

Color Speaks Louder than Words

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ABSTRACT

What if color blind people saw real colors and it was everyone else who's color blind? Imagine finishing a Rubik's cube wondering why people find it so difficult. Or relying on the position, rather than the color of a traffic light in determining when to stop and go. Color matters! Color enhances our perspective, it can change how we feel, but it also varies culturally. In western countries, red and white have opposing symbolic meanings to eastern countries which in turn can send the wrong message if misused. Color can fundamentally change a report, therefore, finding the right color palettes for data visualizations is essential. In this paper, I will cover the significance of color and how to pick a palette for your next SAS® Visual Analytics report.

INTRODUCTION

Color is used in the workplace to improve performance and productivity. Color is used in marketing to establish identity. Color is used in paintings to communicate emotion. Color is used in stores to sell products. Color is everywhere and generally applied purposely. The government of Australia spent several months researching to find the world's ugliest color. Why? They were looking for a color so distasteful that if it was used for packaging tobacco products it would deter people from smoking [7].

Just as the Australian government needed to pick the right color for a specific job, it is essential to select the right colors for your data visualization so their meanings are conveyed and interpreted correctly. Using the world's ugliest color, opaque couché, is probably not going to be the color of choice for your next data visualization. In this paper, we will explore color. How to select colors using color harmonies, the importance of color in reporting, selecting colors that are easy for the color deficient to distinguish and using colors in SAS Visual Analytics.

BACKGROUND OF COLOR

When thinking about color and how it's used in data visualizations, a good place to start is with the color wheel. Figure 1 shows a circular illustration representing associations between colors. There are three categories on the color wheel: primary colors which are blue, red and yellow. The corresponding secondary colors are green, orange, and purple. The tertiary colors are green-yellow, yellow-orange, orange-red, red-violet, violet-blue and blue-green.



Figure 1 Color Wheel

The color theory is where things get interesting, specifically when it comes to choosing color palettes for data visualizations. The color theory provides practical guidelines for mixing colors through the use of color harmonies. *Color harmony* is simply a fancy way of suggesting colors that work well together and are pleasing to the eye. This paper elaborates on the color harmonies more a little later.

IMPORTANCE OF COLOR IN REPORTING

Selecting colors that go well together and when used correctly can effectively guide the user's eyes to what is important in data visualizations. This is true for a number of reasons.

COLOR GIVES REPORTS MEANING

Using color efficiently creates a report that is not only user-friendly, but also conveys information quickly. In the gauge dashboard below, the first thing that pops out is the different colors. The red to green spectrum is usually interpreted as good versus bad. So, just by looking at the colors we understand the meaning without looking into the details.

Product Reviews

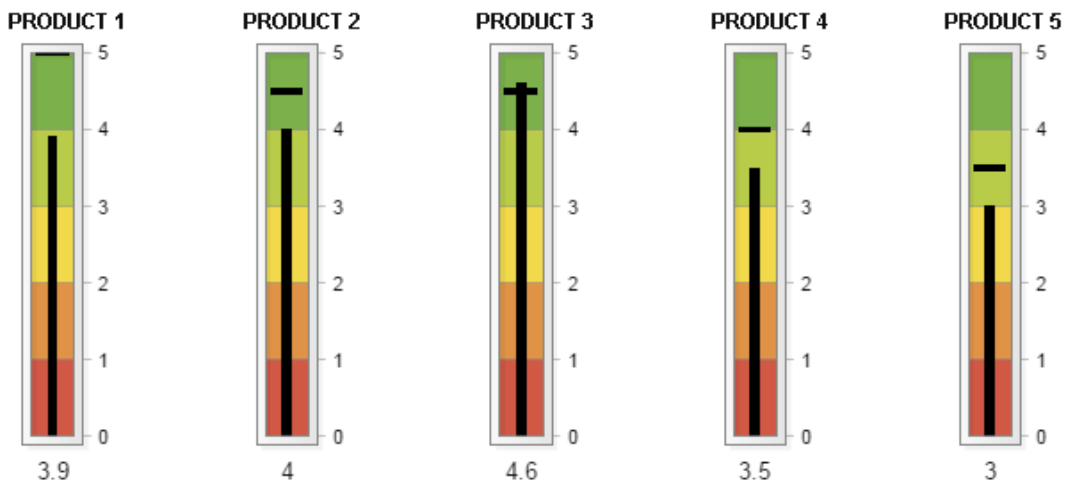


Figure 2 Representation of how color gives reports meaning

COLOR SHOWS ASSOCIATIONS

Usually the best time to introduce colors is when differentiating between specific groups. In the following figure, the bar graph difference in colors allows your brain to associate the colors by product across regions. A good rule of thumb when trying to decide if multiple colors are useful, is to think about whether or not that color serves a purpose.

