Incorporation of automated cartographic generalization in INEGI

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Abstract:

The INEGI is an autonomous public National Agency responsible for regulating and coordinating the National System of Statistical and Geographic Information and capturing and disseminating information on Mexico regarding the territory, resources, population, and economy, which allows us to announce the characteristics of our country and help decision-making. As an Institute that generates geographic information, it prepares data concerning the relief, vegetation, climate, soil, water, and localities; among other topics, distributing the data is through printed maps or digital cartography to users.

The Institute, like other National Mapping Agencies, is involved in the continuous and accelerated process for the generation and attention to the demand for geographic information by users; regarding the creation of printed and digital maps, it has been working on strengthening the processes through the automated cartographic generalization and the configuration of the representation of the symbology.

The first product that needed an automated cartographic generalization process was the National Road Network (RNC), a unique land transport network that integrates the country's highways, roads, and paths. It is modeled and structured with the specifications that characterize the Intelligent Transport Systems, which are used to analyze transport networks and are updated yearly. A detailed product allows information to be derived at smaller scales of representation and placed in other printed or digital map products generated by INEGI. It will enable users to receive annually updated information about highways and roads.
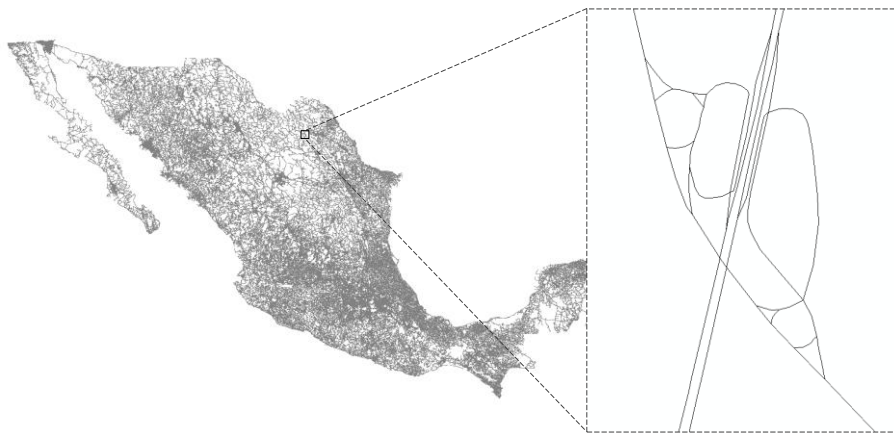
Figure 1. Red Nacional de Caminos 2021 covers 830,076.51 km of highways, roads, and validations.

To provide a solution to the generalization of the RNC, a review of the literature review was started, where authors such as Bertin (2011), Shea, K.S., & Master, R.B. (1989), Stoter, J.E., Post, M., van Altena, V., Nijhuis, R., & Bruns, B. (2014), Stoter, J.E., Burghardt, D., Duchêne, C., Baella, B., Bakker, N., Blok, C.A., Pla, M., Regnauld, N., Touya, G., & Schmid, S. (2009), summarized a conceptual model that describes the generalization process that meets the current needs of the Institute. Seen from its simplest form, considering the inputs, process, and outputs, based on the regulations of the Institute, good international practices, and knowledge of expert personnel in cartography and GIS software.
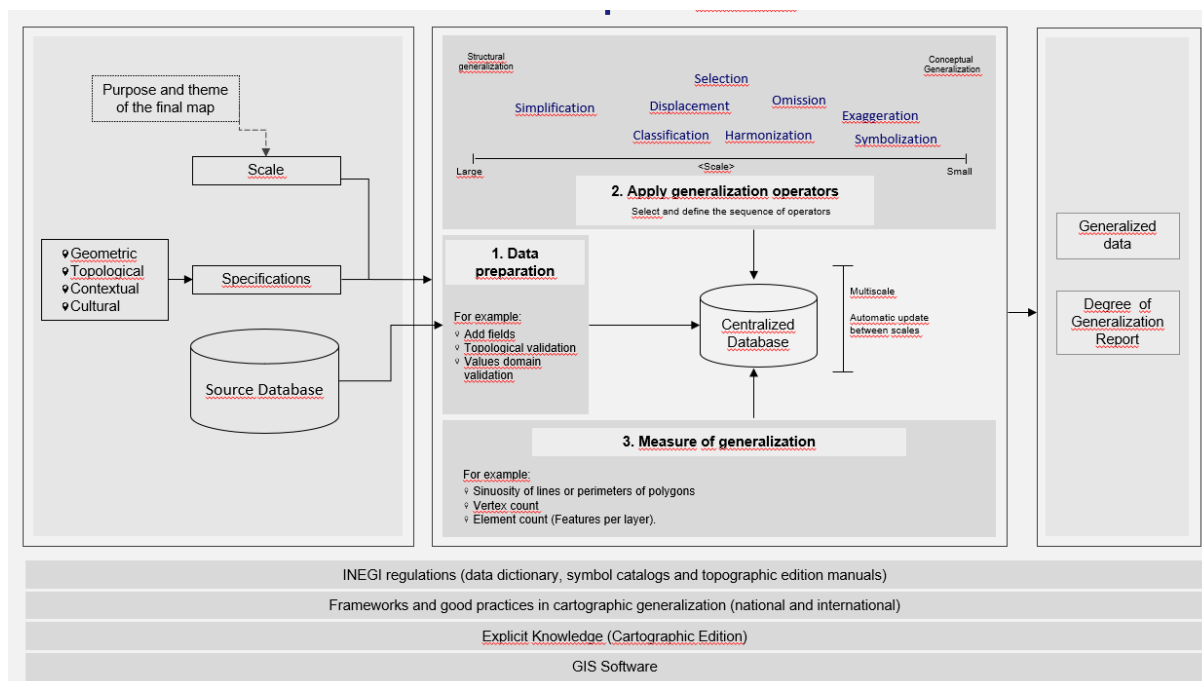
Figure 1. Conceptual model of cartographic generalization

