

Computational Fundamentals: D3

Week 6: Drawing Data 2: Color

Nicole Cote, Spring 2024

Check in

What we'll cover

- Color, A Quick Overview
- Color and Data/Visualization
- Design Considerations for Color Difference
- Color in D3
- Color Tools

Color, A Quick Overview

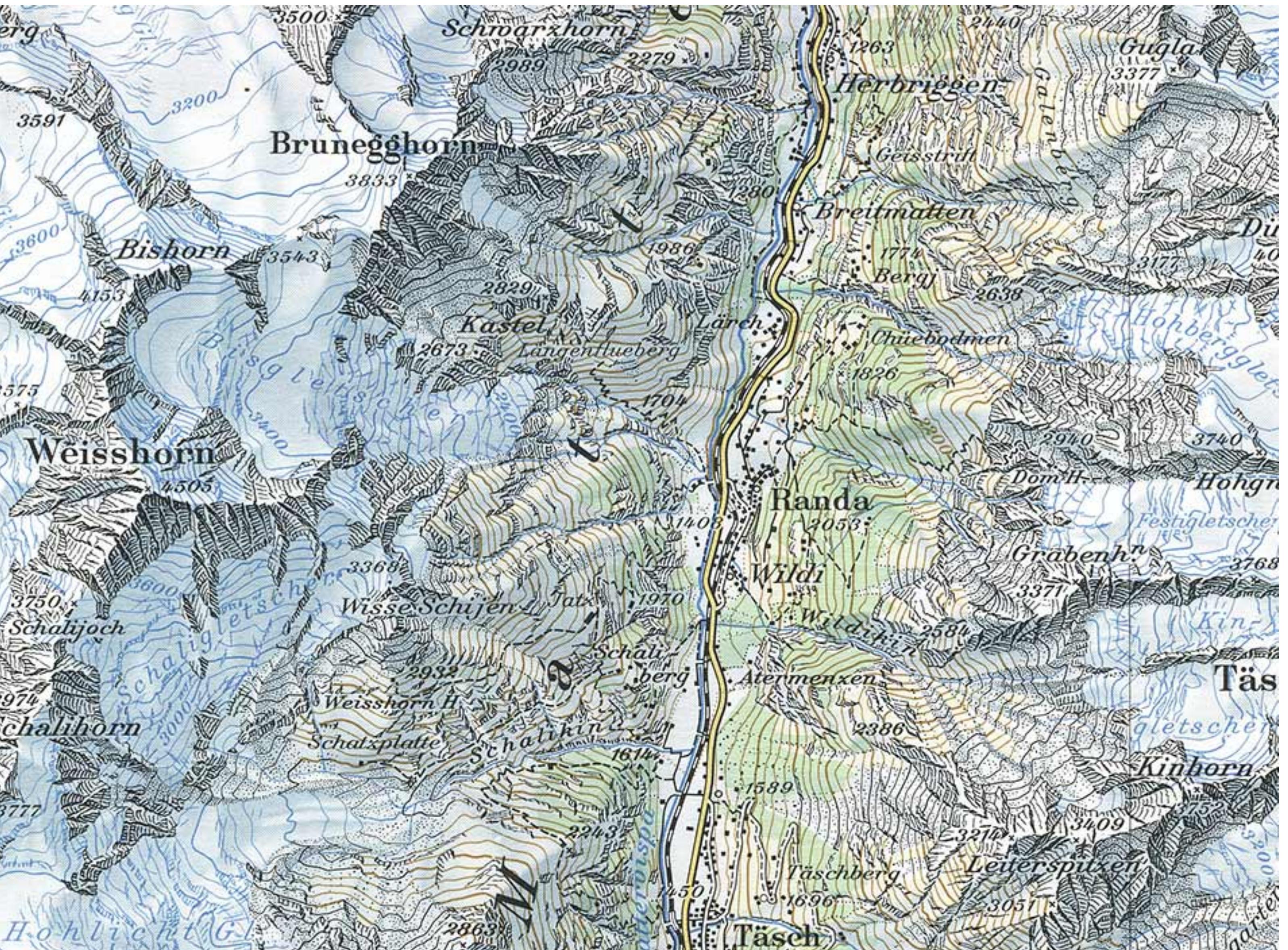
Color Formats

- Named Colors: i.e. “yellow”, “pink”, “orange”
- RGB: quantity of red, green, blue from 0-255: i.e. `rbg(128, 0, 128)`
- RGBA: RGB color with a (transparency value 0.0-1.0): i.e. `rgba(128, 0, 100, .75)`
- HSL: hue, saturation, lightness: `hsl(206, 70%, 70%)`
- Hex (hexadecimal): i.e. `#697e15`, `#e53242`, `#ffffff`, `#000000`

Color and Data/Visualization

Color to:

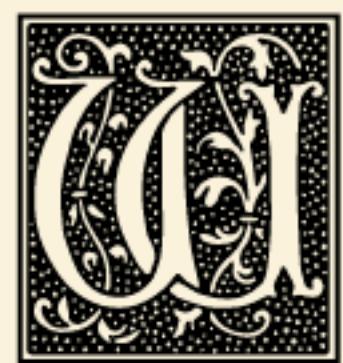
- Label
(color as a noun)
- Measure
(color as quantity)
- To represent or imitate reality
(color as representation)
- To enliven or decorate
(color as beauty)



Quote Source: Tufte, Edward. "Color and Information"
Envisioning Information. Graphics Press, 1990. (81)

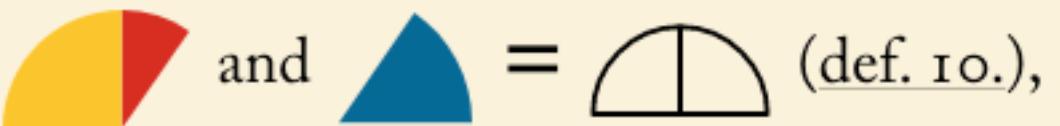
Image Source: https://www.edwardtufte.com/bboard/q-and-a-fetch-msg?msg_id=0003vq

PROPOSITION XIII. THEOREM.



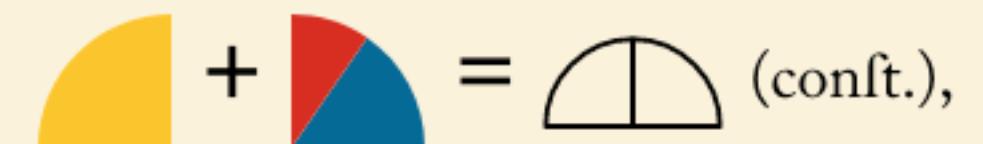
HEN a straight line (—) standing upon another straight line (—) makes angles with it; they are either two right angles or together equal to two right angles.

If — be \perp to — then,



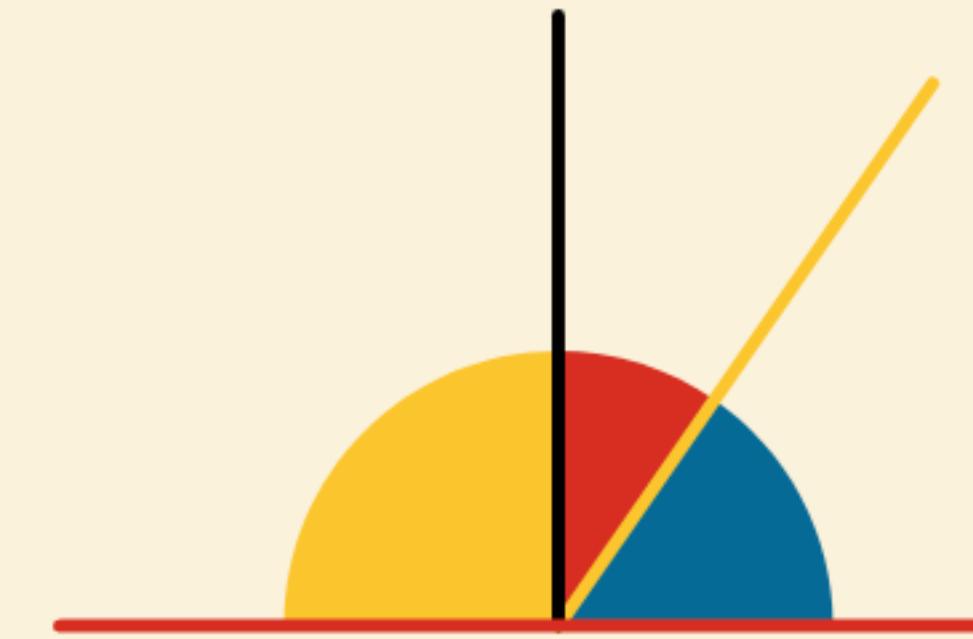
But if — be not \perp to — ,

draw — \perp — ; (pr. 11.)



$$\begin{aligned} &\text{---} + \text{---} = \text{---} \text{ (const.),} \\ &\text{---} = \text{---} = \text{---} + \text{---} \end{aligned}$$

$$\begin{aligned} \therefore \text{---} + \text{---} &= \text{---} + \text{---} + \text{---} \text{ (ax. 2.)} \\ &= \text{---} + \text{---} = \text{---} . \end{aligned}$$



Q. E. D.

Book I: The First Six Books of the Elements of Euclid (Oliver Byrne, London 1847)

