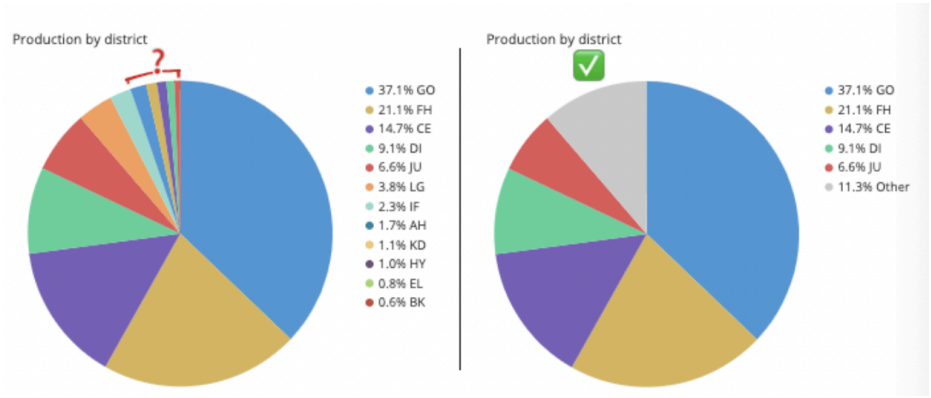
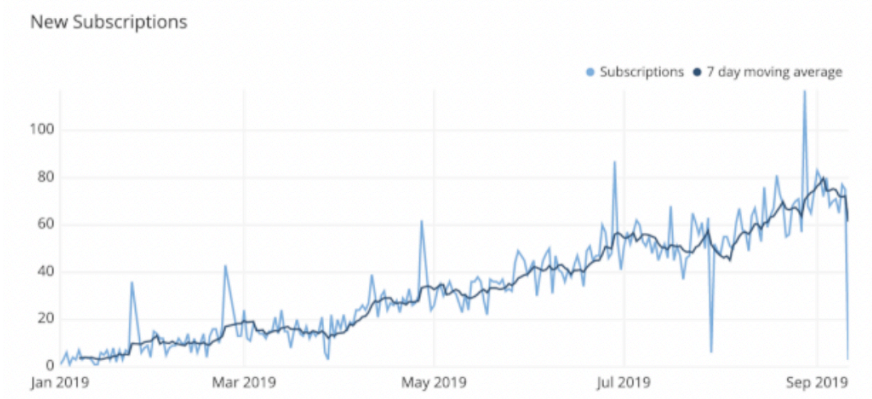
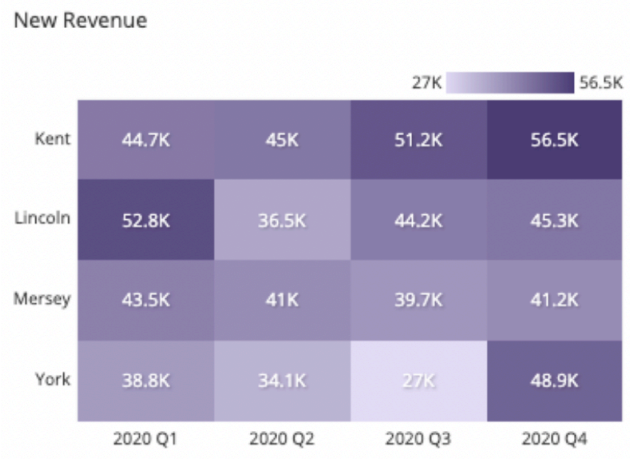
CDS DS 594

How to Choose Colors for Data Visualizations

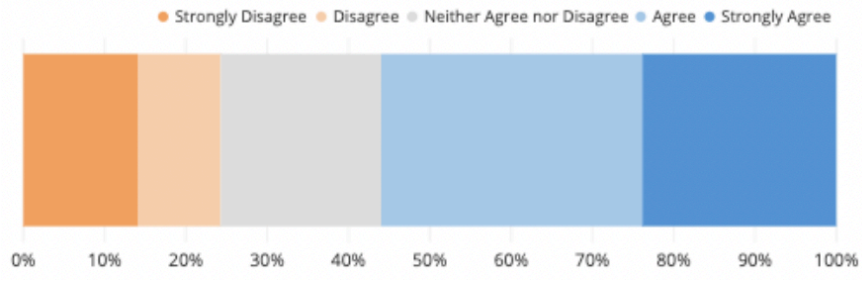
1. Types of Color Palette
    a. Three major types of color palette
        i. Qualitative palettes
            1. Used when variable is categorical
            2. Colors are assigned to each group need to be distinct
            3. Try to limit the maximum palette size to ten or fewer colors and if there is more color needed, try bundling values together
            4. 

            5. Main way of generating distinctiveness between colors is through their hues, adjusting lightness and saturation (but it is good to not make the differences too large since too much difference might suggest that some colors are more important than others)
            6. 

