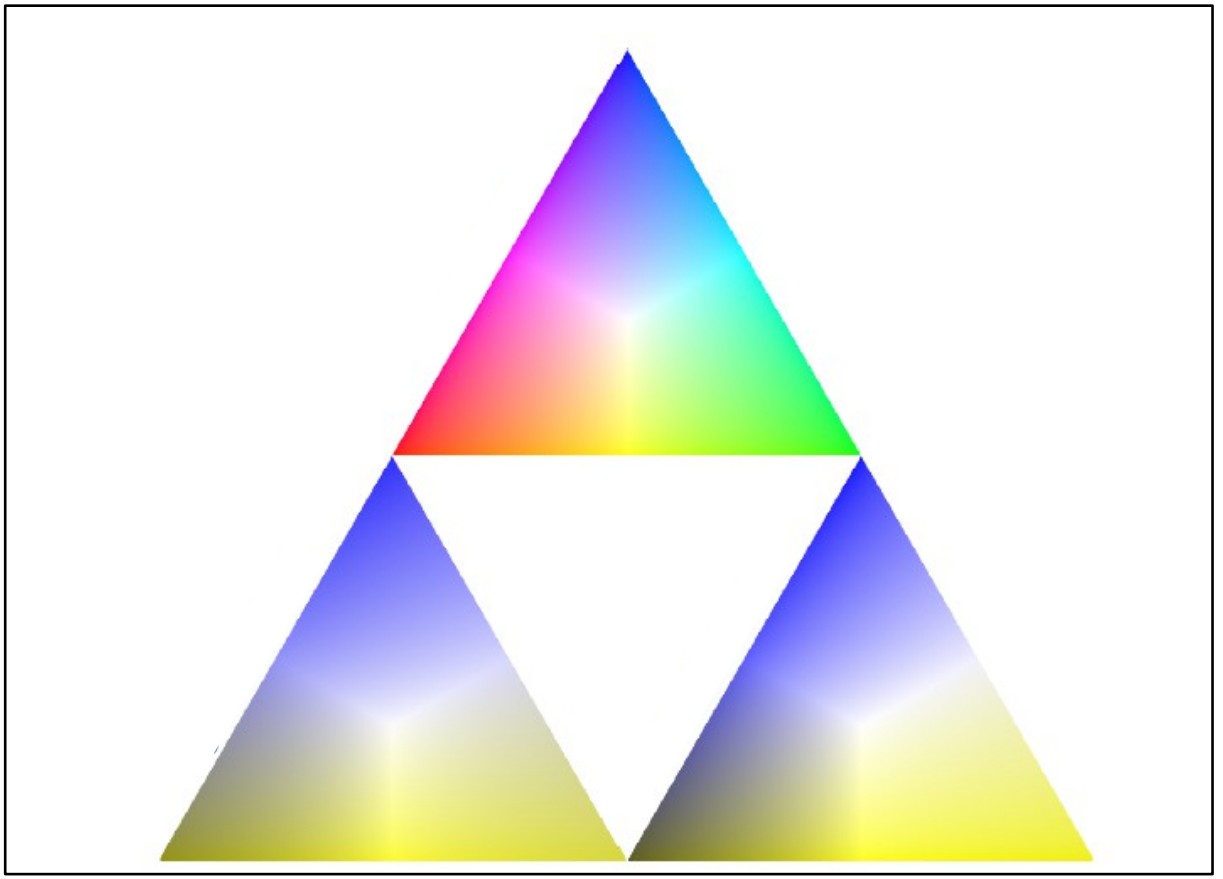
Colors



Cristóbal Sifón

Introduction

Good color combinations:

1) Do not hurt your eyes
2) Display properly in black & white
3) Display clearly in projectors and not-too-dark rooms
4) Are color-blind friendly

Additionally, good colormaps:

5) Have color and brightness variations that reflect changes in the data faithfully

Some eye-hurting

Is this text difficult to read?

The red and gray have the same luminance value. This color combination creates a **chromosteropsis** effect.

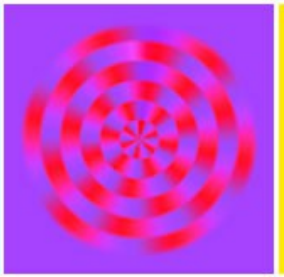
Green can be problematic as well.

Blue and red are a poor choice...

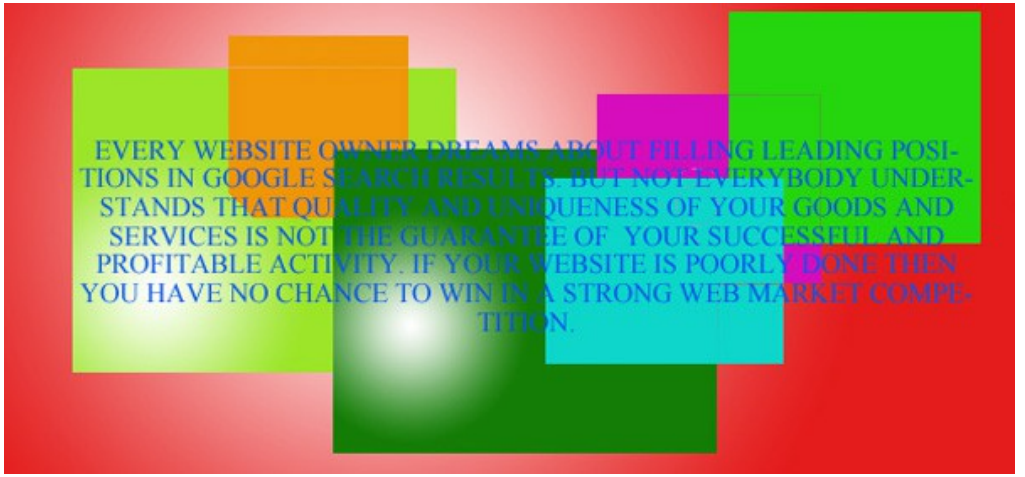
Especially red on blue.