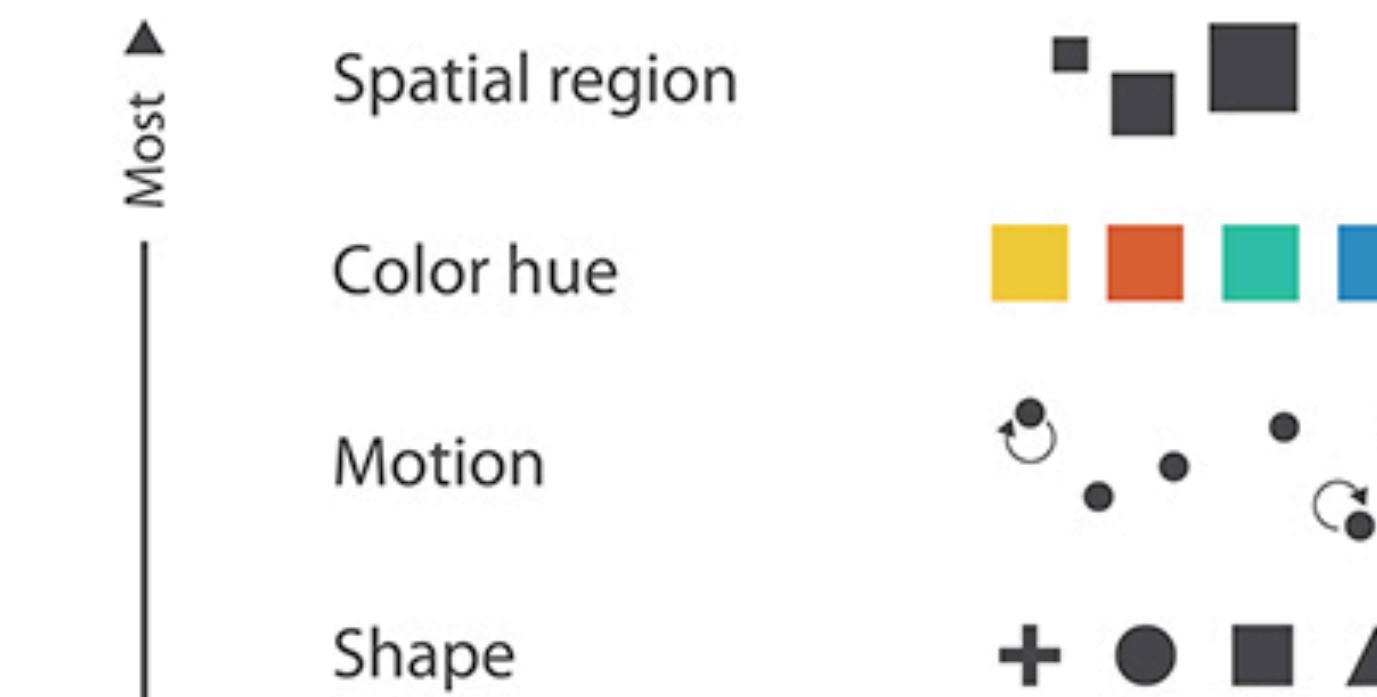
Image Source: *Byrne's Euclid* (an interactive recreation by Nicholas Rougeux) (<https://www.c82.net/euclid/>)

Channels: Expressiveness Types and Effectiveness Ranks

④ Magnitude Channels: Ordered Attributes



④ Identity Channels: Categorical Attributes



Encode > Map

④ Color

→ Color Encoding

→ Hue



→ Saturation



→ Luminance



→ Color Map

→ Categorical



→ Ordered

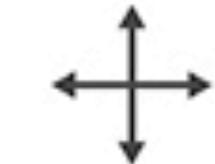
→ Sequential



→ Diverging



→ Bivariate

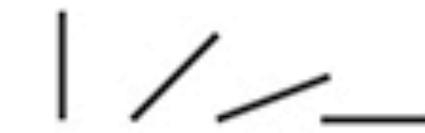


④ Size, Angle, Curvature, ...

→ Length



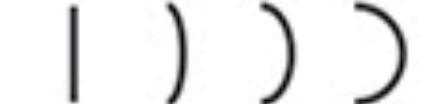
→ Angle



→ Area



→ Curvature



→ Volume



④ Shape



④ Motion

→ Motion

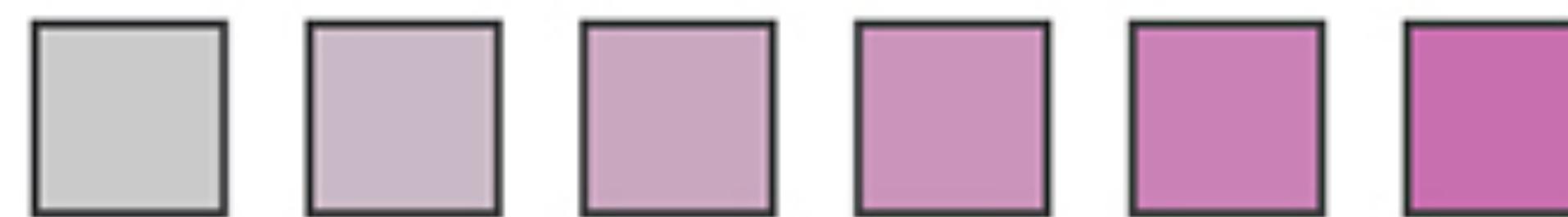
*Direction, Rate,
Frequency, ...*



Luminance



Saturation



Hue



Color Use and Data Type

- Continuous Data: showing distinction between numbers or estimating a value (ordered)
- Categorical Data: clearly distinguishing between categories
- Ordinal Data: distinguishing rank and type (ordered)

Gray is essential for visualization.

7 of the top 10 design concerns have 10 or more concerns per 1,000.

Discussion: is this an acceptable default rate?

Top 10 design concerns

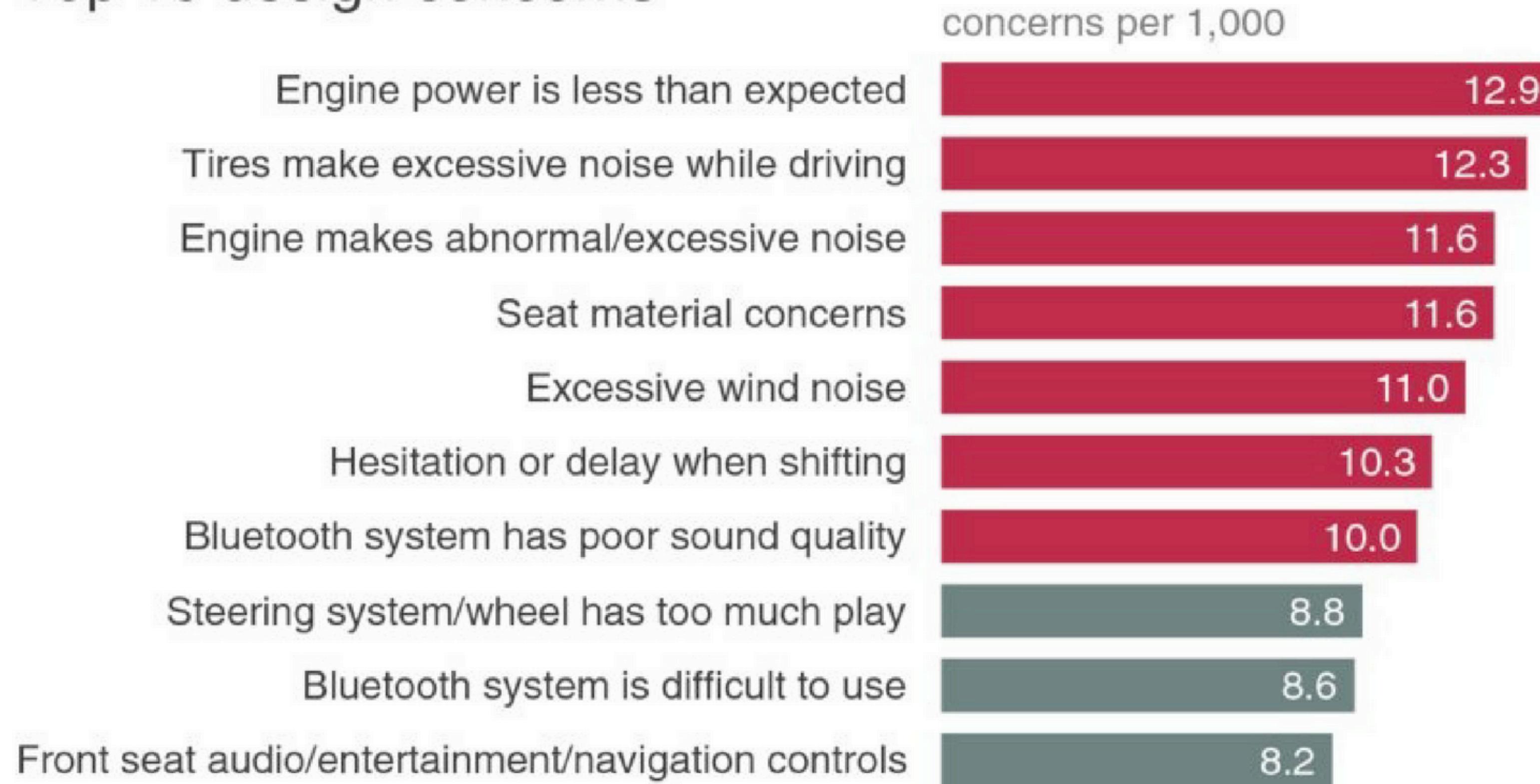
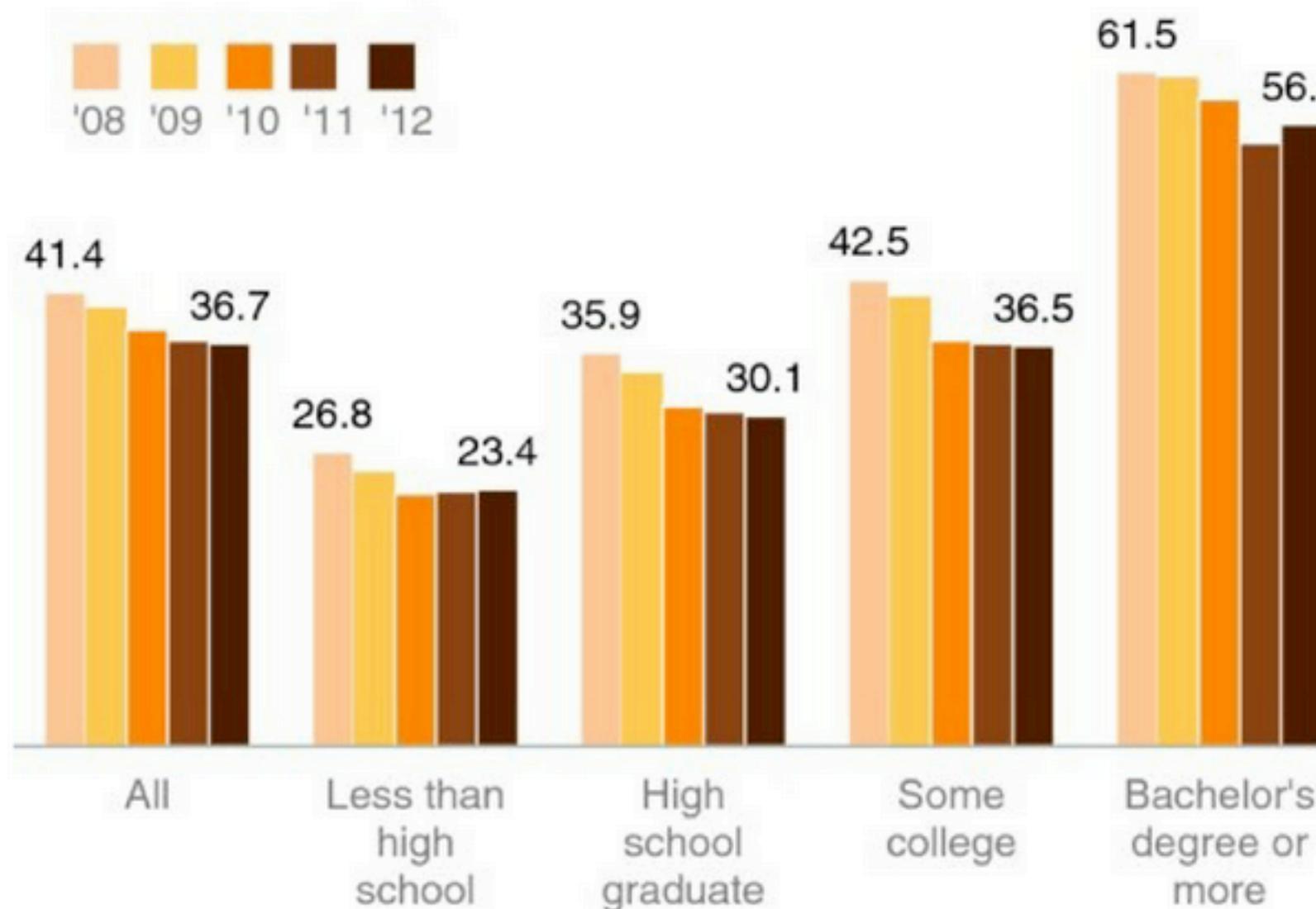


