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Progressive river network selection for pan-scalar maps

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Abstract:

Map generalisation is one of the main requirements for pan-scalar map designs. Defined as interactive zoomable applications composed by numerous maps at different zoom levels where each representation at an individual scale is incomplete to facilitate pan-scalar navigation (Gruget et al., 2023), pan-scalar maps need a pan-scalar design in order to work effectively. Yet, despite the profusion of generalisation algorithms, there is neither a consensus on what is a ‘good’ multi-scale generalisation, nor a clear statement on map standards for multi-scale evaluation.

Thus, progressiveness appears to be one way to offer a new pan-scalar map design, but was often set aside by technical limits for fully-automatic maps (Revell et al., 2011). Used in both discreet and continuous generalisations, progressiveness is here defined with attributes coming from cinema, an art that has mature considerations over progressiveness. Thus, it can be linked with editing, and its three functions: semantic, syntactic and rhythmic (Aumont, 2015). Applied to cartography, the semantic function means that consecutive scales should preserve the sense of the map, e.g. it should be understandable that building polygons transform into built-up areas as we zoom out. The syntactic function refers to the consistency of the transition between scales. The rhythmic function is related to the timing of the change of level of detail across scales. Only by respecting these three functions can a cartographer reach progressiveness.

Heavily restricted by the complexity of map generalisation, either produced automatically to design flexible and easily updated maps, or done manually by cartographers who favour quality over time-consuming tasks, interactive maps have often few considerations over progressiveness. Map generalisation is often minimalist, inducing cartographic flaws such as discrepancies, discontinuities or irregularities when the map is considered in a multi-scale perspective as we can see in the hydrographic network extracted from the French reference map (A) ‘Plan IGN’¹ in the Figure 2. In order to evaluate progressiveness, it is therefore fundamental to add pan-scalar evaluation criteria to the standardised guidelines developed for cartography. Assuring the quality of single scale maps, these rules promote readability such as avoiding overlaps, or setting a minimum size for the eye to keep perceiving data, but still do not evaluate progressiveness. Thus, we argue that in designing progressive pan-scalar maps, it is highly beneficial to take into account other constraints such as progressiveness constraints, in order to fully and better generalise a pan-scalar map.

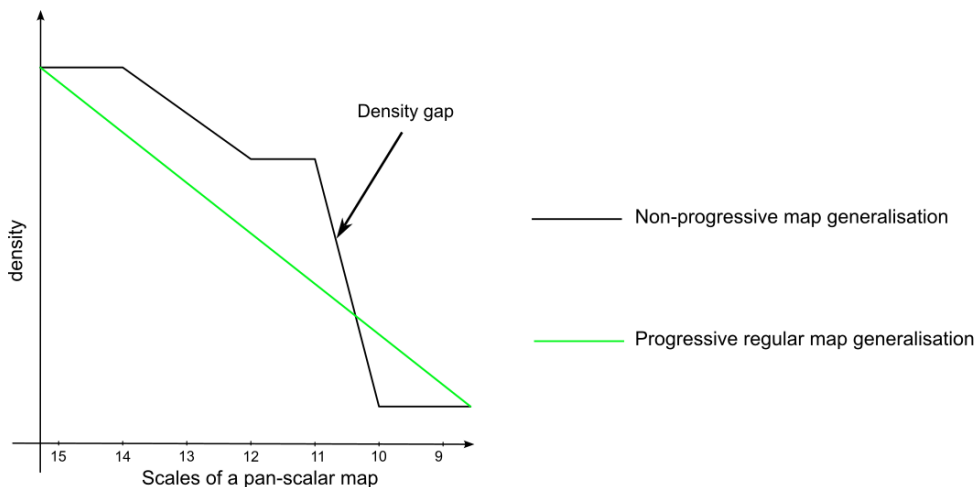


Figure 1 : Two different curves of density in pan-scalar maps

In this article, we propose therefore two progressiveness constraints that specifically try to evaluate and smooth the change of scales: a density constraint and a consistency constraint. We argue that a pan-scalar map design has to keep a consistency that avoid discontinuities and discrepancies while keeping a progressive curve of density over scales

¹ The Plan IGN, a pan-scalar map published on geoportail : <https://www.geoportail.gouv.fr/carte>

(Figure 1) in order to avoid gaps of density. However, we think that a macro evaluation on the entire pan-scalar map is not enough and leads to add a meso evaluation, on local areas in the map. These progressiveness constraints could also be used in different steps of the generalisation process, as they can both evaluate the progressiveness of a generalised map and guide algorithms by re-configuring their parameters accordingly.

With these progressive constraints in mind, we therefore tried to evaluate different river network pan-scalar selections, on a same area of 90km² in the south of France (Figure 2). The Plan IGN (A), our reference map, does not have generalised data in every zoom levels. In order to improve progressiveness, we tried to configure existing generalisation tools implemented in the CartAGen platform (Touya et al., 2019) with fully automated algorithms such as the classical selection parameters of the Horton ordering (Touya, 2007) to generalise each zoom levels of the pan-scalar map between the zoom 15 and 9 (B). However, we also noticed an inability to preserve different shapes of rivers with the same parameters, which is likely to induce local gaps of density. A different option is to use an algorithm that does not remove a whole river but rather line parts to be more progressive. In the Figure 1 (C), we show a new selection algorithm derived from the Strahler order, which mimics the flow of water as you zoom out.

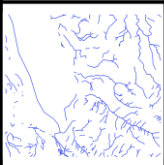


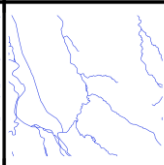
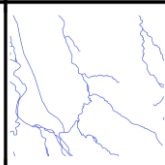




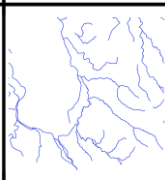

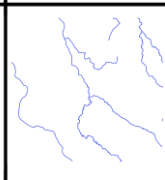
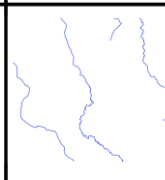
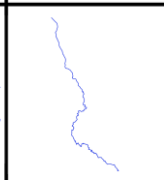


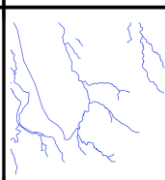
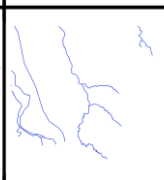
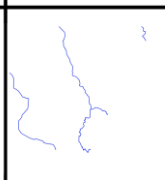
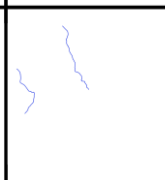

Zooms	15	14	13	12	11	10	9
A							
B							
C							

Figure 2. Results of different generalisation processes: A) Plan IGN, a semi-automatic generalised map that has few considerations on progressiveness, B) Our first results by tweaking a river selection algorithm for more progressiveness, C) A river selection derived from Strahler order that mimics the flow of water for more progressiveness.

With this work, we aim to make steps towards a definition on pan-scalar standards that could help designing multi-scale progressive maps in the future.

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