

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.

Getting Ready

If you are familiar with ggplot2, great! Keep going.

If you need a refresher on ggplot2, please see the Panopto lecture from CS 510 before continuing!

Be sure you have ggplot2 installed and ready to go before continuing!

Download three scripts:

**ColorPalettes.R
QualitativeColoring.R
ColorsandMaps.R**

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 each 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()`

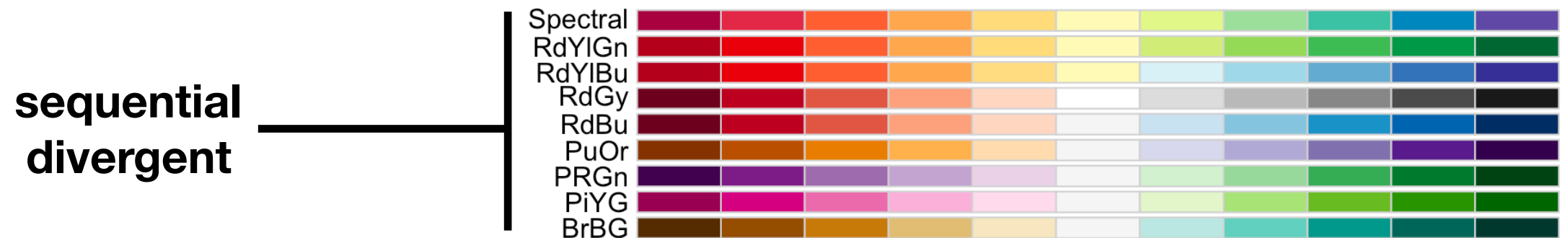
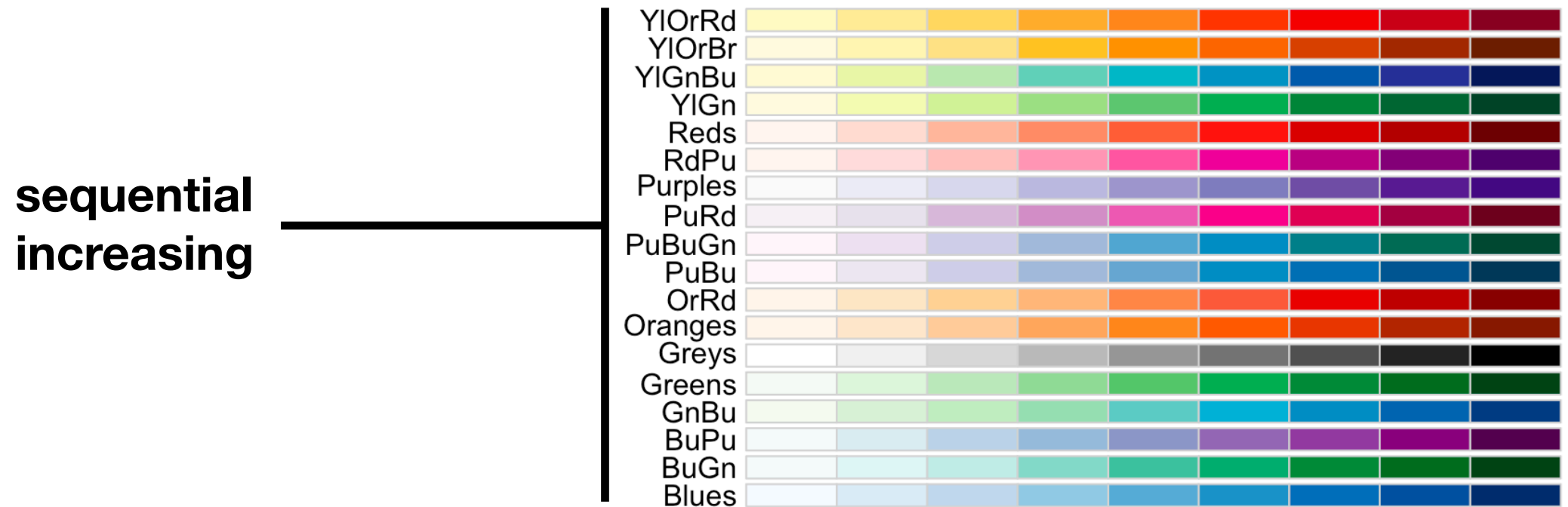
and specify the palette: `> display.brewer.pal(n=8, name='Dark2')`



