Improving Settlement and Road Network Generalization for Maps of Small Scales Using Artificial Intelligence and Graph Theory

A magnifying glass allows us to see small elements, and the map can be understood as its reverse. Thanks to it, you can look at a large area of the Earth's surface. Such a view is pleasant to look at it, but it is only a nice picture, showing very little information about the area. Presenting only selected objects and phenomena allows you to understand their mutual position and dependence. Such knowledge can be used in a myriad of goals - from spatial planning to tour planning. Different goals require maps of having different scale and content. In the age of digital maps, which can be "zoomed in" and "zoomed out" freely, it is necessary to develop maps on-demand at various detail levels. Unfortunately, **deciding about showing or not an object on the map is a very complex process, which constitutes essential element of map design and is called cartographic generalization**. Experienced cartographers make decisions based on many conditions and dependencies relying on their subjective experience and knowledge. Describing these decisions process and translating them into the language understood by machine is a very challenging task. Thanks to advanced analyses, however, we can design and create methods and algorithms that give results very similar to the work of a cartographer. Successful attempts to automate selection in large scales are the motivation for further work in this field. **So far, no consistent solution has been developed that would allow correct, fully automatic data generation in small scales. This project motivation is to close this research gap.**

This project aims to develop comprehensive selection methodology for settlement and road network for the purpose of small-scale map desing. The subject of the research concerns small scales (from 1: 250 000 to 1:500 000), which until now have been omitted in generalization studies. The elaboration of the selection method requires answering the question: which features of settlement and roads influence the cartographer's decision to show them on the map or not? Measurable, numerical determination of how these features affect the decision process will allow designing an algorithm that supports fully automated selection. Such solutions would speed up the mapping procedure, limit the number of people involved in it, and reduce costs. The considered research problem can be reduced to the automatic classification of settlement and roads selected for the presentation on the map and omitted. The input data (the database containing all objects) and the generalization result (a map with selected objects) are known. The rules governing the process occurring between are searched. **Thanks to advanced technologies, we can carry out objects classification using models based on artificial intelligence (AI), especially machine learning (ML).** With the use of ML we can effectively analyze large data sets, and determine the rules governing the process of settlement selection and carry it out automatically. Information on the regularities and rules governing the cartographer's design process allows us to specify the selection parameters - what conditions must be met by the objects to be selected. These are boundary values of features or their collections.

This research shall be the first step on the way to automate the spatial data generalization process in small scales. The selection of settlements and roads is the first step in the process of simplifying map content. **The development of an optimal selection methods and algorithms would allow this process to be carried out automatically, which means repetitively, fast and consistently.**