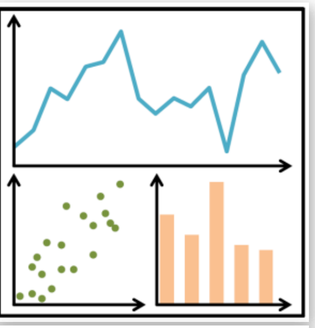
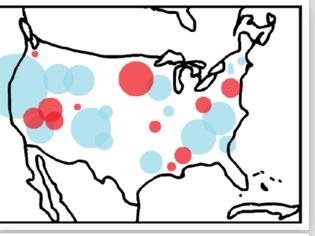
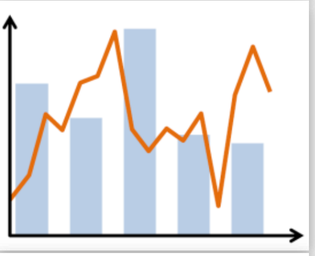
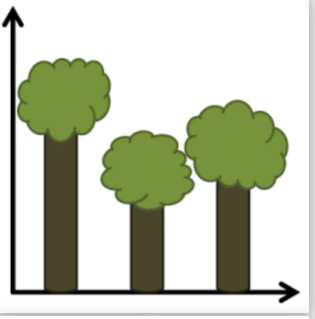
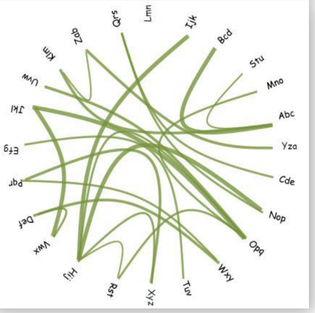






Color

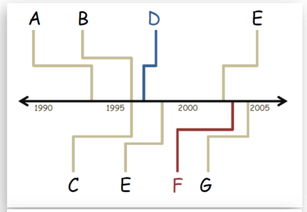
DS 4200

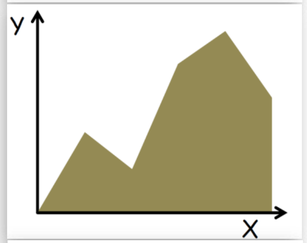
FALL 2020

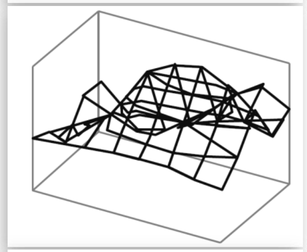
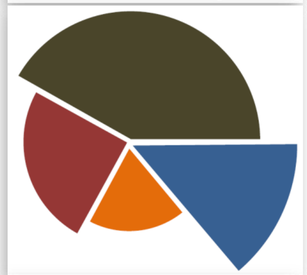
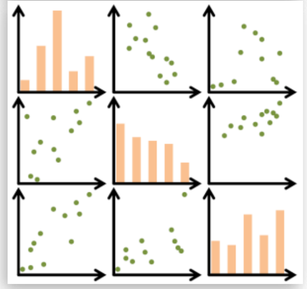
Prof. Cody Dunne

NORTHEASTERN UNIVERSITY

Slides and inspiration from Michelle Borkin, Krzysztof Gajos, Hanspeter Pfister, Miriah Meyer, Jonathan Schwabish, and David Sprague





Check-in

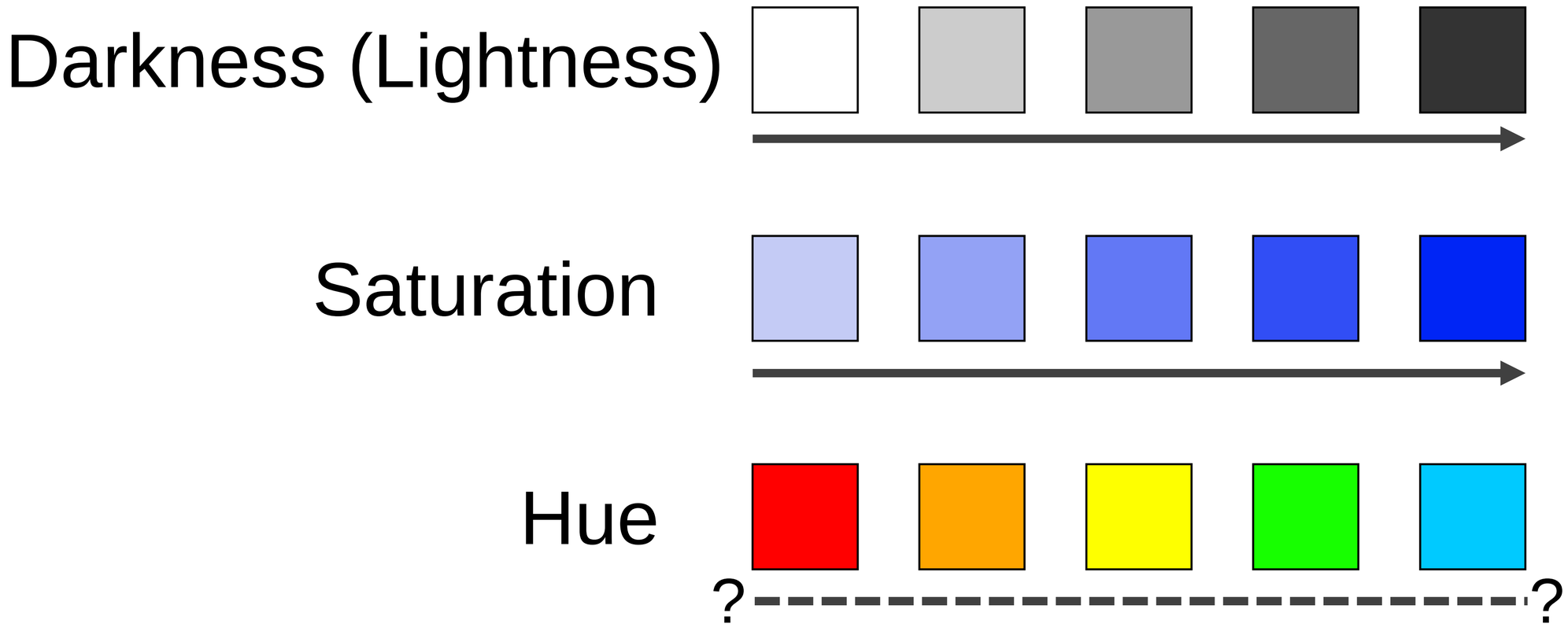
BRUSHING & LINKING SOLUTION

PREVIOUSLY, ON DS 4200…

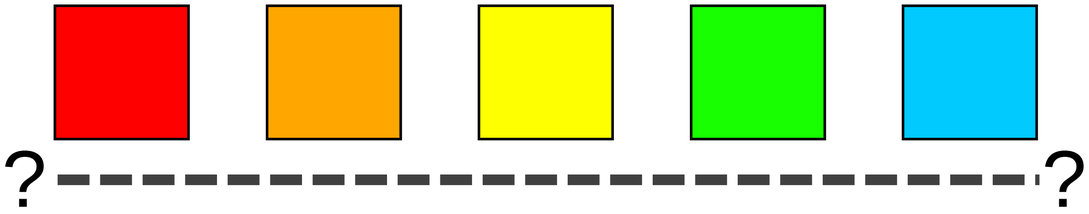
“…avoiding catastrophe becomes
the first principle in bringing color
to information: above all, do no harm.”

-Edward Tufte

Color Vocabulary and Perceptual Ordering



Rainbow Color Map (Hue)



Why this color map is a poor choice for quantitative data…

- No perceptual ordering (confusing)
- No darkness variation (obscures details)
- Viewers perceive sharp transitions in color as sharp transitions in the data, even when this is not the case (misleading)

Borland & Russell, 2007

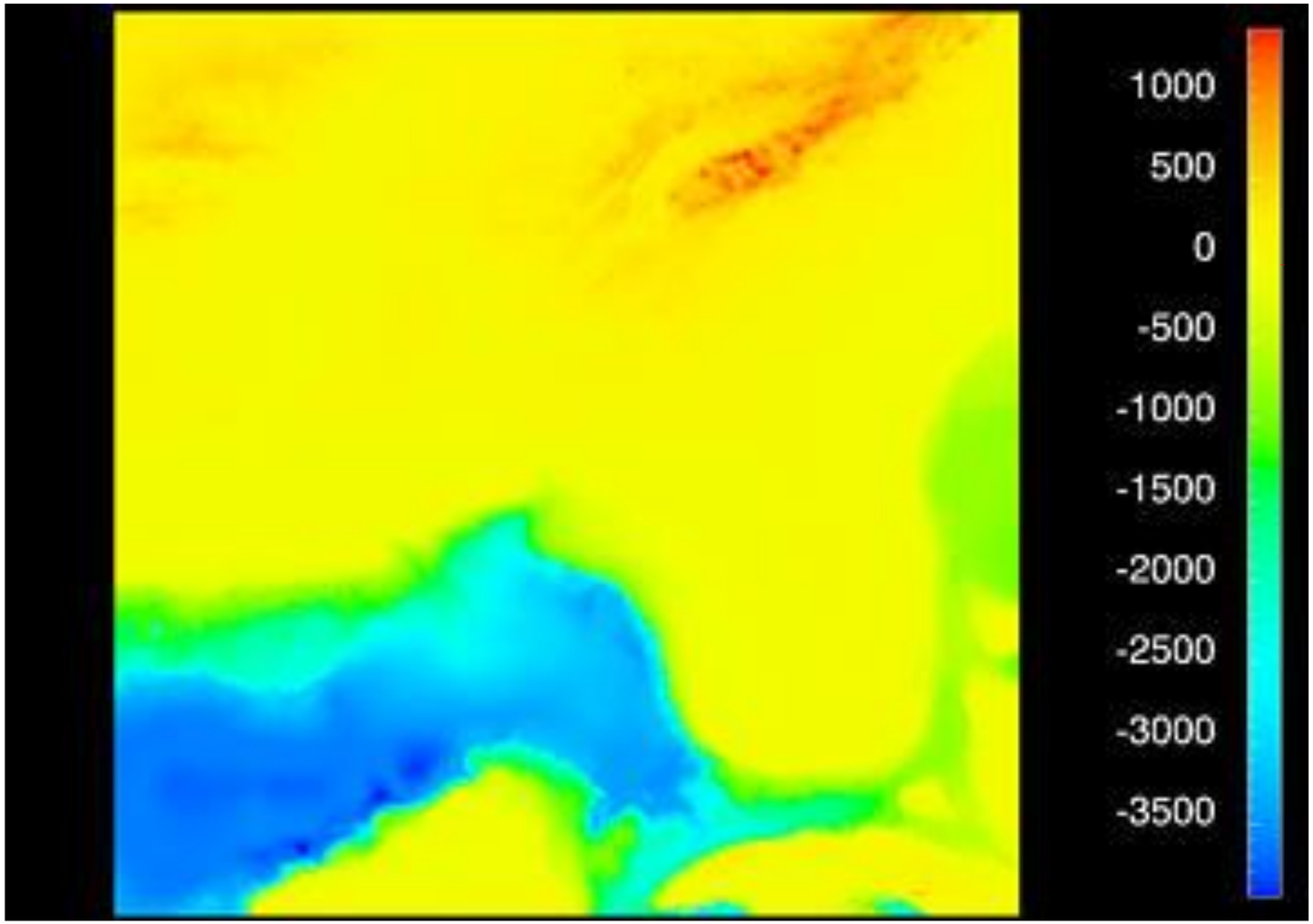
Now, on DS 4200…

COLOR

Goals for Today: learn How…

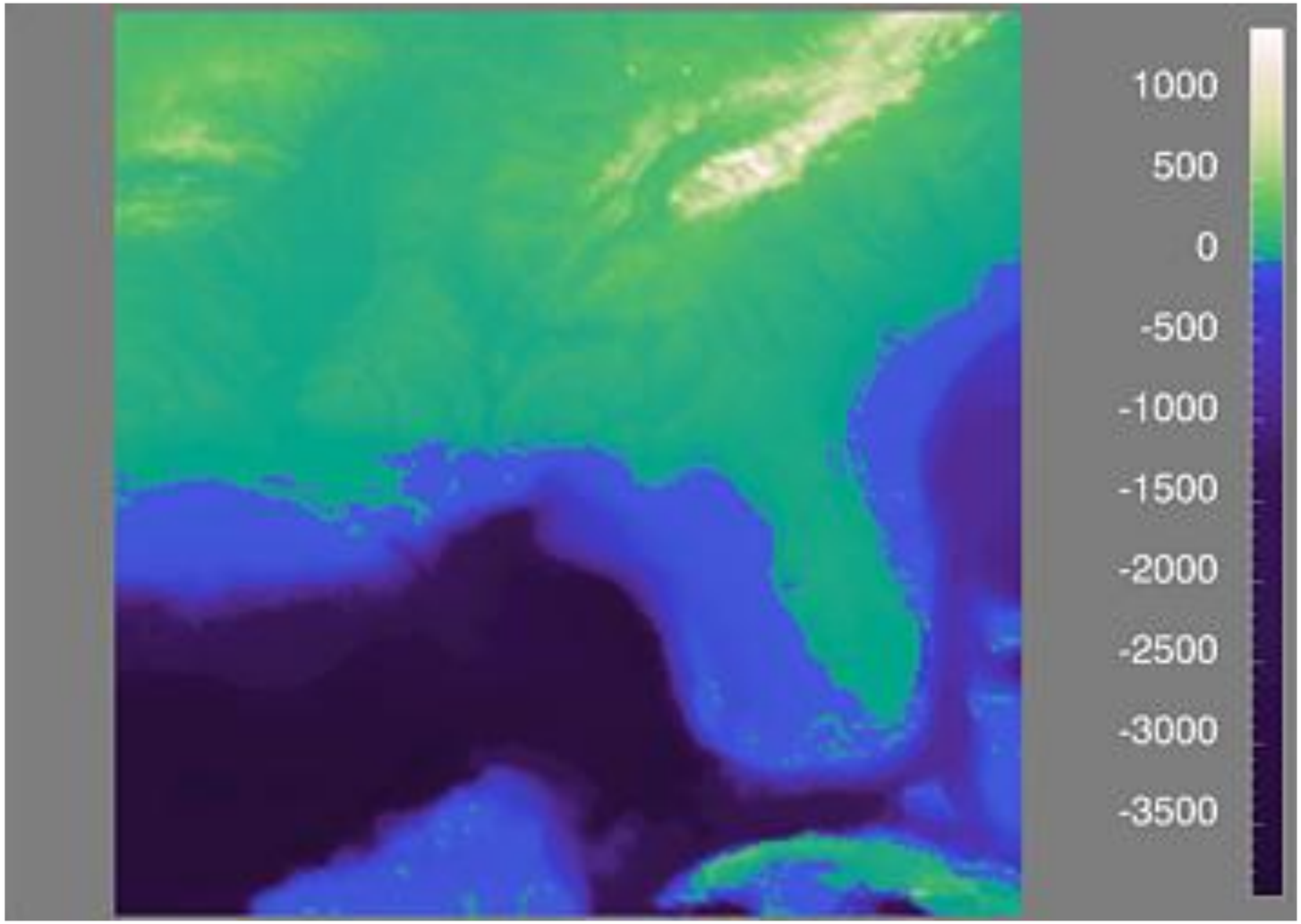
- …to effectively use color as a channel for visual encodings including different colormap types.
- …we process color in the visual system.
- …individual color differences (i.e., colorblindness) should be accommodated in visualizations.
- …interactions can occur between colors and with lighting.
- …illusions and tricks can affect perception.