1. Red on Blue
1. Red on Green
1. Blue on Green
1. Yellow on White

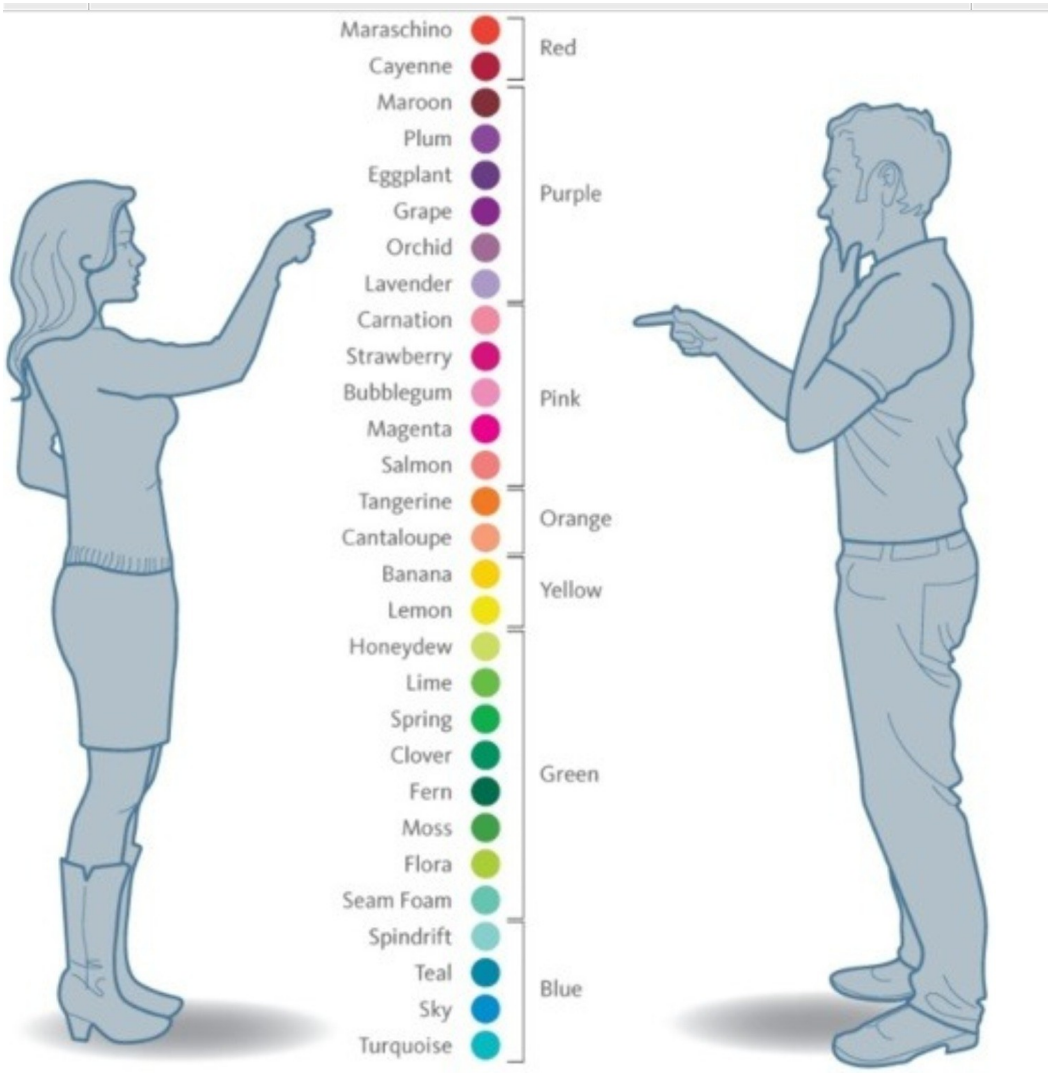
OWWWW!! MY EYES!!



Bright, yes. But not painful.

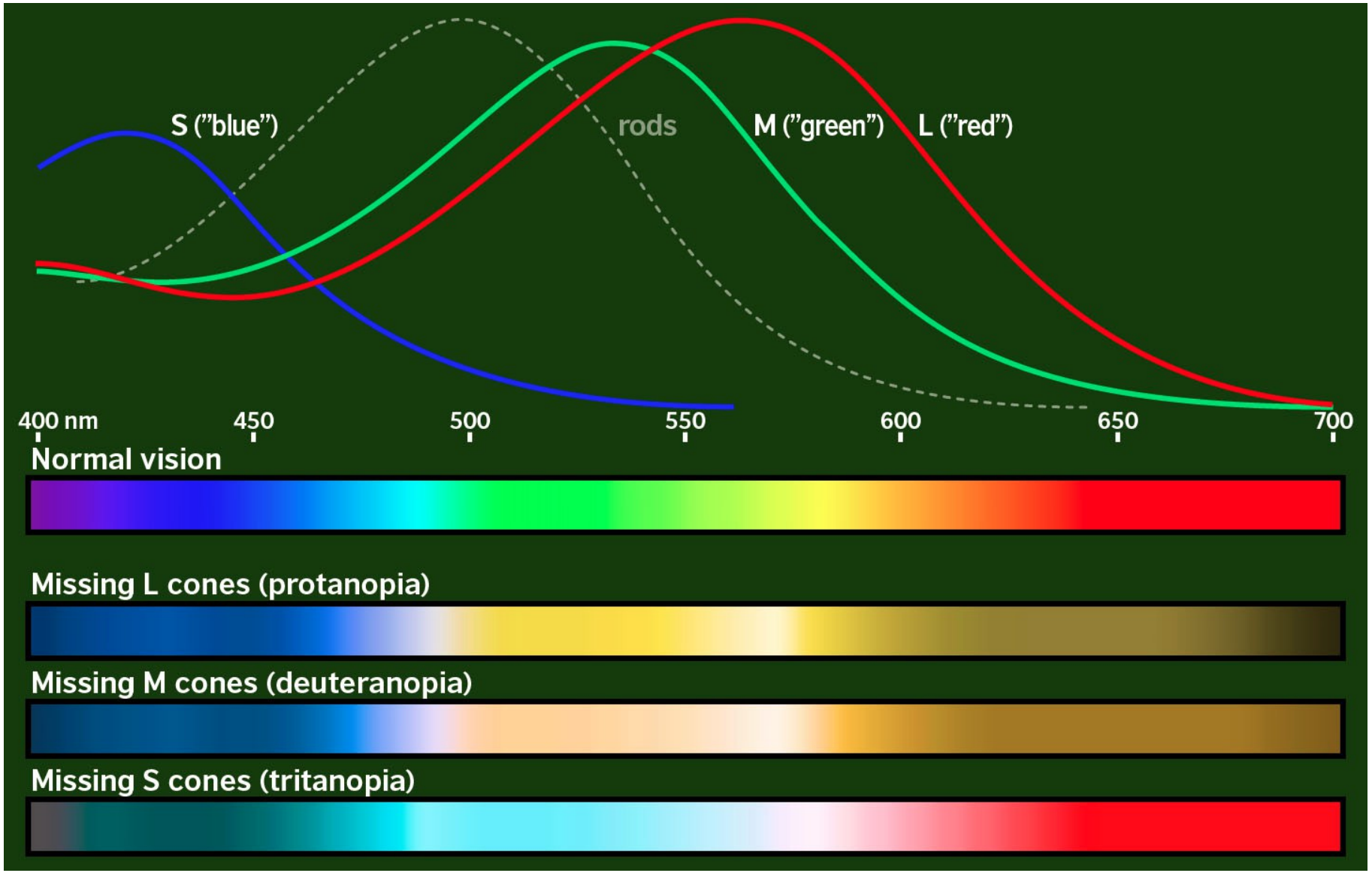


Hue



How similar a color is to red, green, blue and yellow

Color blindness



Color blindness

Prevalence of color blindness[*clarification needed*][51]

