Lecture 07 – Applications of Color in *R*

Today's Learning Objectives:

1. Describe the basic structure and conventions of ggplot2.

2. Implement design guidelines regarding color on plots and maps.

Colorspaces and Interfaces in R

- Creating colors with RGB (red-green-blue) and HEX color codes.
    - HEX color codes are natively supported in R, go to town!
    - In Base graphics: `rgb()` arguments take the form of numbers 0-1 for reach red, green and blue, produces a HEX color code response you can use.
    - In the colorspace package, `RGB()` is a function that is similar.

- Creating colors with HSV (hue-saturation-value).
    - colorspace offers a similar color space constructor called HCL (hue-chroma-lightness). Unlike HSV, changes in hue while chroma and lightness are held constant, this does not change brightness with changes in hue: `polarLUV()`

- Other color systems in colorspace: `LUV()`, `polarLAB()`, `LAB()`, `XYZ()`, `sRGB()`, and `HLS()`

Color Palettes in R

- Default palette is `palette()`. Pretty basic, not very pretty.

- See **RColorBrewer** package, powerful set of palettes for a lot of data types.

  To see all colors: `> display.brewer.all()`

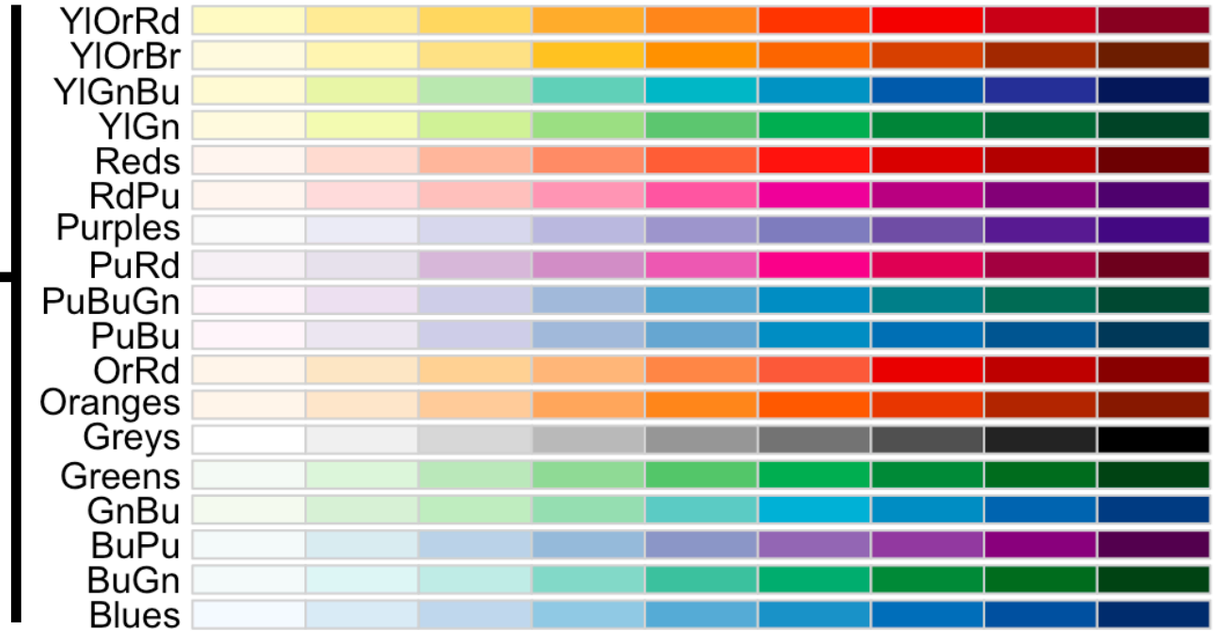
  To see a specific palette: `> display.brewer.pal()`
  and specify the palette: `> display.brewer.pal(n=8, name='Dark2')`

Dark2 (qualitative)

