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Digital Terrain Model Geospatial Modelling

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Abstract. The modelling means the world object cognition based on the analogy. This analogy presents an idea and material imitation of some properties of the existing world. It is processed by various anthropogenic objects, in which the chosen properties are presented, defined and characterised as shapes and relations of original objects. The simplified objects are created. These objects are specially created only for world study. These types of objects are called models. To edit the digital terrain model correctly, it is necessary to understand the geospatial modelling.

1. Introduction

Space and time are continuous and due to computer memory boundaries, it is impossible to create continuous spatial models, object models and phenomena models in the computer environment. Due to this fact, spatial, object, phenomena discretization is mostly used. During spatial data processing, discretization is also known as tessellation (object division into regular or irregular geometry object series). During the universal model creation, there is an effort to create a model that obtains a large number of different objects. The model objects may be grouped into groups based on the common properties that define the category, kind or object class. The process of object segmentation is called classification.

2. Classification

In some cases, the object classes are hierarchically structured. It means that some classes are a part of the upper classes. The typical example may be the cadastral plot class, which is part of the cadastral district that is part of the upper classes (township, district, state). There are known model properties such as *isomorphism* (every model component corresponds to one object modelled component), *homomorphism* (due to the extent of the modelled object and its complexity, the part of every component corresponds to each component, but not in the opposite way), *variability* (it limits the homomorphic simplification) and *metric* (the minimal distinguishable value of two models' statuses – distance definition) [1]. (Figure 1)



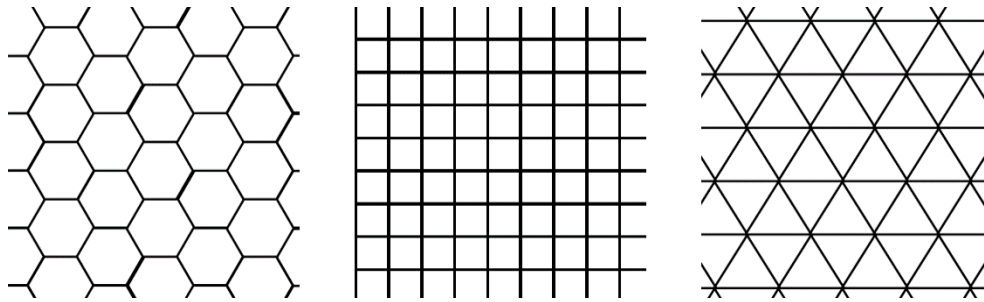


Figure 1. The samples of regular grid plane tessellation

During the modelling process, the basic characteristic and object importance for the application must be defined. The conceptual model is created. The extent, precision and complexity of the model is chosen for the examined problem. The complexity of conceptual models results from the necessity of modelling, positioning, spatial relations, attributes, properties and dynamic changes in time. Based on this fact, the six segments are defined. [2] *Geometrical segment* means capturing of position (coordinates, geo-codes) in space and description of geometrical properties (length, area, volume, shape, orientation, slope, position of the centre etc.). *The topological segment* means the description of relations (metric, description in time, syntactic) between the objects. *The thematic segment* is a dual description (property – value) of non-graphical characteristics. *The time segment* presents the object position capturing in the timeline (dynamic). *The functional segment* describes available operations performed on the geo-objects. The last one, the *qualitative segment* describes the object quality (precision, resolution, complexity, consistency etc.). Geospatial modelling may be applied not only to our planet. It may become a part of wider aeronautic discipline related to analyzing of other celestial bodies [3].

3. The basic modelling approaches

During the objects and phenomena modelling in GIS (geographical information system), two basic approaches exist, which lead to different implementations in GIS. *The field-based models* are based on fields, displaying the data as a set of values. Within this process, the creation of a spatial fence for the examined area model and the division of this environment into the final count of single components present the basis. It means the area division into areal elements (locations) covering the whole examined area (point or polygonal raster). Areal elements may obtain various shapes, mostly the square shape, triangular shape or hexagonal shape. The same shape of a single areal element within the spatial fence is regular. This fact causes that the value is the most important parameter. The areal element attribute is a selective value from the area (continuous environment, phenomena) and may be obtained through various means (the average of all values in an element area, the centre value, the most important value, the dominant value, interpolation, function etc.). The attribute value within the point element is obtained similarly from the point element surrounding. These models are suitable for the processing and the visualization of continuous objects and phenomena (areal and satellite images, erosion, pollution etc.). (Figure 2)

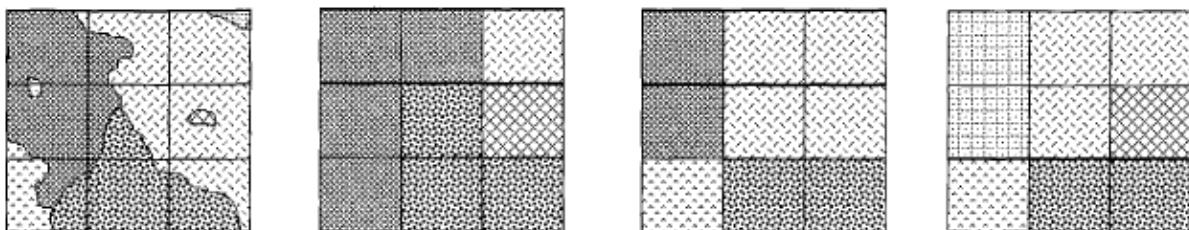


Figure 2. The possibilities of attribute value-adding and different approach (initial status, centroid based status, dominant status, importance status)

