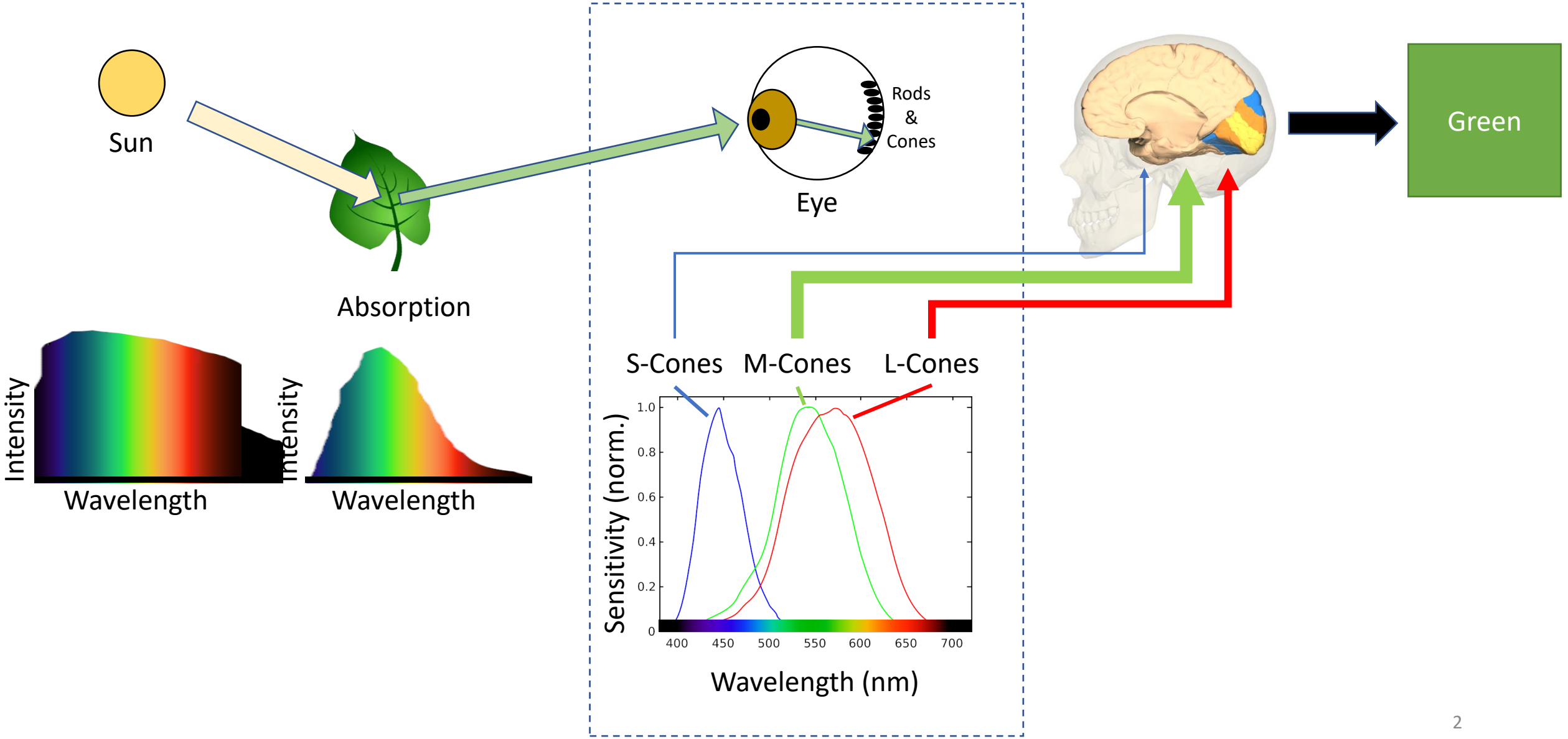
UNIVERSITY OF BIRMINGHAM

Visualisation

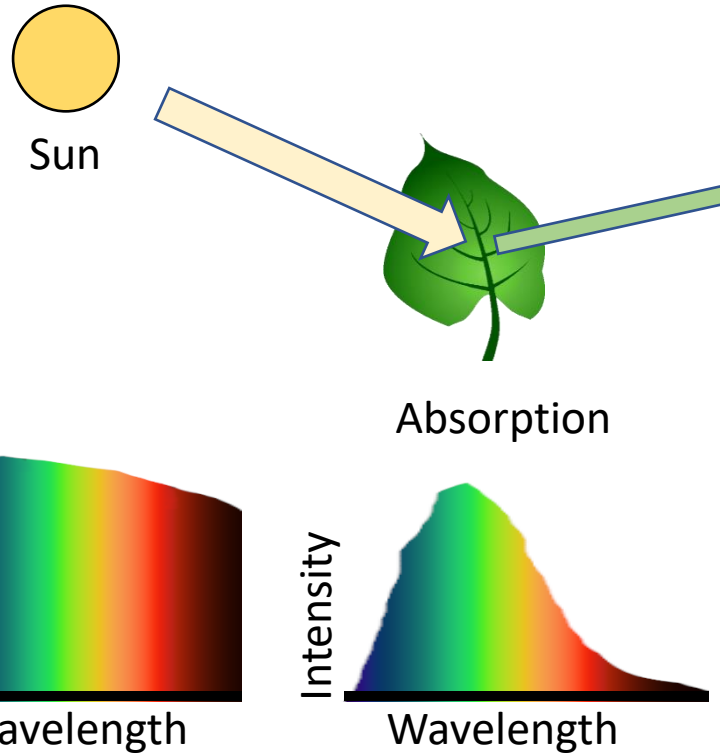
Week 1

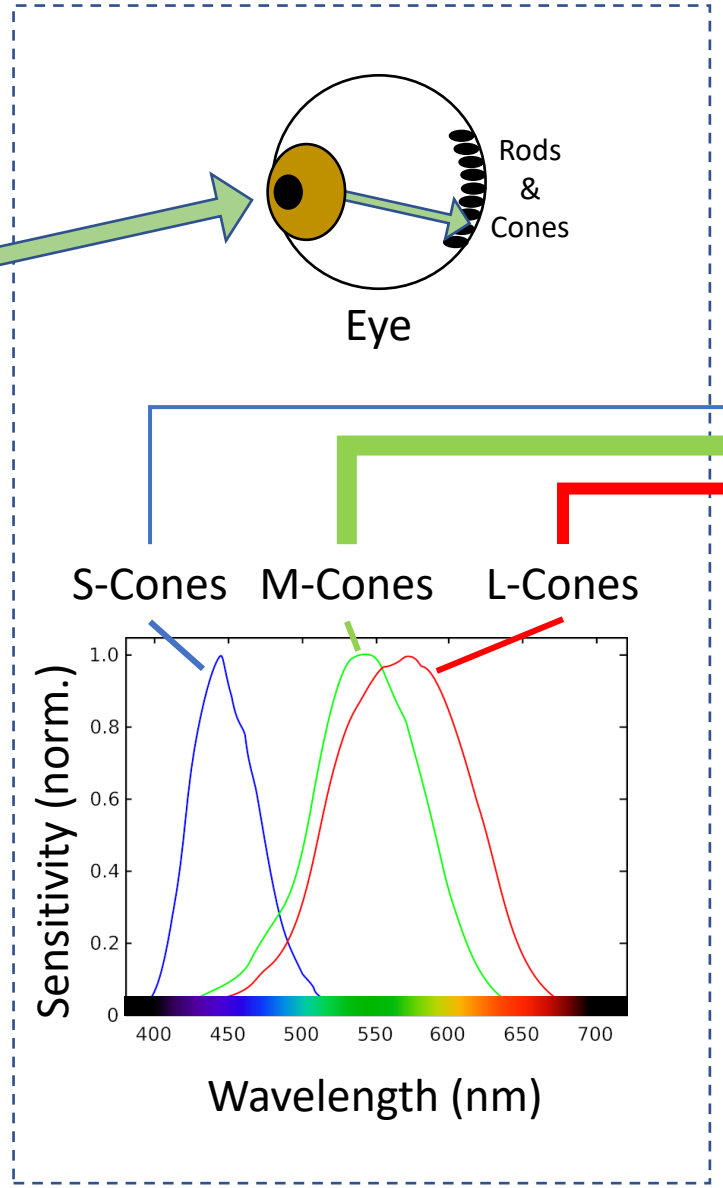
Colour and Colour Scales

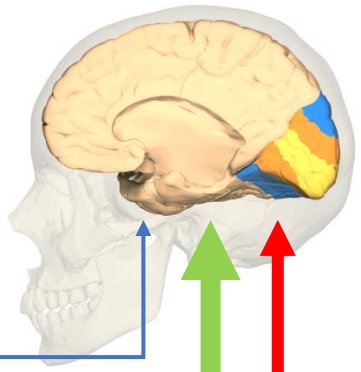
What is Colour? Trichromatic Vision



What is Colour? Dichromatic Vision







Green?
Red?

