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DATA VISUALIZATION AND VISUAL ANALYTICS

How many color?

Female



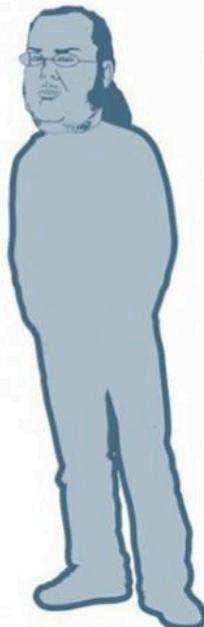
Male

Dog



Programmer

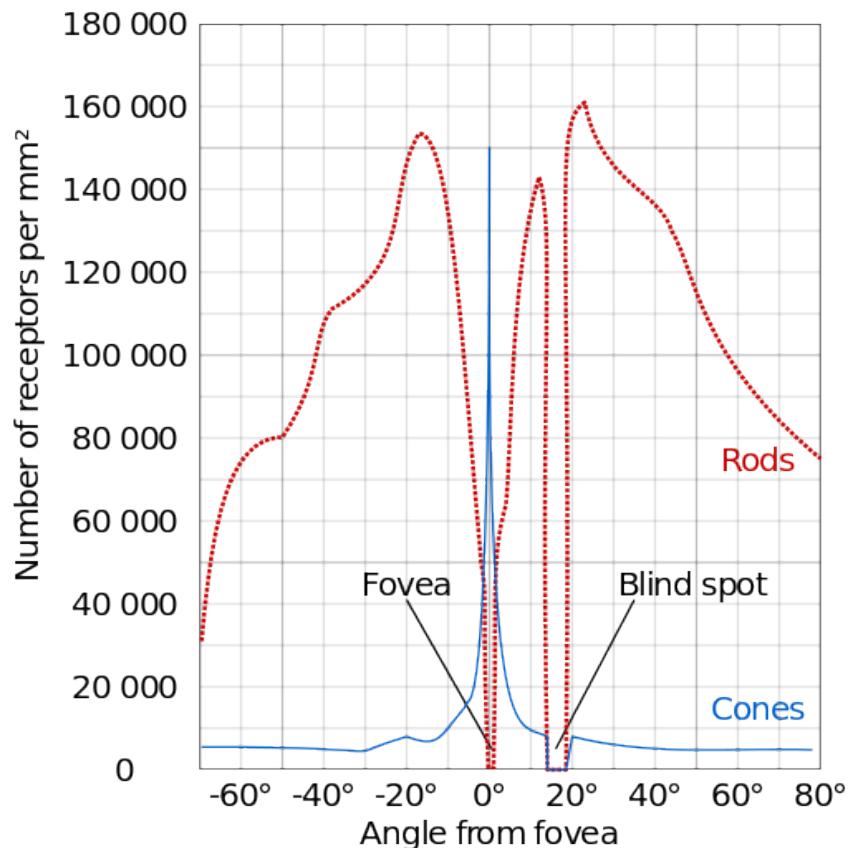
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We Know Memes

