PERCEPTION

PERCEPTION - COGNITION

RED	GREEN	BLUE	YELLOW	PINK
ORANGE	BLUE	GREEN	BLUE	WHITE
GREEN	YELLOW	ORANGE	BLUE	WHITE
BROWN	RED	BLUE	YELLOW	GREEN
PINK	YELLOW	GREEN	BLUE	RED

Is there something wrong?

PERCEPTION

Perception

- Identification and interpretation of sensory information
- From the physical stimulus to recognizing information
- Shaped by learning, memory, expectation

Cognition

- The processing of information, applying knowledge

Hear someone speak: Perception

Understand the language and the words: Cognition

PERCEPTION VS. COGNITION

PERCEPTION

Eye, optical nerve, visual cortex

Basic perception

First processing

Not conscious

Reflexes

COGNITION

Recognizing objects

Relations between objects

Conclusion drawing

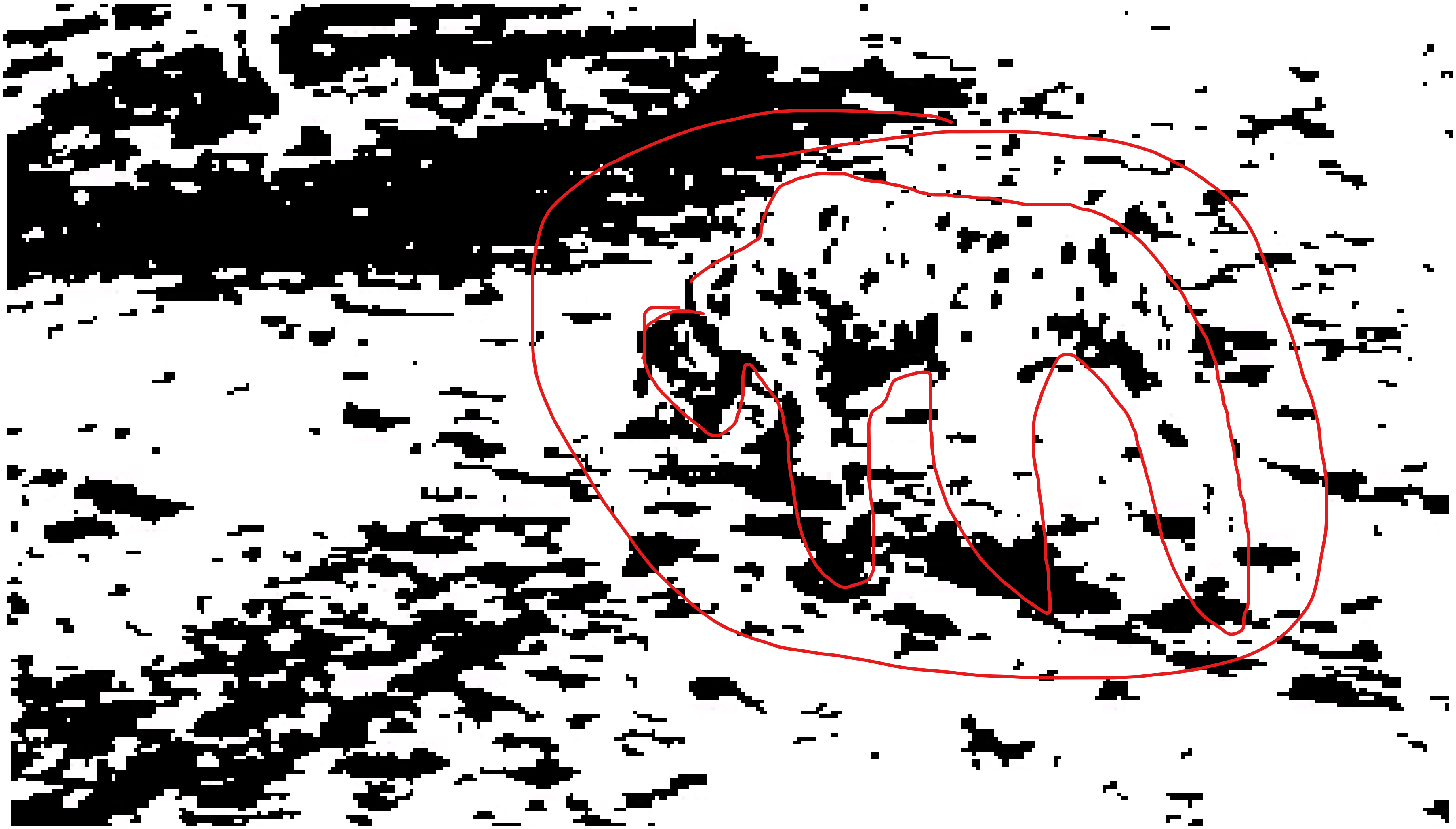
Problem solving

Learning, …

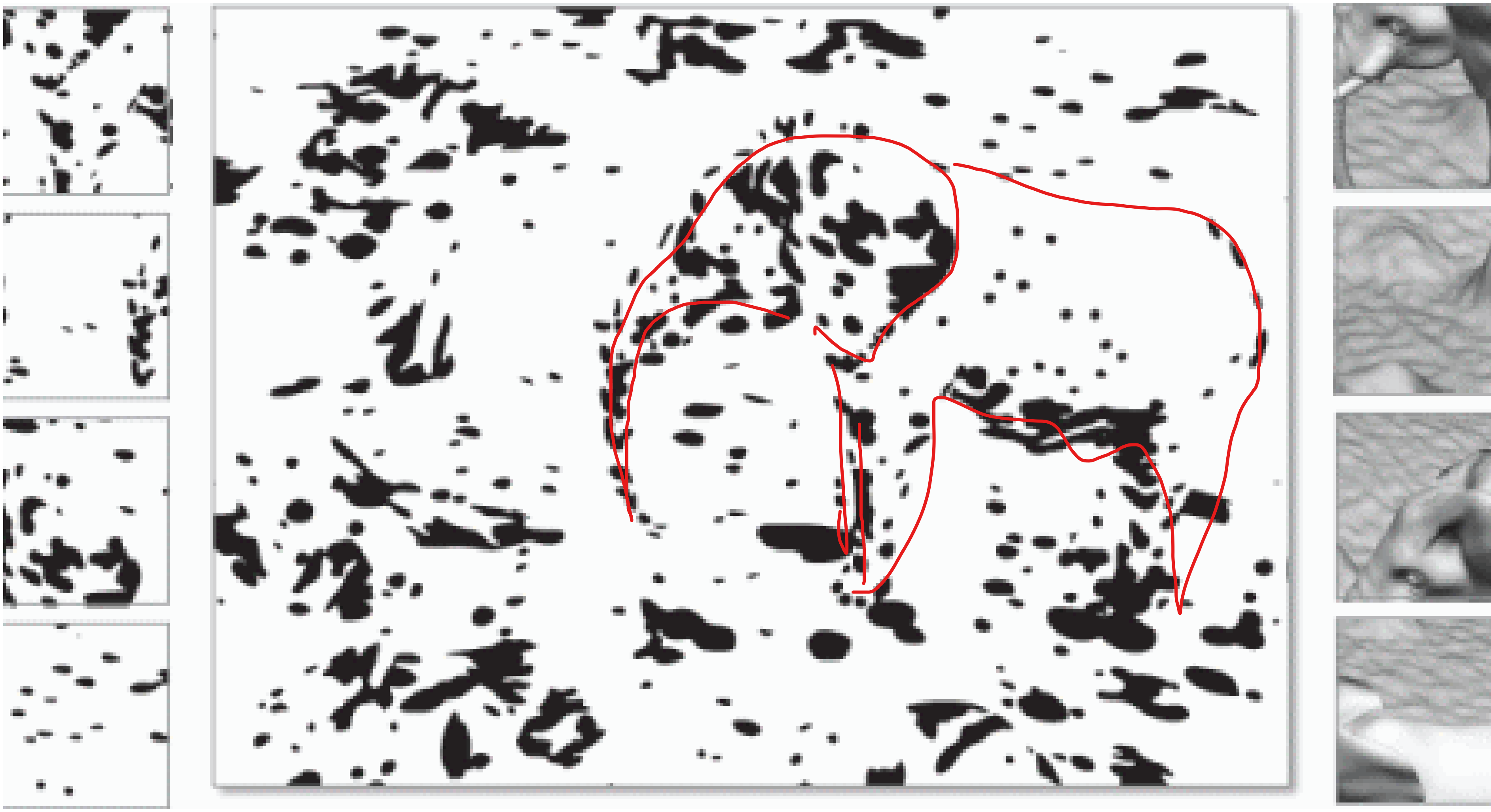
PERCEPTION - COGNITION

RED	GREEN	BLUE	YELLOW	PINK
ORANGE	BLUE	GREEN	BLUE	WHITE
GREEN	YELLOW	ORANGE	BLUE	WHITE
BROWN	RED	BLUE	YELLOW	GREEN
PINK	YELLOW	GREEN	BLUE	RED

WHAT IS THERE
VS
WHAT DO WE SEE



Emergence Images

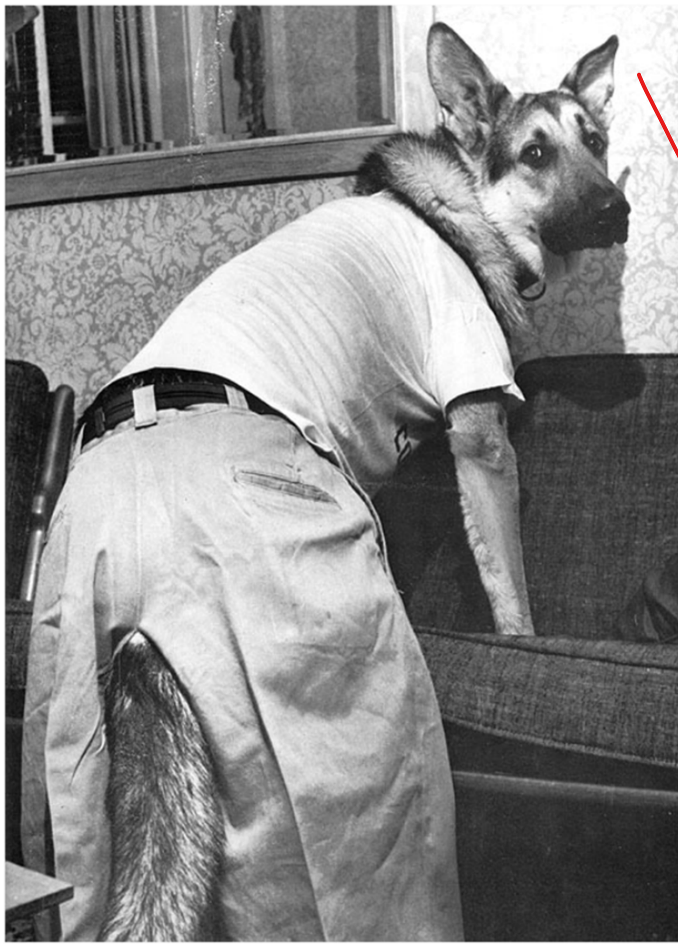


http://graphics.stanford.edu/~niloy/research/emergence/emergence_image_siga_09.html

OUR PERCEPTION IS BASED ON PRIORS

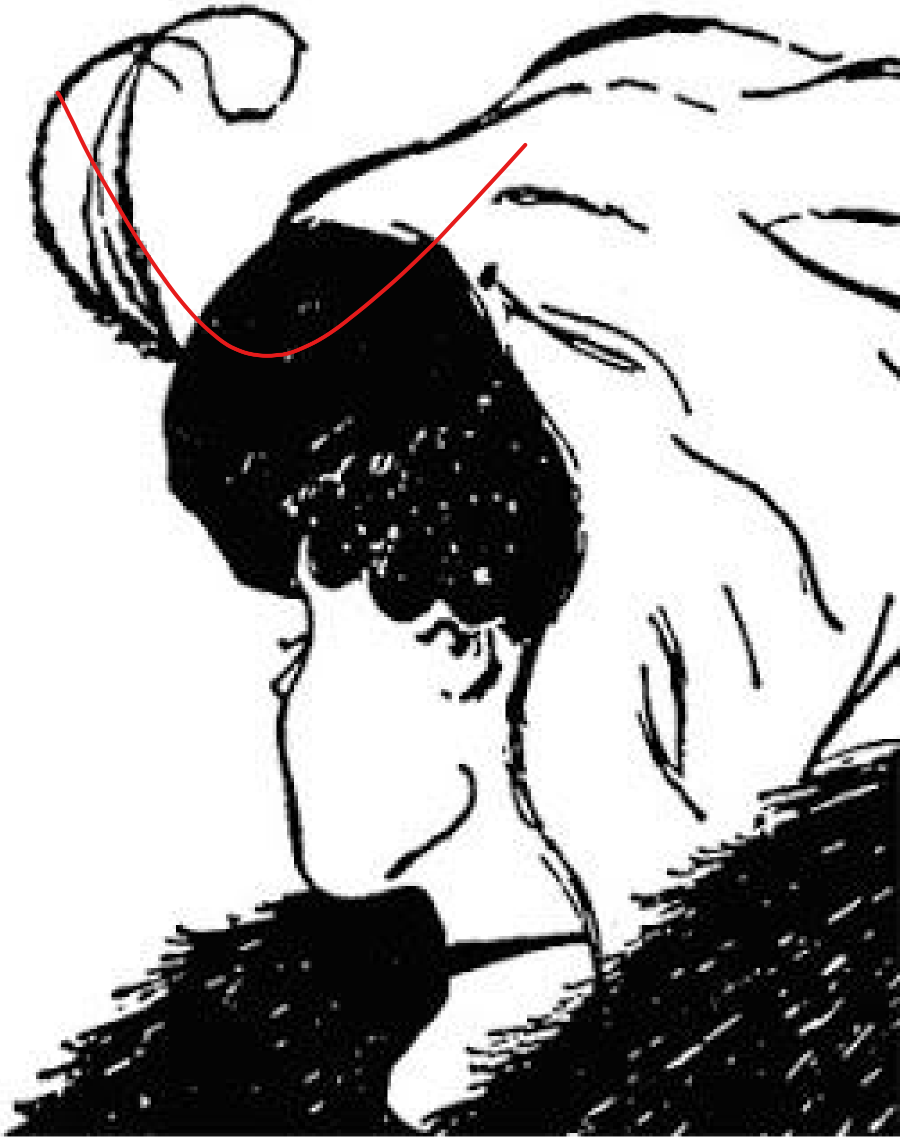
We have a model of the world

We try to fit what we see into this model



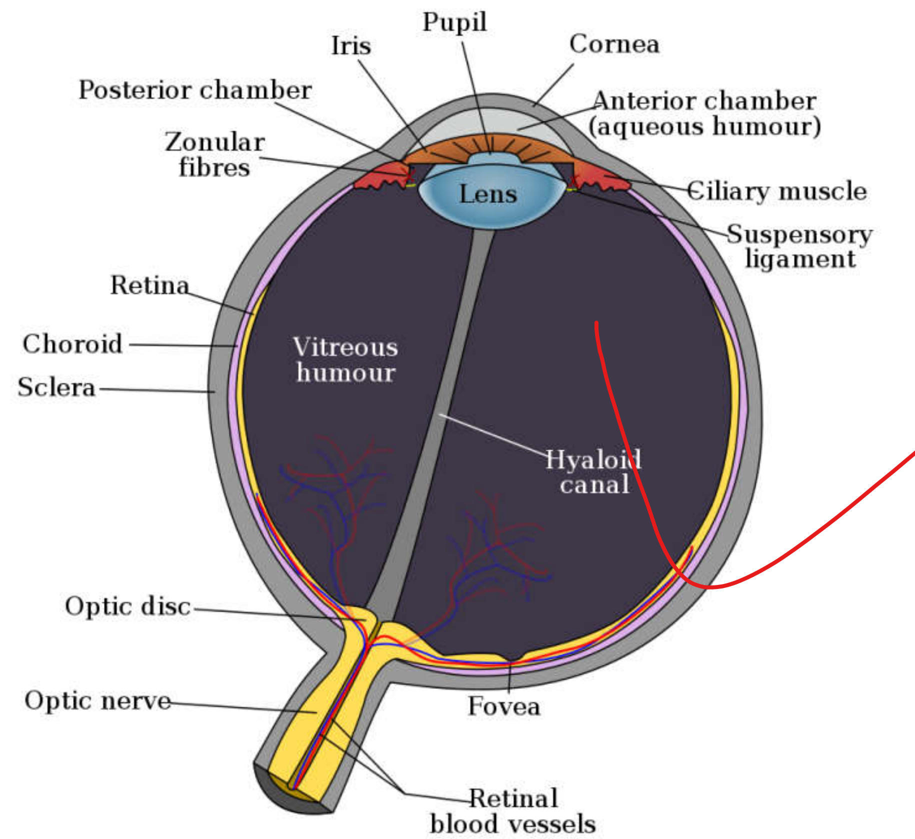

dribbleglass.com

WHO DO YOU SEE?