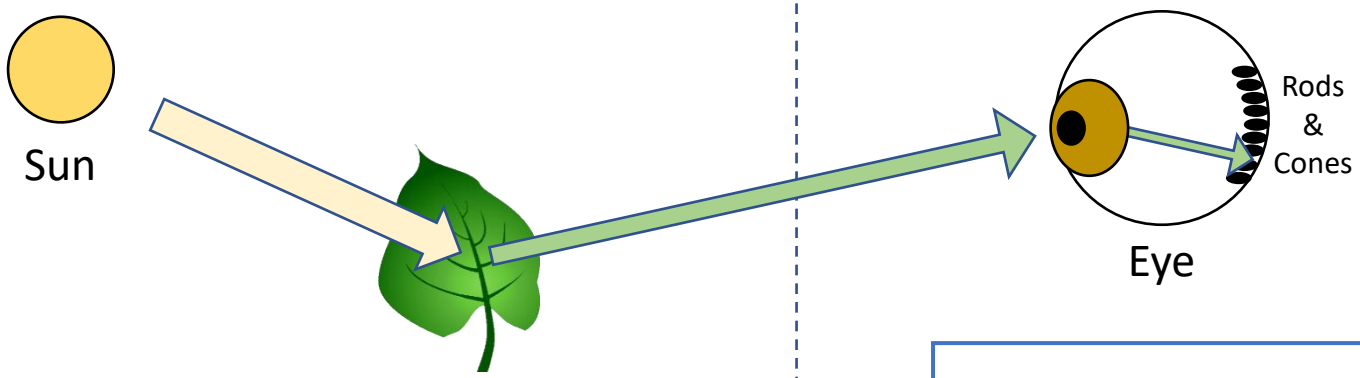
Trichromatic Vision

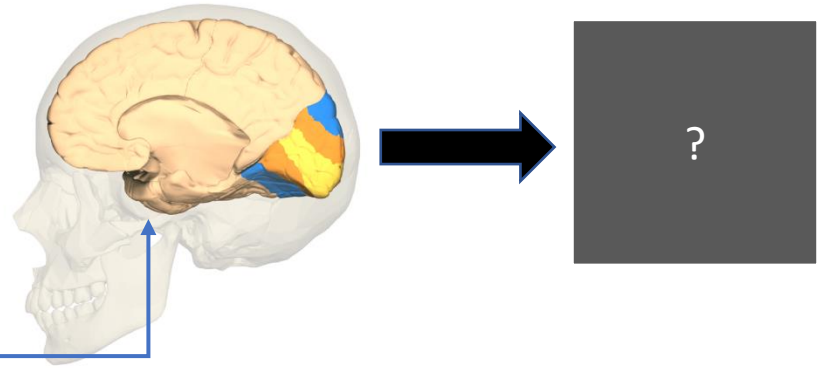
Dichromatic Vision

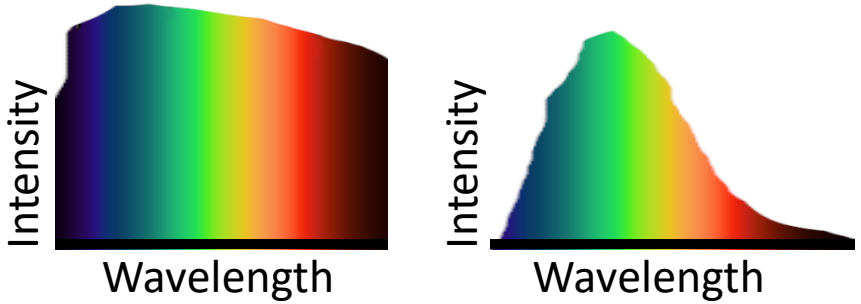
1% of males (deuteranopia)

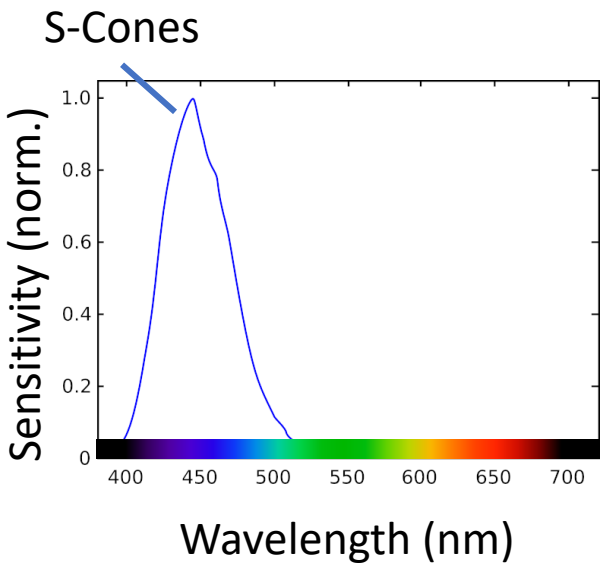
6% of males (deuteranomaly)

What is Colour? Monochromatic Vision



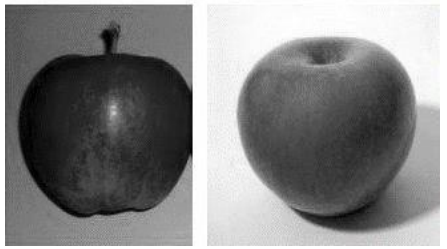




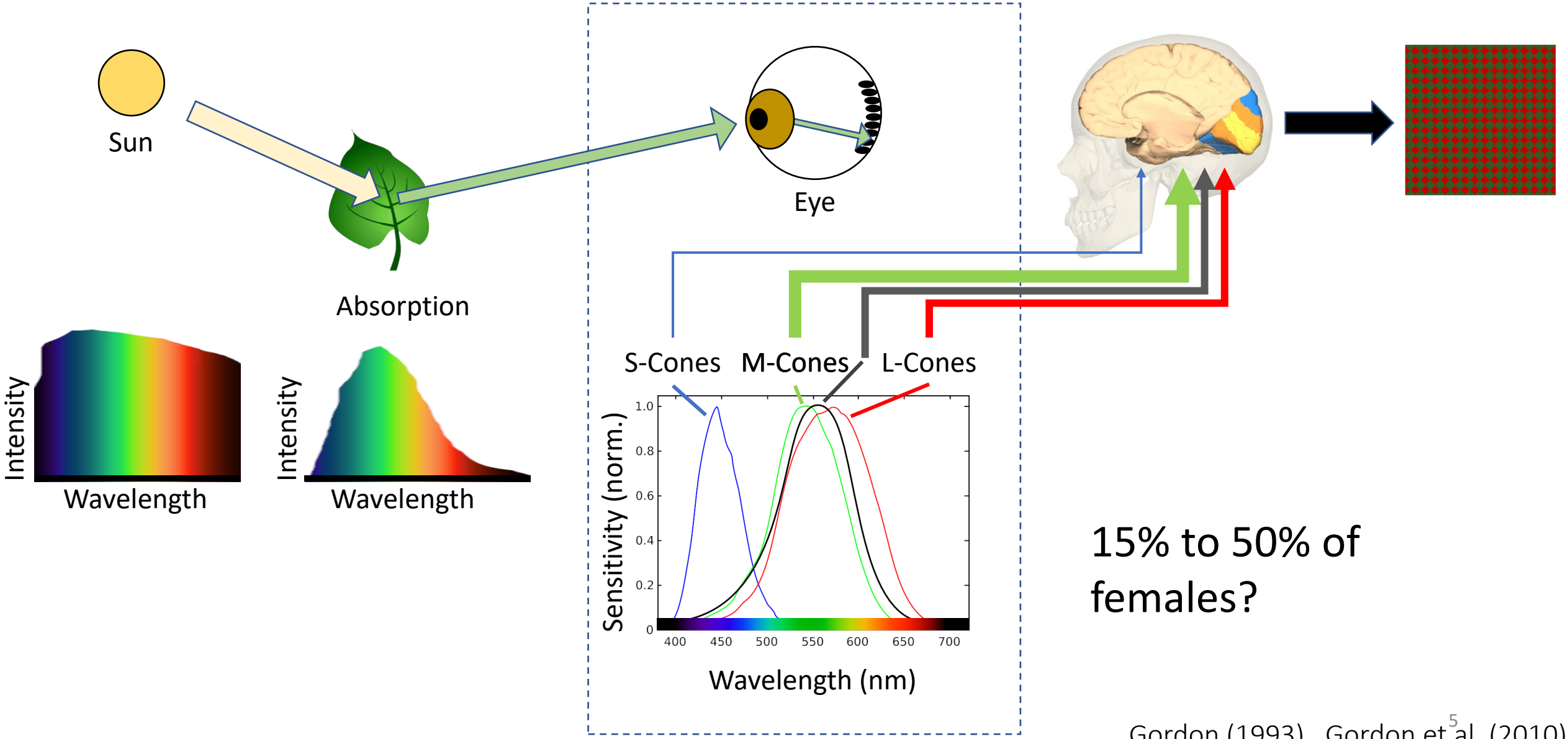


Trichromatic Vision

Monochromatic Vision



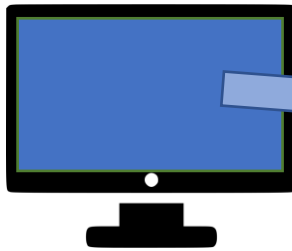
What is Colour? Tetrachromatic Vision

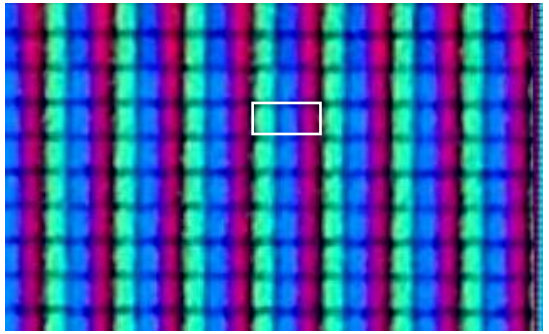


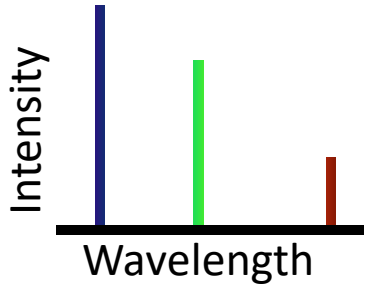
15% to 50% of females?

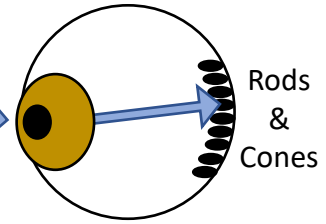
Gordon (1993), Gordon et al. (2010)

What is RGB Colour?

