Lesson 2:

Discrete spatial variables

Unit 5:

Regionalization

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Unit 3: Pattern and neighbourhood of spatial features

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Unit 5: Regionalization

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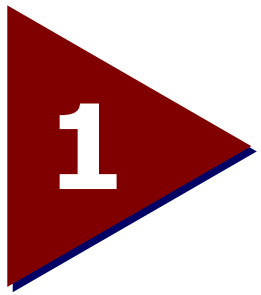
3: Thematic allocation (labeling)



Introduction

Context of regionalization

When the spatial distribution of phenomenon properties is assumed as discontinuous, it is important to consider several situations for assigning properties to features

- **Most of the time properties of a phenomenon are measured on specific locations (measurement sites). This set of data is called sample**
- **From these point feature measurements thematic properties should be assigned to a set of spatial features**

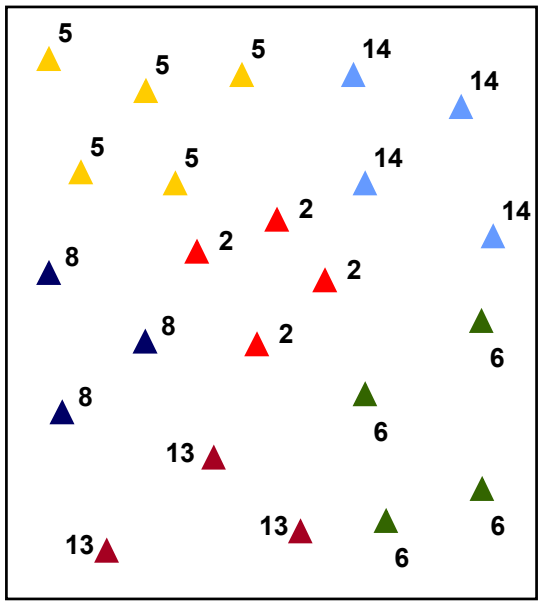
Objectives of regionalization

Two complementary objectives can occur

- To derive spatial features from the spatial distribution of measured properties:
  - This process of object construction is called regionalization in the strict sense
- To assign a global thematic property to each spatial object from a pre-existing set, based on sample data
  - This process is called thematic allocation or labeling and can be considered as part of the regionalization

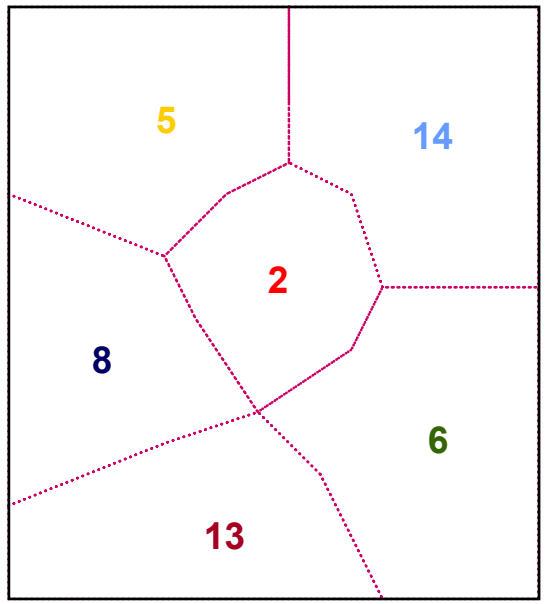
Example of object construction process

What spatial features can be derived from the distribution of properties ?



Point units of measurement (sample)

Zoning by inference

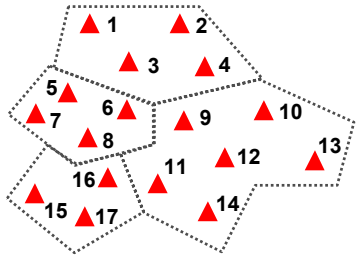


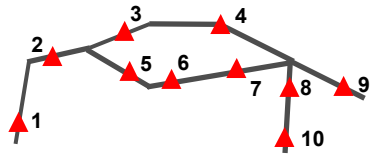
Production of areal features (spatial objects)

Example of thematic allocation process

What is the thematic property for each feature ?