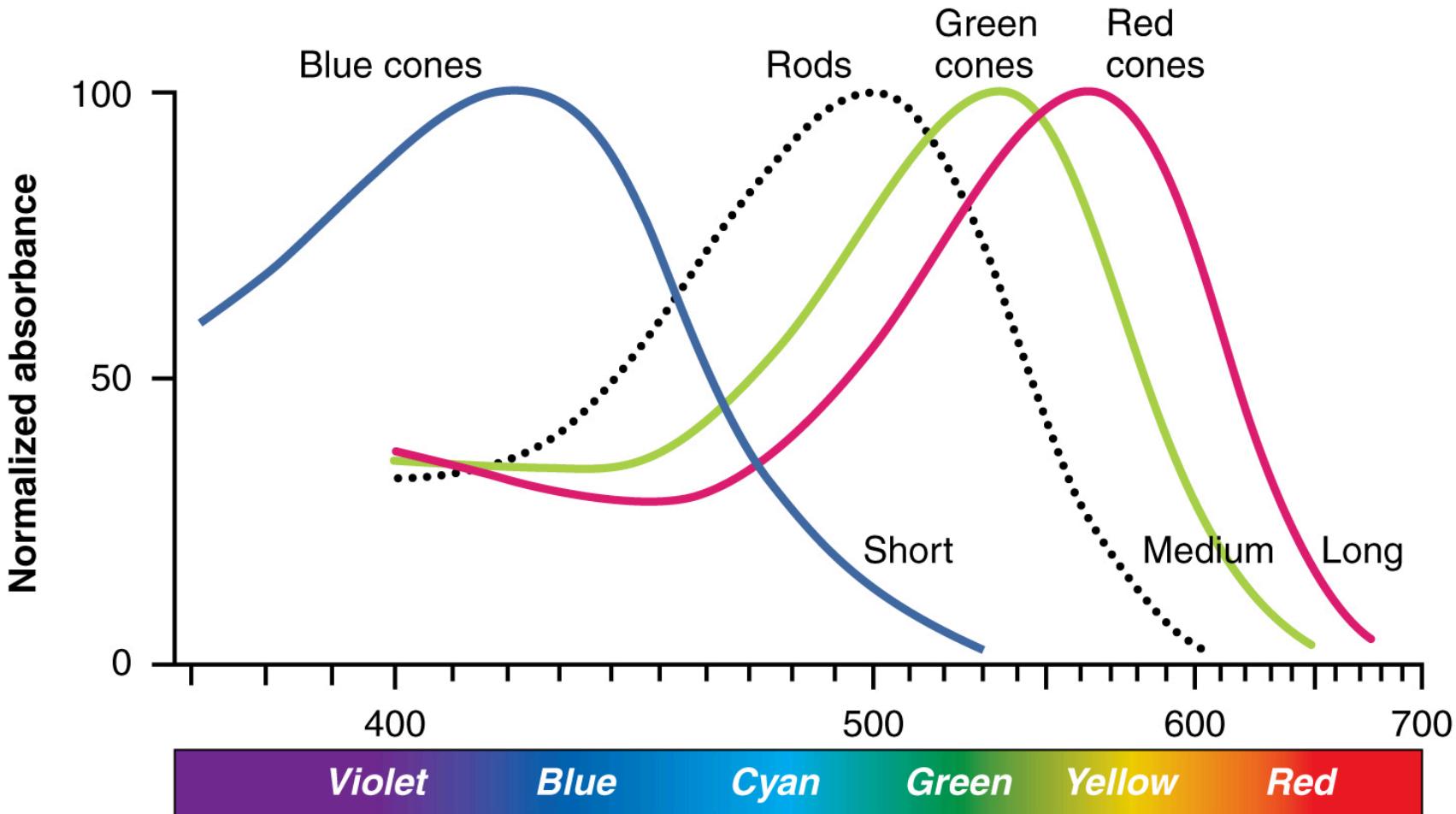
Photo Receptor Cells

- Two types of light sensitive cells
 - Rod Cells (~120M)
 - Provide low-light vision
 - Peripheral vision
 - Almost no role in color vision
 - Cone cells (~6M)
 - Provide normal vision
 - Three sub-types of cells
 - Sensitivity to different light wavelengths
 - Used for colored vision



"Human photoreceptor distribution" by Cmglee - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Human_photoreceptor_distribution.svg#mediaviewer/File:Human_photoreceptor_distribution.svg

Photo Receptor Cells



Vision System(s)

- Low light vision is managed by rods
- **Scotopic vision system**
- Peak of efficiency around 500nm
- Cannot distinguish colors
- Activation requires a long time
- Normal light vision
- **Photopic vision system**
- Peak of efficiency at 560nm

Game #6



color

click to get started

Color of the Year: 2016

COLOR FORMULA & GUIDES

PANTONE Color of the Year 2016 can be found in the following color systems:

ROSE QUARTZ

FASHION + HOME PANTONE 13-1520TCX

RGB for TCX

sR	sG	sB
247	202	201

CMYK for TCX

C	M	Y	K
0	24	15	0

HTML Values for TCX: F7CAC9

PANTONE Pastel 9281 C (Closest Match)

9281 C RGB

sR	sG	sB
242	221	222

CMYK for 9281 C

C	M	Y	K
0	14	9	0

HTML Values for 9281 C: F2DDDE



Get Rose Quartz & Serenity and color pairings in [ASE file format](#) for [Adobe® Applications](#).

Plastic

PQ-13-1520TCX

SERENITY

FASHION + HOME PANTONE 15-3919TCX

RGB for TCX

sR	sG	sB
146	168	209

CMYK for TCX

C	M	Y	K
42	24	3	0

HTML Values for TCX: 92A8D1

PLUS Series 7451 C (Closest Match)

Plus Series RGB

sR	sG	sB
137	171	227

Plus Series CMYK

C	M	Y	K
46	23	0	0

HTML Values for Plus Series: 89ABE3



Download Rose Quartz and Serenity wallpaper for your mobile device or desktop.

Plastic

PQ-15-3919TCX

Color of the year 2017

COLOR FORMULAS, GUIDES & STANDARDS



COLOR FORMULA & GUIDES

PANTONE Color of the Year 2017 can be found in the following color systems:

GREENERY

FASHION + HOME PANTONE 15-0343 TCX			
RGB for TCX		sR	sG
136		176	75
HTML Values for TCX: 88B04B			

PANTONE 376 C (Closest Match)			
PLUS Series RGB		sR	sG
132		189	0
HTML Values for PLUS Series: 84BD00			

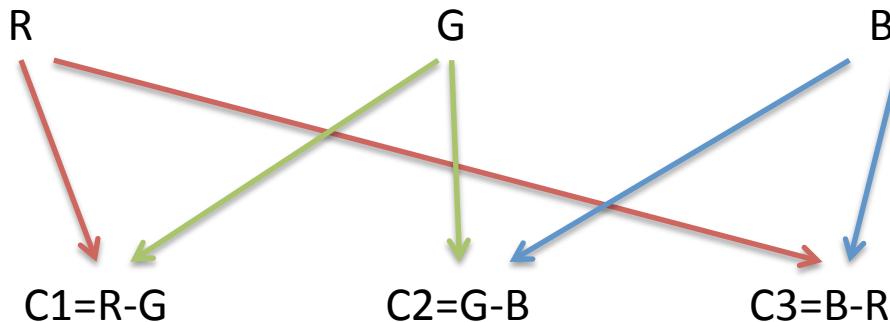
 Get Greenery in ASE file format for Adobe® Applications.
Plastic
PQ-15-0343 TCX

Color Model

- Young-Helmotz Theory (19th century)
 - Separate Red, Green, Blue receptors
 - Actually, three receptors type exist
 - Red and Green are located mainly in green-yellow zone
 - Sometimes named as Long, Medium, Short wavelength receptors
 - Eye present different proportions of R,G,B receptors (40:20:1)