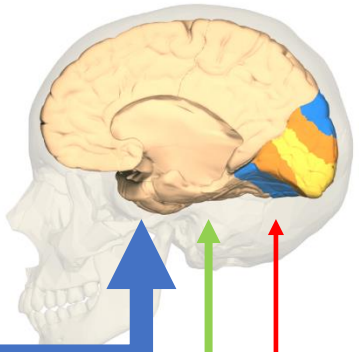






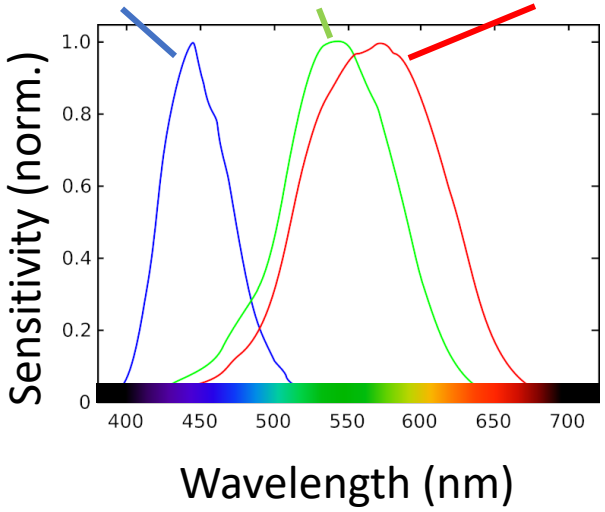


Eye

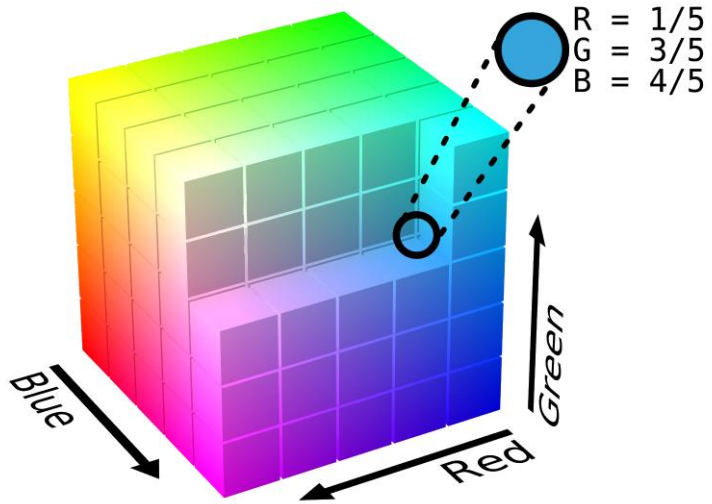


Blue

S-Cones M-Cones L-Cones

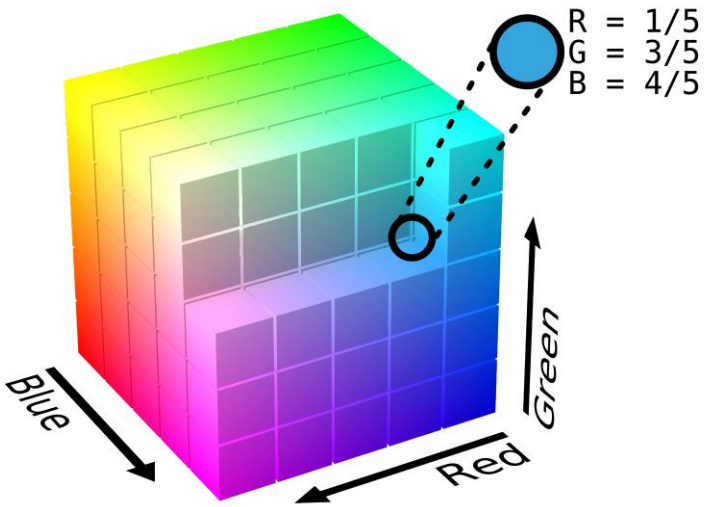


RGB Space

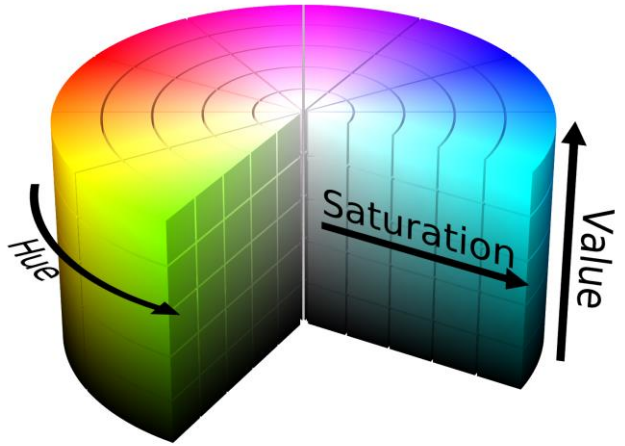


Colour is 3dimensional

