

BME 7400 Midterm Exam

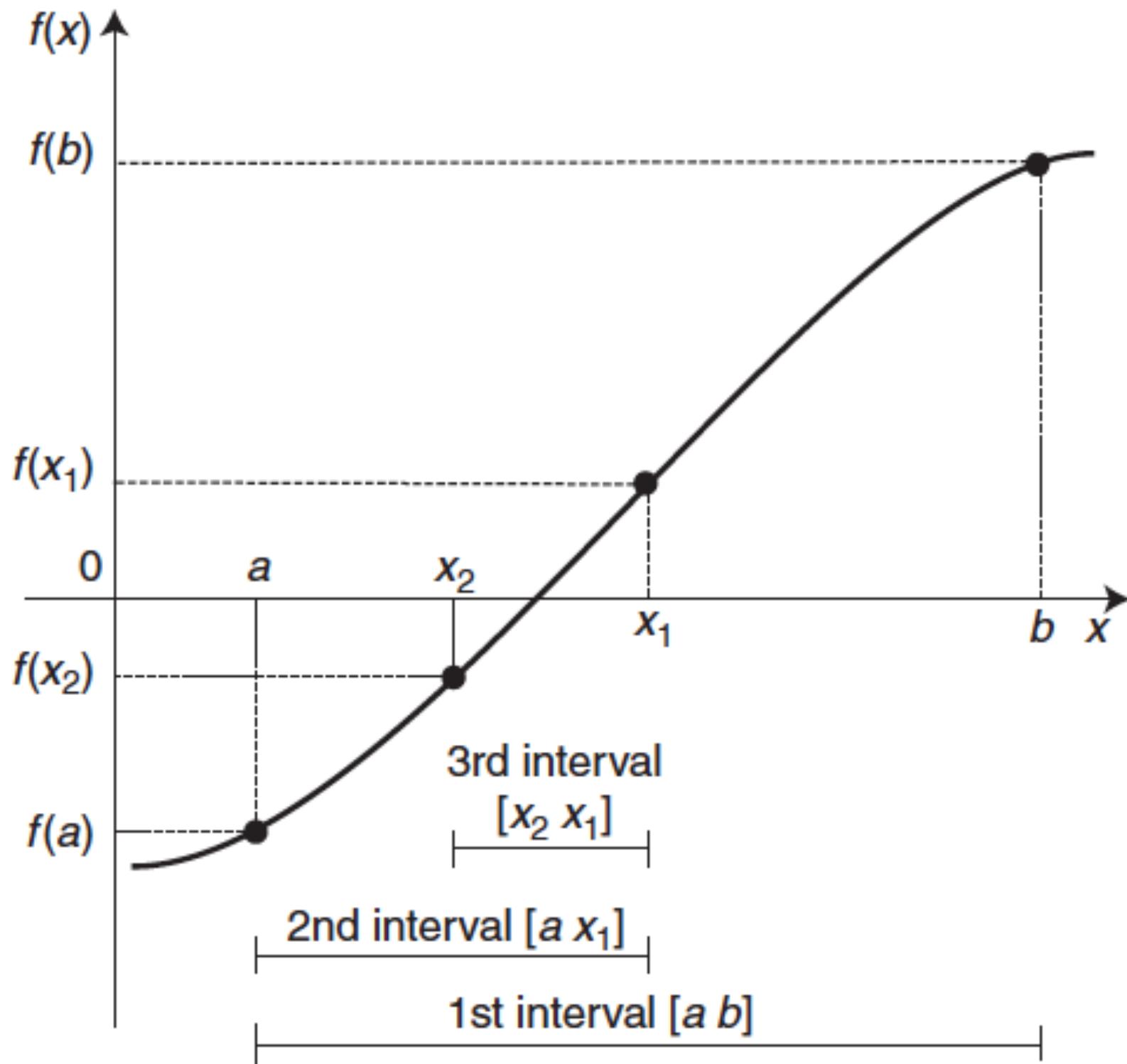
October 12, 2021

100 points total

1. (35 points) The following equation describes the force exerted by a 160 lb(mass) person performing a standing jump, where τ is the push-off duration in milliseconds and F is expressed in units of lb(force):

$$F(t) = 480 \cdot \sin\left(\frac{\pi t}{\tau}\right) + 160(1 - t/\tau)$$

For a value of $\tau = 180$ ms, use the bisection method of nonlinear root-finding to determine the time at which the force is equal to 480 lb(force). Use $1 < t < 75$ as your initial interval, and show the results of the first three iterations.



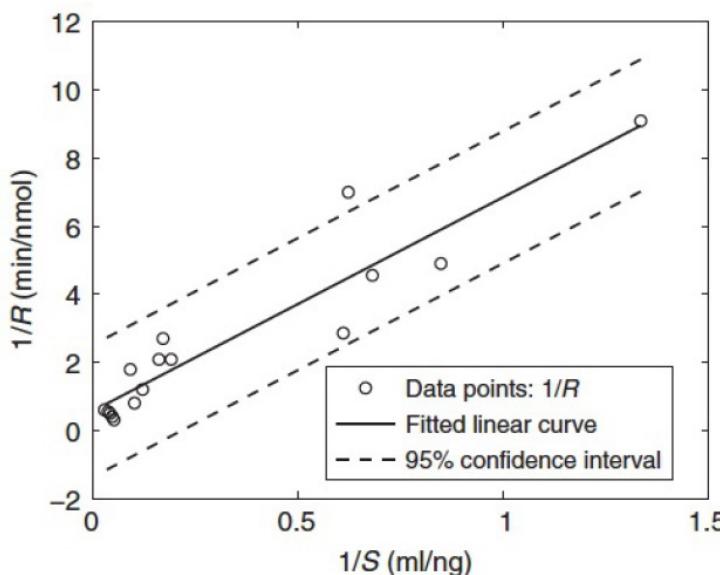
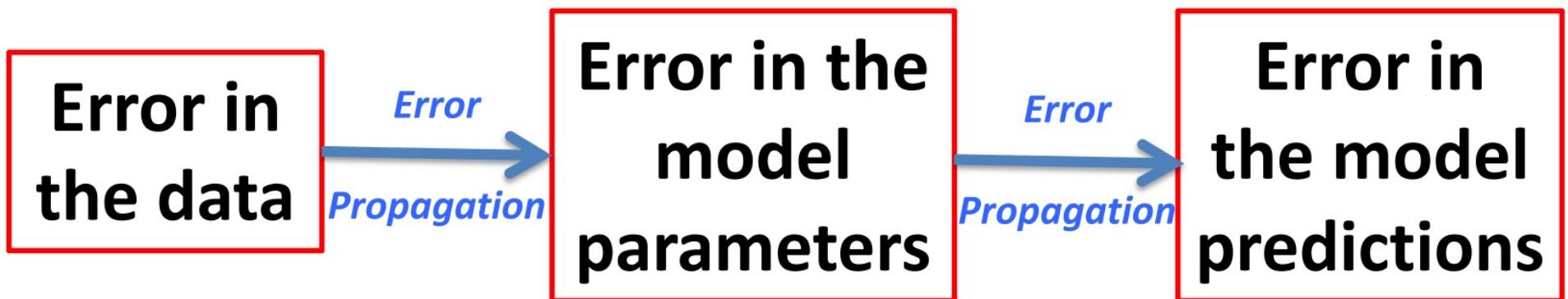
2. (40 points) A new cell adhesion flow chamber has been developed to produce an impinging, “extensional” flow field that resembles regions of the vasculature most susceptible to atherosclerosis. A graduate student perfuses small fluorescent microspheres into this flow chamber to visualize the flow field. An inverted fluorescence microscope is used to focus on a distance 2 microns from the lower wall, and a large quantity of data is collected, measuring the velocity in the flow direction (V_z) as a function of z . The following equation is expected to describe the velocity in the region downstream of the impingement point:

$$V_z = \frac{C_1}{z} + C_2 z^2 + C_3 z + C_4$$

Show how you would perform a linear regression using the Normal equations to determine the four modeling parameters C_1 – C_4 . You should explicitly write out the composition of the matrix of modeling functions \mathbf{A} and the other vectors. After accurately determining the best-fit model, we would like to rely on this model to predict the velocity at any z -position, without having to redo the microsphere flow measurement every time we perform a cell adhesion experiment. Thus, you should show exactly how you would calculate the uncertainty in the best-fit model prediction for V_z .

Linear Regression Error (Sec. 3.7)

- Road map for today, and for any linear regression error calculation:



3. (15 points) A sample of acute myeloid leukemia (AML) cells are run through a Coulter Z2 Cell Counter to determine the distribution of cell sizes. This instrument determines the volume of each cell in the sample quite accurately, and reports a mean cell volume of 623.6 ± 289.1 (S.D.) μm^3 . Recognizing that the spherical cell diameter (d) is simply related to the volume (V) by the relation:

$$d = \left(\frac{6V}{\pi} \right)^{1/3},$$

use the error propagation formulas discussed in lecture to calculate the mean cell diameter and standard deviation in diameter for this sample of AML cells.

$$s_z^2 \approx s_x^2 \left(\frac{df}{dx} \Big|_{\bar{x}, \bar{y}} \right)^2 + s_y^2 \left(\frac{df}{dy} \Big|_{\bar{x}, \bar{y}} \right)^2 + 2s_{xy}^2 \left(\frac{df}{dx} \Big|_{\bar{x}, \bar{y}} \right) \left(\frac{df}{dy} \Big|_{\bar{x}, \bar{y}} \right).$$

4. (10 points) Using Matlab code, show how you would find the largest element along the diagonal of the 4×4 matrix **M**, and then put that value into a new variable called **bMd**.