OUR EYE

HUMAN VISUAL SYSTEM



Cone cells: for color vision.

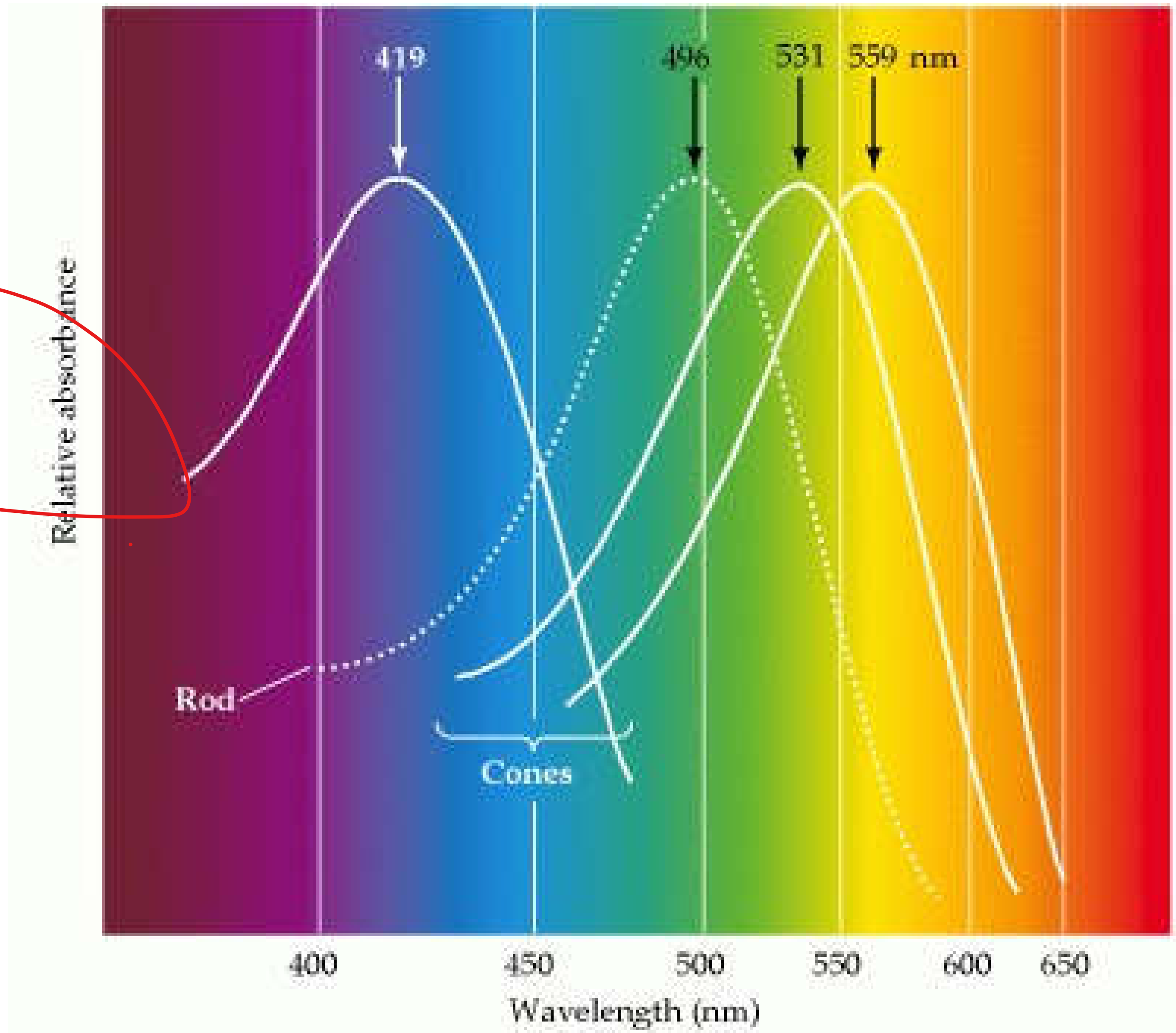
- Dense in the center. Fovea has only cone cells

Rods cells: for black/white

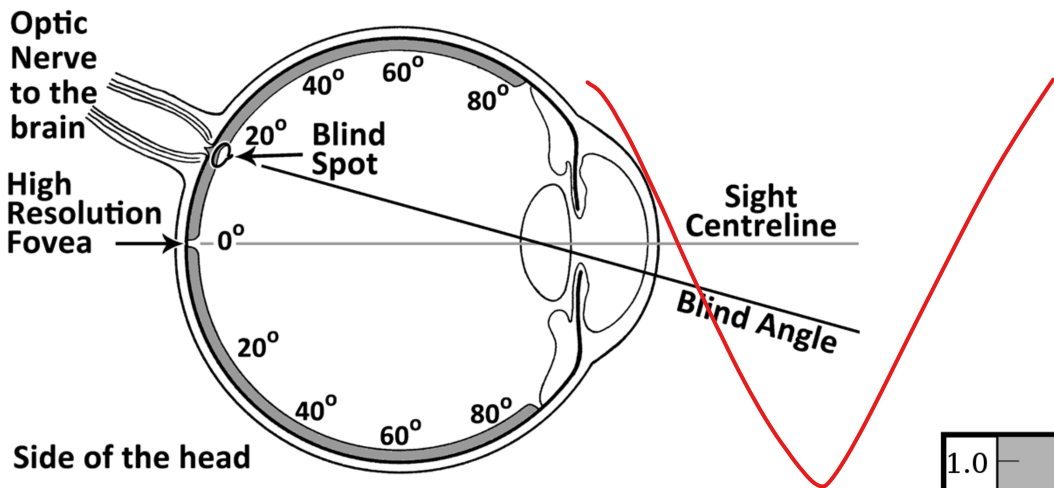
COLOR VISION

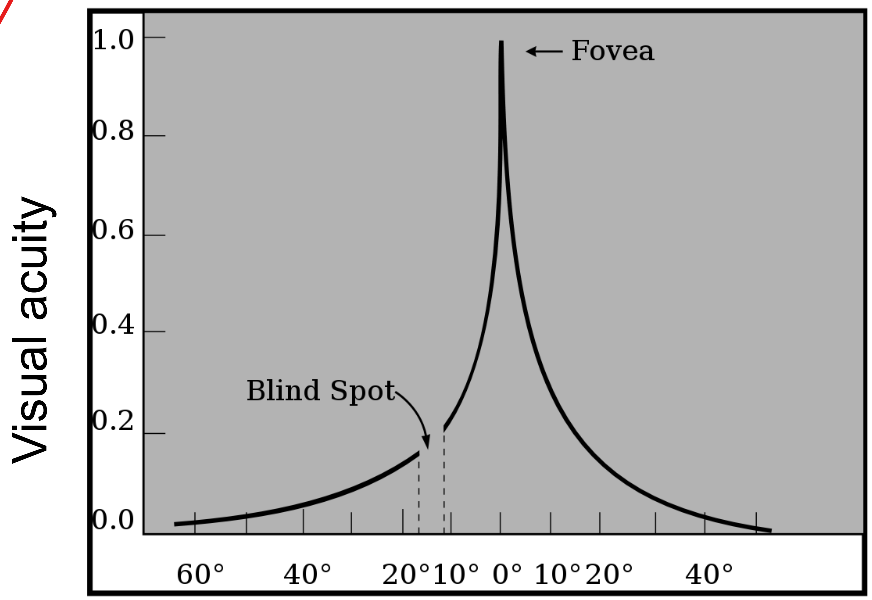
3 types of cone with different sensitivity to light:

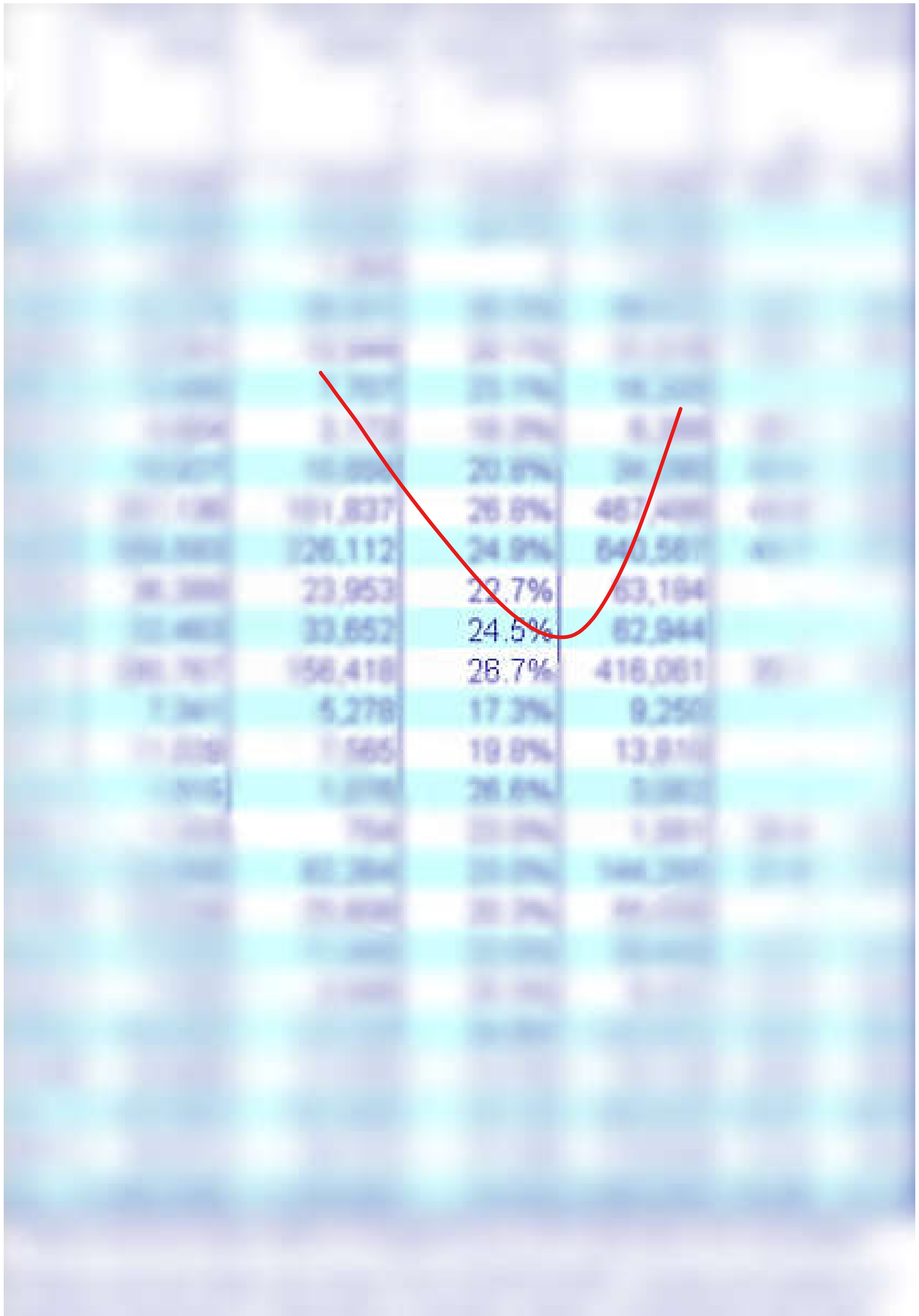
- Red (63%)
- Green (31%)
- Blue (6%)



VISUAL ACUITY







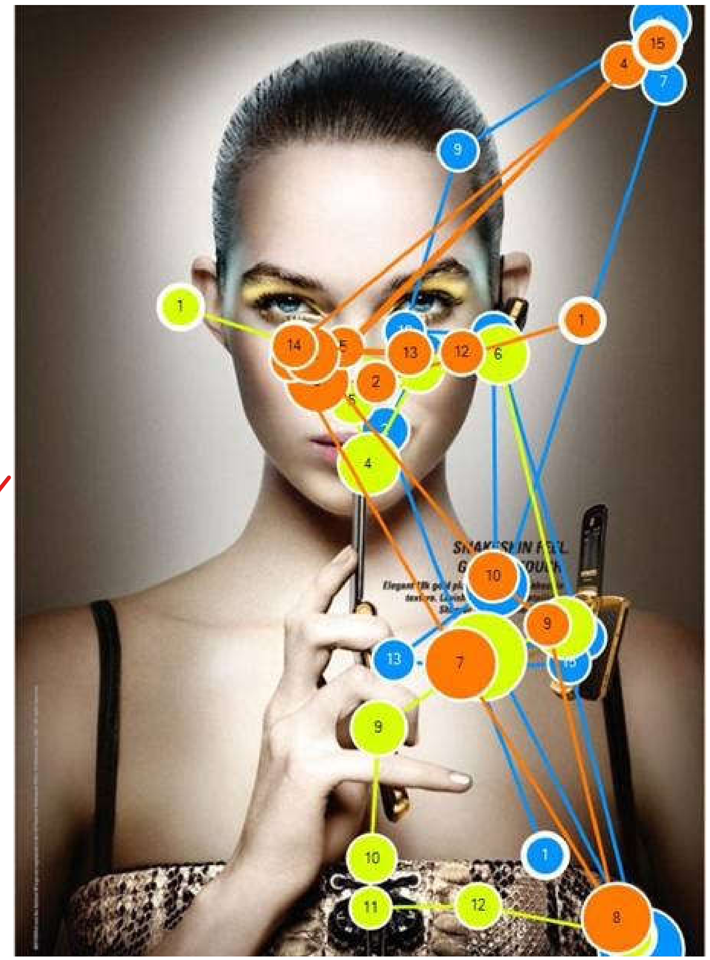
23,953 22.7% 63,194
33,652 24.5% 62,944
156,418 26.7% 416,061
5,278 17.3% 9,250

HUMAN VISUAL SYSTEM

Not similar to a camera

Vision works as sequence of

- **Fixation**: maintaining gaze on single location (200-600 ms)
- **Saccades:** moving between different locations (20-100 ms)