The computer solution developed met the philosophy of the model, captures the programmed algorithms based on the generalization operators and the order in which they should be applied, in addition to having the ability to derive information at different scales based on restrictions and configurations of the process that result in vector data commensurate with the output scale. The computer solution is composed of scripts developed in Python language that make use of the ArcGis Destokp Advanced and ArcPy Toolbox tools.

The following stages were defined for the execution of the tool:

- Definition of generalization requirements be clear about the purpose of the generalized data and its characteristics and analyze the source data.
- Preparation of information. In this, the topological validation of the data is carried out to guarantee that everything is connected, there is no duplication of information, and there is consistency in the connections. Add fields that will be used to apply the flow of adequate tools in the generalization, for example, identifying the parallel lines since, depending on the scale, they can be collapsed into a single line, whether considering the value of the name field or not.
- Fine-tuning of generalization parameters. They are defined from the geometric, topological, and contextual restrictions and the configurations of the generalization process.
- Execution of the computer solution with the parameters and data.
- Validation of the data resulting from the generalization process.

Each of the generalization stages represents a challenge to achieve automation; for example, in the requirements definition stage, it is essential to identify the valid conceptual and geometric transformations between a data whose aim is to solve a route between two or more points and a generalized data whose purpose is to cartographically represent the adequate level of detail of highways and roads in the country depending on the scale of interest, for example, 1:2,000,000, 1:4,000,000 and 1:10,000,000.
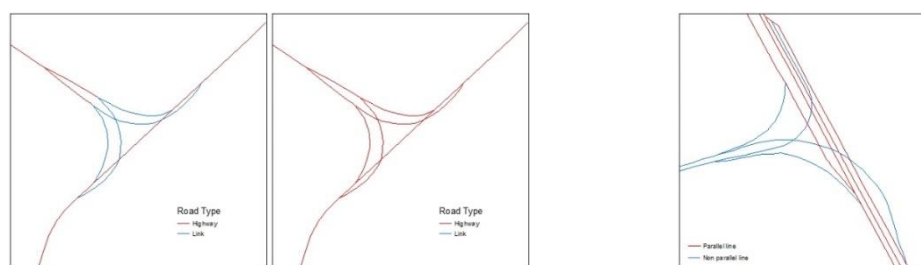

Figure 3. On the left, the reclassification of the data type is exemplified, and on the right, the identification of parallel lines.

The process is 90% automated given the complexity of the information that enters the process; the remaining 10% is adjusted manually. Work continues to try to reach 100% generalization; however, to achieve this, it is necessary that in addition to working on the tool, it is essential to have input data of the best possible quality.
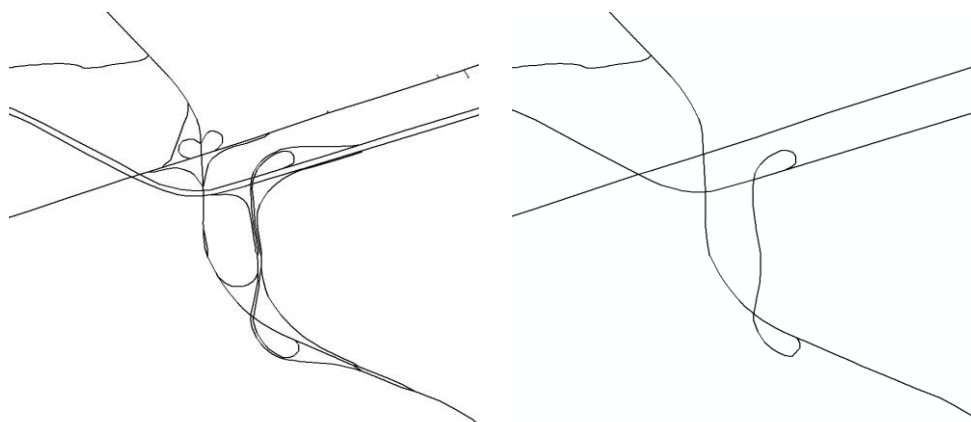

Figure 4. The image on the left shows the data without generalizing and the image on the right shows the generalized data.

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