Color Maps



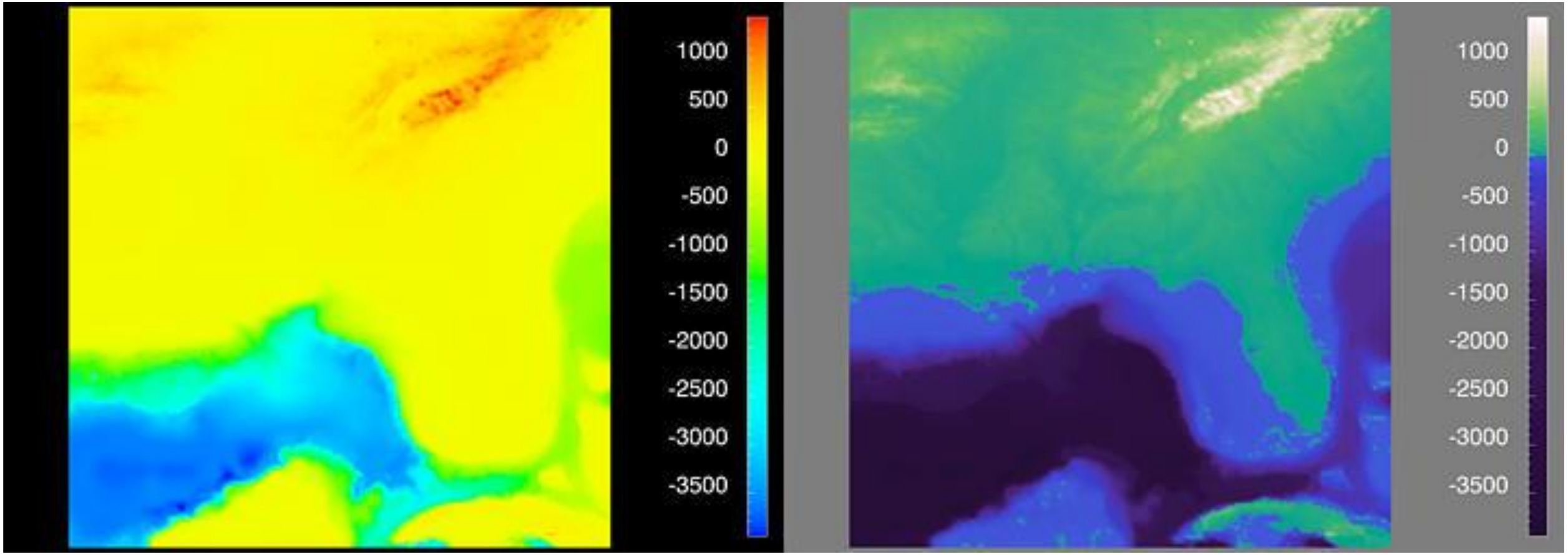
Rogowitz & Treinish, 1996

Color Maps



Rogowitz & Treinish, 1996

Color Maps



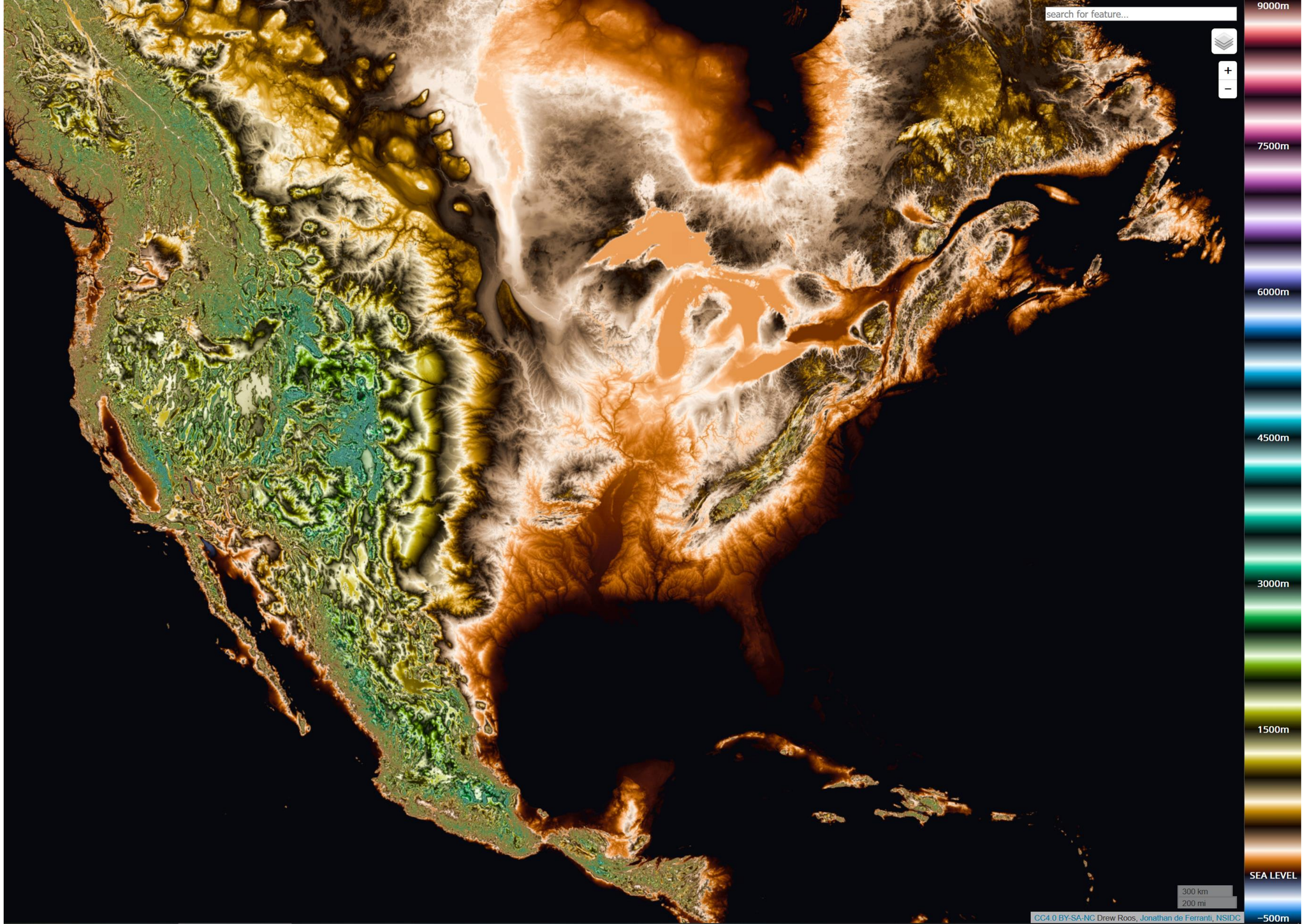
Sequential (possibly wrong)

Diverging

Sequential rainbow (wrong!)

Rogowitz & Treinish, 1996

Roos, 2015

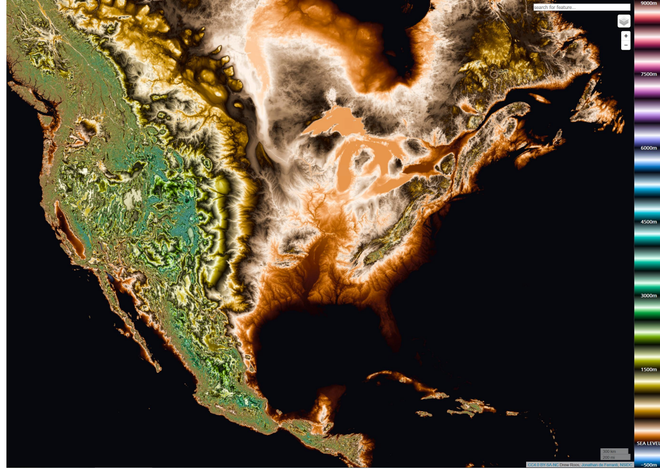

search for feature...
9000m
7500m
6000m
4500m
3000m
1500m
SEA LEVEL
−500m
300 km
200 mi
CC4.0 BY-SA-NC Drew Roos, Jonathan de Ferranti, NSIDC

Roos, 2015

IN-CLASS EXERCISE

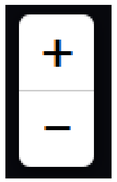
In-class exercise: Oilslick

10m



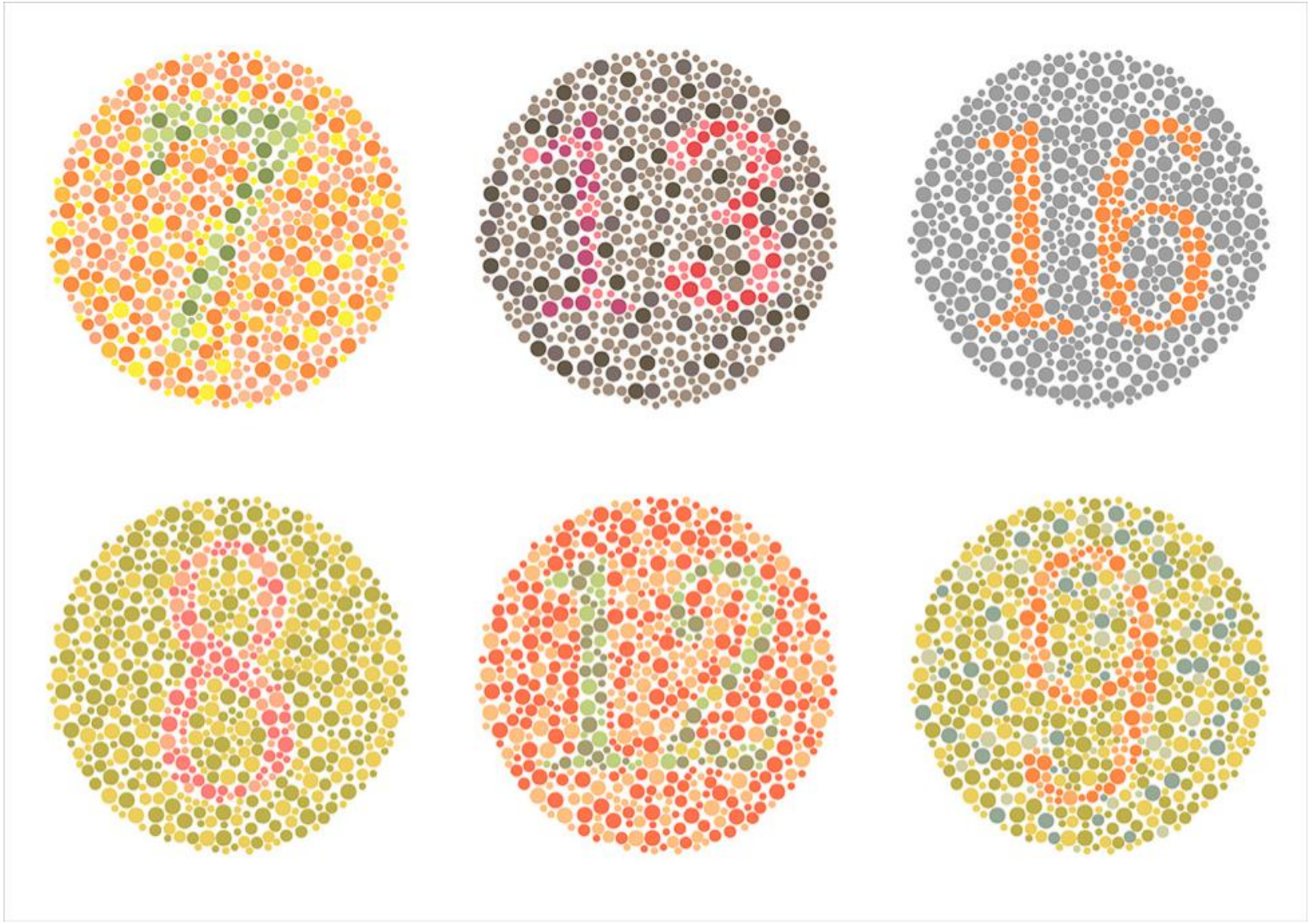
INSTRUCTIONS:

- Working individually, go to https://mrgris.com/projects/oilslick/
- Experiment with the different layers, different zoom levels, and different locations



- Think of answers to these questions:
  - What areas are particularly interesting?
  - Which layer / color scale works best, and for which tasks?

- Several of you will be asked to share your findings.

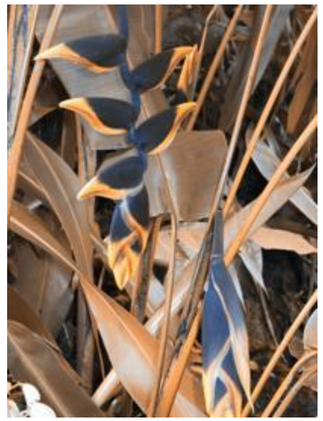


Those with deuteranope color blindness (red/green) will have difficulty seeing the numbers.

