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Mapping Quantitative Data in Dark Mode: Need for Reversing Color Schemes?

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Abstract:

Relevance

Dark mode is an increasingly common design option that uses a dark screen background with light-coloured text and graphic elements - in contrast to light mode, which uses a white or at least light background. A number of advantages are cited for the use of dark mode - in particular, supporting eye protection, reducing energy consumption or improving aesthetics (Eisfeld and Kristallovich 2020). Even if these benefits have not yet been fully proven, supply and demand for the sole or alternative use of dark mode has increased significantly in recent years – which is affects the generation and use of maps.

Research Question

In this context, the question has to be raised whether a change of the conventional white (or bright) to black (or dark) background also requires a change in colour schemes used for depicting quantitative data in maps. As respective investigations are very rare (with exceptions like Qiau and Wu 2023; Bartling et al. 2021, Deeb et al. 2015), we will narrow down this issue and firstly focus on the order of colours in sequential schemes, which conventionally follows the "dark-is-more bias" (i.e., the darker the larger the value). Using now the dark background, one could think of reversing this rule based on the assumption that dominant or more prominent colours – compared to the background – are associated with the dominant (i.e., largest) attribute values.

Because it is expected that the impact of the dark background differs between different map types, we will distinguish between choropleth maps (showing a complete coloured filling of spatial units, with only the outer areas being dark) and point symbol maps (with much less colour in relation to more dominant background). Separate empirical studies will be performed in order to answer the overarching question whether an inverse background needs a change in ordering colours.

Choropleth maps

For the case of choropleth maps, an empirical web-based study has been conducted (Schiewe 2024), in which 214 persons took part in a within-subjects design. Independent variables of the study were the different backgrounds of the map (light/dark) and different realizations of colour schemes (Fig. 1). In total, 24 maps were presented, in which one region was marked with a circle - the test subjects were asked to decide whether this colour filling belongs to the class with the largest or smallest values (or whether an assignment is difficult).

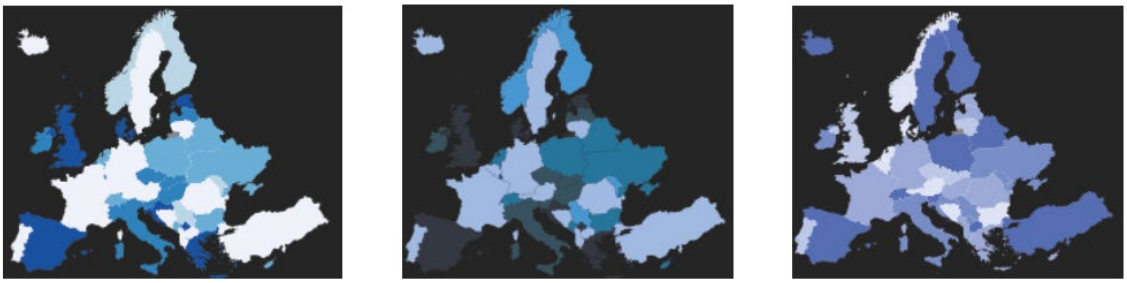

Figure 1. Different colour schemes in dark mode presentation (for details, refer to Schiewe 2024).

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Depending on the different colour schemes, 87.1 % to 93.5 % preferred the dark-is-more concept for dark mode and 95.1 % to 97.0 % for light mode representations. With that it can concluded that the dark-is-more is still clearly the most frequent approach in colour perception and recognition. Although this frequency is lower than in light mode, it is not statistically significant in most cases.

It also became clear that the certainty of the decision depends on the colour scheme presented. From the given three schemes an own version was tested slightly best (Fig.1, right). This scheme was developed based on findings in literature: Colour saturation is set to constant value of 65 %, darkest colour to a minimum contrast of > 2:1 to the background (with value #252525) and lightest colour with a lightness of approx. 90 % (for avoiding a pure white).

Point Symbol Maps

For the case of point symbol maps, one can expect that due to the larger proportion of dark background compared to the small areas of symbols the dominance of the background plays a larger role. Currently, we are planning an empirical study that focuses on this type map. Independent variables of the study will be different backgrounds (light/dark) as well as different symbol properties – including hue, size, type (geometric vs. figurative), amount and density. The dependent variable is again the correct assignment of symbol colour to large or small attribute values. Results of this will be presented during the ICC conference.

Final remark

Independently of the detailed results of the second study, this contribution will encourage further investigations in the context of maps in dark mode, e.g., concerning adapted colour distances or effects on users with colour viewing deficiencies.

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