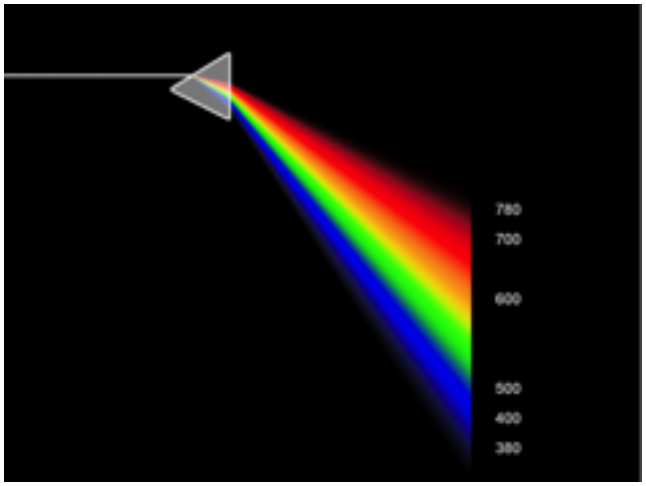
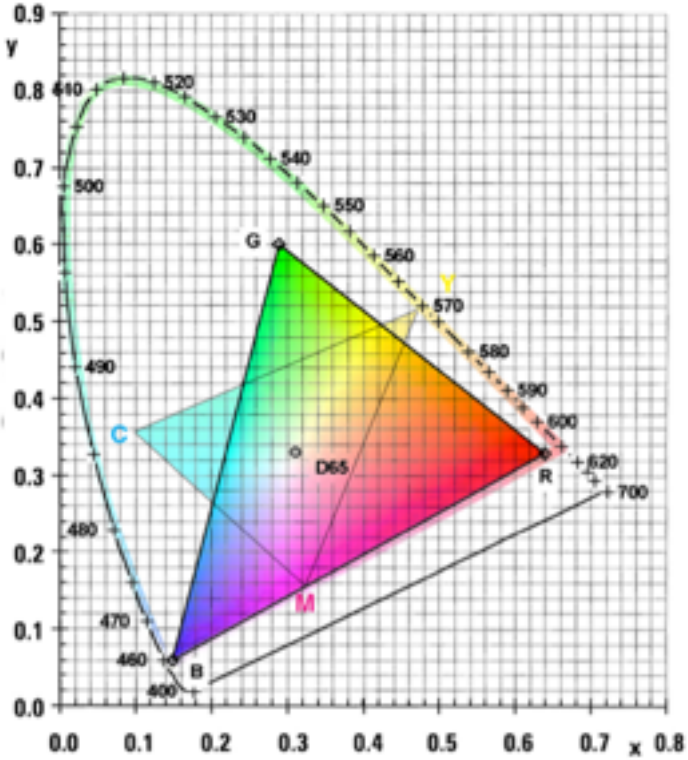
RGB, HSL, and CIE Lab Color Spaces – 10-min Review