Dark2 (qualitative)

Types of Color Palettes

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



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.

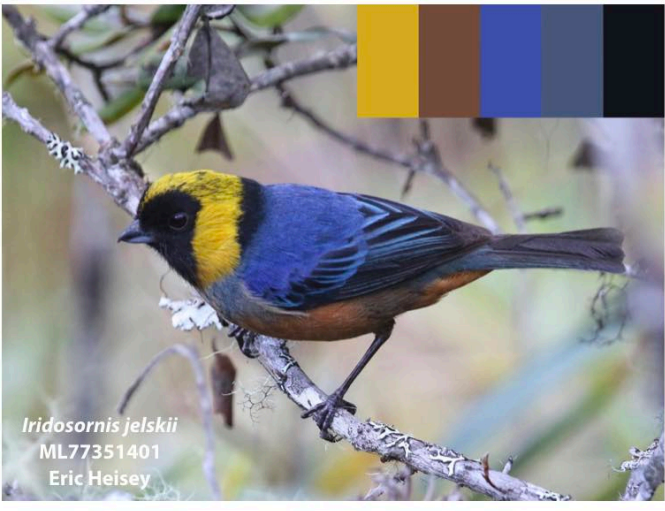
The Life Aquatic



The Royal Tenenbaums



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



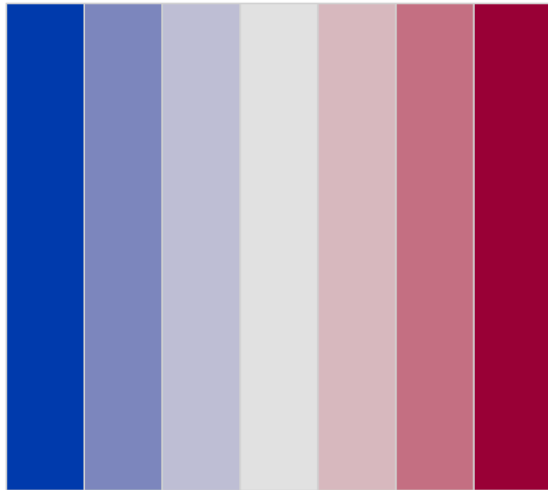
- **nationalparkcolors** package: color palettes based on various national park posters.



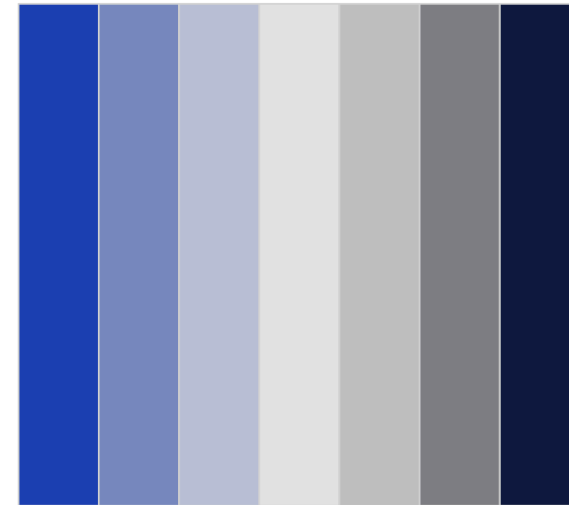
colorspace's color-vision deficiency simulators