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[nature](#) > [technology features](#) > article

TECHNOLOGY FEATURE | 04 October 2021

Colour me better: fixing figures for colour blindness

Images can be made more accessible by choosing hues, shapes and textures carefully.

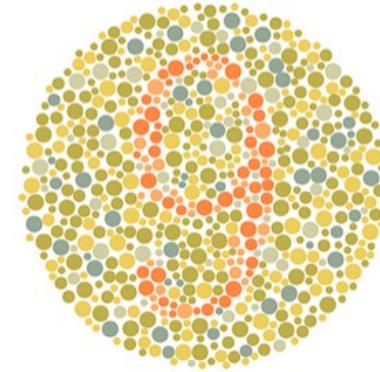
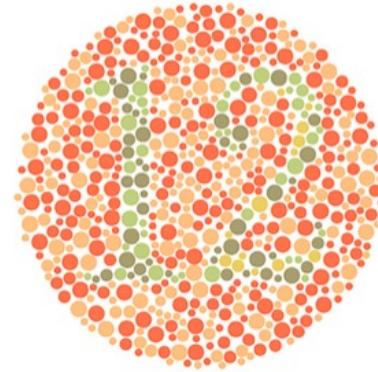
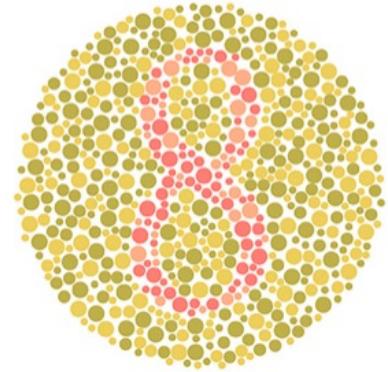
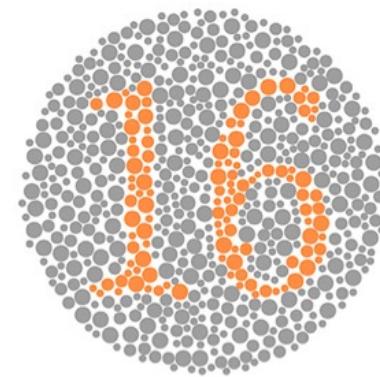
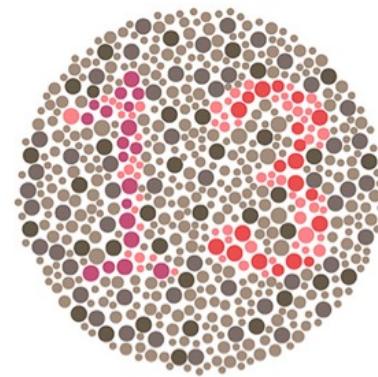
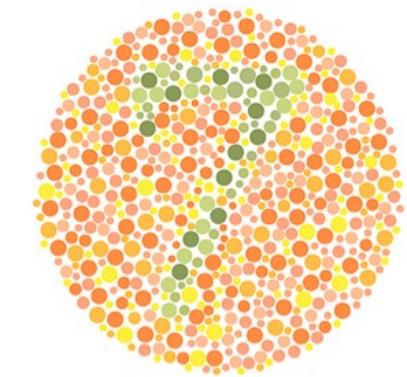
[Alla Katsnelson](#)

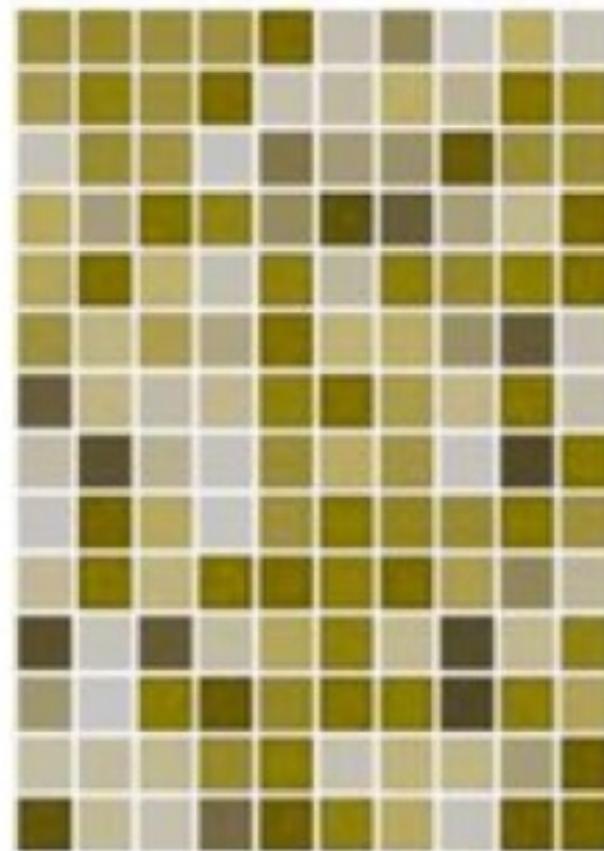
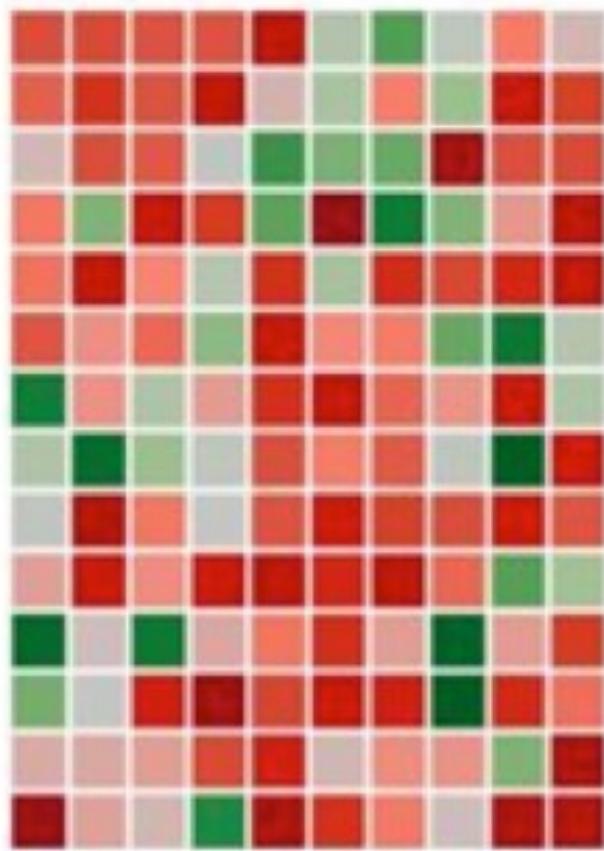


Tips and tools

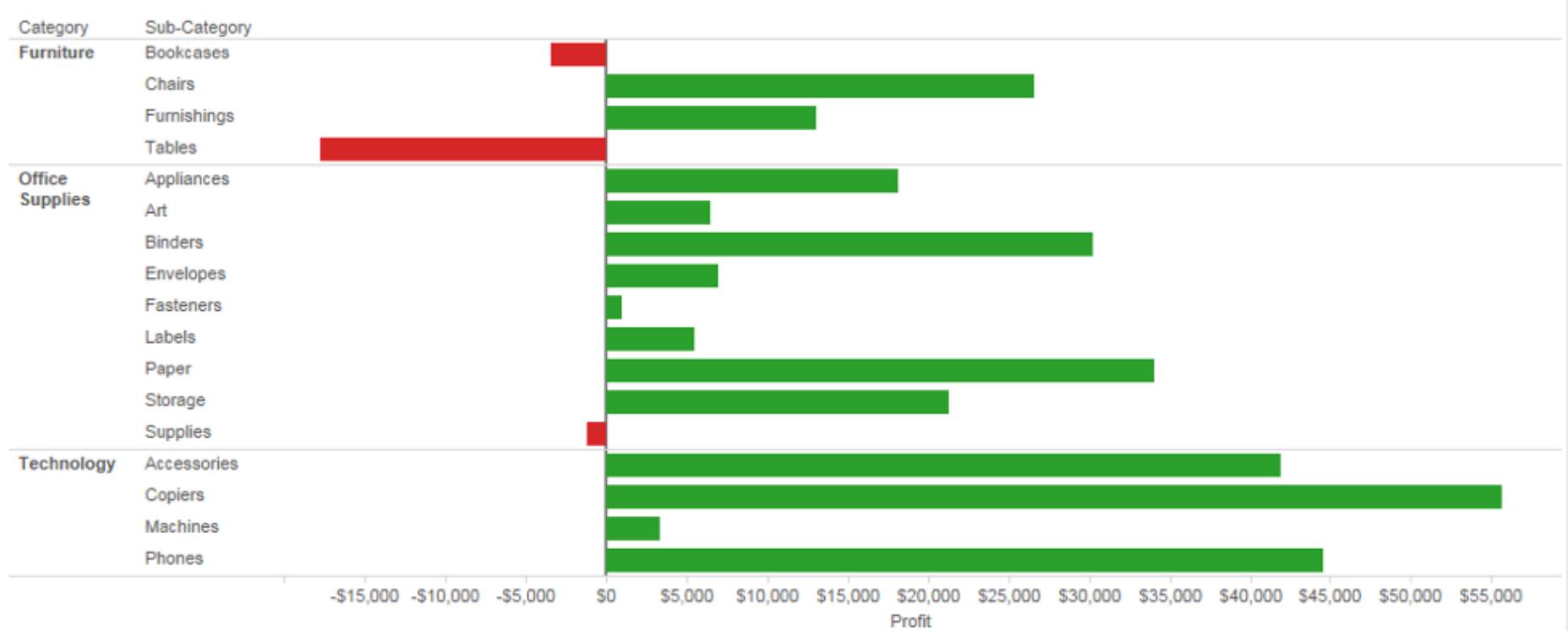
Some basic principles can be applied to generate accessible images.