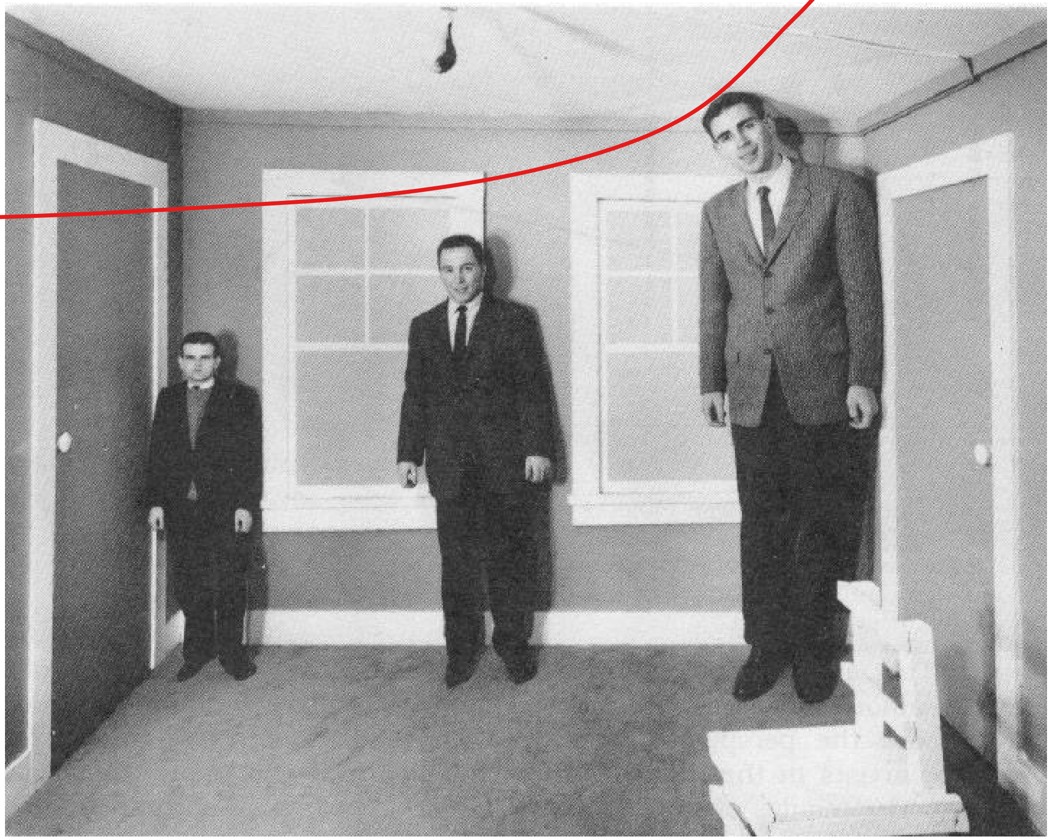
HUMAN VISUAL SYSTEM

No general purpose vision

What we see depends on our goals and expectations

Relative judgements: strong

Absolute judgments: weak



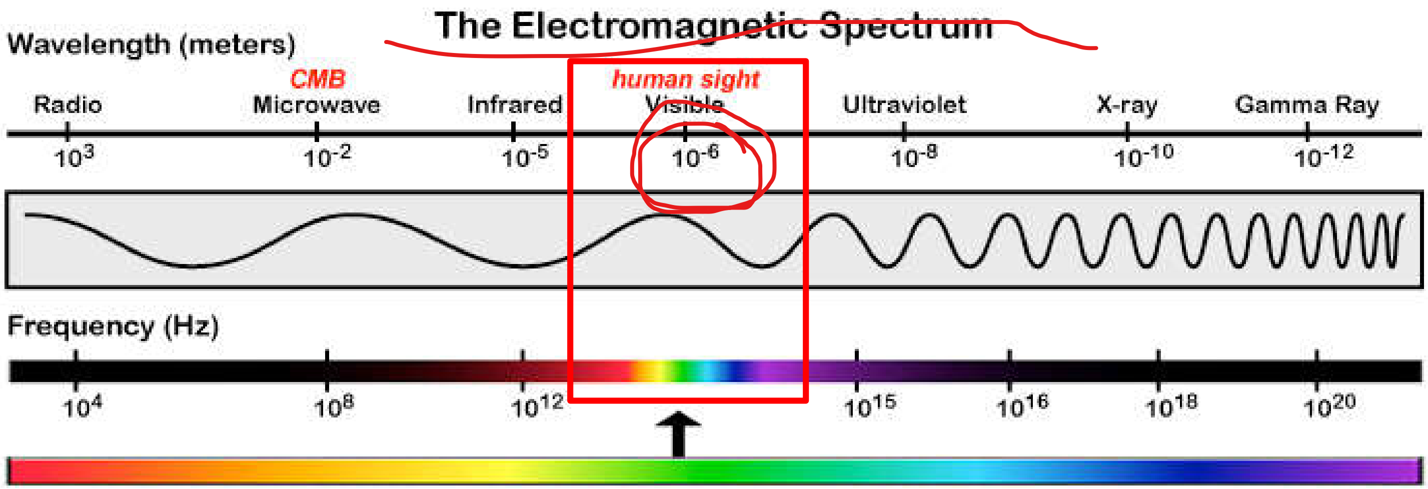
Ames Room

AMES ROOM

COLOR

COLOR BASICS

The electromagnetic spectrum

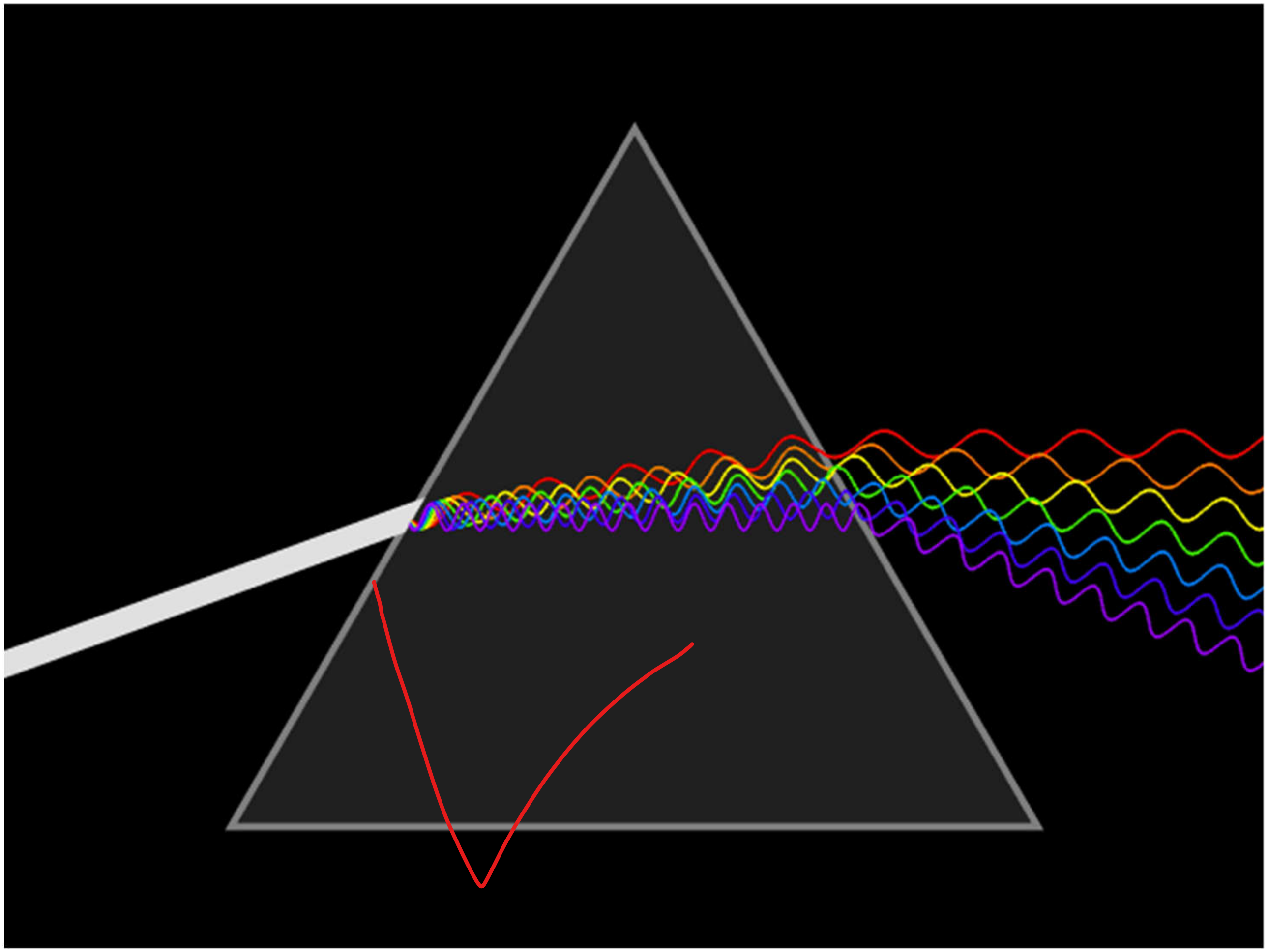


- Visible part: 390 – 750 nm

- Spectral colors: evoked by a single wavelength
(red, orange, yellow, green, blue, and violet**)**

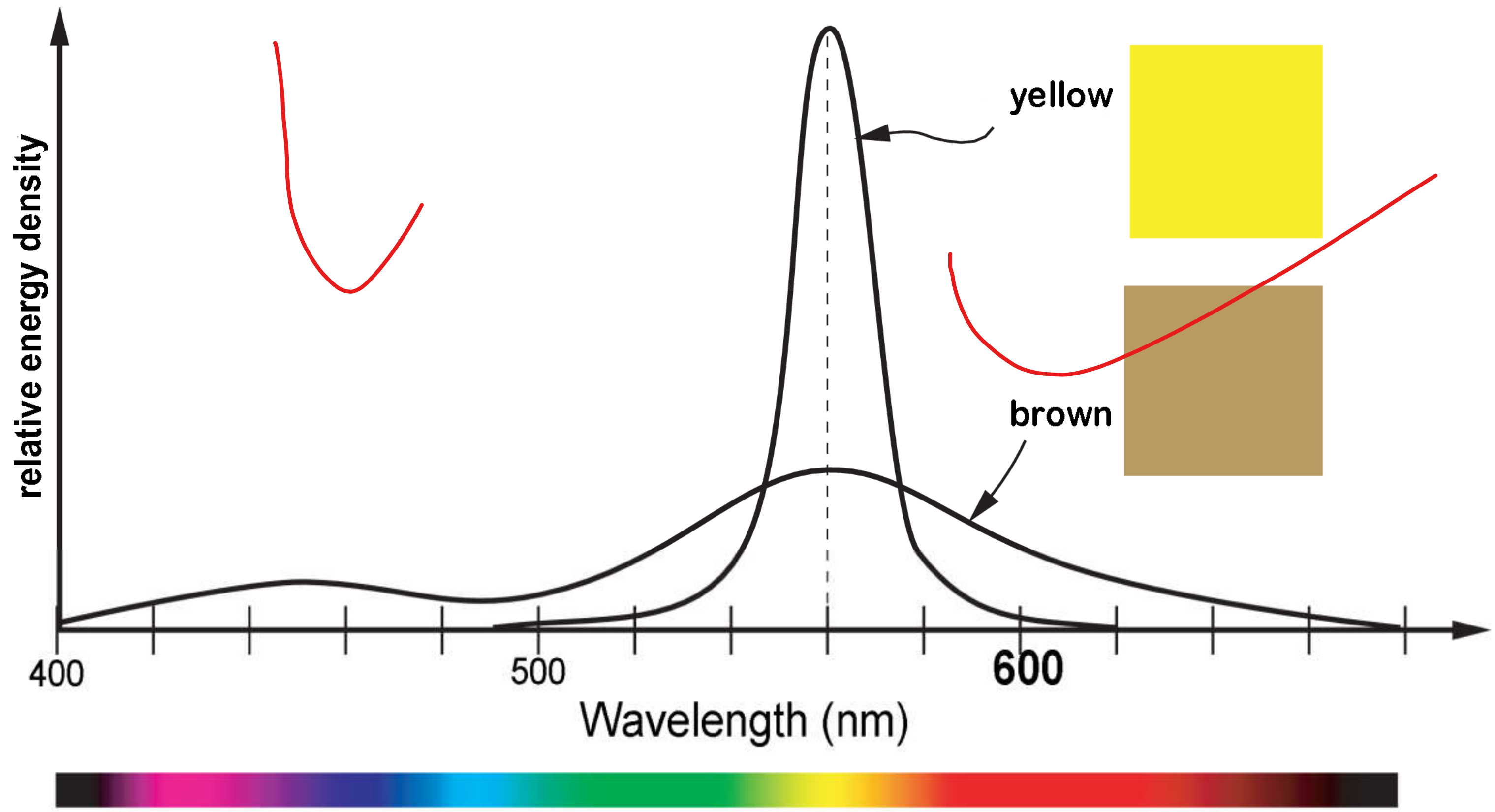
- Other colors: unsaturated colors: mix of multiple wavelengths
(purple, magenta, … and white**)**

DISPERSING LIGHT WITH PRISM



COLOR != WAVELENGTH

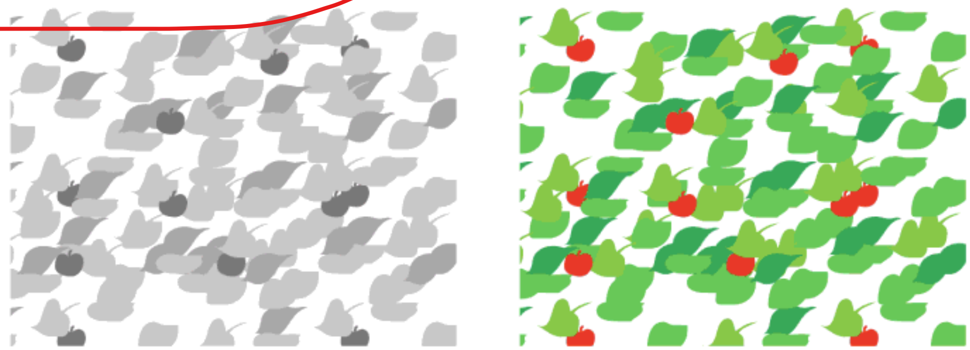
color = wavelength + energy



COLOR

Color is irrelevant to much of normal vision.
Does not help to perceive

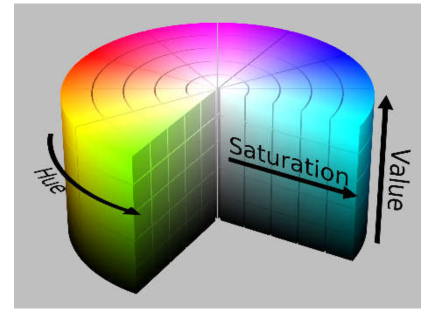
- layout of objects
- how they are moving
- what shape they are



Color breaks camouflage

Tells about material properties (e.g. quality of food)

DIMENSIONS OF COLOR

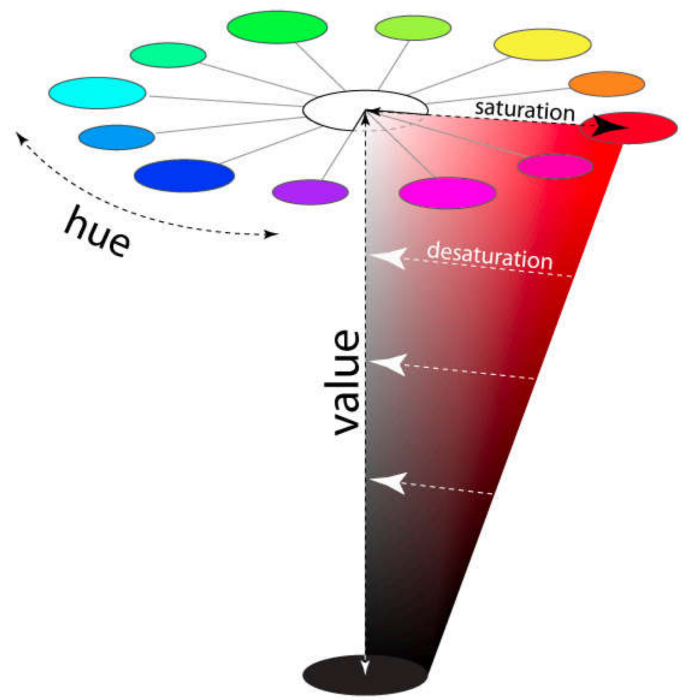


HSV model

Hue
color value expressed as a number from 0 to 360

Saturation

- the purity of a color
- pigments: no white/black is added
- light: what is the ratio of dominant wavelength to others

