

Evaluation of ColorBrewer & Color Oracle for Colorblind-Safe Cartography

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Abstract

To evaluate tools that help incorporate practices in Cartography that aid color-vision impaired population to benefit substantially from Cartographic products similar to people without the deficiency. The two tools under consideration are Color Brewer and Color Oracle. This is a short evaluation of these tools and how effective their use can be in cartography.

Keywords: Color-vision deficiency, color schemes, cartographic tools, evaluation

1. Background

Color-vision impairment, a disability where the affected cannot distinguish between certain colors, can be developed but is mostly inherited in males. About 8% of males suffer from inherited color vision deficiency (Culp, 2006). While acquired form of this disability can result from age, diabetes, macular degeneration, cataracts and glaucoma ((Pacheco-Cutillas et al., 1999) as quoted by (Culp, 2006)). “Inherited color-vision deficiency is marked by a difficulty in discerning red from green, while acquired color-vision deficiency is marked by a difficulty in discerning blue from green.” ((Schmidt, 1934; Hood et al., 2006; Birch, 1993) as quoted by (Culp, 2006)).

Though the affected population may seem like a small number for cartographers to consider while designing maps for masses, this can be significant if crucial members of the audience have this disability. Therefore, there is a need to devise ways that are convenient and aid the cartographic process of keeping the maps color blind safe.

2. Introduction

In efforts to enhance the participation of color disabled viewers, many tools have been created to let designers and visual content creators choose colors that cater to the needs of the color blind minority as well as the masses. This paper focuses on two of these tools:

1. ColorBrewer (<http://www.colorbrewer2.org/>)
2. Color Oracle (<https://colororacle.org/>)

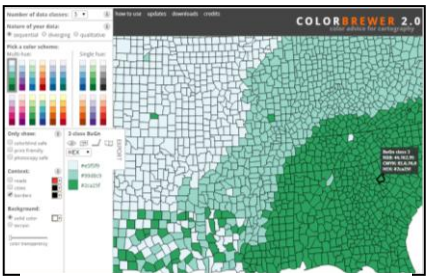


Figure 1: ColorBrewer web interface

Choosing the right colors for a map is a tedious task and sometimes requires trial and error to understand, on top of that choosing colors for the color-vision impaired is even more difficult. Color Brewer, developed by Mark Harrower and Cynthia Brewer (2003) is an online tool designed to help thematic map designers choose ordinary as well as color blind safe color schemes. ColorBrewer was designed with federal agencies in mind that collect spatial data for cartographic communication and lack time to create color schemes for individual maps (Gardner, 2005). Figure 1 shows a screenshot of the ColorBrewer web interface.

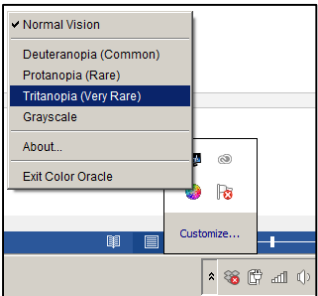


Figure 2: Color Oracle Screenshot showing vision simulation options

While ColorBrewer is specific to cartographic use, Color Oracle is an open-source software for all sorts of designing. It is a color blindness simulator for Windows, Linux and Mac

which means it shows people the colors on the screen how they would appear to a person with color vision deficiency (Jenny and Kelso, 2007). For Windows, Color Oracle is accessible in the bottom tray where you can select the type of impairment in a drop-down menu. As shown in Figure 2, there are 3 types of impairment simulations to choose from along with the option of normal vision and grey scale. The simulation shows the screen in the chosen format and returns to normal upon pressing a key or clicking the cursor.

3. Interpretation through Exploration

3.1 ColorBrewer

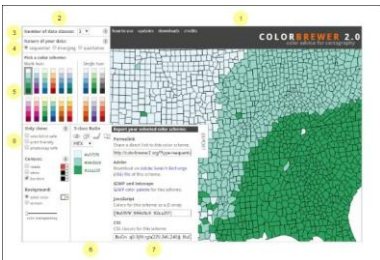


Figure 3: ColorBrewer Interface labelled

ColorBrewer is convenient in access as it is easily available to anyone on web. From the time it was first introduced it has improved and the current version includes more capabilities. Using the labels on Figure 3, the aspects of its present interface are mentioned as follows:

1. *Large map area* to display the colors in multiple classes and data types as they would appear in geographical features
2. Options pane on the left to use ColorBrewer.
3. On the top left of the options pane, ColorBrewer allows one to choose the number of *data classes* ranging from 3-12.
4. This option allows you to select the *nature of your data*, whether it is *Sequential*, *Diverging* or *Qualitative*.
5. The apparent *color schemes* are based on the nature of data. Sequential data can be shown by variation in a single hue, therefore there are

single hue legends available only for sequential data and multiple hues for other data forms.

6. Color codes for the selected scheme are available in all 3 gamut's (RGB, CMYK, HEX). The small icons above the gamut drop down inform whether the select color scheme is suitable for color vision impaired, photocopy, LCD or print, respectively. This is quite essential for checking whether the chosen color scheme is fit for all audience and purpose or not.
7. One of the most beneficial aspect of ColorBrewer is the Export option for the selected color scheme. This option can share and export the selected scheme into Adobe, GIMP, Inkscape and translate it into a JavaScript array as well as CSS classes.
8. The most important and relevant aspect of this technology comes under this label as it lets user select the option that enables only color blind safe color schemes to appear. Apart from this, there is also the availability of viewing print safe and photocopy safe schemes.