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

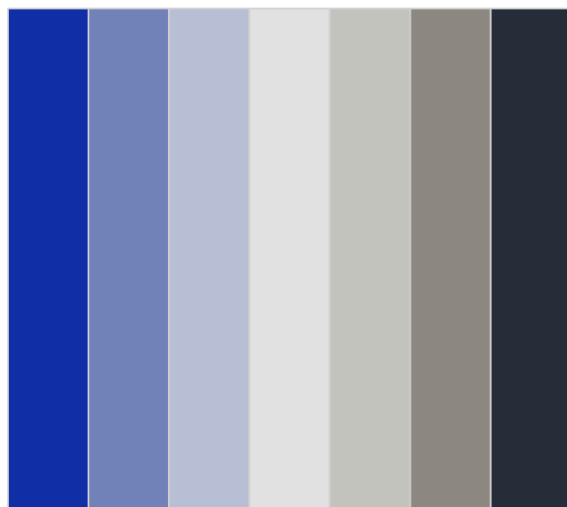
typical vision



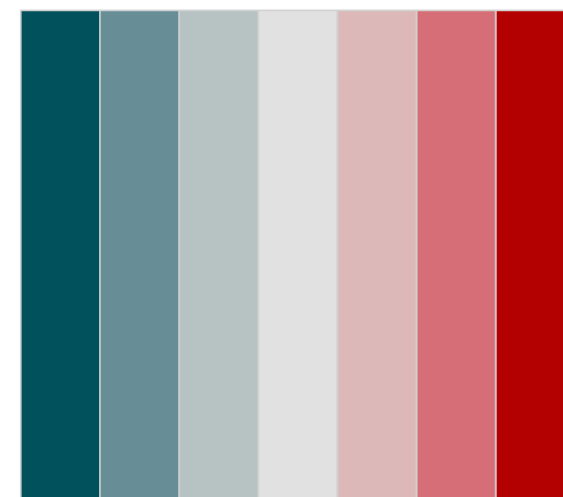
protoanomaly with `protan()`
defective L cone



