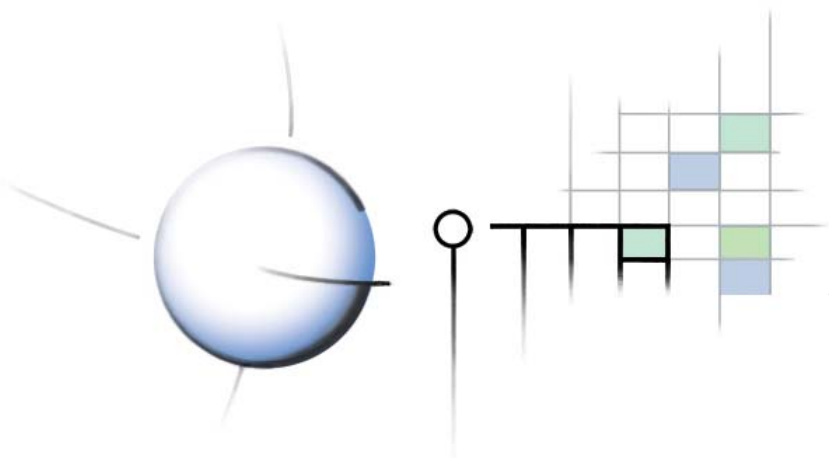

Lesson 2:

Discrete spatial variables

Unit 1:

Introduction

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Content of Lesson 2

Unit 1: Introduction

1: Definition and example of discrete spatial variables

2: Spatial features

3: Structure of the Lesson

4: Links

1

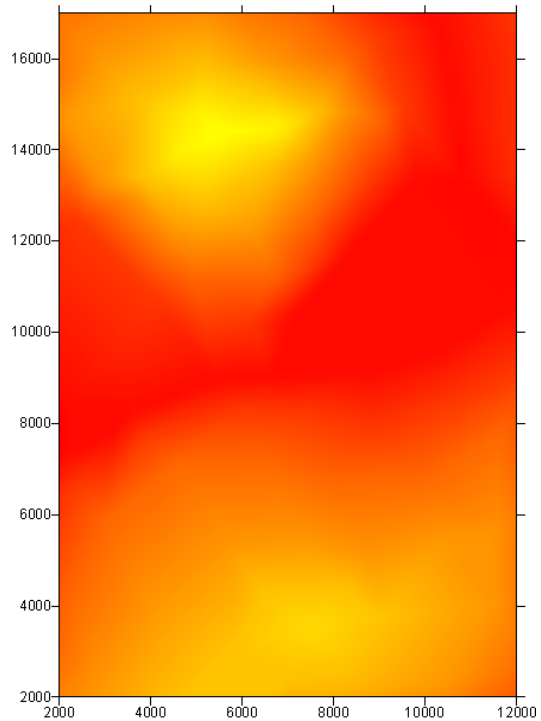
Definition and example of discrete spatial variables (discontinues)

2 types of spatial distribution of phenomena

- **During the process of modeling the reality, properties of phenomena are considered as distributed into space in two different manners:**
  - Continuously: the spatial arrangement of properties produces a continuous surface more or less complex
  - Discontinuously or discretely: the spatial arrangement of properties produces spatial features with clearly defined limits (boundaries)

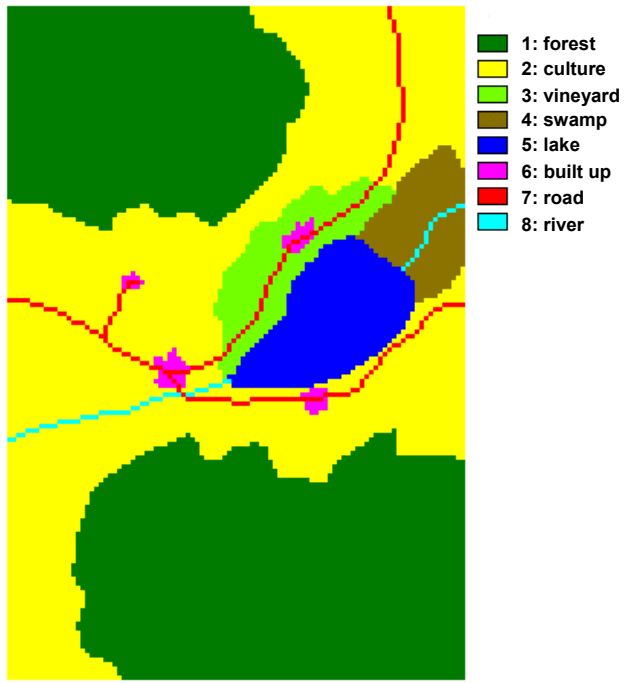
Example of 2 types of spatial distribution

Continuous distribution



Elevation

Discontinuous distribution



Landcover

The reality is more fuzzy ...