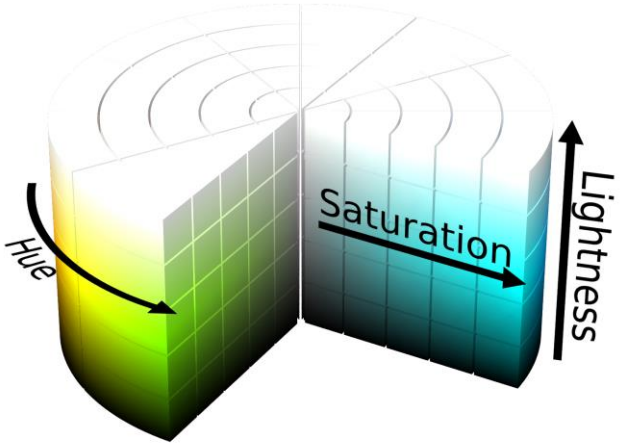
RGB Space



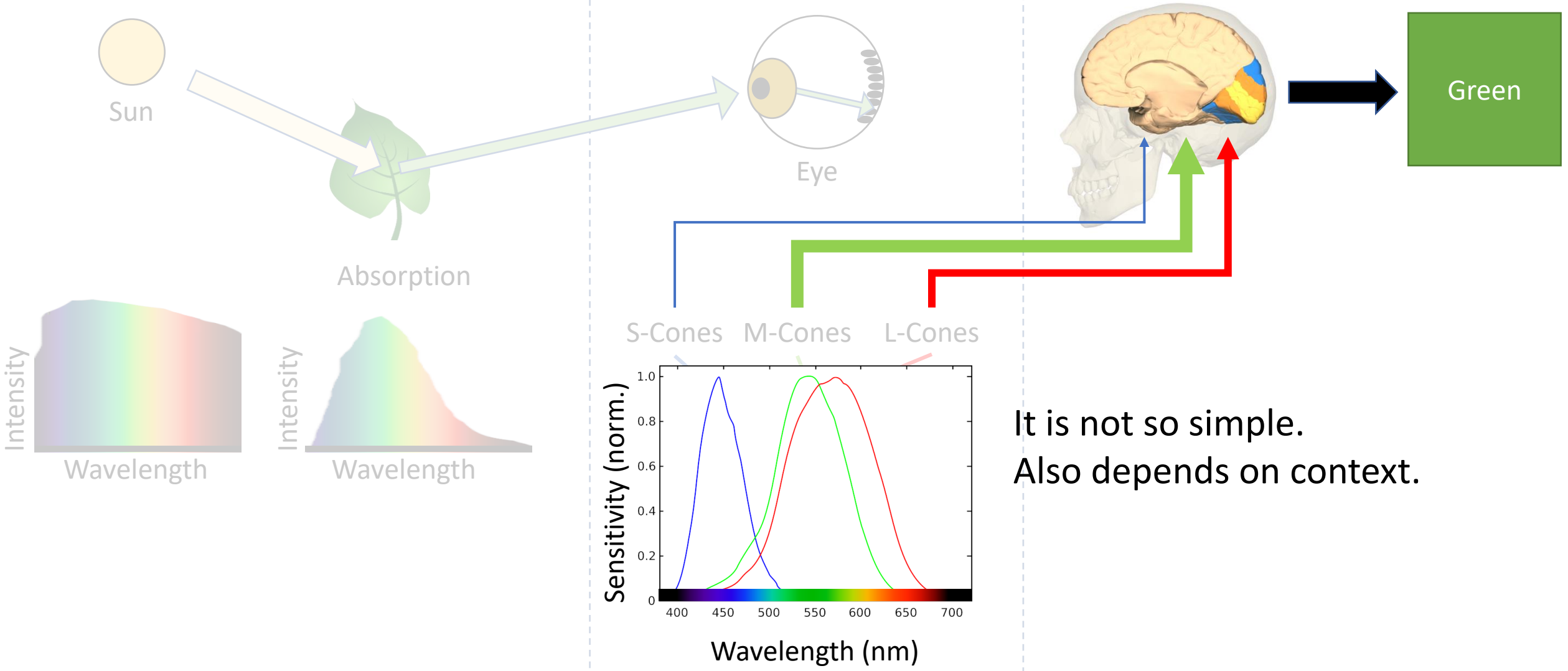
HSV Space



HSL Space

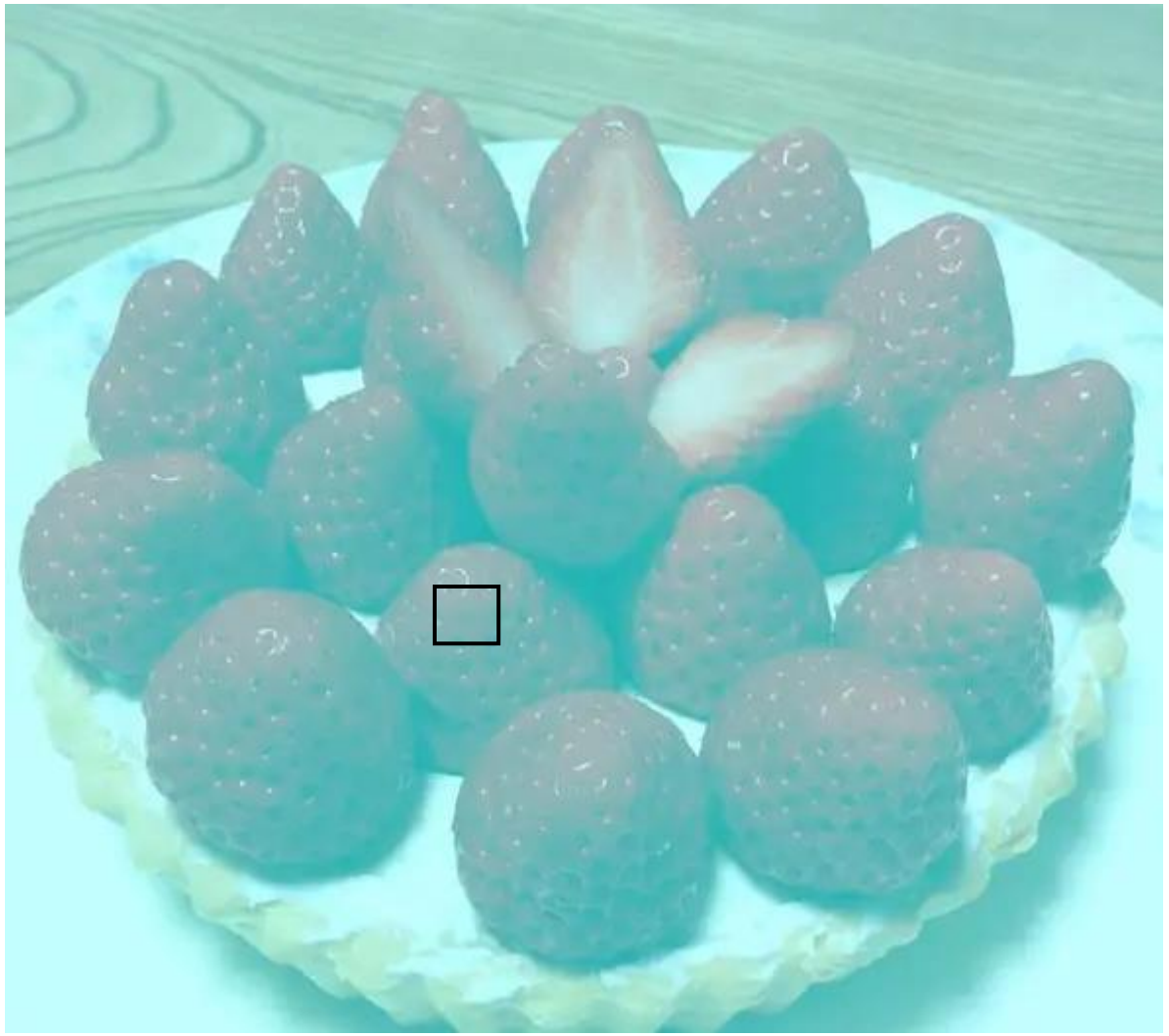


What is Colour? Trichromatic Vision



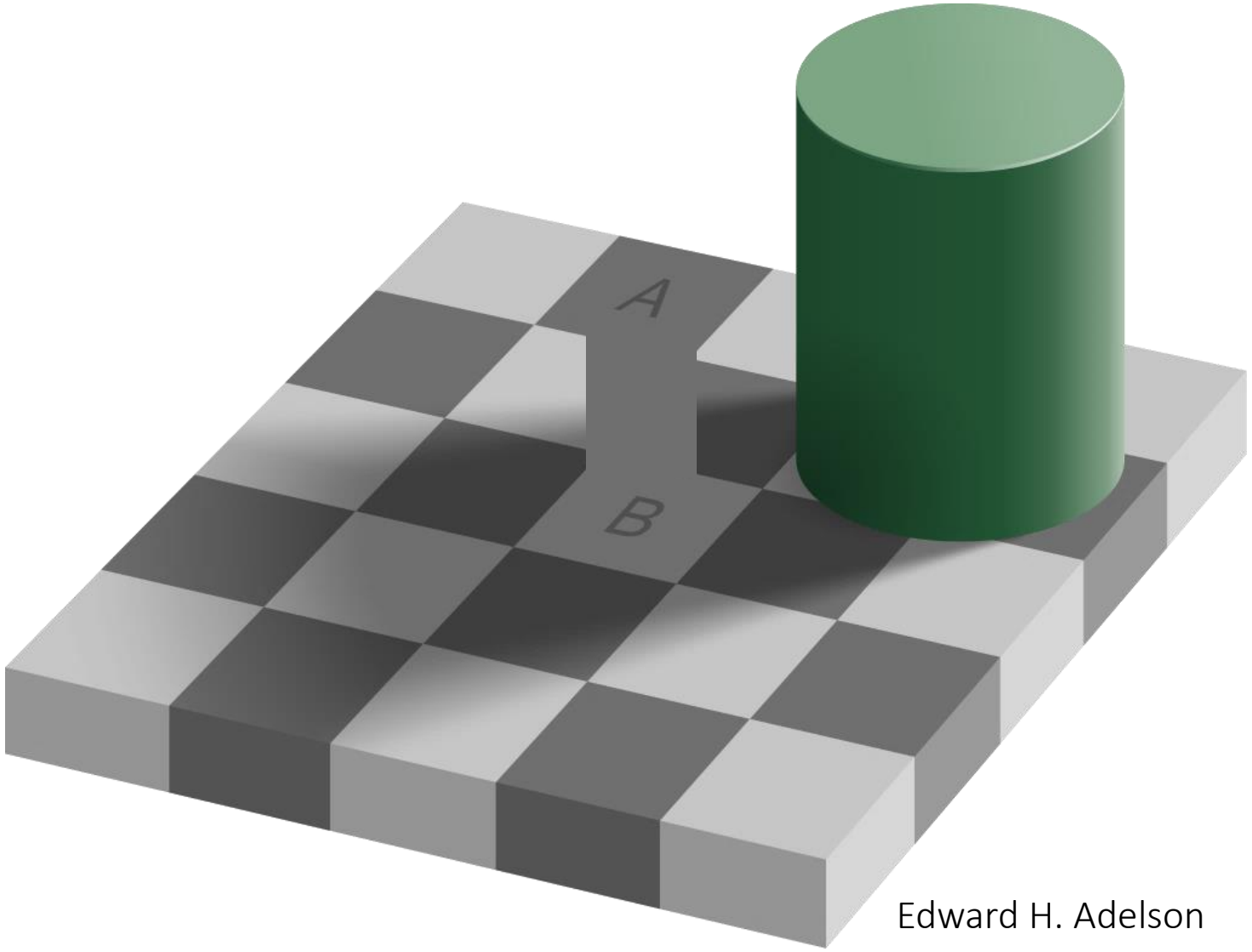
It is not so simple.
Also depends on context.

