Adding intermediate representations in a multi-scale map to enable a smooth zooming

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1 Motivations

Mapping applications, i.e. websites where a multi-scale navigation in topographic maps is available, may be used for wayfinding purpose for instance. Such mapping applications display multi-scale maps, i.e. set of maps at different scale. However, the displayed representations can present large differences (Fig. 1). To recognize the different representations of the same real world entity across scales, users sometimes have to make a quite important cognitive effort. We make the assumption that adding intermediate representations may be one way to reduce the gaps between the existing levels and thus to ease the user navigation.

Fig. 1. These different levels of a multi-scale map may present large differences (IGN-France).

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Developing methods to automatically derive these intermediate representations requires dealing with the following research issues:

– At which scales some intermediate representations are needed?
– How could the intermediate representations be designed?
– How can we automatically derive these intermediate representations?

2 Related work

To produce a map, a cartographic vector dataset and its symbolization must be defined according to the map scale and purpose. To derive the less detailed levels in the multi-scale map, the producers may use less detailed sources, or cartographic generalisation. This process aims at simplifying the map content and symbolization to fit a given scale, ensuring the map legibility. The generalisation operators and their parameters have to be chosen depending on the target scale and the map purpose. An iterative adjustment of the generalisation process is often needed to refine the result.

To ensure the map legibility, the generalisation process may reduce the quantity of information and simplifies their geometry and symbolization. Modelling this process for a multi-scale map forces us to define a smooth and consistent evolution of the map content. These issues are addressed by the literature related to level of detail and degree of generalisation [14]. Some other works use a simplification ratio [3], derived from the Töpfer radical law [10], which proposes to use a quantity of map objects proportional to the scale.

Researchers in the generalisation field are currently working on its automation, but it is still an issue to model this process [8]. Some structures, such as the ScaleMaster system [1], provide a multi-scale generalisation framework. This system allows the modelling of a generalisation process on a whole scale range (Fig. 2). Its implementation on a Java platform [11] provides an automated multi-scale generalisation system.

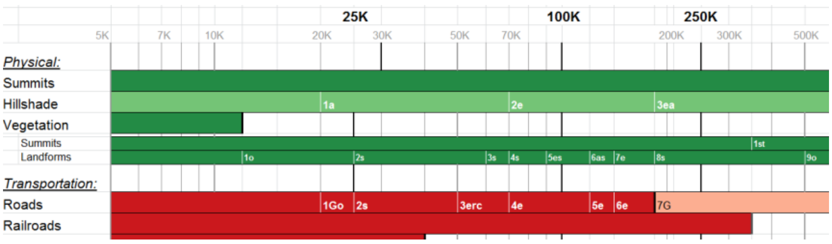

Fig. 2. The ScaleMaster system [1]. On each line, a multi-scale generalisation process is described for a given geographic object. Data sources are represented by colour variation, while generalisation operators and parameters are specified by alphanumeric codes.

As inconsistencies between scales have been identified as a disturbing factor [2], the added intermediate levels should be consistent with the existing levels. We will specially care about the spatial relationships consistency, such as maintaining topological relationships or spatial patterns, which can guide the user navigation. To ensure this consistency, the generalisation process should take the existing less detailed representations into account, as proposed in [4]. It supposes that the links between multiple representations are available. It could be managed with a Multi-Representation Database (MRDB) for instance [6,13]. To build an MRDB from existing independent datasets, data matching techniques can be used to link homologous representations. A recent example of data matching method, mixing geometric, topological, semantic and labelling criteria is proposed by [7].

3 Methods and expected results

Studying existing mapping applications helped us to identify potential approaches for navigation improvement. We analysed a group of sixteen general and national multi-scale maps (e.g. Google Maps or the French geoportal). The identification of heterogeneous representations was our first concern, as they are difficult to interpret by users and thus represent the problems to solve. If we are able to detect these disturbing patterns, we know when an intermediate level is needed and which type of transition it has to improve.

We will have to define at which scale intermediate levels should be derived. The study of mapping applications allowed us to compare the different used strategies for the scales distribution. For instance, a common scale in most applications is probably a useful scale and maybe a required one. Then, we will try to define a difference threshold between two levels. User tests could help us to define this maximal distance beyond which the feeling is disturbing.

We will then need a difference measurement. Two levels can be different in terms of content, symbolization or both. Regarding the content difference, the generalisation process may decrease the number of objects (selection, aggregation or typification), but also modify their shape or move them to ensure their legibility. Measuring the number of deleted, aggregated and modified objects may give us an idea of the content difference between two levels. On the other hand, the symbolization difference may be owed to a simplification of the semantic abstraction, with fewer classes for the roads for instance. To measure this specific difference, we could compare the number of classes in each level or maybe more meaningfully, the number of objects which have changed class. More generally, visual density and clutter measures [12] may help us to control the homogeneity of the multi-scale map.

Then, we will model a multi-scale generalisation process to provide the automated levels derivation. For each intermediate level to produce, we will have to choose the source datasets, the generalisation operators and their parameters. Knowledges to guide this process will come from the study of generalisation strategies in existing maps. Then, we will use the ScaleMaster system [1,11 to orchestrate this complex process. The generalisation modelling will be guided by iterative tests, where the results will be validated by common generalisation evaluation methods [5,9], but also with the difference measurement previously mentioned.

We will have to improve the ScaleMaster system [1,11] to provide the consistency checking of intermediate levels. Less detailed representations will be stored in an MRDB, which has to be built beforehand. Some other ways of improvement should be then explored. For instance, it would be useful to take the geographic context into account while generalising.

Finally, user tests could help us to validate our hypothesis than adding intermediate levels can ease the user navigation in a multi-scale map.

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