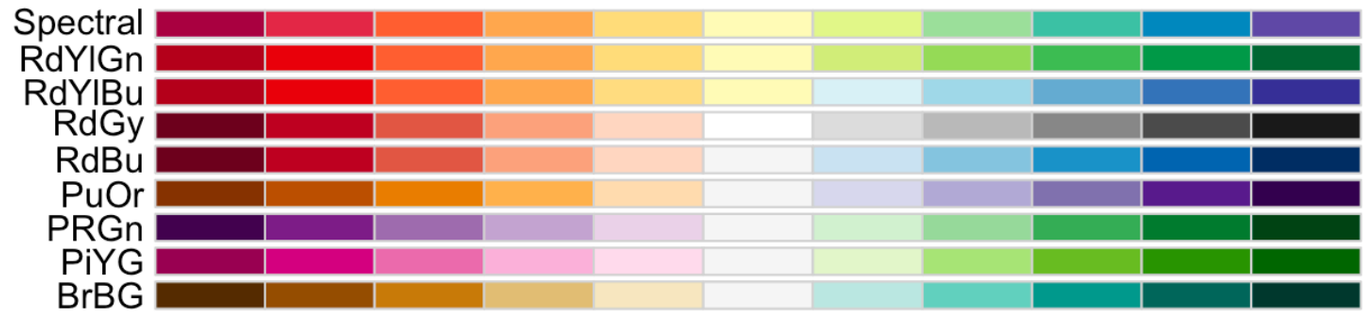
Types of Color Palettes

- Palettes come in three types that reflect the type of data you are visualizing:

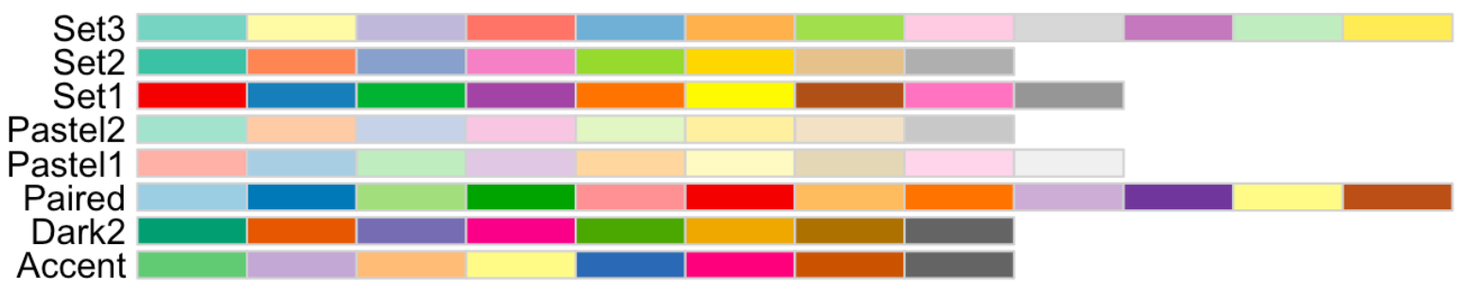
sequential increasing



sequential divergent



qualitative



Color Palettes in R

- **colorspace** package provides a broad toolbox for selecting individual colors or color palettes.
    - colorspace can generate colors based on color models.
    - it has several unique color palettes ready made that work by varying hue, relative luminance, chroma, or a combination of these.
    - colorspace can be used with base graphics (by generating HEX colors) or ggplot2, where it has a special function!

- **viridis** package recreates the python matplotlib viridis color map.
    - Viridis palettes are already colorblind friendly!
    - Varies relative luminance so that they stay true when converted to grayscale.