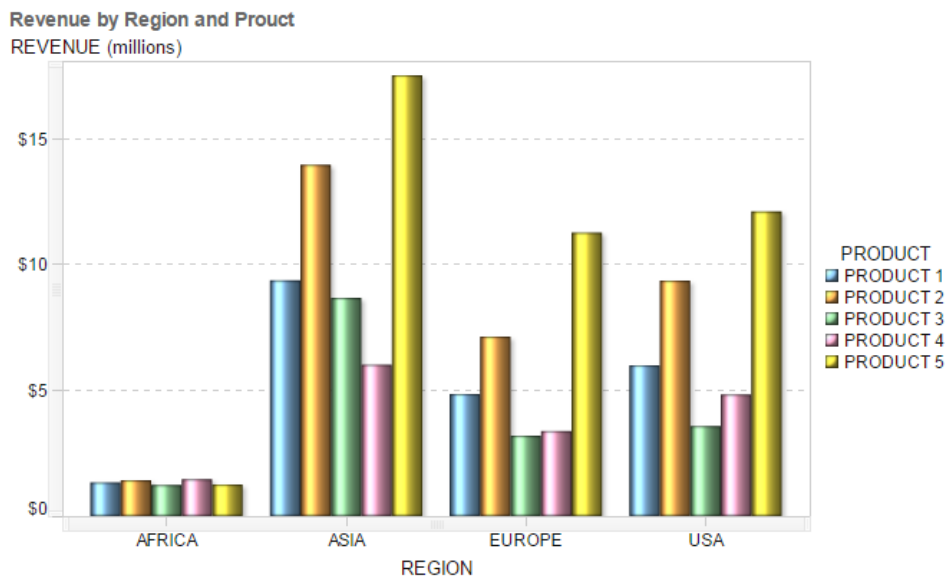


Figure 3 Representation of Color helps to show associations

Further, here's an example of an effective and ineffective use of color. The graph below is a good demonstration of using color ineffectively in reporting. The colors are pretty to look at, but they serve absolutely no purpose. The bars represent the revenue value. By adding color, we add a level of confusion and unnecessary effort as users of the report may spend valuable time trying to determine the purpose of the colors.

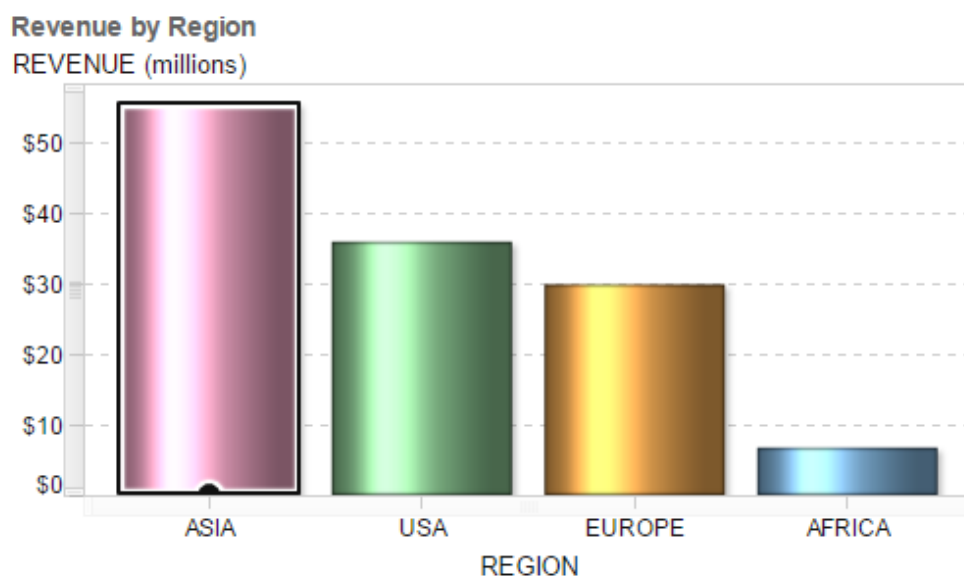


Figure 4 Example report with ineffective use of color

A better way of coloring the report would be to use a single color as shown below. Clean, easy to read and straight forward.