deutanomaly with `deutan()`
defective M cone

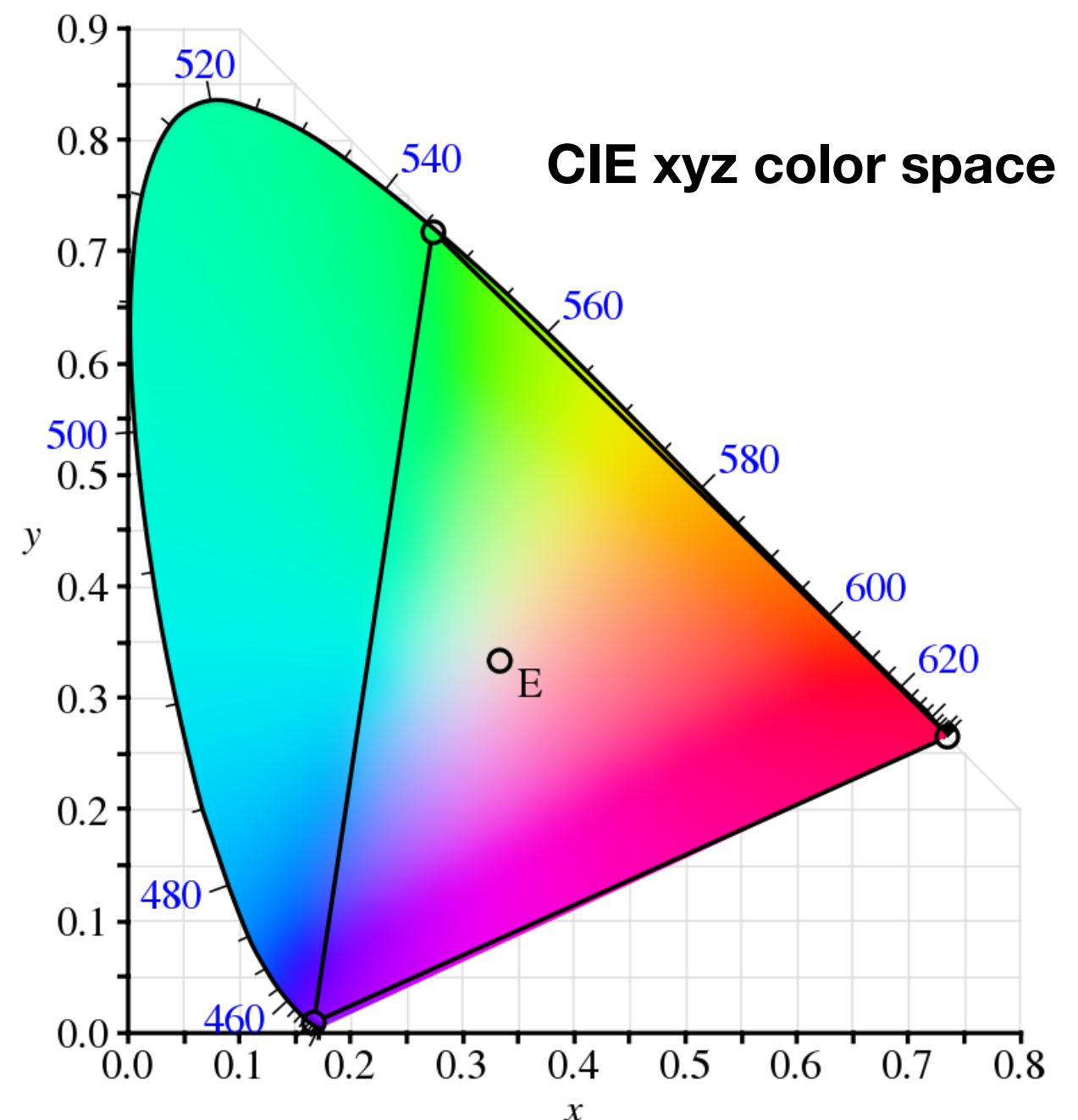


tritanomaly with `tritan()`
defective S cone



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!



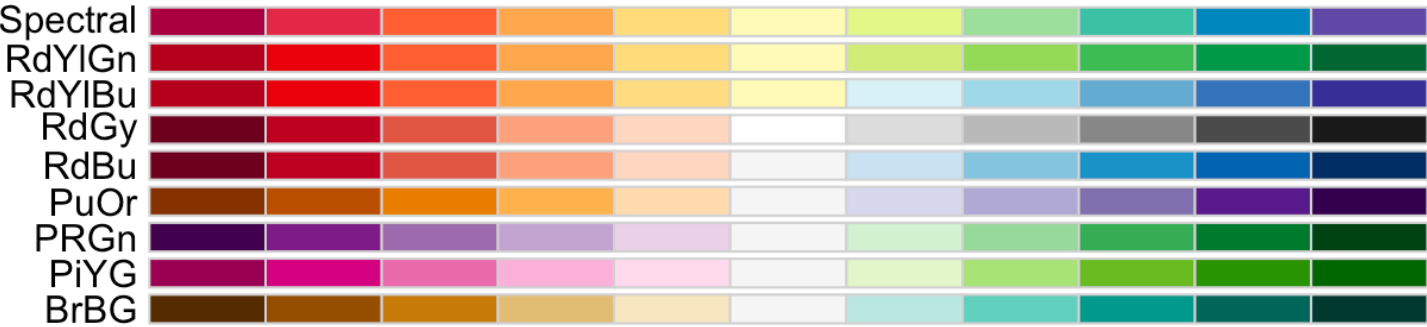
Color Sequences for Maps

- 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**



Assignments

On your own: Use the US map to plot two factors on by state: murder rate varying by hue and arrest rate varying by saturation.

Optional: The colorspace 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.