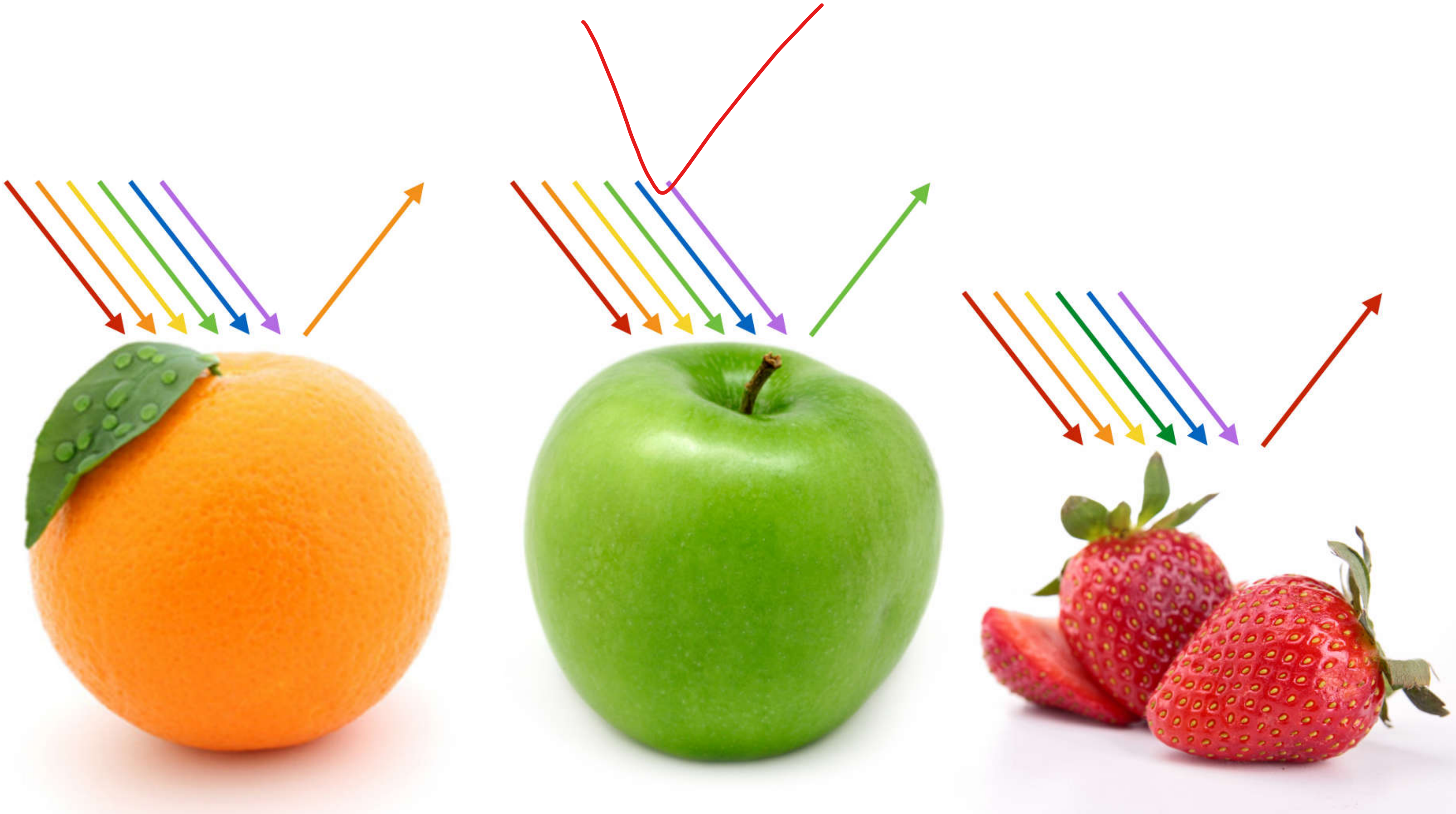


Value

Lightness or darkness of a color
the intensity of light

Other color models: RGB, HSL, …

COLOR IN REAL LIFE



PAINT MIXING

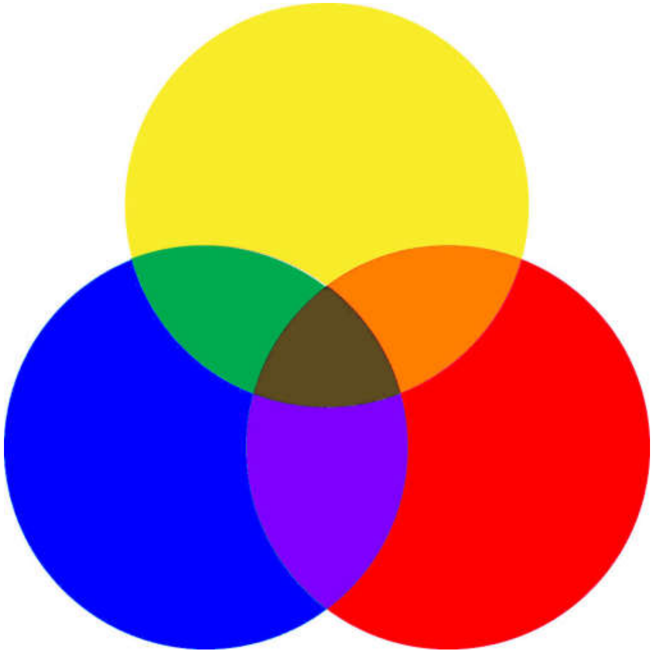
Physical mixing of opaque paints

Primary: red, yellow, blue

Secondary (mixed): green, orange, purple

Subtractive model

- absorb wavelength



INK MIXING

Subtractive mix of transparent inks

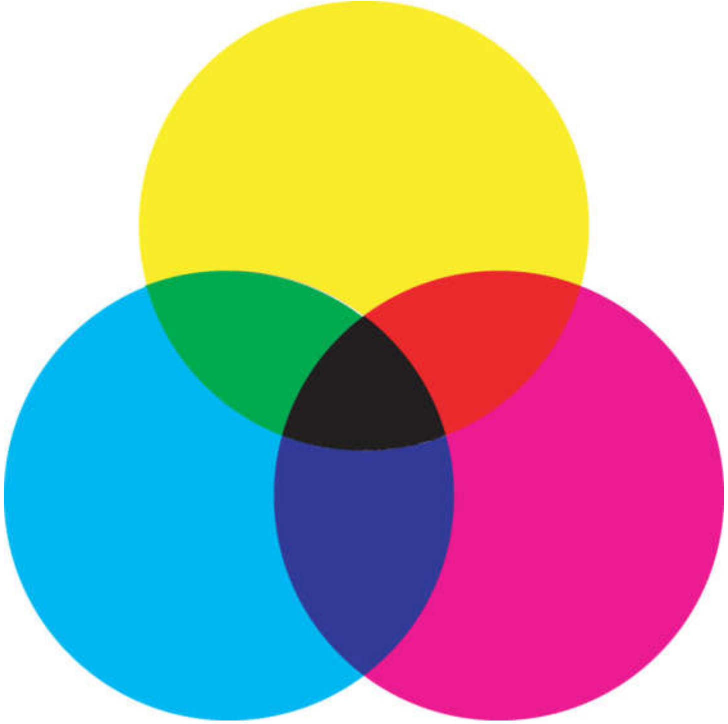
Primary: cyan, magenta, yellow

Secondary: RGB

Approx. black = C+M+Y

True black = C+M+Y+K

Subtractive model



LIGHT MIXING

Additive mix of colored lights

Primary: Red, Green, Blue

Secondary: Cyan, Magenta, Yellow

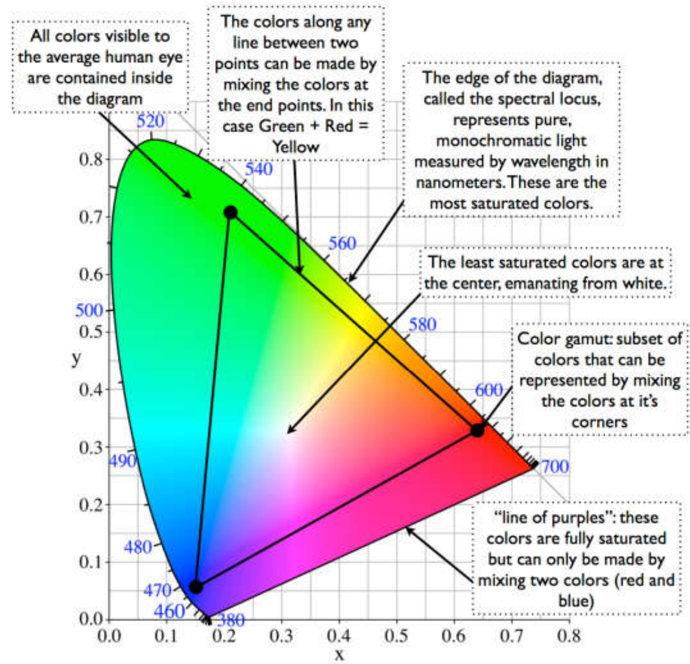
Additive model

COLOR GAMUT

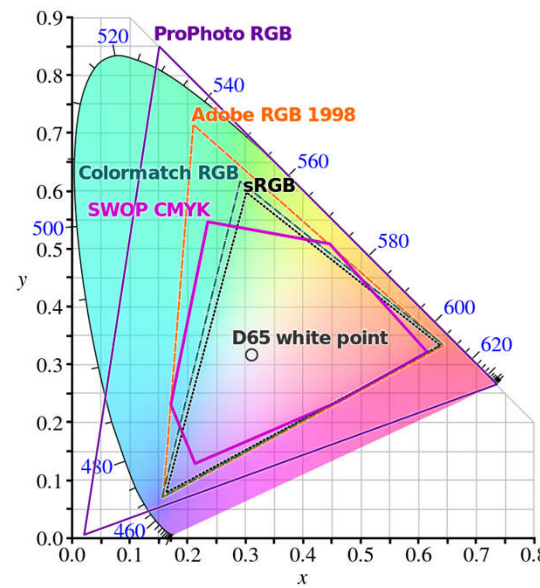
The curve shows all visible colors

Polygon: Set of all colors that can be produced by a device

Primaries are arbitrary



Anatomy of a CIE Chromaticity Diagram

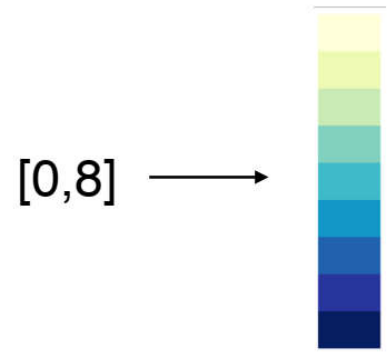


COLOR IN VISUALIZATION

COLORMAP

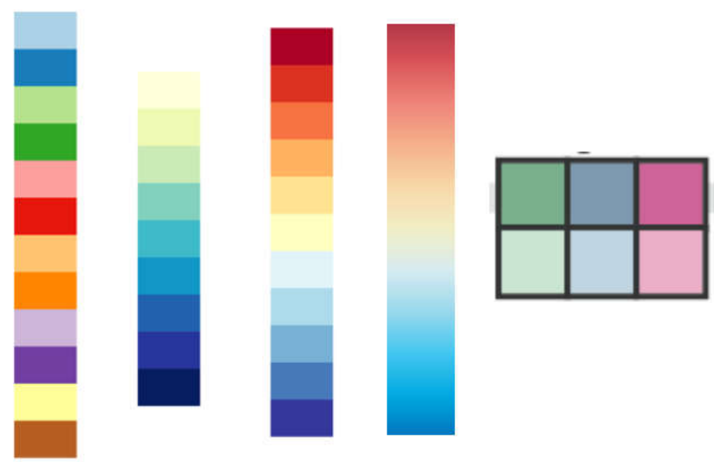
Specifies a mapping between color and values

- Categorical vs ordered
- Sequential vs diverging
- Segmented vs continuous
- Univariate vs bivariate