Opponent Color Theory

- Based on estimation of opposite readings
 - red-green comparison
 - blue-yellow comparison
 - dark-light comparison



$$C_1 + G + B = 0$$

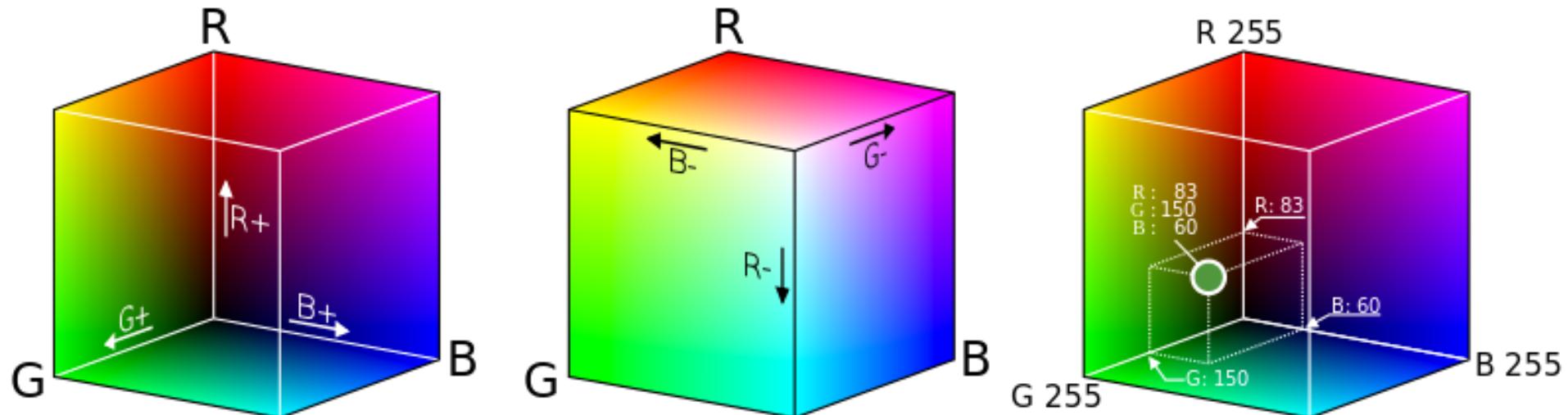
$$C_1 = R - G$$

$$C_3 - C_2 = B - R - G + B = 2B - (R + G)$$

$$A = 2R + G + B / 20$$

RGB Color Model

- Based on direct specification of three primary colors
- Additive model, each component is summed with the others

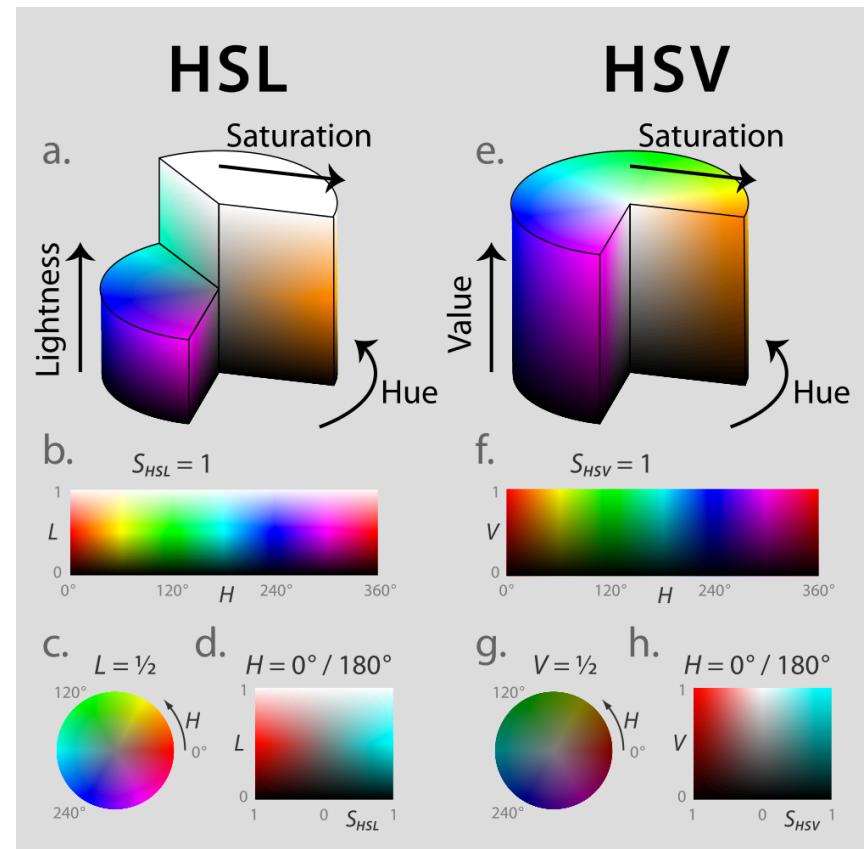


RGB Color Model

- R,G,B values may be expressed in range [0,1]
- Some applications use the range[0,255]
- Usually a hexadecimal notation is used for range [0,ff]
- Not really intuitive: how to define brown?