Color Deficiencies (Color Blindness)

Person with faulty cones (or faulty pathways):

Protanope = faulty red cones



Deuteranope = faulty green cones

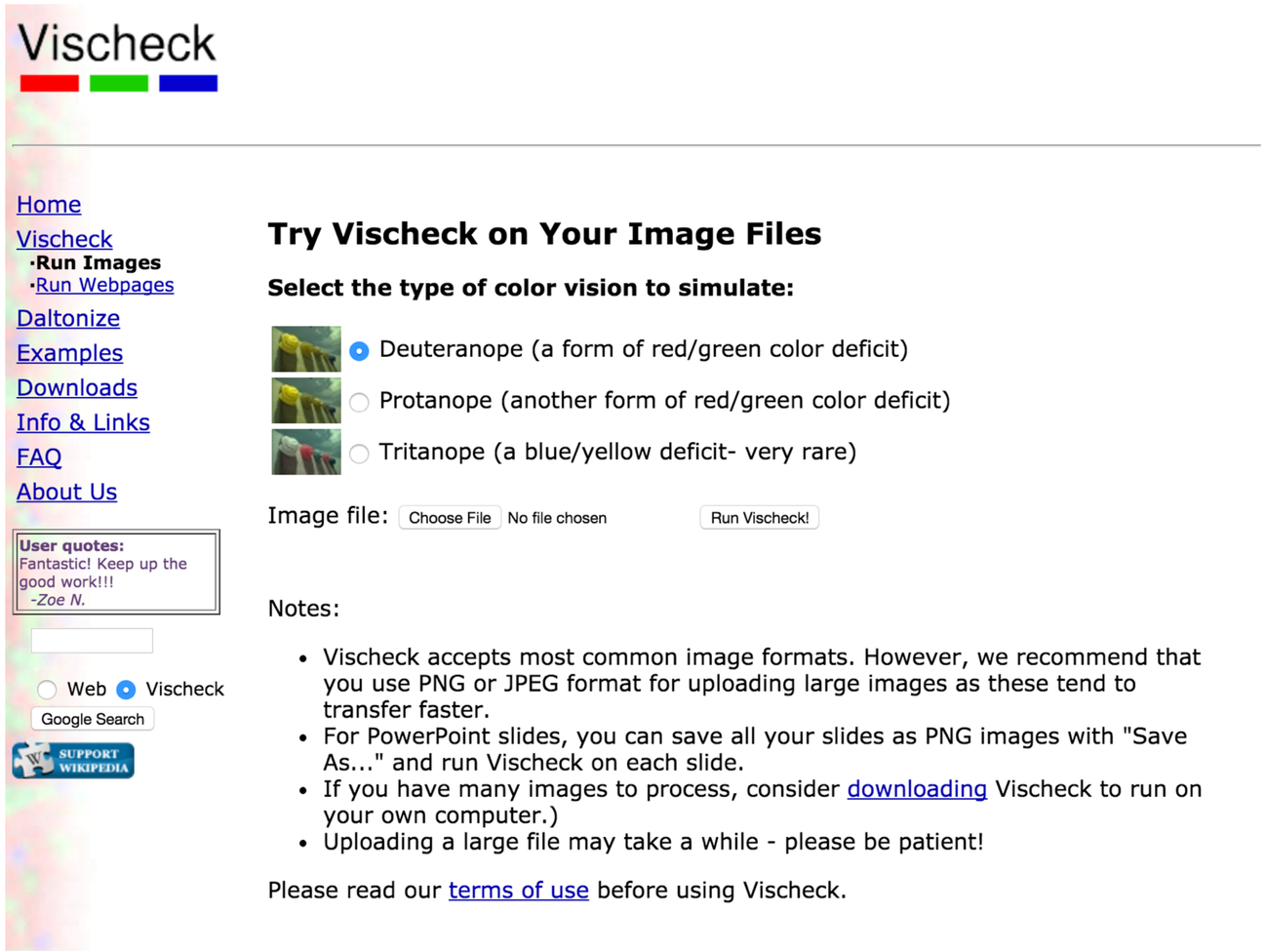
normal

Tritanope = faulty blue cones

Color Deficiencies (Color Blindness)

Based on Slides by Hanspeter Pfister, Maureen Stone

Check your images/colormaps for issues!



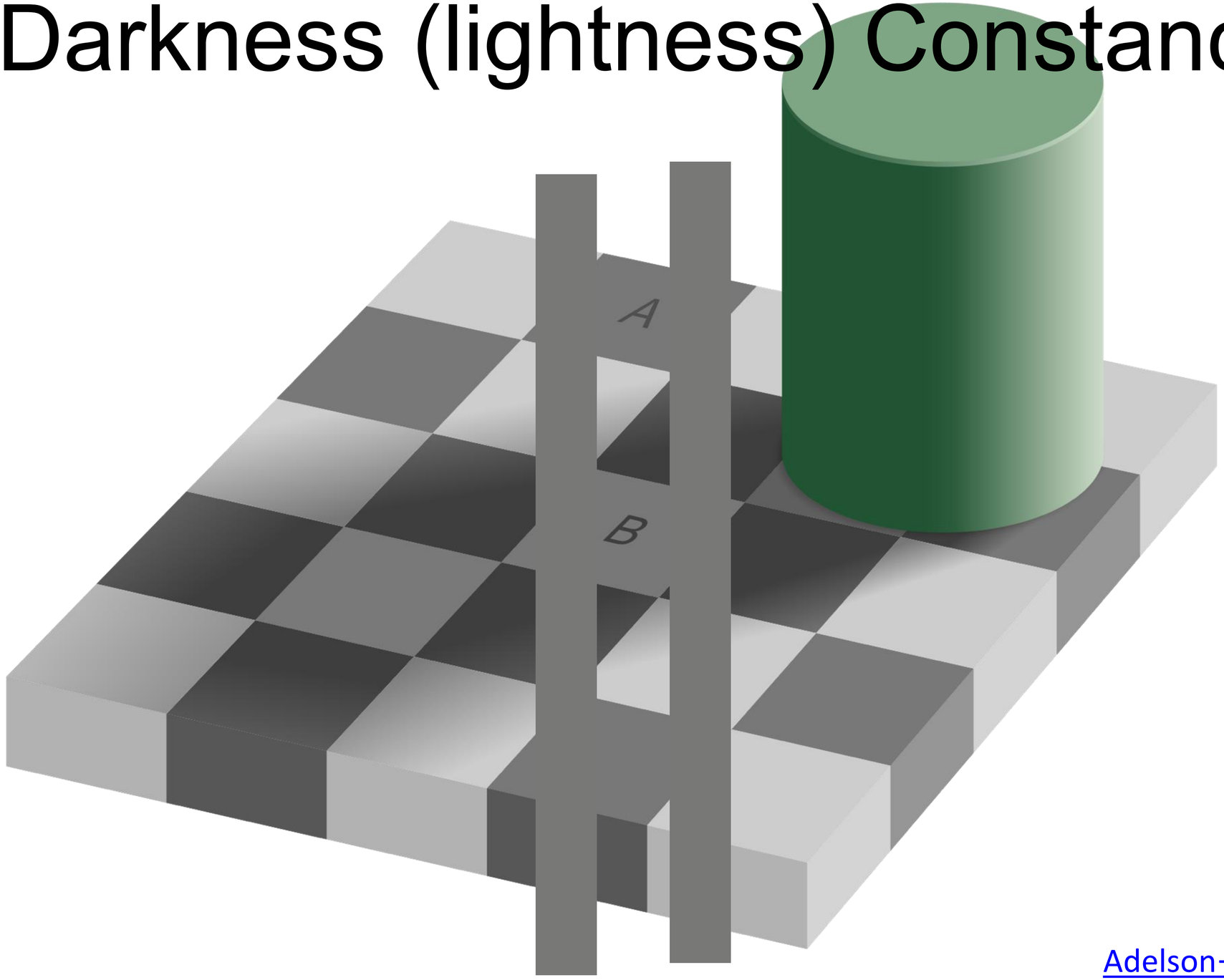
http://www.vischeck.com/vischeck/vischeckImage.php https://www.color-blindness.com/coblis-color-blindness-simulator/

Interactions between Colors and with Lighting

“Lightness Constancy”

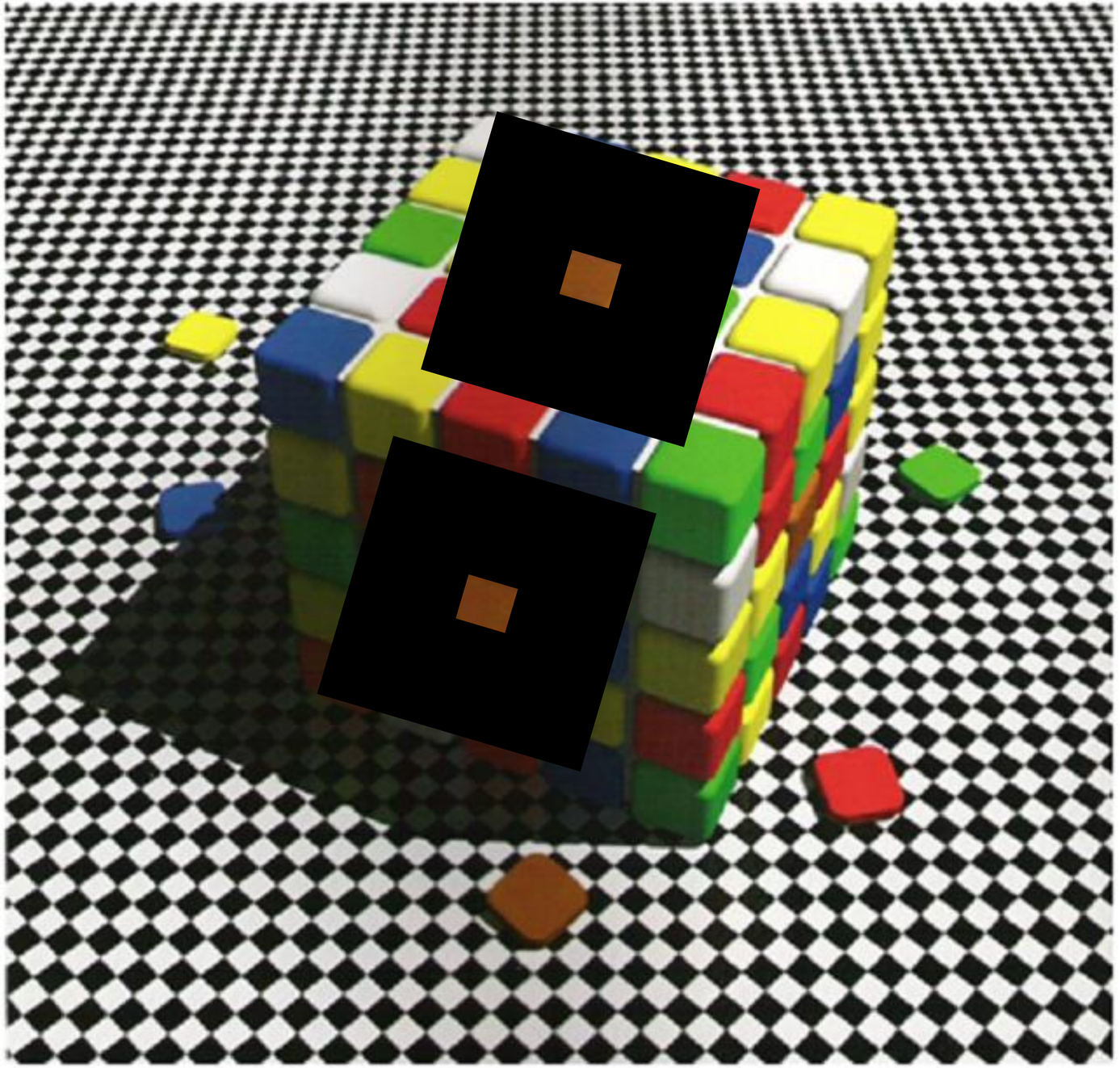
The perception that the apparent brightness of light and dark surfaces remains more or less the same under different luminance conditions is called **darkness (lightness) constancy**.

“Darkness (lightness) Constancy”



Adelson→Pingstone, 2015

“Color Constancy”



Lotto, 2009

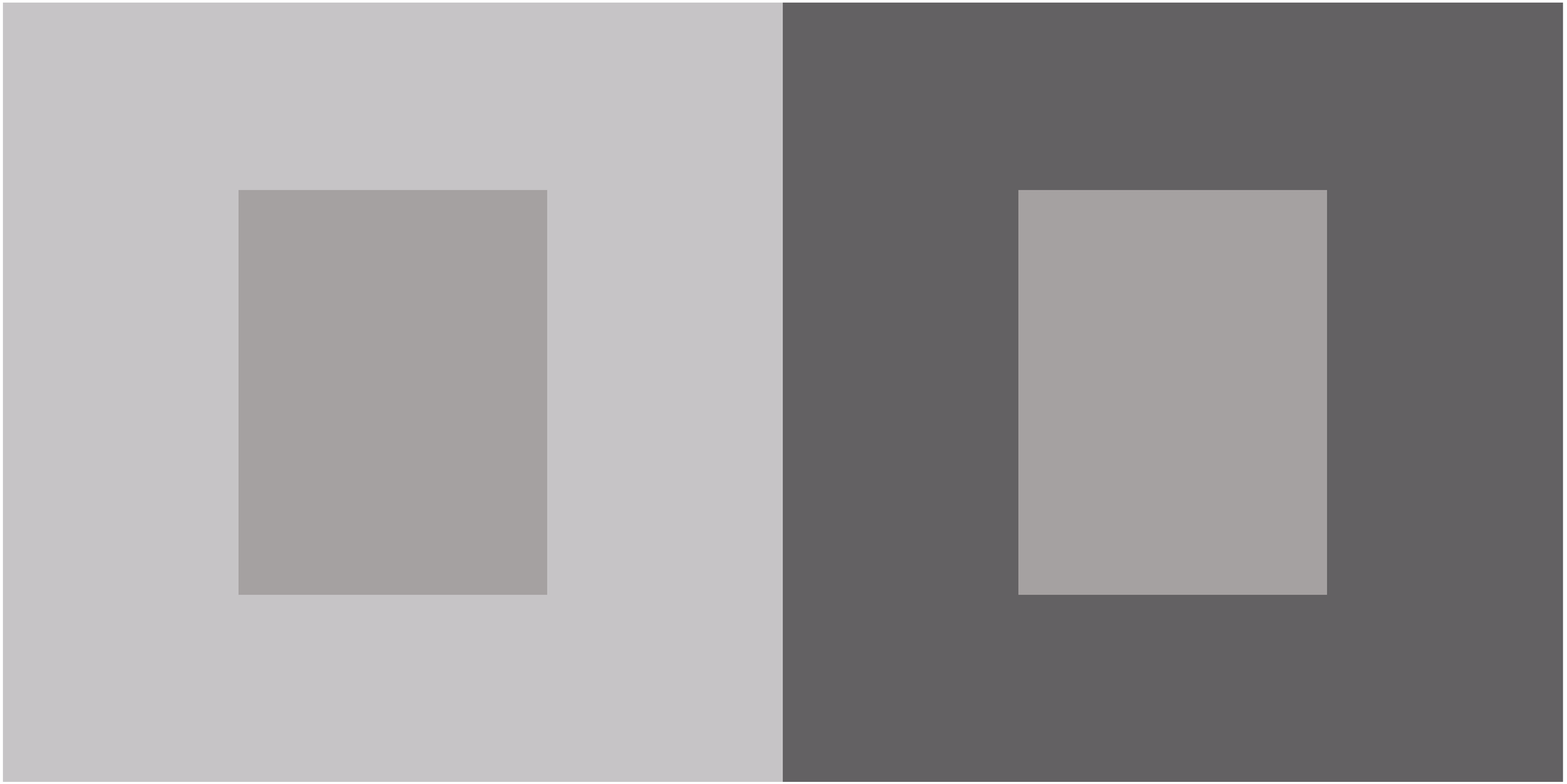
“Simultaneous Contrast”