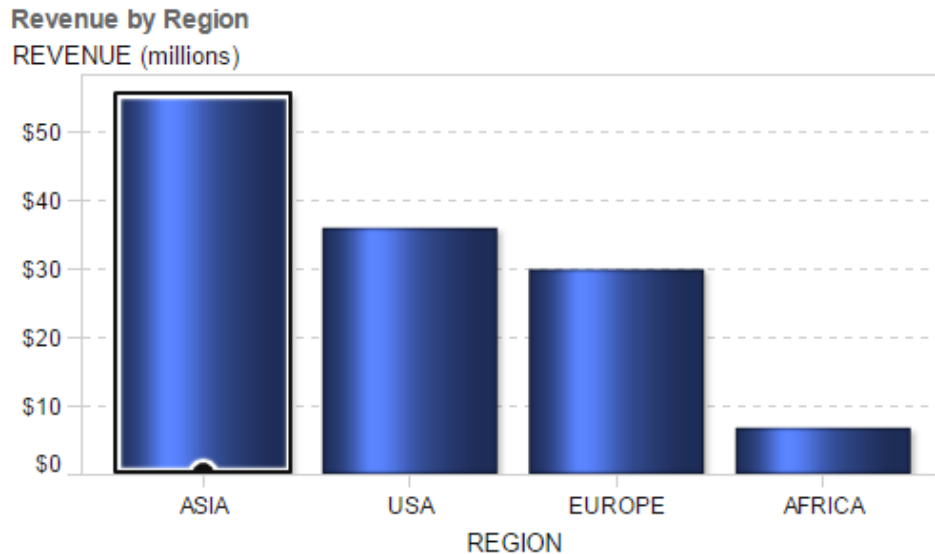


Figure 5 Example report with effective use of color

COLOR HELPS TO VISUALLY SEARCH A REPORT QUICKLY

The example below taken from Aanderud *Visual Analytics: Use Geo Regional Maps for Overall Comparisons* blog post is a great example.[2] With no effort, our eyes are drawn to the darkest spot, Ohio, and we want to know why it is darker than the others. The map depicts tornado events and its damages across the United States. And with a little investigating we learn that the darker colors represent areas that had lots of damage while the lighter colors show little to no damage.

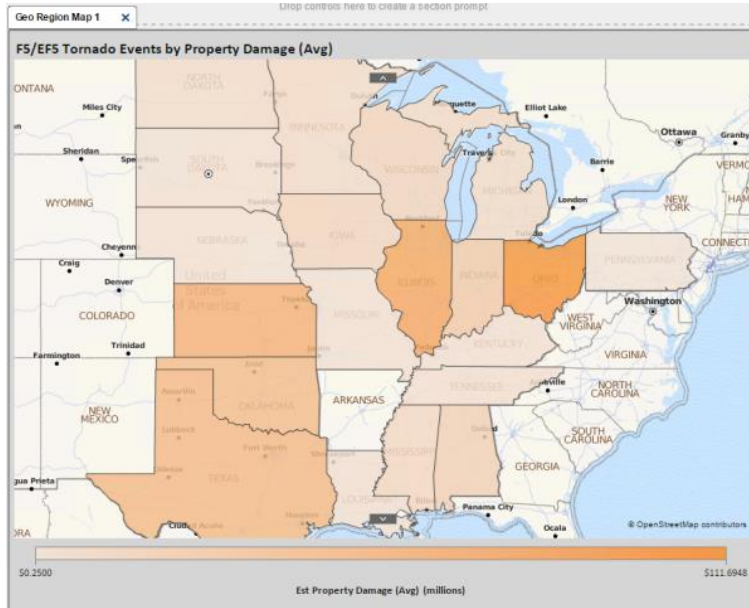


Figure 6 Representation of how color helps to visually search a report quickly

KEEPING THE COLOR DEFICIENT IN MIND

There is a misconception that people who are color blind cannot see color at all. There is a small percentage of the population that proves this true, those who have monochromatic vision. But the majority of people considered color deficient can see colors. They just have difficulty differentiating between colors. Red and green being the hardest for them to distinguish. Facebook co-founder, Mark Zuckerberg is red-green color blind. In an interview, he told a reporter that blue is the richest color he can see. Hence why Facebook has remained monochromatic with a blue color scheme.