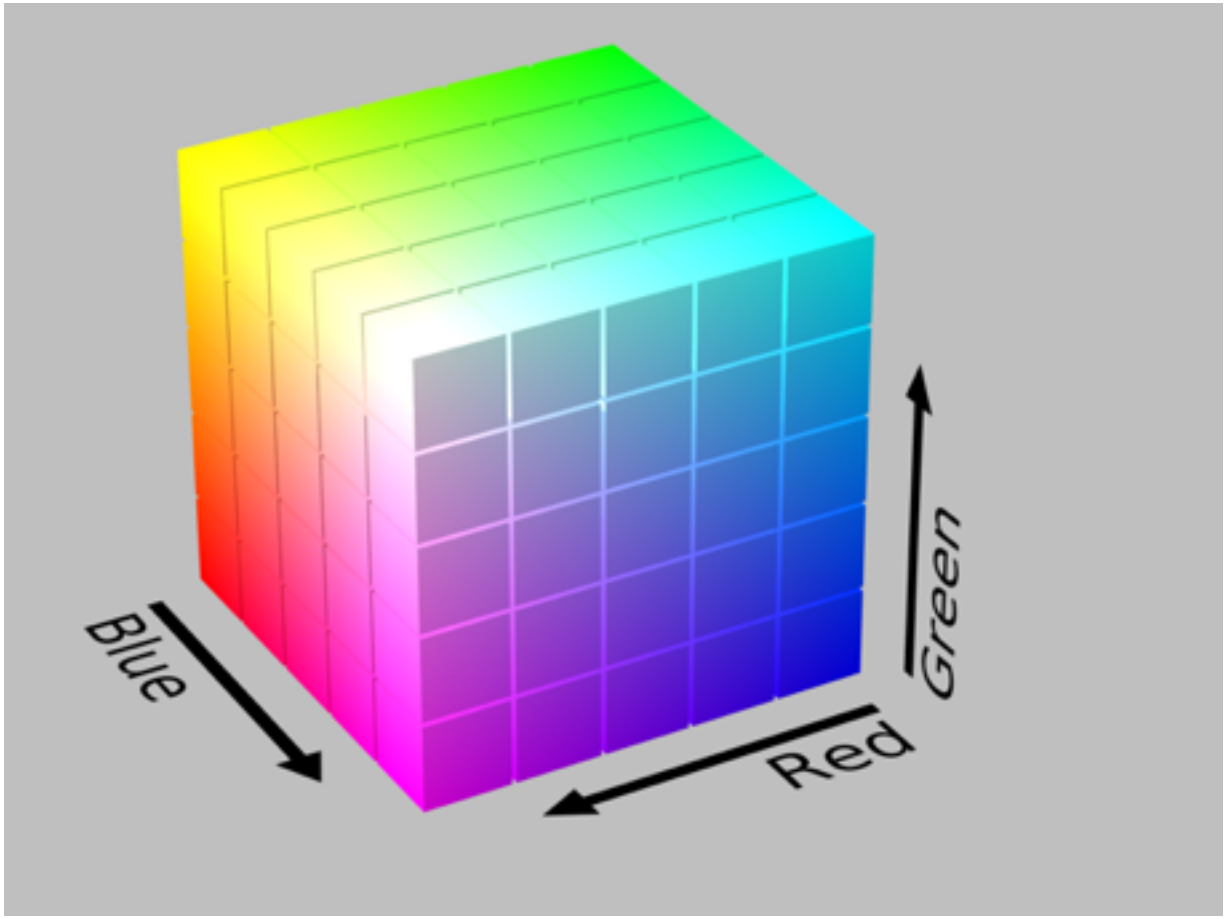
COMP 150 DL
Dylan Cashman





- RGB is not a bad representation of color for images
- Color is fundamentally a human perception
- HSL and CIE are different representations that take perception into account

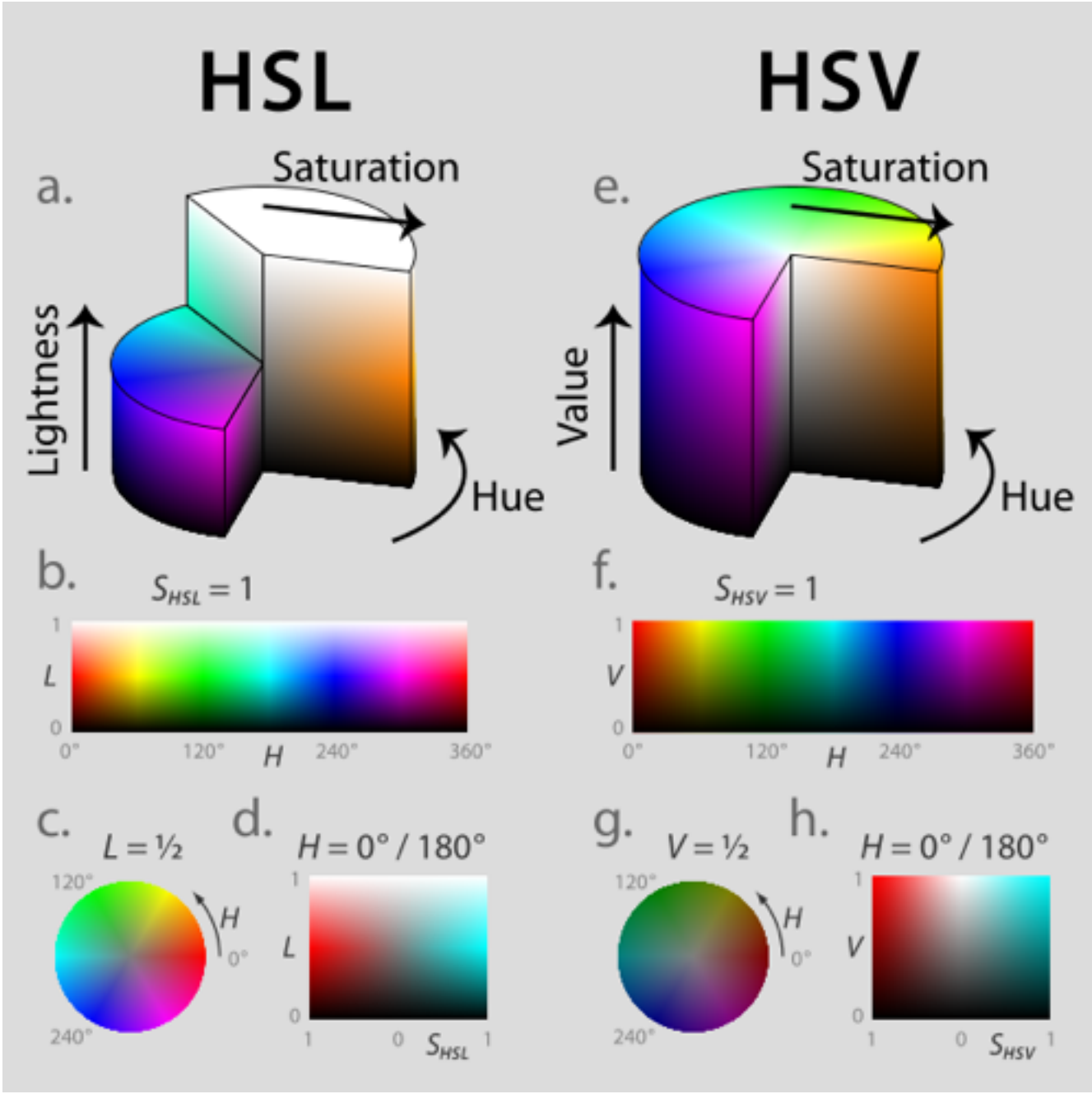
RGB: Problem?