Figure 4.8 Leverage color to draw attention

New Marriage Rate by Education

Number of newly married adults per 1,000 marriage eligible adults



Note: Marriage eligible includes the newly married plus those widowed, divorced, or never married at interview.

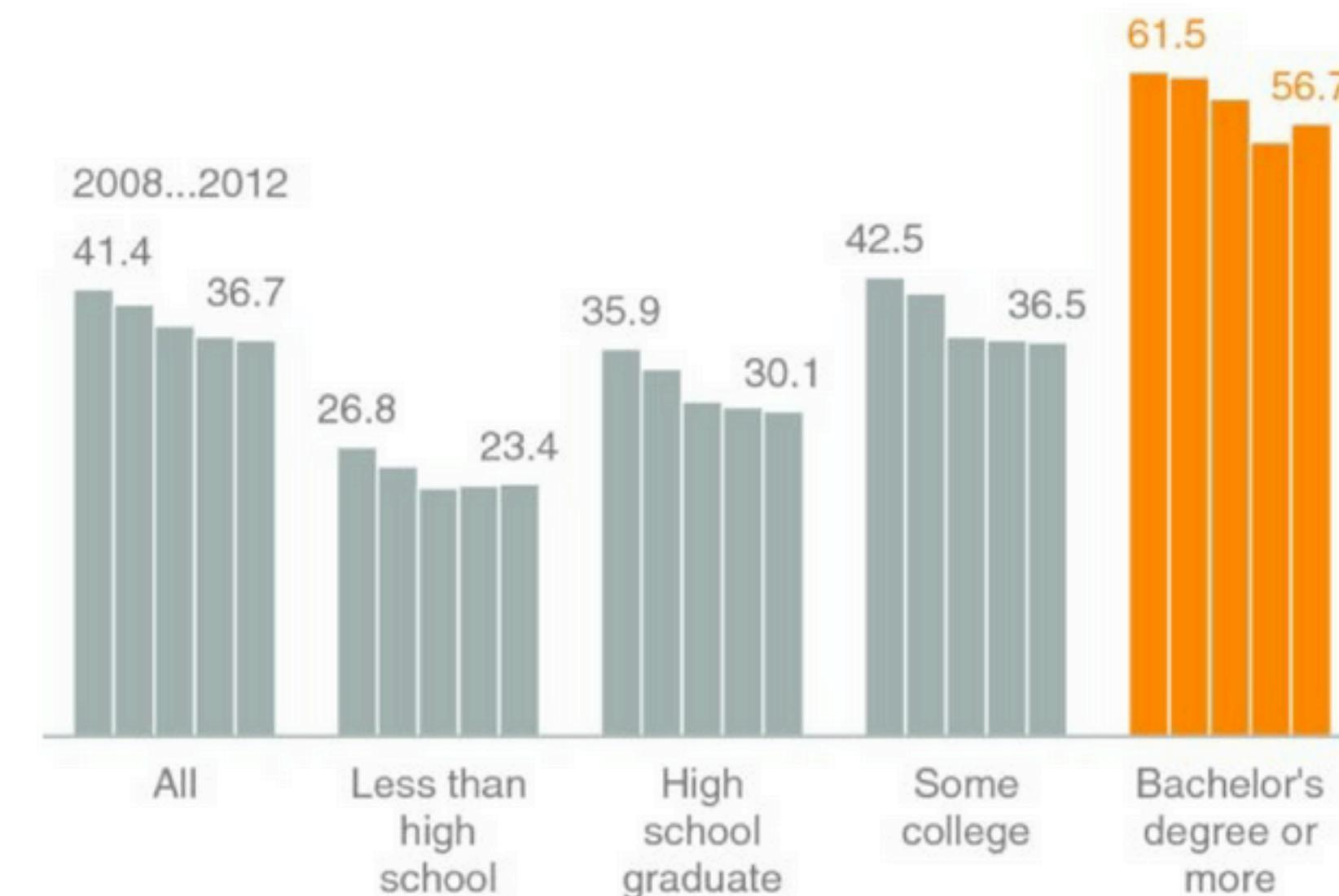
Source: U.S. Census

Adapted from PEW RESEARCH CENTER

[Figure 5.2](#) Pew Research Center original graph

New Marriage Rate by Education

Number of newly married adults per 1,000 marriage eligible adults



Note: Marriage eligible includes the newly married plus those widowed, divorced, or never married at interview.

Source: U.S. Census

Adapted from PEW RESEARCH CENTER

[Figure 5.3](#) Highlight the important stuff



Image Source: Josef Albers, "Interaction of Color," 1973 <https://www.artsy.net/article/artsy-editorial-auction-houses-galleries-working>

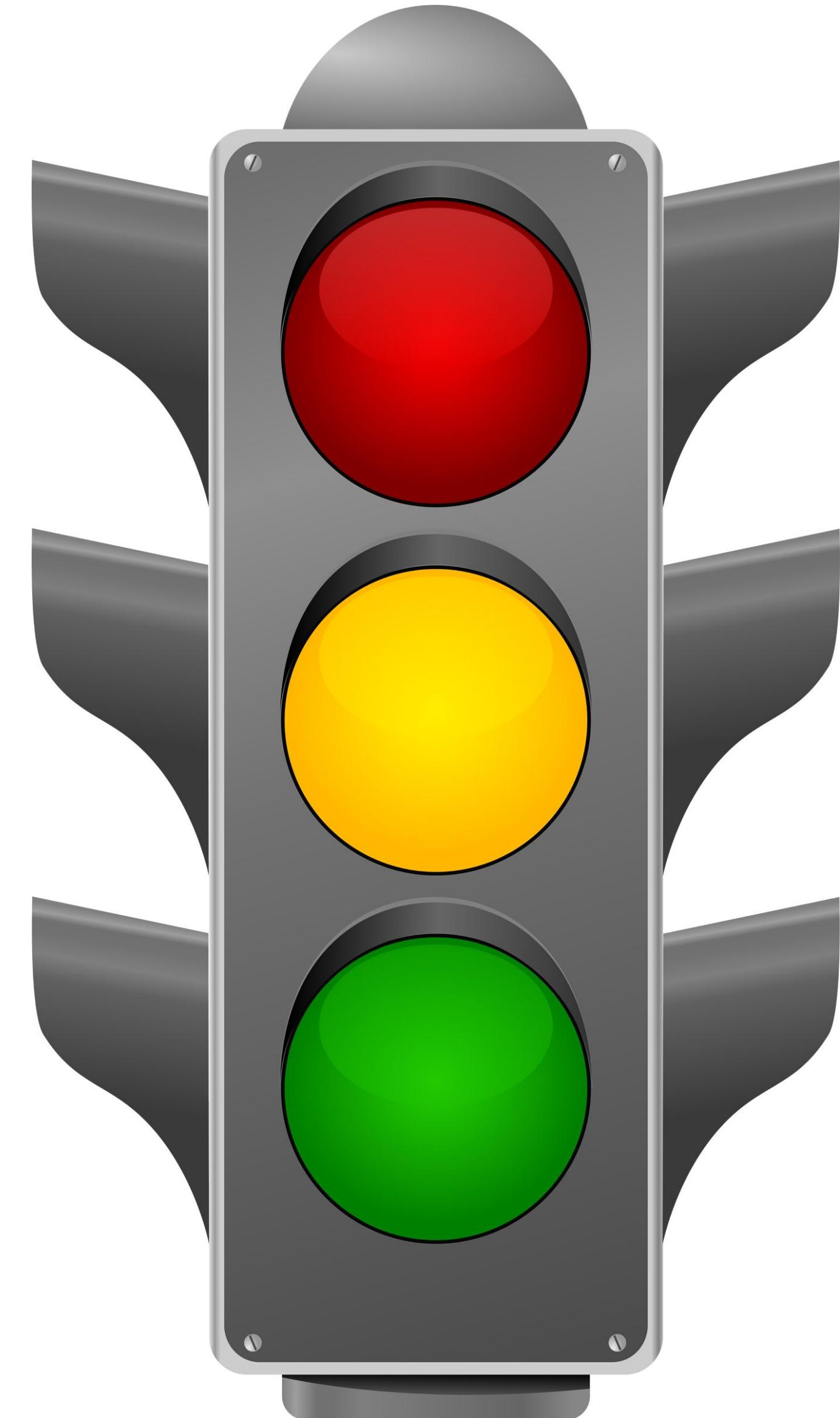
Considerations in Designing for Color Difference