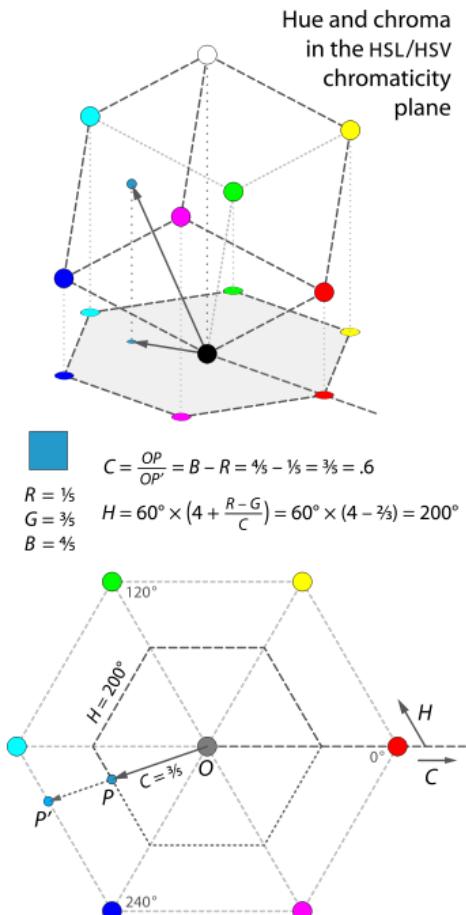
HSV Color Model

- Based on the intuitive concepts of
 - Hue
 - Saturation
 - Value
- Component values are expressed in ranges $[0,1]$ or $[0,255]$

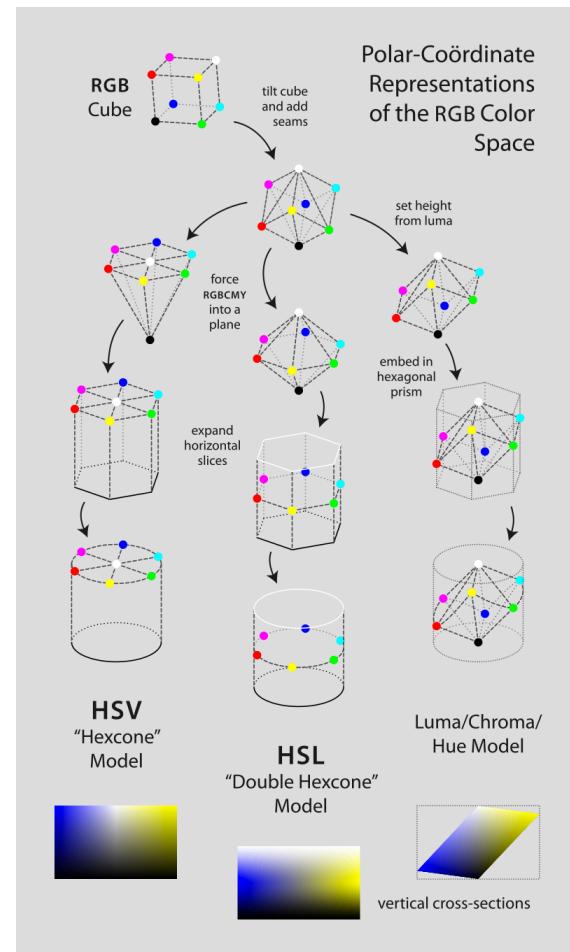


"Hsl-hsv models" by Jacob Rus - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Hsl-hsv_models.svg#/media/File:Hsl-hsv_models.svg

RGB and HSV



"HSL-HSV hue and chroma" by Jacob Rus - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - [http://commons.wikimedia.org/wiki/File:HSL-HSV_hue_and_chroma.svg](http://commons.wikimedia.org/wiki/File:HSL-HSV_hue_and_chroma.svg#/media/File:HSL-HSV_hue_and_chroma.svg)



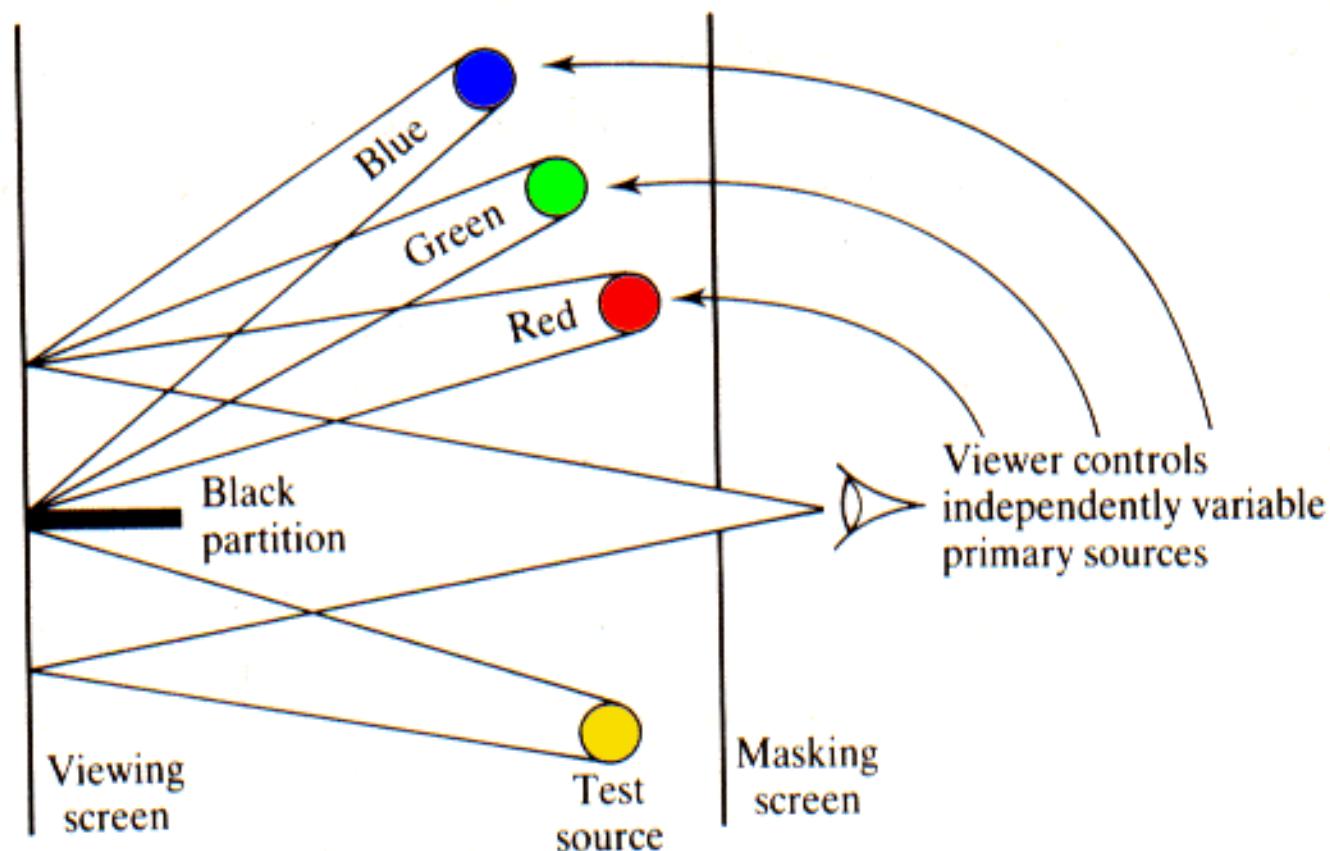
"Hsl-and-hsv" by Jacob Rus - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - [http://commons.wikimedia.org/wiki/File:Hsl-and-hsv.svg](http://commons.wikimedia.org/wiki/File:Hsl-and-hsv.svg#/media/File:Hsl-and-hsv.svg)