- **Do not use rainbows.** Use a perceptually uniform colour map, such as viridis or cividis.
- **Avoid red.** Especially in combination with green.
- **Go grey.** Check your figure in greyscale, or by completely desaturating it.
- **Pick a palette.** Choose one that [works for everyone](#), such as [Color Universal Design](#) or Color Blind 10 Palette, or create your own using [i want hue](#) or [Viz Palette](#).
- **Think bigger.** Use features such as shapes and line textures to disambiguate colour.
- **Test drive.** Use a simulator such as [Color Oracle](#) or [Coblis](#) to ensure images can be interpreted accurately by everyone.





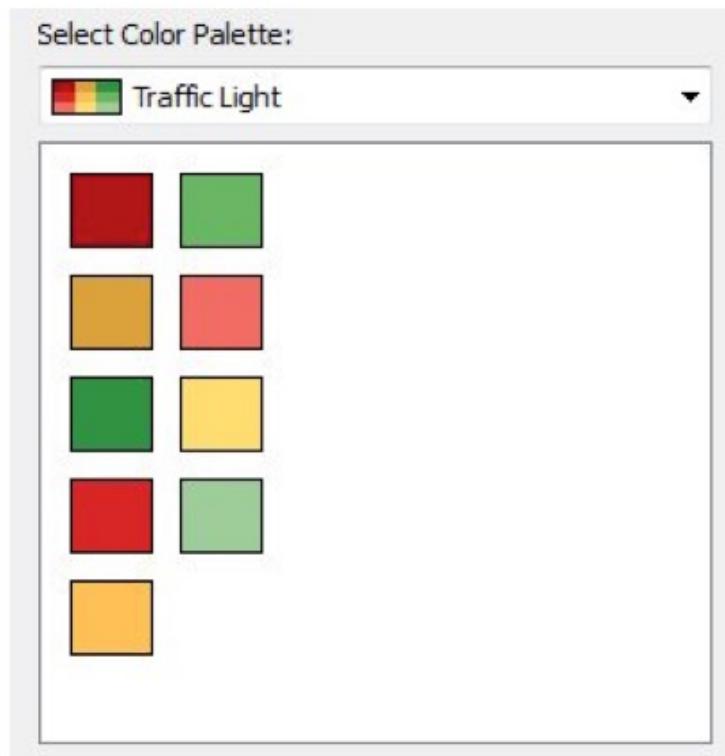
Deutanope simulation



This use of red-green if fairly harmless

Your Results:

Original Image



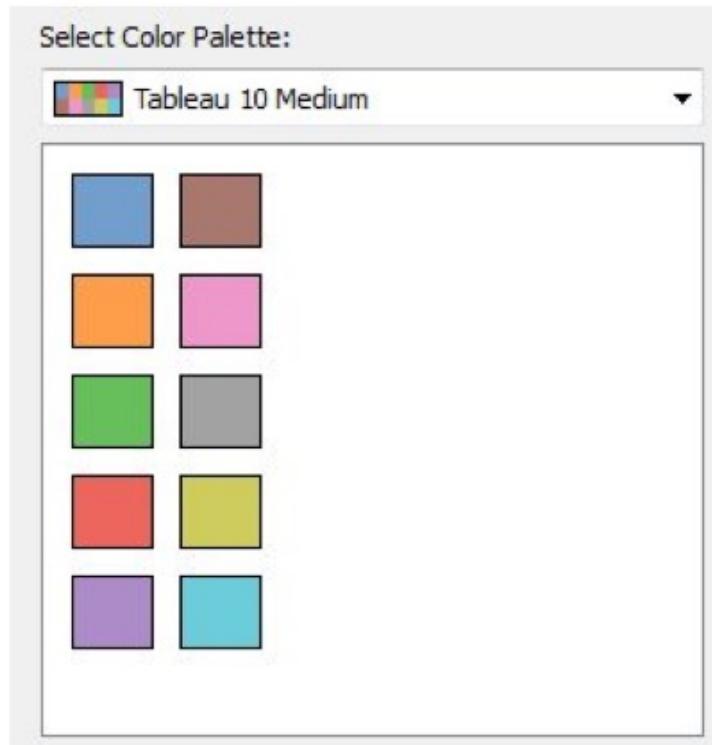
Protanope Simulation



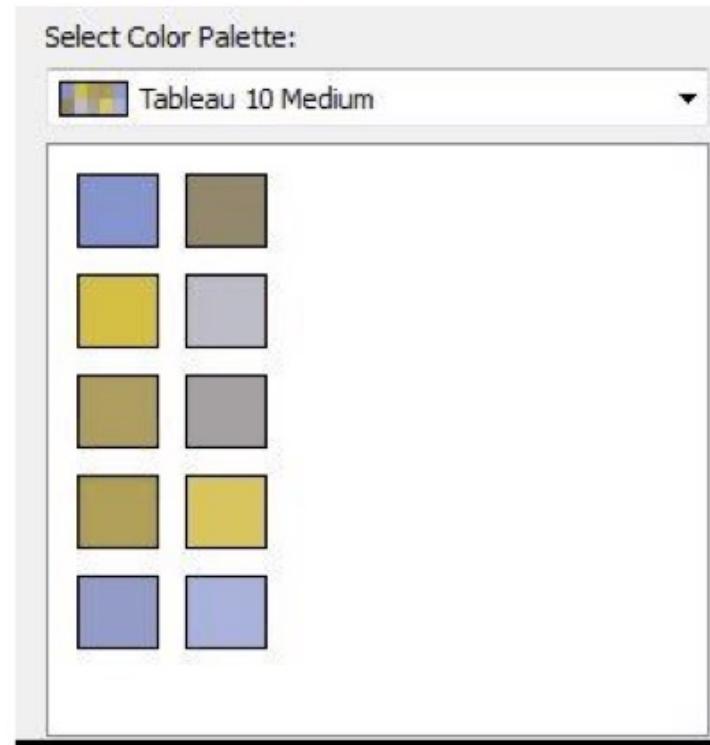
More complicated than just red vs. green

Your Results:

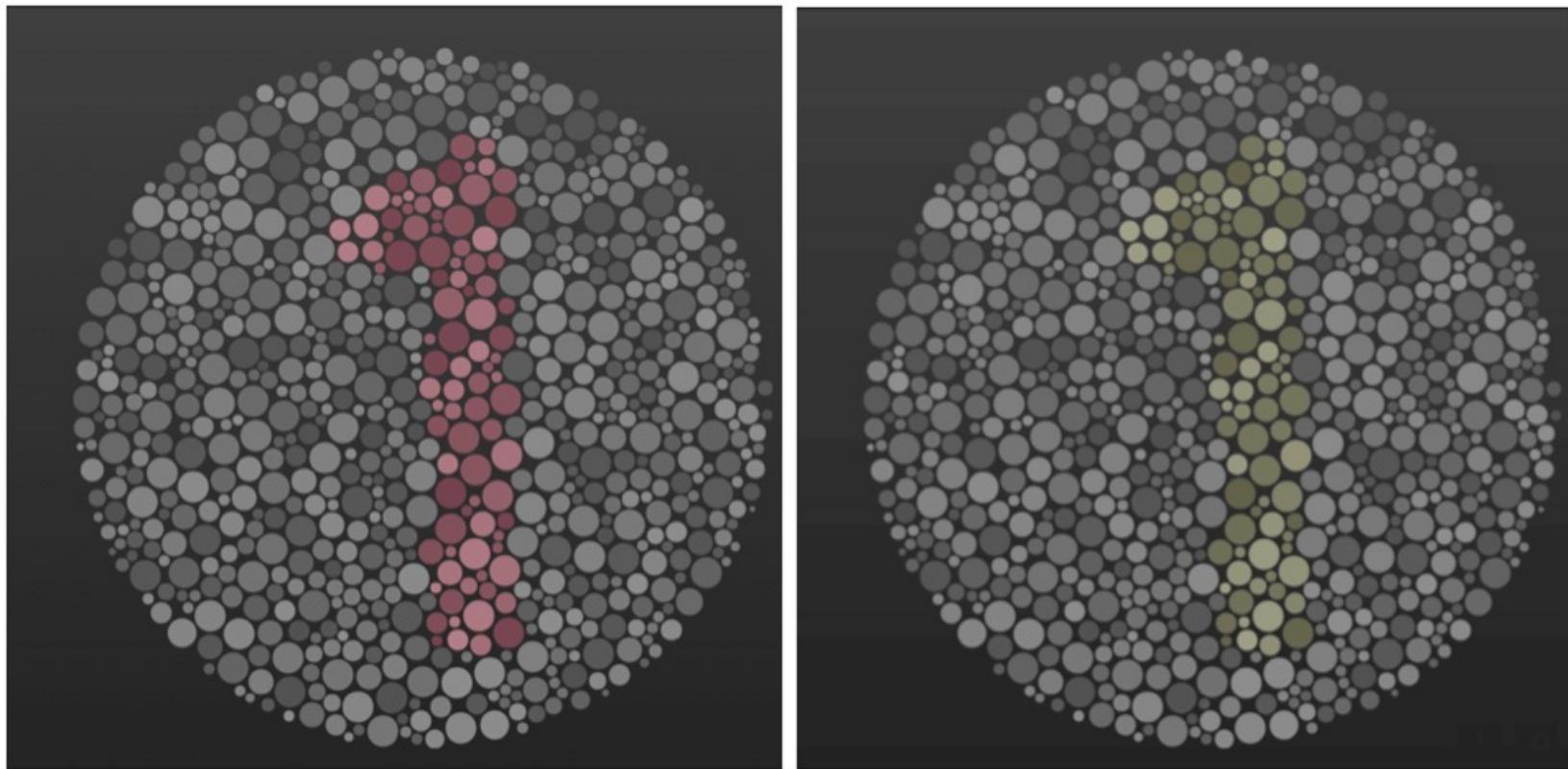
Original Image



Deuteranope Simulation



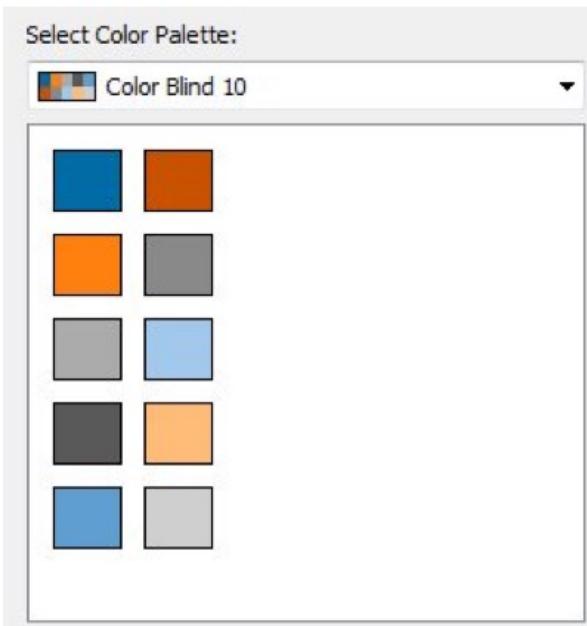
The blending of colors can also be problematic: purple, pink etc.



Protanopia simulation

Your Results:

Original Image



Deutanope Simulation

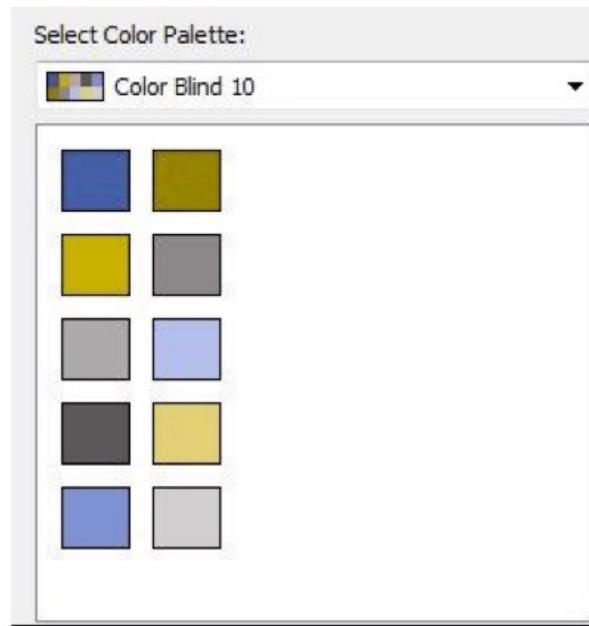
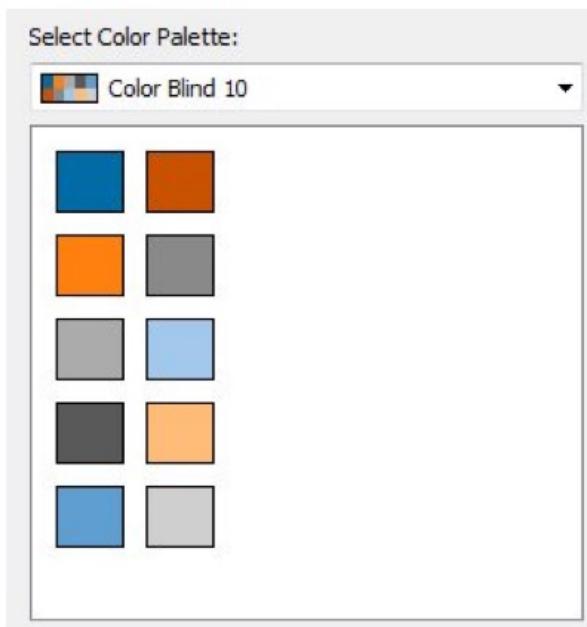


Tableau has a built-in colorblind-friendly palette designed by Maureen Stone

Your Results:

Original Image



Protanope Simulation



Color Oracle

Design for the Color Impaired



Color Oracle is a free color blindness simulator for Windows, Mac and Linux. It takes the guesswork out of designing for color blindness by showing you in real time what people with common color vision impairments will see.

Color Oracle applies a full screen color filter to art you are designing, independently of the software in use. Eight percent of all males are affected by color vision impairment – make sure that your graphical work is readable by the widest possible audience.

Download

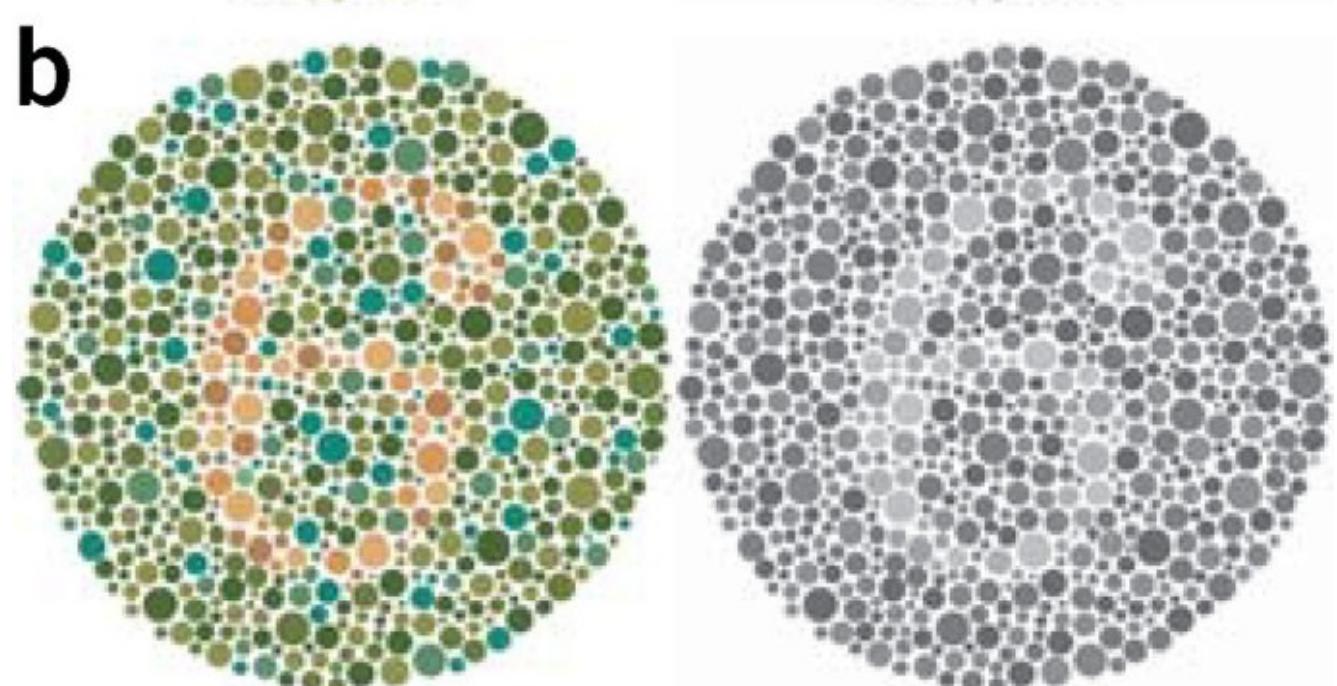
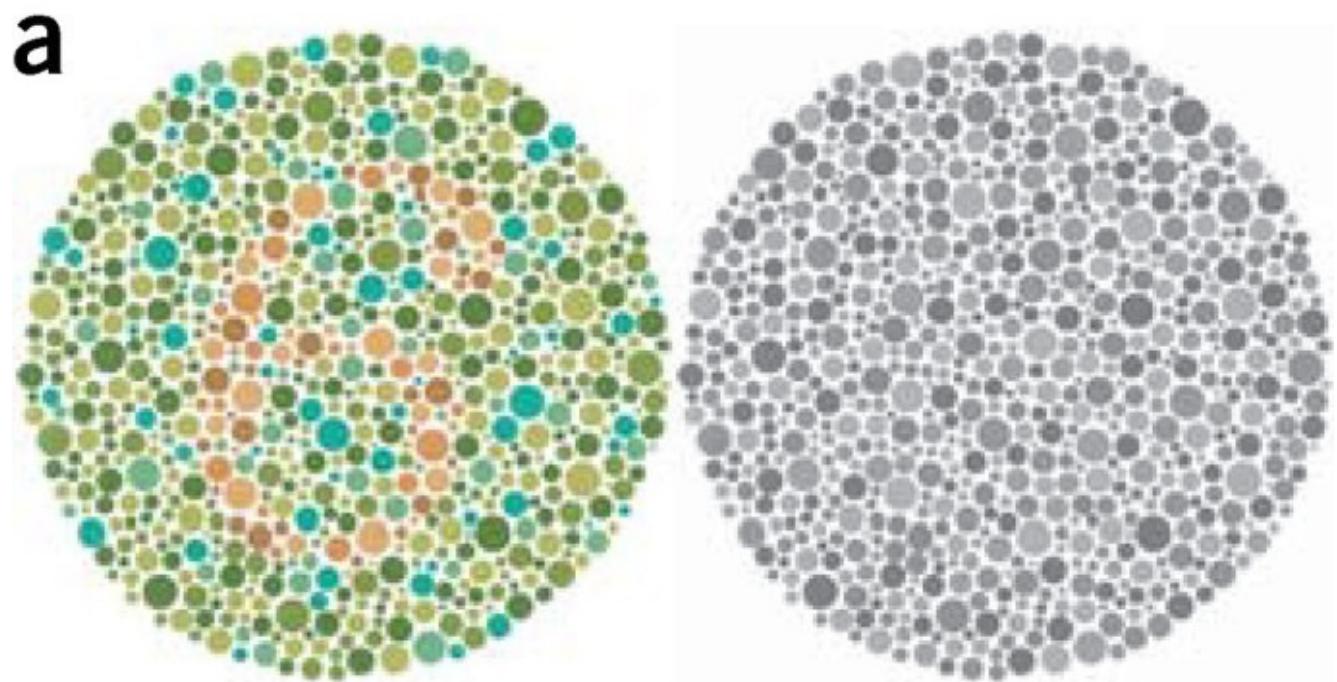
Version 1.3, May 5, 2018.

