

DEVELOPMENTS IN CARTOGRAPHIC GENERALIZATION

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Abstract

In recent decades great efforts and successes have been achieved in digital technology generalization. The main focus in this process has been the formalization of generalizing digital theory and its practice in reality. Depending on whether you will generalize data vector or raster, there are different tools for generalization of GIS data using ArcGIS. This article discusses briefly how the state of new technology and cartographic generalization helps to understand the needs and plans for the implementation of digital generalization capabilities in Albanian institutions and companies of GIS and Cartography. The article emphasizes the importance of integrating knowledge and systems of cartographic generalization.

Keywords: *Cartographic Generalization, digital generalization, GIS, generalization tools, expert systems.*

INTRODUCTION

The theory of generalization/ mapping generalization is closely related to the general theory of cartography, because it deals with the processes and stages important for mapping such as: analysis, selection, simplification, harmonization and clarification, in perfect accordance with the scale, predestination, thematic and geographical features of the territory under study. In this context, cartographic generalization narrows the vision of the real world, but to the extent that the content of maps is acquired to maximum by the reader and the user.

Mapping generalization as a process is realized when creating a new map based on an existing map with the largest scale, aerial photographs and satellite images, measurements or field surveys, work in the office, etc. or when a piece of content of a new map must be original (basic, additional, auxiliary). During this process a certain number of data is selected, which is of particular importance and can appear clearly on the new map.

The effectiveness of cartographic generalization during the mapping process impact the generalization of objects in nature, which is usually accomplished by means of classical methods (survey with menzol, takimetri etc.) and through modern methods like GPS, etc.; optic generalization which is linked to the allowed ability (AA) / resolution (R) aerial photographs or satellite images and physiological generalization who has to do with the ability of the human eye to distinguish objects and phenomena (that appear in the photograph or image) and have very small dimensions.

Cartographic generalization, can be geometrical, where spatial shapes of buildings and geographical or conceptual phenomena are generalized where the semantic / content of buildings and geographical phenomena are generalized. This generalization is conditional on a number of factors, the consideration of which has led in the development of many mathematical models. But, cartographic generalization to a certain extent is a subjective work, which stands out particularly in thematic maps.

Computerization has led to the need for solutions algorithmic processes of mapping generalization. Digital generalization in fact has to search computerized techniques, to make something that is not implemented consistently or not treated theoretically before GIS appeared.

CHANGES IN MAPPING GENERALIZATION

Regardless of the type of environmental disclosure - paper or digital - an adaptation of the content of the map depends on the degree. It is clear that a small-scale map contains less detailed information than a large-scale map of the same area. Not only scale, but also the theme of mapping but also the density of data represented. The process of reducing the amount of data and the adjustment of information on the scale and theme set is called mapping generalization [1]. This procedure summarizes and reduces the information from reality, while preserves cartographic specifications and important features of the mapped area. It is easily seen that this process is very complicated and takes time. Mostly proliferation of new media (such as multimedia, internet, etc.), the speed of information delivery process has become increasingly more important. Today, generalization is needed in real time, as the user does not expect more than a few seconds for the visualization of a personalized map on the Internet [2]. Due to increased volume and density of information that can be derived from servers of internet, mapping of cartographic generalization is becoming more important than ever and should be adapted to new requirements in the mapping process [3]. In addition, future cartographic products should continue to be more service oriented. On one hand users do not have to face a lot of requests to detail system by default preferences and demand that is generated and should understand what type of maps users want to have. On the other hand, for experienced users, opportunity to define more precise requirements should be available (eg scale, layout, content and spatial extent).

Cartographic generalization is one of the most unpleasant problems in cartography. Traditionally this process has predominantly manual methods conducted individually and subjectively. Computer technology needs precise criteria of skilled labor, work that used to take place through acts of intuition, evaluation and human reason.

Cartographic generalization is divided into three basic components - selection, generalization and harmonization - then the choice (reduction of elements) is adapted to almost simple needs/requirements of the computer processing of the map. These criteria apply to the database used for the processing of the map or set of map makers (author, publisher/editor) as used in traditional processing technologies mapping in past centuries.