“Simultaneous Contrast”

“Simultaneous Contrast”

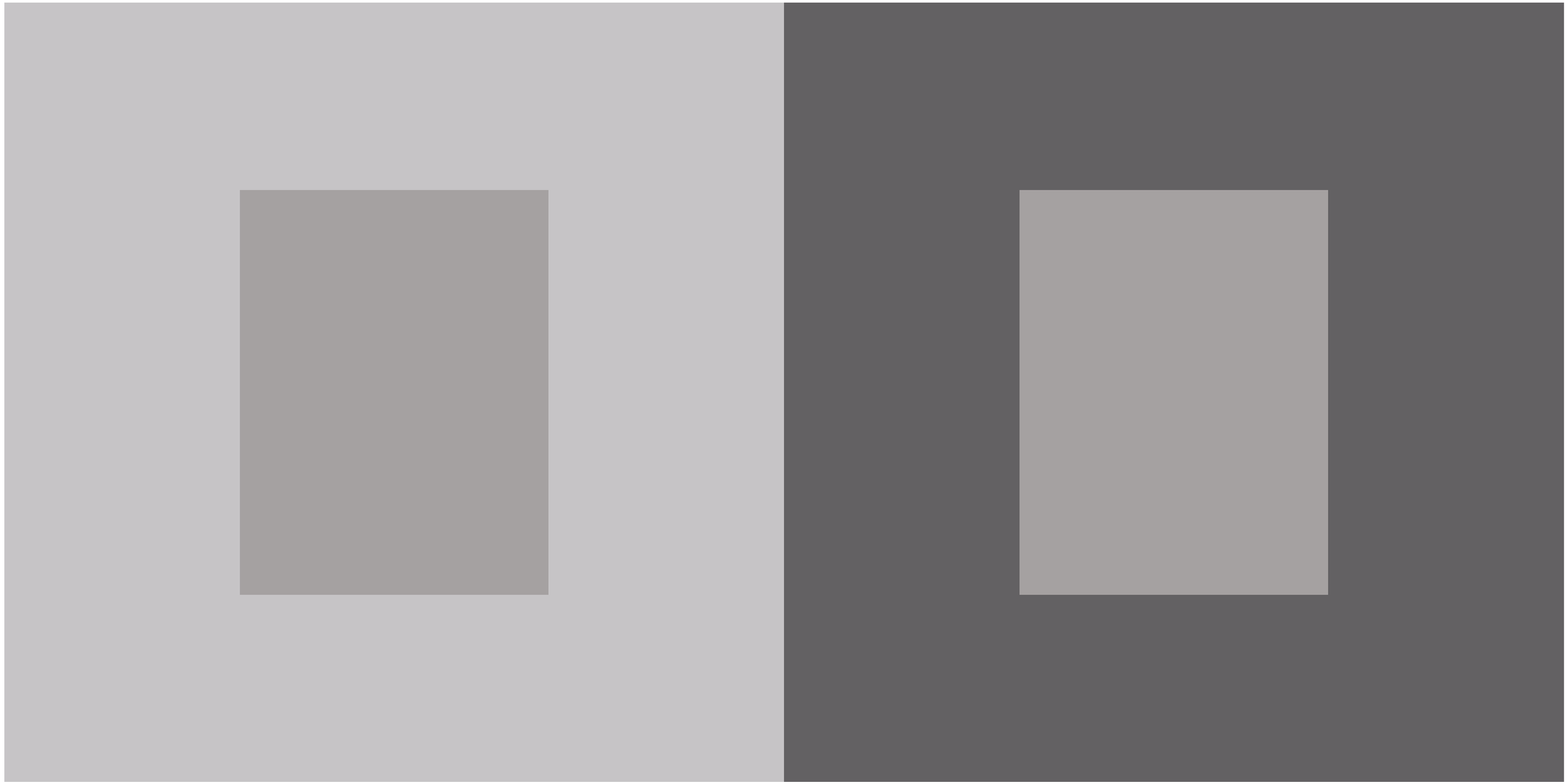
Avoid gradients as backgrounds or bars!

“Simultaneous Contrast”



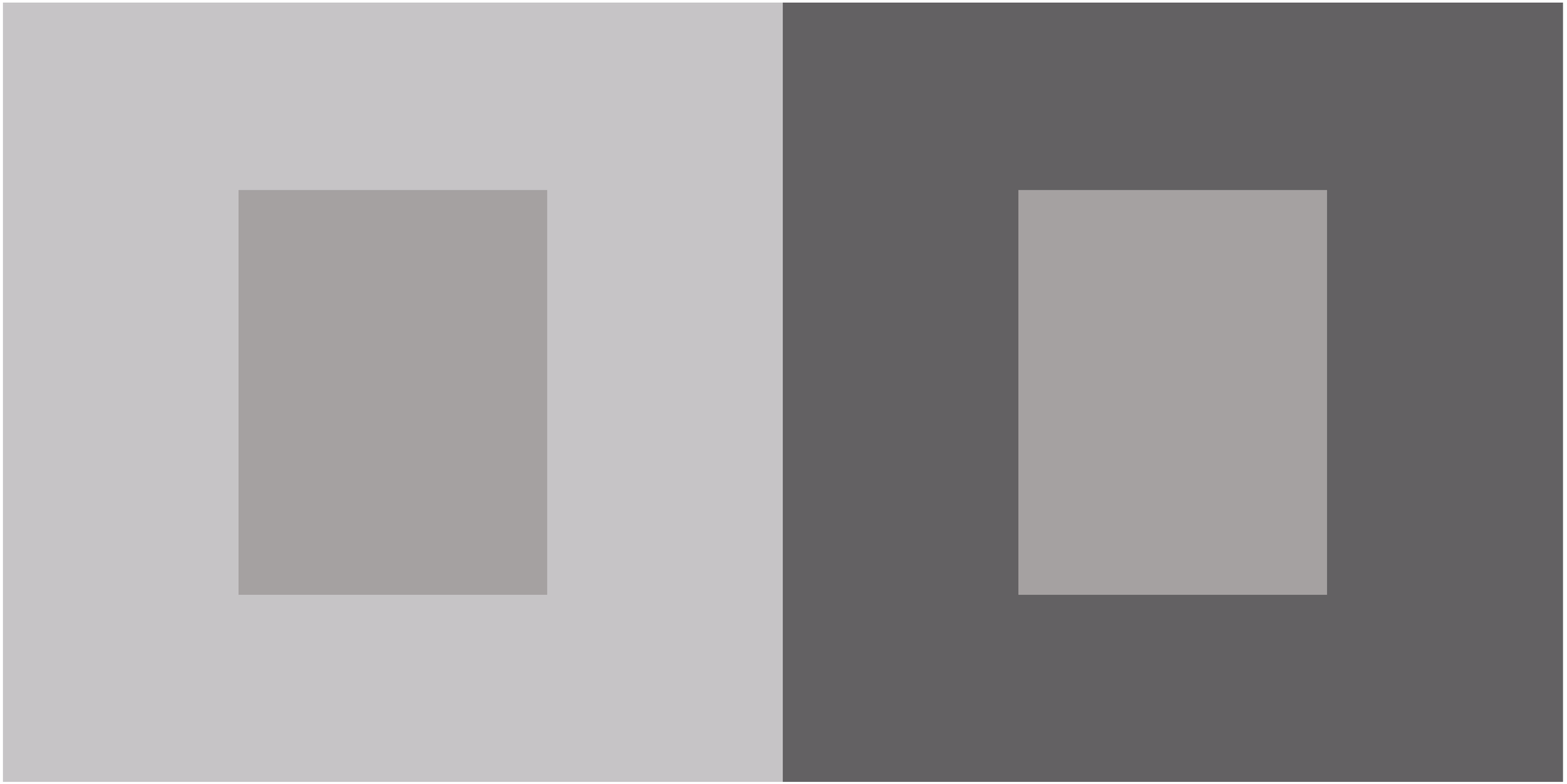
“Simultaneous Contrast”

“Simultaneous Contrast”

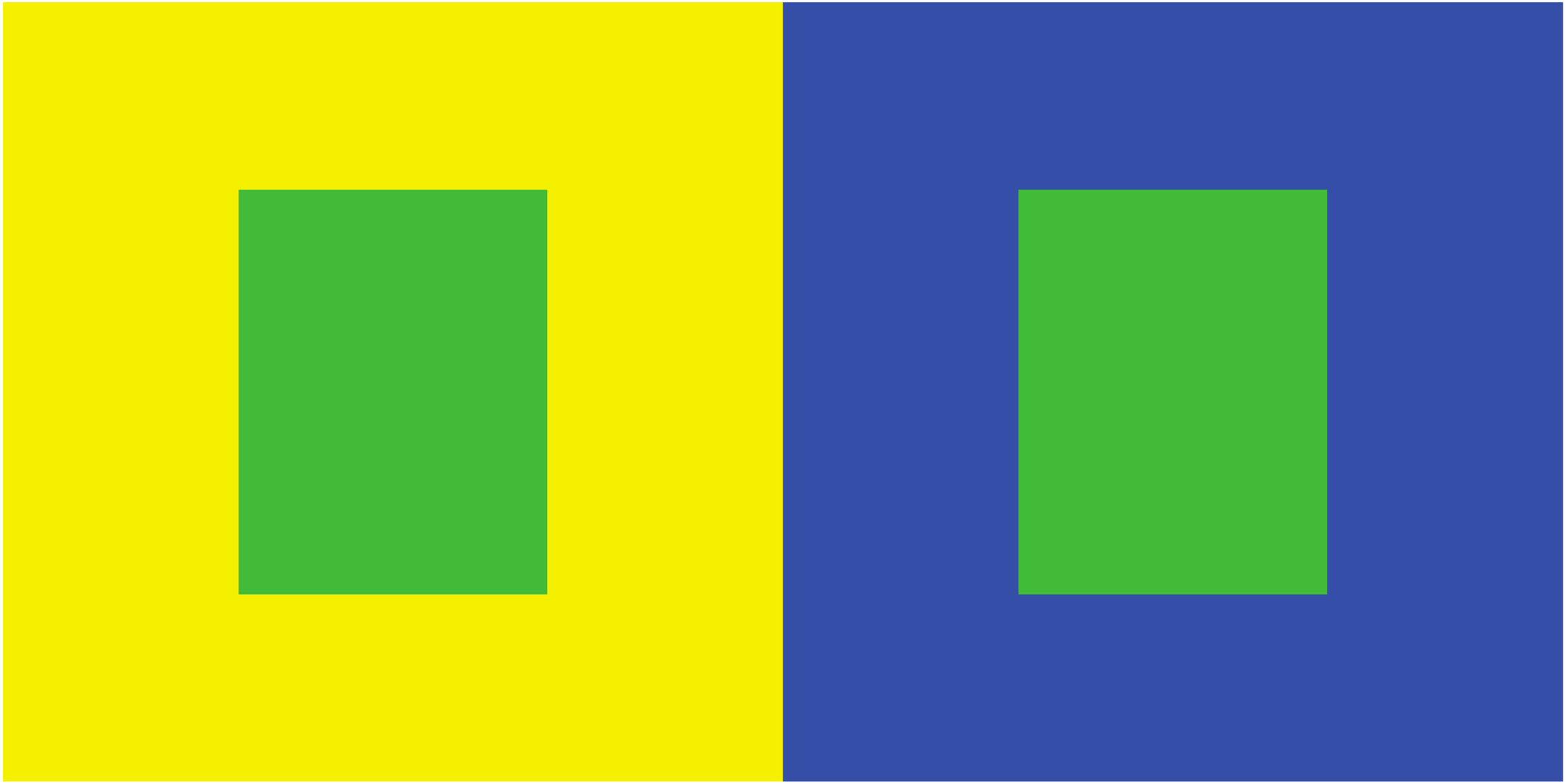


“Simultaneous Contrast”

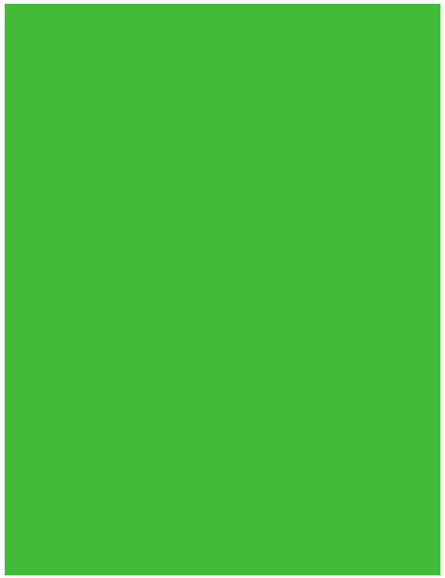
“Simultaneous Contrast”

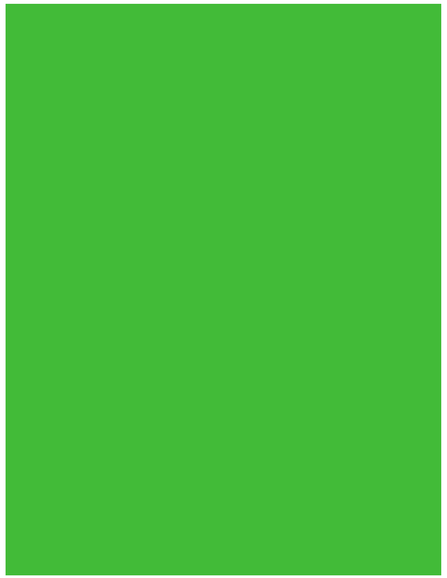


“Simultaneous Contrast”