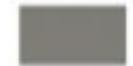
[macOS](#) [Windows](#) [Linux](#)

Colour Oracle for Windows and Linux requires Java 6 or higher.

macOS 10.15 Catalina users, please [see the manual for fixing a common issue](#).

In a study published in March, Jambor and her colleagues found that almost half of cell-biology papers and up to one-quarter of physiology and plant-science papers in leading journals contained images that would be completely or partially inaccessible to readers with deutanopia, another form of red–green colour blindness². “The tools are there for anybody that really wants them,” says Claus Wilke, a computational and evolutionary biologist at the University of Texas at Austin and author of *Fundamentals of Data Visualization* (2019). “The biggest challenge is actually to teach people to pay attention.”

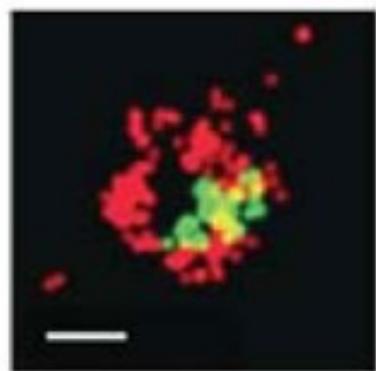


Color	Color name	RGB (1–255)	CMYK (%)	P	D
	Black	0, 0, 0	0, 0, 0, 100		
	Orange	230, 159, 0	0, 50, 100, 0		
	Sky blue	86, 180, 233	80, 0, 0, 0		
	Bluish green	0, 158, 115	97, 0, 75, 0		
	Yellow	240, 228, 66	10, 5, 90, 0		
	Blue	0, 114, 178	100, 50, 0, 0		
	Vermillion	213, 94, 0	0, 80, 100, 0		
	Reddish purple	204, 121, 167	10, 70, 0, 0		

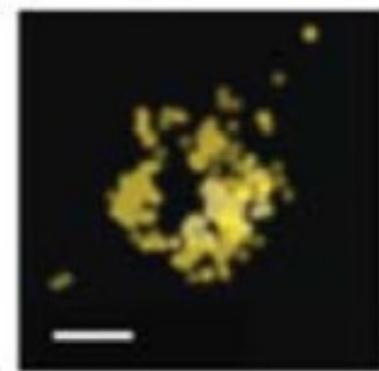
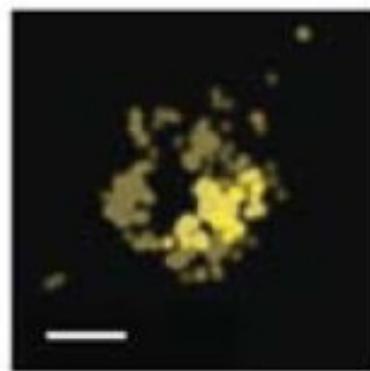
Natural color
images

a

Original image
with red and
green color
coding



Simulated colors as seen by:
protanope deutanope



b

Image with red
replaced by
magenta

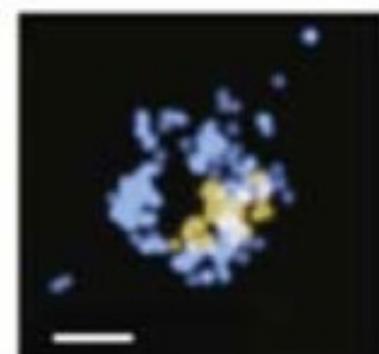
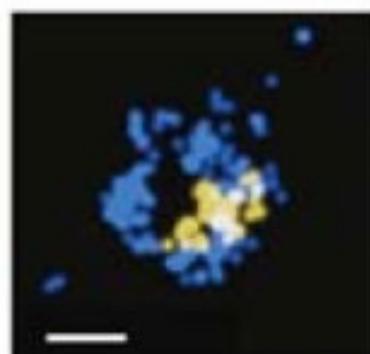
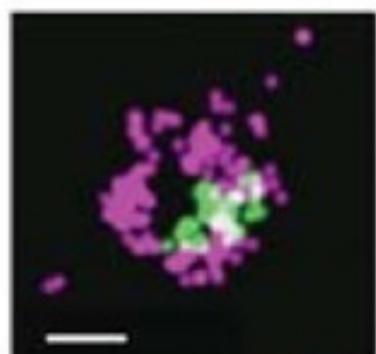
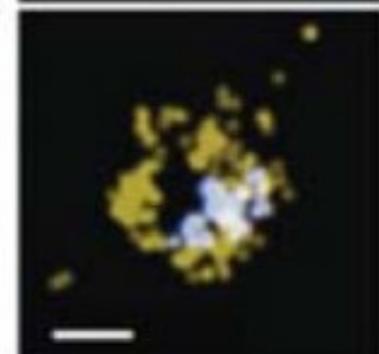
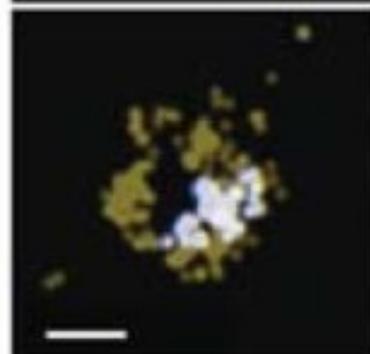
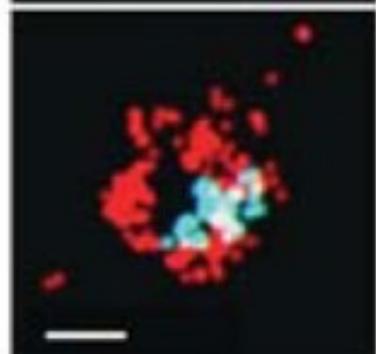
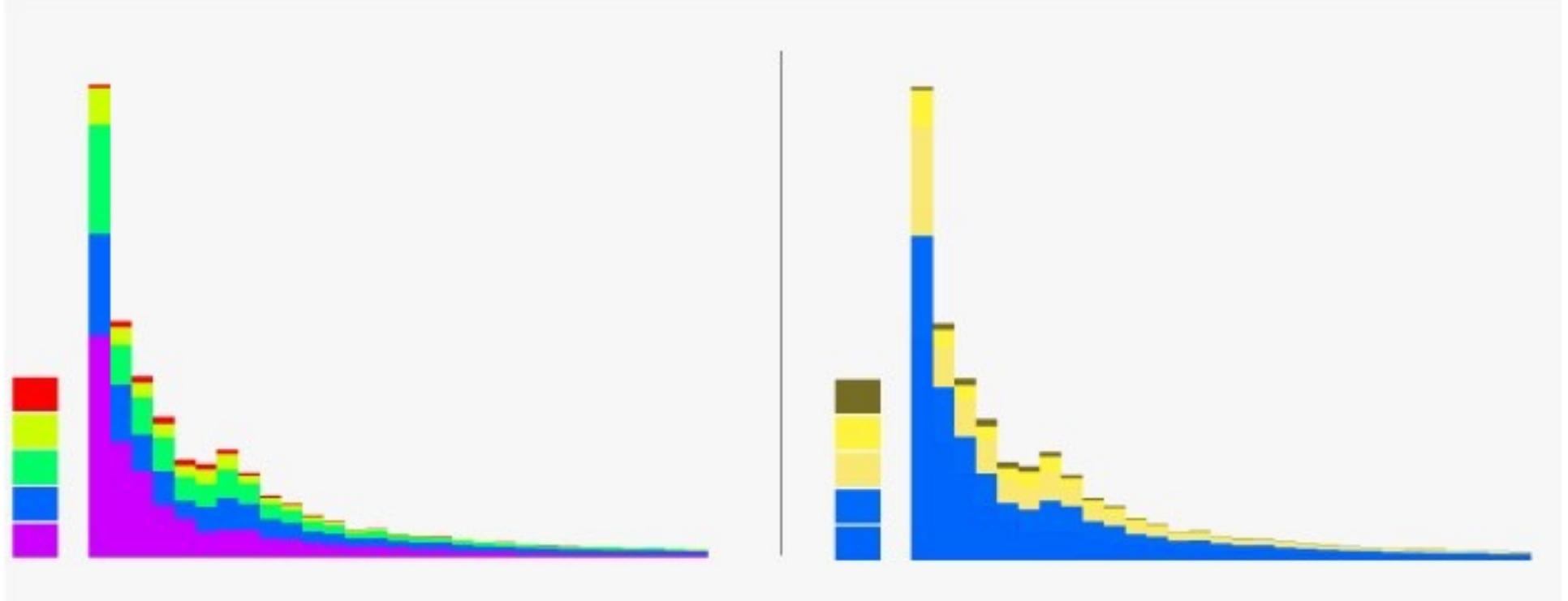
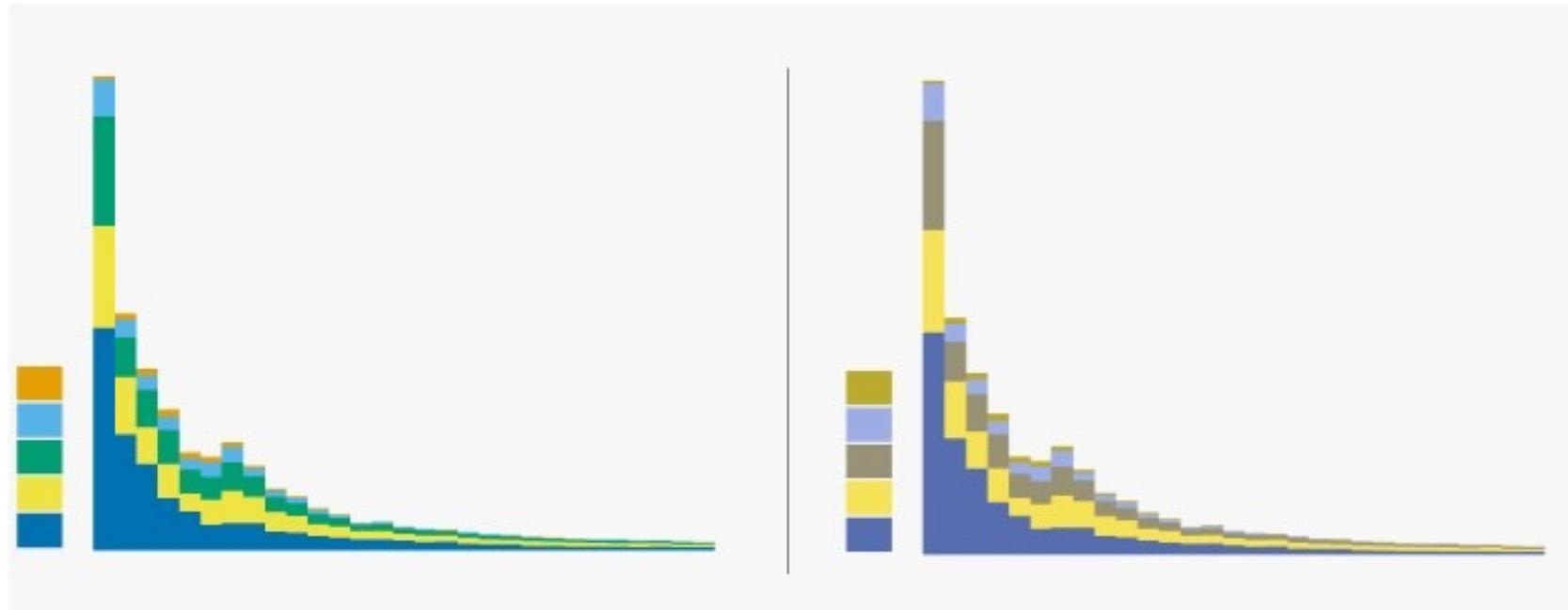