Some ways of understanding color difference

- deuteranomaly: green anomaly
- protanomaly: red anomaly
- deutanopia: green deficient
- protanopia: red deficient
- tritanomaly: blue anomaly
- tritanopia: blue deficient
- greyscale: no color

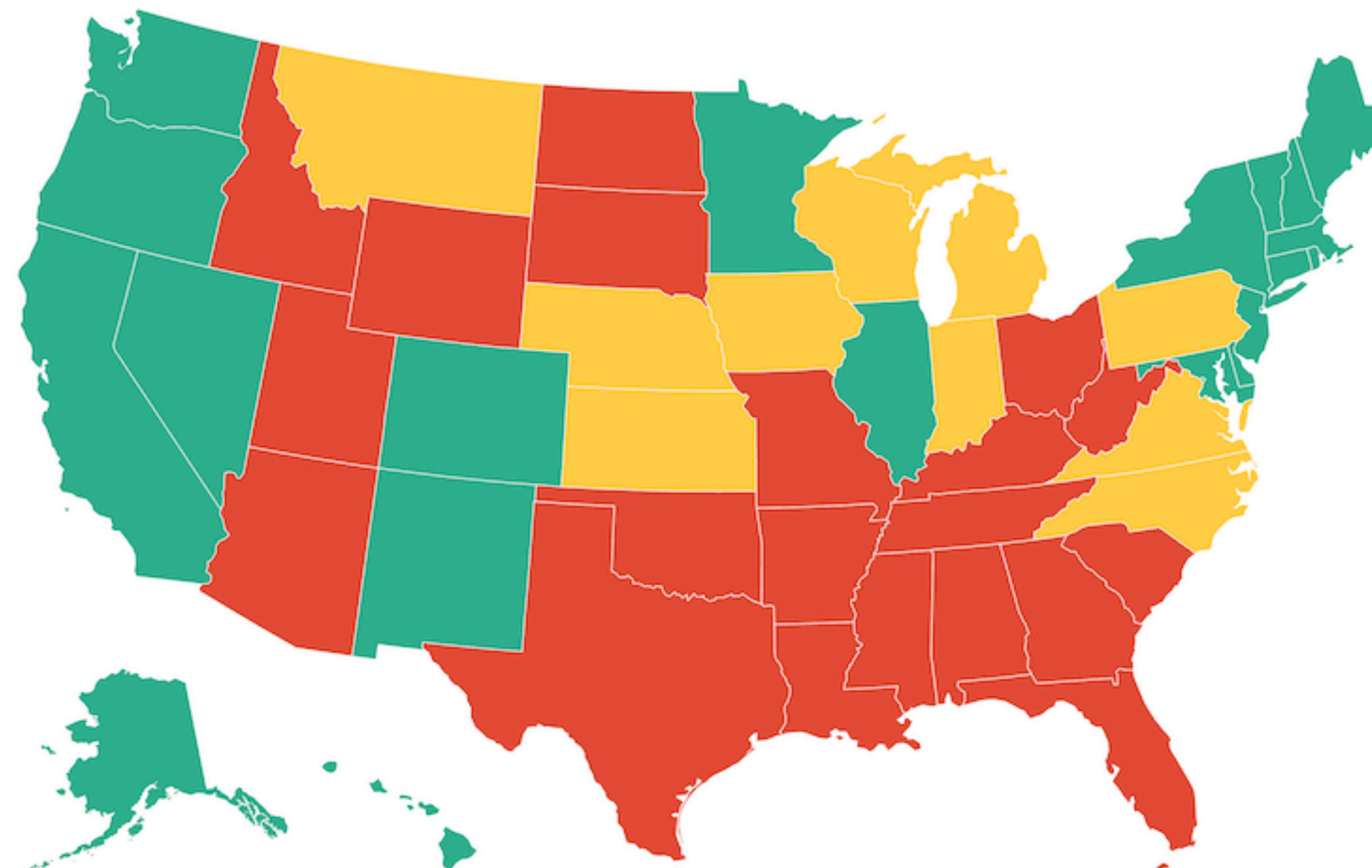
Red-Blue/Yellow-Blue color combinations are generally safe

Avoid stoplight color scales.