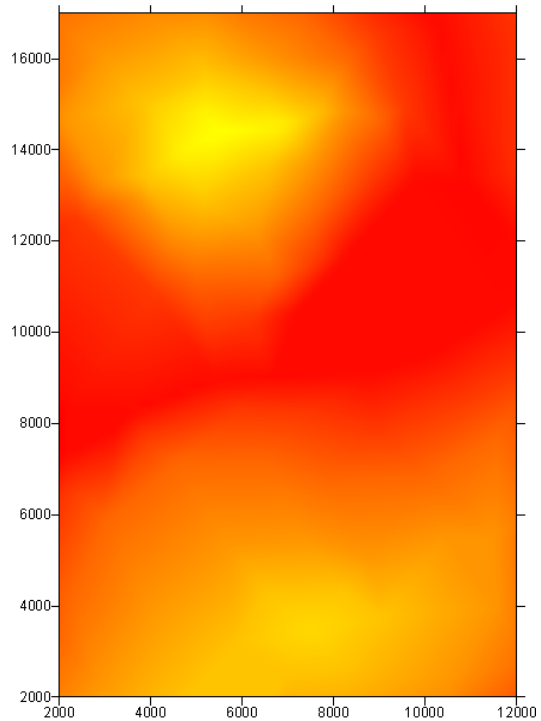
- **In the real world numerous phenomena lie within these 2 extremes:**
  - Continuous distribution: one can often observe local discontinuities, such as cliffs in elevation distribution
  - Discontinuous or discrete distribution : Limits between features are often fuzzy, such as between forest and grassland, or between waterbody and land

The reality is more fuzzy ...

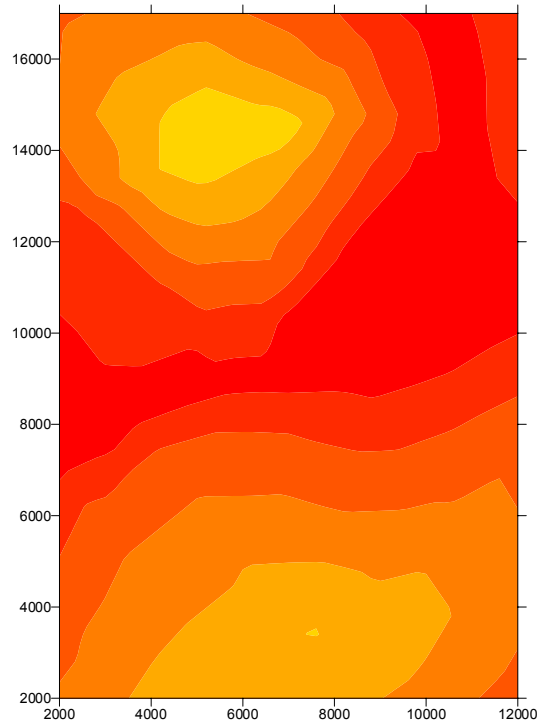
- **Regardless of the nature of a phenomenon, the spatial continuity or discontinuity is decided during the process of modeling the reality :**
  - The phenomenon of « elevation » can be considered as:
    - continuous: spatial properties are then describes as a continuous surface, with a regular mesh of values at an intervall-ratio scale (continuous)
    - discontinuous: spatial properties are elevation class values at an ordinal scale (discontinuous), therefore space is organised into regions of same property.

Continuous or discrete modeling of a phenomenon

Continuous distribution



Discontinuous distribution



From the phenomenon to the variable ...