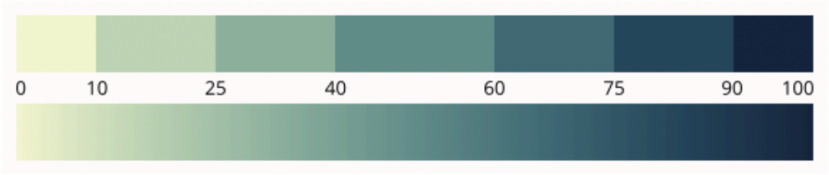
        ii. Sequential palettes
            1. Used when variables are numeric or have inherently ordered values
            2. Colors are assigned to data values in a continuum, usually based on lightness, hue, or both

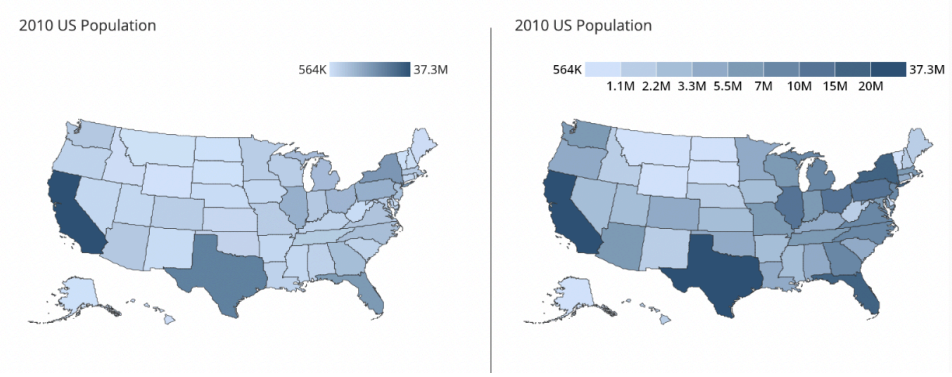
3. Most prominent dimension of color for sequential palette is lightness
4. Lower values are associated with lighter colors and higher values with darker colors (reverse on dark background)
5. Secondary dimension for sequential color palette is its hue (it is fine to have a single hue, varying lightness to indicate value)
6. Typically, warmer colors (red or yellow) will go lighter end and cooler end (green, blue, or purple) will go darker end
7. 

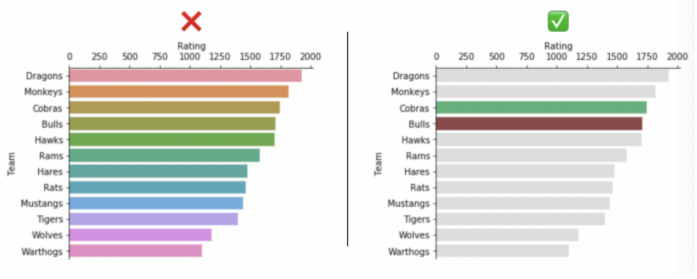
iii. Diverging palettes

1. Used when numeric variable has meaningful central value, like zero
2. Combination of two sequential palettes with a shared endpoint sitting at the central value where values larger than the center are assigned to colors on one side while smaller values get assigned to colors on the opposing side
3. Used for each of the component sequential palettes to make it easier to distinguish between positive and negative relative to the center
4. 

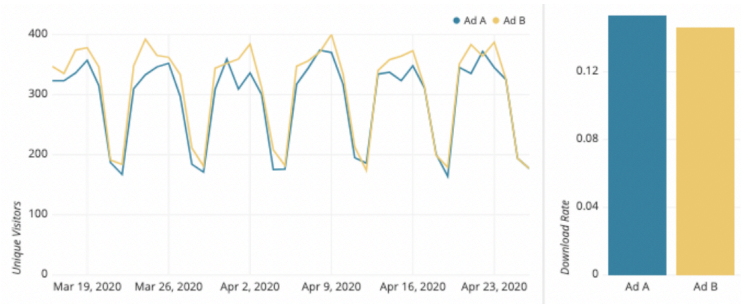
b. The type of color palette in a visualization depends on the nature of data mapped to color

2. Discrete vs Continuous Palette
    a. Sequential and diverging palettes can be associated with data values in two ways: discrete (each one associated with a numeric range), continuous function between numeric value and color
    b. 