Pre-existing objects with point measurements of thematic properties

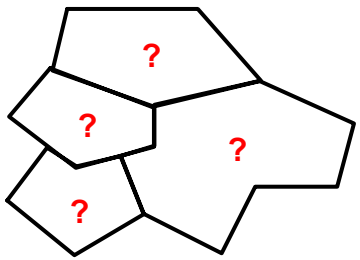


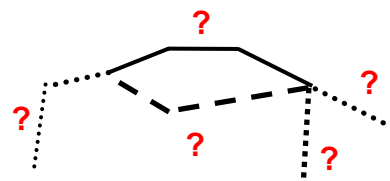


Allocation by labelling

Allocation by labelling

Global thematic property assigned to each object





2

Setting of spatial features (regionalization)

Regionalization: a global definition

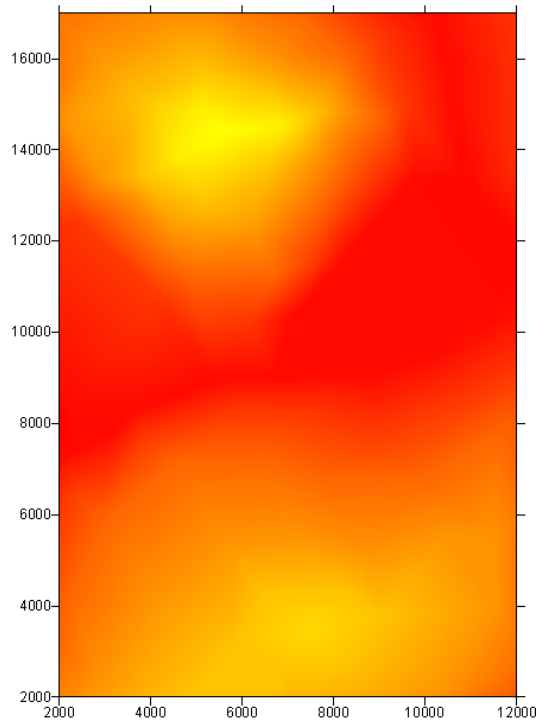
Regionalization can be defined as:

“ The process of generalizing properties of a phenomenon throughout space, based on a set of observations”

- This definition is common to both continuous and discrete spatial distribution

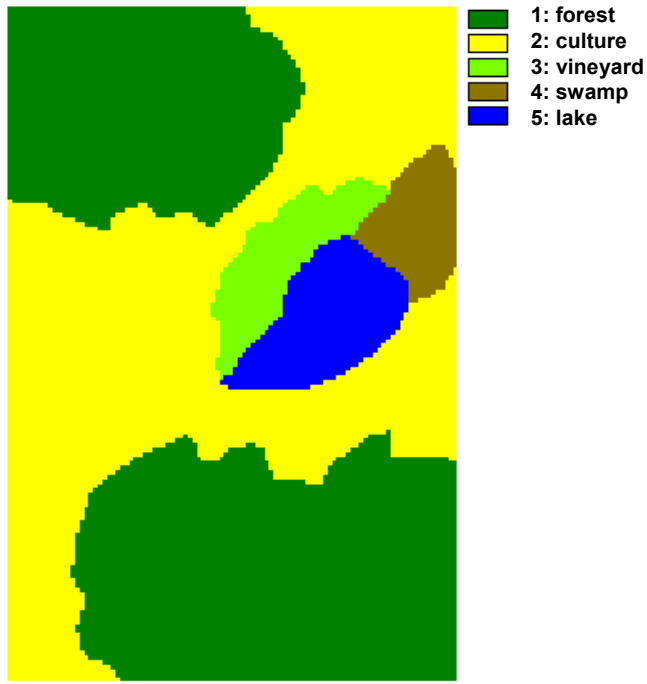
Example of 2 types of regionalized distribution