Image with
green replaced
by turquoise





Rainbow color scheme bad for folks with protanopia



Color Universal Design palette is better than rainbow, still shows differences for the colorblind

ColorBlindSets

version 1.0.0.0 (328 KB) by [Massimo Ciacci](#)

Helps you choose a palette of color blind friendly colors

SMALL: 9+2 colors: OPT readability

Black
Blue
Red
Orange
GreenMedium
Aqua
Azure
Violet
Magenta
Pink
Grey1
Black
Blue
Red
Orange
GreenMedium
Aqua
Azure
Violet
Magenta
Pink
Grey1
Black
Blue
Red
Orange
GreenMedium
Aqua

MEDIUM: 13+2 colors

Black
Red
Orange
Amber
YellowHtml
SpringGreen
LightTeal
Aqua
DeepSkyBlue
DodgerBlue
Blue
Violet
Purple
Pink
Grey1
Black
Red
Orange
Amber
YellowHtml
SpringGreen
LightTeal
Aqua
DeepSkyBlue
DodgerBlue
Blue
Violet
Purple
Magenta
Pink
Grey1
Black
Red
Orange
Amber
YellowPrimary
YellowHtml
Lime
Chartreuse
GreenHtml
SpringGreen
LightTeal
Aqua
DeepSkyBlue
DodgerBlue
Blue
Violet
Purple
Magenta
Pink
Grey1
Black
Red
Orange
Amber
Yellow-Html
Lime
GreenYellow
Chartreuse
GreenHtml
SpringGreen
LightTeal
Aqua
ArcticBlue
DeepSkyBlue
DodgerBlue
RoyalBlue
Blue
ElectricViolet
Violet
Purple
Magenta
Pink
CrimsonRose
Grey1
Black
Red

LARGE: 17+2 colors: COLOR BLIND HARD

Black
Red
Orange
Amber
YellowHtml
SpringGreen
LightTeal
Aqua
DeepSkyBlue
DodgerBlue
Blue
Violet
Purple
Pink
Grey1
Black
Red
Orange
Amber
Yellow-Html
Lime
Chartreuse
GreenHtml
SpringGreen
LightTeal
Aqua
DeepSkyBlue
DodgerBlue
Blue
Violet
Purple
Magenta
Pink
Grey1
Black
Red
Orange
Amber
Yellow-Html
Lime
Chartreuse
GreenHtml
SpringGreen

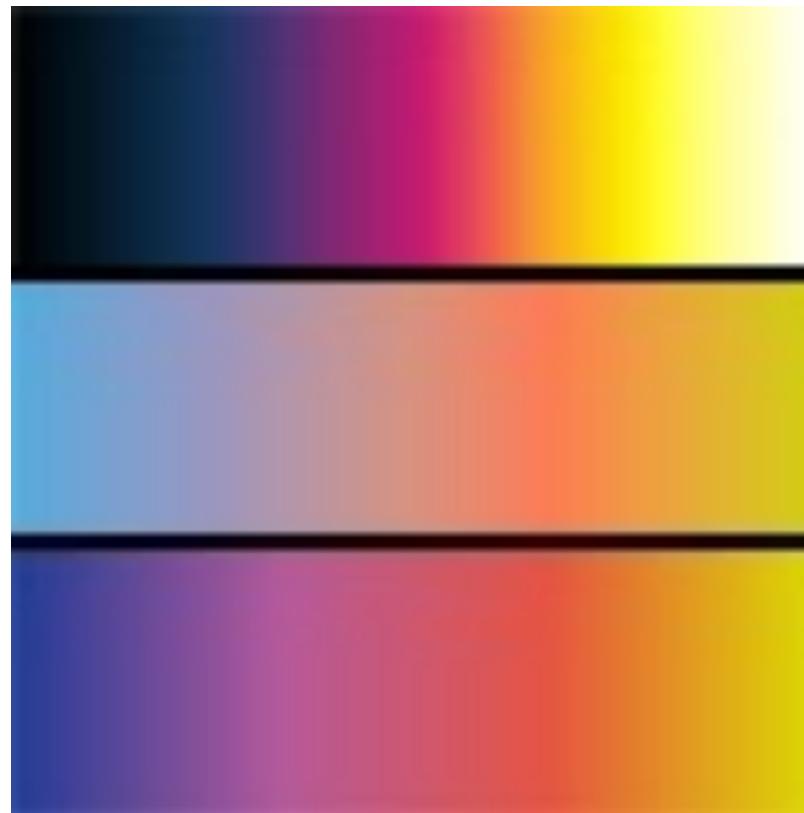
too Large: 24+2 colors

Black
Red
Vermilion
Orange
Amber
YellowPrimary
YellowHtml
Lime
GreenYellow
Chartreuse
GreenHtml
SpringGreen
LightTeal
Aqua
ArcticBlue
DeepSkyBlue
DodgerBlue
RoyalBlue
Blue
ElectricViolet
Violet
Purple
Magenta
Pink
CrimsonRose
Grey1
Black
Red

Colormaps compatible with red-green color perception deficiencies

version 1.5.0.0 (14.5 KB) by [Matthias Geissbuehler](#)