Context Dependent Perception



Akiyoshi Kitaoka

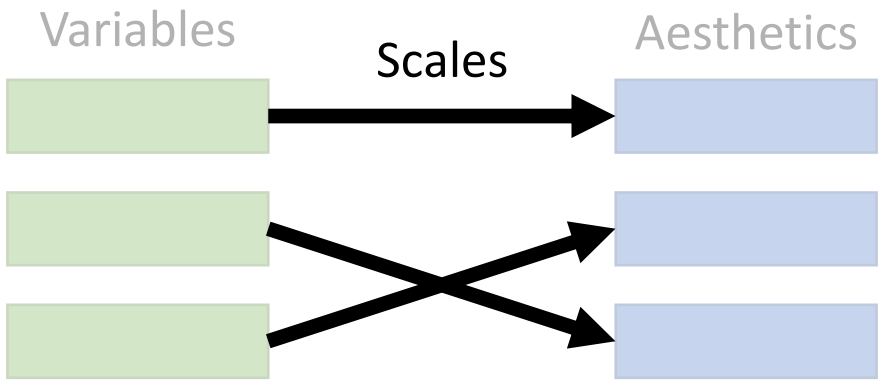
Context Dependent Perception

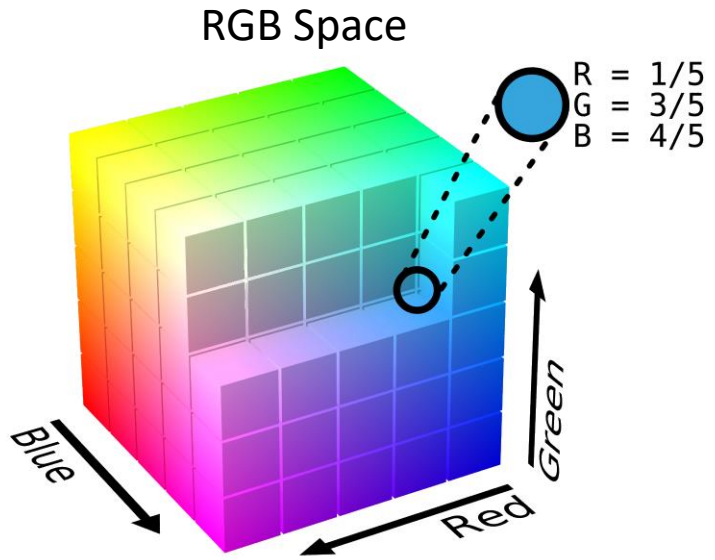


Edward H. Adelson

Colour Scales

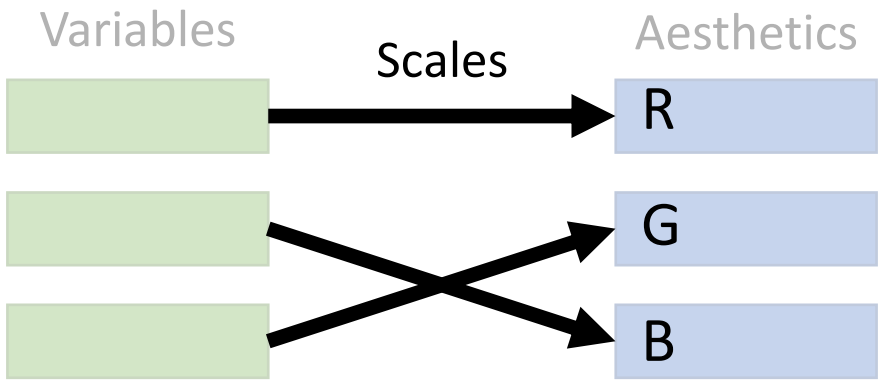
aka Colour maps
aka Colour palettes

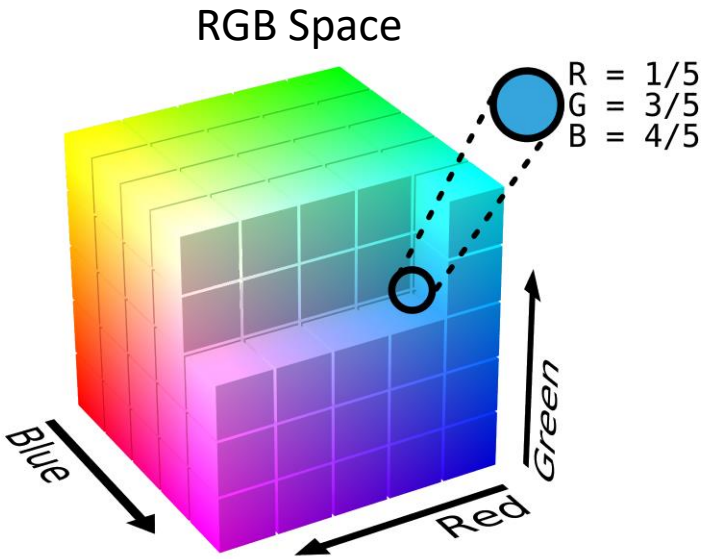




Colour Scales

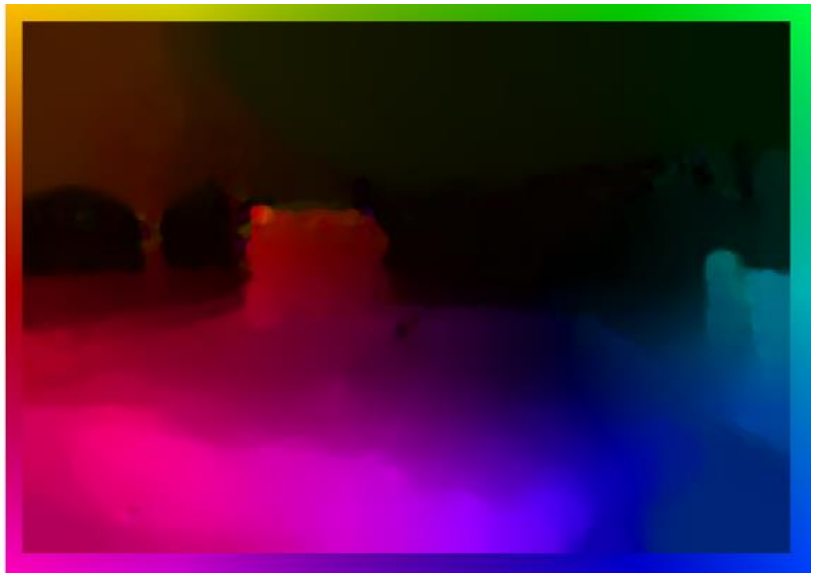
aka Colour maps
aka Colour palettes





- Can we use all 3 colour dimensions?
- Not a good idea in practice ☹

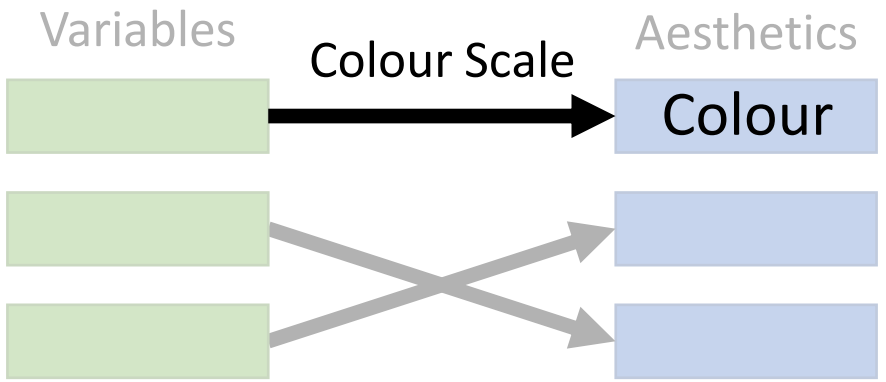
An Exception - Optical Flow Fields

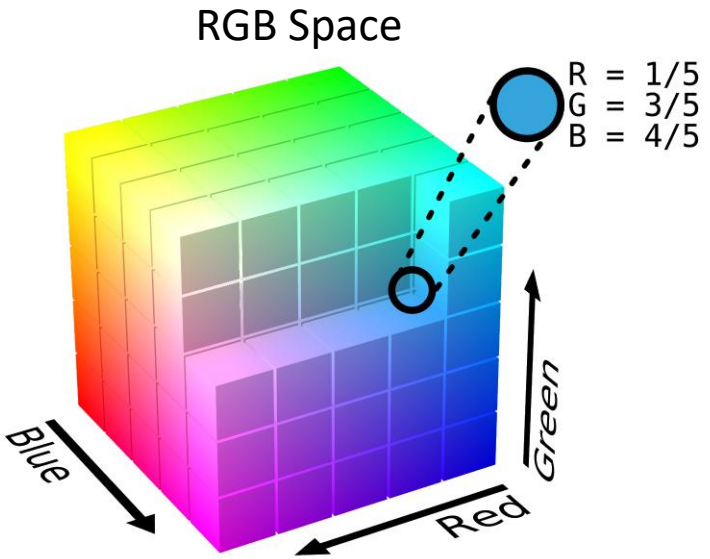


http://www.jarnoralli.fi

Colour Scales

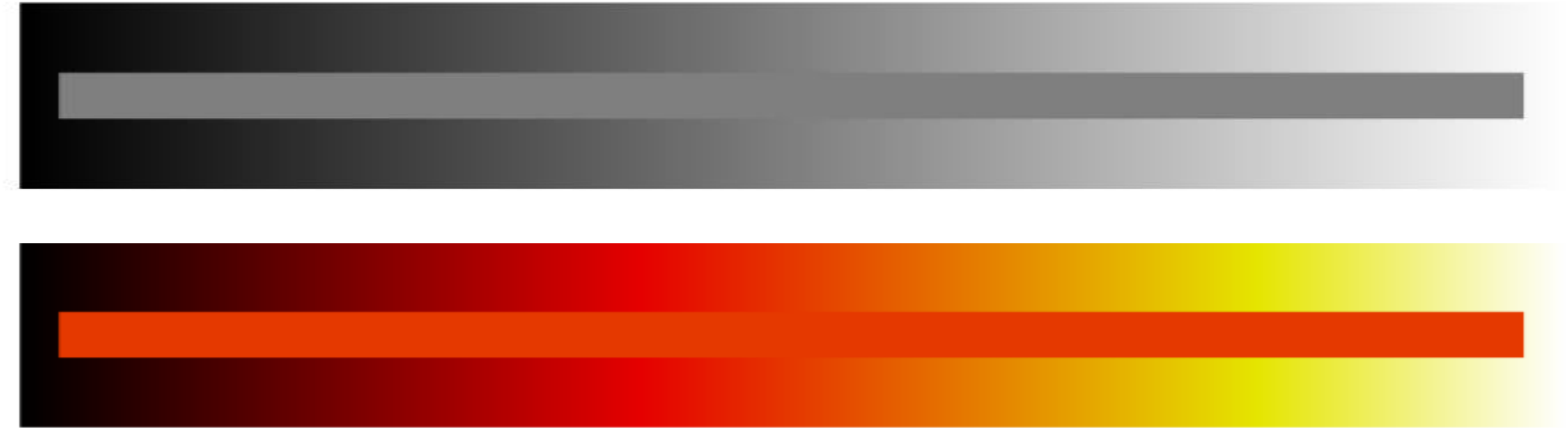
aka Colour maps
aka Colour palettes





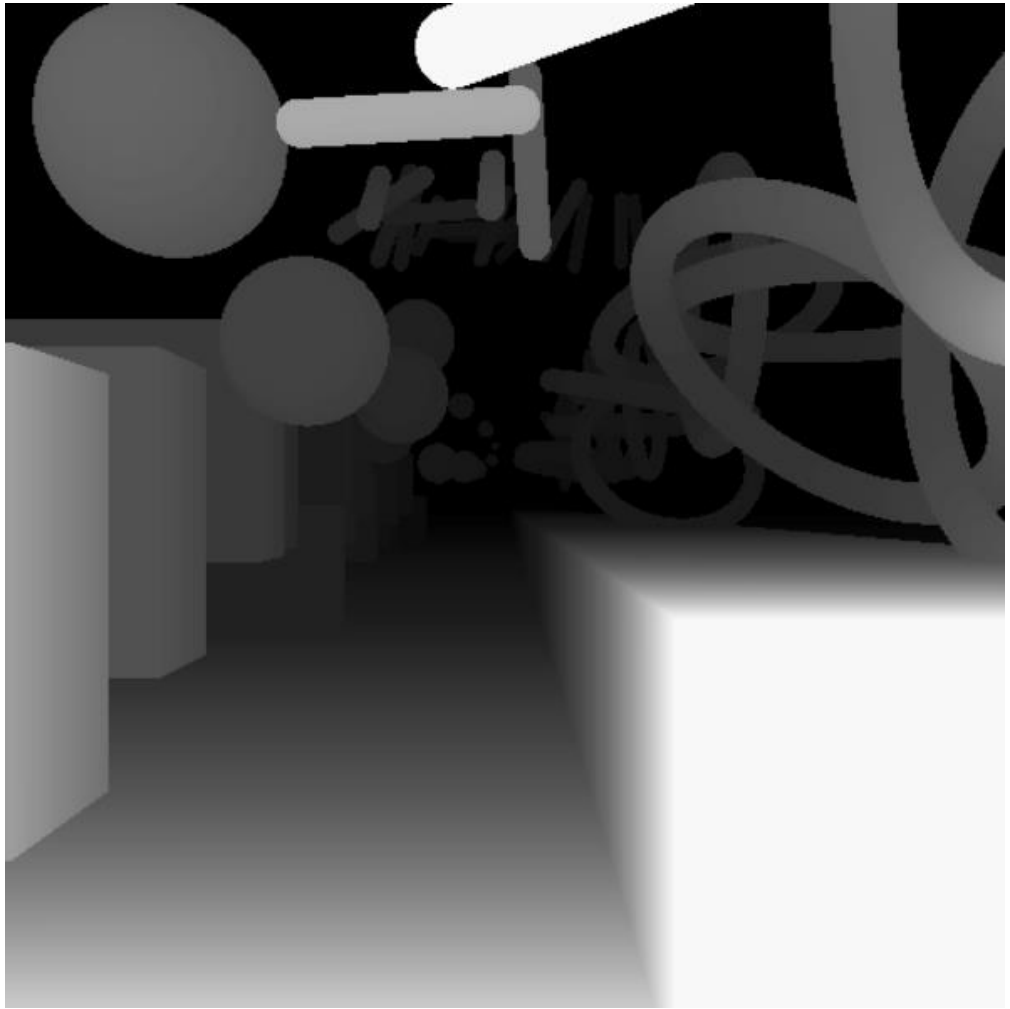
- Usually Colour is single aesthetic.
- Colour scale maps 1 variable to 3D colour.

