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Geographic Information Systems 1
Lecture 2: Abstraction and Modeling in GIS

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Anybody moves in the real world - only partially recognizable.

Views of the world around:

- **object** - the world is perceived as a set of discrete real-world objects described by the values of their properties,
- **phenomenal** - the world is perceived as a set of phenomena described by the distribution of property values in space and time,
- **procedural** - the world is perceived as a set of processes taking place in it and shaping it.

source: Rapant, 2006

We describe the real world through so-called **objects**.

principles:

- perception of the world in the form of **discrete objects** (entities),
- the object has **unambiguous position definition**,
- the object can be described by **properties**,
- objects can be grouped and hierarchically organized.

„The object of the real world is any distinguishable, definable (spatially, temporally, thematically, functionally and relationally) and unambiguously identifiable part of real life.“

Each real-world object can be described by ordered 6-tuple:

$$\{e, a, s, r, f, t\} \tag{1}$$

(Entity, Attributes, Spatial Attributes, Relation, Functions, Time)

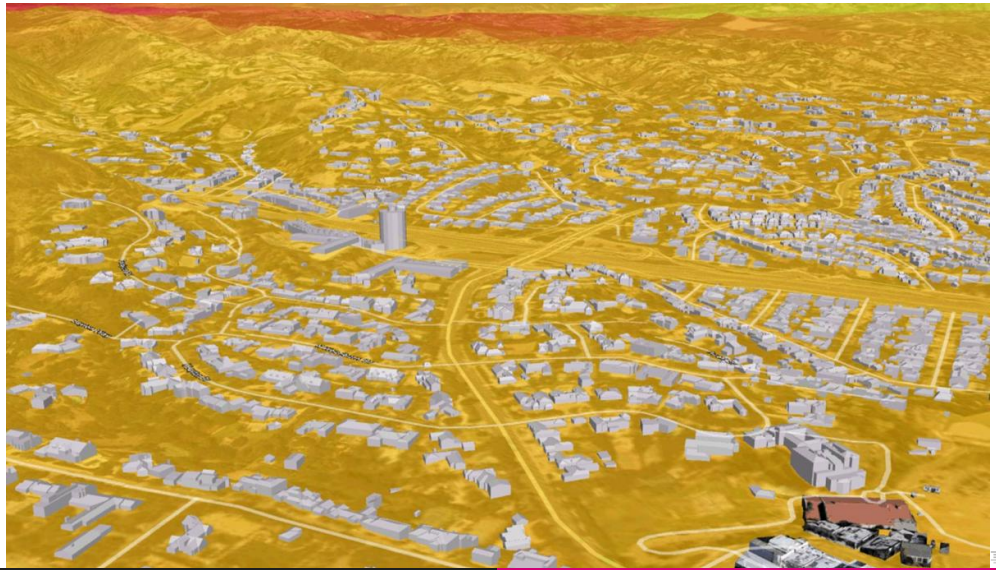
- **physical** objects - „physically tangible“ - e.g. Lužnice, Kleť, planet Eart etc.
- **abstract** objects - artificially created in the human mind - e.g. administrative units (regions, districts ...).

Based on the same features, real-world objects can be grouped into so-called object classes.

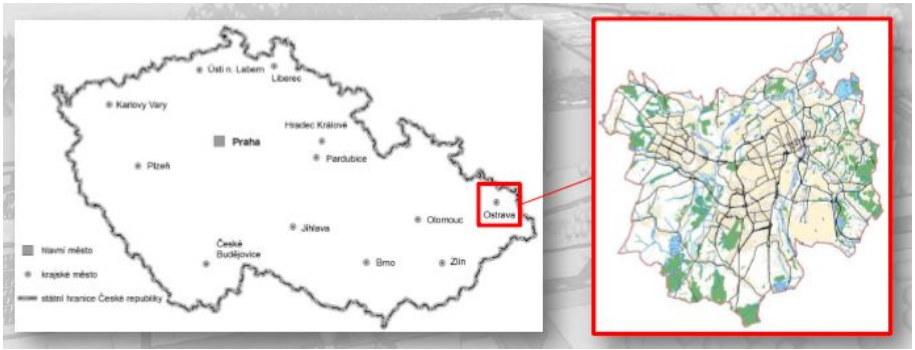
Object class consists of a group of real world objects with common features.

object classes examples: class deciduous tree, villages up to 2 000 inhabitants, etc.

- The object class is **abstract**.
- An object (entity) in particular is an expression (occurrence) of a given class.
- Object classes can be **organized hierarchically**.
- **By aggregating** objects of one or more classes we can create a **complex class**.



The scale of the worldview determines whether the real world object is perceived as **simple** or as **complex**!



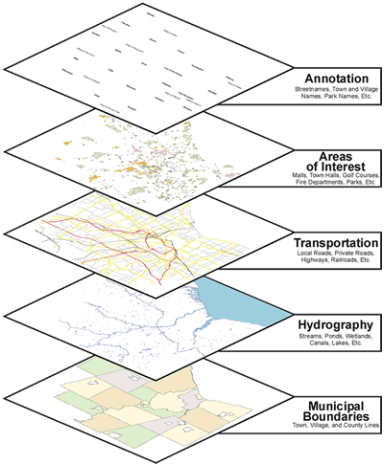
„The real world phenomenon is any distinguishable, definable (spatially and temporally) and unambiguously identifiable property (or logically related set of properties) of the real world, the values of which are usually defined at each point of the studied space.“