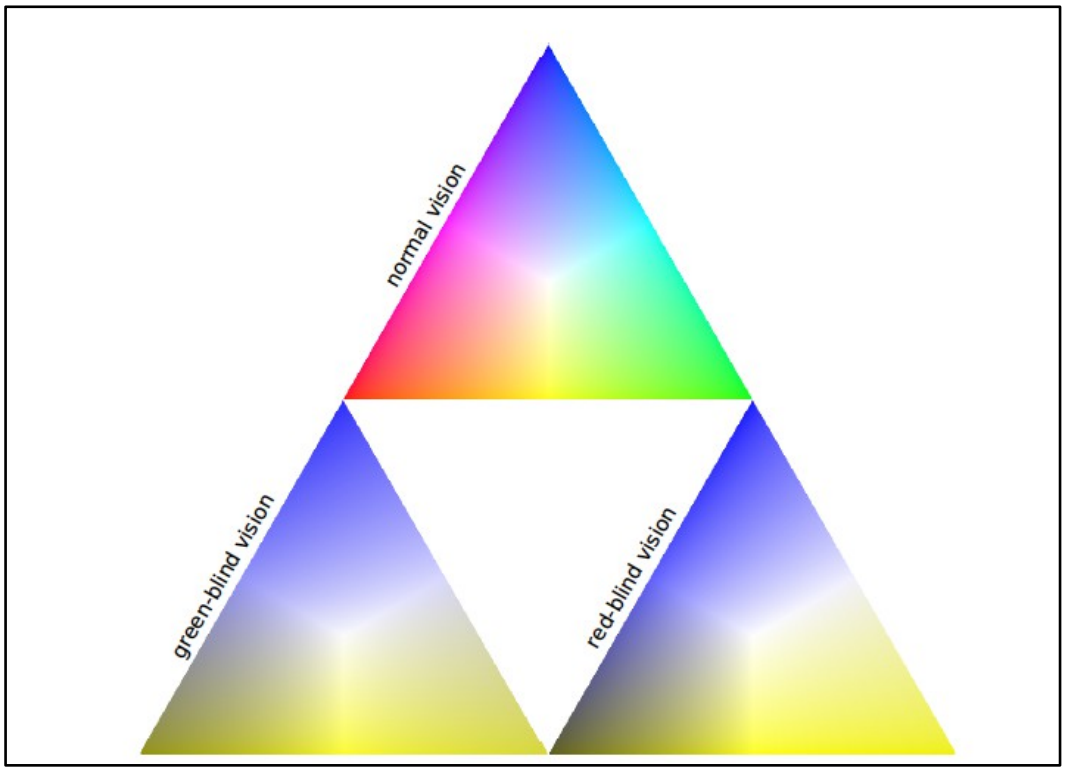
	Males	Females
Dichromacy	2.4%	0.03%
Protanopia (red deficient: L cone absent)	1.3%	0.02%
Deuteranopia (green deficient: M cone absent)	1.2%	0.01%
Tritanopia (blue deficient: S cone absent)	0.001%	0.03%
Anomalous Trichromacy	6.3%	0.37%
Protanomaly (red deficient: L cone defect)	1.3%	0.02%
Deuteranomaly (green deficient: M cone defect)	5.0%	0.35%
Tritanomaly (blue deficient: S cone defect)	0.0001%	0.0001%

Color blindness

Combinations to avoid:

- Red + green
- Red + grey
- Green + yellow
- Blue + purple

Try Color Oracle,
http://colororacle.org/



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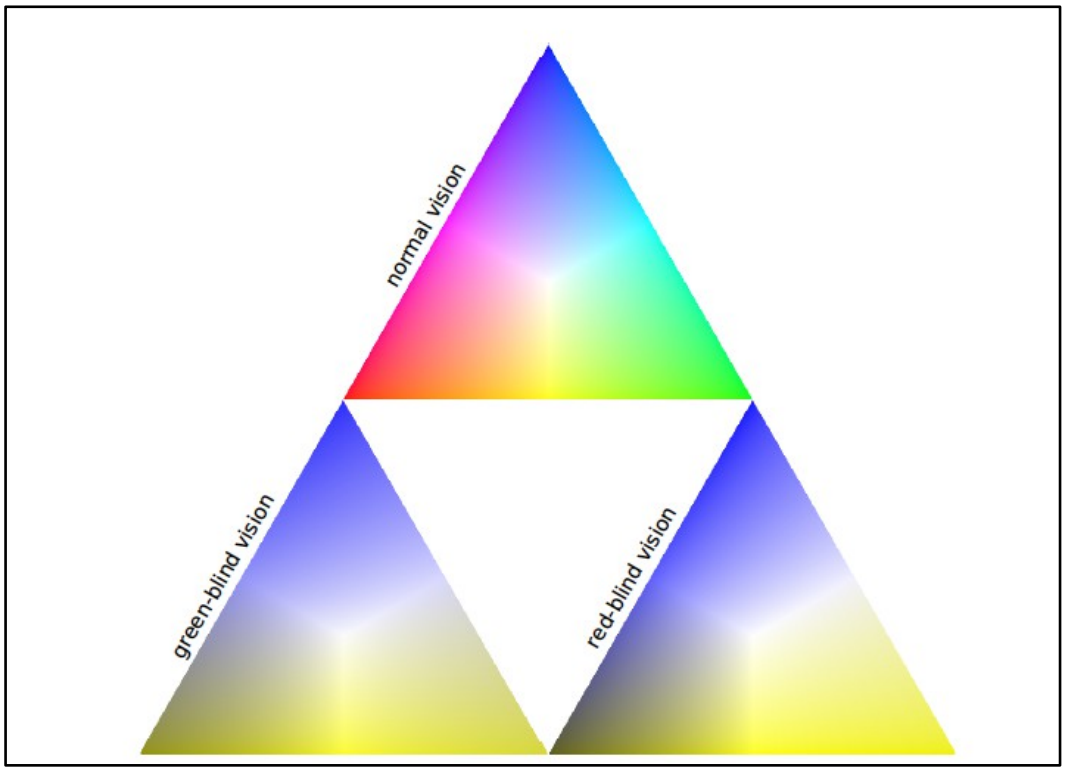
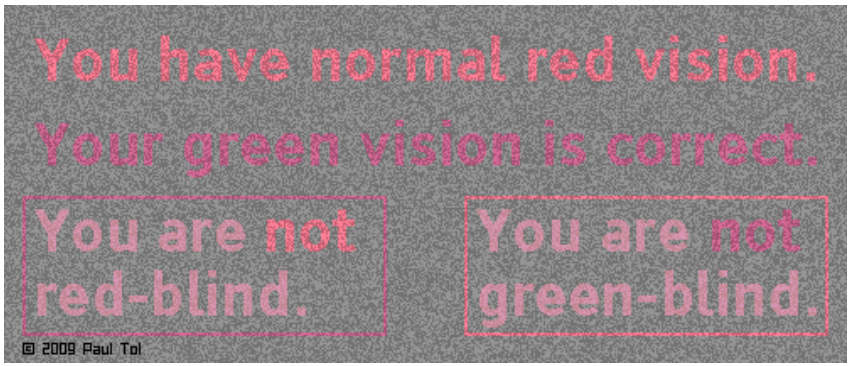
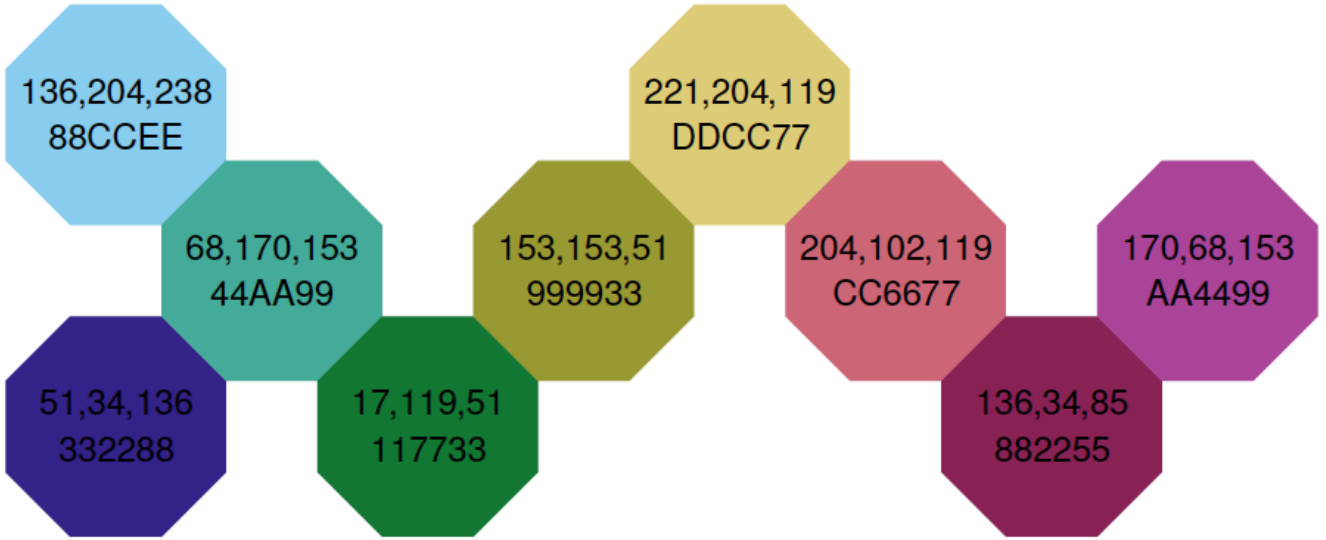
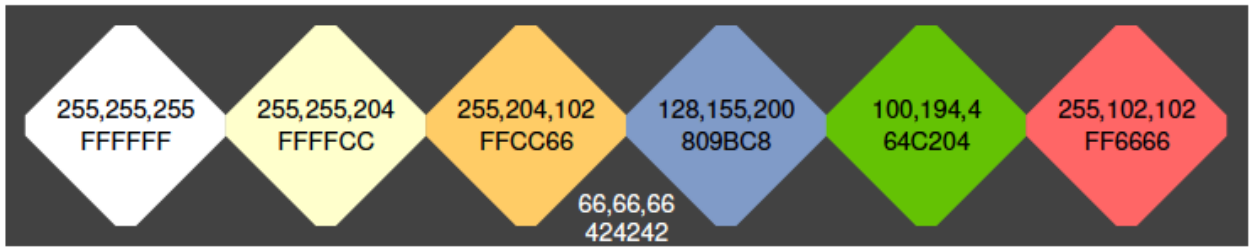




Color blindness: see for yourself

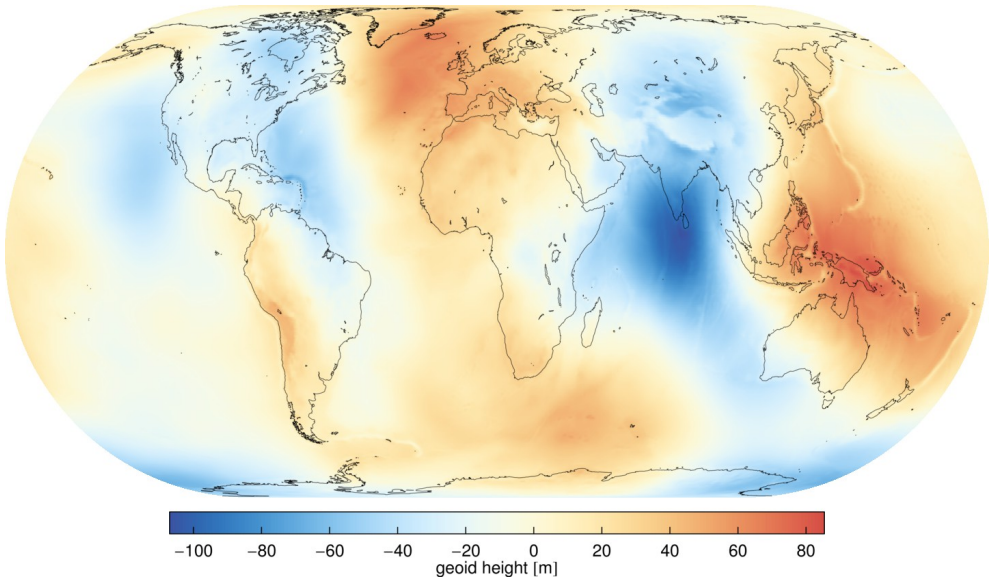
Color blindness: a friendly color scheme