Continuous distribution



Elevation

Discontinuous distribution



Landcover

Meaning of this global definition

Regionalization is an inference process:

- From a sample (a set of located observations) the behavior of the population (any location in this space) should be estimated
- Inference is obtained by the mean of **interpolation methods** adapted to the nature of the phenomenon as well as to its spatial behavior
- Inference process assumes that some knowledge exists about the spatial behavior of the phenomenon to be interpolated

Spatial inference

As inference is a process creating supplementary information, it requires the contribution of a knowledge about the spatial behavior of the phenomenon

- This knowledge is brought into the process as a set of spatial behavior rules
- These rules are specific to each phenomenon, but particularly between continuous and discrete spatial distributions

Different inferential contexts

According to the nature of the spatial distribution

- **For a continuous spatial distribution**
  - Spatial dependency of phenomenon properties (spatial autocorrelation) is assumed to be very high. Thus properties are distributed as a continuous surface
- **For a discrete spatial distribution**
  - Spatial dependency of phenomenon properties is assumed to be only locally high. Thus there are strong discontinuities (changes from a property to another)
  - These discontinuities enable to delineate spatial objects

Regionalization by zoning

For spatially discontinuous phenomena, the process of regionalization is often called "Zoning"

- It produces areal/zonal features (either objects or regions) from point samples
- It is very difficult or almost impossible to define regionalization rules that produce point or line features, as their spatial dimension is limited:
  - zero dimension (0D) for a point feature
  - one dimension (1D) for a linear feature

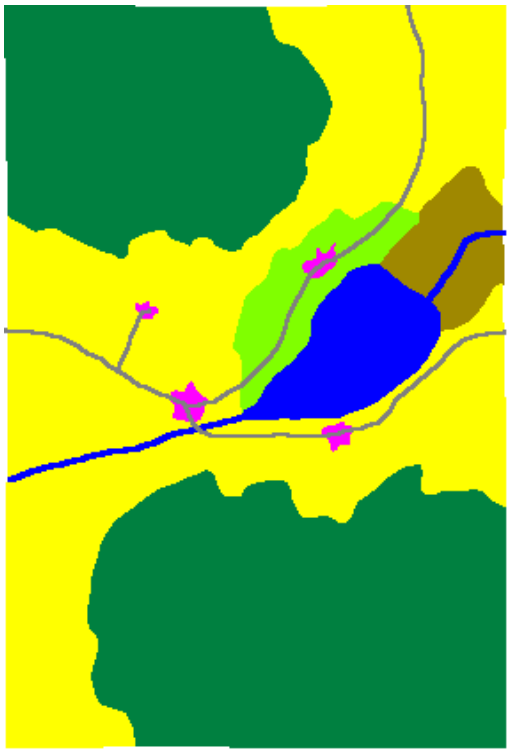
Example of a regionalization process (1)

Regionalization process steps for a discrete phenomenon: Land use/Land cover

1. **Point sampling of properties performed either on field or on image (aerial photograph)**
   - regular or random sampling
2. **Definition of regionalization rules for each considered category (property)**
   - some categories might be grouped or excluded
3. **Application of the regionalization process**
   - delineation of zonal features

Example of a regionalization process (2)