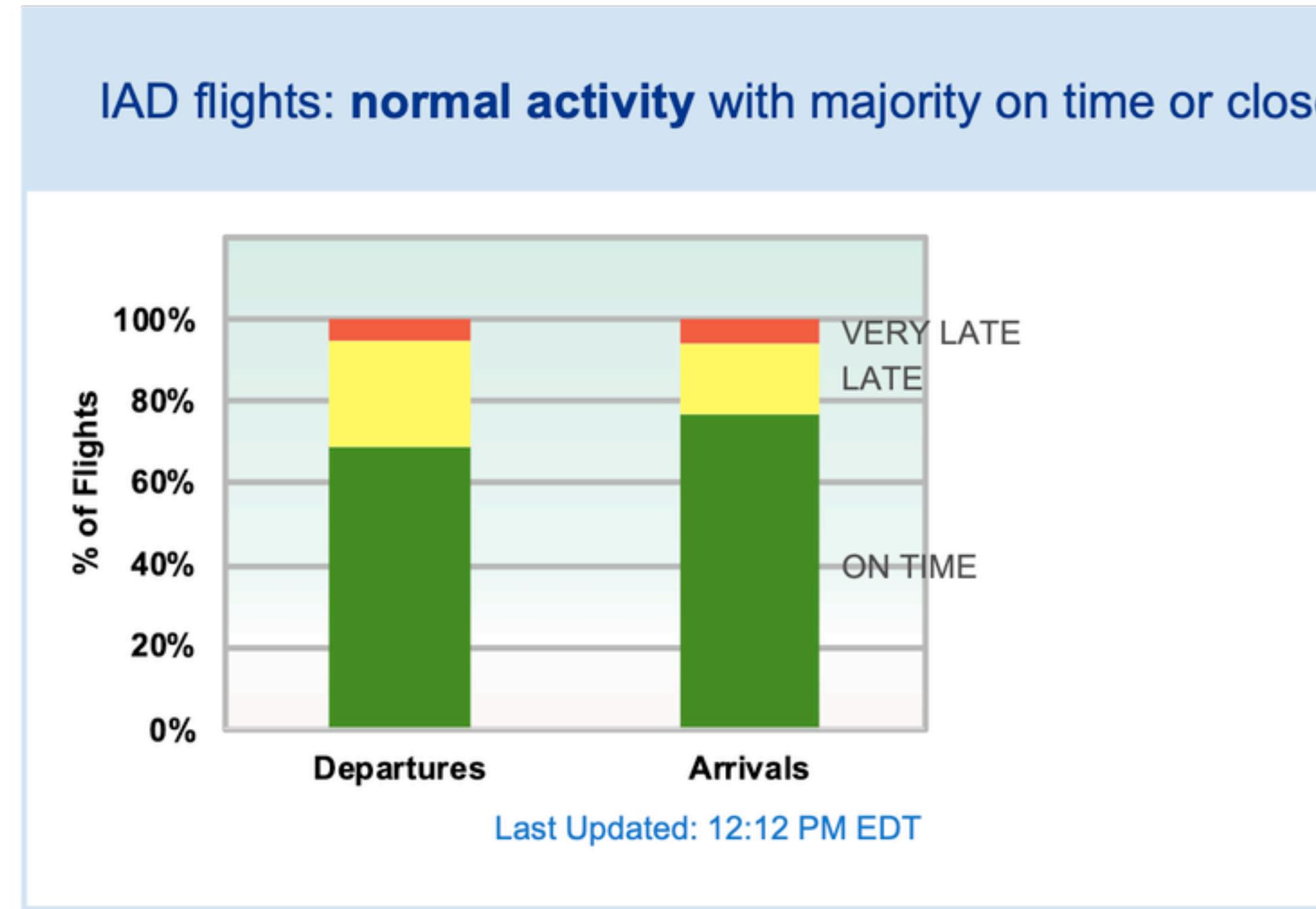


State laws split on abortion rights

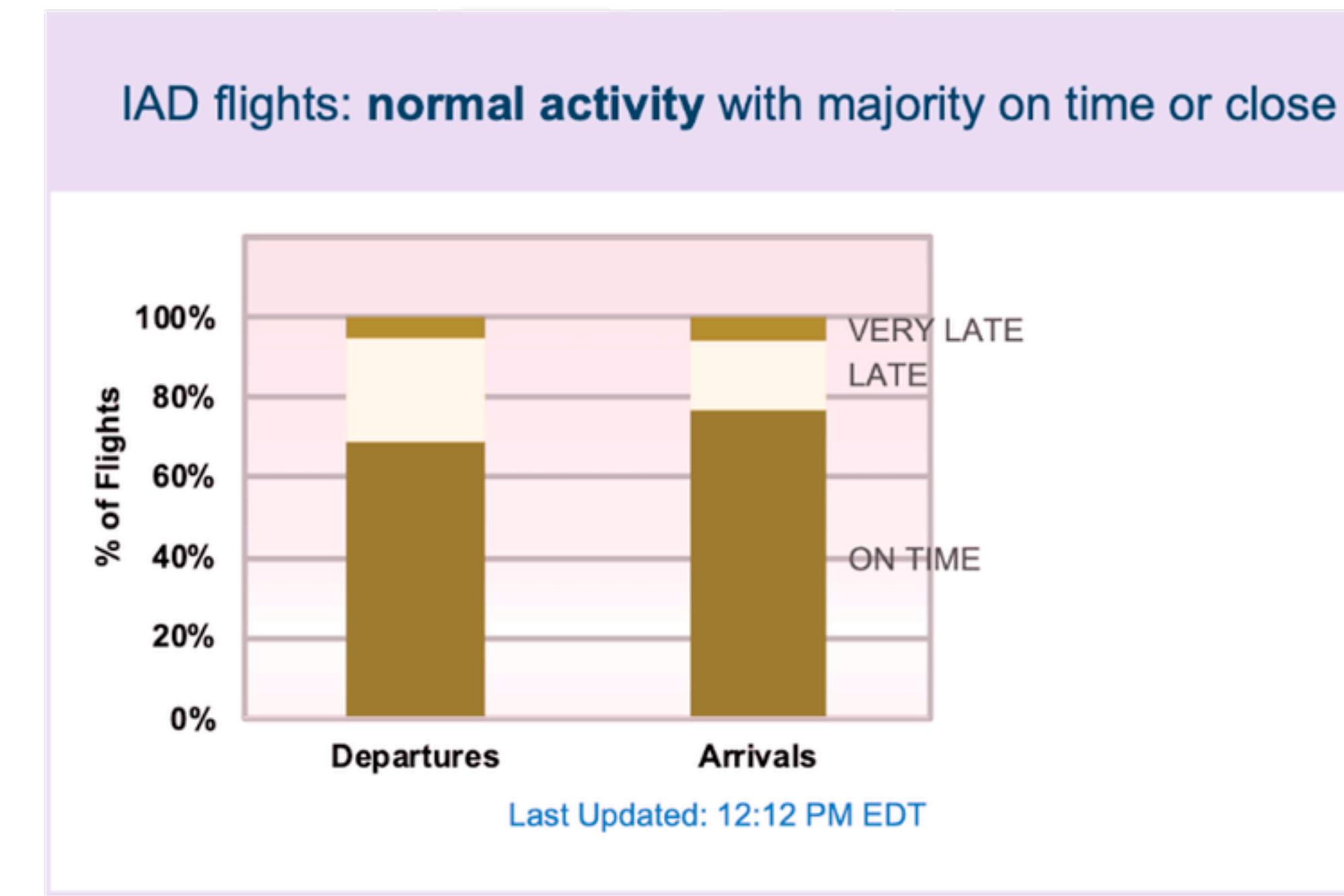
According to a New York Times analysis of state laws, now that the Supreme Court has overturned Roe v. Wade, 20 states **have or are expected to prohibit or restrict abortions**, 20 and the District of Columbia **will continue to protect or expand abortion access**, and 10 have **uncertain or potentially changing** legal situations.



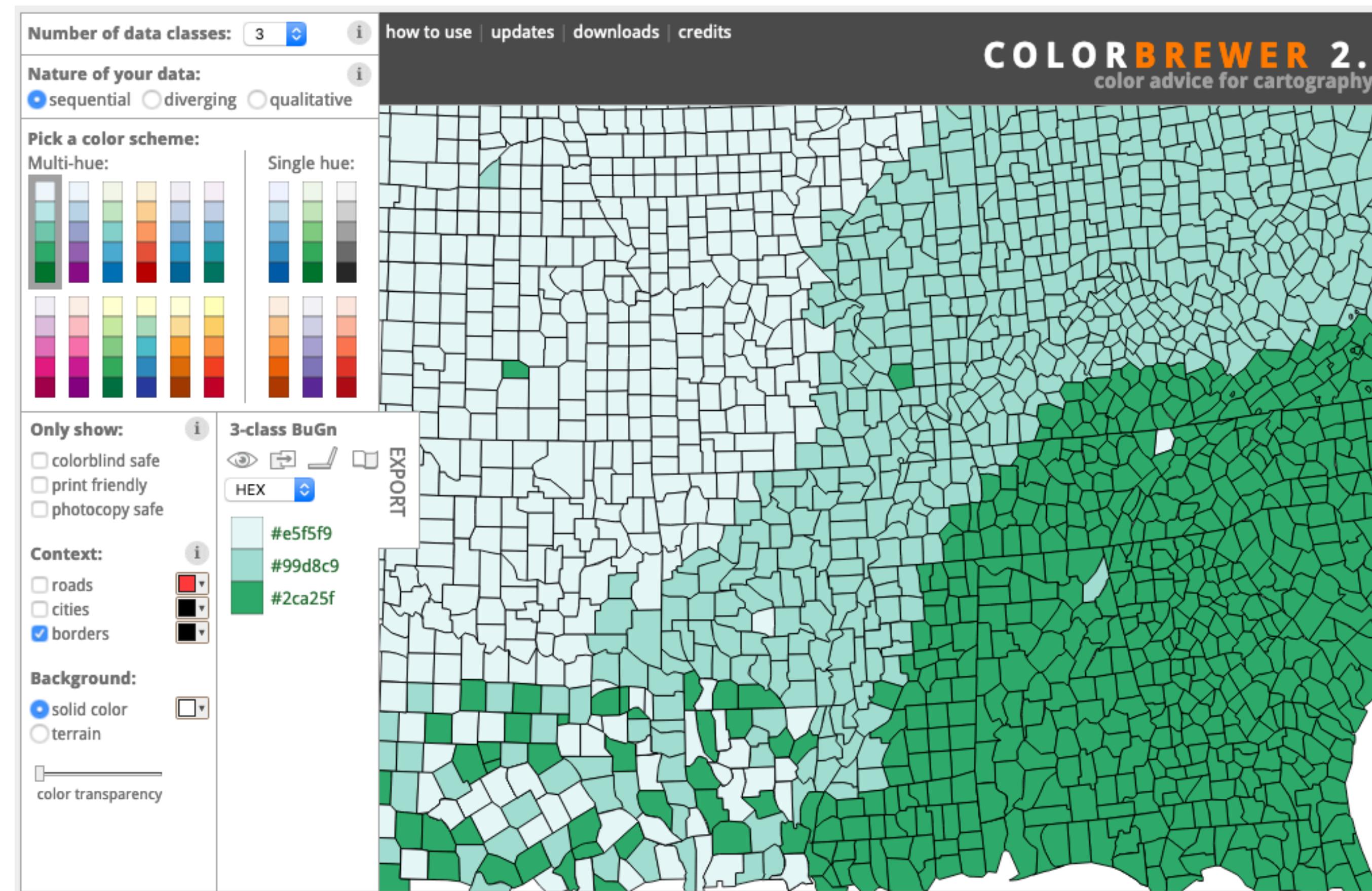
Map: The Conversation, CC-BY-ND • Source: New York Times



Graph with a **colorblind simulation** filter (deutanopia)



ColorBrewer's Colorblind Safe Scales



<https://colorbrewer2.org/>

VIZ PALETTE

By: Elijah Meeks
& Susie Lu

PICK

Use Chroma.js



Use Colorgorical

Use ColorBrewer

EDIT

7 Colors

#hex rgb
 hsl

- ≡ 1 ● #ffd700 ✎ ✘
- ≡ 2 ● #ffb14e ✎ ✘
- ≡ 3 ● #fa8775 ✎ ✘
- ≡ 4 ● #ea5f94 ✎ ✘
- ≡ 5 ● #cd34b5 ✎ ✘
- ≡ 6 ● #9d02d7 ✎ ✘
- ≡ 7 ● #0000ff ✎ ✘