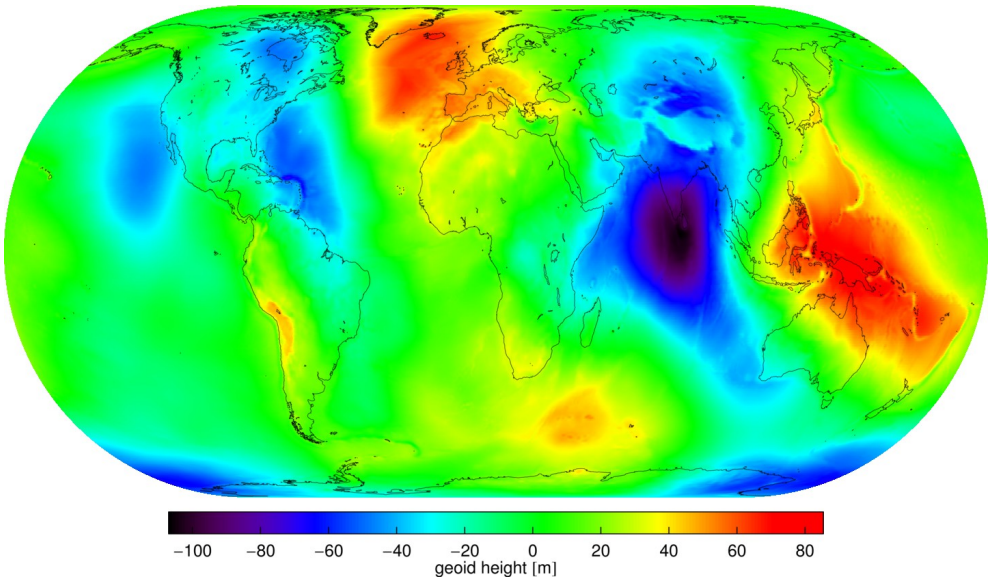




by Paul Tol (SRON)

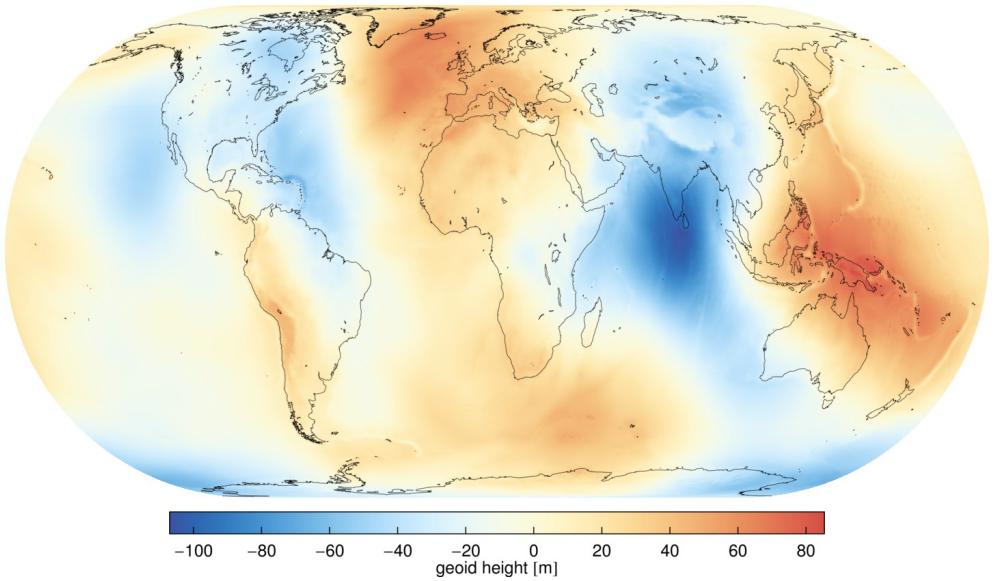
Colormaps

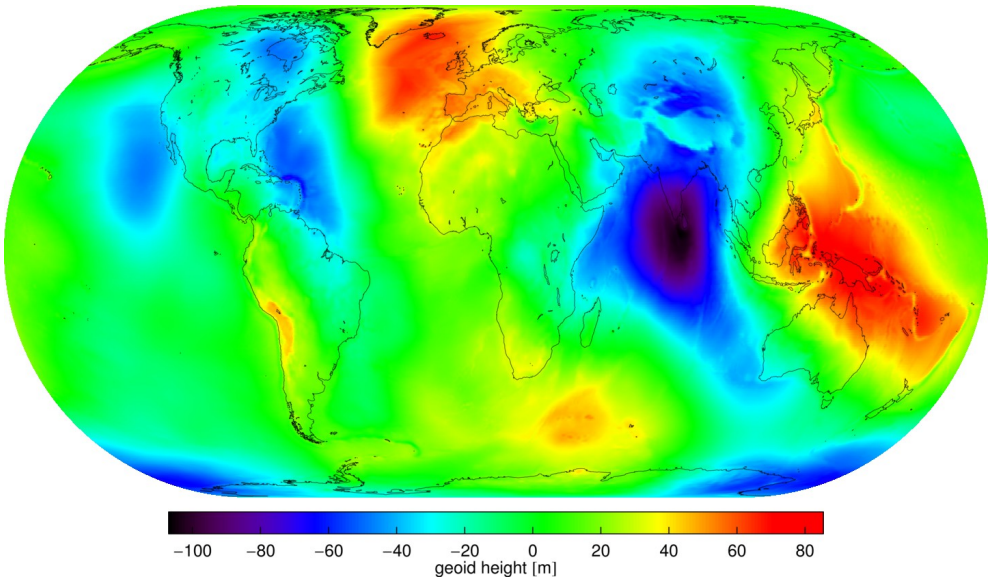




Most rainbow schemes contain bands of almost constant hue with sharp transitions in-between, which are perceived as jumps in the data.