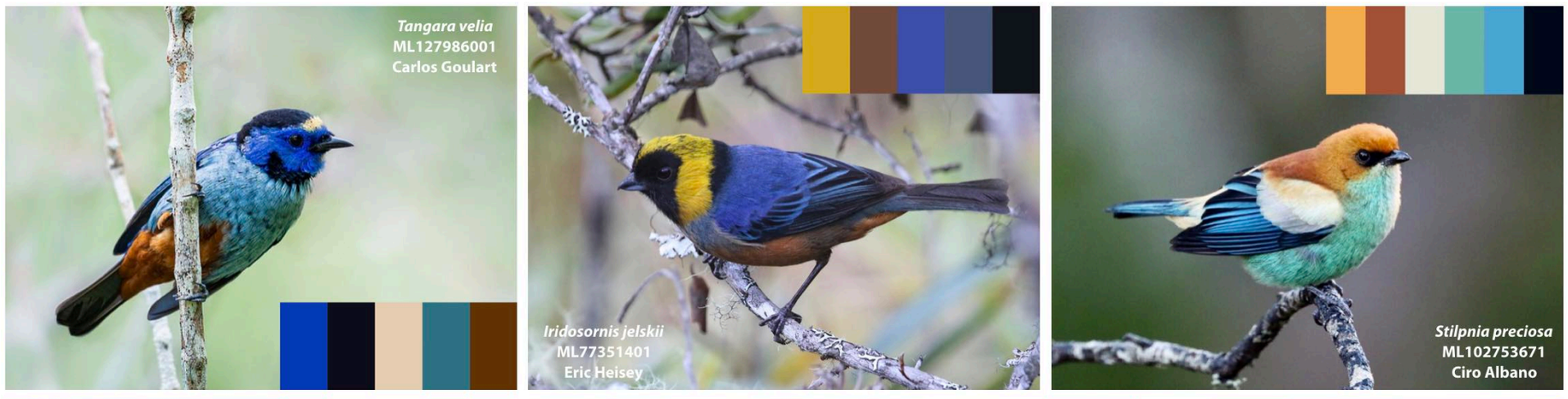
Color Palettes in R

- **wesanderson** package: color palettes based on Wes Anderson movies.

The Life Aquatic

The Royal Tenenbaums

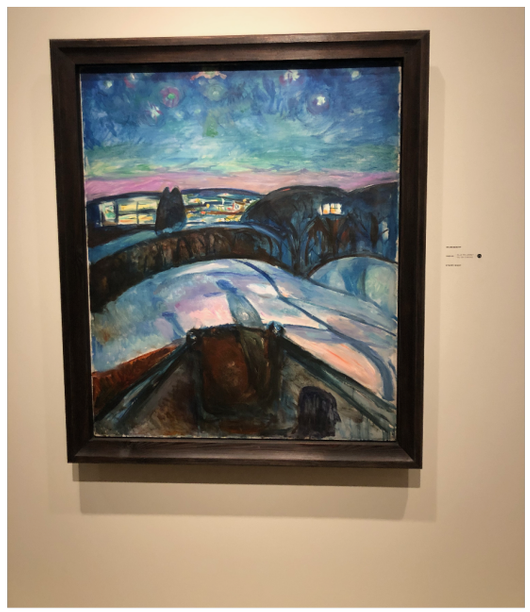
- **tanagR** package: color palettes based on birds in the tanager family.



- **nationalparkcolors** package: color palettes based on various national park posters.

Color Palettes in R

- **munchcolors** package: palettes based on Edvard Munch paintings
  https://github.com/lindsaywaldrop/munchcolors



Qualitative Color Labeling (Nominal Codes)

- *Nominal coding information*: info that has to be recognized and remembered, but not necessarily ordered.

