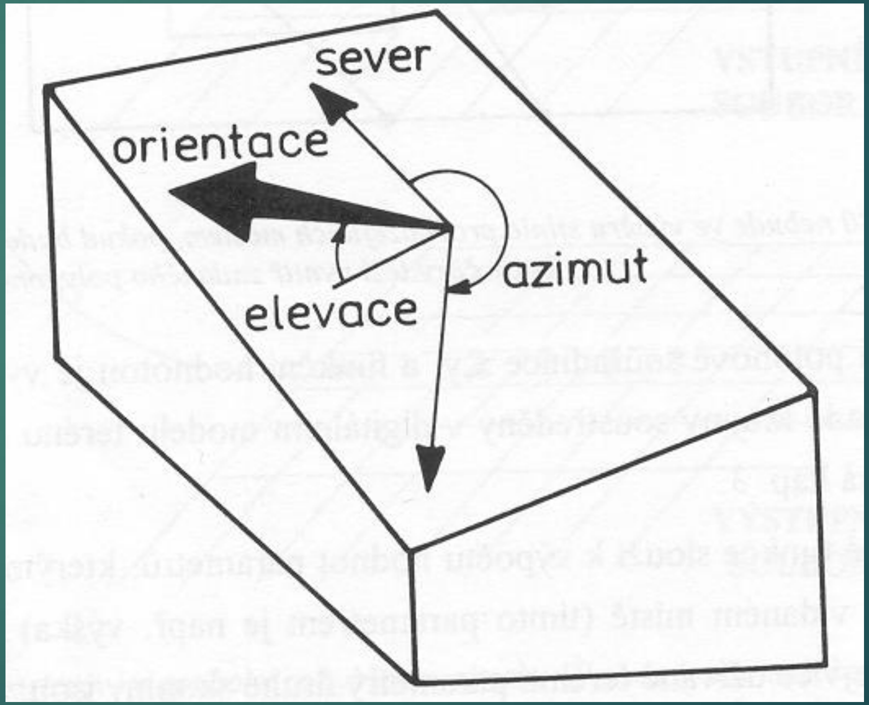
– are used to determine the properties of a surface also described by an altimetry attribute:

- determination of **slopes**
  - in the x and y direction,
  - total slope as a decimal or tangent
- **gradient**
  - total slope in %



3.c Topographic functions

- determining the orientation (aspect)



3.c Topographic functions

These functions can also be used for data other than topographic:

meteorological,

geological,

geochemical,

…

Combined Analysis of Spatial Data

4.3 Features in the vicinity – vector GIS

3.d Creation of isolines

- creating contours,
- temperature isolines, etc.

options are often presented and the user chooses

Combined Analysis of Spatial Data

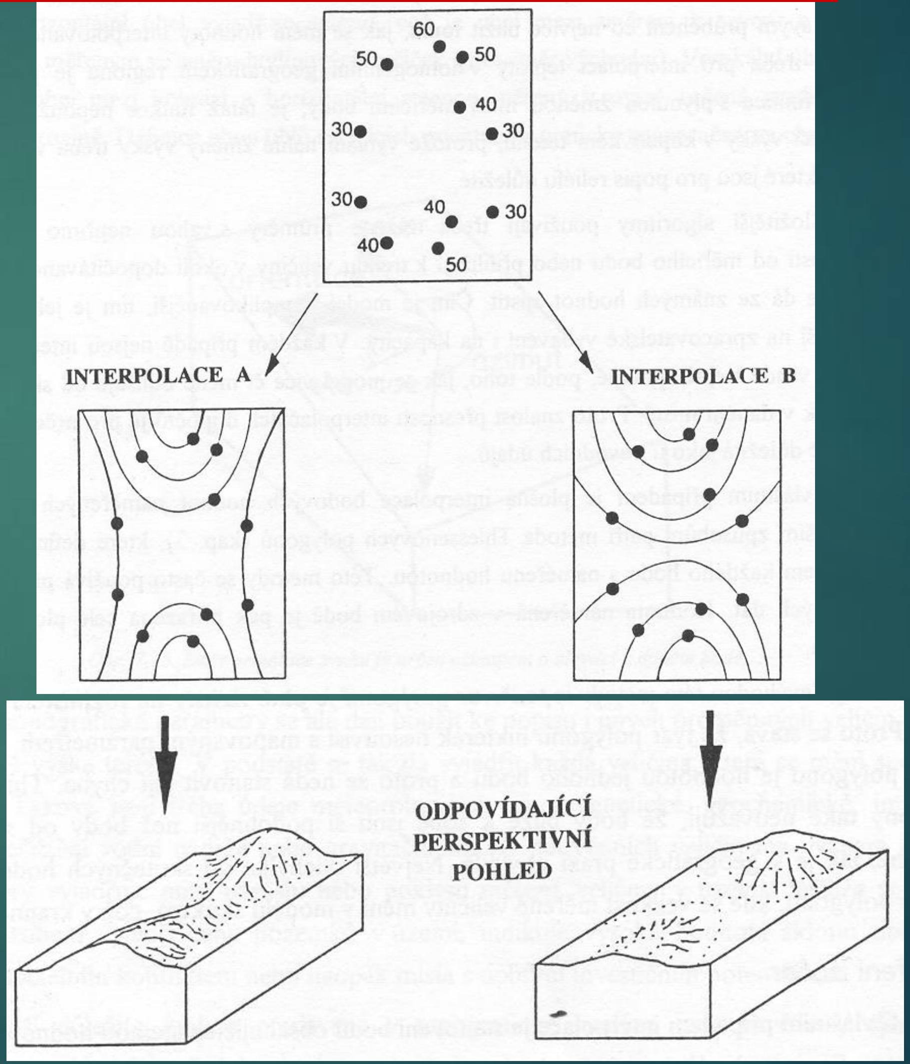
4.3 Features in the vicinity – vector GIS