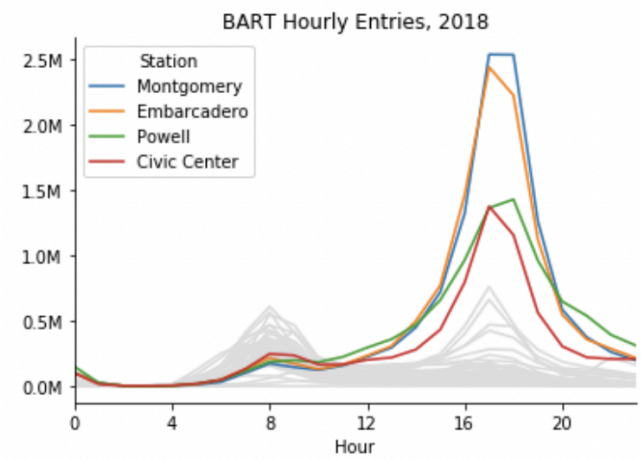
    c. Tools for creating palettes will generally follow first type, while tools that create visualizations often have the capacity to build a continuous association
    d. Discretization of values can reduce cognitive load by bringing out board patterns in data, setting value ranges (if there are outliers, continuous palette might force most of the data into a narrower value range)
    e. If we use discrete color palette, we can create ranges with unequal size to better represent differences in the data
    f. 

    g. One major disadvantage of discrete color palette is that we lose ability to compare elements that fall in the same bin
3. Additional Tips for Using Color
    a. Avoid unnecessary usage of color
        i. Only use color where it is appropriate
        ii. 

    b. Be consistent with color across charts
        i. Match the colors between charts if the report or dashboard includes multiple charts

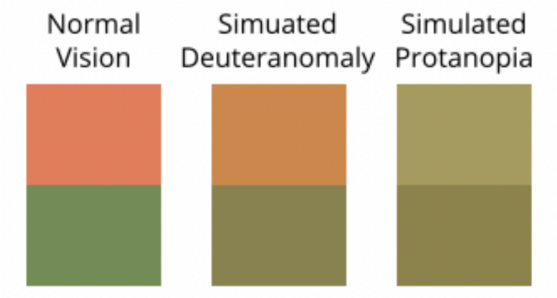
ii. 

c. Leverage meaningfulness of color
    i. Leverage how colors are perceived to enhance the visualizations' effectiveness
    ii. Assign appropriate colors when plotting inherent color conventions (sports teams, political parties)
    iii. Avoid overly high levels of color saturation and brightness in order to reduce eyestrain

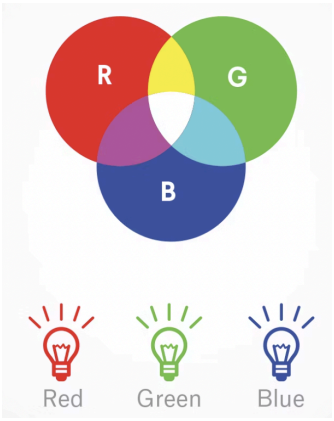
iv. 

    v. Note different cultures can associate different meanings to each hue
        1. Red is danger in Western culture but good fortune in some Eastern cultures

d. Attend to color blindness
    i. Four percent of population have some sort of color blindness
    ii. Red and green shades can cause confusion as well as blue and yellow shades

iii. 

The Fundamentals of Understanding Color Theory

1. Introduction
    a. Color theory is both science and art of using color and explains how humans perceive color, visual effects of how colors mix, match, or contrast with each other
    b. Colors are organized on a color wheel and grouped into 3 categories: primary colors, secondary colors, and tertiary colors
2. Understanding Color
    a. Color is perception
3. RGB: Additive Color Mixing Model
    a. 

    b. Humans see colors in light waves
    c. Mixing light allows to create colors by mixing red, green, and blue light sources of various intensities
4. CMYK: the Subtractive Color Mixing Model
    a. Any color you see on a physical surface uses subtractive color mixing model
    b. “Subtractive” refers to the fact you subtract light from paper by adding more color
    c. Primary colors used in subtractive process were red, yellow, and blue but replaced with cyan, magenta, yellow, and key/black (CMYK) since the combo enables printers to produce a wider variety of colors on paper
5. The Color Wheel
    a. Consists of three primary colors (red, yellow, blue)
    b. Three secondary colors (green, orange, purple)
    c. Six tertiary colors (blue-green, red-violet, etc.)
    d. Warm Colors (red, orange, yellow)
        i. Associated with energy, brightness, and action
    e. Cool Colrs (blue, green, purple)
        i. Identified with calm, peace, and serenity
6. Hue, Shade, Tint, and Tone
    a. Tint is hue to which white has been added (red + white = pink)

    b. Shade is hue to which black has been added (red + black = burgundy)
    c. Tone is color to which black and white (or grey) have been added
7. Color Schemes
    a. Complementary colors
        i. Opposites on the color wheel – red and green
        ii. Due to the sharp contrast between them, they can really make imagery pop but it is important not to overuse them
    b. Analogous colors
        i. Sit next to one another on color wheel (red, orange and yellow)
        ii. One color will dominate, one will support, and one will accent
    c. Triadic colors
        i. Evenly spaced around the color wheel and tend to be very bright and dynamic
        ii. Creates visual contrast and harmony simultaneously