

Over the rainbow: An in-depth examination of the pervasiveness of the rainbow colour scheme

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Abstract:

Colour design is one of the most noticeable and impactful aspects of map design and—in general— data visualisation. Therefore, considerable research efforts have been put forward on a proper and effective colour scheme design, some principles have been established and made it to textbooks, some of which is supplemented with online tools supporting colour decisions (e.g., Brewer et al. 2013). Nonetheless, it appears that some of these principles are often violated due to lack of knowledge dissemination. A key example of this is the rainbow colour scheme (RC) which is commonly utilised despite the advice against its use. In this study, we attempt analysing its pervasiveness through a quantitative survey.

The popularity of the RC might have at least partly to do with the spectacle of the rainbows in nature and its lively appearance with saturated hues following the electromagnetic sequence in the visible spectrum. This colour scheme grabs attention of both data visualisation researchers and practitioners, yet in different ways. Many among the latter appear to frequently use RC for quantitative data visualisation presumably due to its familiar, eye-catching and memorable effect, whereas many among the former pay attention to the RC as research focus. Harmful consequences of the RC use for data visualisation are often documented: The RC does not follow intuitive order, introduces false boundaries due to non-uniform change of hues and lightness, and does not support users with colour vision deficiency (e.g., Borland and Taylor, 2007, Crameri et al., 2020).

The long-lasting debate on the consequences of the RC use in data visualisation has been supplemented with queries in various disciplines on the prevalence of the RC in scientific publications in journals of wide outreach such as information visualisation (Borland & Taylor 2007), neuroscience (Christen et al., 2013), geography (White et al., 2017), remote sensing and planetary science (Gołębiowska & Çöltekin, 2022a), and hydrology (Stoelzle and Stein, 2021). These reviews, despite having been conducted in different time spans, concluded that the RC use is highly prevalent in the domains of investigation in the relevant conference proceedings or journals, in some cases used in even *more than half* of analysed scientific visualisations. To this rather well studied topic, we add new insights by replicating the seminal study of Borland and Taylor (2007), expanded for a 31-year time span. Using an excellent tool VISImageNavigator by Chen et al. (2021), we analysed over 28 000 figures published in IEEE Visualization conference proceedings, i.e., VIS (in years 1990–2011), InfoVis (1995–2020), VAST (2006–2020), and SciVis (2012–2020). Interestingly, in queried information visualisation publications the RC became less prevalent over time, yet it is still strong in other disciplines covered by previous reviews. Most intriguingly, sister domains to cartography and geospatial sciences, i.e., remote sensing and planetary science outlets use the RC fourteen times more than information visualisation outlets (Gołębiowska and Çöltekin (2022b)). Our survey revealed that the lively debate on RC in conferences and social media found its audience in the information visualisation community across the last decades, but did not yet make it further.

Furthermore, we compared the results of 23 empirical evaluations of the RC, conducted in the field of cartography and data visualisation, over the last 60 years. The non-uniform results of RC assessment in user studies, motivated us to consider and analyse the effect of other factors on effectiveness of RC in communicating quantitative information, namely task type (e.g. reading details, pattern comprehension, perceptual order etc.). The RC facilitates reading details quite well, but it does not facilitate pattern comprehension well, whereas for tasks requiring ordering and relying on identifying the perceptual distance it impairs performance. The nuanced evidence on the RC's usefulness as well as selective temporal change in its prevalence highlights the need for communicating visualisation literacy outside disciplinary boundaries, and invites us to reflect how to bring the knowledge that is quite strongly rooted in cartography and geovisualization beyond our usual communities. We detail this review further in a recent publication (Gołębiowska and Çöltekin 2022b), and extend the discussion to cartography and geovisualization.

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