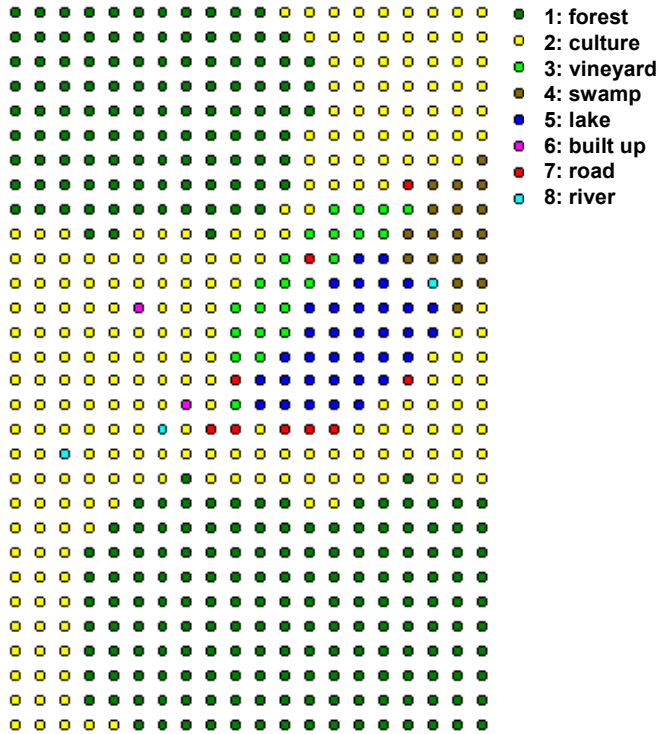
Step 1: Regular point sampling on a 500 meters mesh



"Real word"

Regular sampling

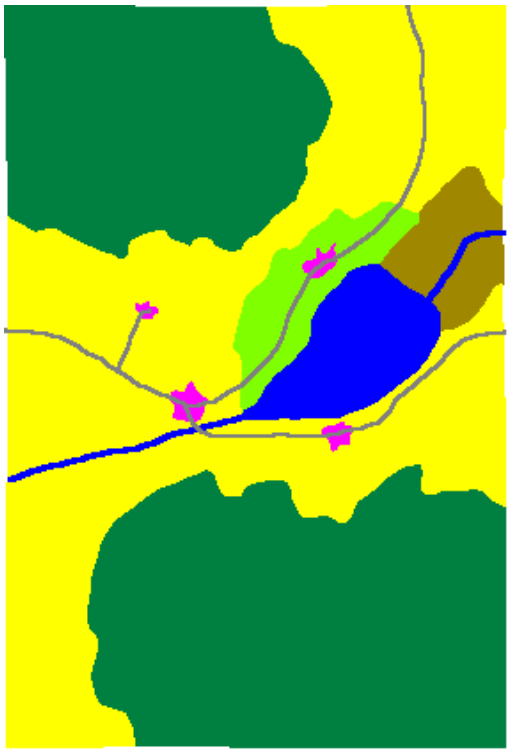
- 500m mesh
- 600 measurements
- 20x30 grid



Sample describing 8 land cover categories

Example of a regionalization process (3)

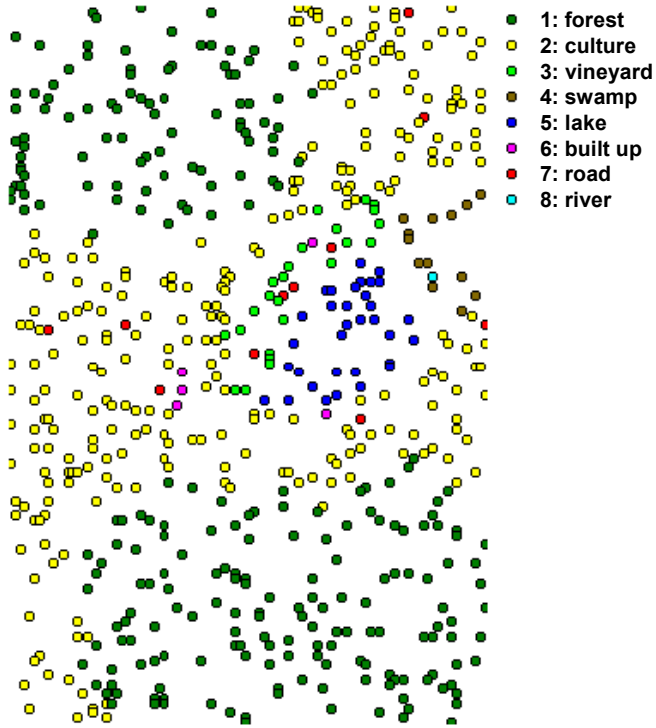
Step 1: Random point sampling with 600 observations