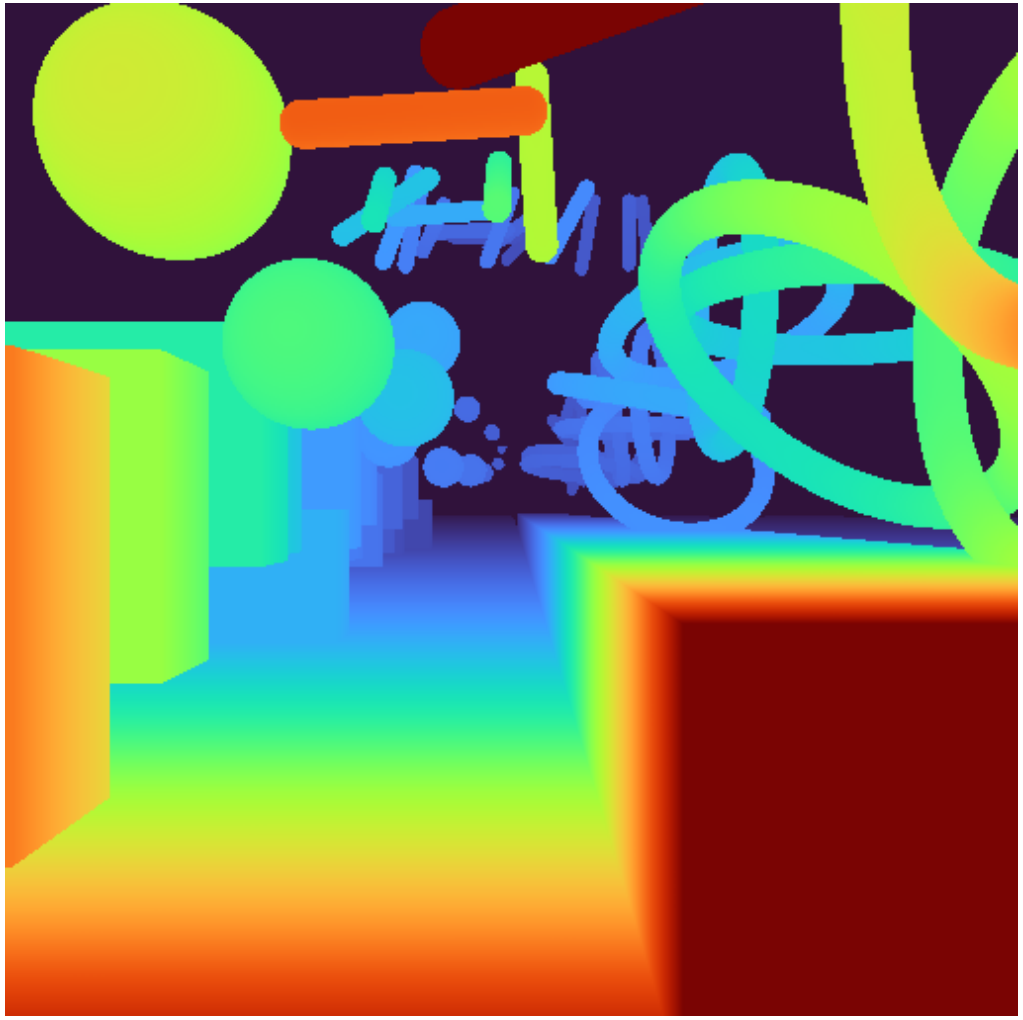
What’s wrong with grey?



Kenneth Moreland (2009)

What’s wrong with grey? – Dynamic Range

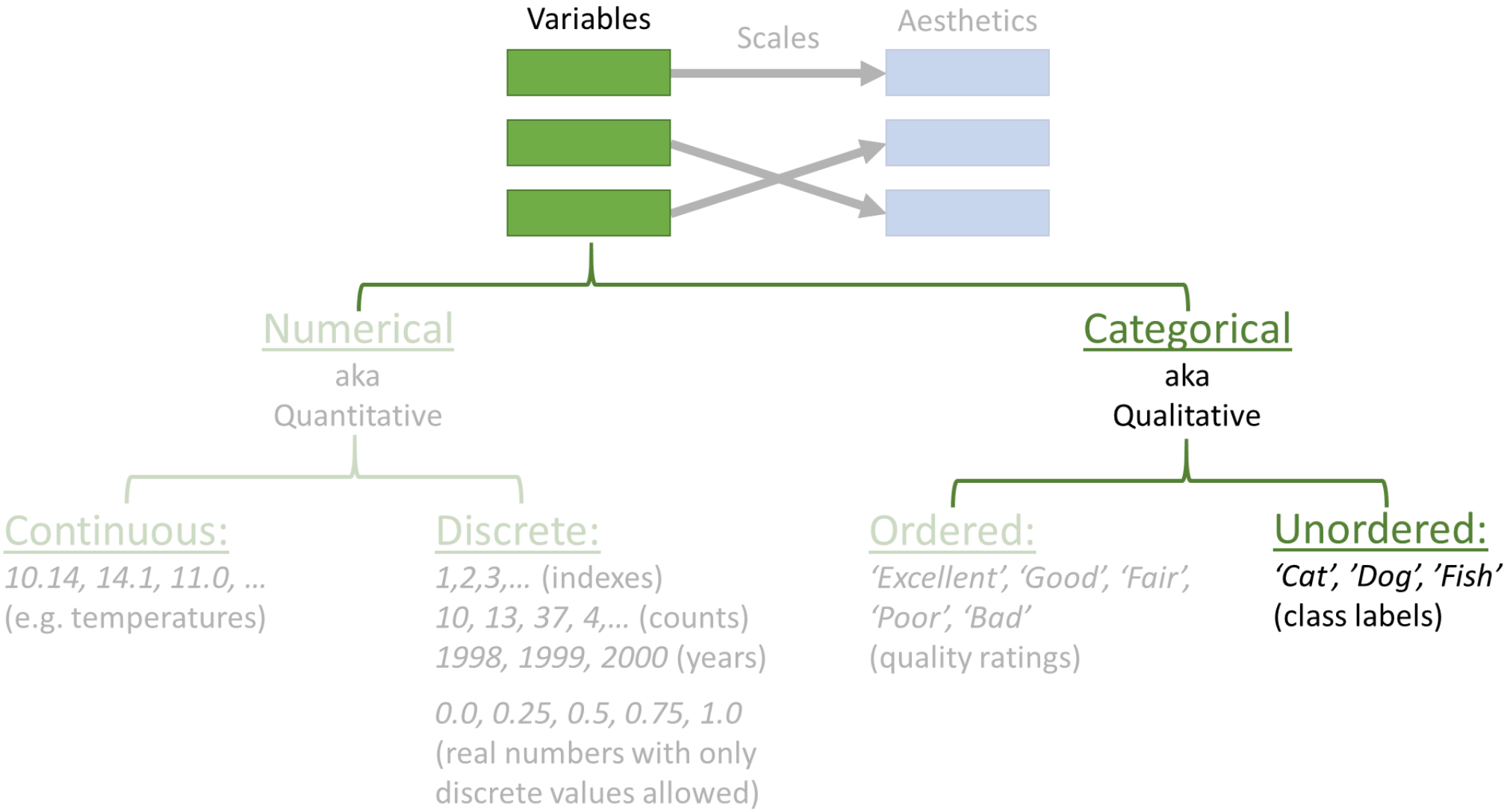




Anton Mikhailov (2019) Google AI blog

Colour Scales for Unordered Variables

aka *Categorical* Colour Scales



Colour Scales for Unordered Variables

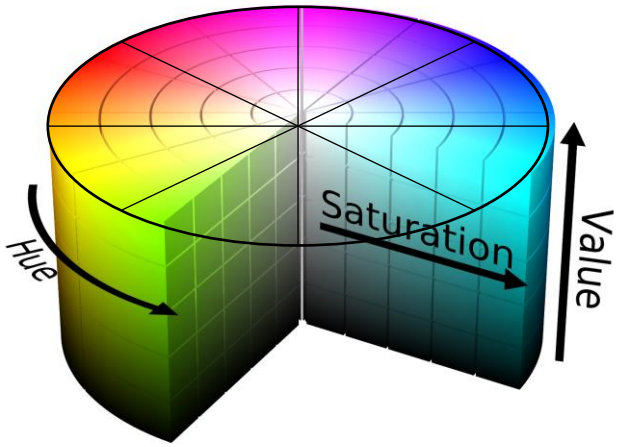
Goals:

- Easily distinguishable
- Should not imply order
- None should stick out

tab10 (seaborn)

Set2 (colorbrewer)

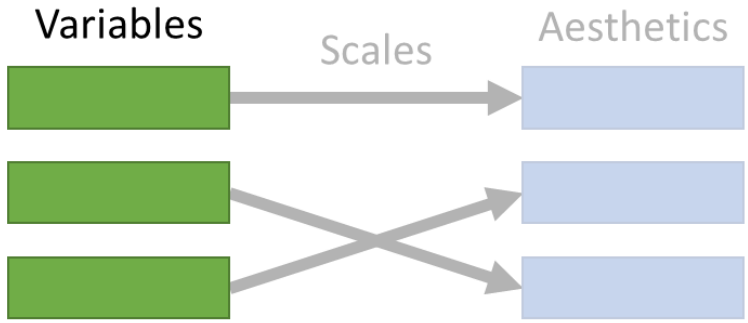
HSV Space



- Fix saturation and value
- Subdivide hue

Colour Scales for Ordered Variables

aka *Sequential* Colour Scales



Numerical
aka
Quantitative

Continuous:
10.14, 14.1, 11.0, …
(e.g. temperatures)

Discrete:
1,2,3,… (indexes)
10, 13, 37, 4,… (counts)
1998, 1999, 2000 (years)

0.0, 0.25, 0.5, 0.75, 1.0
(real numbers with only discrete values allowed)