3.d Creation of isolines

double possible interpolation

2 different morphological types

It is advisable to check with other data (photo)



saddle

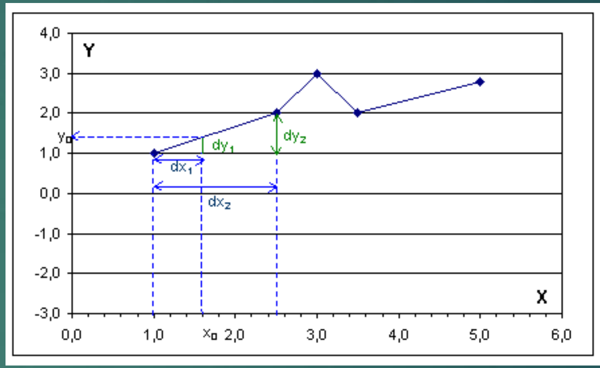
pass

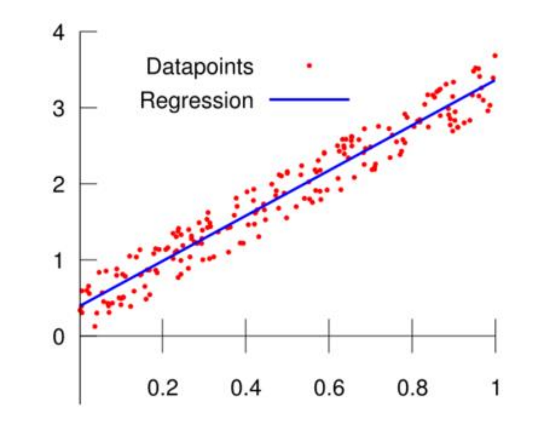
3. Combined Analysis of Spatial Data
4.3 Functions in the vicinity

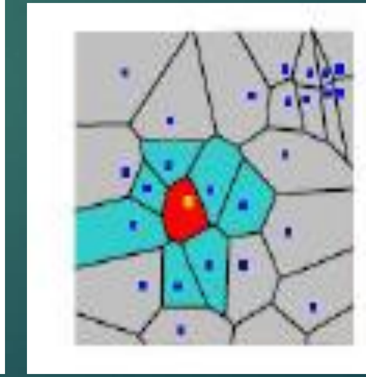
3.e Interpolation functions

– to calculate non-existent values:

- **linear interpolation**
- **polynomial regression**
- **Fourier series** (see below)
- **Thiessen polygons** –
  e.g. for climate data