COLOURIMETRY

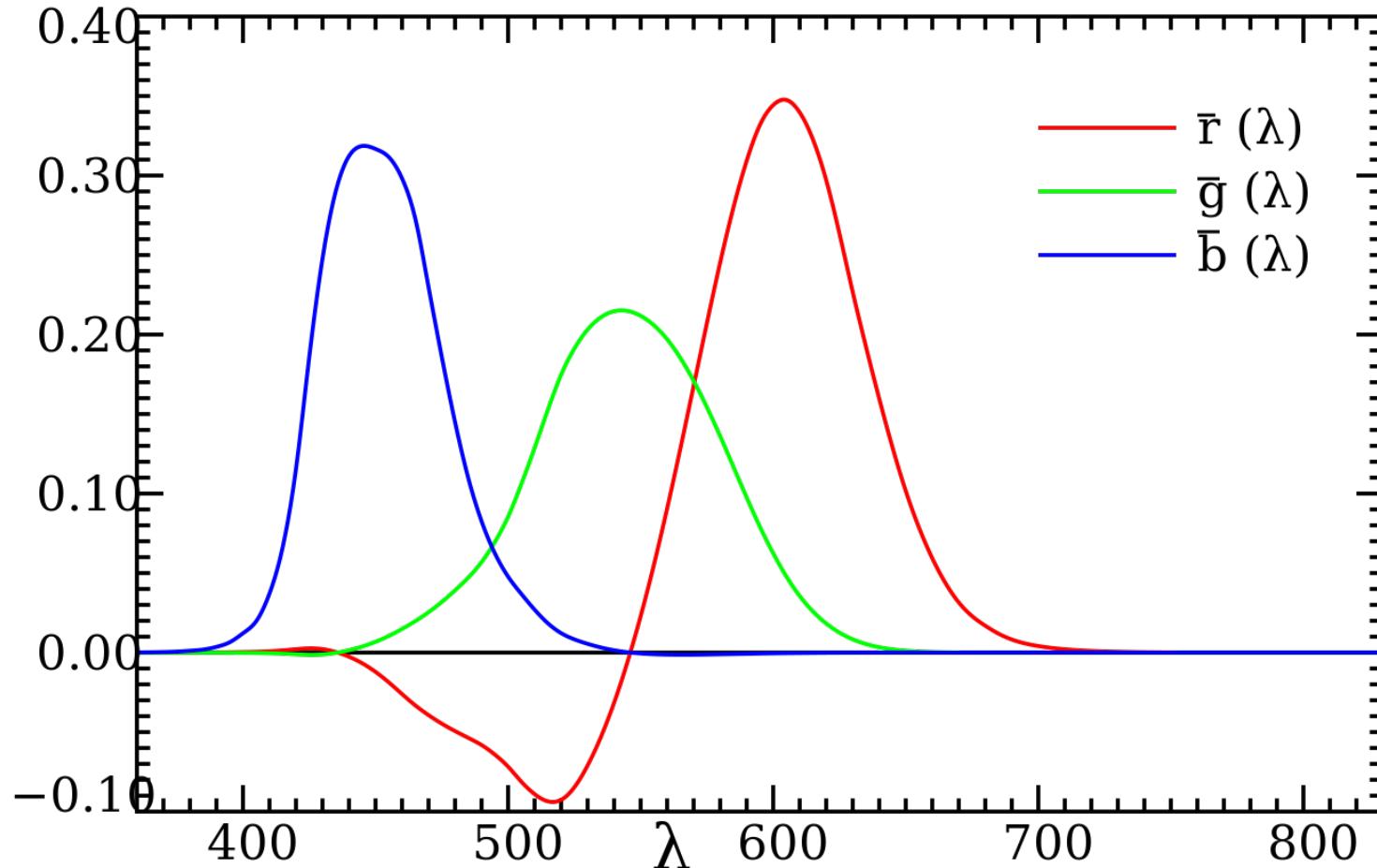
CIE Standard Observer

- CIE: International Commission on Illumination
- Definition of an objective color-mapping function:
 - Standard colorimetric observer
- Experiment
 - An observer is positioned in front of a bipartite screen
 - Observer can manipulate intensities of three primary color beams
 - Task:match the reference color