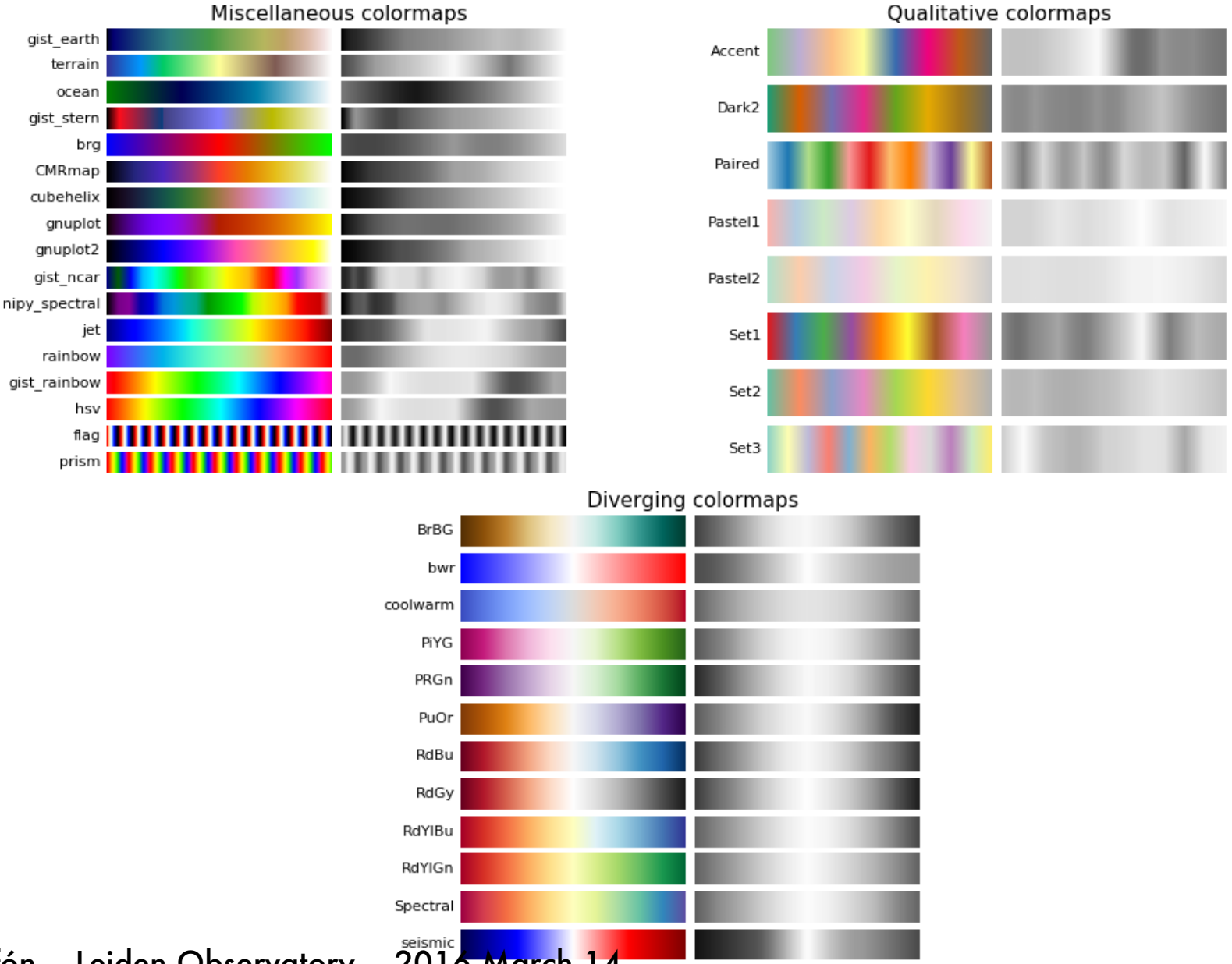
Colormaps



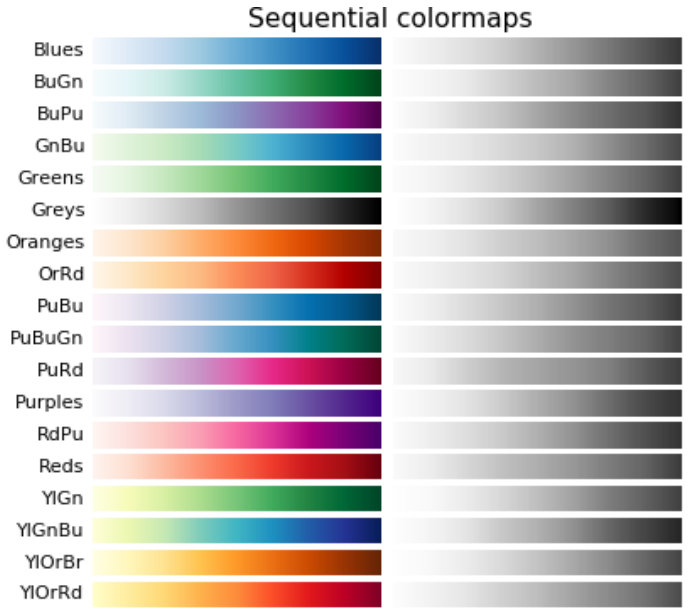


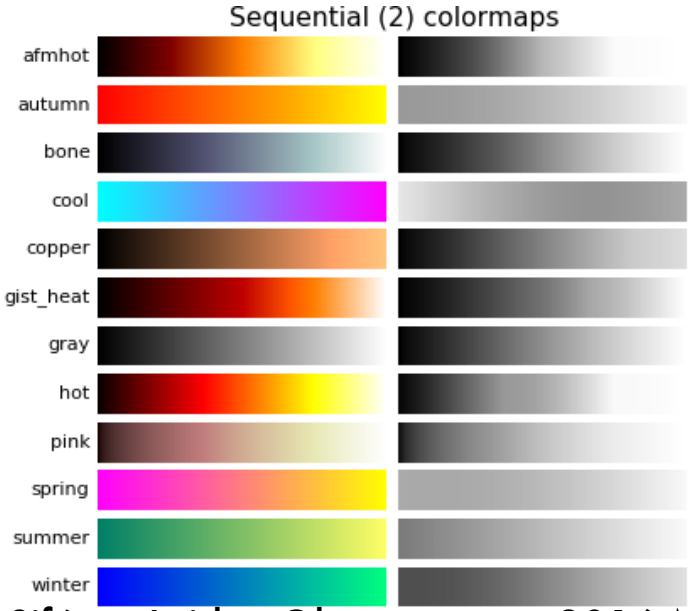
Although different kinds of colormaps may serve different purposes, only sequential colormaps can be properly displayed in B&W

