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Visual complexity and memorability of maps

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Abstract:

There are many efforts to quantify visual characteristics of an image via measures of visual saliency (Itti & Koch, 2001), visual clutter, entropy (Rosenholtz & Nakano, 2007), and more recently, memorability (Bainbridge, 2020). Taken together, these measures can be studied under the umbrella of *visual complexity*. Because there is considerable evidence that attention and memory are tightly coupled (Chun & Turk-Browne, 2007), to characterize visual complexity, we need to examine both measures of attention and measures of recall / memorability. Efforts to quantify visual complexity are interesting both from fundamental and applied science perspectives as they help us understand human visual behavior better, and can help utilize or design visual 'products' in more ergonomic and effective ways.

Even though abovementioned vision-based computational approaches are developed with natural scenes in mind and assume 'free viewing' (i.e., looking at the scene of interest without a specific task), both bottom-up (stimulus-driven) and top-down (cognition-driven) models of attention have been previously proposed (Borji & Itti, 2012; Torralba, Oliva, Castelhano, & Henderson, 2006). Visuospatial information displays, including maps and map-like displays, are different from the images of natural scenes in that they are abstracted to different degrees and intentionally designed, e.g., they contain elements that might suppress or highlight information to adapt to a specific purpose (such as navigation, environmental analyses, journalism etc.), and/or the characteristics of the users (e.g., children, older adults, business professionals etc.). Information displays are also different from natural scenes in that they rarely are 'meant' for free viewing. Thus, algorithmic approaches that are tested on natural scenes may or may not directly work with visuospatial information displays such as maps (Brychtová, Çöltekin, & Paszto, 2016; Brychtová & Çöltekin, 2017). Maps of the physical environment (as opposed to statistical/thematic maps), e.g., navigational or topographic maps, lend themselves well to examine if algorithms from the vision science reliably measure visual complexity of also human-made visuospatial displays, because through satellite imagery we have photographs of the natural scenes as a baseline, *as well as* the visuospatial displays, i.e., maps, designed by cartographers.

Among all information displays, maps are also uniquely interesting from the perspective of how they require the use of visual and spatial memory systems. For example, during navigation, as soon as we decode the information presented on the map, we must make quick comparisons and decisions, or need to remember the routes we learned. Facilitated by such short or long-term recall, map use is a big part of how we acquire and retain spatial knowledge in modern times. In our previous studies we explored measures of map complexity in relation to direct human ranking of complexity at different scales (Schnur, Bektaş, & Çöltekin, 2017), human experience with maps where high levels of information complexity cannot be avoided (Çöltekin et al., 2016; Krejtz, Çöltekin, Duchowski, & Niedzielska, 2017), and if clutter and entropy measures correlate with cartographic generalization (Brychtová, Çöltekin, & Paszto, 2016; Brychtová & Çöltekin, 2017). Given the above, in this work-in-progress paper, we explore how well the computational approaches to visual complexity (e.g., saliency, clutter, memorability) work with maps vs. satellite images by comparing the outcomes across datasets, methods and contexts. Specifically, we examine 'agreement' between methods for maps and satellite images of 50 urban and 50 rural areas (because urban areas contain more objects and object type variation, thus richer in information), as well as compare these outcomes to empirical findings in an experiment (n=40) in which we collected eye movements and measured participant performance in a set of map-based recall tasks.

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