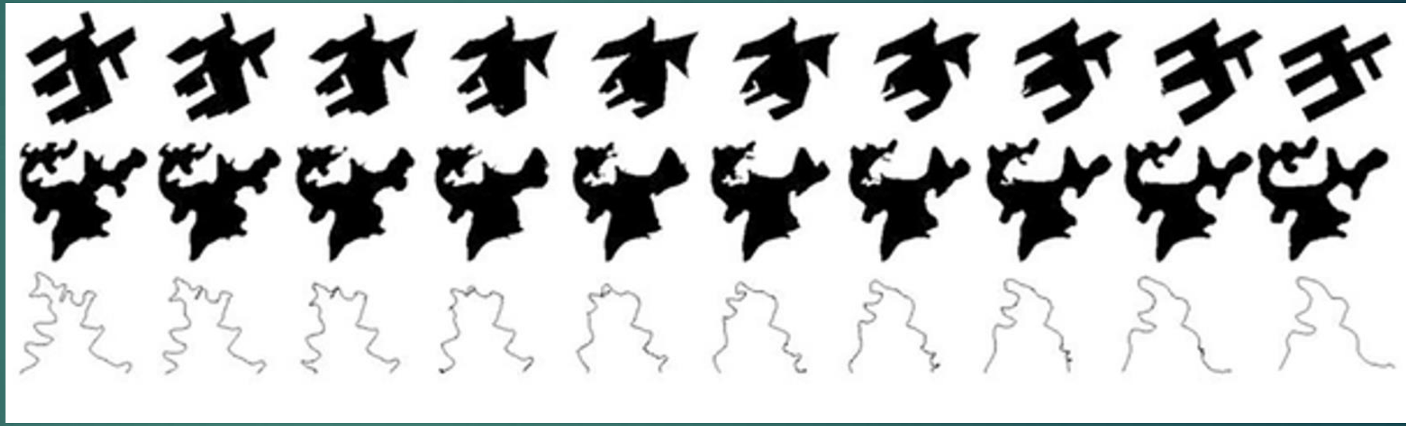


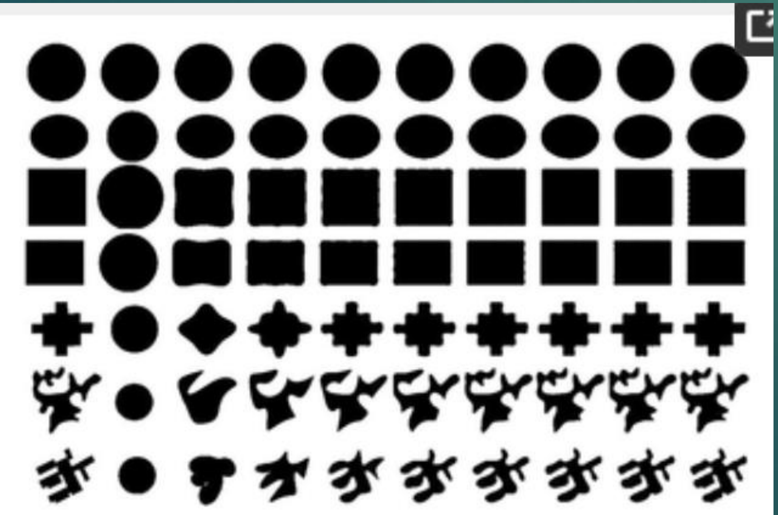




3.e Application of Fourier series for surface shape morphology

Adjusting the shape of polygons by the interpolation method





Modifying the shape of polygons by Fourier series
The polygons in the left column are the original P_1 to P_7, and the other 9×7 polygons in each column are approximated by a Fourier series with a different value of n (see previous page)
n are 1, 5, 9, 13, 17, 21, 25, 29 and 33

Combined Analysis of Spatial Data

4.4 Connecting function – vector GIS

4. connectivity functions

They are cumulative functions, they express topological relations

4.a Vector GIS:

Connecting points/lines together

the result at a given point is obtained as the sum of the results obtained at the previous points where the function was applied.

Combined Analysis of Spatial Data

4.4 Connecting function

4. connectivity functions

4.a Vector GIS:

Therefore, each join function must contain:

1. method of connecting test sites (e.g. communication network)
2. rules for moving along these connections (road traffic rules)
3. tested parameter (distance or travel time between specified locations)

Combined Analysis of Spatial Data

4.4 **Raster GIS**

4. connectivity functions

They are cumulative functions, they express topological relations

- **4.b Raster GIS:**

describe the relationships between pixels /cells

- attribute value in one vertex – the sum of all values above it in the raster

– this site is called *a test site* (see runoff from the watershed based on slope directions

Combined Analysis of Spatial Data

4.4 Connecting functions – types

Types of join functions:

- **A. context – both vector and raster data**
- **B. proximity - both vector and raster data**
- **C. network function - vector data**
- **D. Propagation Function - raster data - displayed as a vector**
- **E. Propagation Function with Obstacle - raster data - displayed as a vector**
- **F. Progress function - raster data**

Combined Analysis of Spatial Data

4.4 Connecting function both types of GIS

A. Context

a. Vector GIS

the creation of continuous areas – so that there is no area between individual parts of the territory (see the figure on the next page

b. Raster GIS

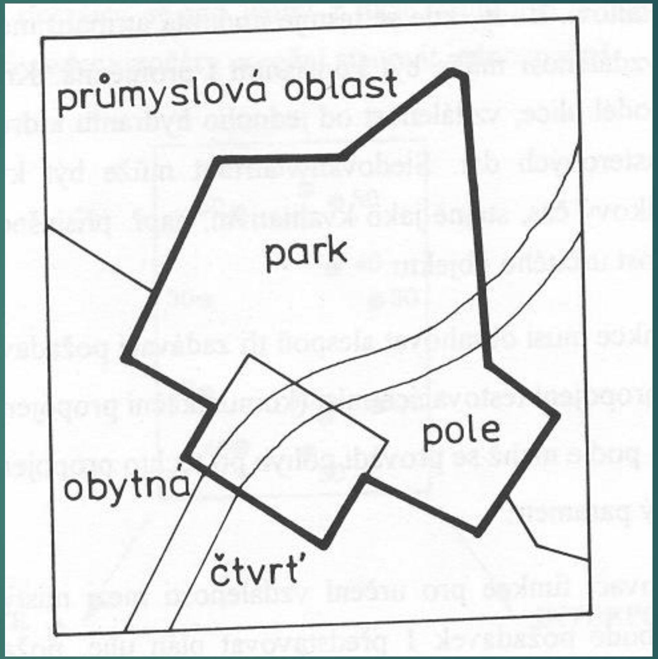
when detecting with raster data :

context is determined

common border or and just a point

Combined Analysis of Spatial Data

4.4 Connecting function



A. Context

and . context in **vector** . GIS

Linked park to field, if any set condition for max line width object that can be attached to both adjacent surfaces (one or the other)