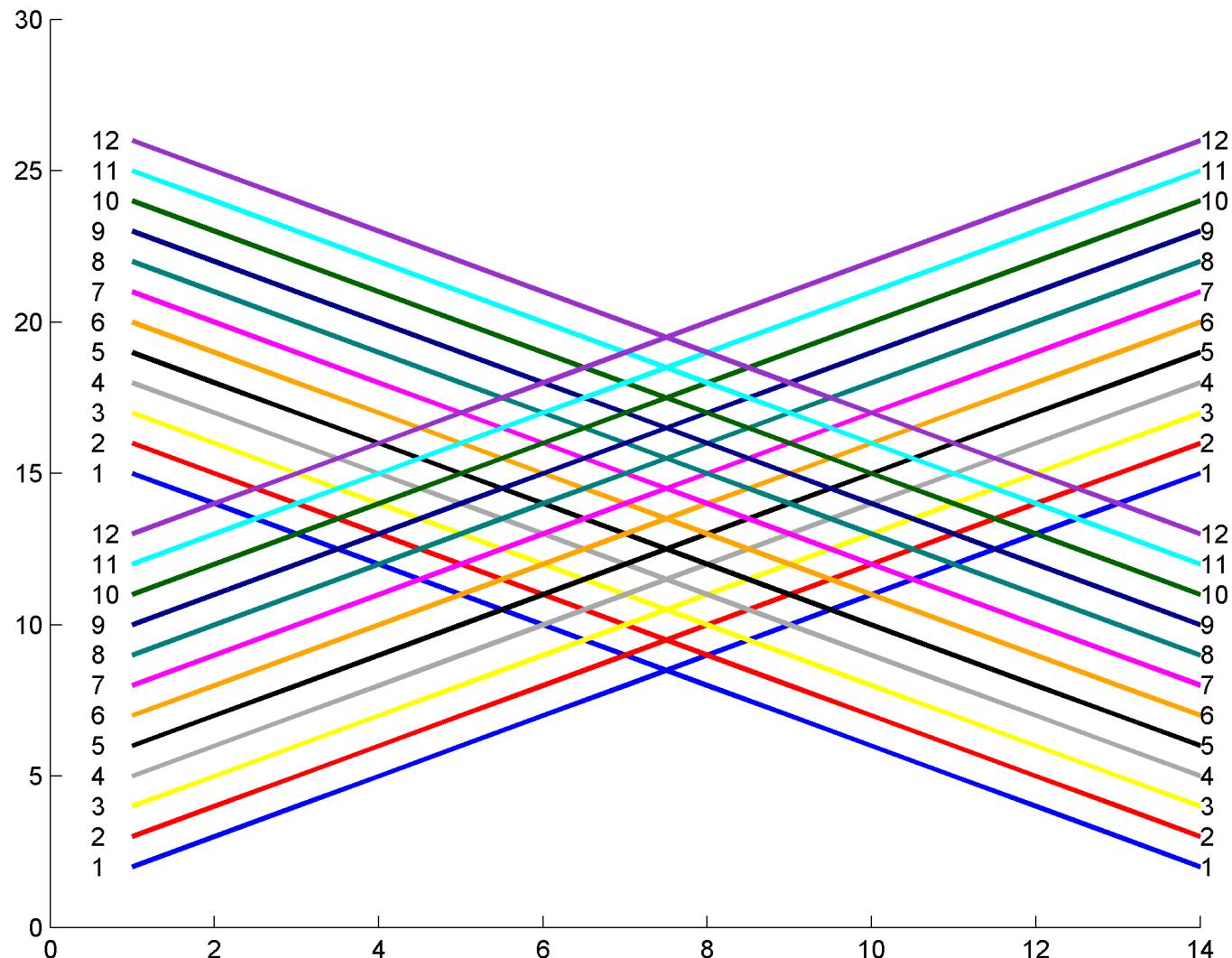
Colormaps for displaying data compatible with red-green color perception deficiencies



Color blind friendly colormap

version 1.1.0.0 (553 Bytes) by [Diana](#)

A colormap that attempts to be color blind friendly



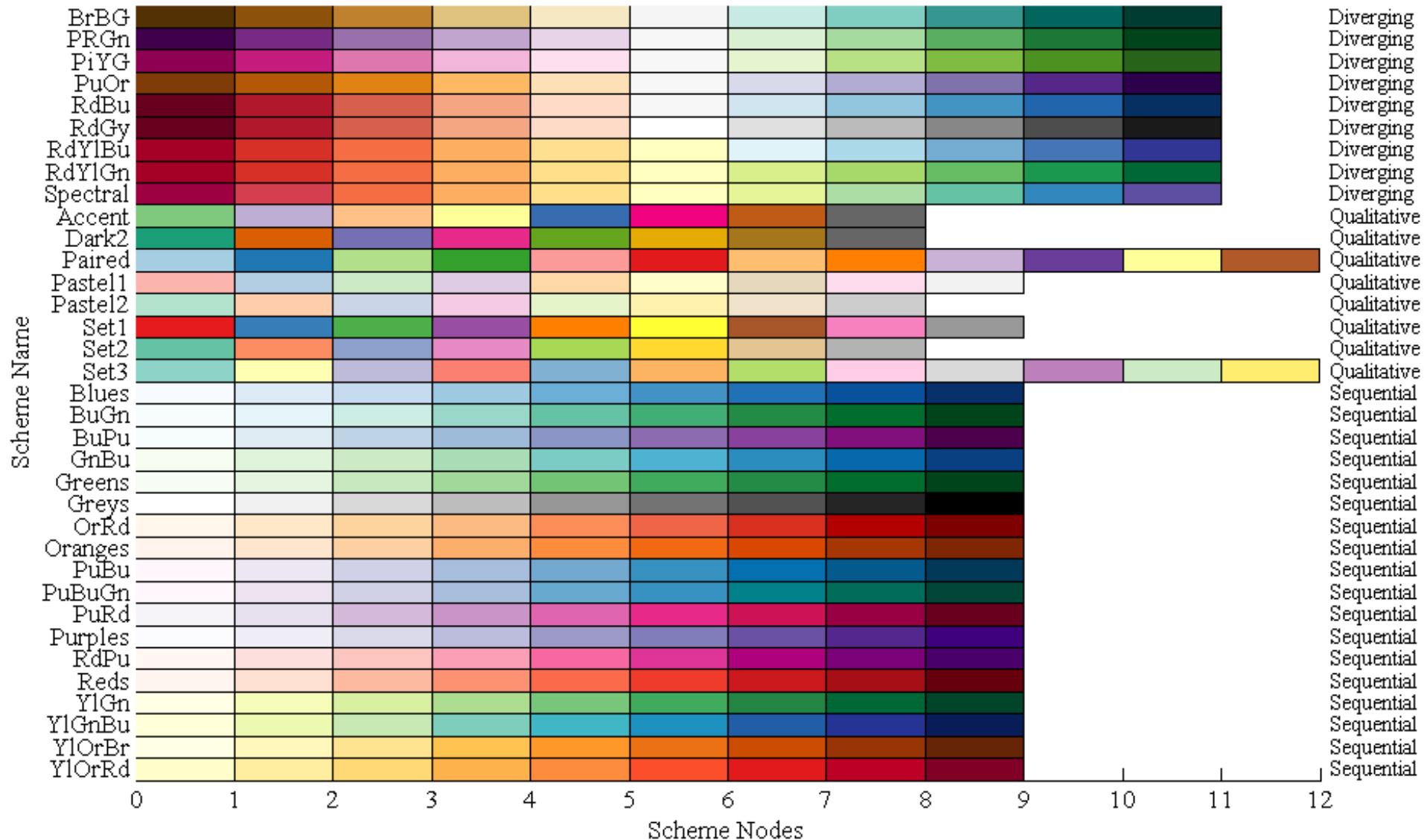
ColorBrewer: Attractive and Distinctive Colormaps

version 3.2.3 (19.1 KB) by [Stephen23](#)

The complete palette of ColorBrewer colormaps. Simple selection by scheme name and map length.

<https://github.com/DrosteEffect/BrewerMap>

ColorBrewer Color Schemes (brewermap.m)

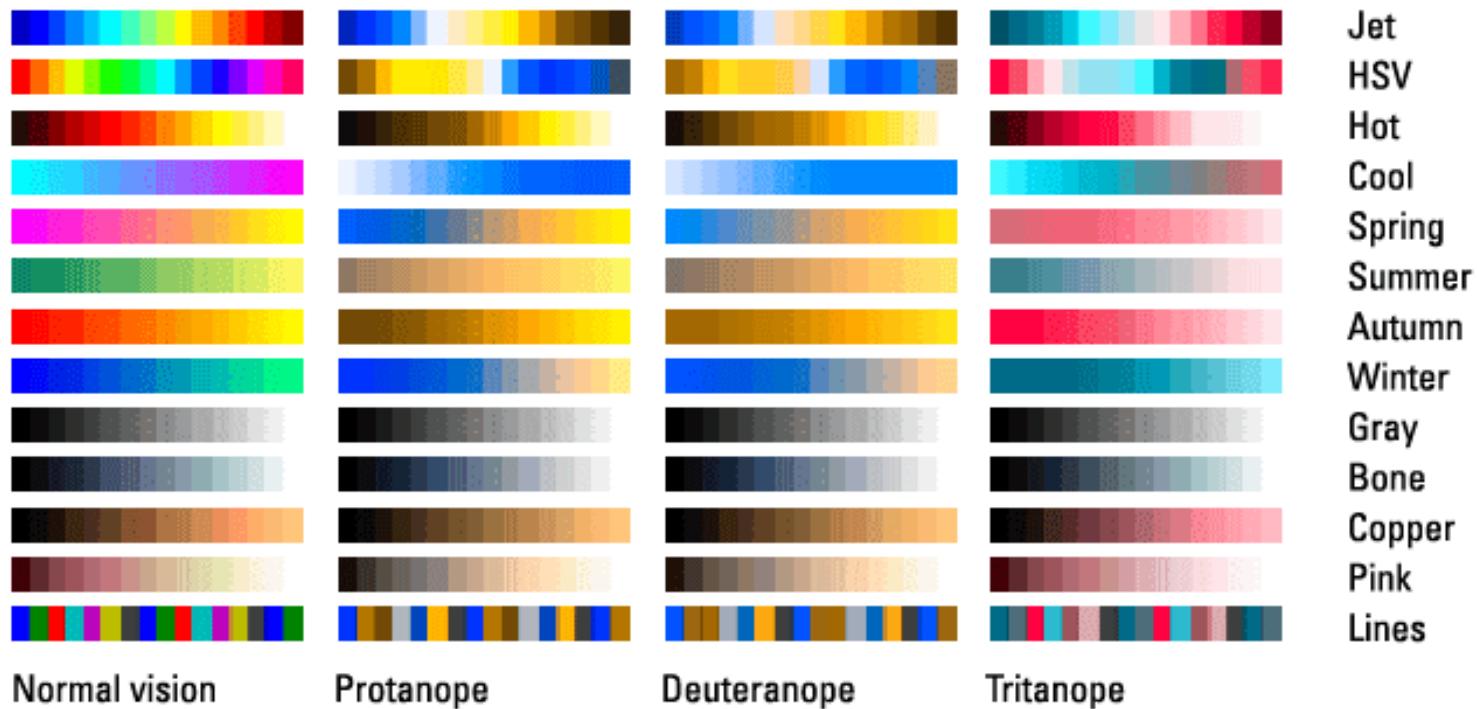


Matlab colormaps as seen by color-blind users

version 1.3.0.0 (29.6 KB) by [Vlad Atanasiu](#)

This image provides simulations of how the standard Matlab colormaps look to color-blind users.