- **Our objective is to describe and to analyse the spatial distribution of phenomena in the real world**
  - At information level, properties of a phenomenon are expressed numerically as values of a / several variable(s)
  - As properties of variables are located into space, variables are called spatiales variables
  - For phenomena with considered discrete spatial distribution, corresponding variables are called discrete spatial variables

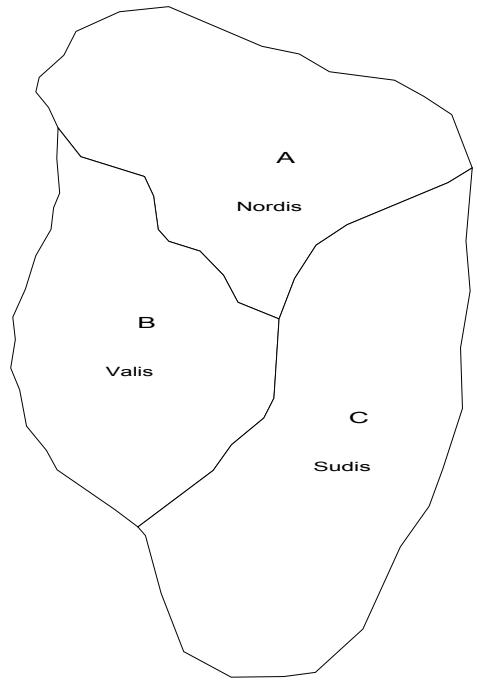
From discrete spatial variable to spatial features

- **Spatial features can be identified in two different manners:**
  - Independently from themes (phenomena) to be described: they are a priori features
    - Example: Census or administrative units (districts, regions, ...)
  - As resulting from the spatial distribution (pattern) of properties for a theme (phenomenon): they are a posteriori features
    - Example: Landcover units (areal, linear, point units related with this theme)

Predefined spatial features (*a priori*)

Thematicaly independent

- The study area is splitted into a fixed number of features, regardless of the considered theme
- This division is set as a framework to collect properties for different themes
- For each considered theme (phenomenon) global feature properties are collected (regionalisation process)



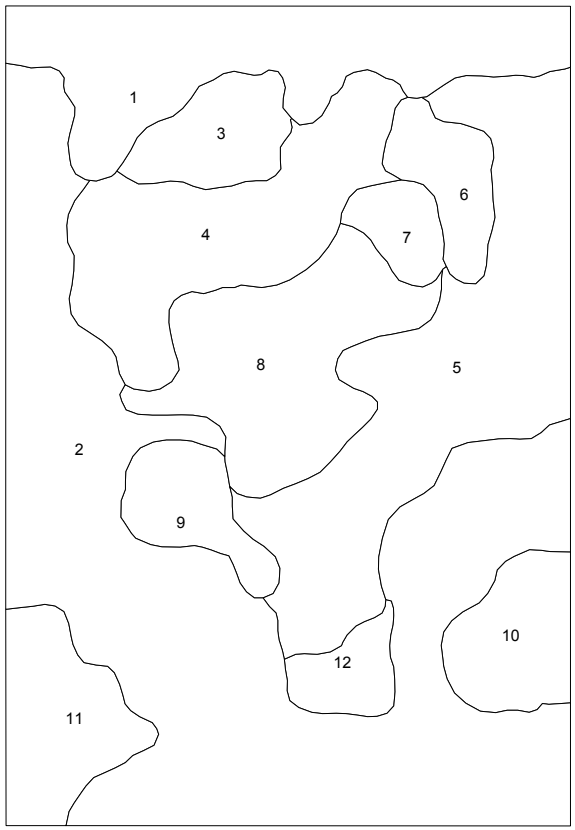
3 features corresponding to Exemplis counties

Resulting spatial features (*a posteriori*)