Figure 7 is an example of what a person who can perceive all colors would see. Figure 8 is the same pie chart, except depicting what a person who is color deficient would see. Notice how the red and green slices appear to the color deficient. They are almost exactly the same shades of brown, and had it not been for labeling, the slices may not have appeared different.

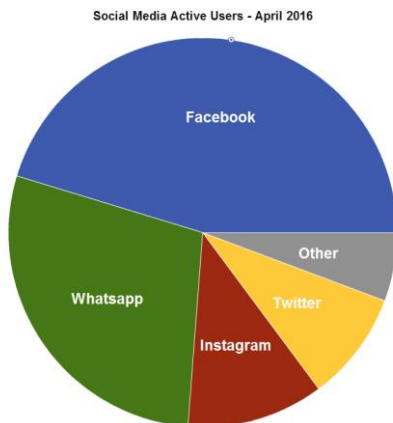


Figure 7. Pie chart using unfavorable colors for the color deficient

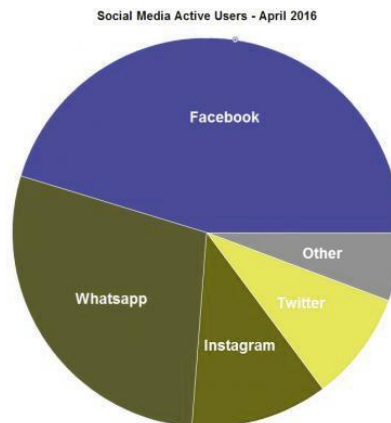


Figure 8. Pie chart depicting what the color deficient perceives

Good design practices would ensure you take all of the population into consideration when creating data visualizations. An easy way to do this is to use a tool like Color Brewer [4] for selecting color deficient safe palettes. If you are creating your own, to avoid color deficient pitfalls, here are some considerations:

- Use a standard color palette that is *color deficient friendly* – having a standardized palette set up is a sure way to avoid colors that may prove difficult or frustrating to the color deficient
- Know the combinations – some colors are harder for the color deficient to differentiate. Avoiding color combinations like red and green, light green and yellow, brown and green
- Use monochrome – distinguishing between colors can be difficult, using various shades of one color is a safe way to avoid issues when designing with the color deficient in mind
- Differences in hue, saturation and brightness can be used to your advantage as color blind people can still perceive contrast.

Following good design practices as previously mentioned, Figure 7 was recreated using monochromatic colors as shown in Figure 9. Figure 10 illustrates what a color deficient person would see, while the colors have changed slightly, the shading is consistent.

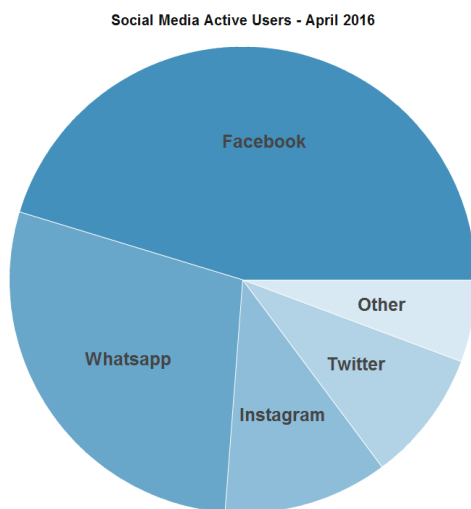


Figure 9. Monochrome pie chart

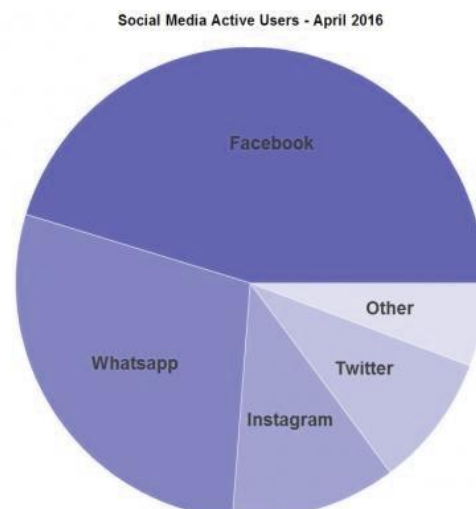


Figure 10. Pie chart depicting what the color deficient perceives

COLOR AND CULTURE

When considering colors to use in data visualizations think through what each color means. This may not always be necessary especially if your audience is native, but if your work will reach an international audience, color considerations are important. Colors hold different meanings across cultures. Thus, knowing the audience of your report or design can play a significant role. For instance, in Western cultures, red promotes a feeling of anger or danger. While in Chinese cultures, it represents good luck and success. Purple is associated with royalty and honor in Western cultures. In Thailand and Brazil, purple represents mourning. White is linked to purity, cleanliness, and weddings in Western cultures. In Eastern cultures it represents death, unhappiness, and mourning.