GET

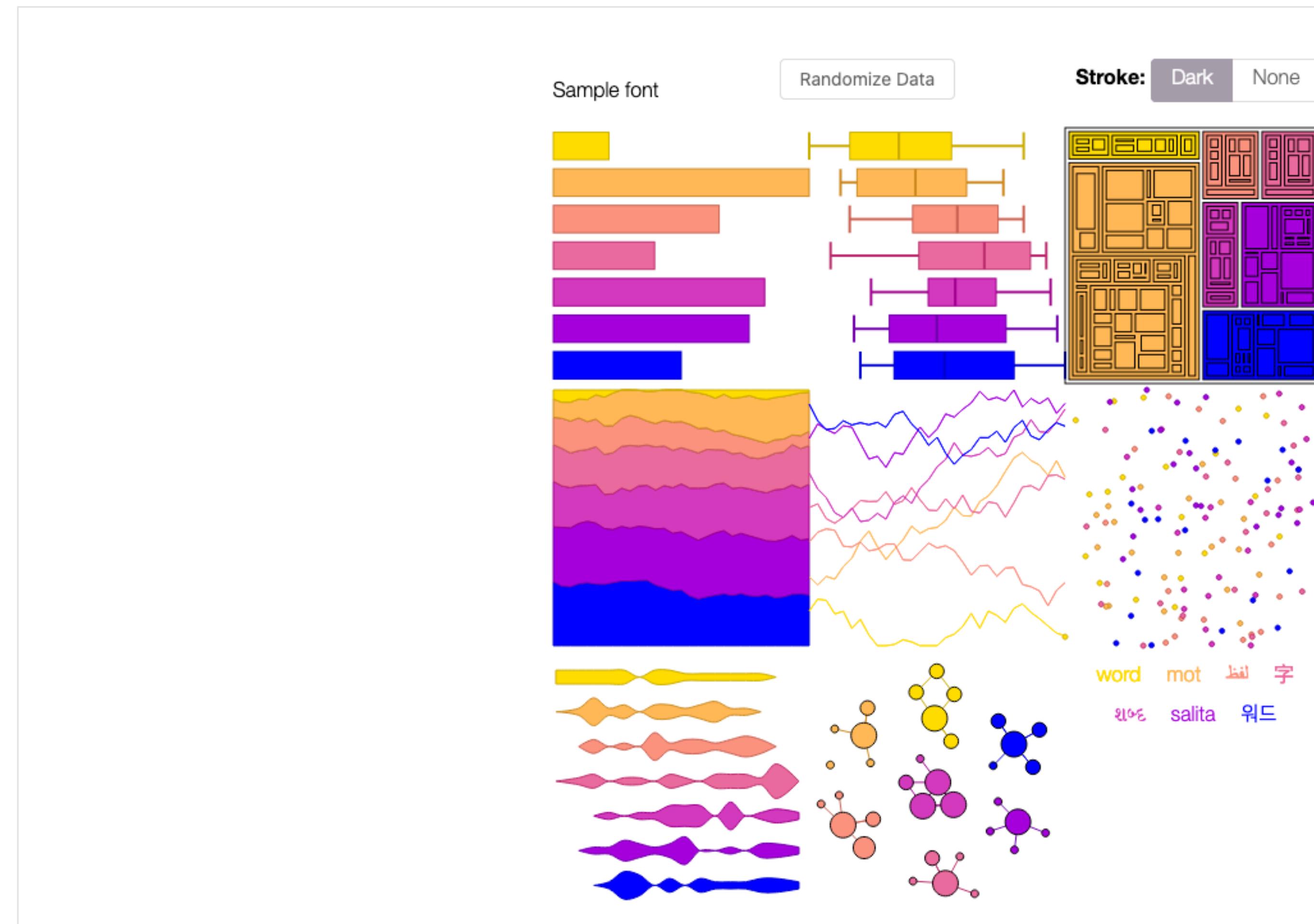
#hex rgb
 hsl

String quotes
 Object with metadata

```
[ "#ffd700",
  "#ffb14e",
  "#fa8775",
  "#ea5f94",
  "#cd34b5",
  "#9d02d7",
  "#0000ff"]
```

COLORS IN ACTION

Color Population: No Color Deficiency - 96% Deuteranomaly - 2.7% Protanomaly - 0.66% Protanopia - 0.59% Deuteranopia - 0.56% Greyscale



<https://projects.susielu.com/viz-palette>

Coblis

Drag and drop or paste your file in the area below or: [Browse...](#) No file selected.

Trichromatic view: Anomalous Trichromacy: *Dichromatic view:* *Monochromatic view:*

Normal Red-Weak/Protanomaly Red-Blind/Protanopia Monochromacy/Achromatopsia
 Green-Weak/Deutanomaly Green-Blind/Deutanopia Blue Cone Monochromacy
 Blue-Weak/Tritanomaly Blue-Blind/Tritanopia

Use lens to compare with normal view: No Lens Normal Lens Inverse Lens

[Reset View](#)



Zoom, move and lens functionality only with your own images available.

High Color Contrast

Per Web Content Accessibility Guidelines (WCAG),
text contrast must be at least **4.5** to pass AA,
and at least **7.0** to pass AAA.

Color. review

The **contrast** between foreground and background is **11.3**

Text **AAA** ✓ Headlines **AAA** ✓ ↗ color.review/check/083B6B-FFFFFF

A screenshot of the Color.review website. At the top left, it says "The contrast between foreground and background is 11.3". Below this is a large preview area showing a blue gradient background with white text. The text includes the word "Color." and the word "review" in a large, bold, black font. On the right side of the preview area, there are two color swatches: one for the "Foreground" (blue) and one for the "Background" (white). Below each swatch are their respective CMYK, RGB, and HSL values. At the bottom of the preview area is a horizontal color picker bar with a blue dot indicating the current color being analyzed.

Foreground

c 93 m 45 y 0 k 58
rgb(8, 59, 107) hsl(209, 86.7%, 22.5%)

Background

c 0 m 0 y 0 k 0
rgb(255, 255, 255) hsl(145, 0%, 100%)

Flip ⚡ RGB HSL CMYK CSS

<https://color.review/>

Colorable

Aa 7.84AAA

[Tweet](#)

Contrast is the difference in luminance or color that makes an object (or its representation in an image or display) distinguishable. In visual perception of the real world, contrast is determined by the difference in the color and brightness of the object and other objects within the same field of view.

Text

#004466

Hue 200°

Saturation 1

Lightness 0.2

Background

#00ffa2

Hue 158°

Saturation 1

Lightness 0.5

“If one says ‘Red’ (the name of the color) and there are 50 people listening, it can be expected that there will be 50 reds in their minds. And one can be sure that all these reds will be very different.”

– Josef Albers

"In treating usability as communication, we would be thinking not only of whether it is obvious how to use something but who can use something.... [Y]ou can be addressed by a sign on a door. You can also be addressed by a door. Scholars in disability studies have developed some of the most important insights into the uses of use, through exploring how the world has been designed for a body with assumed capabilities. As Aimi Hamraie describes in *Building Access*, "Examine any doorway, window, toilet, chair, or desk...and you will find the outline of the body meant to use it".... Intended functionality is about the creation of such outlines: for whom something is supposed to function. An outline is not simply an idea of who is the user. An outline is an enabling or a disenabling of somebody. If an outline of a person is intended, then those who are outlined can use something; those who are not cannot. Usability can thus be reframed as a question of accessibility: it is not just whether an object or environment can be used but who can use an object or environment given how it has been designed and who cannot."

Don't forget text!

Plain Language and/or “Sparkling Lucidity”

See: Sara Hendren, “The Opposite of Jargon” (re:“sparkling lucidity”): <https://sarahendren.com/2021/08/30/the-opposite-of-jargon/>
See: Critical Design Lab, “On Plain Language”: <https://www.mapping-access.com/blog-1/2021/1/14/on-plain-language>

Additional Considerations (an incomplete list!)

- Do not assume everyone views your chart the same way! Learn about disabilities (*do your own HW*) and work with disabled people as valued knowledge producers
- In addition to using high color contrast, avoid relying solely on color. Use other encodings or interactive elements to convey the message or important explanations
 - Use explanations and legends
 - Consider adding labels directly to the chart
 - Use a secondary encoding (opacity, size, patterns, & etc.)
- Include clear, short, and thorough textual explanations—written with “sparkling lucidity”
 - Ensure both the included language and context is widely understandable
 - Have your title convey clear meaning: i.e. the chart’s function
- Link to the CSV/data source within the chart’s text if possible
- Ensure alt text is clear, explains the function of the chart, and is succinct—but meaningful
- Consider testing out your work with accessibility checkers

Color with D3/SVG

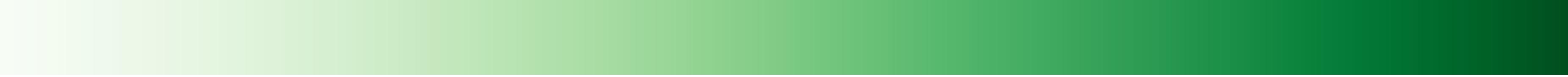
Color with D3/SVG

- Opacity
- Color Scales

Opacity

- RGBA
- .style("opacity", ...)

**d3.scaleSequential()
d3.scaleOrdinal()**



d3.interpolateGreens
d3.schemeGreens[k]

D3 Examples

Tools for Finding Colors/ Creating Color Palettes



Tutorials ▾

Exercises ▾

Certificates ▾

Services ▾

Search...