Issues

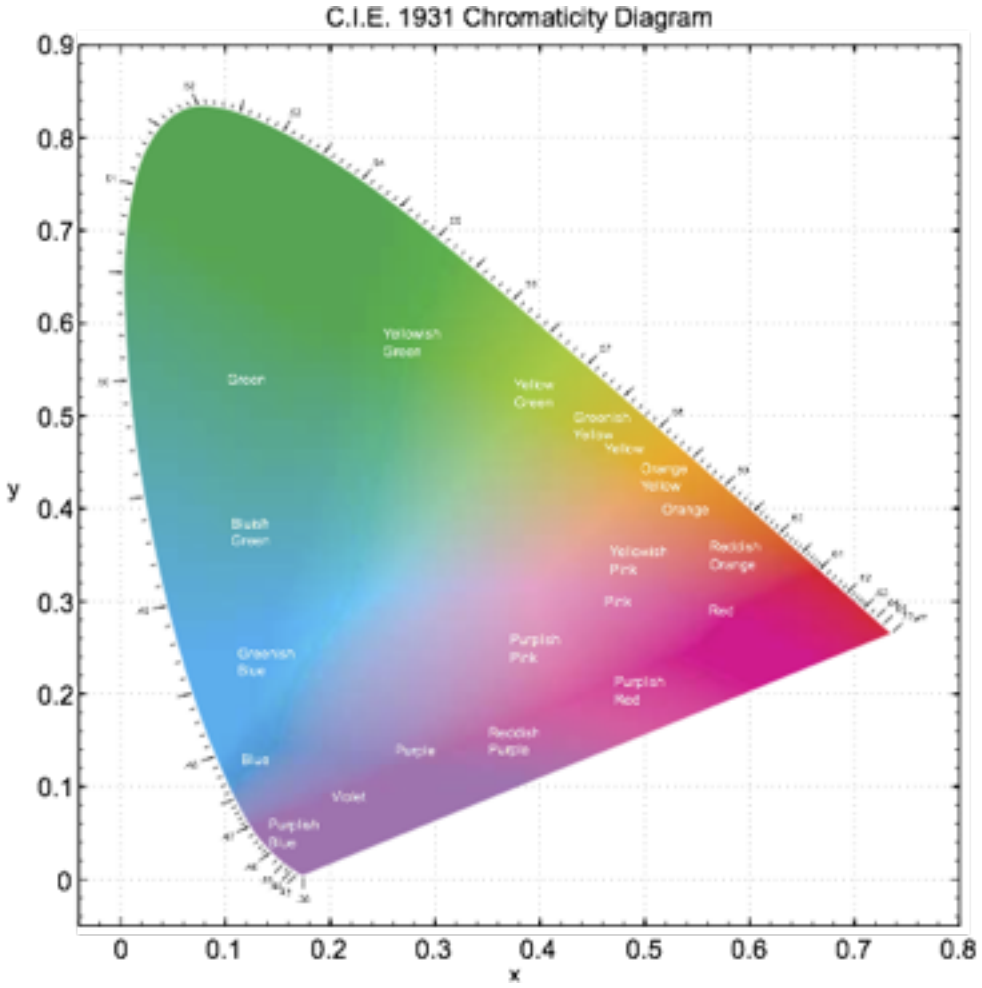
- Red + Blue + Green don't capture all the colors

Slide from Connor Gramazio (Tufts 2012)


HSL
HSV
a.
Saturation
Lightness
Hue
e.
Saturation
Value
Hue
b.
$S_{HSL} = 1$
L
H
0°
120°
240°
360°
f.
$S_{HSV} = 1$
V
H
0°
120°
240°
360°
c.
$L = ½$
H
0°
120°
240°
d.
$H = 0° / 180°$
L
S_{HSL}
g.
$V = ½$
H
0°
120°
240°
h.
$H = 0° / 180°$
V
S_{HSV}

Wikipedia

CIE xyY (chromaticity diagram)