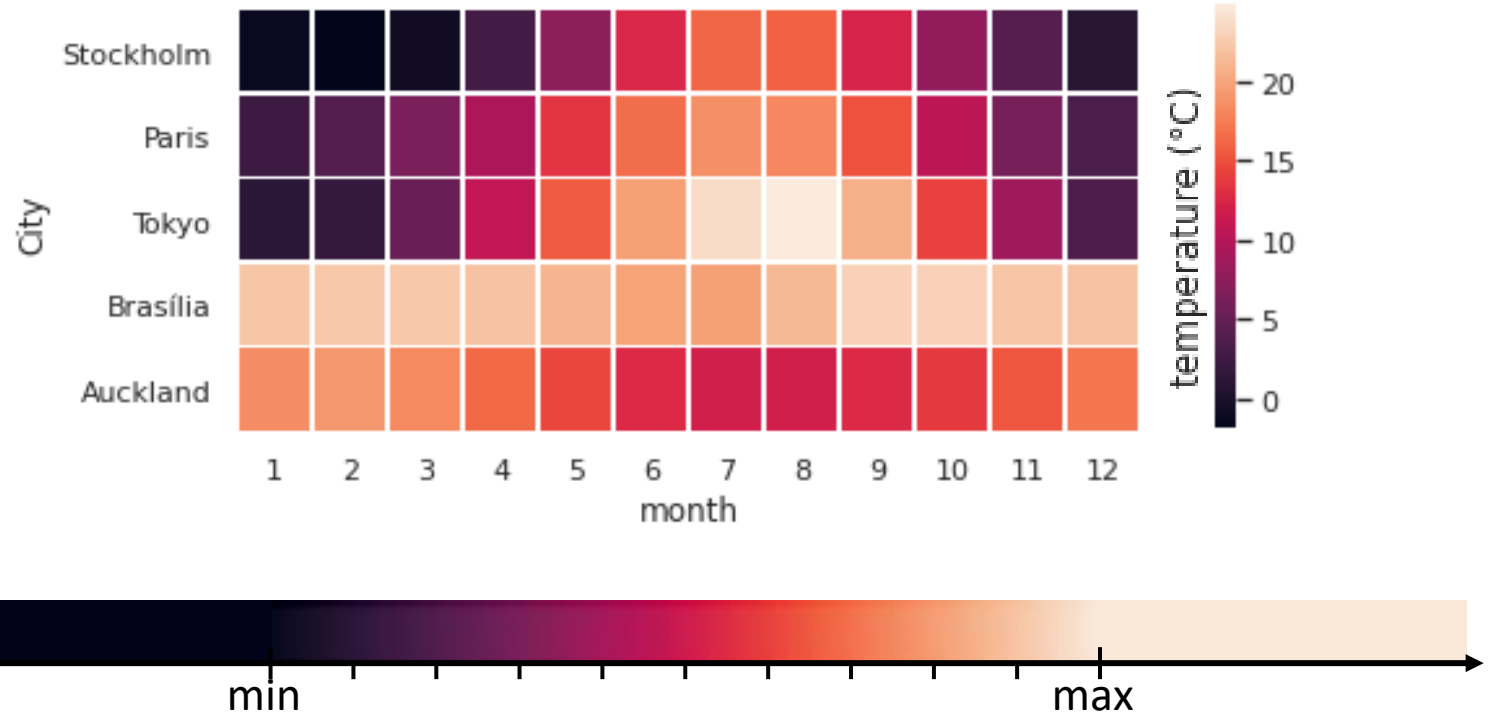
Categorical
aka
Qualitative

Ordered:
'Excellent', 'Good', 'Fair', 'Poor', 'Bad'
(quality ratings)

Unordered:
'Cat', 'Dog', 'Fish'
(class labels)

Colour Scales for Ordered Variables

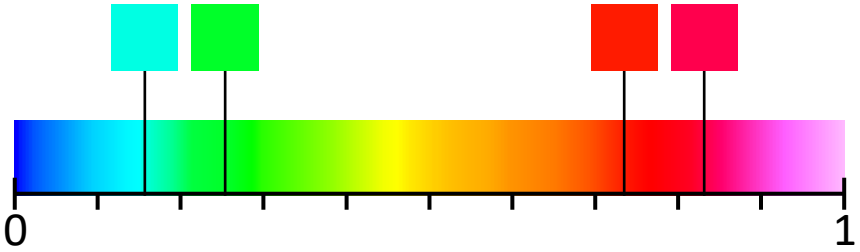
aka *Sequential* Colour Scales



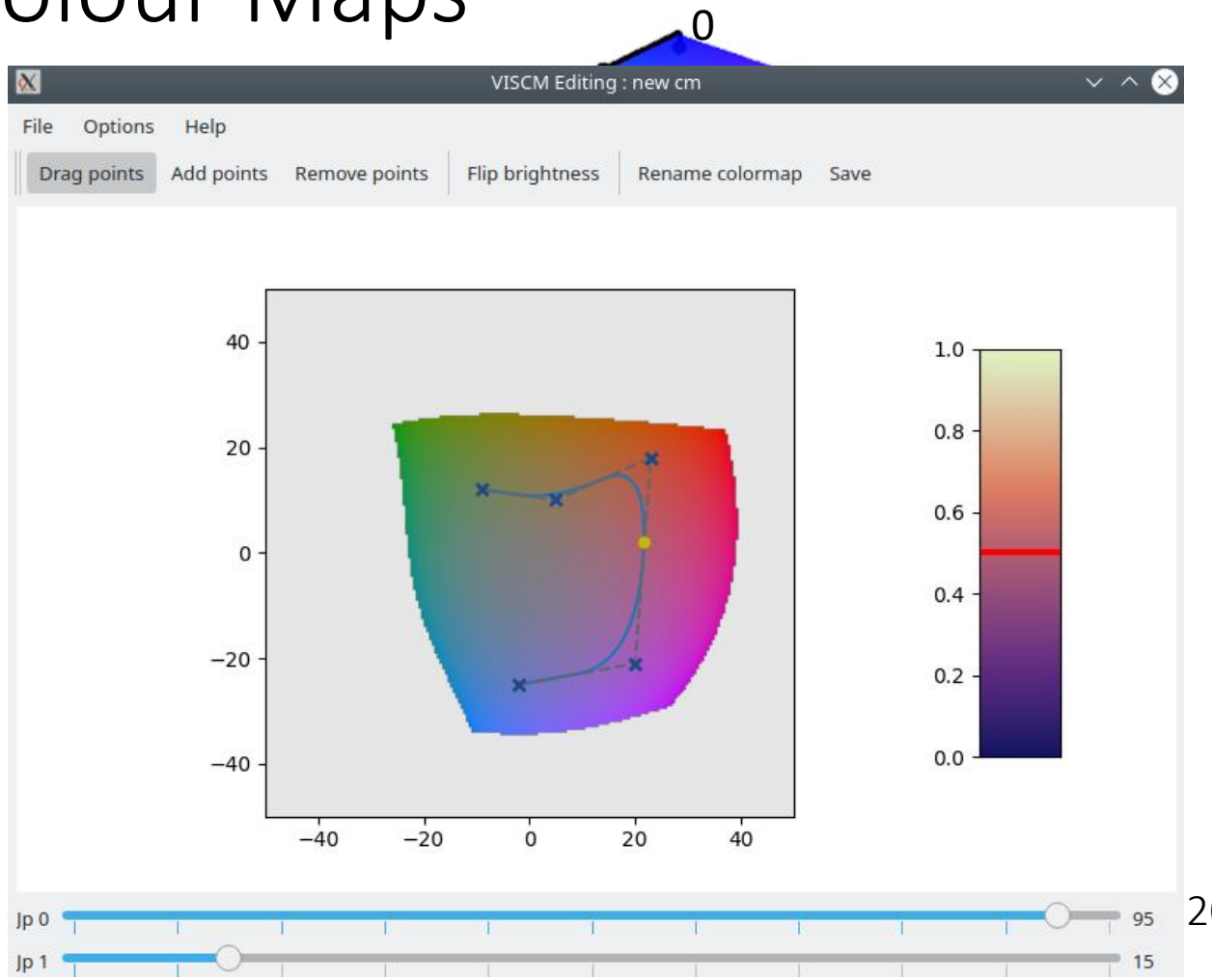
Goals:

- Indicate which of two values is larger.
- Indicate how far apart two values are.

Perceptually Uniform Colour Maps



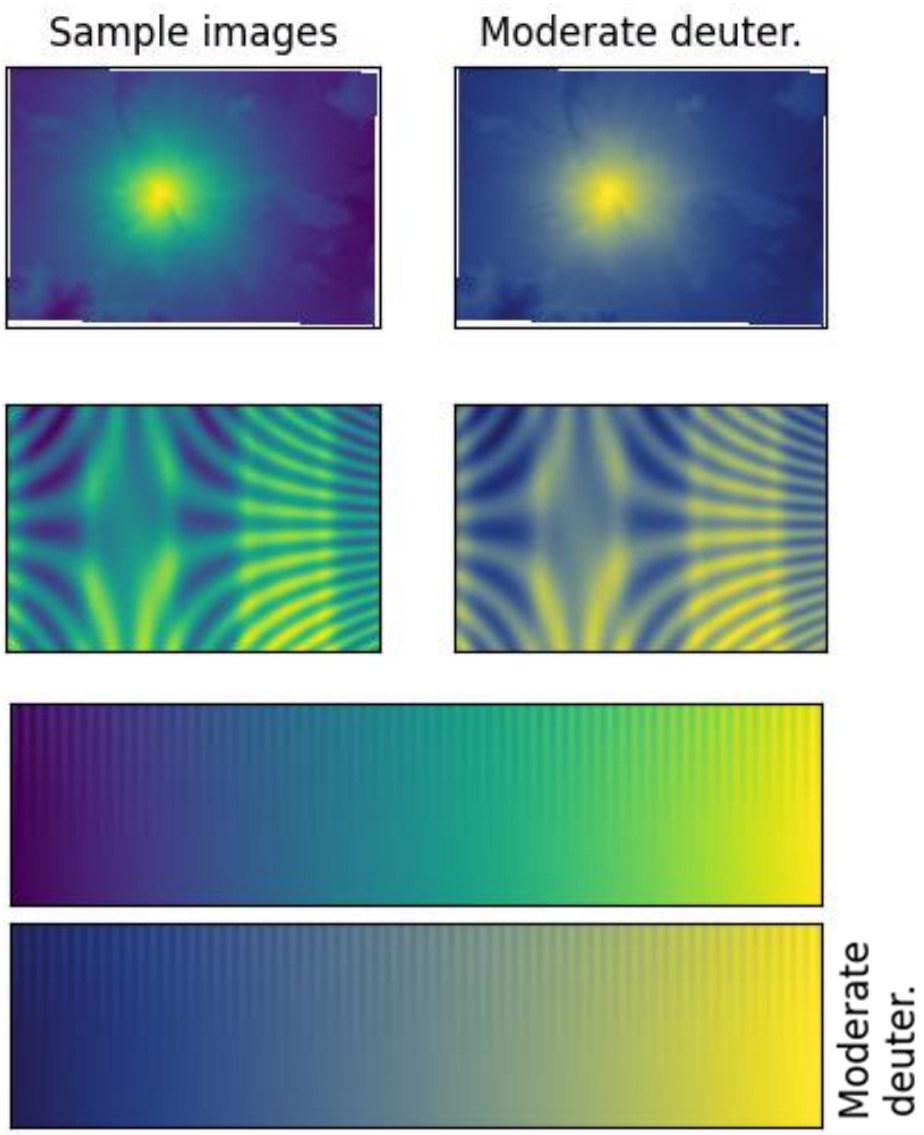
Perceptually uniform, colour-blind-friendly, grayscale compatible