Standard Observer Experiment

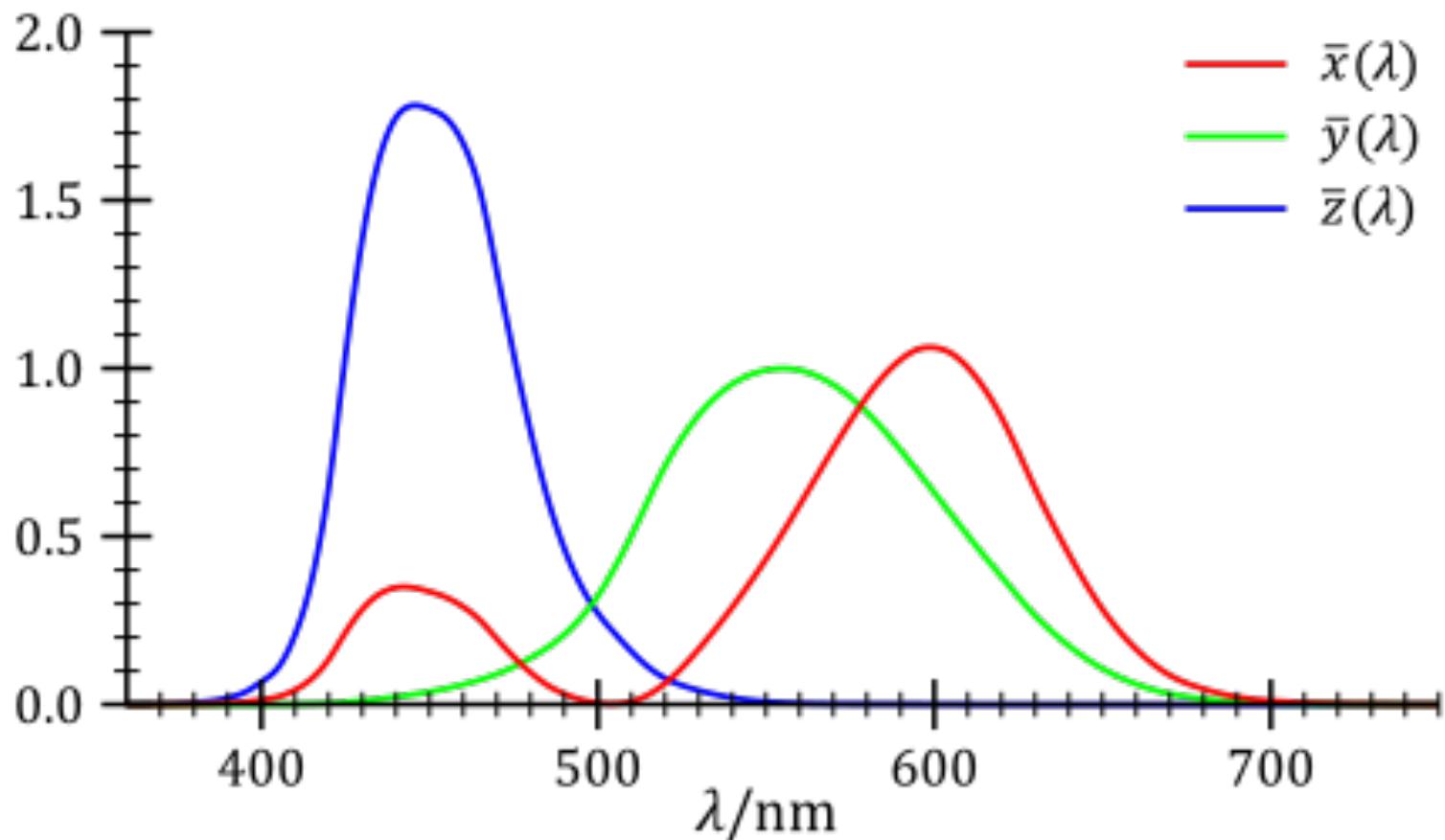


Standard Observer Results



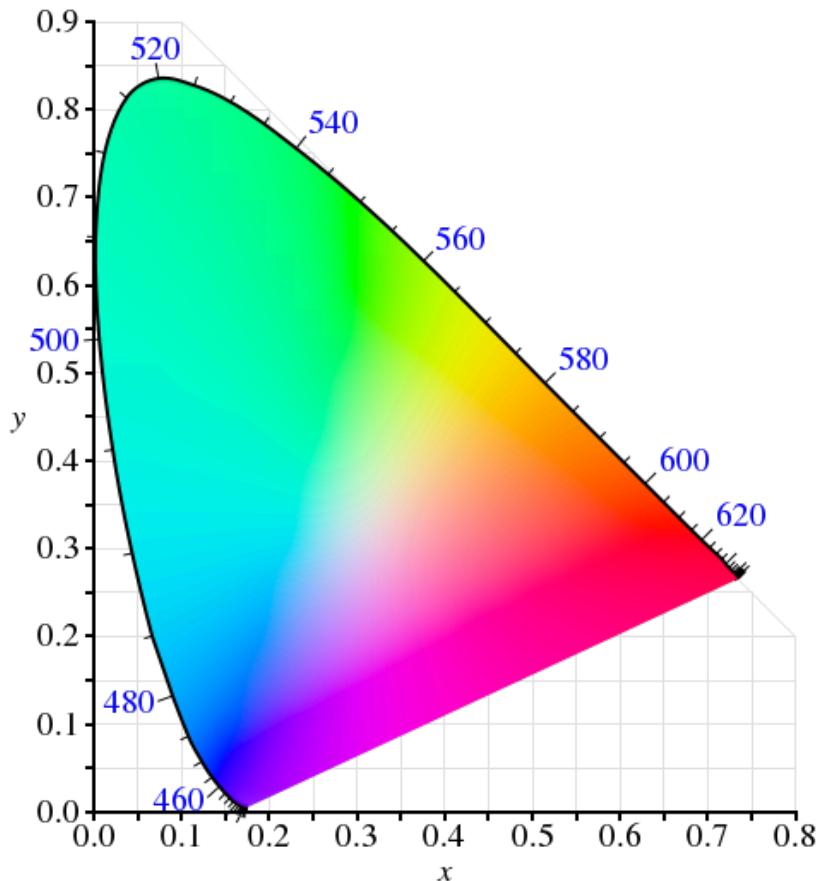
"CIE1931 RGBCMF" by Original uploader was Marco Polo at en.wikipedia - Transferred from en.wikipedia; Transfer was stated to be made by User:Kanie.. Licensed under Public Domain via Wikimedia Commons - [http://commons.wikimedia.org/wiki/File:CIE1931_RGBCMF.svg#media/File:CIE1931_RGBCMF.svg](http://commons.wikimedia.org/wiki/File:CIE1931_RGBCMF.svg#/media/File:CIE1931_RGBCMF.svg)