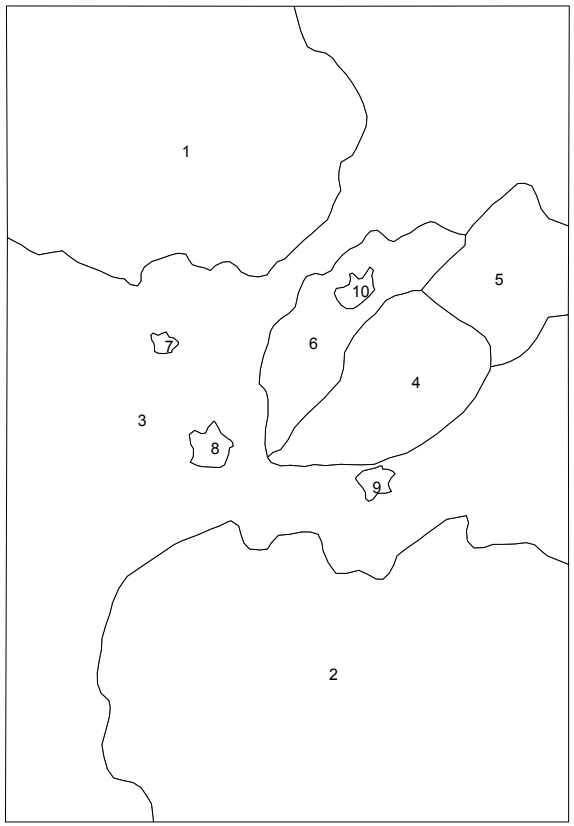
Thematicaly dependent

- The study area is composed with specific number and type of spatial features, related with the considered theme
- This division is specific to the considered theme
- The production of resulting spatial features assumes the presence of a very dense spatial sample (point or area) in order to construct such spatial features (regionalisation process)
- Obviously such division can then be considered as a set of predefined features for the description of other thematic properties

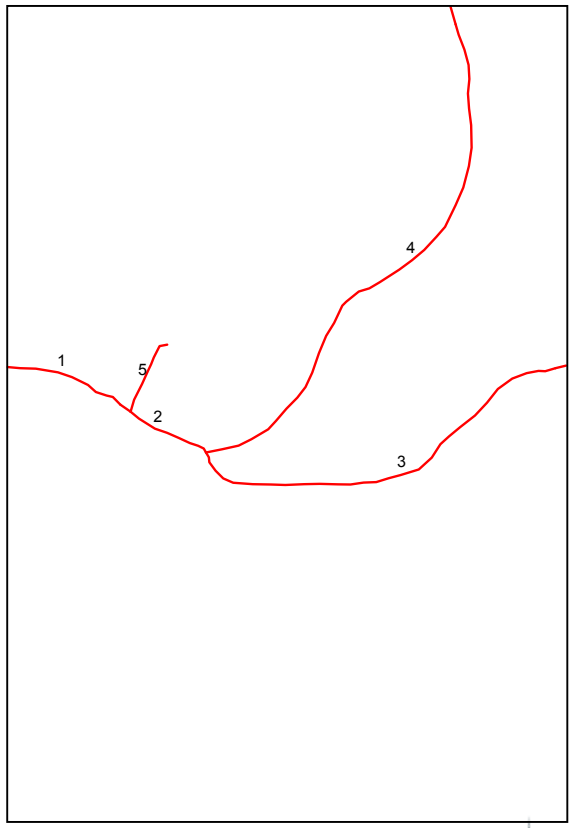
Examples of predefined features in a study area



1) Soil features



2) Landcover features



3) Road segments from a network

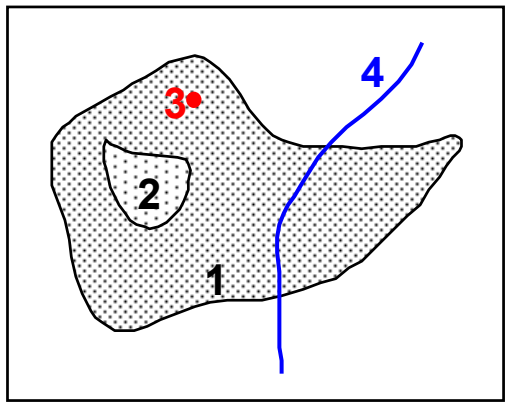
2 Spatial features (reminder)

Definition of a spatial feature (1)

- **It is a clearly bounded portion of space**
- **It can express:**
  - a unit of observation (of measurement)
  - a unit of exploitation (resulting from a transformation of units of observation, by agregation ou desagregation)
- **It can be of 3 types:**
  - zonal feature
  - linear feature
  - point feature