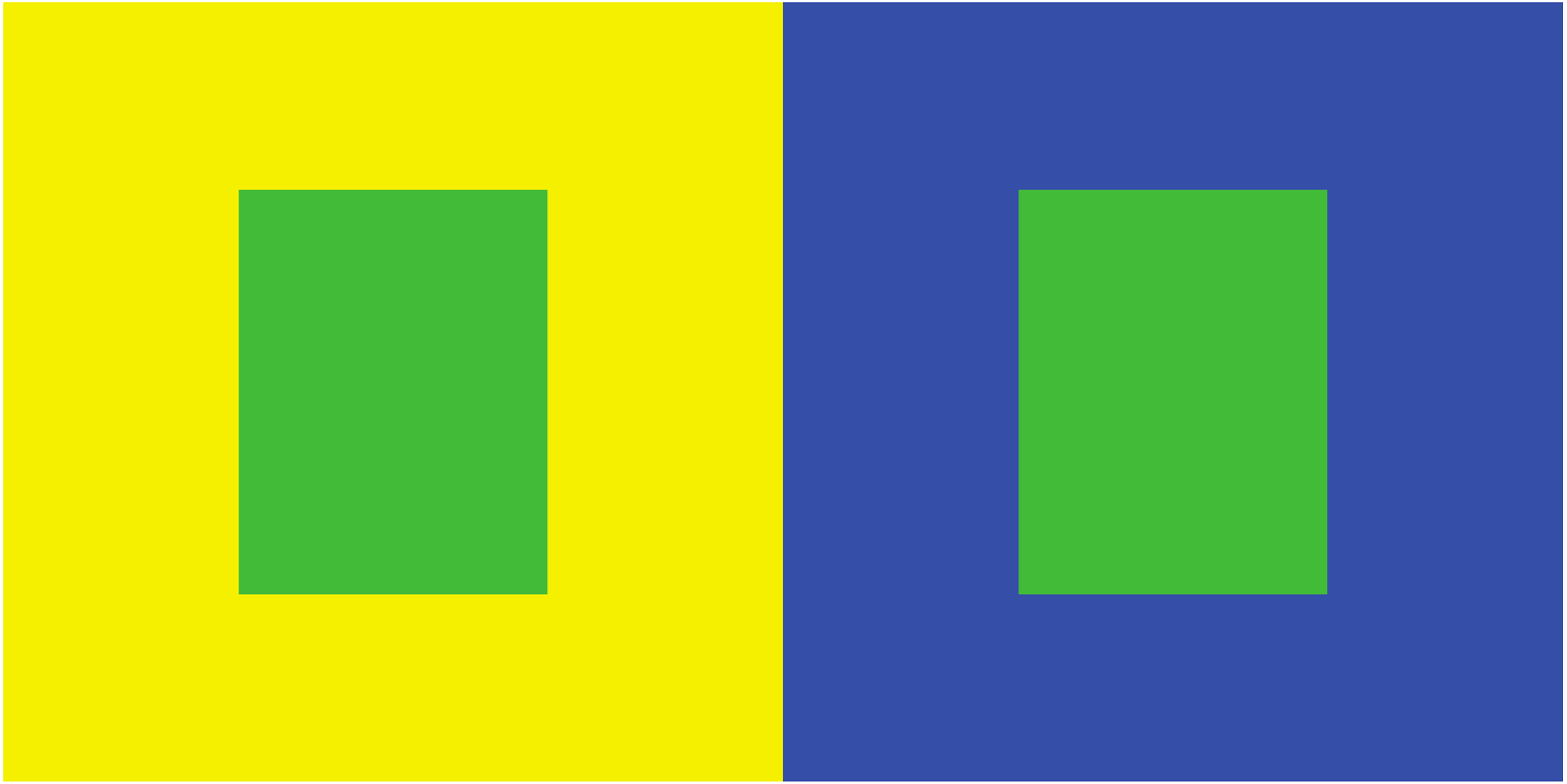


“Simultaneous Contrast”

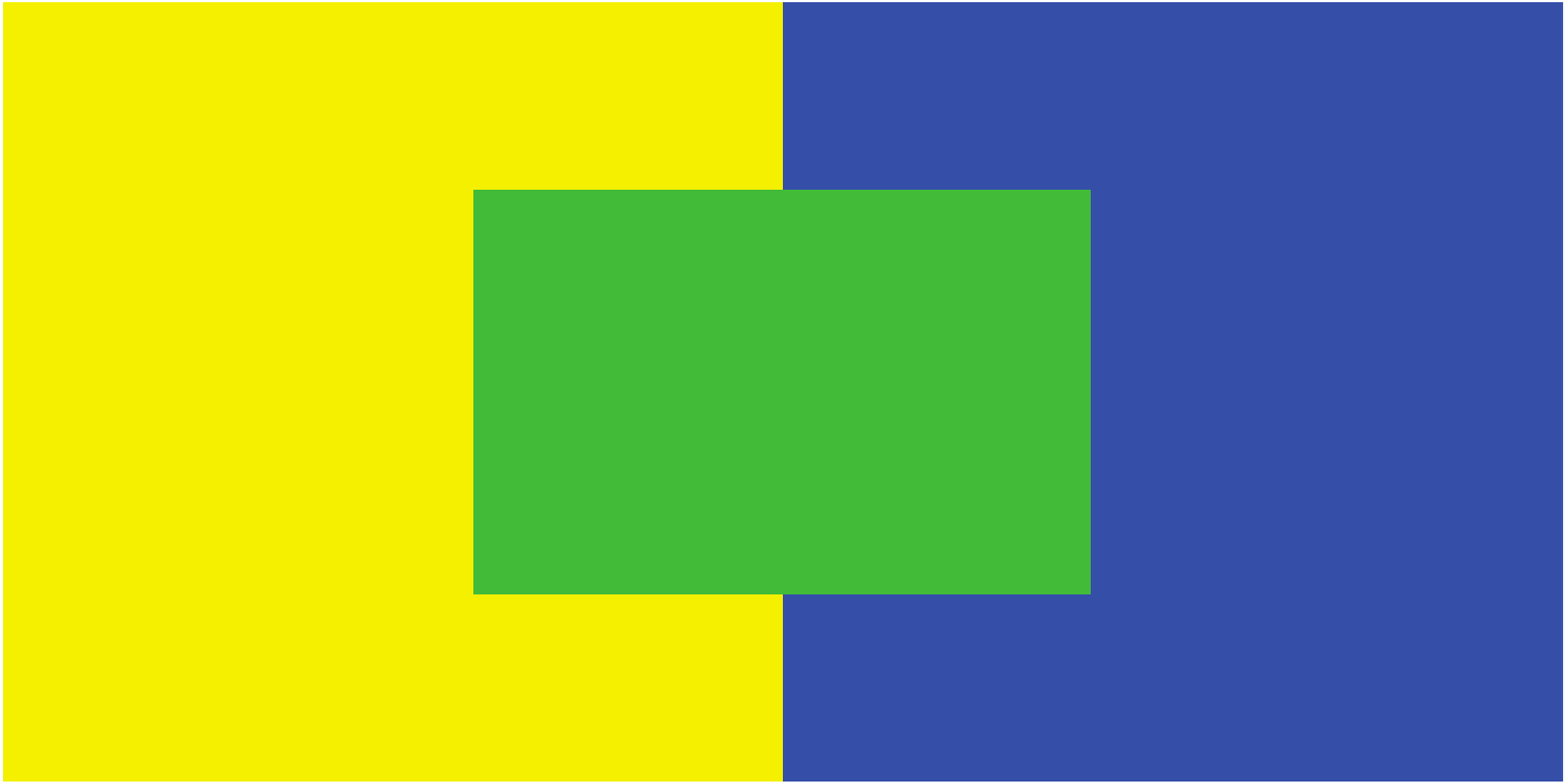




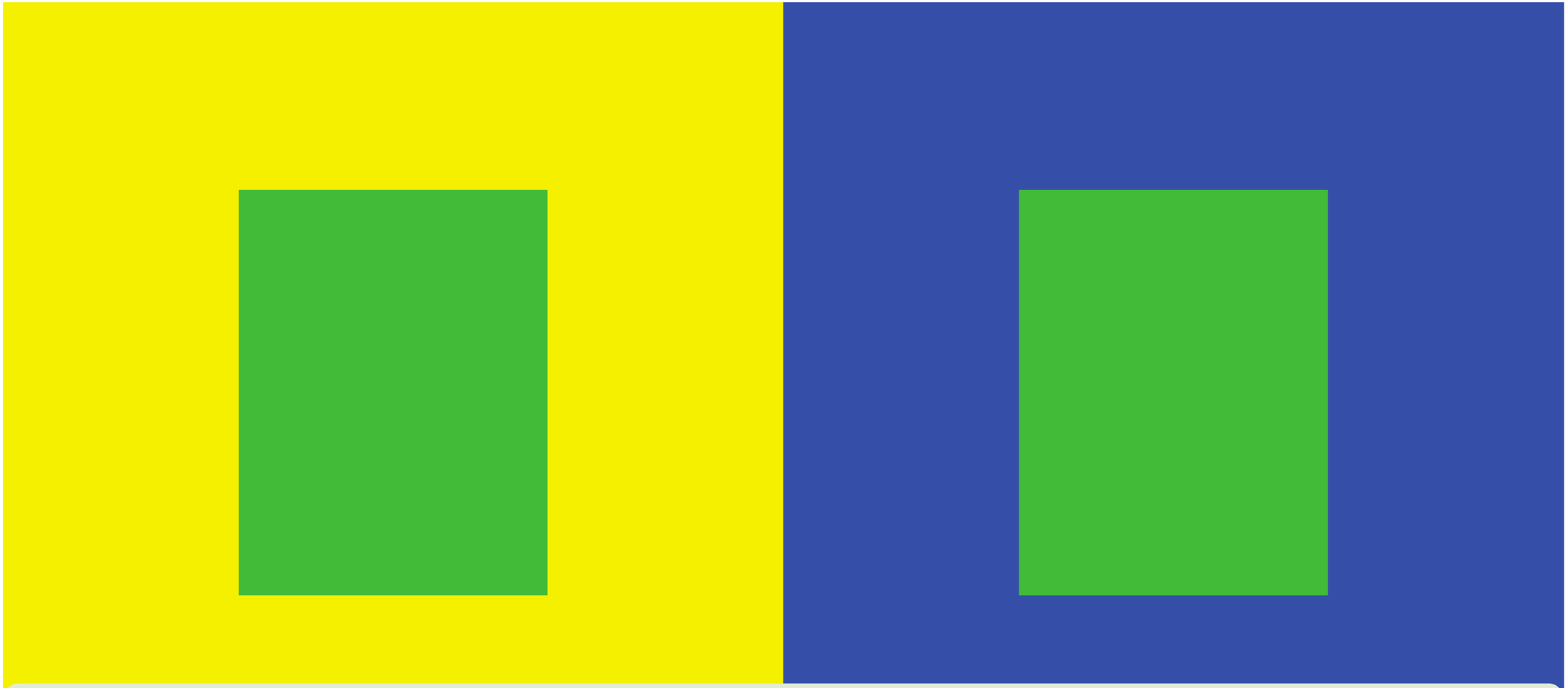
“Simultaneous Contrast”



“Simultaneous Contrast”



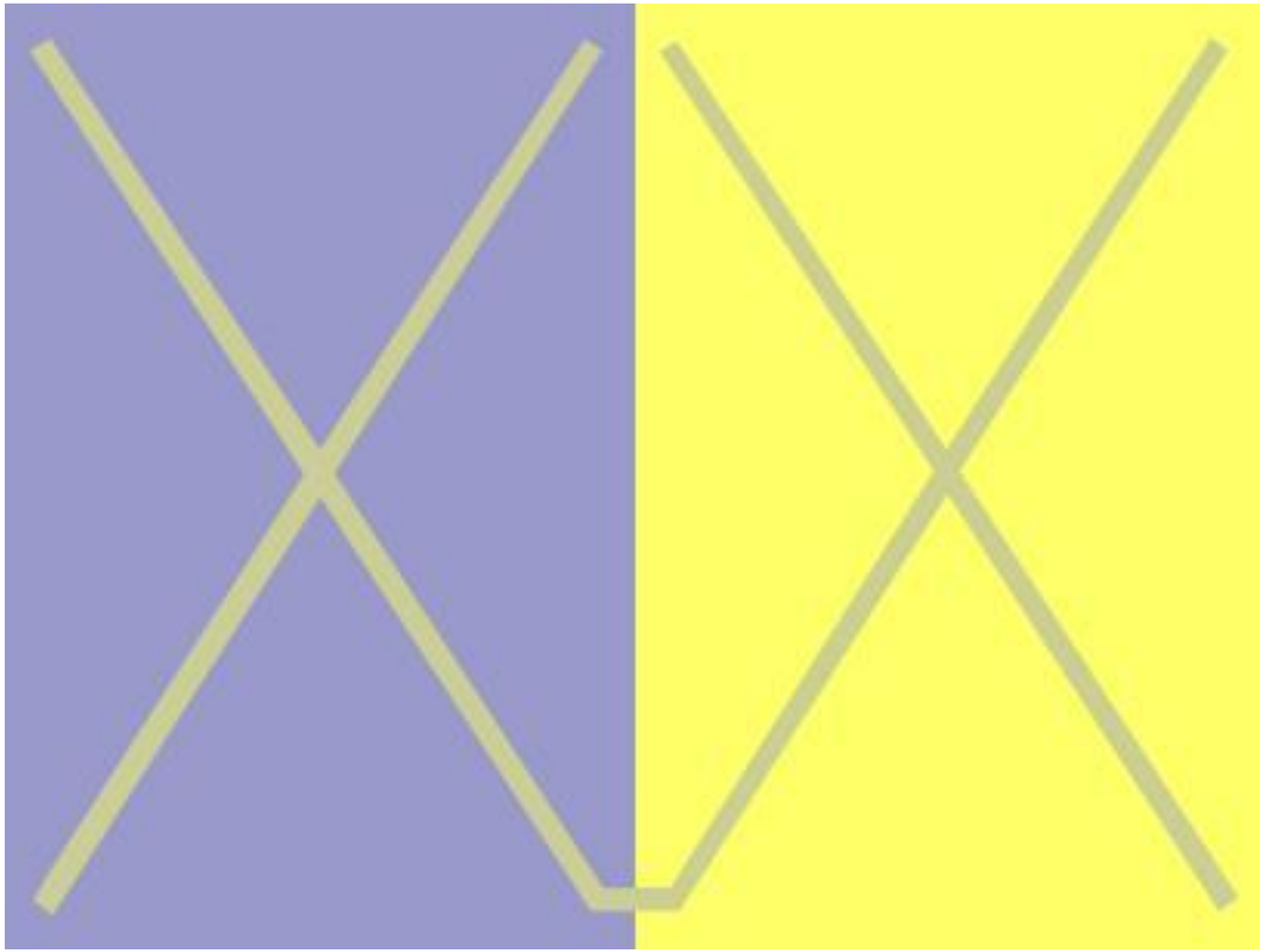
“Simultaneous Contrast”