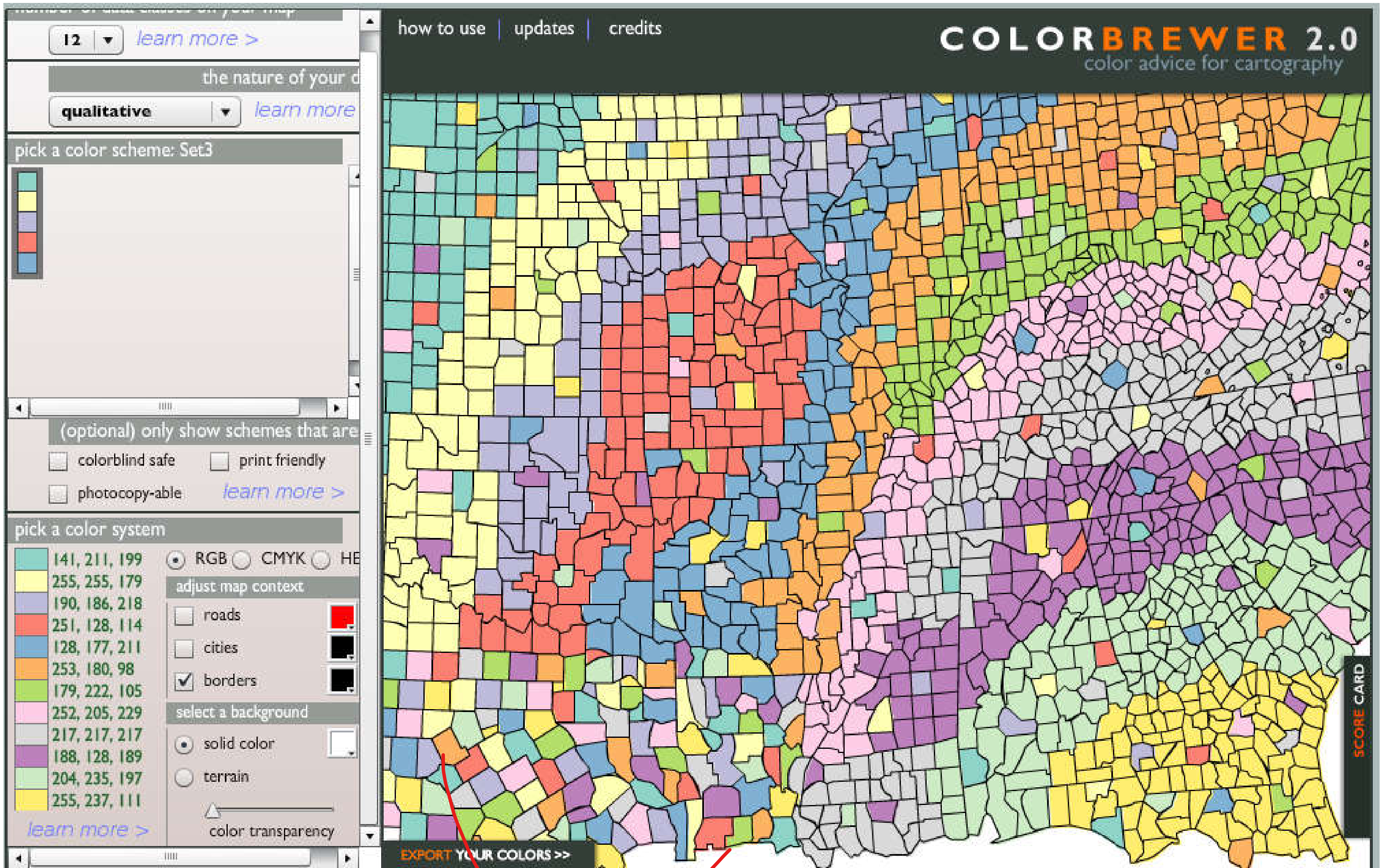


Expressiveness

Match colormap to attribute characteristics



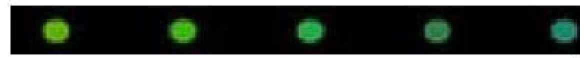
APPLICATION: LABELLING

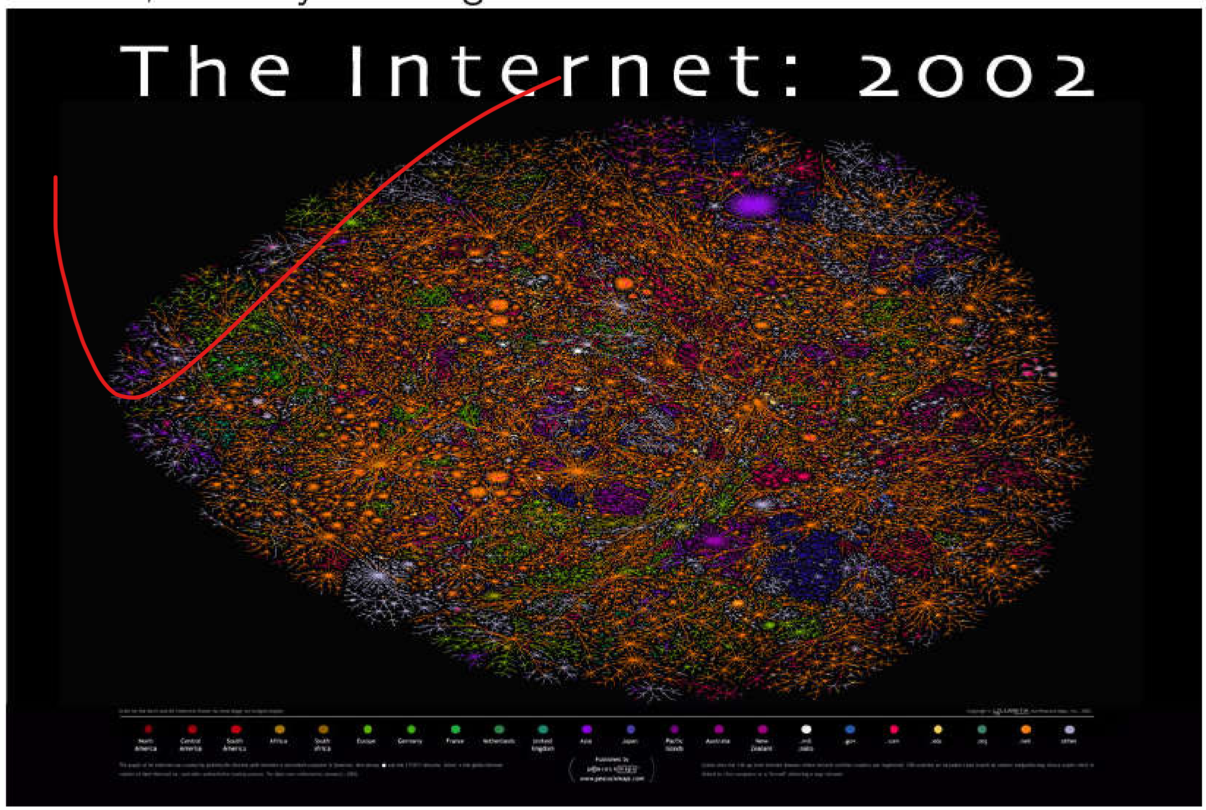


Carefully designed color scheme for 12 colors [colorbrewer]

COLOR FOR QUALITATIVE DATA

Color labeling (nominal information coding)
recommended: about 6, no more than 10

22 colors, but only 8 distinguishable 



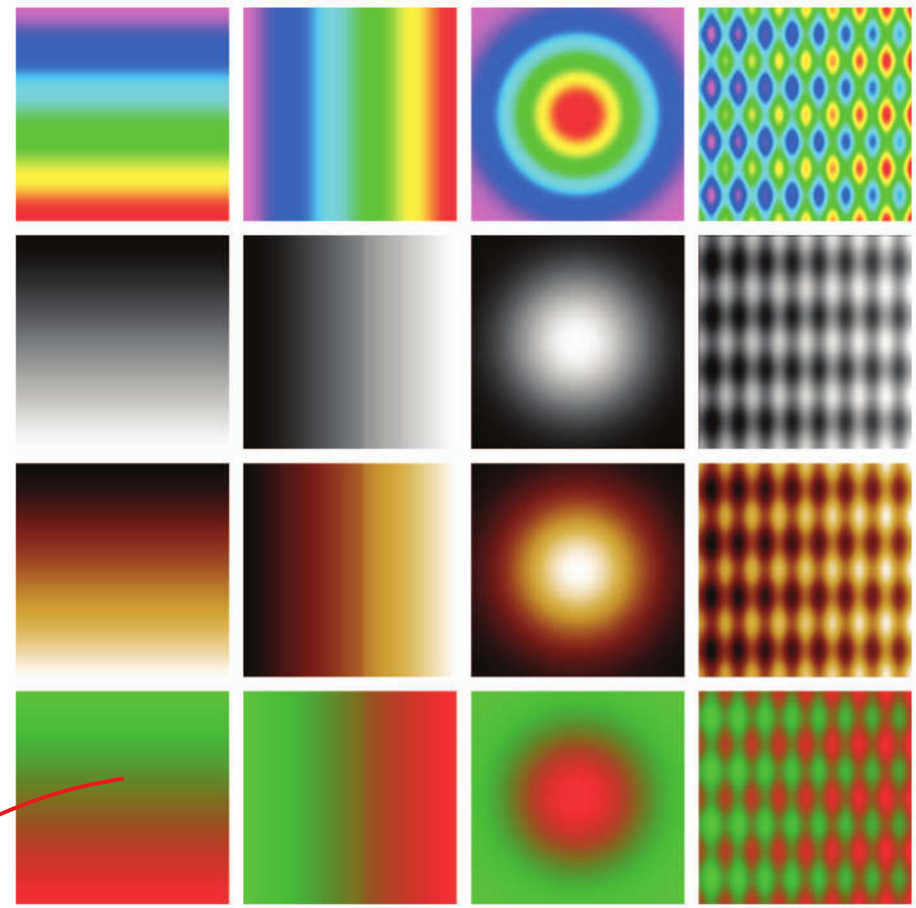
COLOR FOR QUANTITATIVE DATA

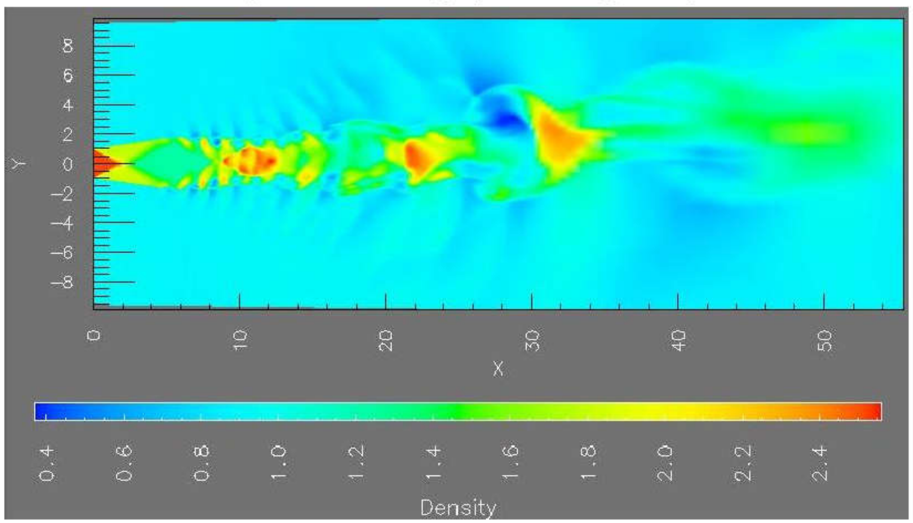
use **value**

saturation works but not as good

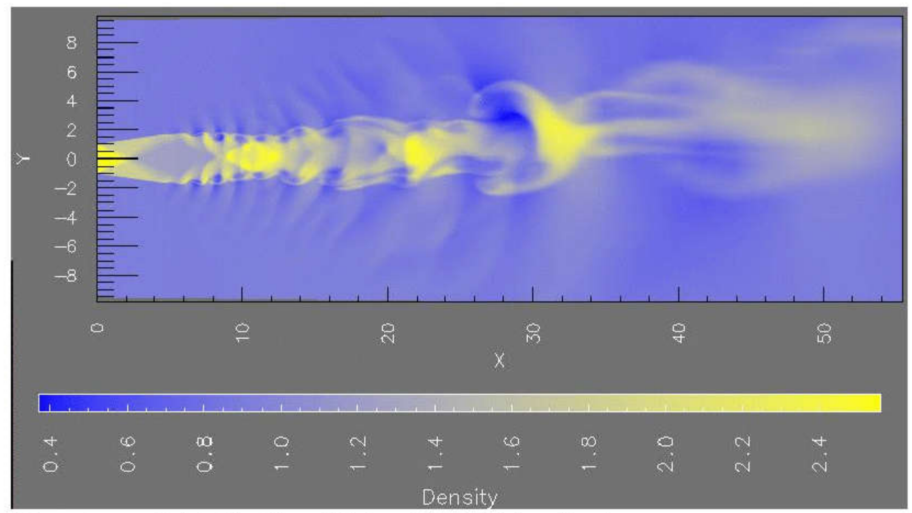
don‘t use **hue**!

Danger: rainbow color map





[Rogowitz and Treinish, Why Should Engineers and Scientists Be Worried About Color? http://www.research.ibm.com/people/l/lloydt/color/color.HTM]



[Rogowitz and Treinish, How NOT to Lie with Visualization, www.research.ibm.com/dx/proceedings/pravda/truevis.htm]

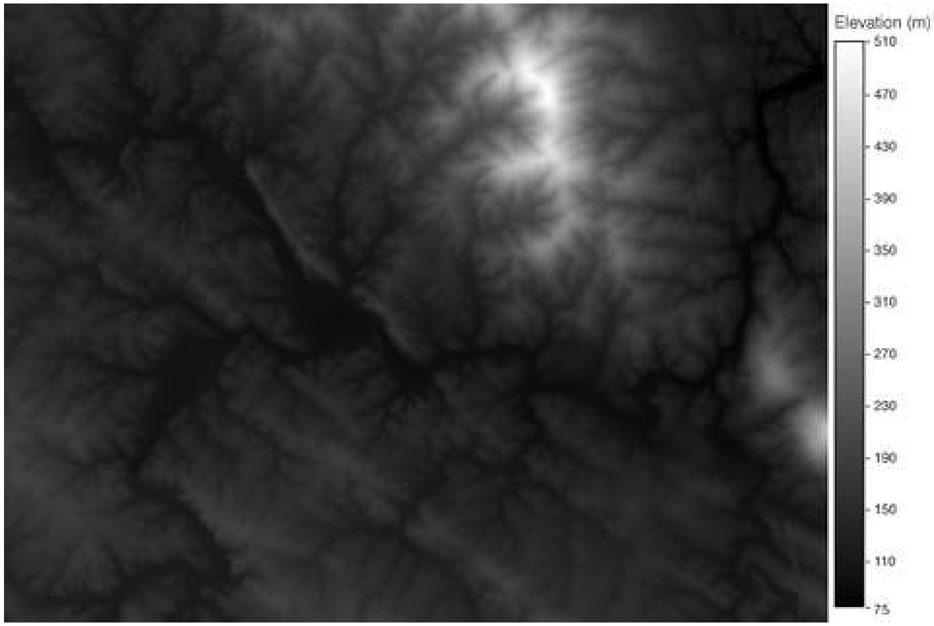
TO BIN OR NOT TO BIN?

What is faster?

What is more accurate?

Continuous was faster

Binned was often more accurate



Evaluating the Impact of Binning 2D Scalar Fields
Lace Padilla, P. Samuel Quinan, Miriah Meyer, Sarah Creem-Regehr
Proceedings of InfoVis16

COLOR BLINDNESS

NOTION

10% of males, 1% of females

Most common: red-green weakness / blindness

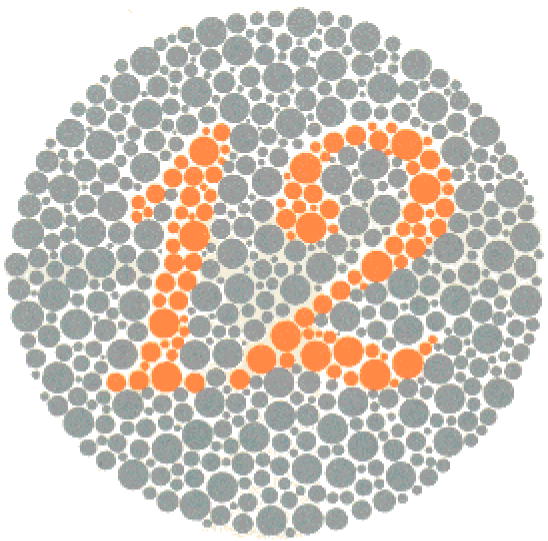
Reason: lack of medium or long wavelength receptors, or altered spectral sensitivity (most common: green shift)

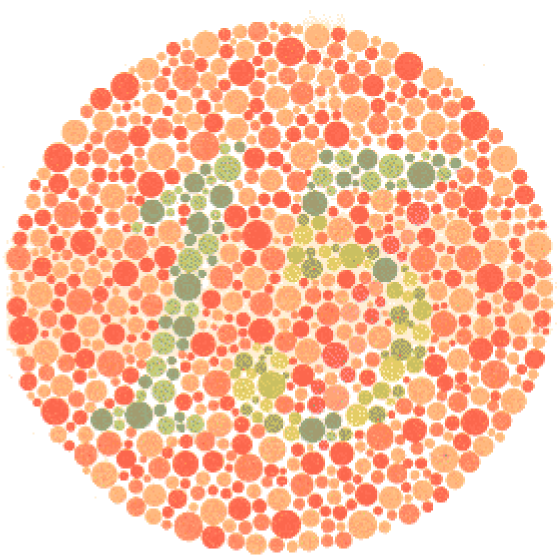
Normal

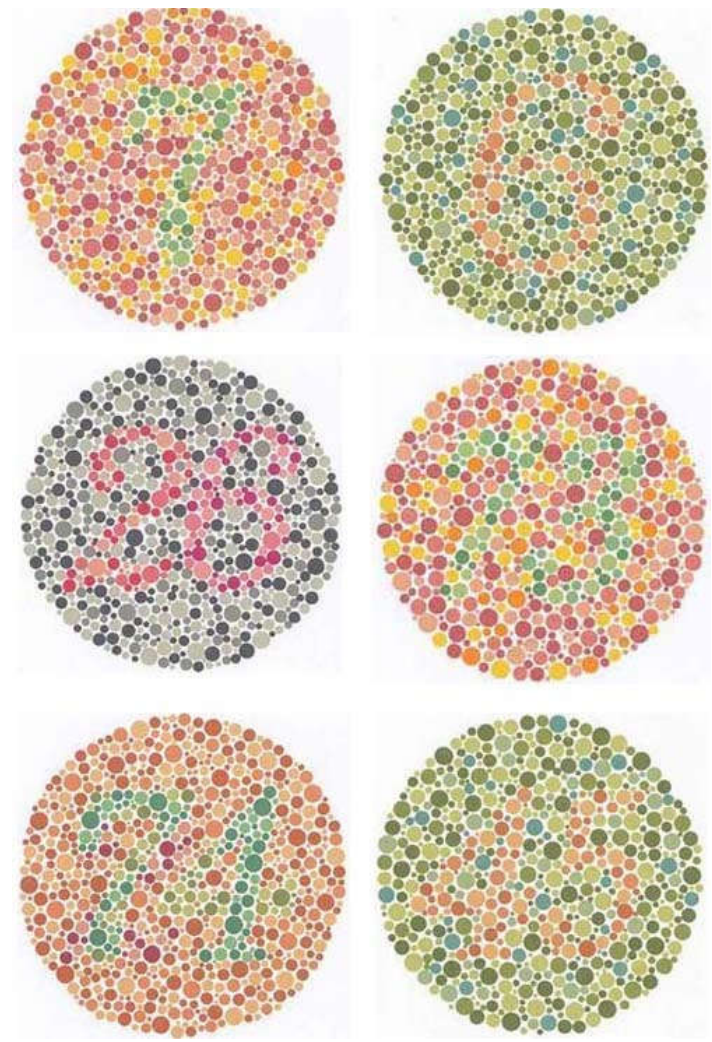
Deuteranopia (no green receptors)