Color Matching Functions: imaginary primary colors



"CIE 1931 XYZ Color Matching Functions" by User:Acdx - Own work. Licensed under GFDL via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:CIE_1931_XYZ_Color_Matching_Functions.svg#/media/File:CIE_1931_XYZ_Color_Matching_Functions.svg

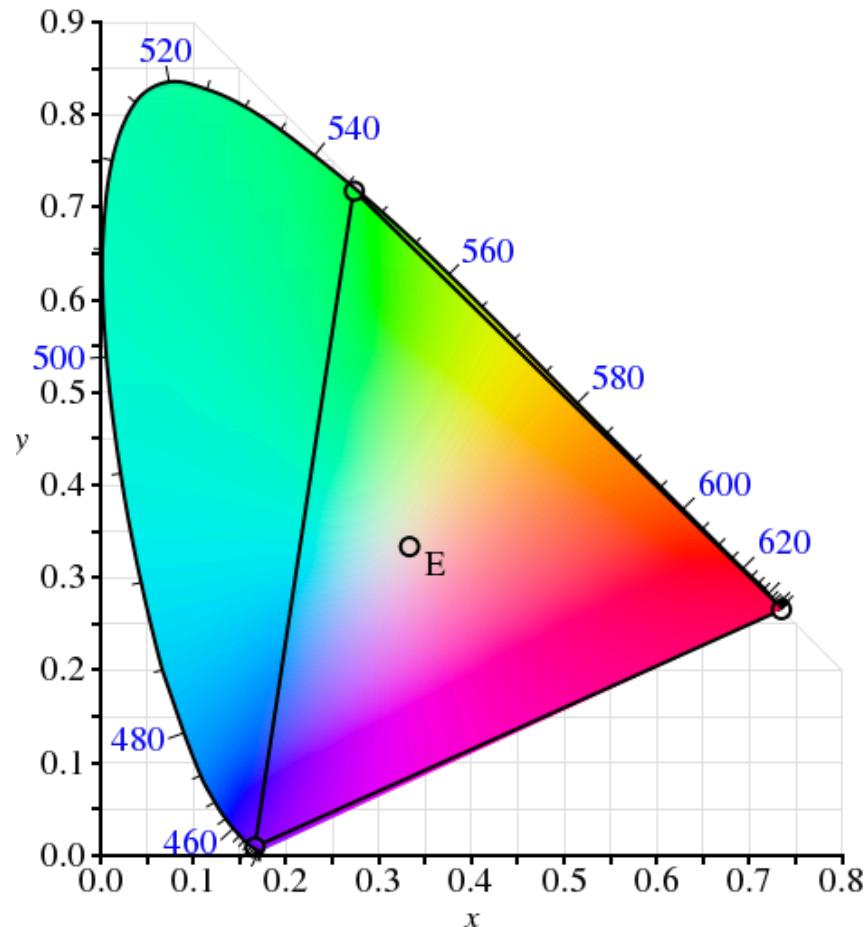
Chromaticity Diagram



- A mixture of two colors lies on the line connecting the two colors
- Chromaticity Diagram (**gamut**) is convex
- All visible colors are non-negative combination of x, y, and z
- An equal combination of two colors does not lie in the mid-point

Color Mixing

- Given three primary colors, the corresponding triangle cannot cover the whole gamut



"CIE1931xy_CIERGB" by BenRG - Own work, inspired by File:CIExy1931.png. Licensed under Public Domain via Wikimedia Commons - [http://commons.wikimedia.org/wiki/File:CIE1931xy_CIERGB.svg](http://commons.wikimedia.org/wiki/File:CIE1931xy_CIERGB.svg#/media/File:CIE1931xy_CIERGB.svg)