Matlab colormaps as seen by color-blind users



Review of Color Blindness Removal Methods using Image Processing

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E-mail: ruchi_kulshrestha23@yahoo.com

Modifying Images for Color Blind Viewers

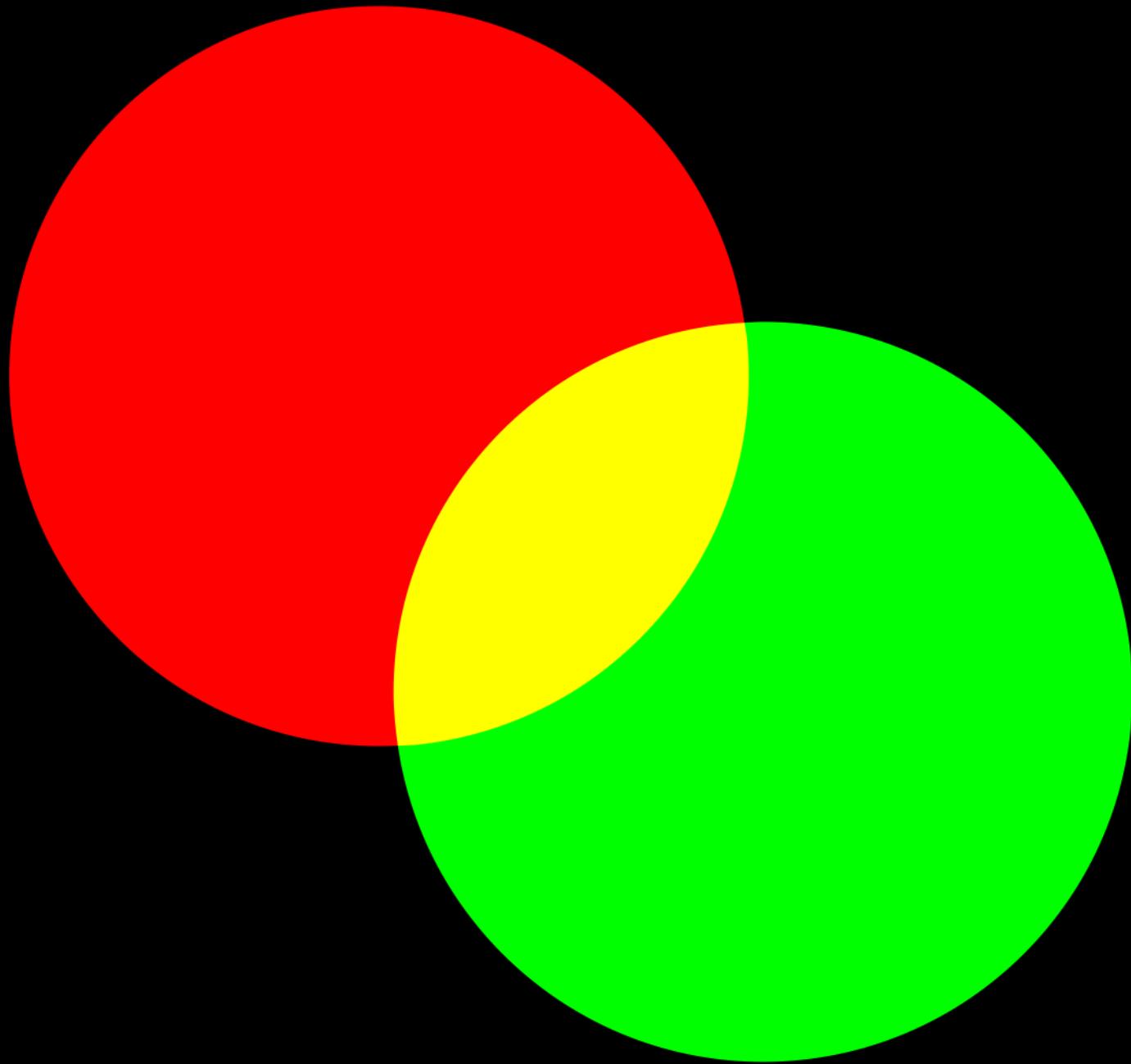
William Woods

Electrical Engineering Department

Stanford University

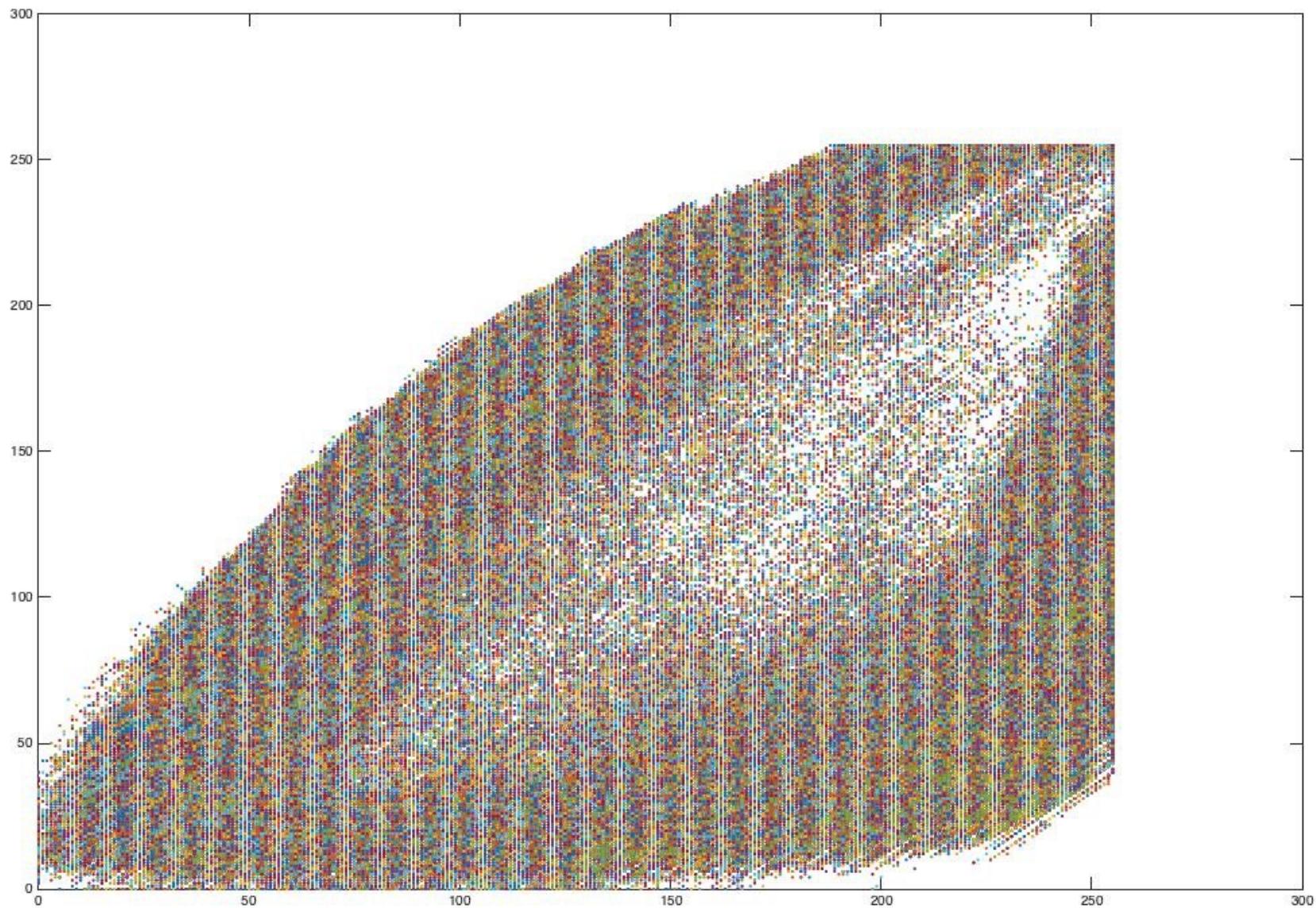
Stanford, USA

wwwoods@stanford.edu





```
RGBpep=imread('redgreenpeppers.jpg');  
plot(RGBpep(:,:,1),RGBpep(:,:,2),'.')
```





```
RGBlem=imread('lemons.jpg');
plot(RGBlem(:,:,1),RGBlem(:,:,2),'.')
```