Combined Analysis of Spatial Data

4.4 Connecting function

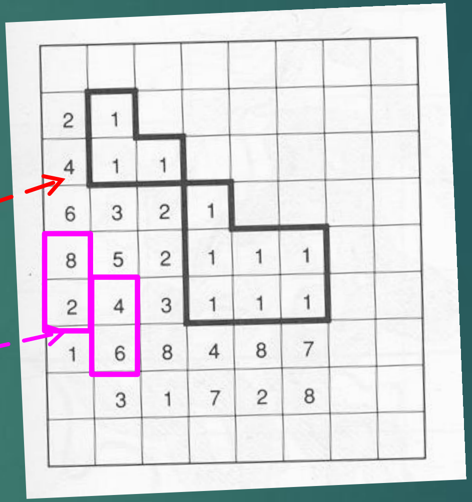
A. Context

b . context in **raster** GIS (contiguity)

2 types:

8-point - over edges and points

4-point - only through the edges



Combined Analysis of Spatial Data

4.4 Connecting function

B. Proximity

can be used for both **vector** and **raster** data

- the most common connecting function – **envelope (buffer) zones (buffers) are created**
- surfaces around geometric objects (fig. next page)

points

linear

surface - internal, external, both proximity

More complex buffers for non- **constant** size of the wrapping zone

Combined Analysis of Spatial Data

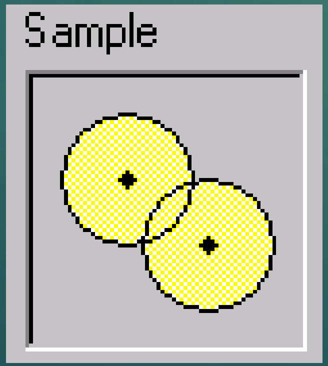
4.4 Connecting function

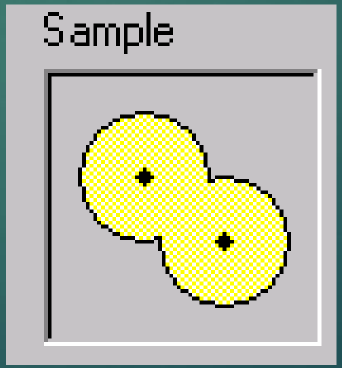
B. Proximity – and. vector data

envelope zone of **constant size** around **the points of** h-objects

= 2 options – vector data of both surfaces

separately or **combined into one**





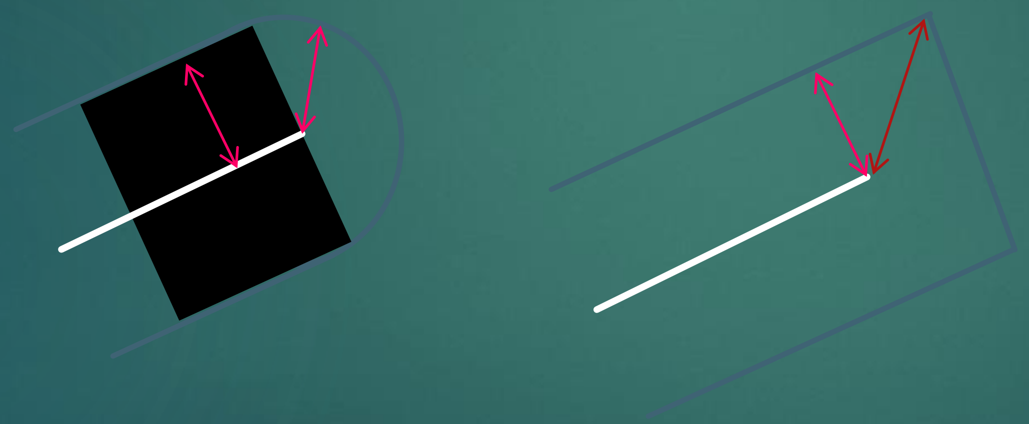
Combined Analysis of Spatial Data

4.5 Connecting function

B. Proximity – and . vector data

wrapping zone of **constant size** around **line** objects

SW offer 2 options



right by definition wrong by definition but software allows

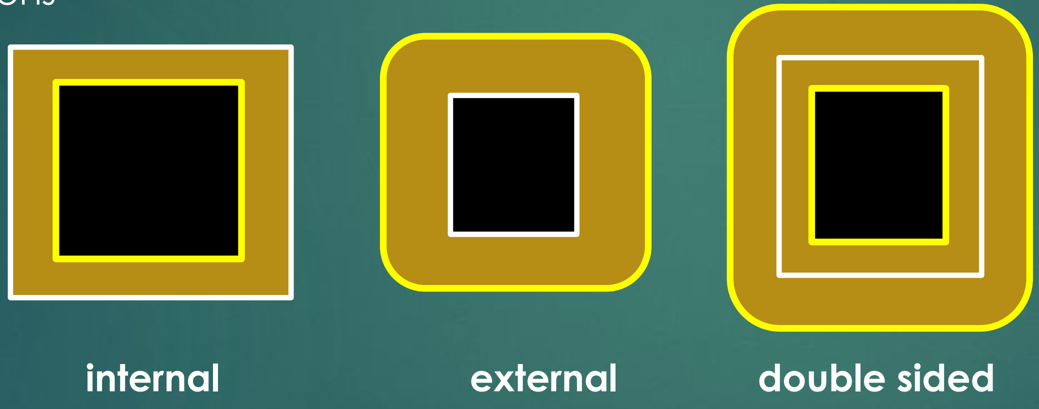