$x = X / (X+Y+Z)$

$y = Y / (X+Y+Z)$

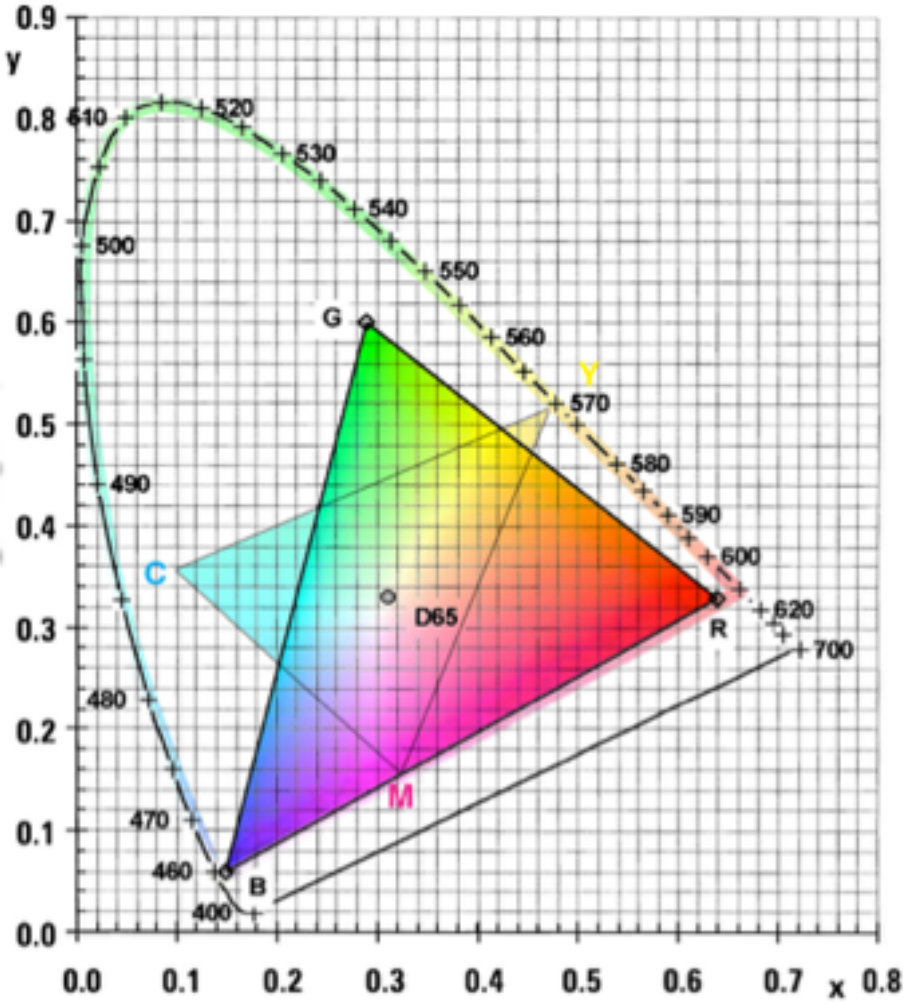
$Y = Y$

x,y: “chromaticity”