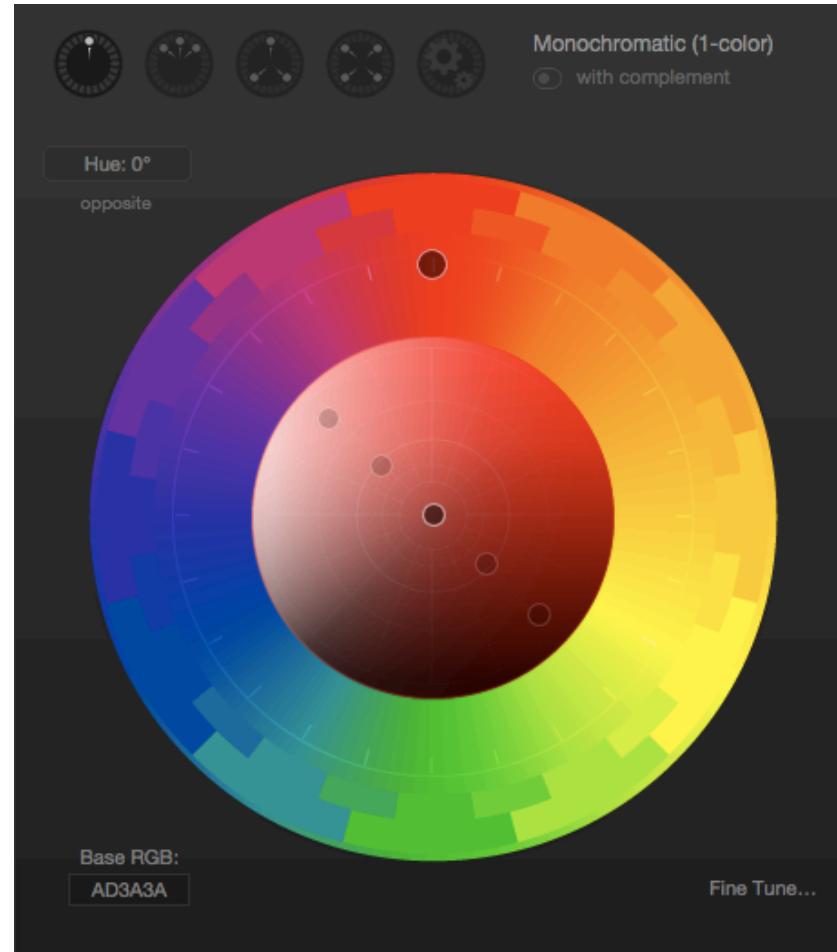


PALETTE

Color Schemes

Cold colors

Warm colors



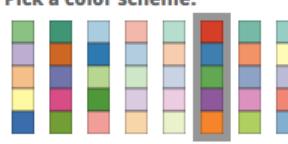
<http://paletton.com/>

Color Schemes for Cartography

Number of data classes: 3

Nature of your data:
 sequential diverging qualitative

Pick a color scheme:



Only show:
 colorblind safe
 print friendly
 photocopy safe

Context:
 roads
 cities
 borders

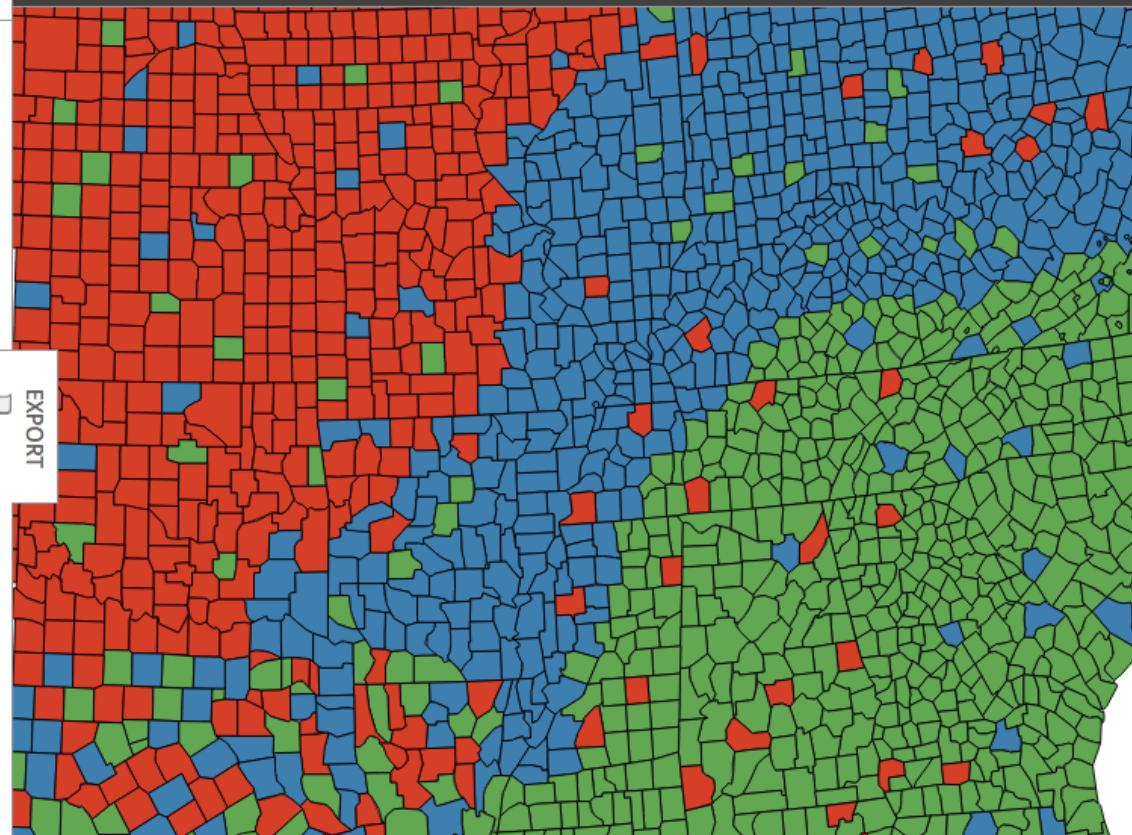
Background:
 solid color terrain

color transparency

how to use | updates | downloads | credits

COLORBREWER 2.0
color advice for cartography

3-class Set1



<http://colorbrewer2.org/>

Takeaway Messages

- Different color models and encodings
- Color palettes to represent scales of values