Combined Analysis of Spatial Data

4.4 Connecting function

B. Proximity – and vector data

envelope zone of **constant size** around **planar** objects

= SW offer 3 options



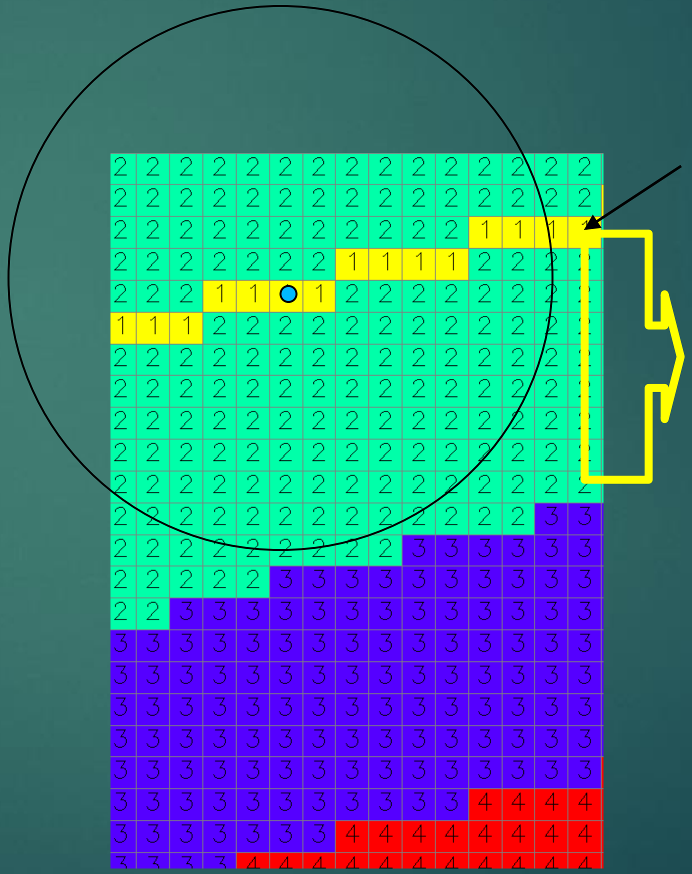
all right by definition - depends on the task

Combined Analysis of Spatial Data
4.4 Connecting function

B. Proximity – b . raster data

Distances are measured from cell center to cell center

A <u>multiple</u> of the cell size y



road

Protective belt (buffer):
cat 2: 0- <250m
8 x 30=240m
for a 30m grid

Protective belt
cat. 3 : 250-500m
(8+9) x 30 = 510m

Combined Analysis of Spatial Data

4.4 Connecting function

C. Network functions (network functions) – **a. vector** data – only

it is used for solutions for linear objects - a task focused on e.g. a connection between two or more places, there are also non-GIS applications

4 defining components of analysis:

1. Assembly resources (goods to be delivered)
2. Places where are resources located (warehouses)
3. Places to resources are to be delivered
4. The network including its restrictions of reduced speed, one-way street, etc.

Combined Analysis of Spatial Data

4.4 Connecting function

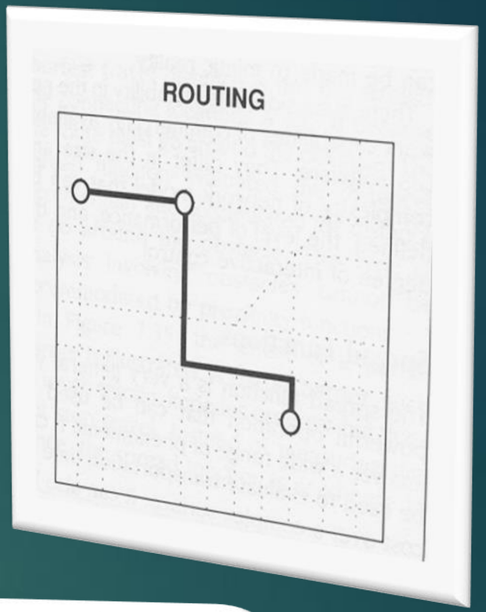
C. Network functions a. vector data

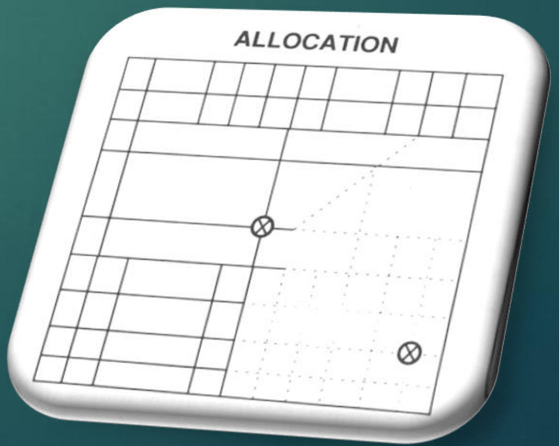
– practical tasks:

1. Predict network load
2. Optimize routes based on current conditions
3. Plan the deployment of resources (warehouses)

instead of A

instead of B





Combined Analysis of Spatial Data

4.4 Connection function in GIS

These functions only apply to raster data

D. Spread function

E. Barrier propagation function

F. Progress function

Combined Analysis of Spatial Data

4.5 Connection function in GIS

D. Spread function

extends the proximity function to **every** point in the specified territory, studies **the change of the property with distance from the source**, evaluates the phenomenon that **accumulates with distance** .

It is performed step by step in all directions from one or more starting points. It works with **raster data format** and the result is often **displayed vectorially** in the form of **isolines**. An example can be a map of the time availability of individual places from a given location

are close to the proximity function – adds the value of the given attribute every time the location coordinates change.

It is the procedure of the specified step in all directions – e.g. **the time of moving between two pixels (according to 4 or 8 directions)**

Combined Analysis of Spatial Data

4.5 Connection function in **raster** GIS

D. Propagation function

for determining the travel time between two points in the grid (and gradually from A to **all directions)**

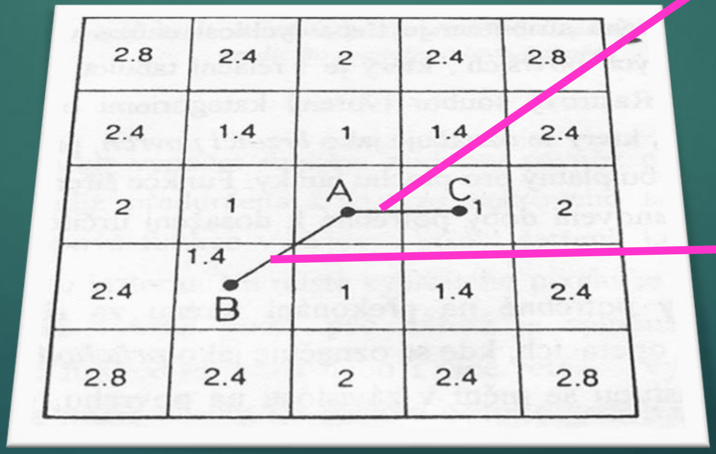
Travel time from A to C = 1

Travel time from A to B = 1.4

In **raster** GIS – it can also work with attributes whose distribution it is irregular in area

In Fig. for distances only

AC length = 1 unit = 1 cell



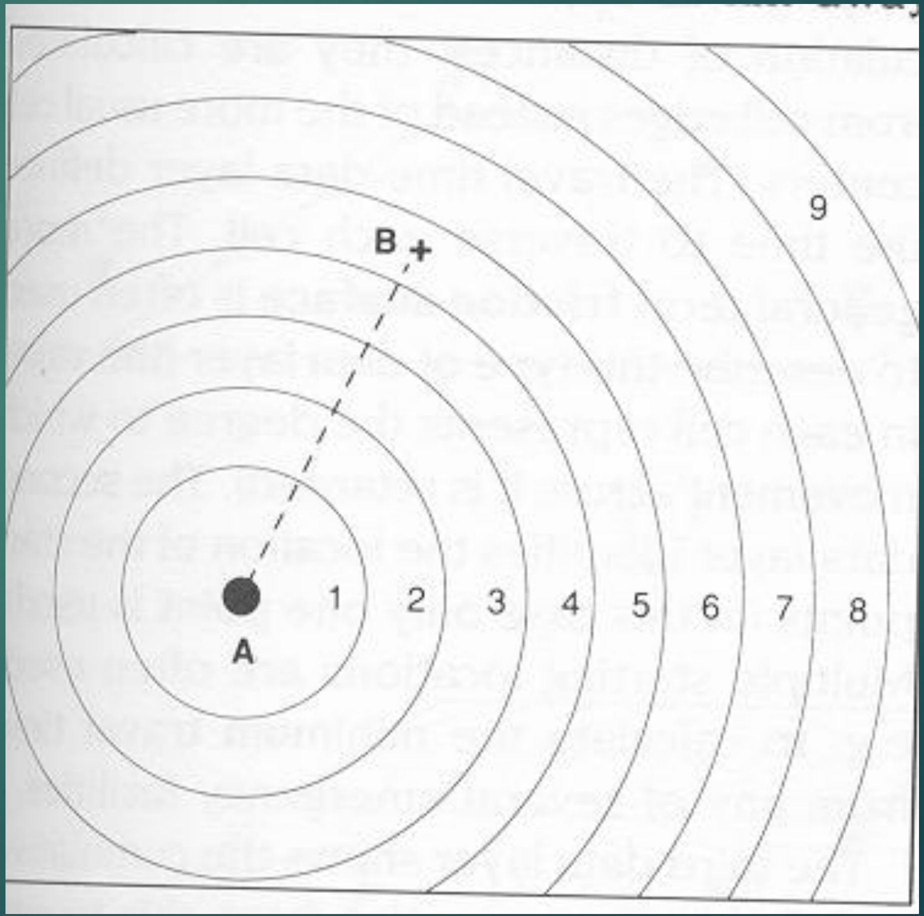
Length AB = 1.4 units (cells)