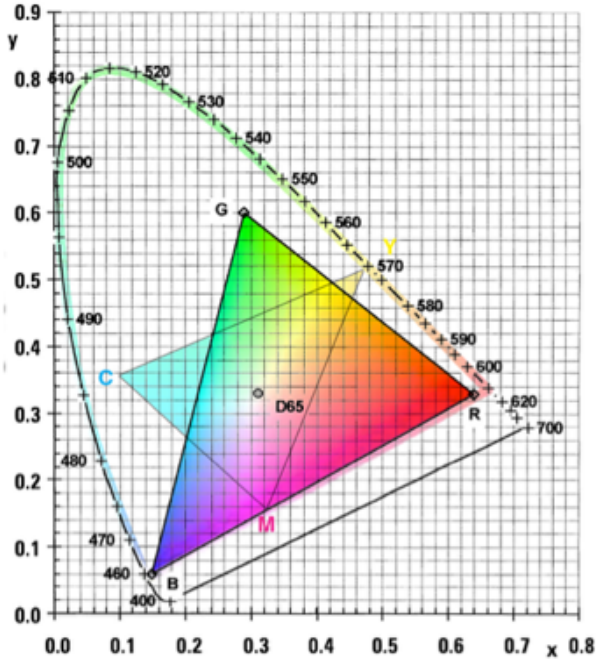
→ Color – luminance

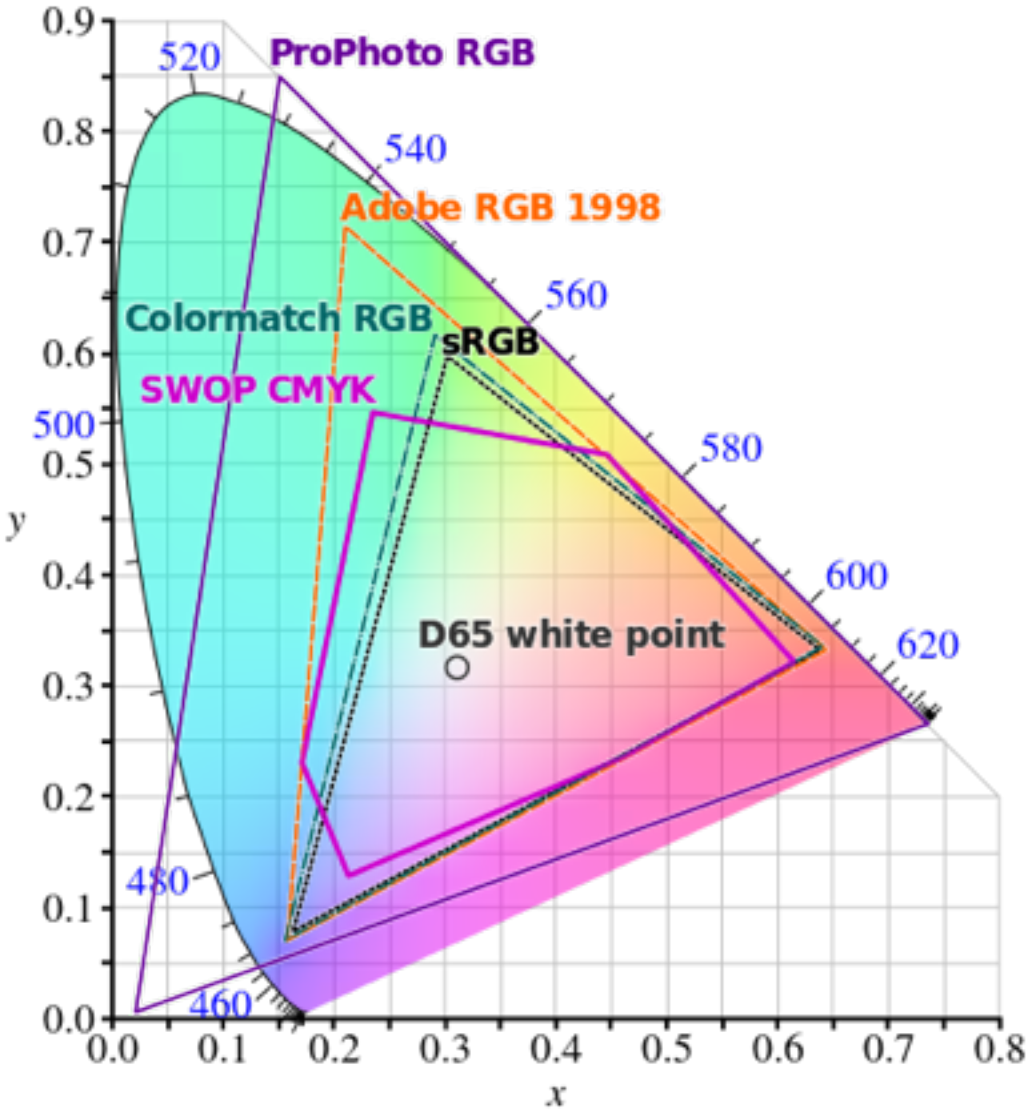
Y: luminance

Gamut

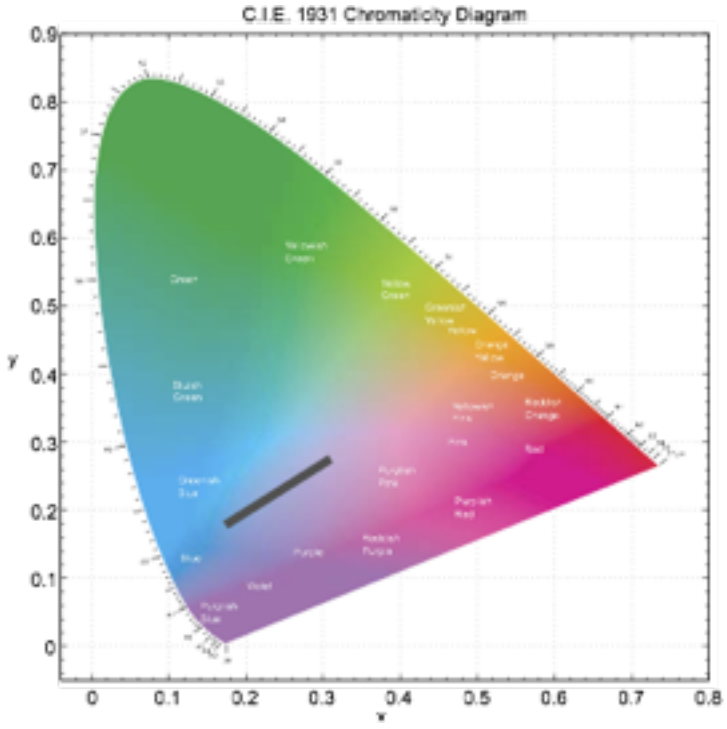

y
x
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
500
510
520
530
540
550
560
570
580
590
600
620
700
490
480
470
460
400
G
Y
C
D65
R
M
B

Gamut


y
x
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
400
460
470
480
490
500
520
530
540
550
560
570
580
590
600
620
700
G
Y
C
D65
R
M
B


ProPhoto RGB
Adobe RGB 1998
Colormatch RGB
sRGB
SWOP CMYK
D65 white point
520
540
560
580
600
620
500
480
460
y
x
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9

Problem: “perceptual uniformity”