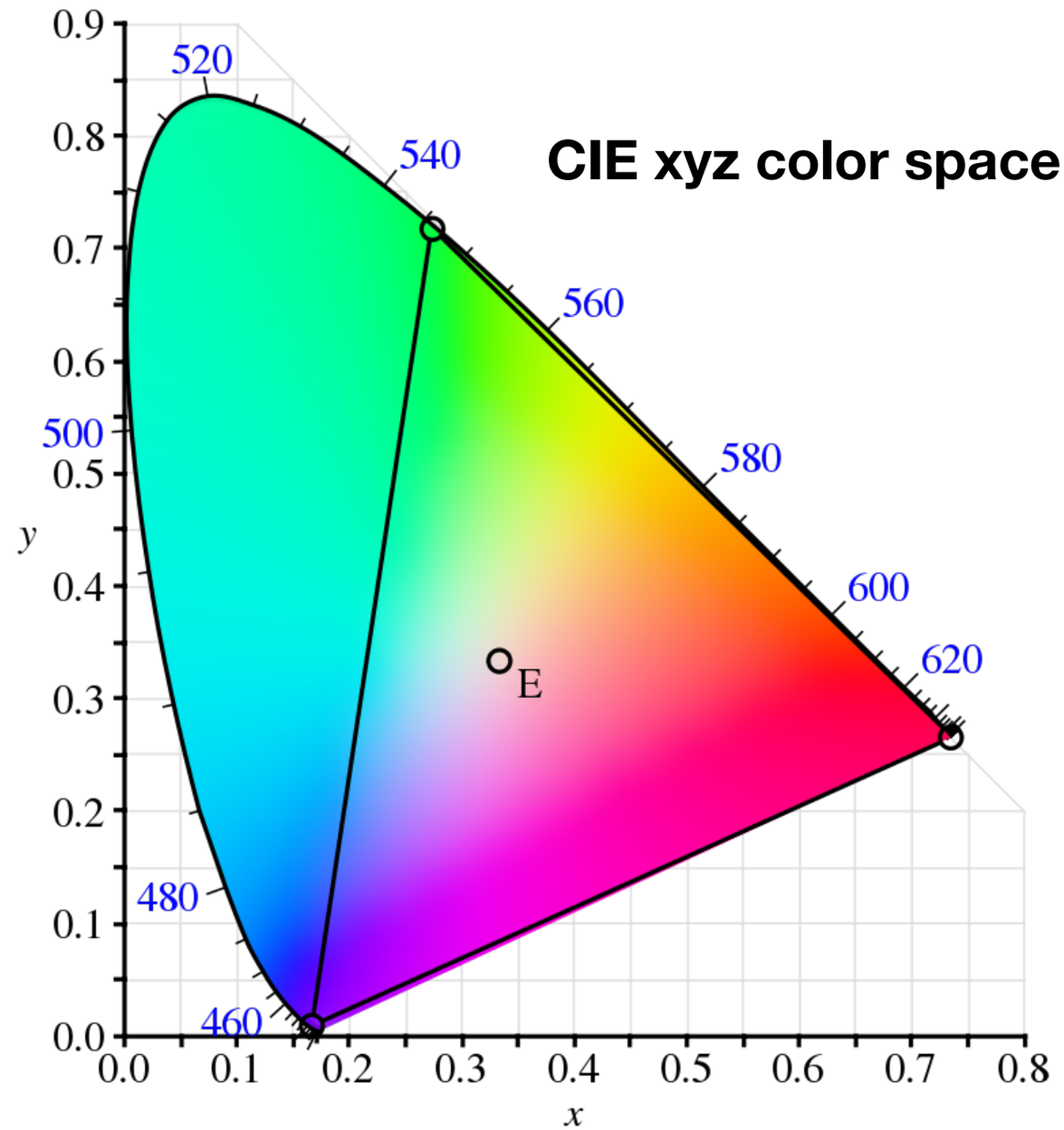
- Use qualitative coloring! Many palettes are available.

- Colors should be distinct, consider using very different hues.

- If data don't need to be ordered, then don't order it!

- Pay attention to contrast with the background.

- If you need one point to stand out, consider plotting non-essential values on CIE color scale to form polygon, make your stand-out color sit **outside** of the polygon!



CIE xyz color space

https://en.wikipedia.org/wiki/CIE_1931_color_space

Color Sequences for ordered data

- Most maps will have some sort of ordered colors that depend on data. For these use quantitative color palettes: **sequential**.