Combined Analysis of Spatial Data

4.5 Connection function in **vector** GIS

D. Spread function

in raster, it is often displayed as vector **isolines**



Combined Analysis of Spatial Data

4.5 Connection function in **vector** GIS

E. Barrier propagation function

The **result from the raster** GIS is therefore displayed in the vector form of isolines

The spread function can work with an obstacle (unlike the proximity function).

There are 2 types of obstacle:

- **complete**
- **partial**

Combined Analysis of Spatial Data

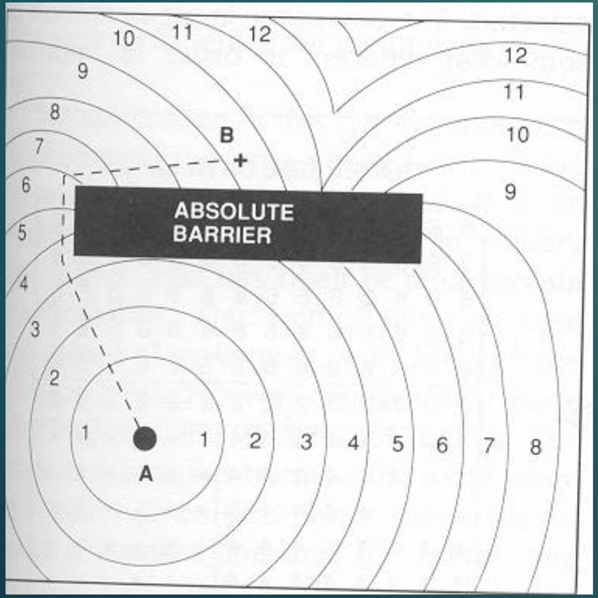
4.5 Connection function in **vector** GIS

5. Obstacle propagation function

5.a Complete obstruction

Driving distance as a unit increment in each direction after 10 km

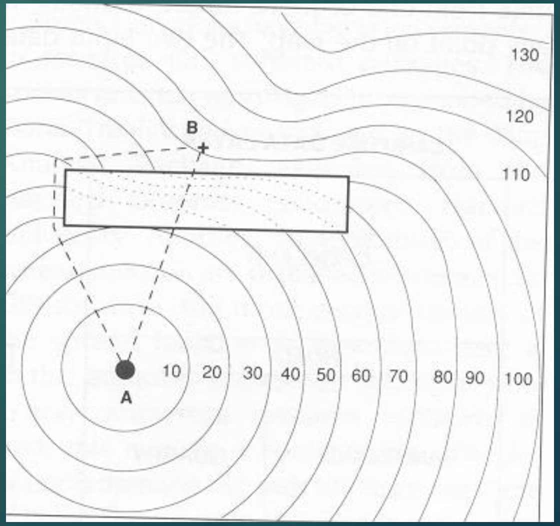
Determination of travel time = addition along modified isolines



5.b Partial obstruction

2 route options, both routes take 90 minutes here,

- longer with faster progress
- shorter with slower progress (dotted isolines)



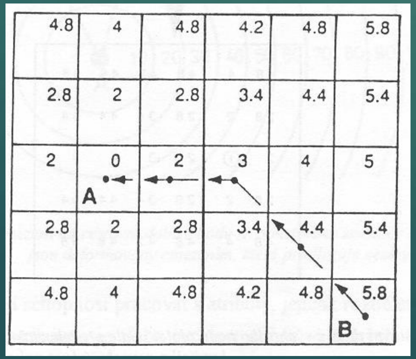
Combined Analysis of Spatial Data

4.5 Connection function in **raster** GIS

F. Progressive function (Seek steed stream functions)

is analogous to network optimization functions in vector GIS

– performs the calculation of a certain value after certain intervals – is performed in a raster, at each step it performs an investigation which of the surrounding pixels **meets the specified selection** criterion



to choose the **optimal** route from B to A

The cell with the minimum value is always selected here (the values of the selected attribute are listed)

Combined Analysis of Spatial Data

4.5 Connection function in **raster** GIS

F. Progressive function

is analogous to network optimization functions in vector GIS

above the raster data format, it repeatedly saves **which of the surrounding pixels fits the** specified selection criterion.