Therefore, when designing visualizations, especially for an international audience, keep in mind the effect your color scheme will convey. For instance, in the US, "being in the red" has negative meaning. In the Chinese culture, it's portrayed as good luck, a positive meaning.

USING COLOR PALETTES

Knowing your audience helps when selecting colors as international audiences may interpret the message differently. When it comes to red and green, it is probably best to choose one of the two colors for your palette to show consideration toward the color deficient. Colors can enrich data understanding in a visualization. Having a predefined set of color palettes can help save a significant amount of time and effort when creating graphs and other reports.

Stephen Few suggests a list of 9 colors (Gray, Blue, Orange, Green, Pink, Brown, Purple, Yellow, Red) that work well together. [6] These 9 colors can be separated into meaningful color palettes using the various hues. Light and medium hues for conventional use and bright hues for highlighting.

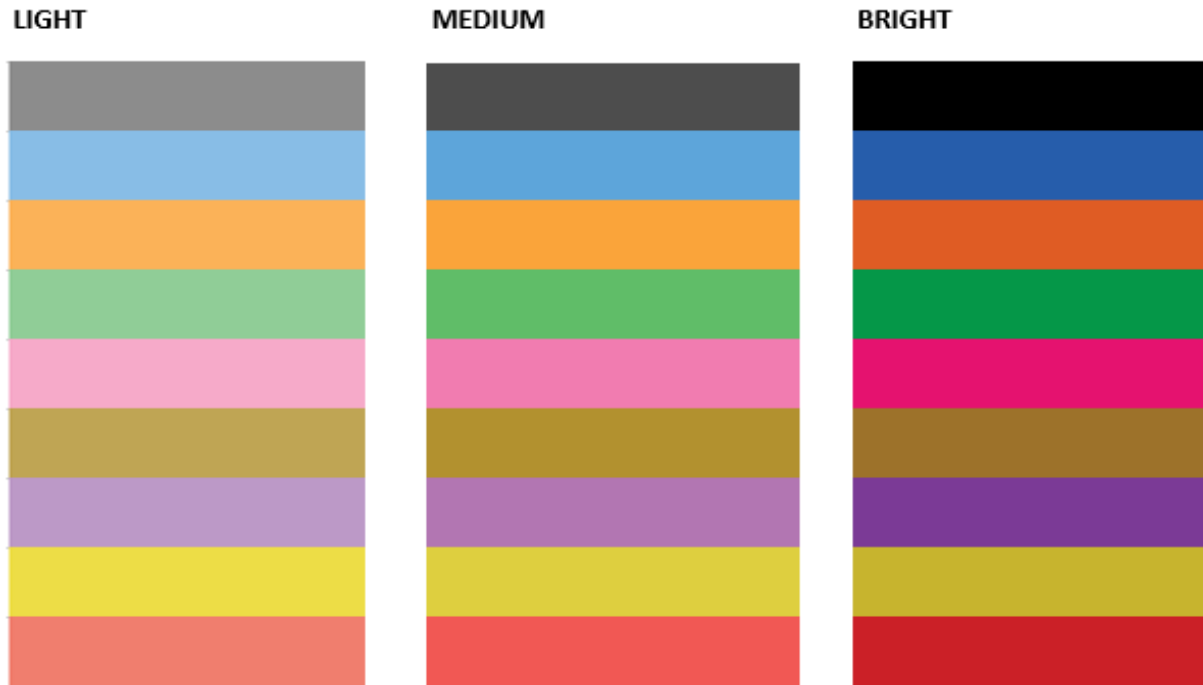


Figure 11 Sample color pallets

A LITTLE BIT ABOUT COLOR SCHEMES

According to Blender Guru [9] there are 6 color schemes that work well together:

Monochromatic

Involves only one color – allows the user to focus on the details and changes in values



Analogous

Colors adjacent on the color wheel



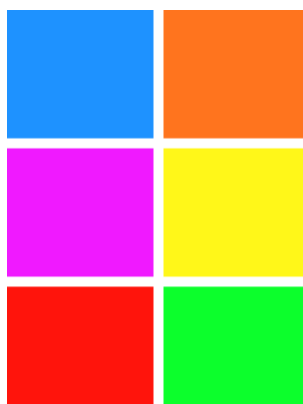
Triadic

Equally distant on the color wheel



Complementary

Opposing colors on the color wheel – these colors are naturally pleasing to the eye



Split Complementary

One complementary end extended



Tetradic

Two pairs of opposing colors



Figure 12 Color Schemes

The Color Calculator [5] is an interactive color wheel. It is an awesome tool for exploring the color harmonies mentioned above. It allows you to pick a color and a harmony. The colors produced will display as a report with the hexadecimal, RGB, and CMYK values. Further, you can tweak the colors on the fly to compare color schemes and choose the right one for your data visualization.

When creating data visualizations, light palettes with a complementary scheme is a good choice. They are easy on the eyes and when meaningfully assigned not only looks good but relays the data message in a profound way.

USING COLOR IN SAS VISUAL ANALYTICS

In SAS Visual Analytics there are many useful tools to help you select colors that are appropriate for your data visualizations. First, if you'd like to keep things simple and not dig much into colors there are a few themes within the Visual Analytics Theme Designer which all contain predefined color palettes that can be used. The SAS Snow report

theme was introduced in SAS Visual Analytics 7.2 and it's the new default theme. SAS Snow is definitely a personal preference as it delivers a clean white surface for building reports. This can be changed in the Styles tab of a report window. Also note that within the style tab you have the option of overriding/ customizing the report background, the prompted background and the font.

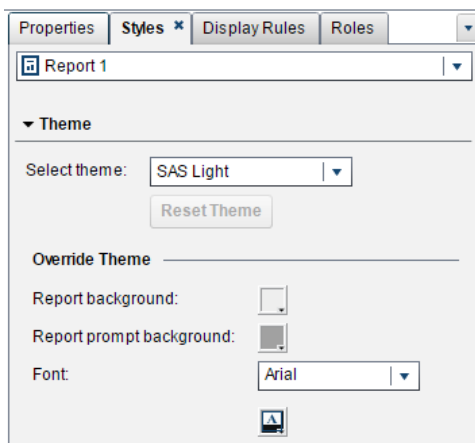


Figure 13 Setting color

Secondly, when using any report object, you have the ability to change the colors that represent the values of the report. Again, within the style tab, once the report object is selected, within the "Data Colors" section you can select any color and change it to the one that meets the needs or visual aspect you are trying to relate in your report. Selecting "Data Colors" also allows you to customize a color using its corresponding HEX value.