"Real word"

Random sampling

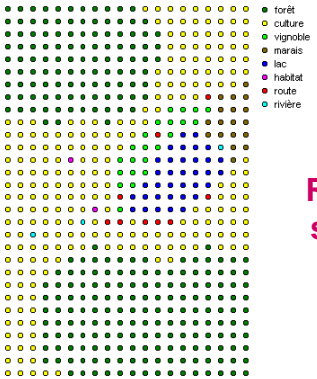
- 600 measurements



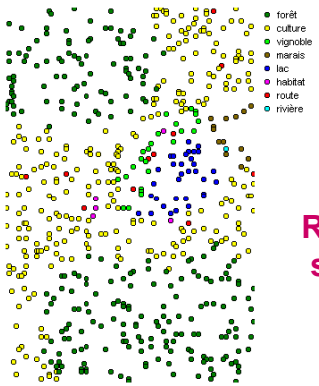
Sample describing 8 land cover categories

Example of a regionalization process (4)

Step 2: Definition of regionalizing rules for each category



Regular sample



Random sample

Observation of the 2 samples strengths the poor representativeness of the following features:
- linear: road (7), river (8)
- small size zonal: built up (6)

Regionalization rules (zoning)

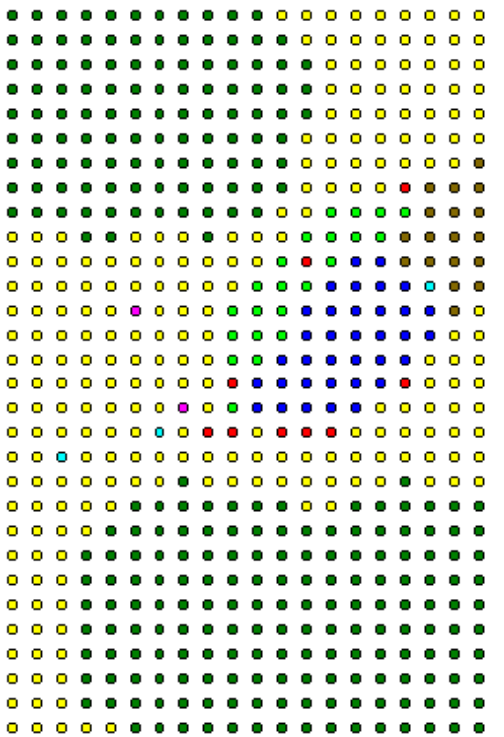
To keep only thematic properties with a spatial order producing zonal objects with a size suited to the sample size (inference distance). Thus properties 1 to 5 are kept

To replace other properties (6 to 8) with the most presence in the neighbourhood

To define object limits at mid-distance to considered point samples

Example of a regionalization process (5)

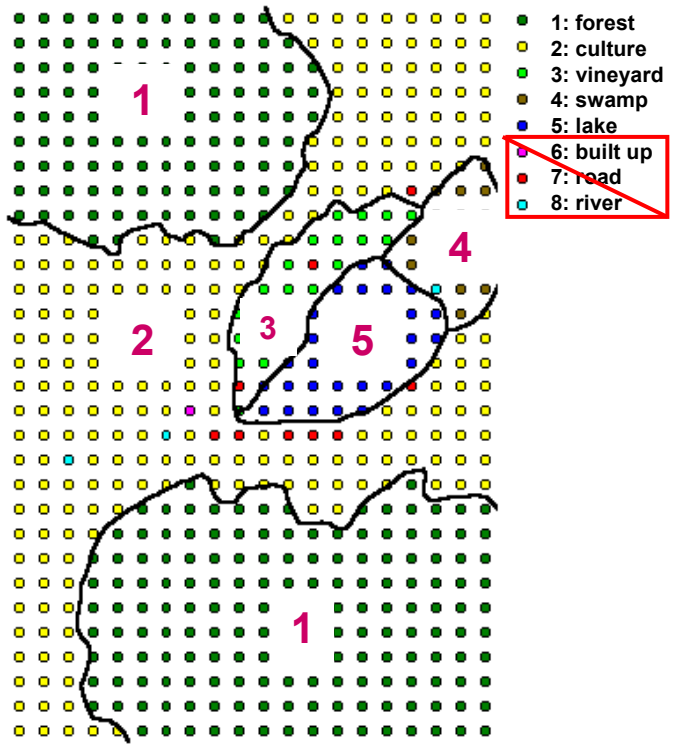
Step 3: Application of the regionalization process