Set Goal

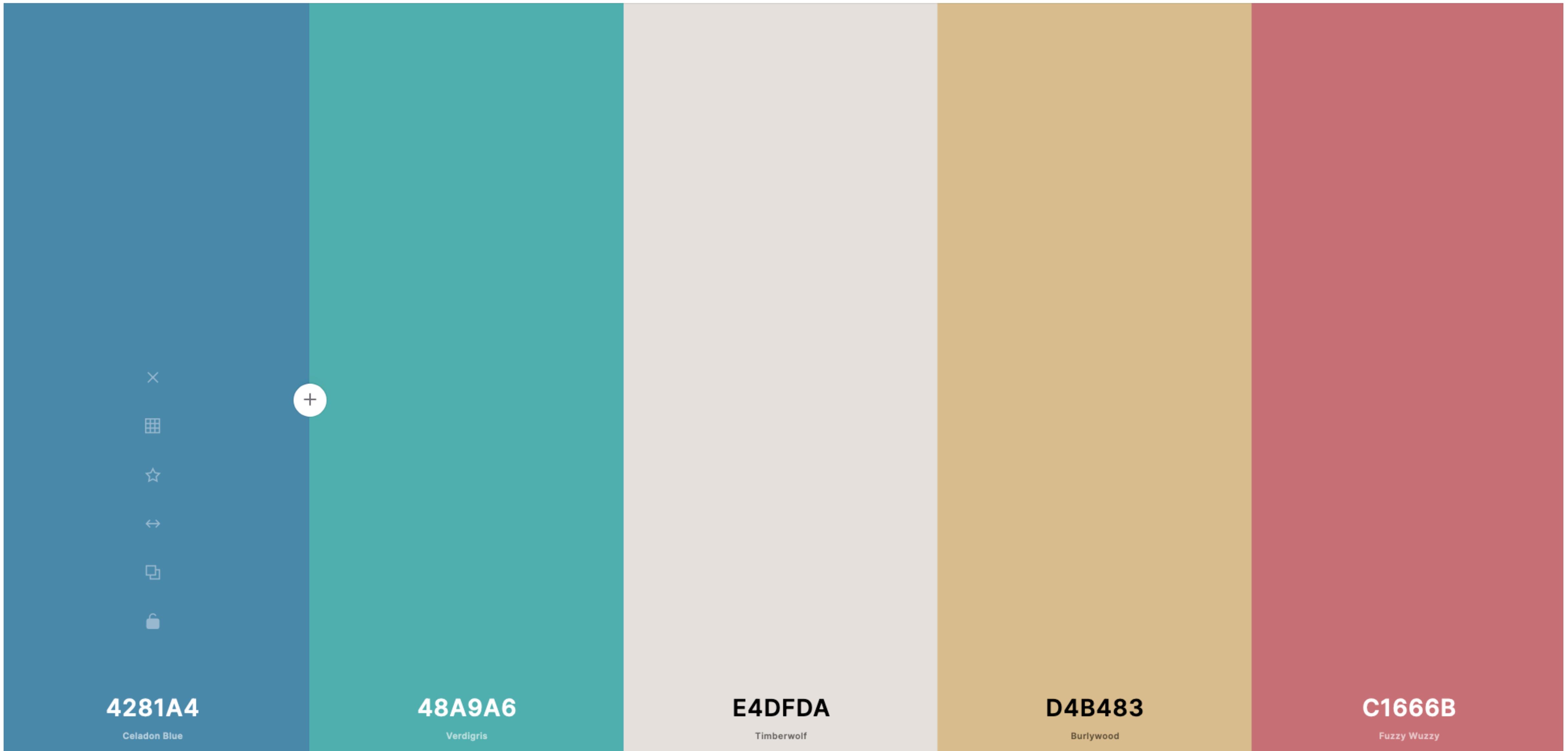
Spaces

Get Certified

HTML	CSS	JAVASCRIPT	SQL	PYTHON	JAVA	PHP	HOW TO	W3.CSS	C	C++	C#	BOOTSTRAP	REACT	MYSQL	JQUERY
Colors Tutorial Colors HOME Color Names			Blue #0000FF				BlueViolet #8A2BE2					Brown #A52A2A			
Color Values				BurlyWood #DEB887			CadetBlue #5F9EA0					Chartreuse #7FFF00			
Color Groups					Chocolate #D2691E			Coral #FF7F50				CornflowerBlue #6495ED			
Color Shades					Cornsilk #FFF8DC			Crimson #DC143C				Cyan #00FFFF			
Color Picker						DarkBlue #00008B		DarkCyan #008B8B				DarkGoldenRod #B8860B			
Color Mixer						DarkGray #A9A9A9		DarkGrey #A9A9A9				DarkGreen #006400			
Color Converter						DarkKhaki #bdb76b		DarkMagenta #8B008B				DarkOliveGreen #556B2F			
Color RGB															
Color HEX															
Color HSL															
Color HWB															
Color CMYK															
Color NCol															
Color Gradient															
Color Theory															
Color Wheels															
Color currentcolor															
Color Hues															
Color Schemes															
Color Palettes															
Color Brands															
Color W3.CSS															
Color Metro UI															
Color Win8															
Color Flat UI															
Color Psychology															
Color Schemes															
Colors Monochromatic															
Colors Analogous															
Colors Complementary															
Colors Triadic															
Colors Compound															

https://www.w3schools.com/colors/colors_names.asp

Press the spacebar to generate color palettes!



<https://colors.co/>



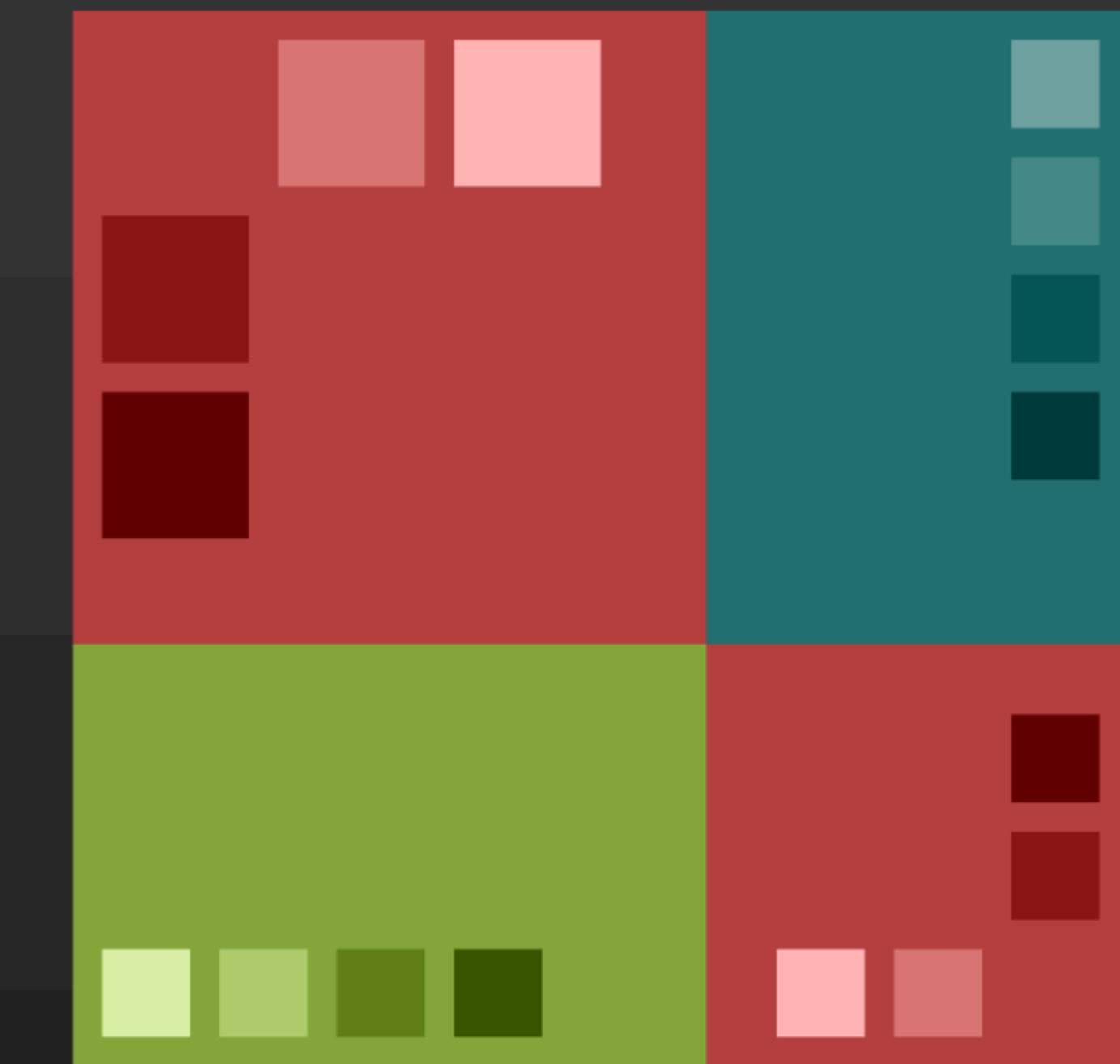
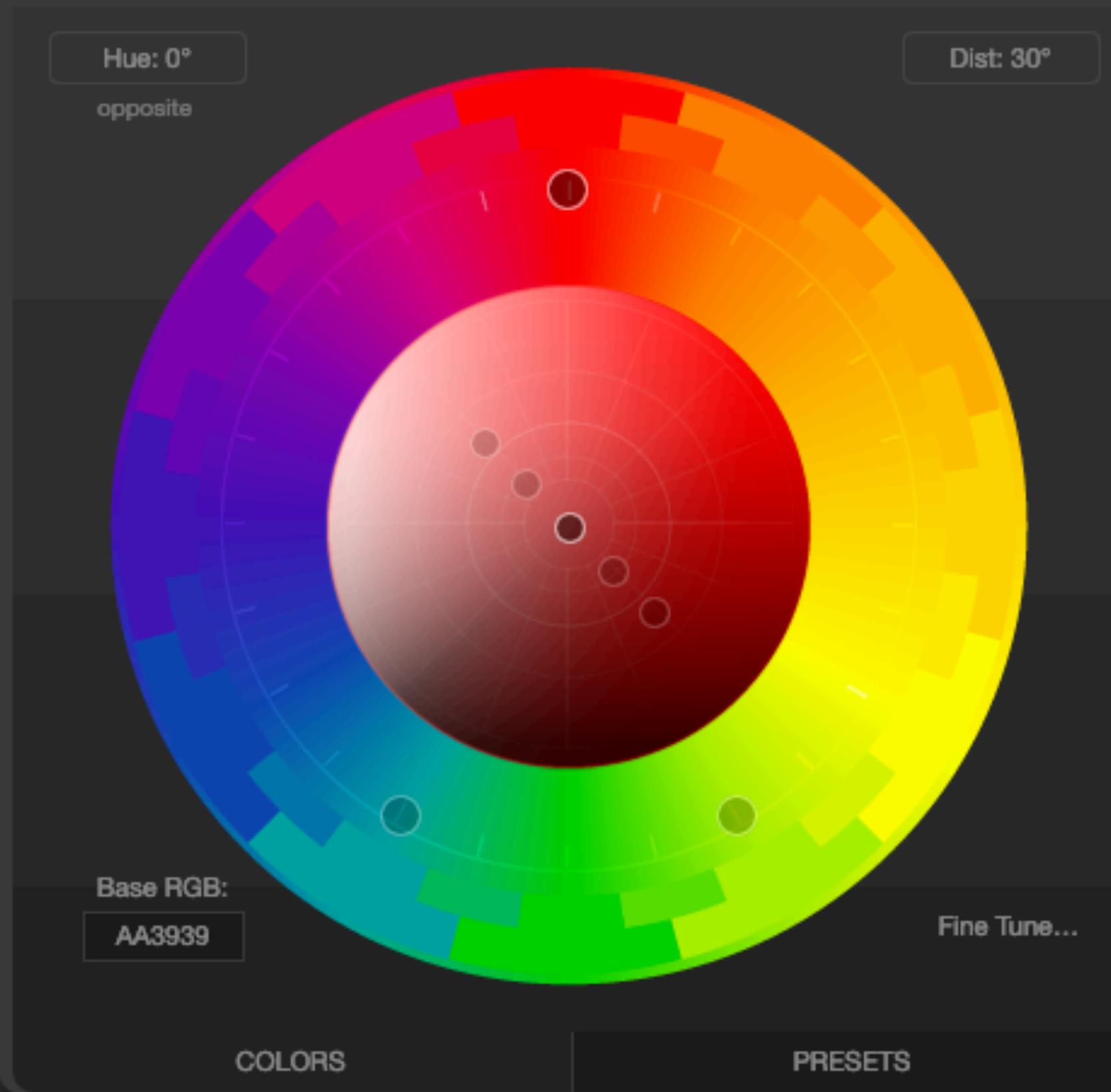
< UNDO REDO > RESET RANDOMIZE... MORE INFO ▾

Donate



Triad (3-colors)
 add complementary

My Palette: Share palette ▾



Vision simulation ▾

PREVIEW ▾

EXAMPLES...