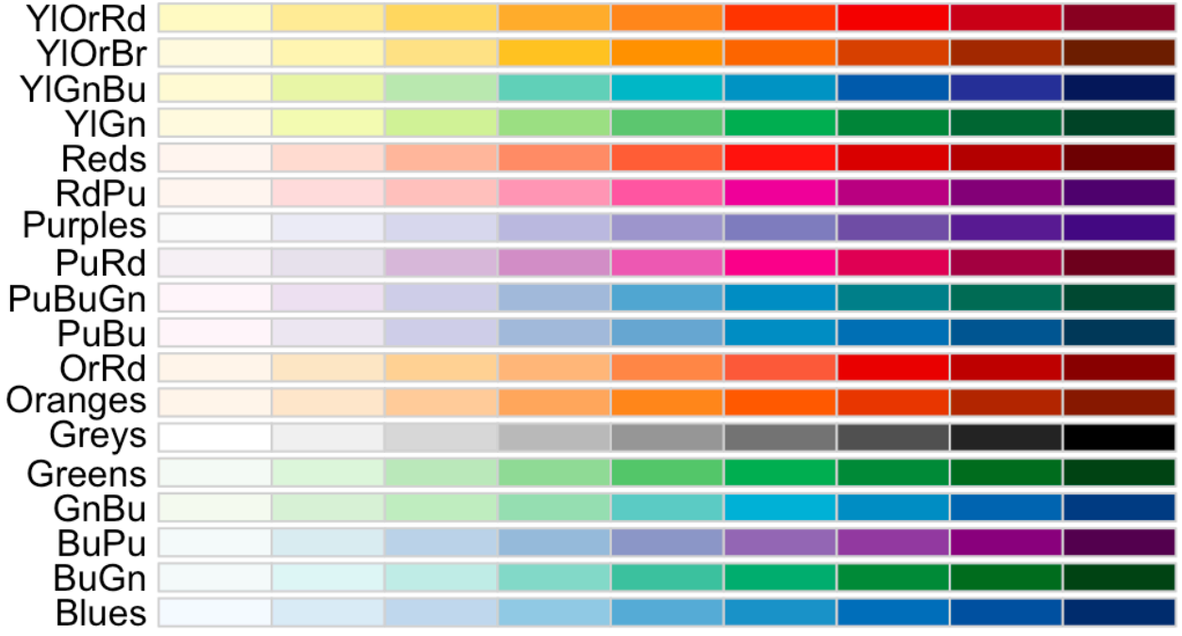
- These palettes can vary in hue, relative luminance, chroma, or a combo of these.

- Two types of sequential palettes: **increasing** and **diverging**.

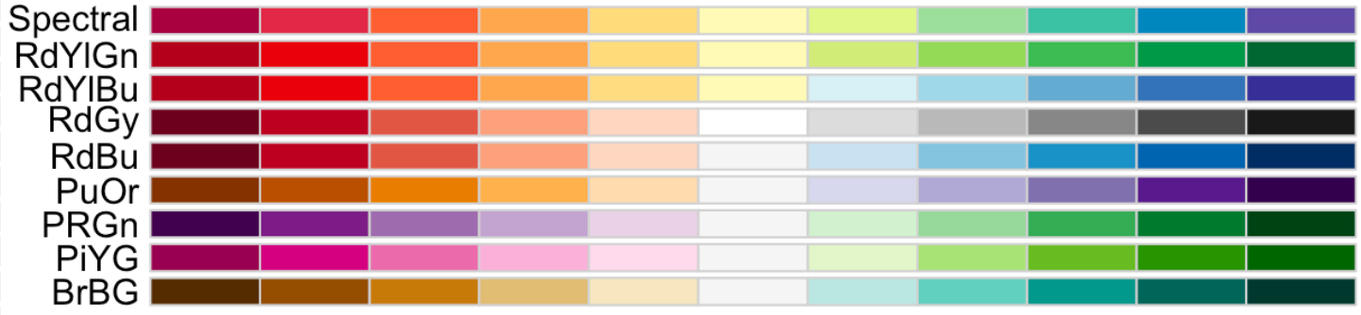
    - Use increasing for monotonically increasing data.