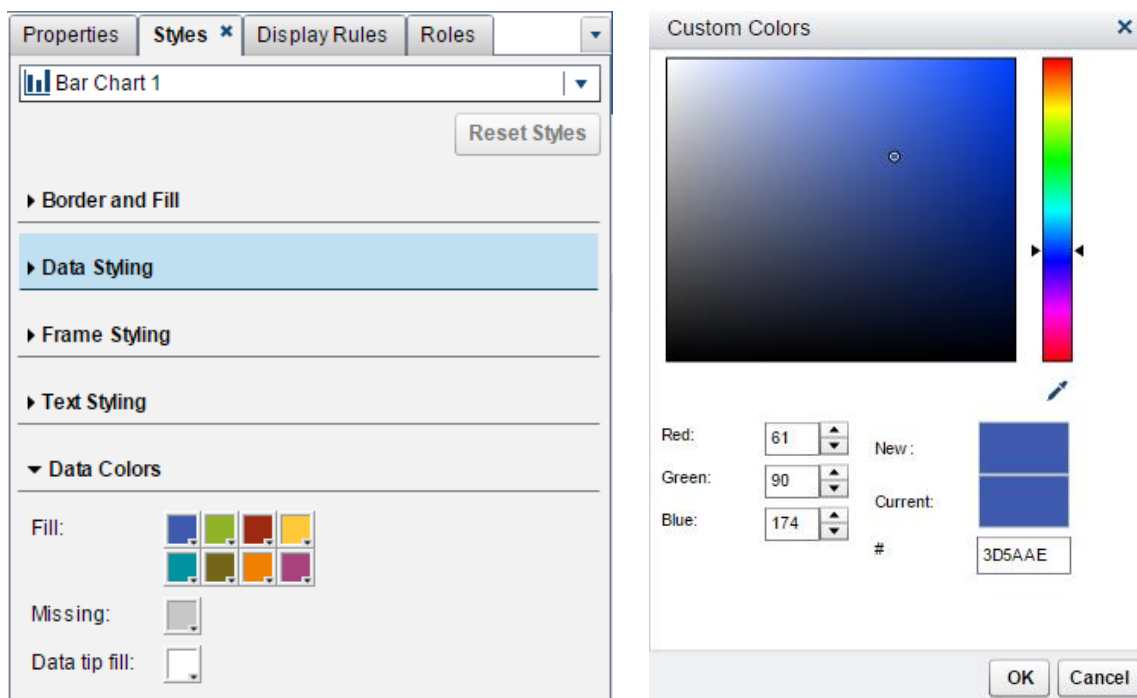


Figure 14 Setting specific colors

Display rule, color-mapped values are another useful way of applying color to graphs and reports. Colors can be applied to columns or values and utilized at the report object level or the report level. If the display rule is set up at the report object level, the colors correspond only to the report object. At the report level, the specified colors apply to all report objects within the report.

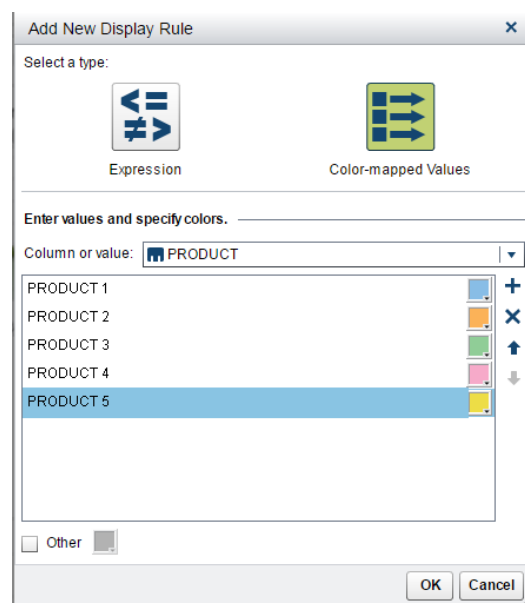
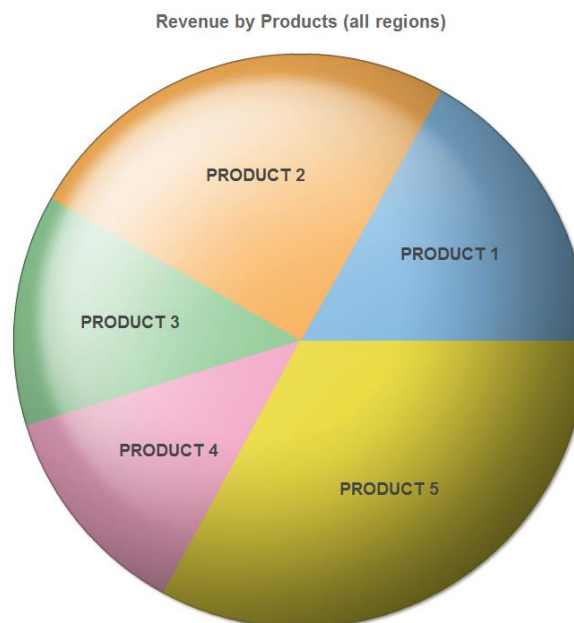


Figure 15 Using color mapping



CONCLUSION

Color is essential in data visualization. It is used as a means of communication, to help search a report quickly, show associations, improve user experience and invoke emotion. There are endless possibilities for choosing color palettes. The meanings of colors can be completely opposite across cultures but some can also be universal. When selecting colors be sure to think of your audience, know which colors to avoid and remember, Color Matters!

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- [10] PublicDomainPictures.net, Color Wheel
- [11] Types of Colour Blindness. <http://www.colourblindawareness.org/colour-blindness/types-of-colour-blindness/>

RECOMMENDED READING

- *Information is Beautiful*, David McCandless
- *Show Me the Numbers*, Stephen Few

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