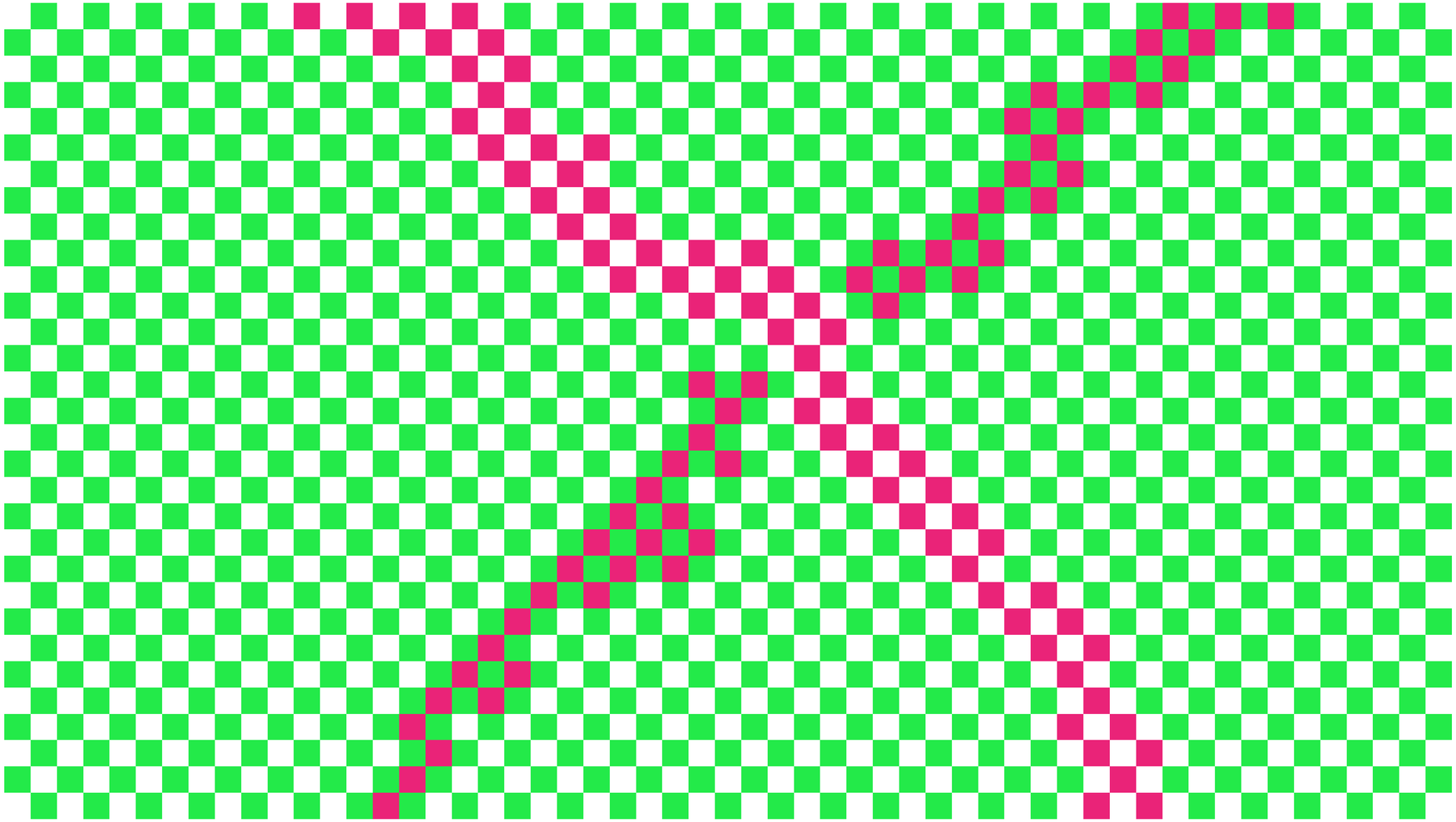
Be careful with bars and scatter plot points - the colors may appear differently with different background colors and neighboring colors!

Be aware that colors in legends may appear different than on the plot!

“Simultaneous Contrast”

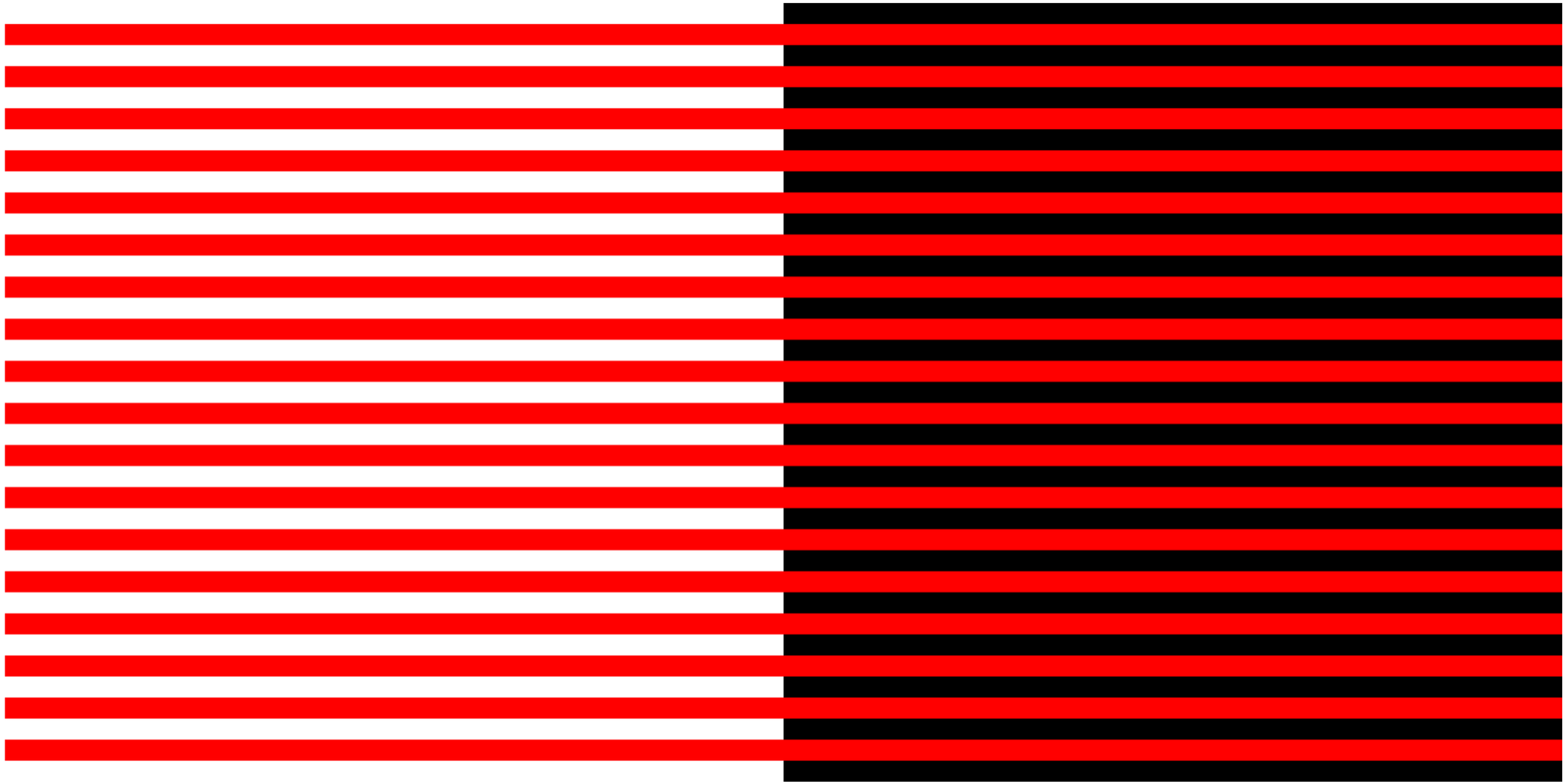


“Simultaneous Contrast”

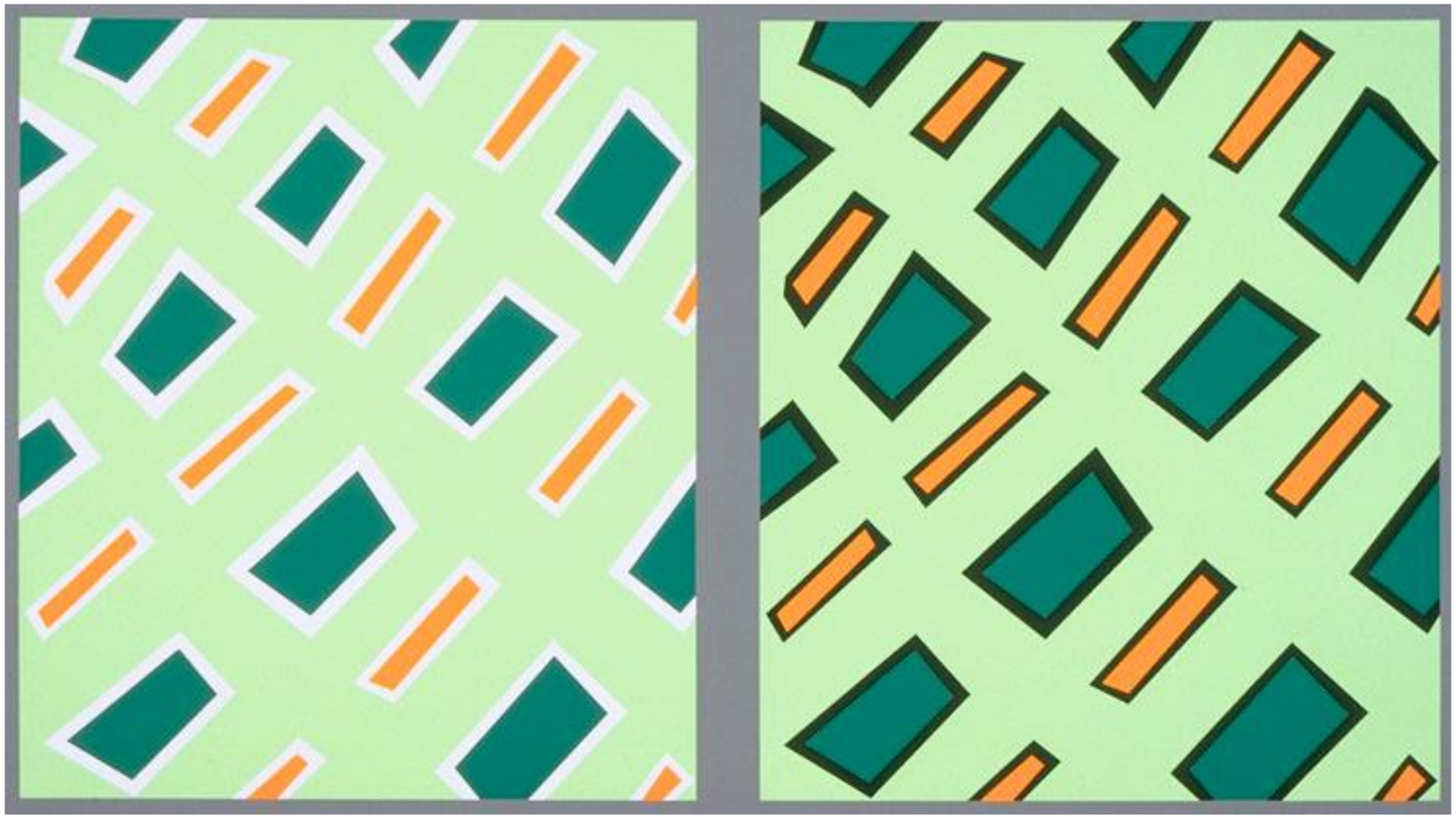


Griffin, 2015

“von Bezold Spreading Effect”



“von Bezold Spreading Effect”



Be careful with colors in scatter plots!
Be aware of color changes when adding borders around bars and plots!
Be aware that colors in legends may appear different than on the plot!

Which area is larger (green or red)?

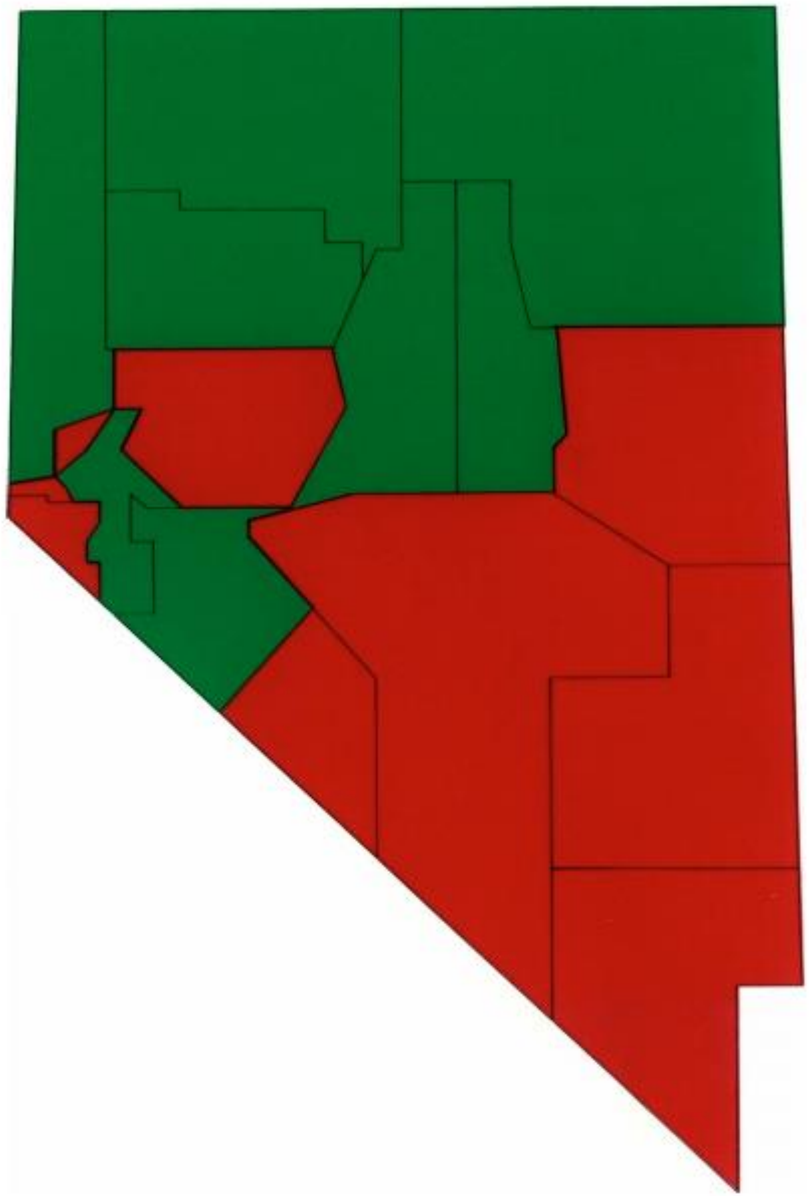


Figure 1. Stimulus From the High-Saturation Group

Cleveland & McGill, 1983

Which area is larger?