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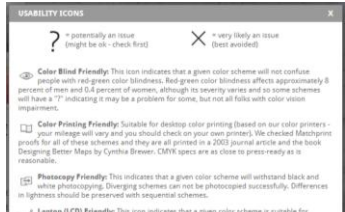


Figure 4: Screenshot of Usability Icons of ColorBrewer

Additionally, one can toggle between the roads, cities and borders layers to see their potential overlay with the color contrasts that would suit the affected viewers.

Furthermore, the background option enables users to add a background see whether the chosen colors are distinguishable with an underlying terrain or color.

3.2 Color Oracle

There is no complexity or detail when it comes to exploring Color Oracle. The simulator is an application in the computer, once enabled by running the application, in windows it appears in the task bar tray at bottom as mentioned before.

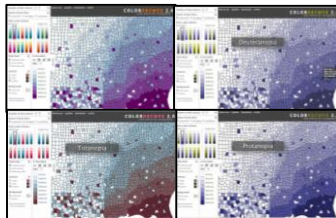


Figure 4: Screenshots of ColorBrewer in 3 types of color-vision deficiency simulations.

By viewing the ColorBrewer in the options for three types of color vision deficiencies, the simulations were explored. The resultant screenshots can be seen in the Figure 5. The top left image is in normal vision while the other 3 are in affected vision simulation.

The simulations are named after the deficiencies to correctly depict the view of the affected to the viewer.

1. Deuteranopia (Common)
2. Tritanopia (Rare)
3. Protanopia (Very Rare)



Figure 6: A cartogram in Normal vision (top left) and in Color Oracle simulations

Another instance used while exploring the simulations is a cartogram which has a diverging color scheme, showing 7 classes. The result is apparent in Figure 6. While it is visible how the red-green confusion exists in Deuteranopia and Protanopia and blue-green exists in Tritanopia, it is also easy to realize that this specific diverging color scheme is still suitable for this audience. Despite the confusion, the classes are distinguishable.

4. Critique


4.1 Pros of ColorBrewer

- The 'how to use' guide gives a very good description of the things to consider while choosing color schemes.
- The 'colorblind safe' option makes it possible to only



Figure 5: Screenshot of the 'How to Use' guide for ColorBrewer

view color schemes that are suitable for color blind audience.

- The info icon  with most options is a very good instructor for anyone getting familiar with ColorBrewer. It helps in making informed choices for your needs.
- The Export options makes it easy to use the chosen color scheme in multiple formats instead of figuring out codes and formats by further searching on them. This creates true convenience for users.
- While catering to color blind needs, there are additional options for seeing if the color schemes are safe for LCDs as some LCDs wash out colors, for print and for photocopy, this enables catering colors for all sorts of final cartographic products.

4.2 Cons of ColorBrewer

- While the number of data classes are from 3 to 12, in a sequential data, the number of classes to select doesn't go beyond 9, this is because the color schemes cannot accommodate more than 9 classes for sequential data.
- Moreover, the tool can also not accommodate more than 4 classes of qualitative data in the available color schemes for color-vision deficient audience. And even for 4 classes, there is only one color scheme available.
- Only help cartographic processes apart from thematic mapping to a small extent and doesn't help in keeping multiple layers of cartographic data, color blind friendly.

4.3 General Findings:

- In case of sequential colors, the variations are easy to see in the legend but difficult to distinguish when they appear on the map itself. The user must be able to distinguish between all the shades, because the outliers also need to be catered for.
- While it is difficult for people with color-vision deficiencies to distinguish between multiple colors in the same area, it is quite easy to distinguish different saturation levels in the same hue. Refer to Figure 6.
- While using the 'color blind safe' filter it was observed that all ColorBrewer sequential color schemes were color blind safe, this was further confirmed when Color Oracle simulations were run to view these schemes. Figure 4 shows the simulation screenshots.

4.4 Overall opinion:

ColorBrewer is a beneficial cartographic tool for thematic mapping and should be widely used, always keeping the color-vision deficient audience in mind. But while it is quite useful for thematic mapping, it is not as beneficial for topological maps, navigation maps or other cartographic products. The context option only helps to a certain extent with labels, roads and borders but for extensive mapping, cartographers need something more.

This is where Color Oracle comes to play. While it looks like a small simulation software, it can be a great help throughout the cartographic process. Unlike ColorBrewer, the application of Color Oracle is not limited to one area of cartography, in fact, it is not limited to Cartography alone. However, its use in cartography is of great value. It can serve as a guide at every step of the cartographic process to keep the end products capable of accommodating the color-vision deficient.

4.5 Future:

Since inclusion of the disabled in the society is always something that can be improved hence people have been working towards it and will continue to do so. The intellectual community has produced technologies like Color Oracle and ColorBrewer. While ColorBrewer is quite beneficial, it can be improved by adding capabilities that help in making other cartographic products colorblind safe as well.

The future of cartography lies in making all cartographic products accommodate all kinds of viewers so there is no need to create separate maps or taking extra measures. Technologies that yield an all-inclusive-audience cartographic product are the future of cartography.

5. References

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