The *object-based models* present the model's field with discrete identified objects (entities). During the modelling based on the objects, the environment is separated into single entities. The processed environment is irregularly separated into basic geometric objects (points, lines, areas). This kind of modelling is closer to cartography, where abstraction and generalization are used for modelling. Every object has properties that differentiate it from the other objects and the organisation in layers is not needed. The environment structure which surrounds the objects directly influences the object specification. The spatial object may be dimensionless (point or dimensional (one or two-dimensional)). The object models are suitable; the processing depends on single objects and properties.

4. Generalization

The point of the generalization is to simplify the Earth surface. The generalization process is based on the choice, geometric simplification, the object, phenomena generalization, and their mutual relations to appropriate graphical illustration in the map. The generalization process is influenced by the map purpose, scale, and resolution, expressing parameters, character key and the cartographical object illustration. Between the basic geometric operation within the generalization which must be considered belong *the choice, simplification, aggregation, translation, spatial reduction and smoothing*. (Figure 3)

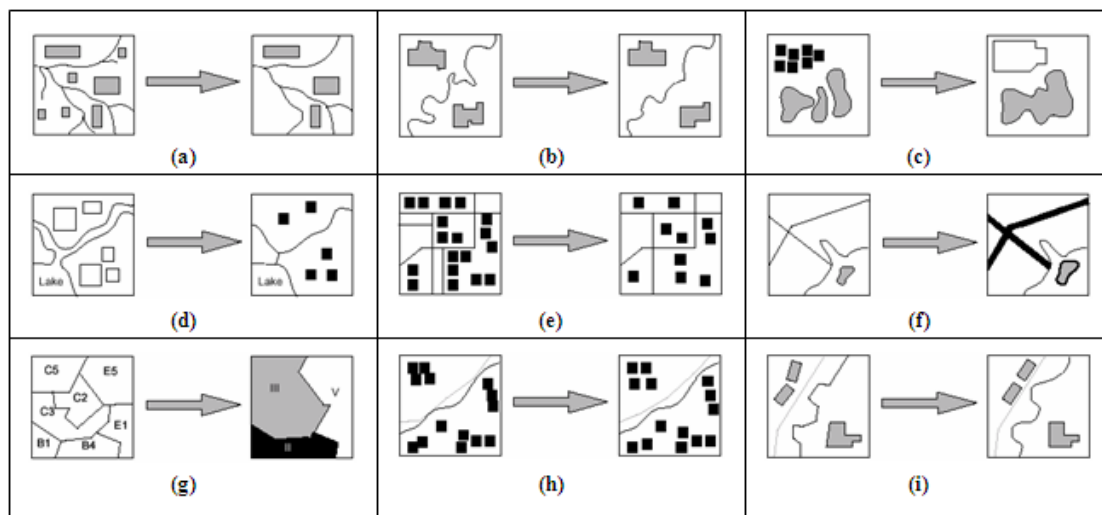


Figure 3. Generalization by methods of choice, aggregation, reduction and smoothing [4]

The object choice must be considered before the data processing. It is the very first generalization step. The objects are divided into groups. The main group is the group of objects with higher importance, which has to be preserved in the final map. The second main is a group of objects with lower importance and may be suppressed or even ignored. The simplification of graphical and attribute data presents ignorance of some object details, which are not interesting for map purposes. It is necessary to preserve the approximate line course in the course of initial lines or approximate area when talking about areal objects. The illustration using the map signs also belongs to simplification processes. The aggregation process presents the redemption of the small objects into bigger ones or aggregation to bigger objects. In addition, the larger objects with the same purpose may be aggregated. [5-6] The translation method is used for better highlighting of separated objects with a different meaning, which is not significantly separated. The objects with lower priority are replaced even when the location precision is disturbed. The spatial reduction is used within the small-scale and medium-scale map processing and it is based on the small areal objects replacement by point (linear) objects. The smoothing is based on the breaking points of the linear objects or the boundaries of the elimination of the areal objects. Its purpose is to increase the esthetical value of the map [7].

5. Conclusions

The generalization is a highly difficult problem with the effort of automatic solutions. The definition of the basic methods in the map explained the basic generalization methods. From the point of GIS, it is necessary to focus on the manipulation, demands, selections and analyses. During the objects and phenomena modelling, it is necessary to take into consideration the generalization steps and methods and the choice of basic maps for GIS creation. During the spatial object modelling, it is necessary to take the generalization processing from the point of precision into consideration, particularly within the secondary sources of the geographic data, from the reasons of using different bases (mainly map bases).

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