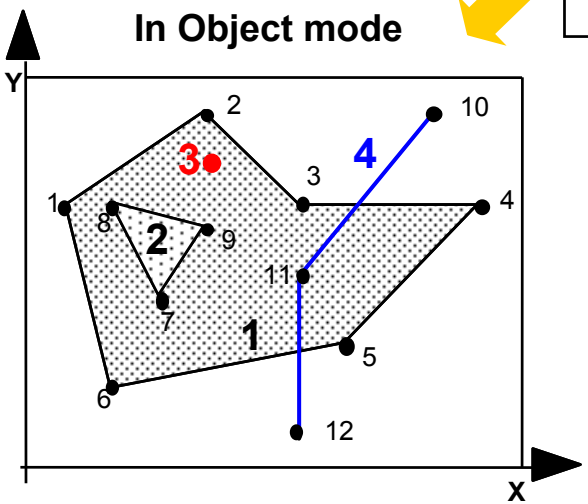
Definition of a spatial feature (2)

Its geometric description is a simplification of its real geometry

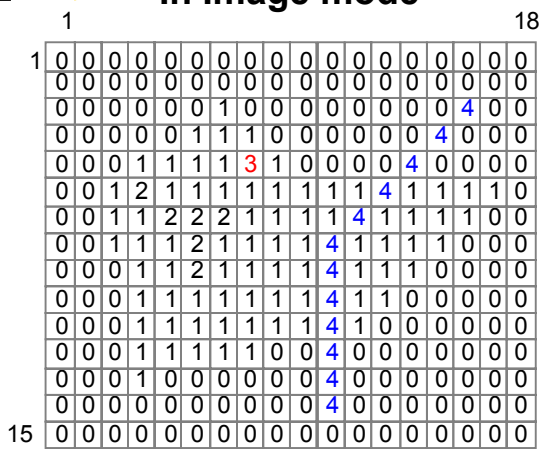


REALITY

In Object mode



In Image mode



Definition of a spatial feature (3)

In object mode

- **It is the spatial unit of observation / of measurement**
- **It is geometrically described as:**
  - a simple or complex polygon, for a zonal feature
  - a broken line, for a linear feature
  - a point, for a point feature
- **Its geometry can be describe with a topological or non topological structure**
- **To its geometrical description is associated a data table (containing thematic properties, ...)**

Definition of a spatial feature (4)

In object mode (continued)

- **The level of details (resolution) of its geometrical description is linked to:**
  - the description scale of the information source
  - the level of generalization defined by the model of reality
  - the geometrical complexity of each individual feature
- **The geometrical resolution is therefore variable and can be adjusted to the complexity of each individual feature**

Definition of a spatial feature (5)

In image mode

- **It is a set of units of observation / of measurement (the mesh, cell, pixel)**
- **It is defined as a set of contiguous cells sharing the same thematic property (value)**
- **It is called a region (zonal, linear or point)**
- **The thematic property of its components (cells) is stored in the numerical grid:**
  - it can express either a true thematic property about the feature or its numerical identification (Id)

Definition of a spatial feature (6)

In image mode (continued)

- **The level of detail (resolution) of its spatial description is linked to:**
  - the description scale of the information source (document)
  - the level of generalisation decided in the model of reality and applicable to all the layers in the GDB
  - the definition of the cell size (unit of observation)
- **The spatial resolution is therefore fixed for all the units of observation (cells) and the whole set of grids (images) in the GDB**