Generalization of line elements (contour lines, communication, boundaries, etc.) has always been the constructor of mapping issues with qualified experience that followed a set of criteria, smaller buildings, smaller curves etc. The elements line; Douglas-PEUCKERT algorithm to simplify the lines was published in 1973 and remains a standard of generalization. But in the case of generalization (new streamlining) surfaces of small, scattered, like islands or lakes, the criterion of "smaller surface" for computer generalization fails. Scientists with experience of geoinformation are turning to various mathematical theories, but the results are partial and unconvincing.

Until now the most successful outcome is achieved in applying the theory of particle [5] "Particles" derives from the term fragmentation of the world and is used in multi-dimensional geometry. Sizing of buildings (D) in Euclidean geometry is always integer (1D, 2D, 3D), but in accordance with geometry which is relatively new sizing of objects in nature and can be expressed by decimals e.g. Sizing of the shoreline may be 1:31 D.

DIGITAL GENERALIZATION

Digital generalization, rooted in conventional mapping is a problem in Geographic Information Systems (GIS) and mapping fields. Although generalized principles and guidelines can be found in literature, mapping and cartographic organizations, there is still no universal set of rules that clearly define how generalization should be carried out.

Manual generalization depends on the experience and judgment of the operator and therefore produced conflicting results. Lack of full understanding of the process and lack of technical tools that mimic human analysis, decision and action, make a generalization automation difficult task. However, the evolution of the generalized development of digital technology has gone through decades. Strong efforts and achievements in this field summarize below:

- In the 1960s and 1970s, some searches were done for mature development of simple techniques to reduce data complicity. Examples of some algorithms which are little mentioned are Douglas PEUCKERT algorithms [5] and Lang [the simplification of line and algorithms Brophy and Chaiken [6].
- Estimates of existing algorithms are performed since the early 1980s [7]. Technical complete automated generalization is continually explored; modeling and rule-based generalization increased the interest in the late 1980s [8];

- Significant progress was made in digital generalization worldwide, in 1990. They created a number of international organizations¹ (see below) to coordinate research projects and digital generalization special meetings. The main focus is the formalization of digital generalization theory and its practice in reality.

MAPPING GENERALIZATION IN GIS

Generalization can be achieved by removing detail, showing only the main borders, country borders, municipalities, etc. In generalization GIS is also used to smooth lines, removing small details such as knots and bends or rivers, etc.

While the details of a simplified geographical feature during generalization, generalized data are less accurate spatially. Calculation of lengths, perimeters, areas, etc., of the general geographical features is associated with errors.

Achieving generalized automatization is represented by the knowledge and skills acquired through generalization manual, rules and logic of a computing environment. ArcGIS features a universal and efficient system tools, which are grouped into toolboxes and toolsets. The tools are called from a dialog box and through the command line; they may also be combined with the written language (e.g. Python) or using ModelBuilder (a component of ArcGIS). ArcGIS contains tools to generalize a system of data network raster and vector.

ArcToolbox- ArcGIS framework of geoprocessing, is set free environment where processes have to execute and manipulate spatial data. Any geoprocessing tools take a certain flow of data (e.g. a feature class or a selection of features) together with any parameter control and makes a product (such as a new class feature). Geoprocessing framework combined with facilities such as cartographic representation / presentation, form the necessary infrastructure for highly automated productive mapping [9].

Depending on whether one will generalize a vector or raster data, there are various tools for data generalization GIS using ArcGIS. There is a group tools in Toolbox of ArcGIS that allows generalization of data raster by various methods. Tools are grouped into three categories: gathering areas of data (Nibble, Shrink, Expand, Region Group, and Thin), smoothing the joints of data (Boundary Clean and Majority Filter), and reducing the resolution of a raster (Aggregate). For vector data ArcGIS has a generalization toolset Editing, which uses an algorithm to simplify, Douglas - PEUCKERT for simplified lines. For additional methods of generalizing, Toolbox provides a range of tools for simplifying and reducing the resolution vector data for mapping purposes.