    - Use diverging for data that crosses zero, deviations around a mean, etc.

sequential increasing



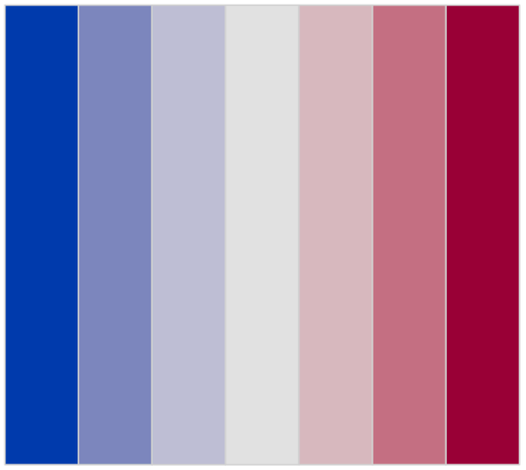
sequential divergent



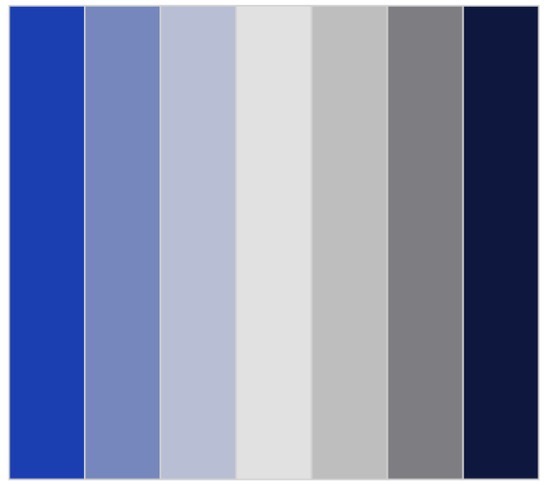
colorspace's color-vision deficiency simulators

- colorspace package comes with simulators of specific color-vision deficiencies, so you can check your palettes for friendliness towards people with colorblindness.

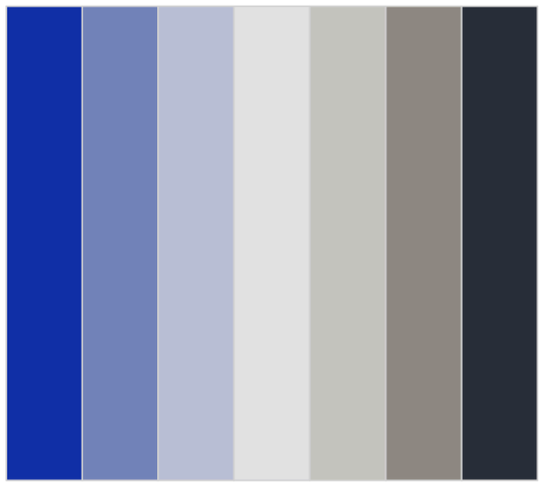
typical vision



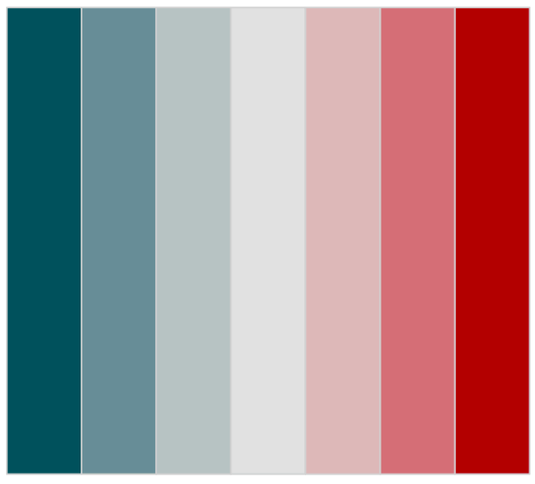
protoanomaly with `protan()`
defective L cone



deutanomaly with `deutan()`
defective M cone



tritanomaly with `tritan()`
defective S cone



Assignments

On your own: Use the US map to plot two factors on by state: murder rate varying by hue and urban population varying by saturation. (HINT: look at the `HSV()` function in colorspace.)

Optional: The colorscience package has a plot of the CIE color space in xyz color coordinates. Create a function that will plot a qualitative color palette on the space in order to test the polygon theory of stand-out color.