Sampled "real word"

Regionalization

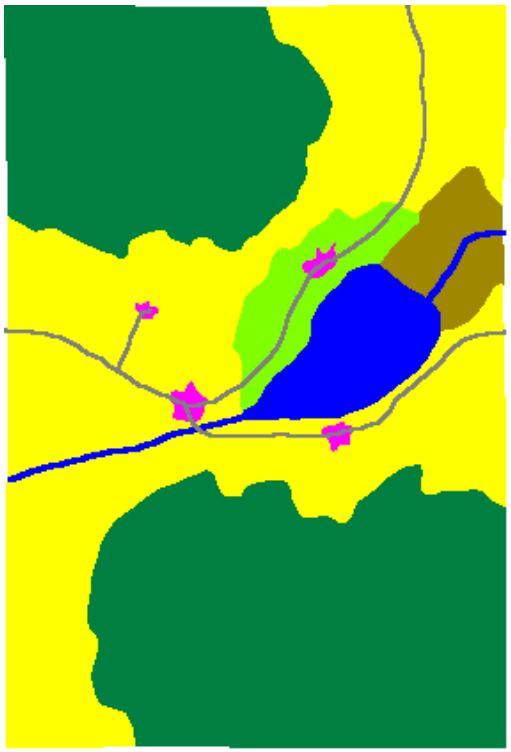
- into 5 categories
- producing 6 zonal objects



Delineation of of zonal objects defined by 5 categories

Example of a regionalization process (6)

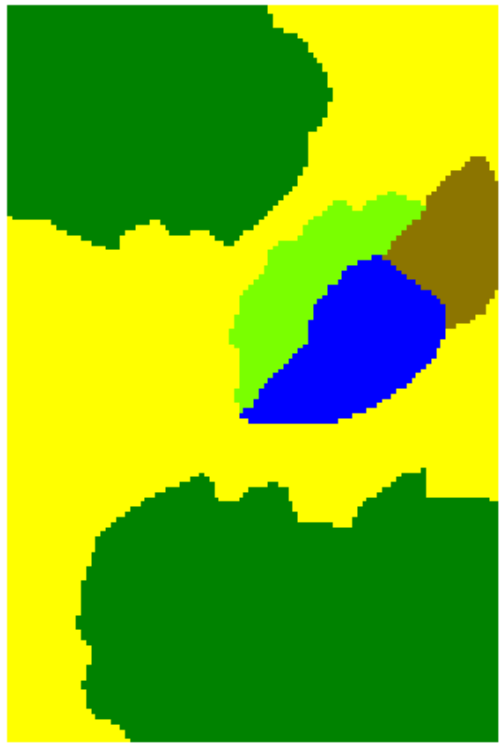
From the “reality” to a “model of reality” built by regionalization



“Real word”

Regionalization

Zoning
by inference



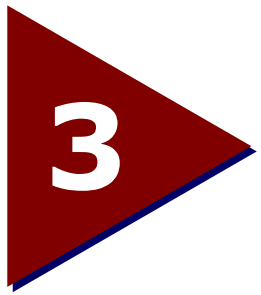
Model of the reality built by regionalization

Illustration of regionalized data

The most frequently used regionalized data are the spatial land use/land cover statistics

- **Most national and international administrations apply a regionalization process similar to the one presented**
  - Point sampling of thematic properties based on aerial or satellite images
  - Category grouping according to the scale of regionalization
  - Definition of regionalization rules for each concerned category
- **The GDB "Swiss land use statistics 1979/1985" and its updates produced by BFS GEOSTAT are an example**