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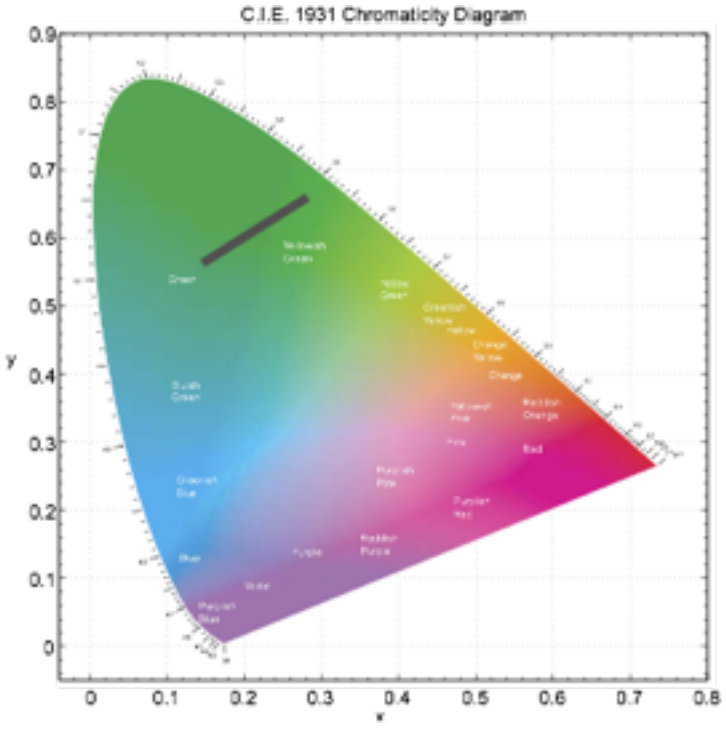
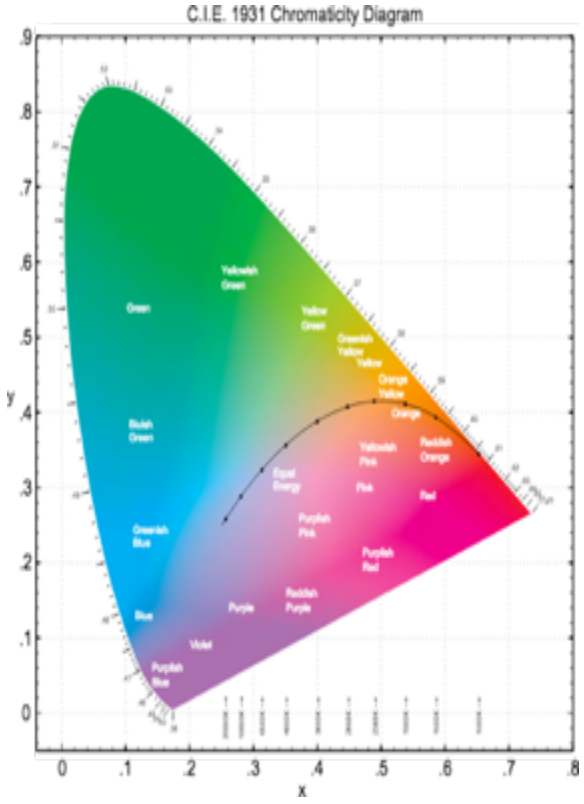
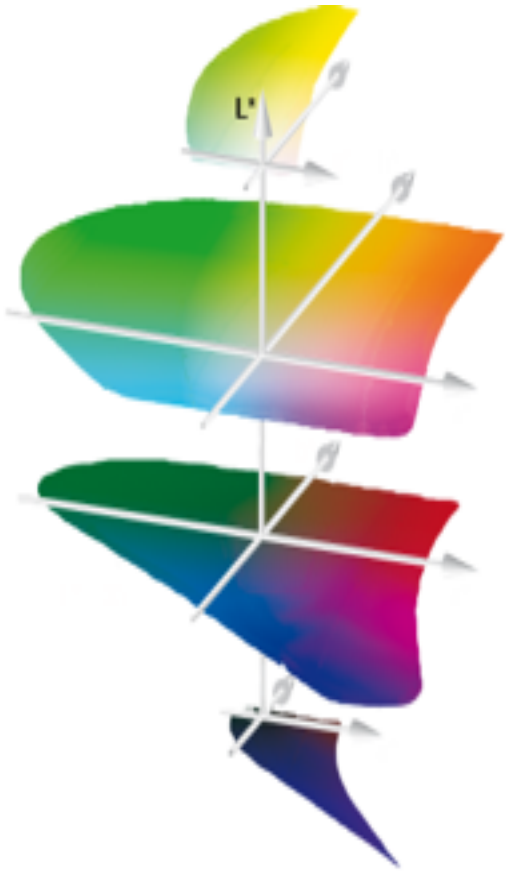
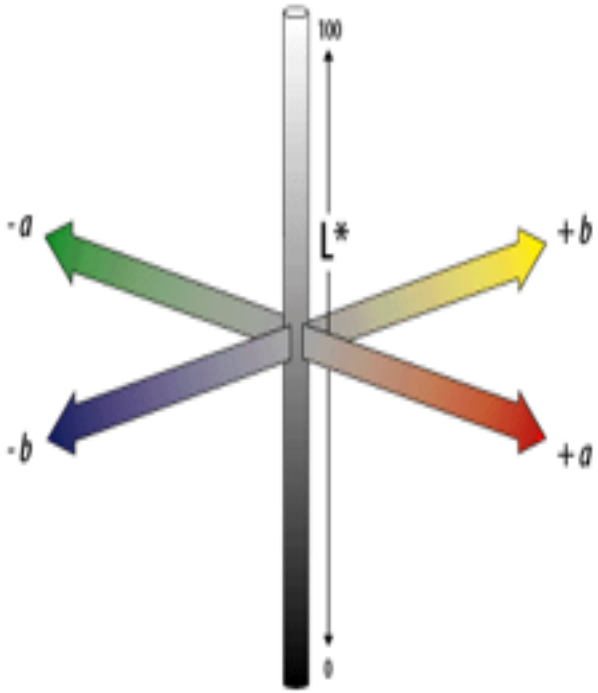


We can’t do MATH in this space!