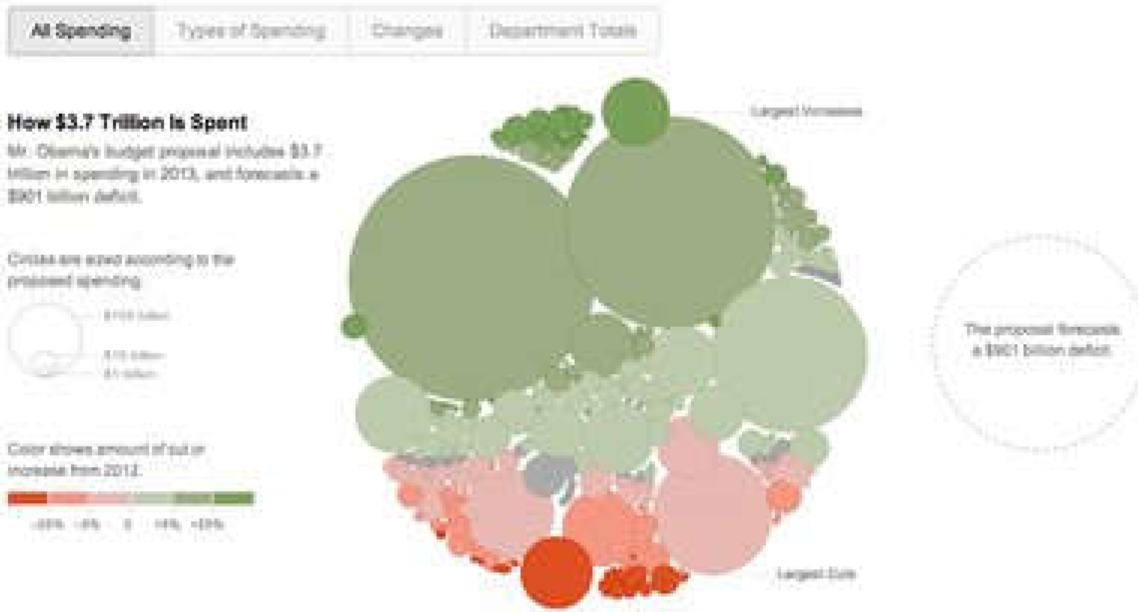
Protanopia (no red receptors)