  Web address : http://www.statistik.admin.ch/stat_ch/ber02/asch/fframe1.htm



Thematic allocation (labeling)

Spatial object labeling

Labeling is the process of thematic allocation to each pre-existing object, based on point measurements

- **According to the modeling of reality, spatial features have been defined. One should then assign a global thematic property based on multiple point measurements**
- **This labeling process is influenced by:**
  - the type of spatial object: point, linear or zonal
  - the nature of the phenomenon and its level of measurement of its properties, as well as the synthetic thematic index to derive

Labeling and object types

How to assign a global thematic property to the different types of spatial objects, based on point measurements?

- **For point features the assignation rule is obvious as the measurement location matches each point feature**
  - the assigned property is the measured property
- **For linear features the assignation rule is the combination of measured properties along each feature**
  - the assigned property is a summary index of measured properties
- **For areal features the assignation rule is the combination of measured properties inside each feature**
  - the assigned property is a summary index of measured properties

Labeling and thematic content

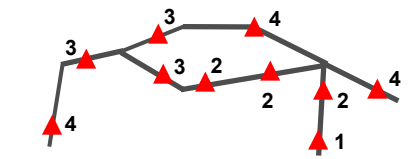
How to create a relevant global thematic property based on point measurements?

- **The level of measurement defines the class of operators to be selected for the synthesis of point measurement values**
  - Class of operators at nominal, ordinal or interval-ratio level
- **The thematic content of the summary index to produce determines the relevant operator to select from the corresponding class**
  - Statistical operators such as the central tendency or the dispersion (variability) index are frequently used relevant operators

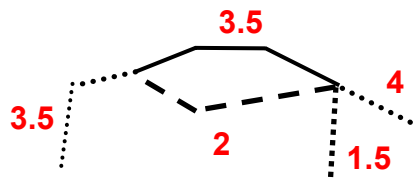
Labeling of linear features

According to the level of measurement

- **Nominal level: mode or diversity**
  - Examples: type of surface material on road sections, type of fitting up in river sections
- **Ordinal level: median or inter-quantile**
  - Examples: quality of the surface material on road sections, variability of water quality in river sections
- **Interval-ratio level: mean or standard-deviation or amplitude**
  - Examples: CO^2 emission from road sections, turbidity in river sections



Allocation by labeling (median operator)

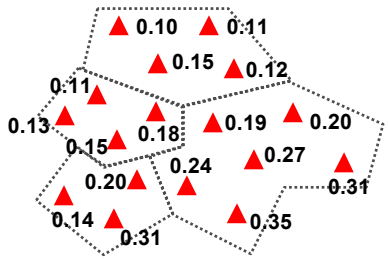


Labeling of surface quality for 5 road sections

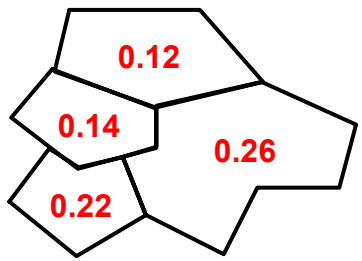
Labeling of areal features

According to the level of measurement

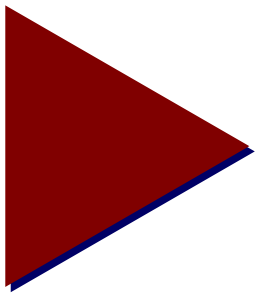
- **Nominal level: mode or diversity**
  - Examples: Major landcover type in districts, their diversity
- **Ordinal level: median or inter-quantile**
  - Examples: Level of noise pollution in districts, variability of this level
- **Interval-ratio level: mean or standard-deviation or amplitude**
  - Examples: Heavy metal content in parcels, snow height in geomorphological zones



Allocation by labeling (mean operator)



Cadmium content (ppm) in 4 parcels of land



End of Unit 5