TABLES / EXPORT...

<https://paletton.com/>

[Color Wheel](#) [Extract Theme](#) [Extract Gradient](#) [Accessibility Tools](#) [New](#)

Save to Your Library

Name Tags
Enter or Select from below

Check for Accessibility

[Save](#)

Apply Color Harmony Rule

 Analogous Monochromatic Triad Complementary Split Complementary Double Split Complementary Square Compound Shades Custom

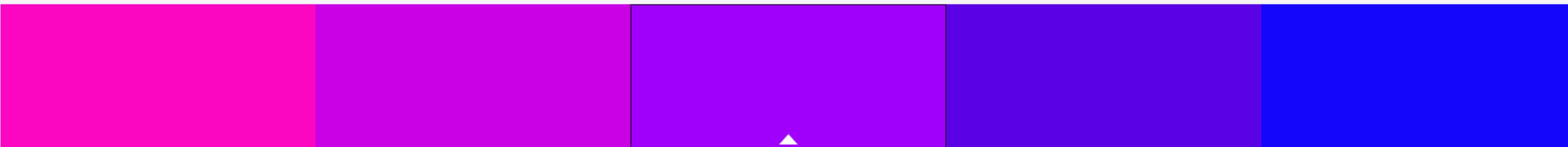
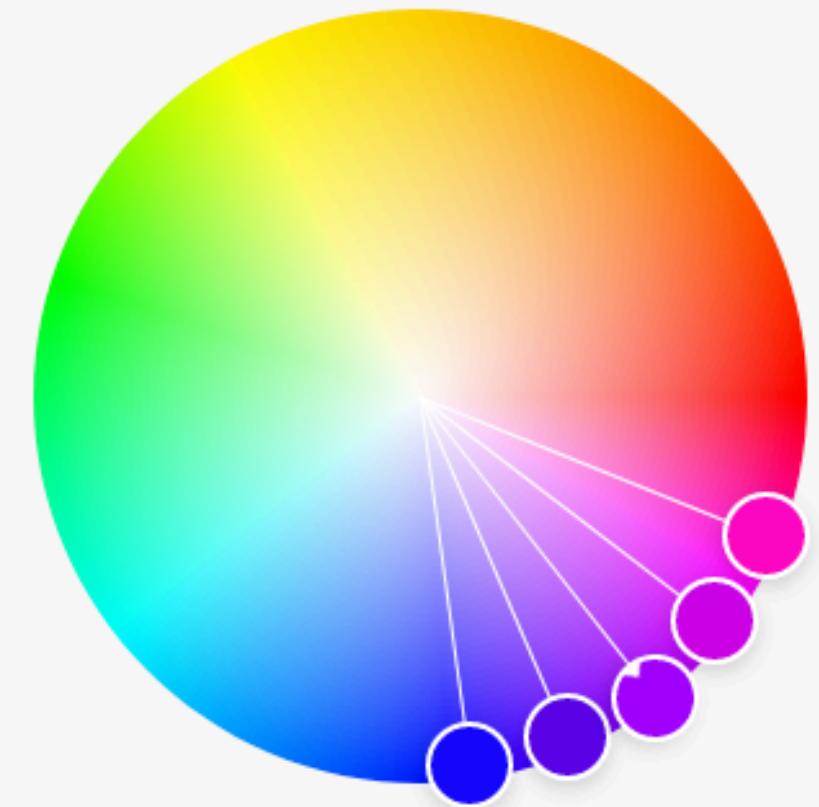
A

B

C

D

E



#FD0ABC

#C709E3

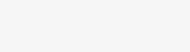
#9702FA

#5009E3

#170AFD

Color Mode

RGB



R 253

G 199

B 151

#5009E3

#170AFD

R 253

G 9

B 250

#5009E3

#170AFD

R 10

G 227

B 227

#5009E3

#170AFD

R 188

G 89

B 98

#5009E3

#170AFD

R 99

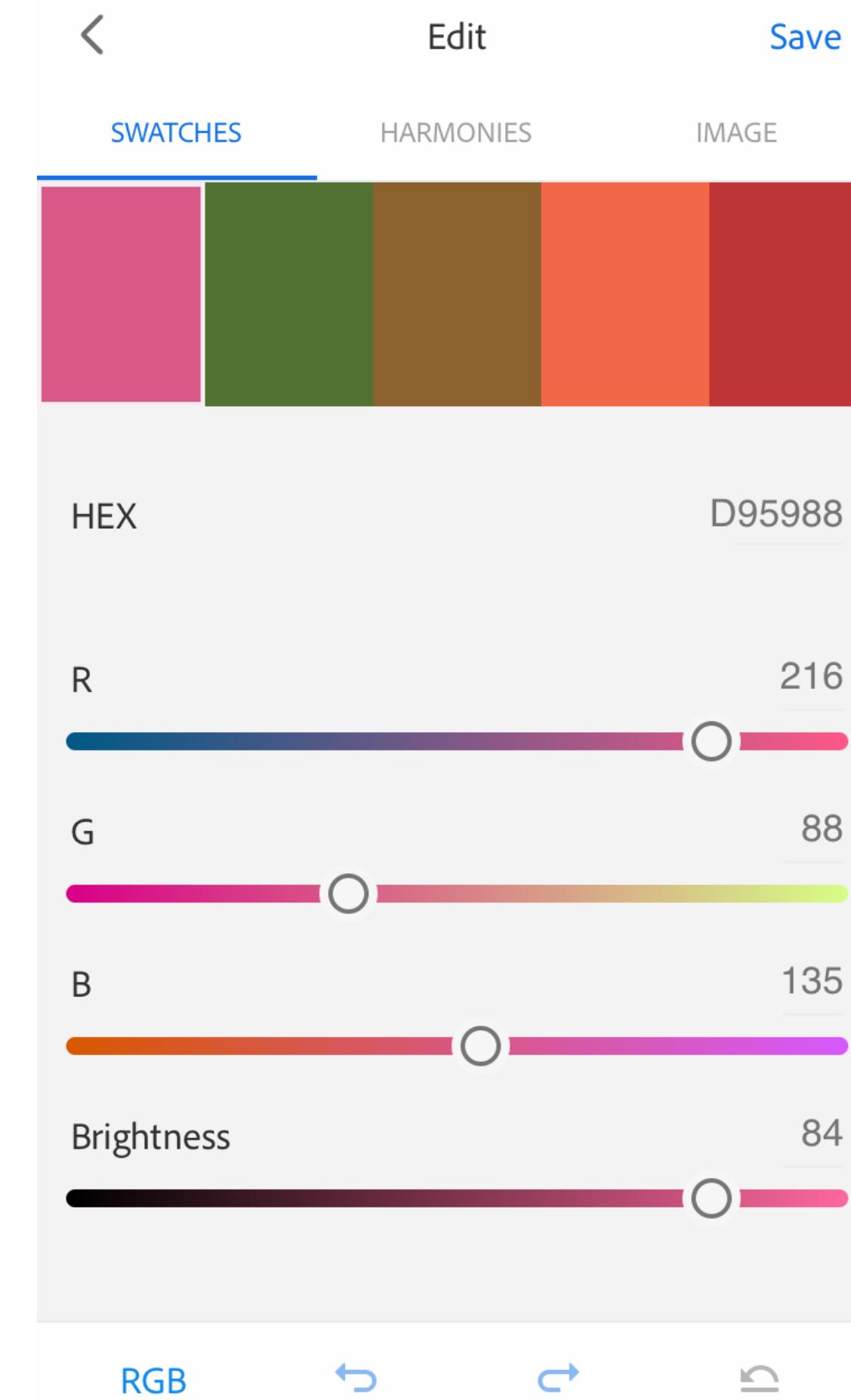
G 253

B 99

#5009E3

#170AFD

Adobe Color (web)



Adobe Capture (mobile)

**What tools do you use for color/
design?**

Homework and Resources

No HW this week. D3 HW 3 to be assigned next week.

Color Resources Referenced

- Adobe Color and Adobe Capture
- Coblis (<https://www.color-blindness.com/coblis-color-blindness-simulator/>)
- Colorable (<https://colorable.jxnblk.com/>)
- Color Brewer (<https://colorbrewer2.org> – also available via Viz Palette)
- Colorgorical: Color Selector Tool (<http://vrl.cs.brown.edu/color>)
- Color Review (<https://color.review/>): a tool for examining color contrast and accessibility
- Coolors (<https://coolors.co>): a palette creator tool that is great for browsing, and looking at random colors together to inspire your project
- “d3-scale-chromatic” (<https://d3js.org/d3-scale-chromatic>)
- David McCandless, “Colours in Culture” <https://informationisbeautiful.net/visualizations/colours-in-cultures/>
- Paletton (<https://paletton.com>)
- Viz Palette (<https://projects.susielu.com/viz-palette>)
- W3 Schools (see, for example: their Color Picker: https://www.w3schools.com/colors/colors_picker.asp and Color Names: https://www.w3schools.com/colors/colors_names.asp pages)
- W3, “Web Content Accessibility Guidelines (WCAG)” <https://www.w3.org/WAI/standards-guidelines/wcag/>