COLOR BLINDNESS TEST



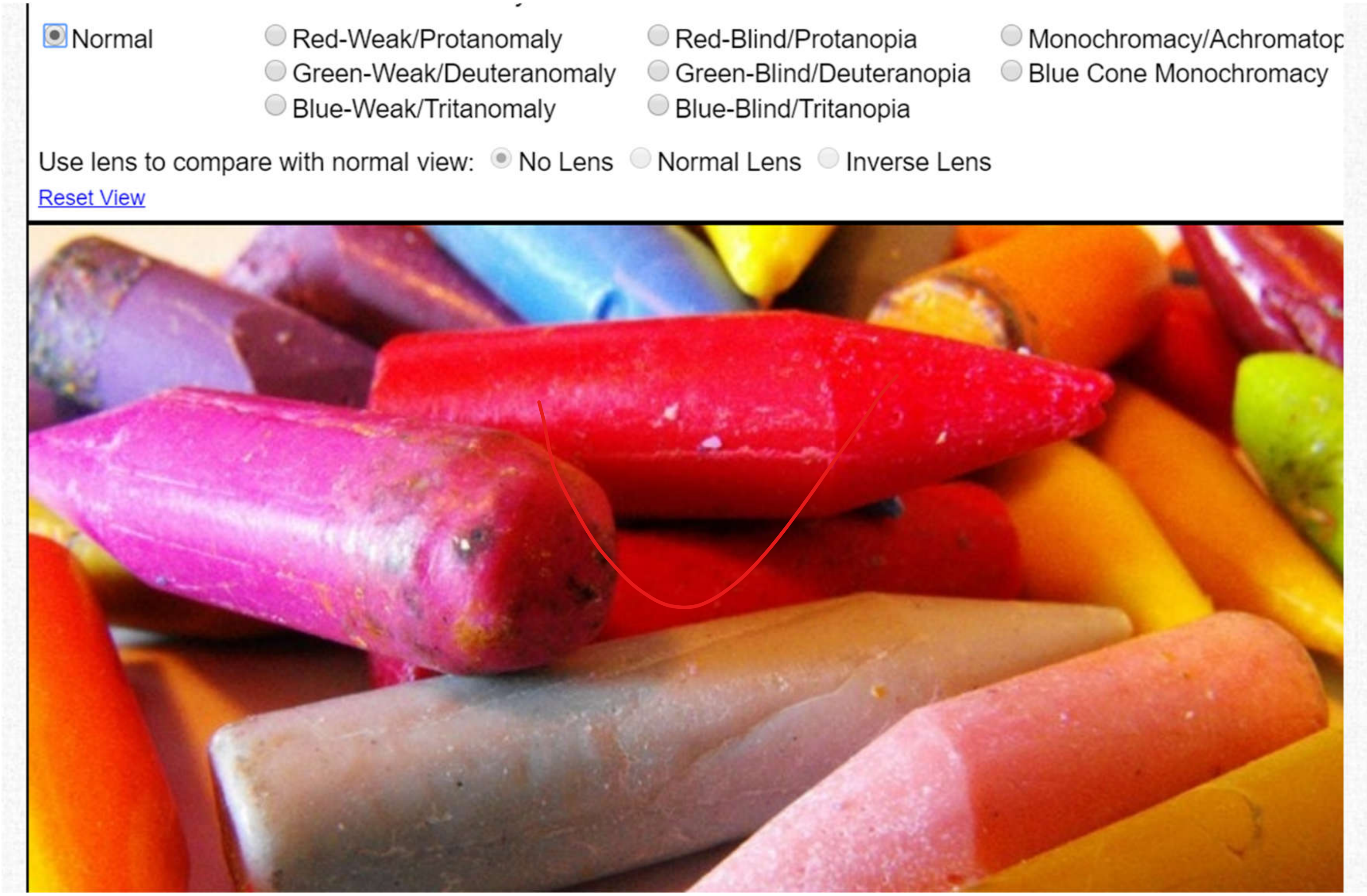






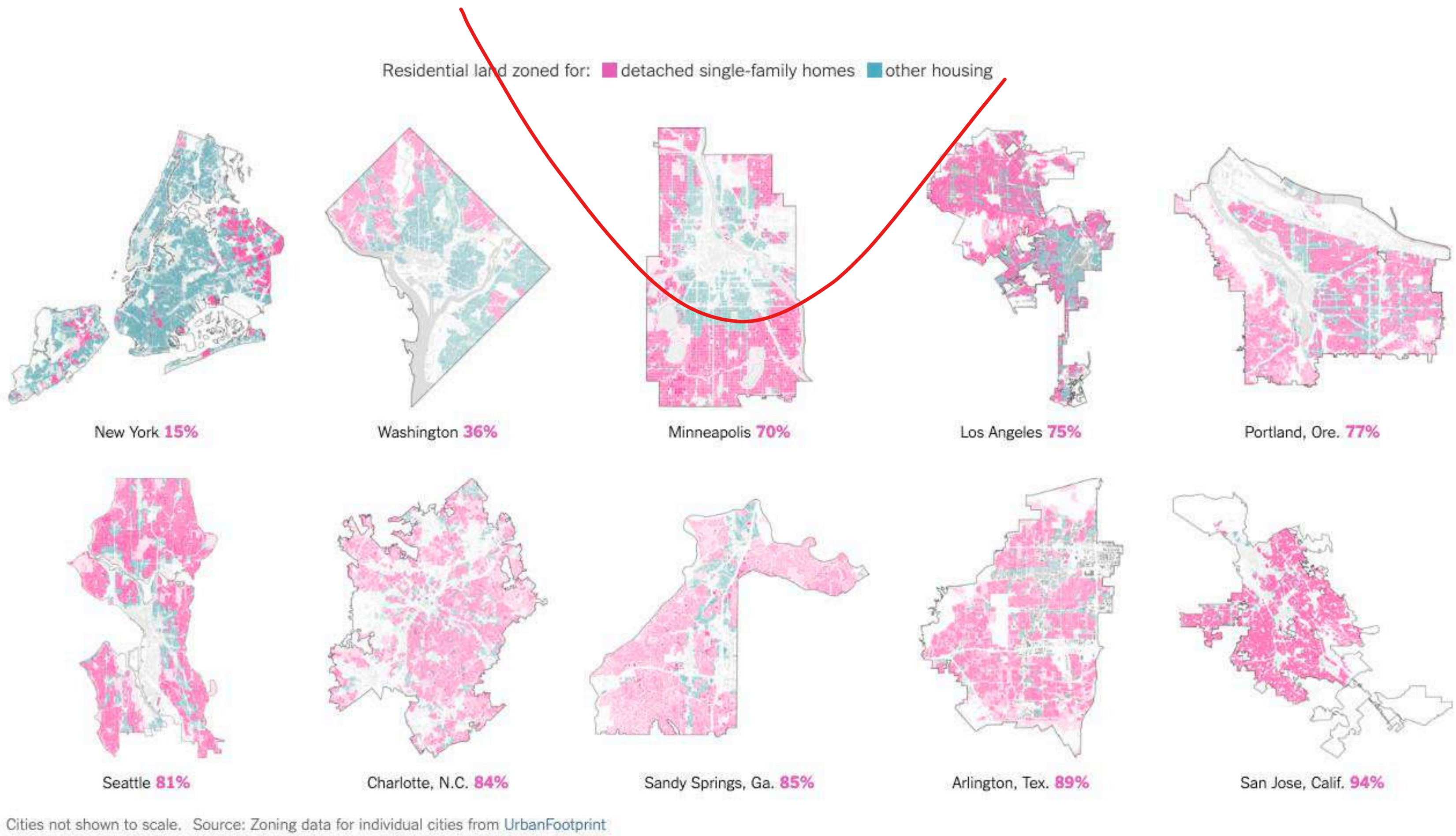
NYT, Feb 12, 2012

SIMULATE COLOR VISION DEFICIENCIES

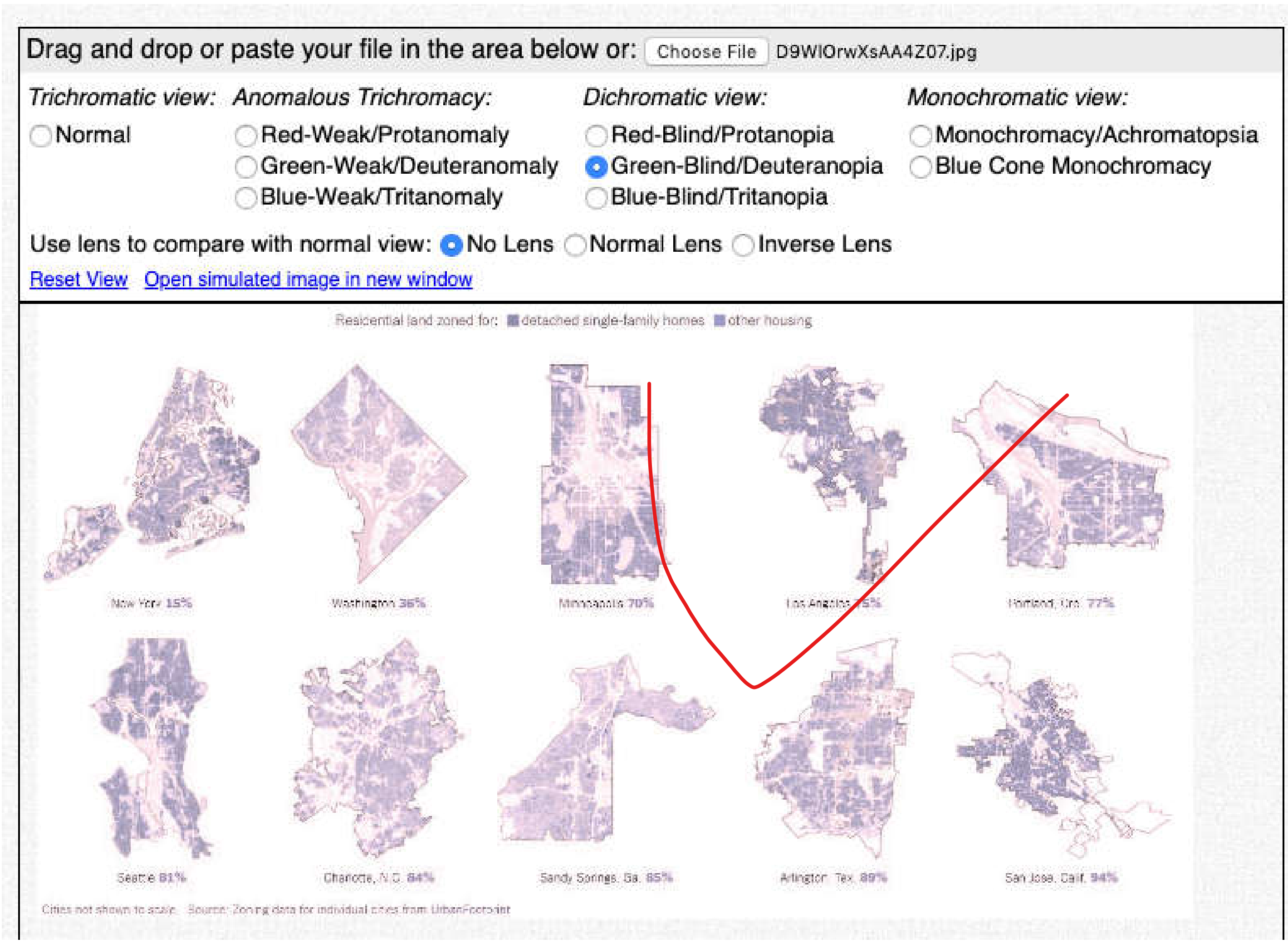


https://www.color-blindness.com/coblis-color-blindness-simulator/

COLOR BLINDNESS CHECKING



NY Times Zoning Maps: http://nyti.ms/2XVAuie

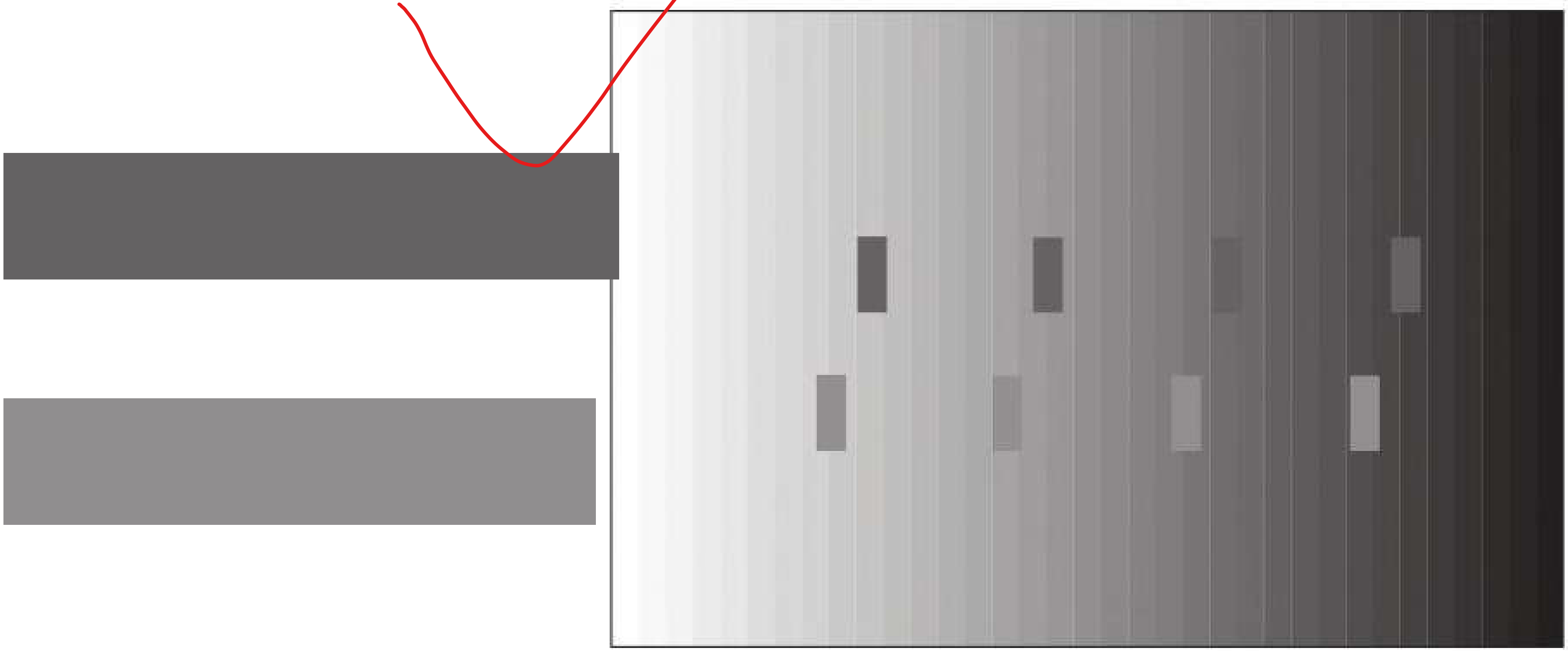


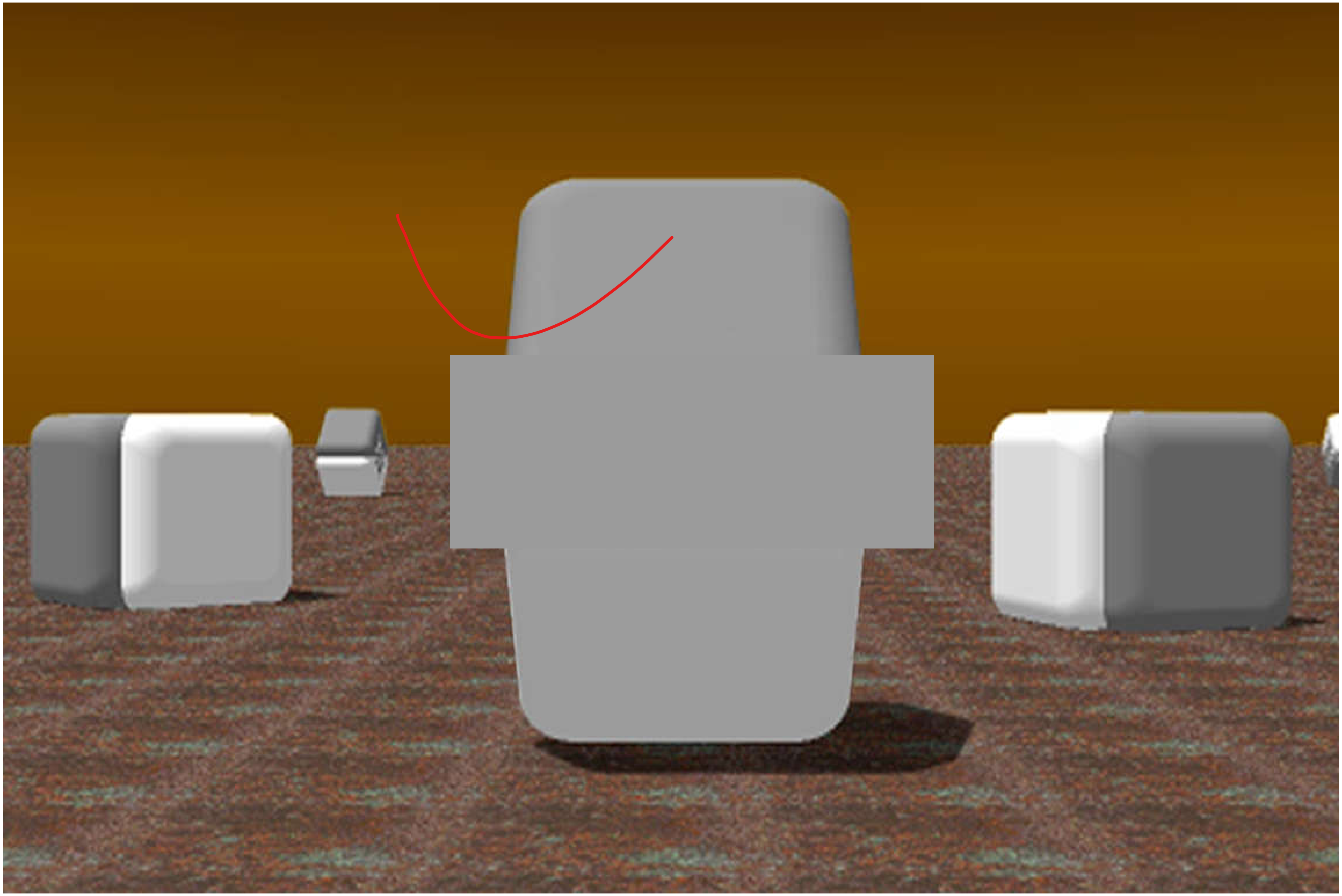
Drag and drop or paste your file in the area below or:
Choose File
D9WIOrwXsAA4Z07.jpg
Trichromatic view:
Normal
Anomalous Trichromacy:
Red-Weak/Protanomaly
Green-Weak/Deuteranomaly
Blue-Weak/Tritanomaly
Dichromatic view:
Red-Blind/Protanopia
Green-Blind/Deuteranopia
Blue-Blind/Tritanopia
Monochromatic view:
Monochromacy/Achromatopsia
Blue Cone Monochromacy
Use lens to compare with normal view:
No Lens
Normal Lens
Inverse Lens
Reset View
Open simulated image in new window
Residential land zoned for: detached single-family homes other housing
New York 15%
Washington 36%
Minneapolis 70%
Portland, Ore. 77%
Seattle 81%
Charlotte, N.C. 84%
Sandy Springs, Ga. 85%
Arlington, Tex. 89%
San Jose, Calif. 94%
Cities not shown to scale. Source: Zoning data for individual cities from UrbanFootprint

COLOR IS RELATIVE

SIMULTANEOUS BRIGHTNESS CONTRAST

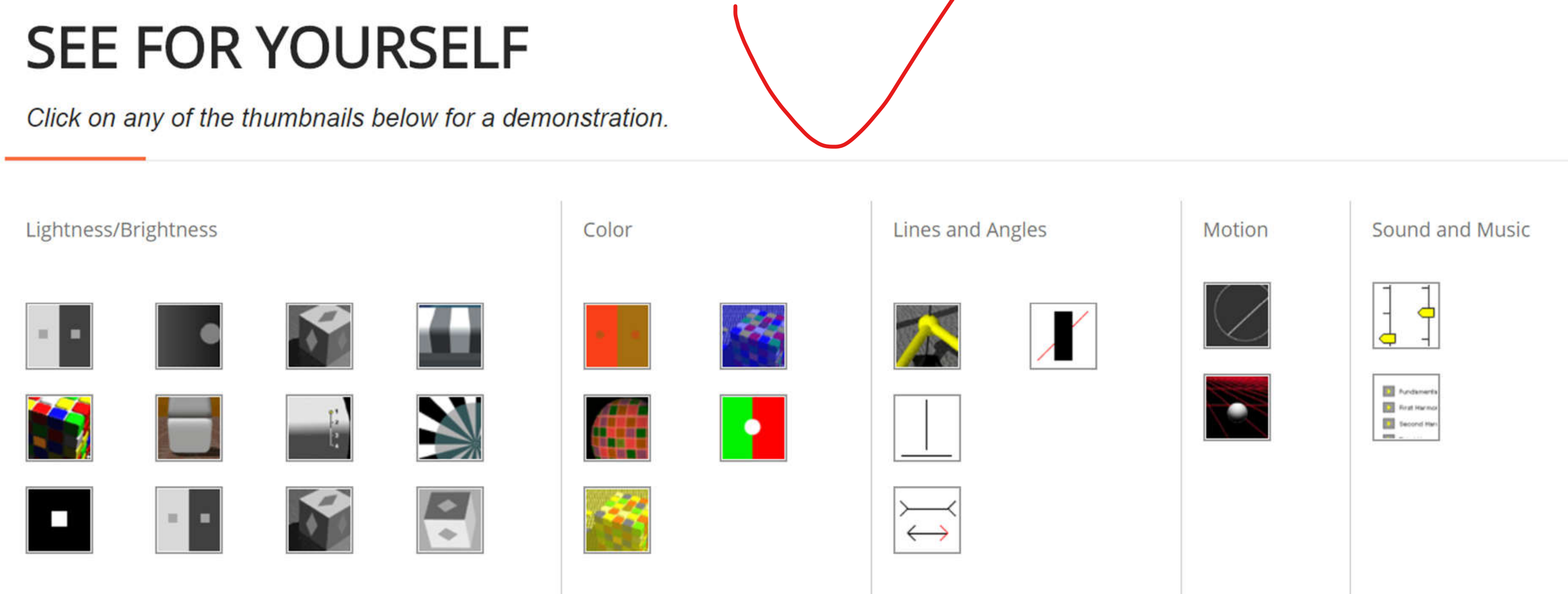
The perceived brightness of an object is relative to it's background