Areas are equal(!).

Study participants favored red in the highly saturated case (left) but were more correct with the desaturated case (right)

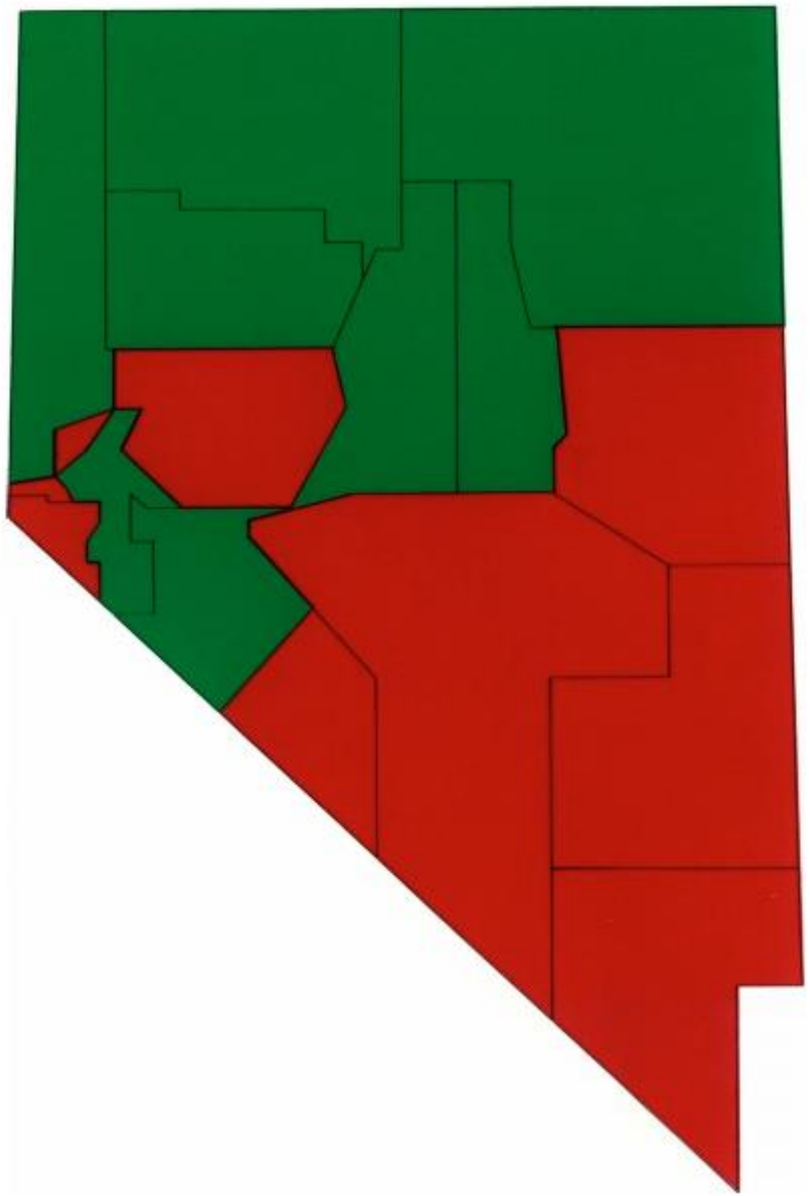


Figure 1. Stimulus From the High-Saturation Group

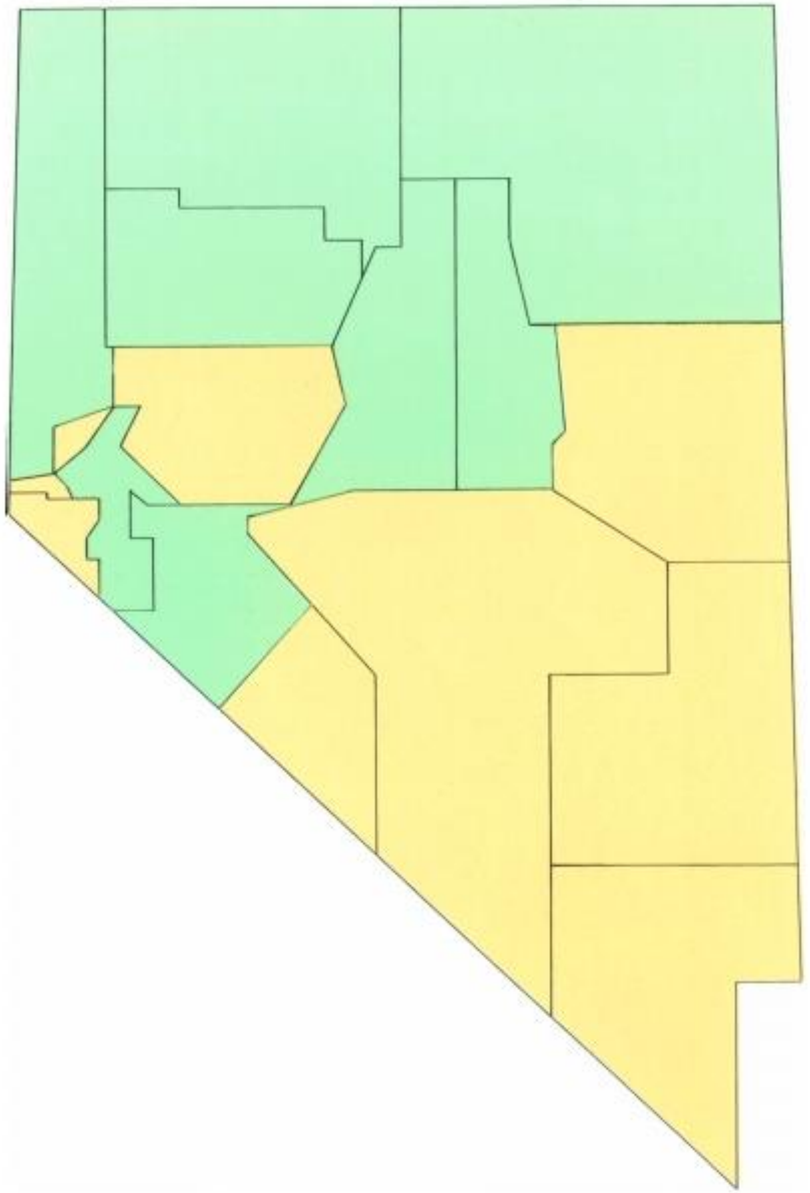
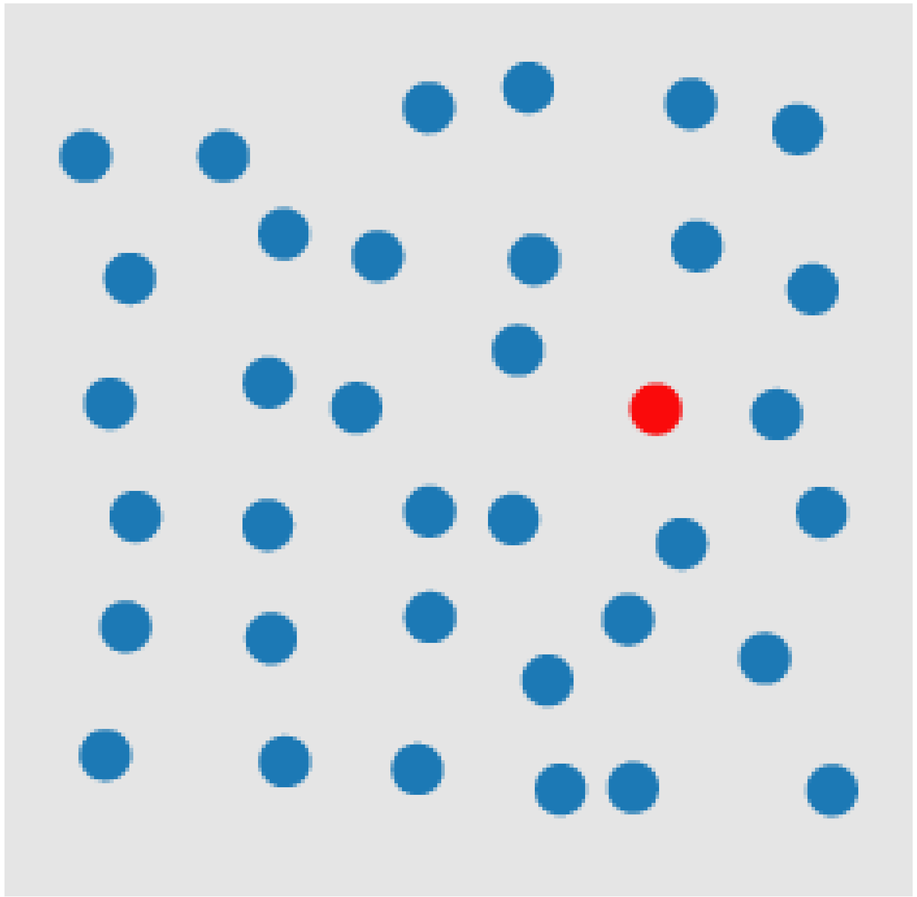
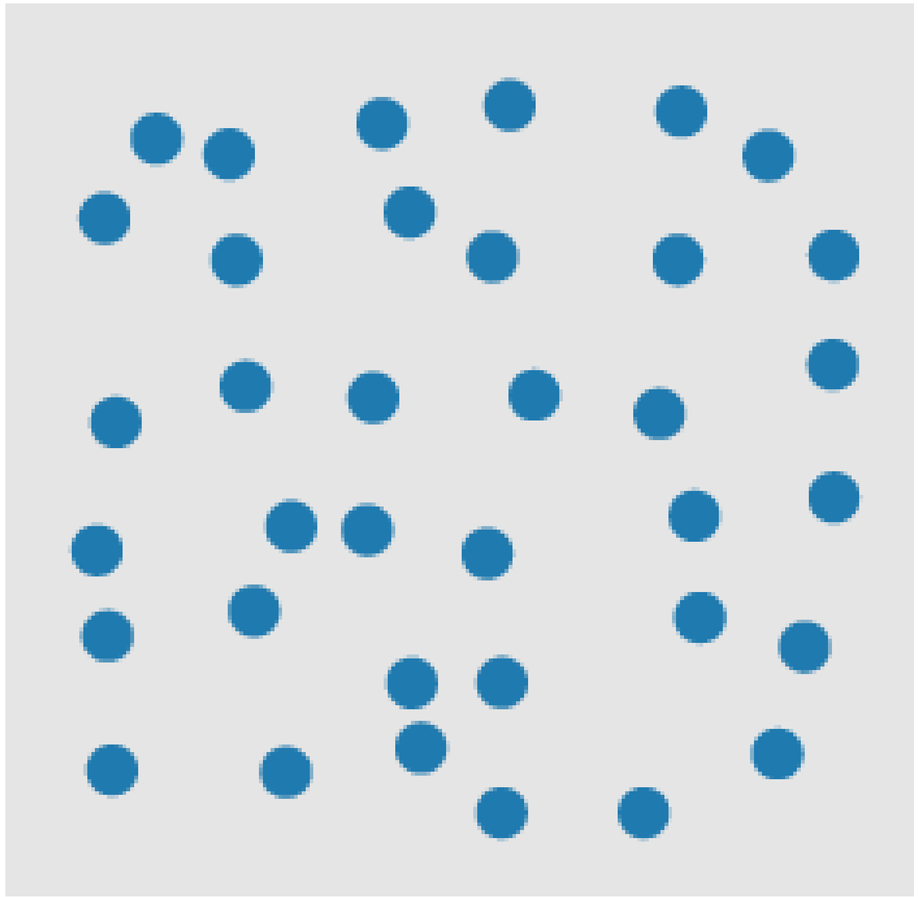


Figure 2. Stimulus From the Low-Saturation Group

Cleveland & McGill, 1983

POP-OUT EFFECTS





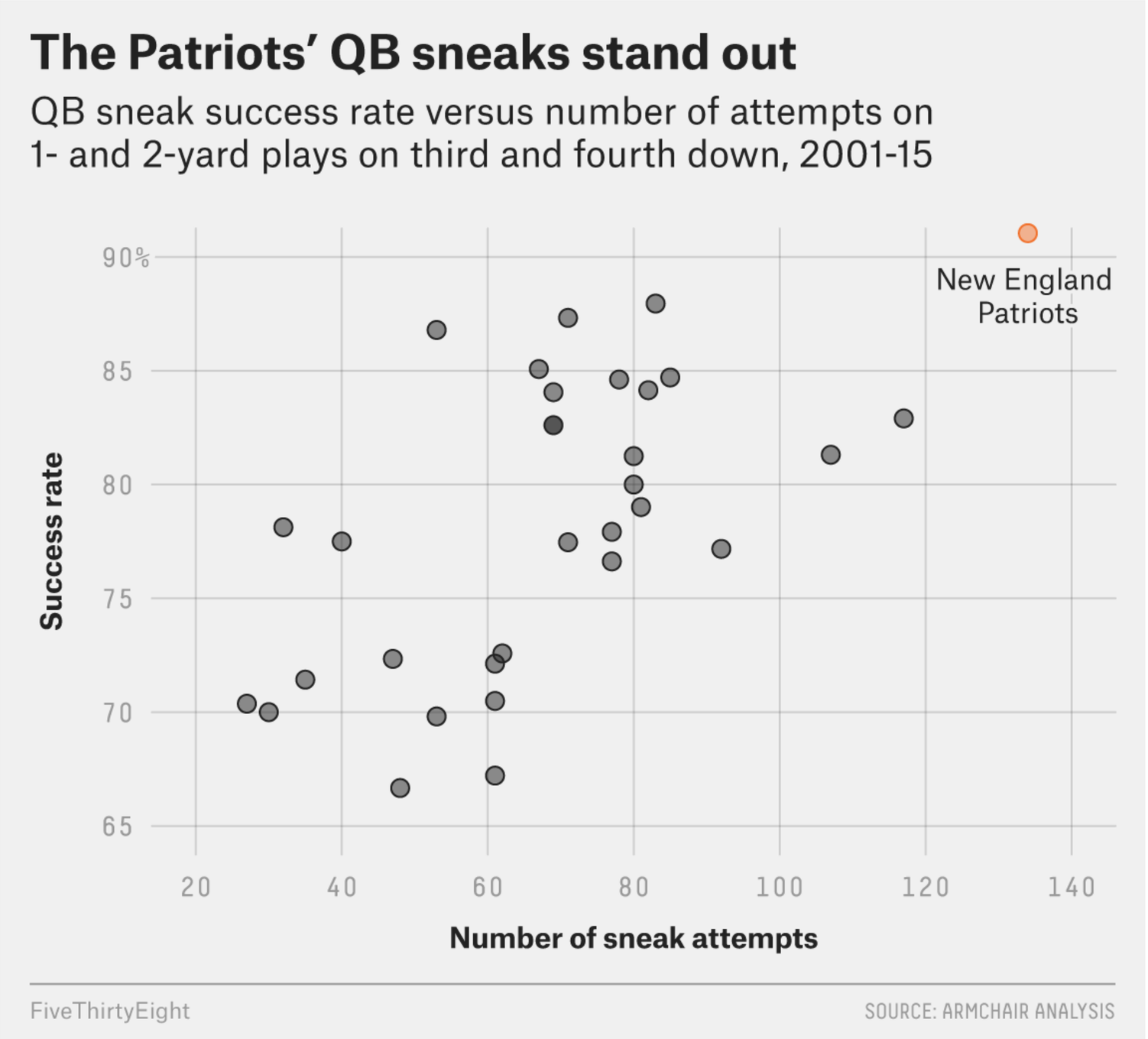
COLOR

Healey, 2012

A quarterback sneak is a play in American football and Canadian football in which the quarterback, upon taking the center snap, dives ahead while the offensive line surges forward. It is usually only used in very short yardage situations.