Over the past decades, a number of systems have been developed for commercial generalization but has not yet become a critical evaluation and comparison of such systems. Thus, the application of system expert (SE) is not yet thoroughly reviewed

Development of system expert represents a major commercial application of Artificial Intelligence (AI) [10]. Also SE is described as a system software or hardware and software combination, capable of adequate implementation of a complex problem specific interpreted by an expert but that requires expertise expression to its solution.

SE adjusts a large amount of evaluation and interpretation of knowledge reasoning through element simulation of a human special knowledge (e.g. performer cartographer or images) and reasoning can be formulated within the knowledge of the classified parts of a community orientation of facts and rules. In other words, it is a means of communication between the knowledge of a user experience and software to solve difficult problems/unfavorable. SE attempts to reduce the cost and time, but increases accuracy, stability and consistency/compliance. SE in various automatic software such as ArcGIS, have a LaserScan and play an important role in automatic generalization. An example of the use of systems based on rules in the field of mapping and informatics, is the extraction of

¹ In order to stimulate and formalization of digital generalization research activities, organizations and working groups are established following:

- Working Group on the map generalization under International Cartographic Association (ICA), as part of the advanced technology. In the Commission the fifteenth International Cartographic Conference (ICC) in Bournemouth, UK, in 1991 was formed. It played an important role in providing a forum for exchange of ideas, supporting a network of communication between people and institutions in the generalization of mapping and coordination of activities with other research groups.
- European Science Foundation organized a research program called GISDATA. GISDATA part of the activities is the creation of different groups that are responsible for the organization of specialized meetings on various issues related to GIS. One of the groups moving up these deals with the topic of generalization. A symposium was held in Compiègne, France, in December 1993. As a result of this meeting, published a book as a collection of articles that present and describe the state of generalization digital mapping.

features/characteristics of the data recorded from afar (Remote Sensing), detection of road networks [11] or generalization of the map.

In reality, the use of expert system is the execution of the AI field [12]. Since the beginning of 1950, the AI community has focused on two main areas: cognitive science and search methods. Cognitive modeling is generalizing interest mapping context.

The study [12], is attempting to combine the expertise of specialist knowledge, mapping tools generalizers, and mapping software Intergraph MGE TM automation, in order to generalize the urban area topographic maps of scale 1:10000 in scale 1:50000. Generally MGE system uses mapping and a rule-based system implemented Integrated System Manufacturer C language (C Language Integrated Production System - CLIPS). This system was developed to control the generalization process by developing a knowledge-based expert system that generates the same results as those captured with manual procedures. One of the key features of this system is the capture of conflict resolution through efficiency of buildings. Interpretation expert system enables an intermediate treatment through integration of applications sweeping operations, generalizing rules and manual intervention.

In earlier publications of the author [13], they were tested in software generalization operators of ESRI's ArcGIS to generalize GEODATA many ways gaining degrees. Despite the fact that the results of Douglas-PEUCKERT and Bend simplify ArcGIS TM are satisfactory, it is clear that manual work is required algorithms while sweeping expression of ArcGIS do not support a dynamic generalization. Generalized to other systems such as dynagen TM, INTEGRAF and Laser-Scan TM Clarity generalizations such support and enable users to obtain a database of a multi-tiered database instructive.

CONCLUSIONS

Due to increased volume and density of information that can be derived from online servers mapping, cartographic generalization is today becoming more important than ever and should be adapted to new requirements in the mapping process

Although generalized principles and guidelines can be found in literature, mapping and cartographic organizations, there is still no universal set of rules that clearly define how it should be carried out generalization.

The lack of a full understanding of the process and lack of technical tools that mimic human analysis, decision and action, make a generalization automation difficult task. However, the evolution of the generalized development of digital technology has gone through decades.

In today's conditions there is a great importance to the integration of knowledge cartographic generalization systems. Another step forward should be the development of the guide to make the generalization as efficient as possible. Guidelines should emphasize the basic and necessary steps for the generalization of small-scale maps in accordance with presenter environment.

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