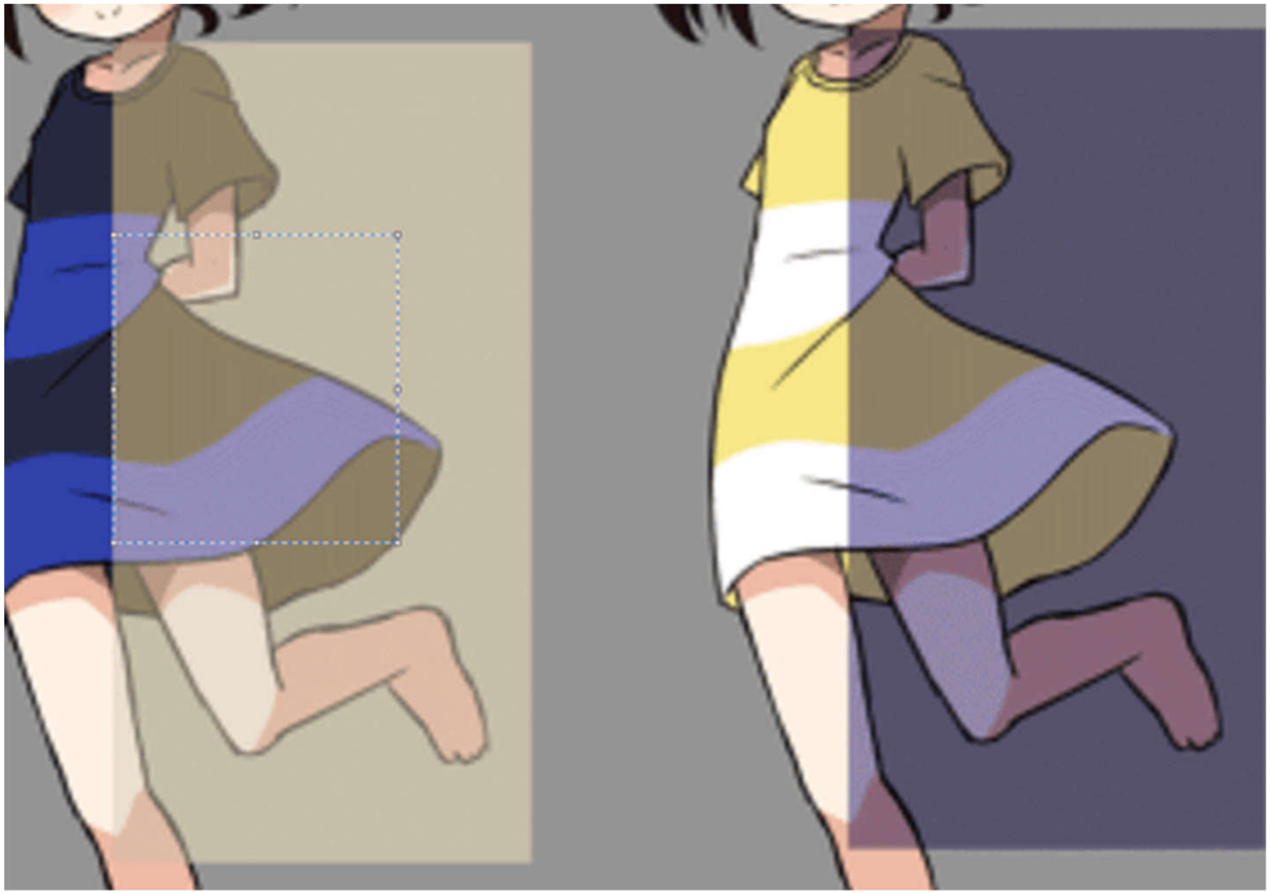
FOR MORE DEMO

http://purveslab.net/see-for-yourself/

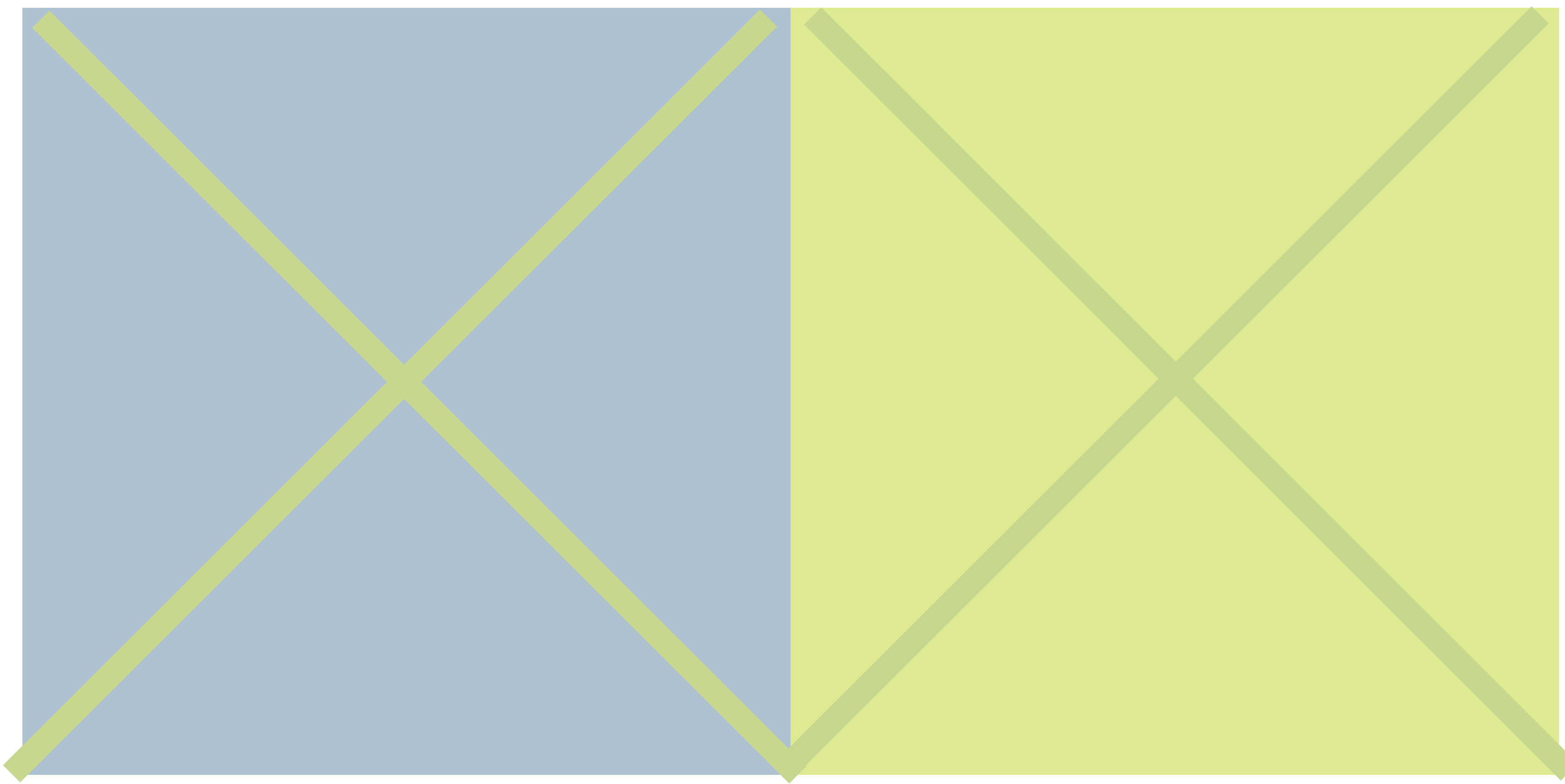


BLACK AND BLUE OR WHITE AND GOLD

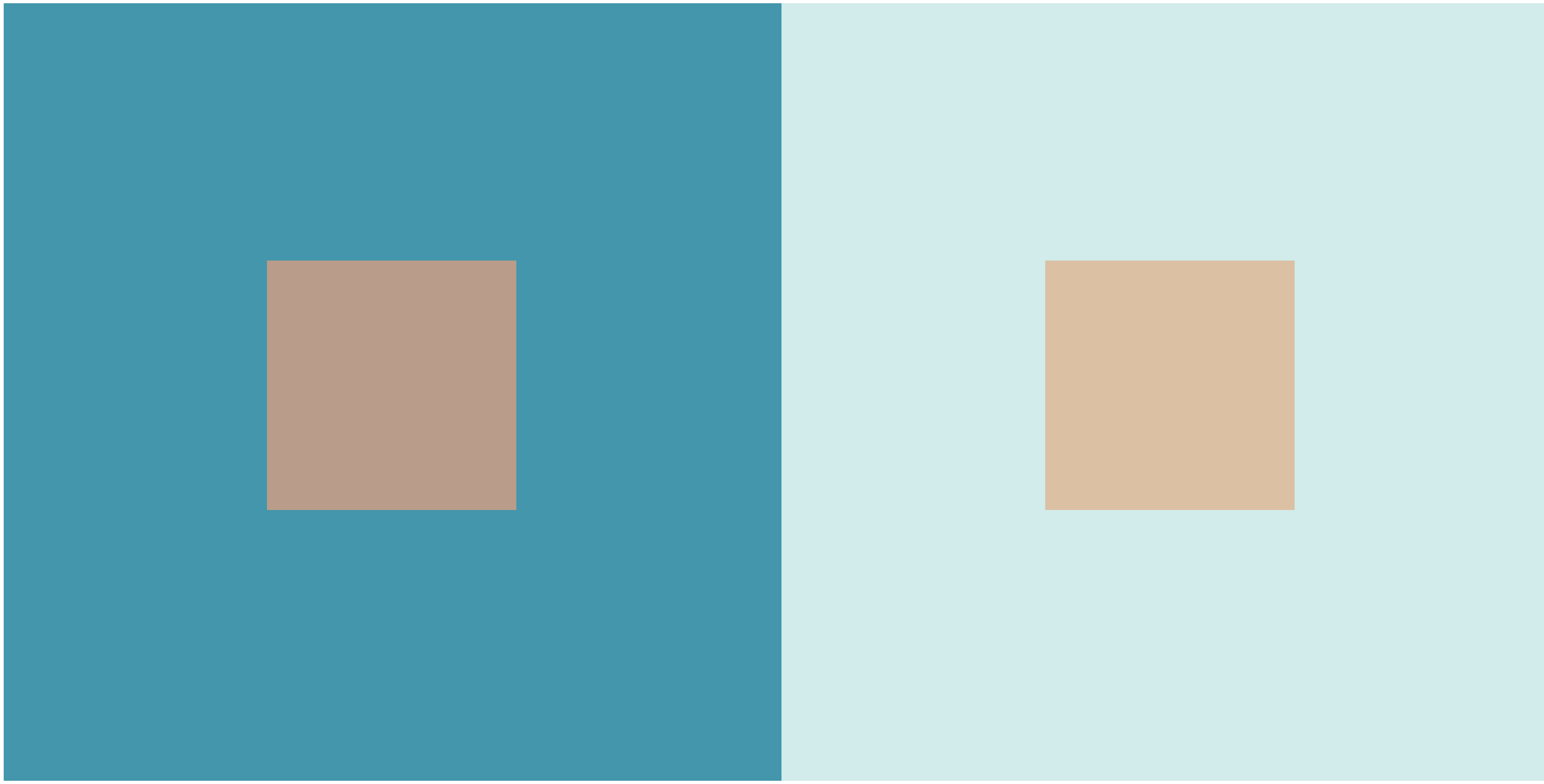
https://imgur.com/hxJjUQB



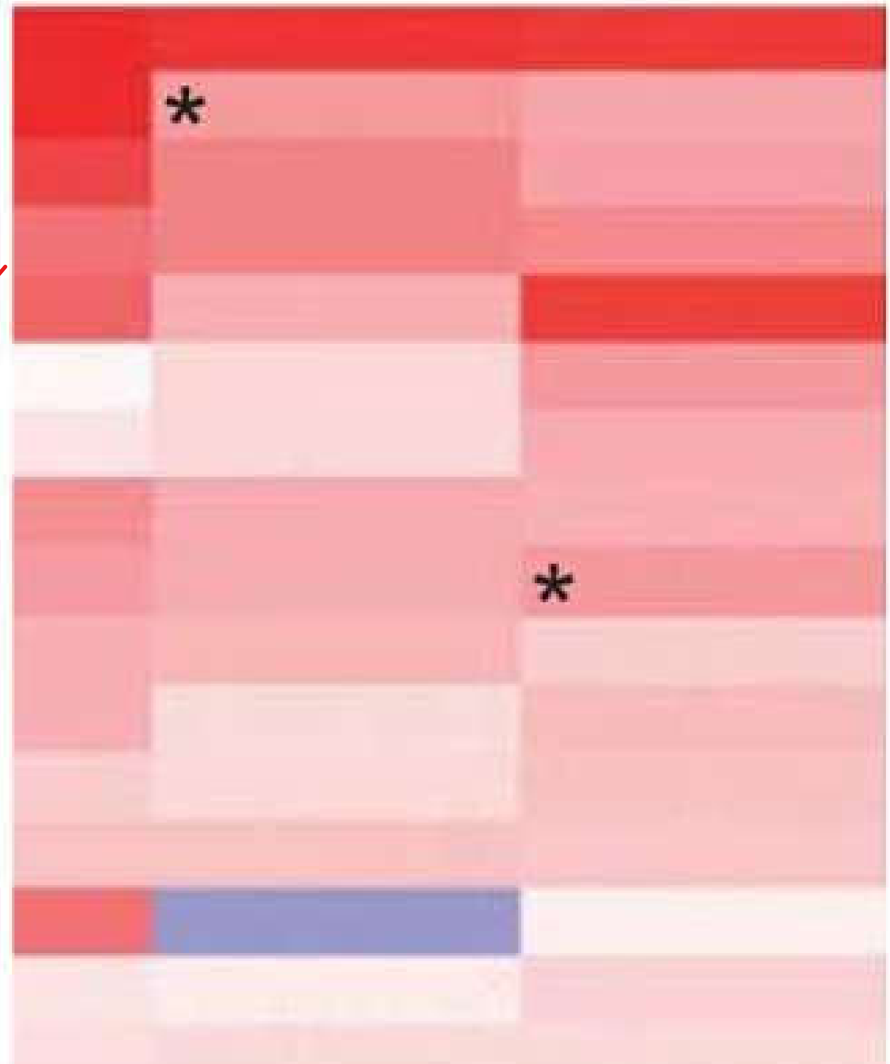
INTERACTION OF COLOR



INTERACTION OF COLOR

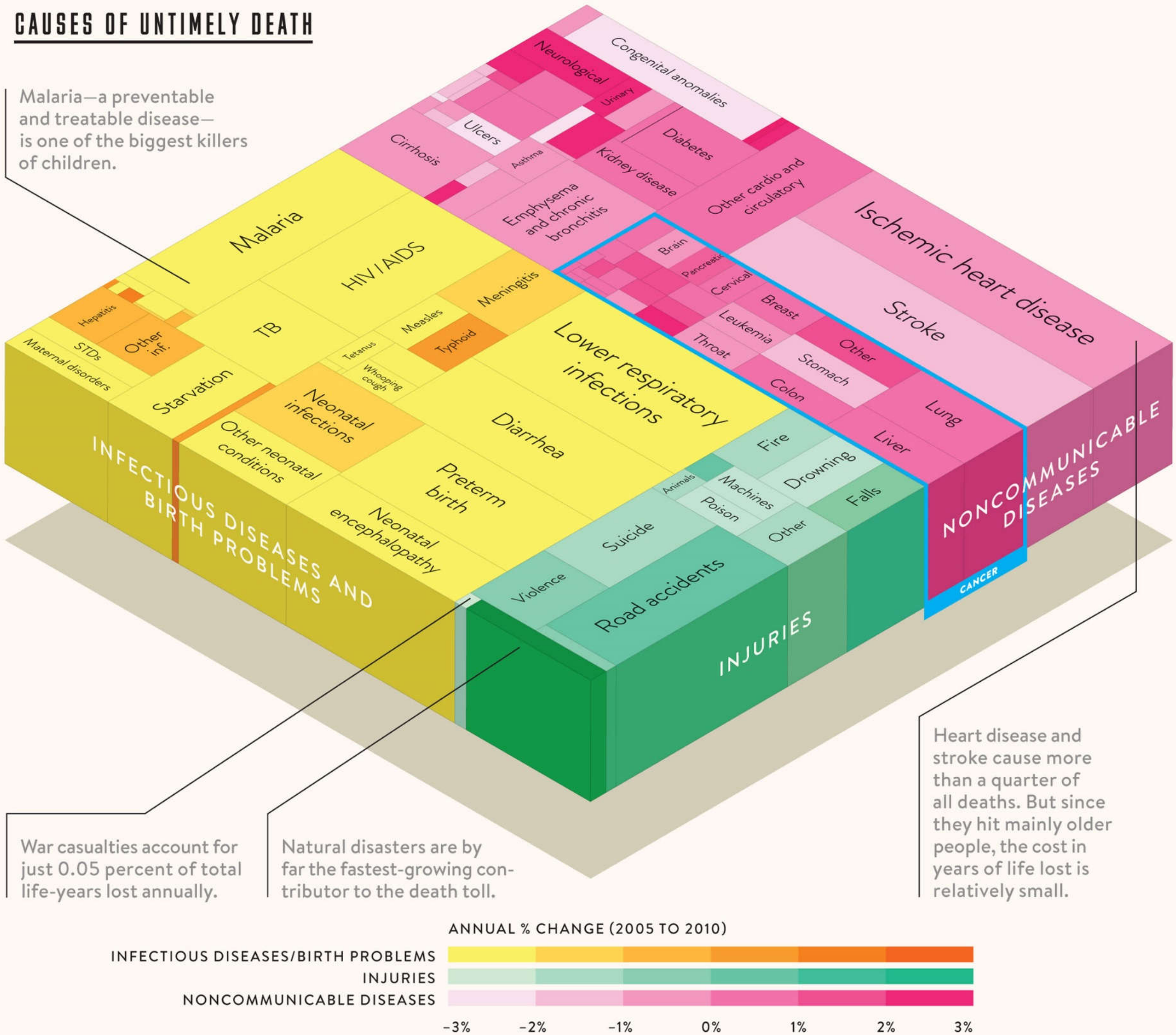


INTERACTION OF COLOR



[Wong 2010]

CAUSES OF UNTIMELY DEATH

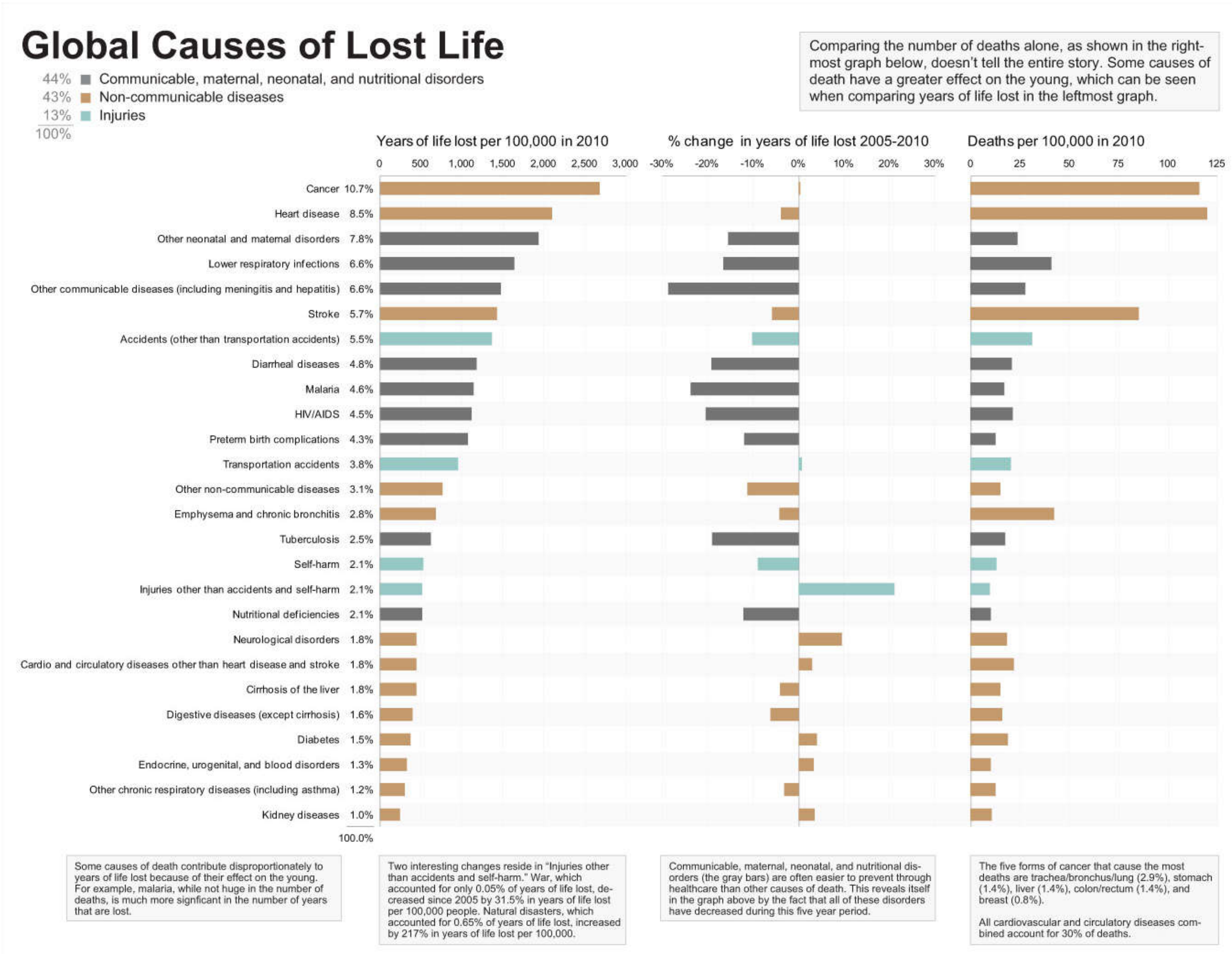


I love this graph because it shows that while the number of people dying from communicable diseases is still far too high, those numbers continue to come down [..] But there remains much to do to cut down the deaths in that yellow block even more dramatically.[…]

Bill Gate

EVALUATE THE GRAPH

how well does the graph above tell this story?



Redesigned by Perceptual Edge