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

Which pop-out effects are used in this example visualization?



Davis & Lopez, 2017

Desaturated background, light blue

**NASA has an amazing collection of visualization and imaging experts. As in the example above, background colors are always selected to be desaturated thus making the foreground have a pop-out effect. The preferred background color is generally light blue which is desaturated and gives a 3D depth effect (i.e., blue sky in the distant background).

NASA/ESA/Hubble Heritage Team (STScI/AURA) / Hester & Scowen

Color Mixing Pitfalls

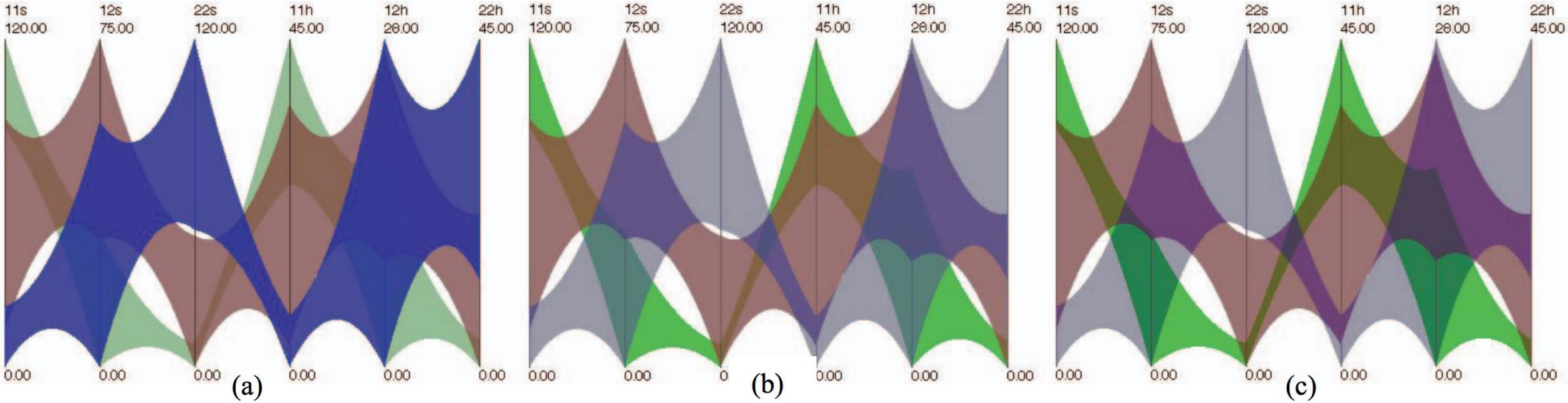


Fig. 12: Illustrative visualizations of a six-dimensional dataset using illustrative parallel coordinates. (a) Ideal visualization with appropriate weightings and color choices, and the use of the local model in overlapping areas. (b) Improper weightings are employed. The blue cluster no longer seems to be in front. (c) The use of improper weightings and the disabling of the local model results in a confusing visualization.

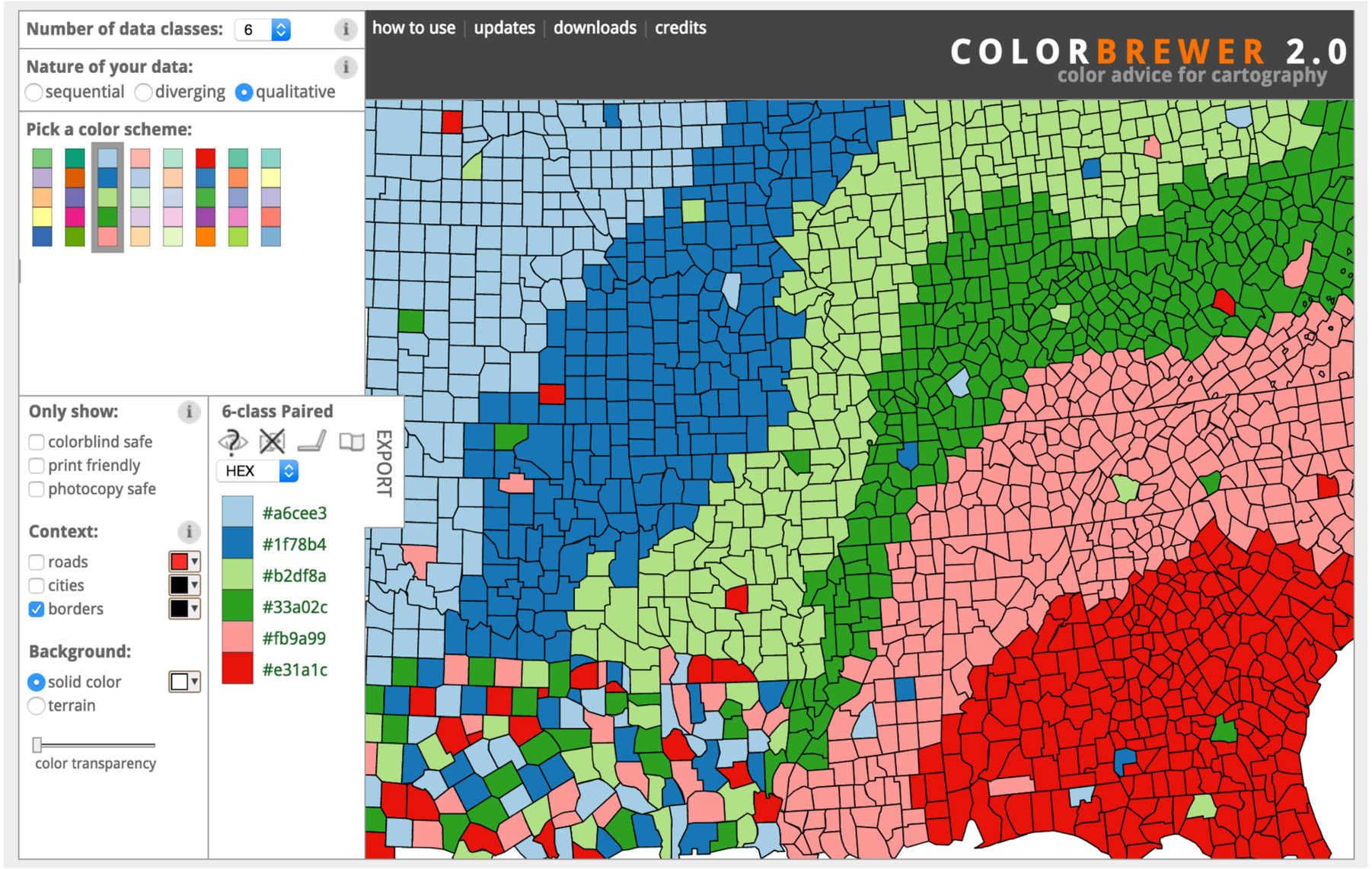
"Aimed at reducing false colors in the overlap regions. …[Reduce] saturation of the color in the rear object only in the overlap region while keeping its lightness."

Note the swap in blue/red for foreground/background vs. NASA

Wang et al., 2008

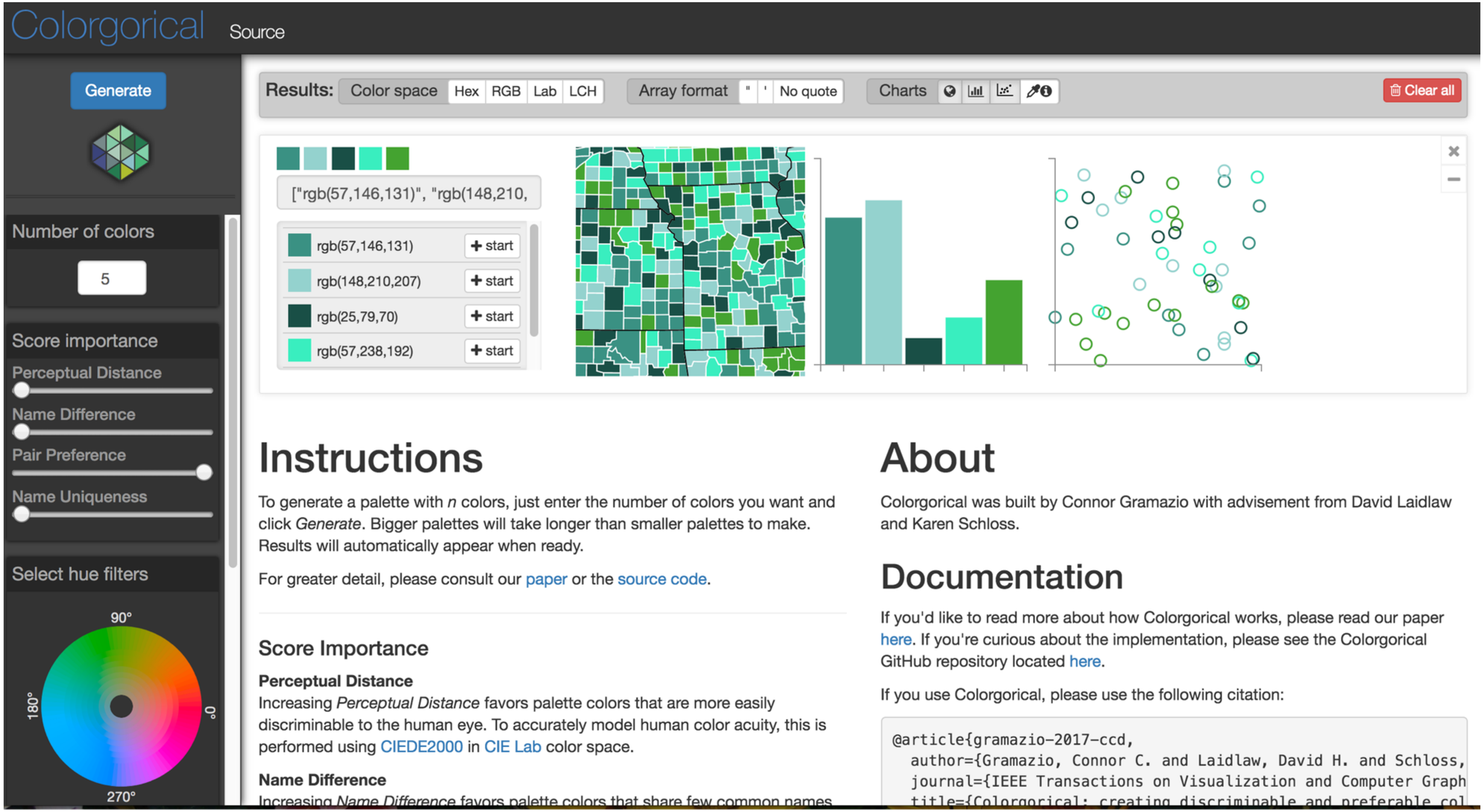
Tools for Picking Colormaps

Color Brewer



http://colorbrewer2.org

Colorgorical



http://vrl.cs.brown.edu/color

Other Useful Tools

- Get a list of colors from an image: https://html-color.codes/color-from-image
- Analyze your palette: https://projects.susielu.com/viz-palette
- Analyze the name similarity of colors in your palette: http://vis.stanford.edu/color-names/analyzer/
- Details on multi-hued color scales: https://www.vis4.net/blog/2013/09/mastering-multi-hued-color-scales/#combining-bezier-interpolation-and-lightness-correction
- Easy picking a multi-hued color scale: http://tristen.ca/hcl-picker/
- Easily correcting darkness (lightness) for a scale: http://gka.github.io/palettes/
- Do a ton programmatically: https://gka.github.io/chroma.js/
- virdis colors: https://cran.r-project.org/web/packages/viridis/vignettes/intro-to-viridis.html

Color Advice Summary

Use a limited hue palette

- Control color “pop out” with low-saturation colors
- Avoid clutter from too many competing colors

Use neutral backgrounds

- Control impact of color
- Minimize simultaneous contrast

Use Color Brewer etc. for picking scales

Don’t forget aesthetics!

Upcoming Assignments & Communication

A look at the upcoming assignments and deadlines

- Textbook, Readings & Reading Quizzes

- 2020-11-10 Project 6 — Sprint 1
- 2020-11-11 No Class — Veterans' Day

- 2020-11-17 Project 7 — Sprint 2 & Paper Draft
- 2020-11-18 In-Class Validation — Final Project Evaluation

- 2020-11-24 Project 8 — Sprint 3 & Prep for Usability Testing
- 2020-11-25 No Class — Thanksgiving

- 2020-11-30 In-Class Usability Testing — Final Projects

- 2020-12-06 Project 9 — Presentation and Video
- 2020-12-07 In-Class Project Presentations
- 2020-12-09 In-Class Project Presentations

- 2020-12-15 Project 10 — Final Project Deliverables and Sharing with Partners

https://c.dunne.dev/ds4200f20

Everyday Required Supplies:

- 5+ colors of pen/pencil
- White paper
- Laptop and charger

Use **Canvas Discussions** for general questions,
email the **instructor & TAs** for questions **specific to you**.

> If you're emailing about a particular assignment, please include the URL of the Submission Details page. (Canvas documentation.)

If you have a project question, **give us your group number**. E.g., include: `Group ## — Topic` with '##' replaced by your group number and 'Topic' replaced by your topic.