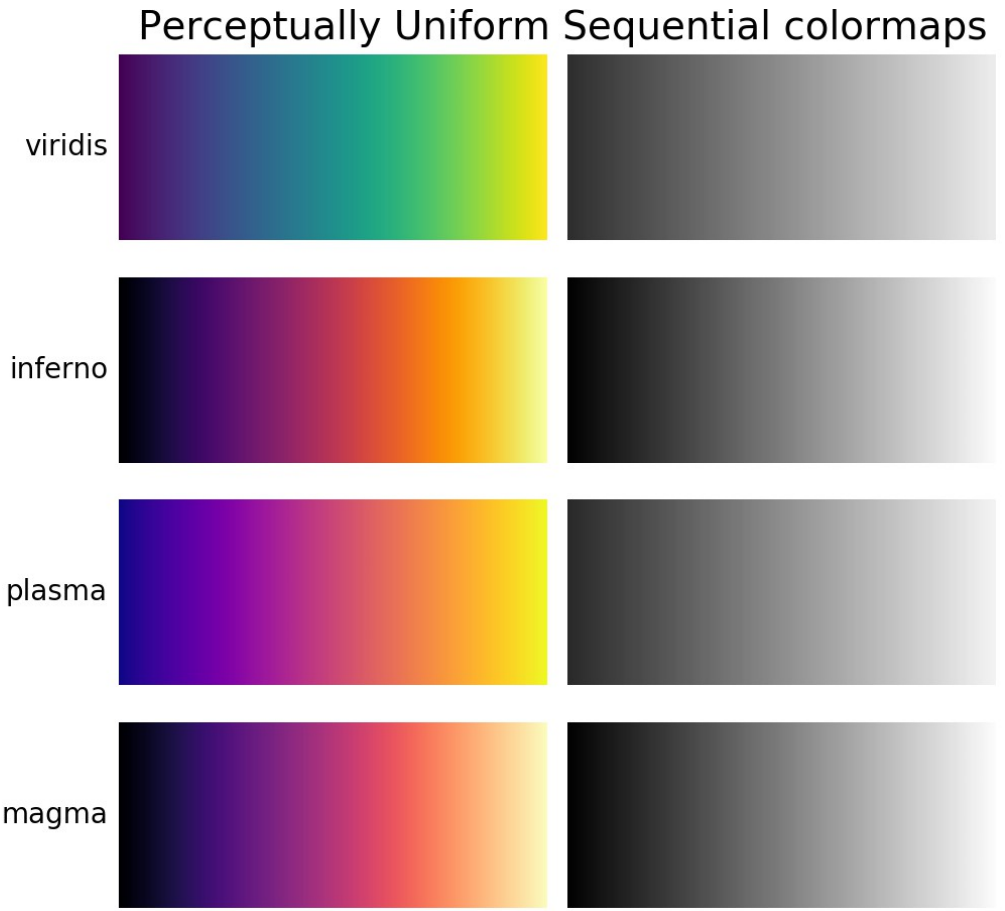
Black & white: bad



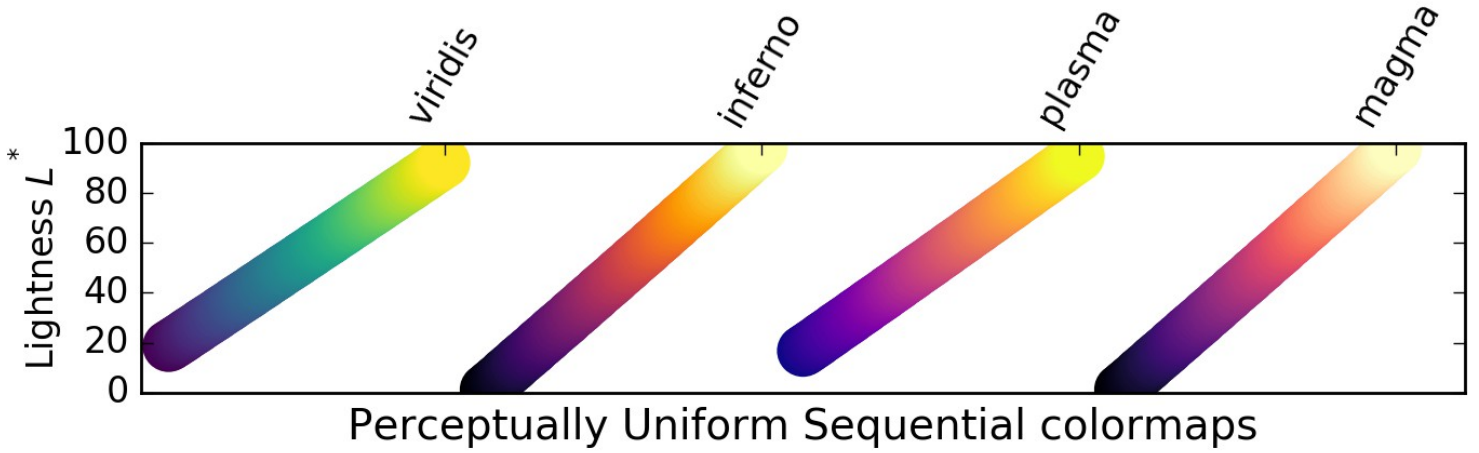
Black & white: good

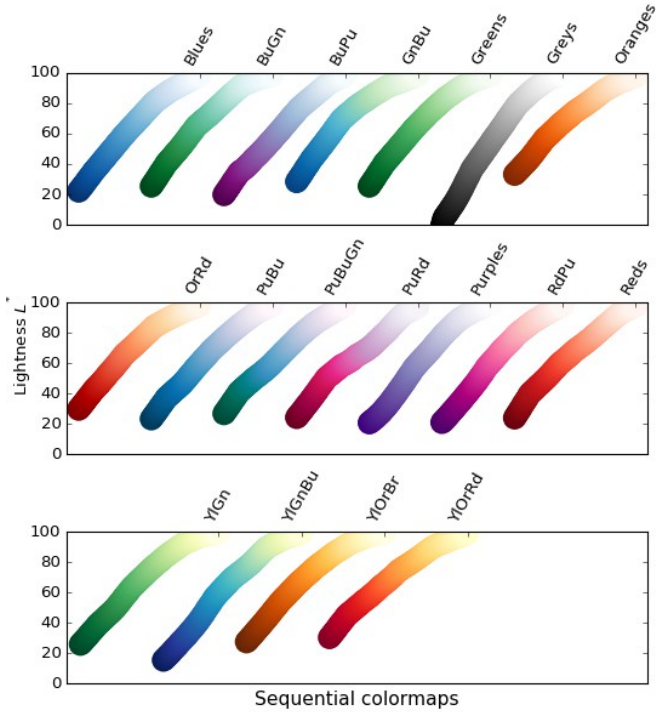


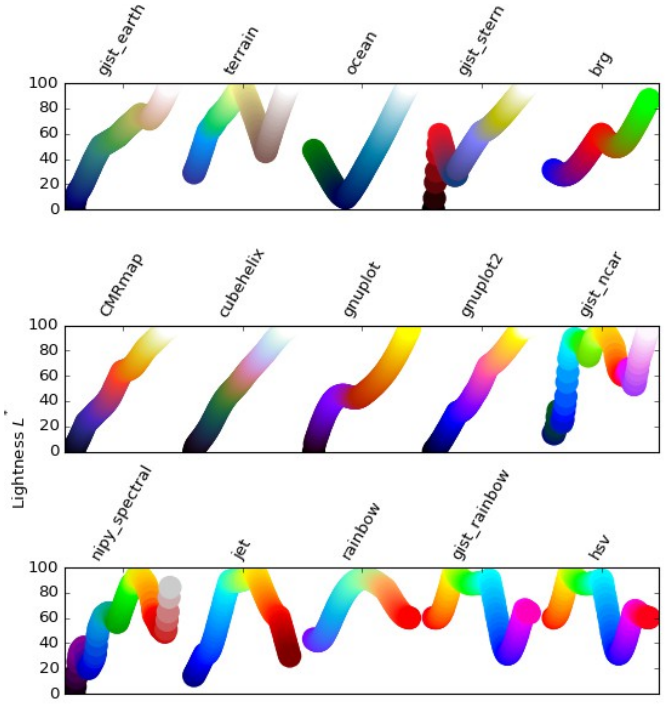




Lightness

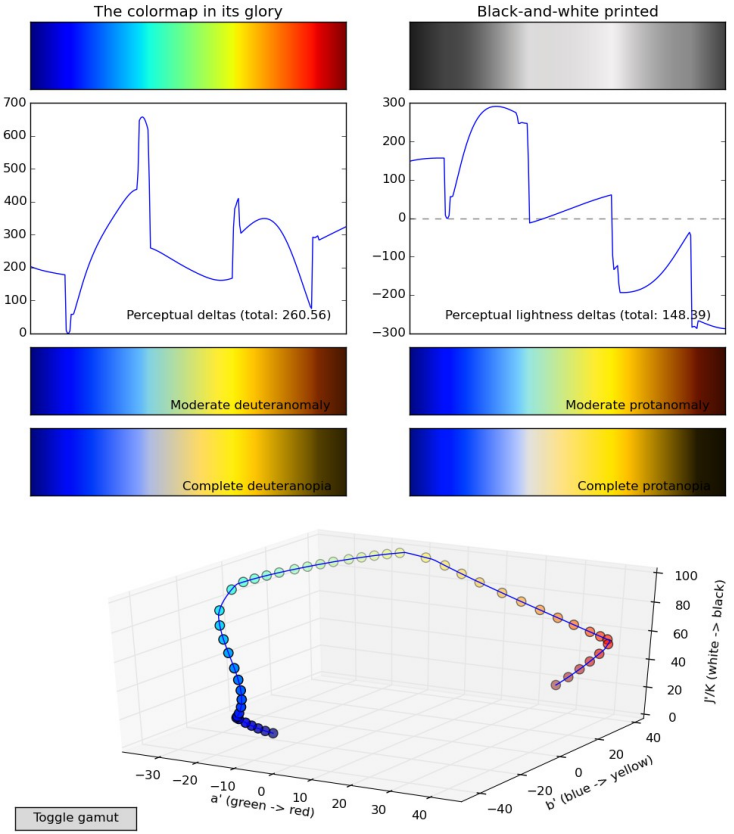

viridis
inferno
plasma
magma
Lightness L^*
100
80
60
40
20
0
Perceptually Uniform Sequential colormaps


Blues
BuGn
BuPu
GnBu
Greens
Greys
Oranges
OrRd
PuBu
PuBuGn
PuRd
Purples
RdPu
Reds
YlGn
YlGnBu
YlOrBr
YlOrRd
Lightness L^*
Sequential colormaps

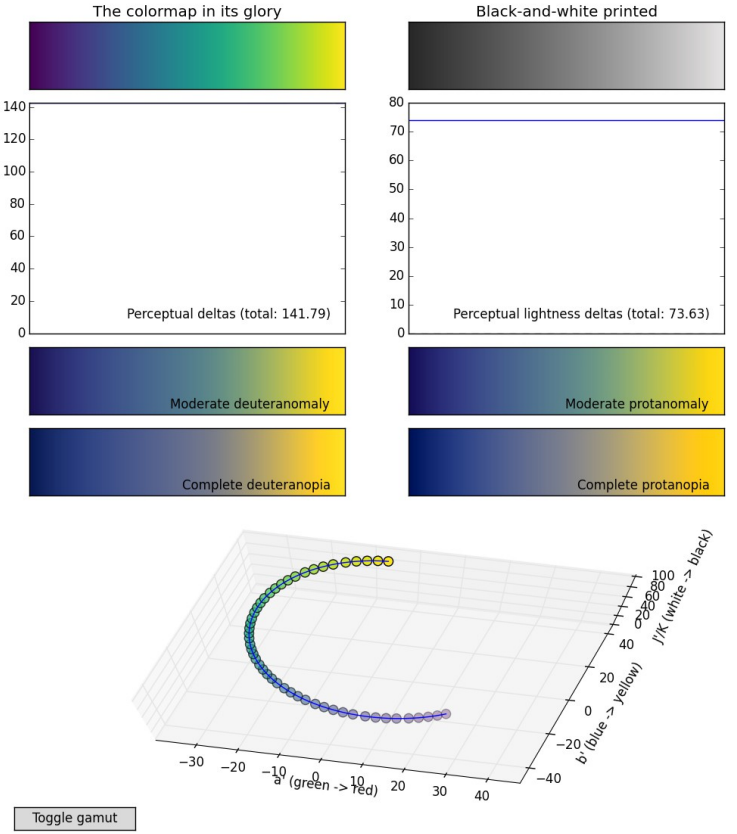

gist_earth
terrain
ocean
gist_stern
brg
CMRmap
cubehelix
gnuplot
gnuplot2
gist_ncar
Lightness L^*
nipy_spectral
jet
rainbow
gist_rainbow
hsv

Colormaps

jet



viridis



Conclusions

0. Do not use jet!
1. We should be careful about what colors we use
2. Choose colors that differ not only in hue ("color"), but also in brightness
3. Try not to mix shades of red and green
4. Use linear colormaps that meet 2) and 3)
5. Good color combinations are just hard to find!

Resources

Matplotlib colormaps, http://matplotlib.org/users/colormaps.html

Matplotlib's new defaults guide, http://bids.github.io/colormap/

Paul Tol's notes, https://personal.sron.nl/~pault/

Color Oracle, http://colororacle.org/

Google!