For example, water runoff from an area can be calculated using a digital terrain model (DMT) and can be used in combination with a map of land cover types to locate areas at risk of water erosion.
It is also possible to determine the locations of watercourse beds

Combined Analysis of Spatial Data

4.6 View functions

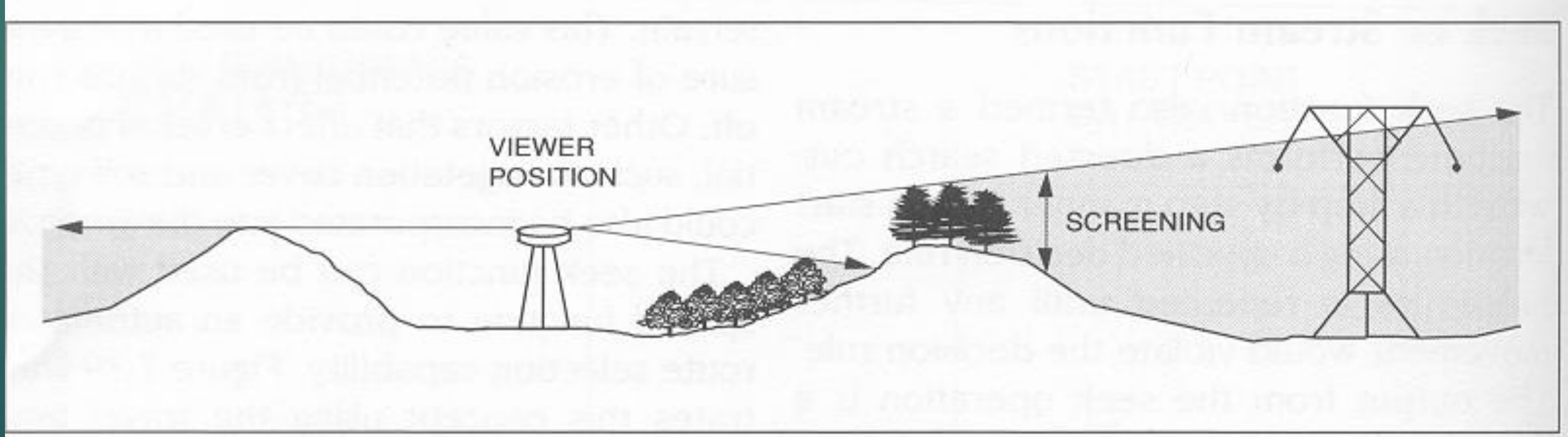
6. View functions (intervisibility functions)

for the propagation of a light ray from a point

AND. visibility = lighting modelling

B. lighting

C. prospective view

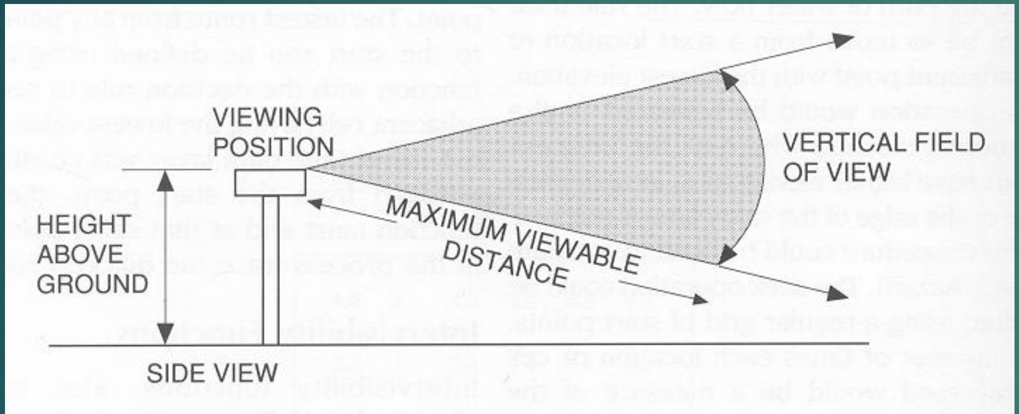


Combined Analysis of Spatial Data

4.6 View functions

A. Visibility and its parameters

vertical section



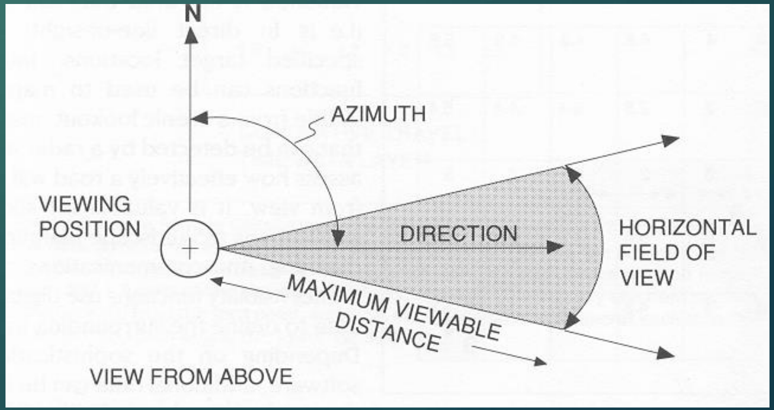
height ratios:

- height above ground
- instead of looking
- sight distance
- vertical field of view

positional conditions

- Instead of looking
- Sight distance
- Direction
- Horizontal field of view

horizontal section



Combined Analysis of Spatial Data

4.6 View functions

B. Lighting (illumination)

– shaded view

we choose:

- height above the territory
- direction of view
- direction of light incidence