CIE Lab:
An ongoing quest for “perceptual uniformity”

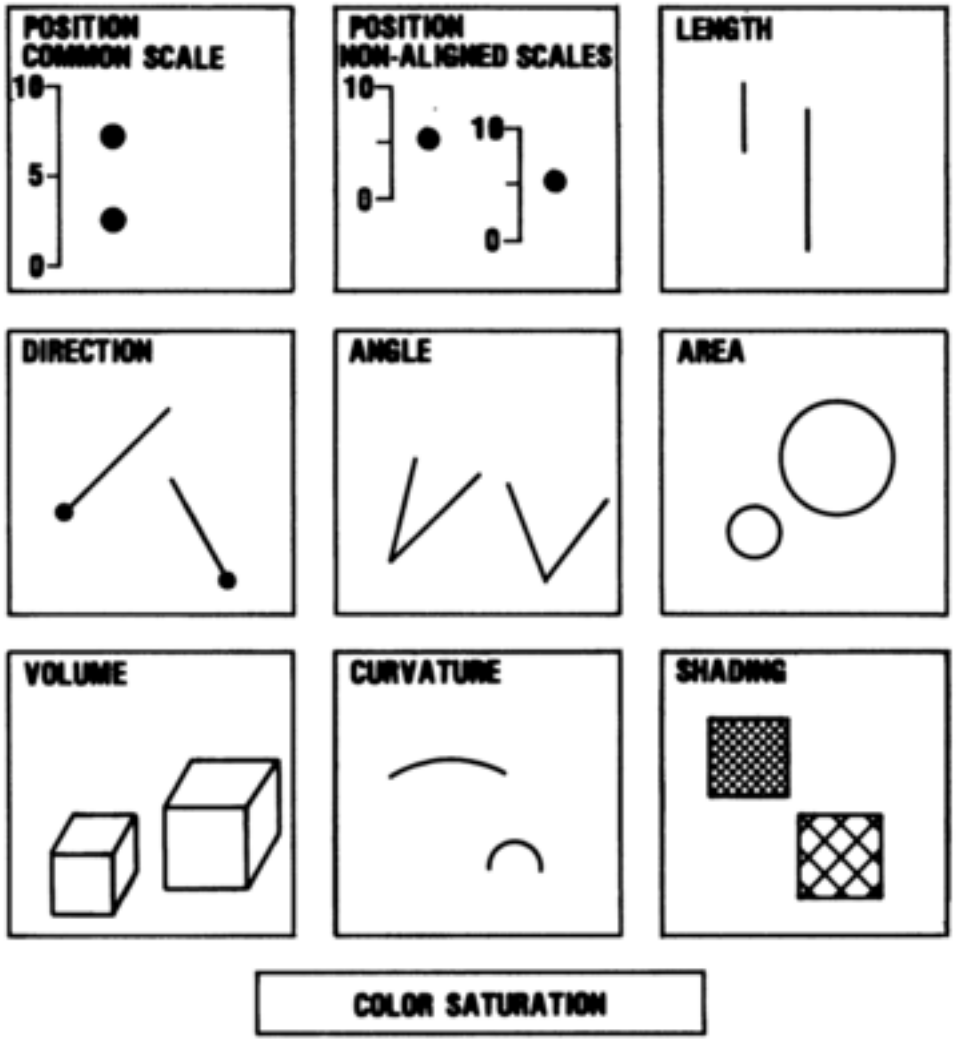






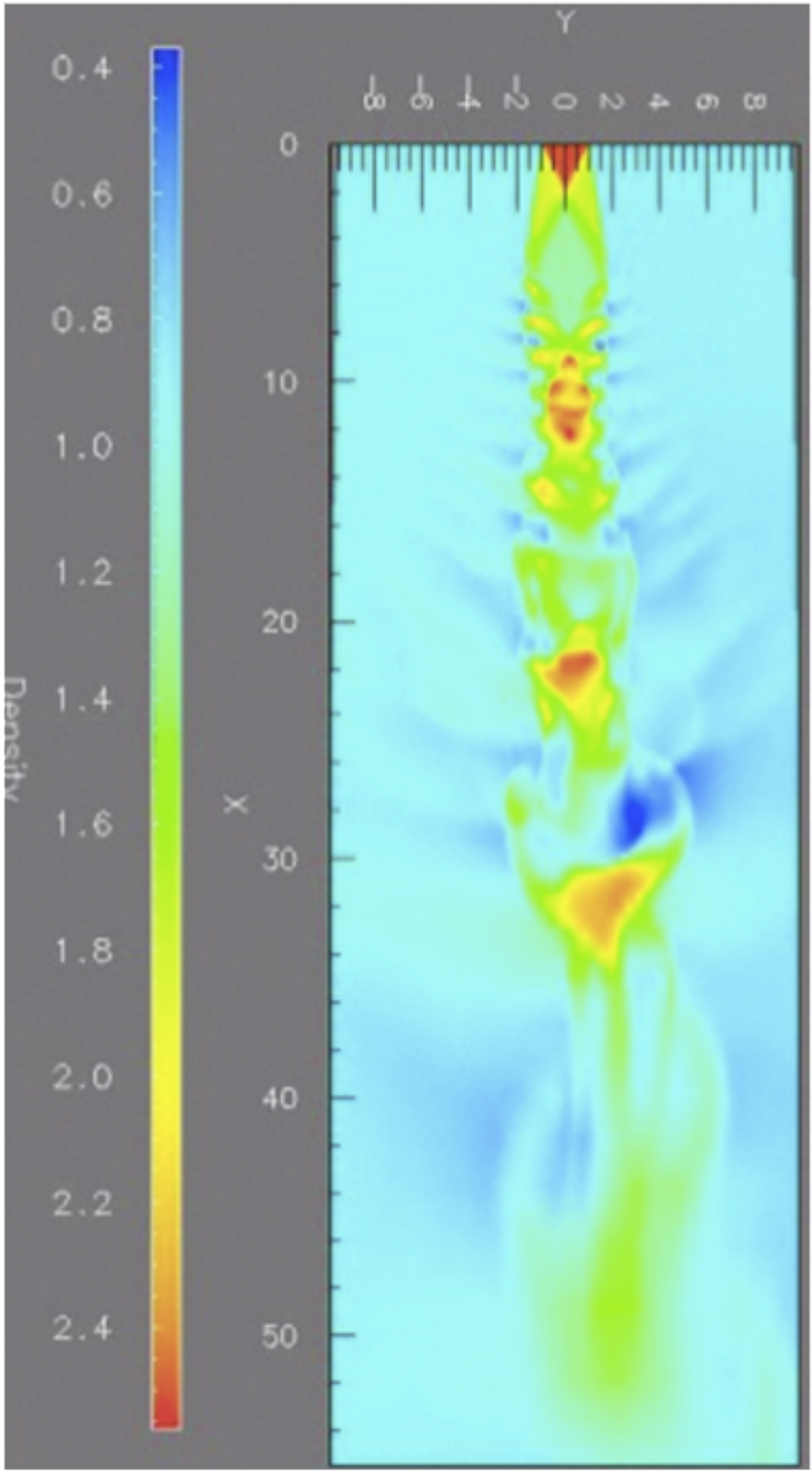
A Quick Pitch

Perception studies give guidance for visualizations

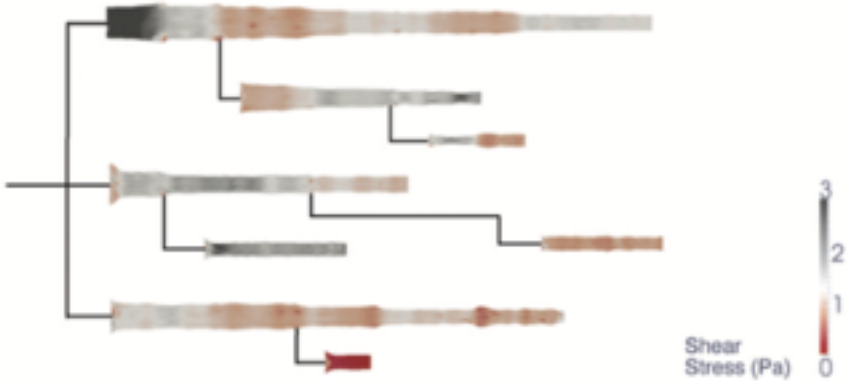


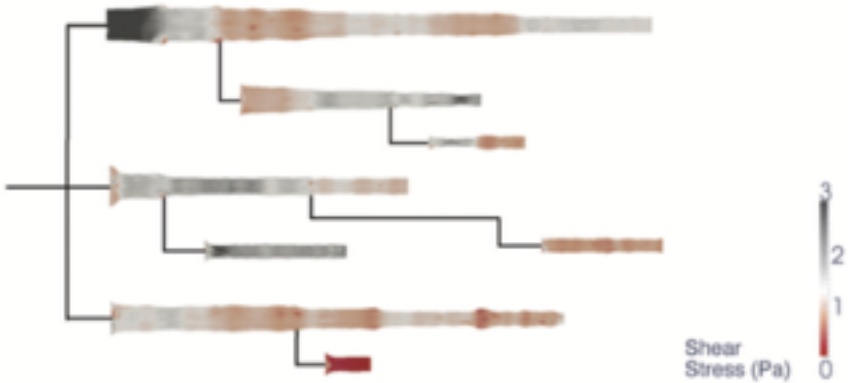
Cleveland, William S., and Robert McGill. "Graphical perception: Theory, experimentation, and application to the development of graphical methods." Journal of the American statistical association 79.387 (1984): 531-554.

2016-11-19


Y
-8 -6 -4 -2 0 2 4 6 8
X
0
10
20
30
40
50
Density
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4


3
2
1
0
Shear
Stress (Pa)


3
2
1
0
Shear
Stress (Pa)



41%

91%

Percent of endothelial shear stress sites in coronary arteries

Lessons

- DON’T USE RAINBOW COLOR MAPS

Lessons

- DON’T USE RAINBOW COLOR MAPS

* for continuous variables

Categorical Variables

- Colorbrewer http://colorbrewer2.org/
- Colorgorical http://vrl.cs.brown.edu/color

Perception is Cultural

- Perception of colors differs from culture to culture