Example of spatial features in object and image mode

Object mode

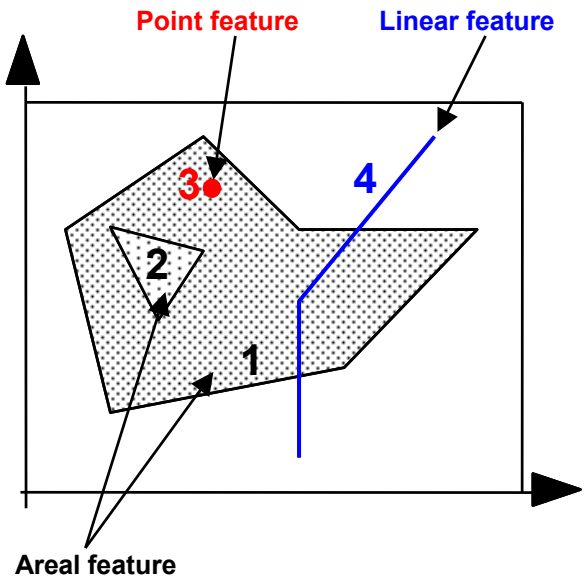
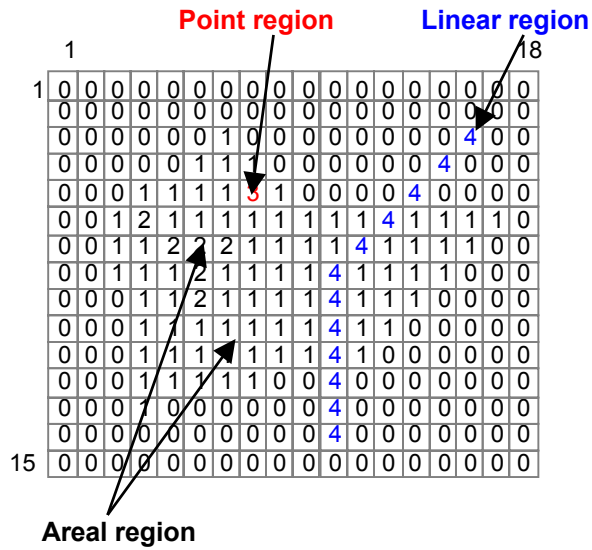
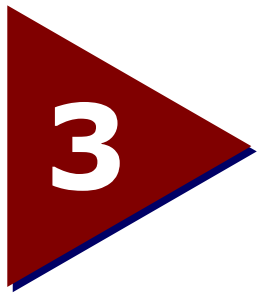


Image mode





Structure of the Lesson

Unit 2: Geometrical properties of individual features

Spatial statistics and indices

- **Individual geometric properties of features:**
  - point features / regions
  - linear features / regions
  - areal features / regions
- **Spatial arrangement (pattern) of a set of features**

Unit 3: Pattern and neighbourhood of features (space is homogeneous)

Spatio-thematic statistics and indices

- **Spatial distribution of spatio-thematic properties:**
  - point features / regions
  - linear features / regions
  - areal features / regions
- **They combine spatial and thematic properties of features**

Unit 4: Weighted Pattern and neighbourhood of features (space is heterogeneous)

Weighted Spatio-thematic statistics and indices

- **Spatial distribution of spatio-thematic properties:**
  - point features / regions
  - linear features / regions
  - areal features / regions
- **They combine spatial and thematic properties of features**

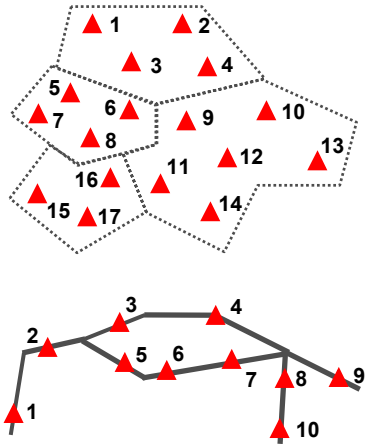
Diversity of spatial and thematic properties indices

Description	Point features	Linear features	Areal features
Global			
- *Spatial*	Position : Mean, Median Dispersion : Stand. dev. in X, in Y, Standard distance, Coefficient of variation in X, in Y Arrangement : Nearest neighbour index, Density index, Chi-square (quadrats), Thiessen polygons	Connectivity (Beta, Gamma), Accessibility, Directionality (orientation), TDCN index, Density index	Contiguity index (Joint counts), Adjacency matrix, Fragmentation index, Moran index(autocorrelation)
- *Spatio-thematic*	Weighted mean, Weighted standard deviation, Fractal Index, Spatial autocorrelation, Variogramme,	Hierarchical tree (Strahler, …), Flow matrix	Association index (Jaccard), Concentration index (Tricot), Autocorrelation index (Geary), Textural indices (ecological)
Individual		Shape indices : length, sinuosity, directionality	Shape indices : perimeter, area, compactness, gravity centre (weighted)