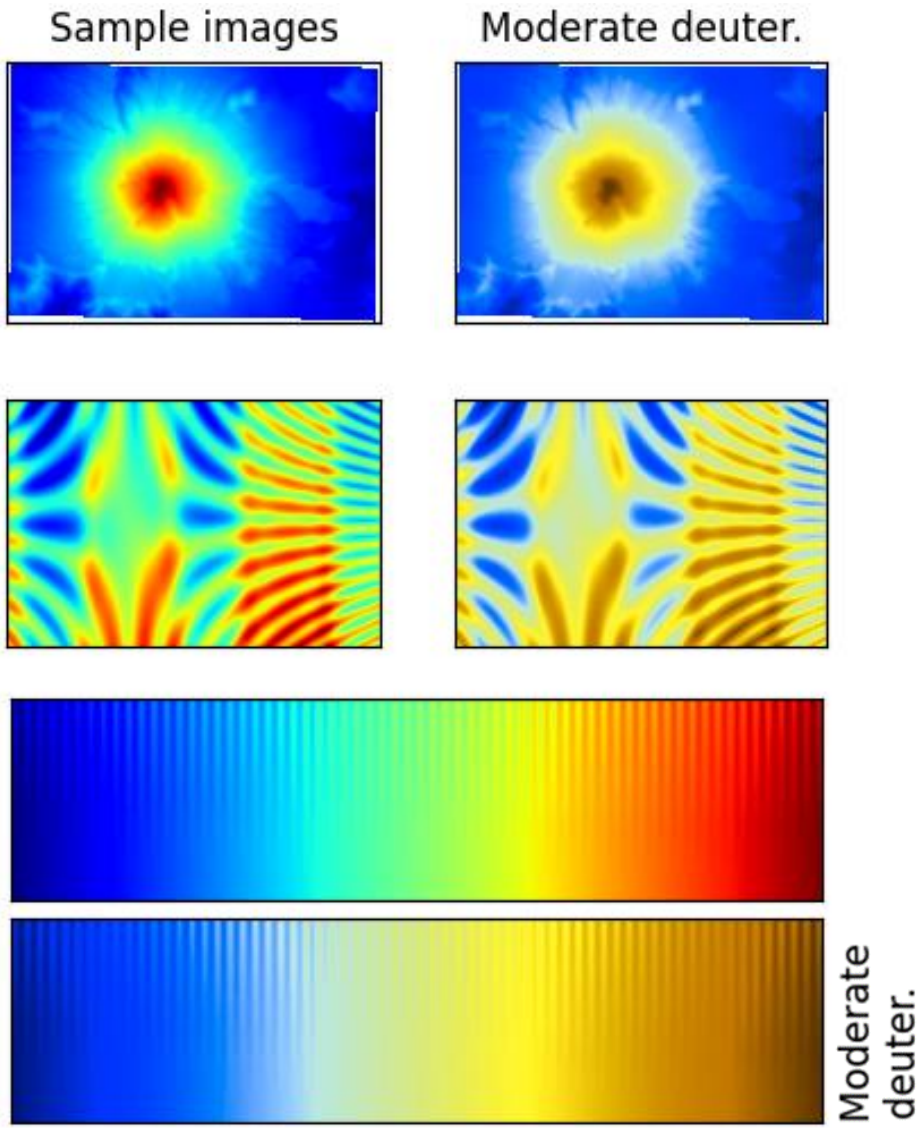
2015)

Stéfan van der Walt and Nathaniel Smith

Not quite perceptually uniform

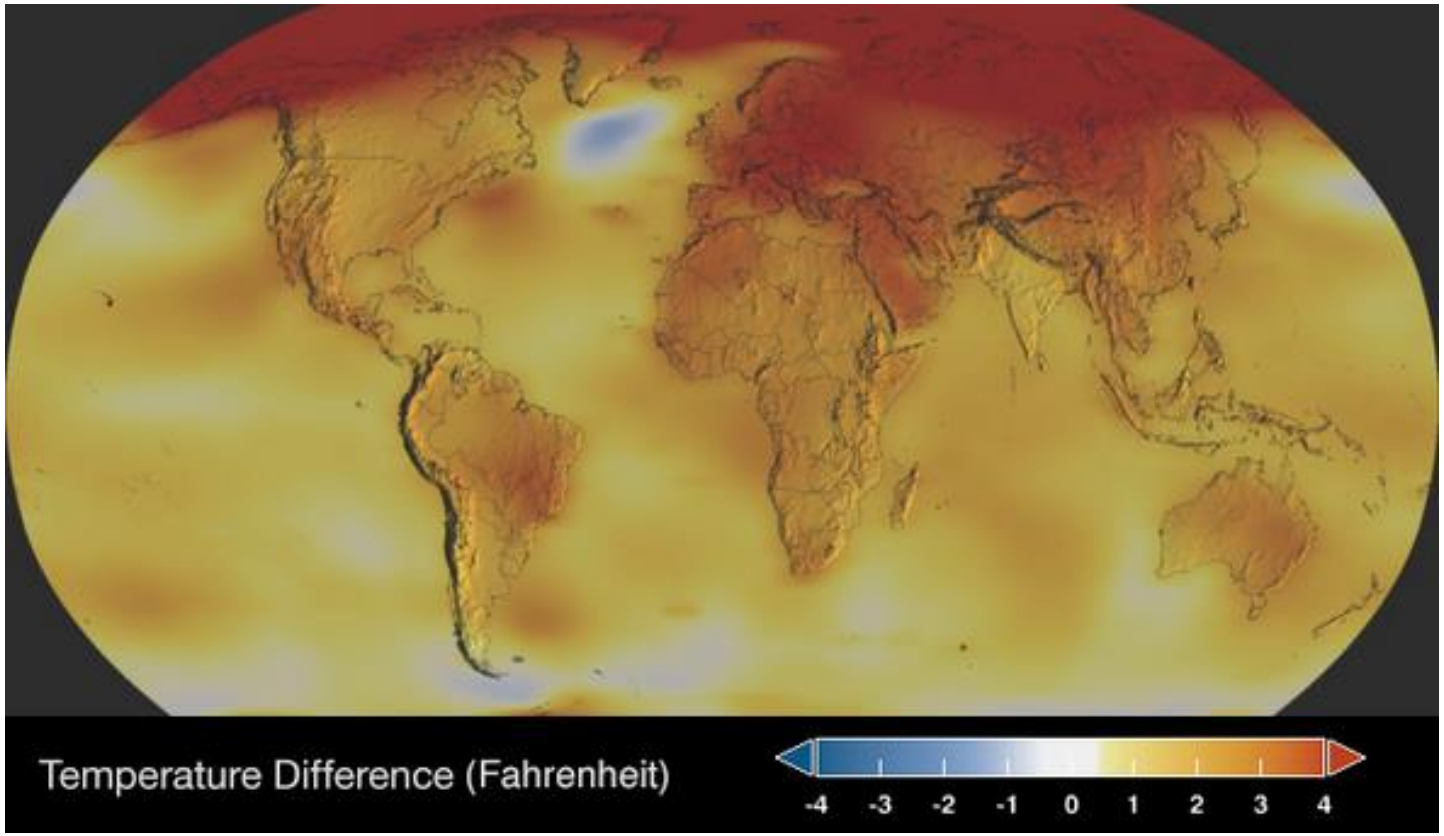

Sample images
Moderate deuter.
Moderate deuter.

Viridis


Sample images
Moderate deuter.
Moderate deuter.

Jet

Diverging Colour Scales



climate.nasa.gov/vital-signs/global-temperature/

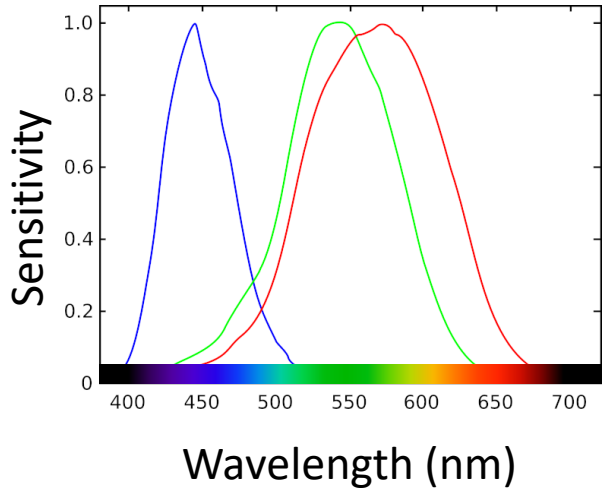
Perceptually uniform

Vlag

Icefire

Take Home Messages

- We are (mostly) trichromats.
  - Light spectra are high dimensional.
  - Our colour perception is 3D.



- Choose your scales carefully. Keep in mind:
  - Ordered versus unordered
  - Perceptual uniformity
  - Colour-blind-friendliness