Each real world phenomenon can be described by ordered 4-tuple:

$$\{a, (x, y, z), b, t\} \tag{2}$$

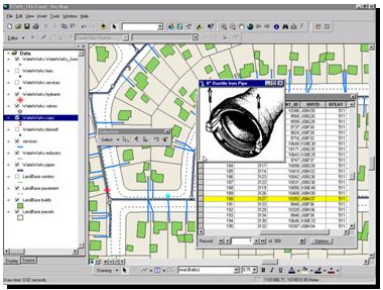
(Attributes, souřadnice (X, Y, Z), Boundary, Time)

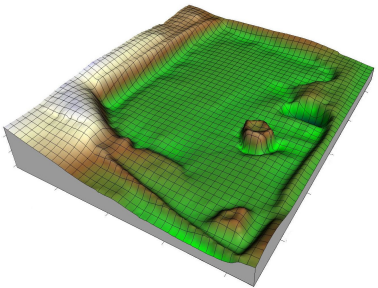
- **qualitative** - e.g. landuse, soil type ...
- **quantitative** - altitude, precipitation ...



by value domain:

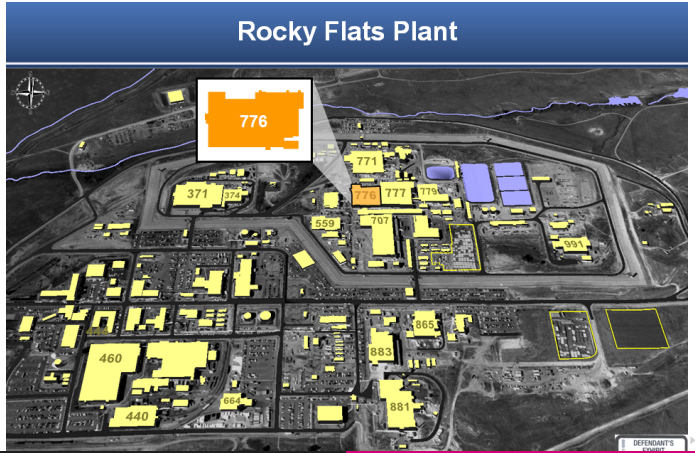
- **discrete** - settlement, administrative units ....
- **continuous** - altitude, concentrations of pollutants in the soil, ...





according to variability over time:

- **static** - unchanged in the selected time scale,
- **dynamic** - changes in the selected time scale.



according to the number of spatial dimensions of the studied phenomenon:

- **0-dimensional (point)** - e.g. concentration of pollutants at a given point, depth of well ...
- **1-dimensional (line)** - concentration of pollutants along the river,
- **2-dimensional (planar)** - landuse, geological structure, soil types ....,
- **2.5-dimensional = surfaces** - altitude,
- **3-dimensional (volumetric)** - concentration of ore minerals in the deposit, concentration of pollutants in the atmosphere.

„A real world process is any activity or sequence of activities (whether natural or artificial) affecting real world objects and phenomena, or other real world processes.“

processes classification:

- **non-spatial** - changes/influences the values only of non-geometric properties of objects (without direct connection to their position), does not change the spatial arrangement and also does not depend on it - e.g. change of ownership of a work,
- **spatial** - changes/influences the spatial arrangement of objects, or also the values of their non-geometric properties - e.g. division of the plot into several parts, soil erosion ...

In the case of an object view of the real world geoinformatics creates real world models, whose central building block is the model real world object image - geo-element (geo-feature):

Geo-element (feature) is a model image a localizable real-world object, which is further indivisible into units of the same class and which is described by geodata.

- He is uniquely identified!
- It can represent both abstract and physical objects!

feature class - a group of similar geo-elements

- consists of following parts:
  - geometric,
  - thematic (descriptive),
  - time,
  - relational,
  - functional,
  - qualitative.

For real world phenomena modeling we can use for example so-called rasters.

Raster is usually a regular network of cells square shape, which is possible separately assign values to displayed properties.

There can be used also networks for modeling real world phenomena. The basic building block of the network is usually a cell representing a defined part of the space real world and bearing the values of the monitored properties.

Network is a set of n -dimensional cells usually distributed evenly in m -dimensional space.

The cell is a unit of discrete division space that is unequivocal localizable and which can be self-contained assign attributes.

- geoinformatics does not yet explicitly address,
- if necessary, it uses tools developed in other areas (such as programming products for modeling the spread of pollution in groundwater or in the air, for modeling of traffic flows, etc.)

Model = abstraction of certain aspects of reality

Modeling - one of many possible ways to view the real world, carried out in order to examine the objective laws existing therein.

Modeling - a process of abstraction in which essential aspects are studied parts of the real world emphasized and insignificantly eliminated - all with respect for the purpose to be fulfilled by this modeling.

Why spatial modeling?

- We often need to consider a few variants of the next possible procedure or estimate what the next development will be.
- It is not possible to perform experiments in the real world.
- Therefore, replacement systems are used - the so-called **models**.
- Geoinformation systems are based on spatial models.
- The spatial model is abstract and well defined by a system of so-called concepts.
- It defines, among other things, the dictionary that can be used to describe objects, phenomena and processes.

- saving the description of objects and phenomena or processes real world
- and support for their:
  - querying,
  - analysis,
  - visualization,
  - and possibly simulations of real-world behavior in specified situations.

When building a model, ie when modeling real world, we must consider in the first place in a row:

- the purpose of the created spatial model,
- from the purpose we derive which part of the real world will be the subject of modeling and which aspects of the real world will the model consist of and which, on the contrary, omits.

It ís necessary to pay close attention to problems of spatial modeling of the real world - reasons:

- the geodata stored in them are extremely long service life (usually decades),
- and extremely high price (large budgets applications of geoinformation systems are common range in the tens of millions of crowns and on geodata up to 90 % of this amount).

Thank you for your attention.