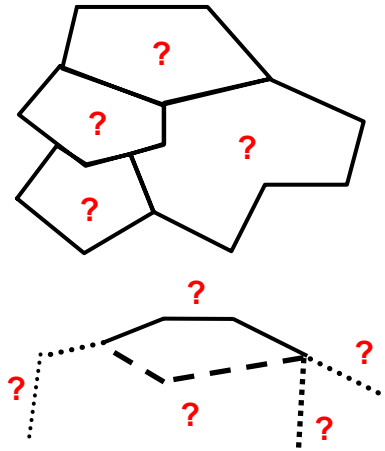
Unit 5: Regionalization

Feature properties allocation

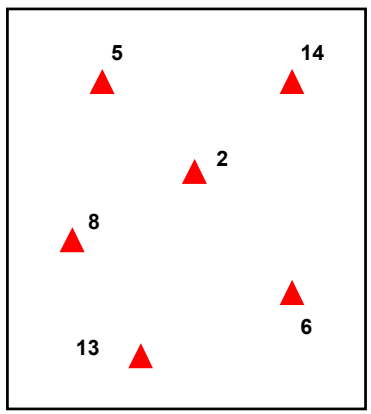
- **From a set of point measurements (sample):**
  - assigning a representative property to pre-defined features (labelling)
  - zoning space into features with homogeneous properties (inference)
- **For agregated features**
- **For desagregated features**



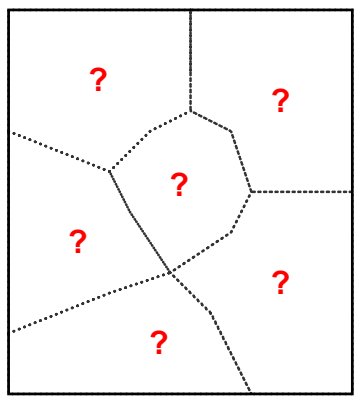
Allocation
by labelling



What is the thematic property for each feature ?

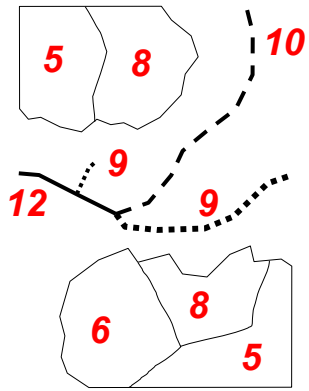


Zoning
by inference

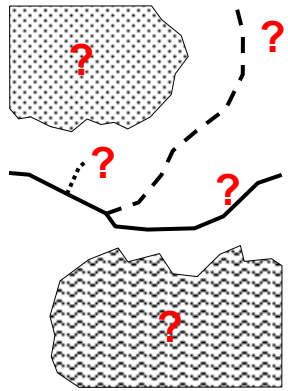


Unit 6: Transformation of spatial features

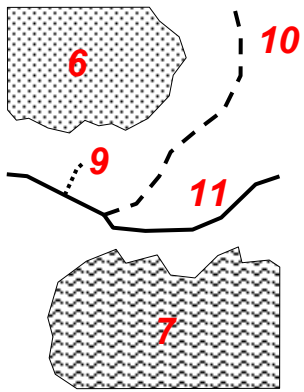
- For aggregation of spatial features
- For breaking up (disintegration) of spatial features



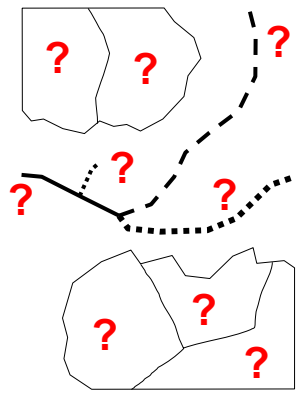
Agregation
by grouping

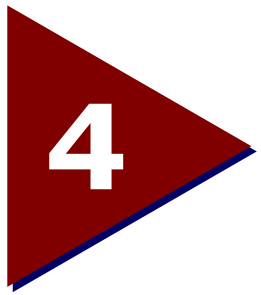


What is the thematic property for each feature ?



Desagregation
by inference





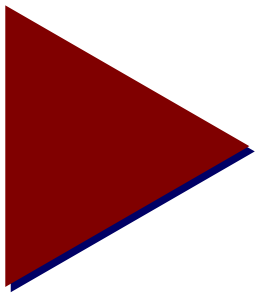
Links with
- other Lessons
- other Modules

Links with other Lessons

- **Spatial properties: isotropy, anisotropy**
  - Lesson ?
- **Spatial dependency: autocorrelation**
  - Lesson ?
- **Distance: euclidian (plane), weighted**
  - Lesson ?

Links with other Modules

- **Unit of observation: in object mode, in image mode**
  - Module B-SM
- **Sample: sampling process, methods**
  - Module B-DC
- **Dimensions: thematic, spatial, temporal**
  - Module B-SM



End of Unit 1