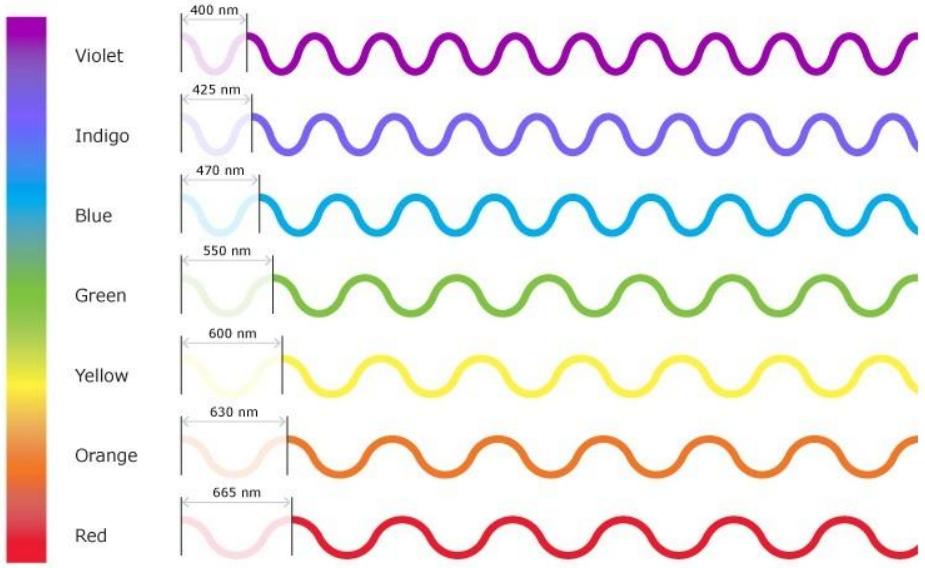
RGB Color Model

Color is a huge topic

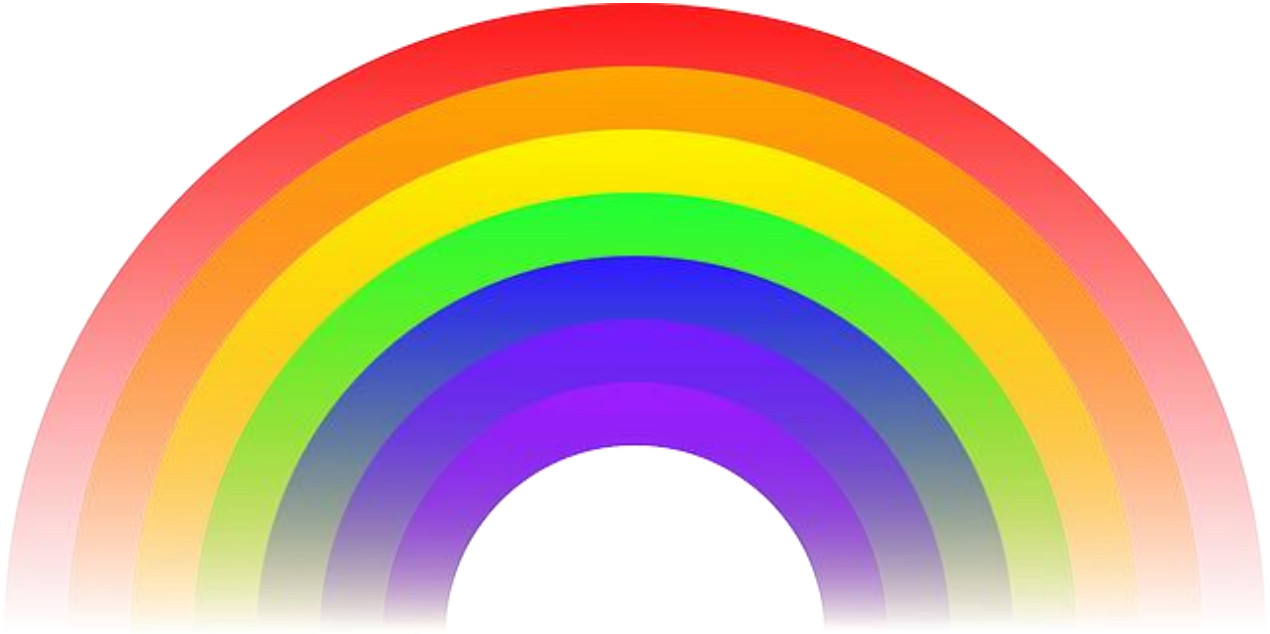
We can talk about color in terms of

- Medicine and eyesight
- Physics and wavelengths
- Design
- Art
- Aesthetics
- … and more



All people see is color

- Everything we see is color between purple and red.
- Depth, outline, movement, shadows – everything is simply different colors.



What do bees see?

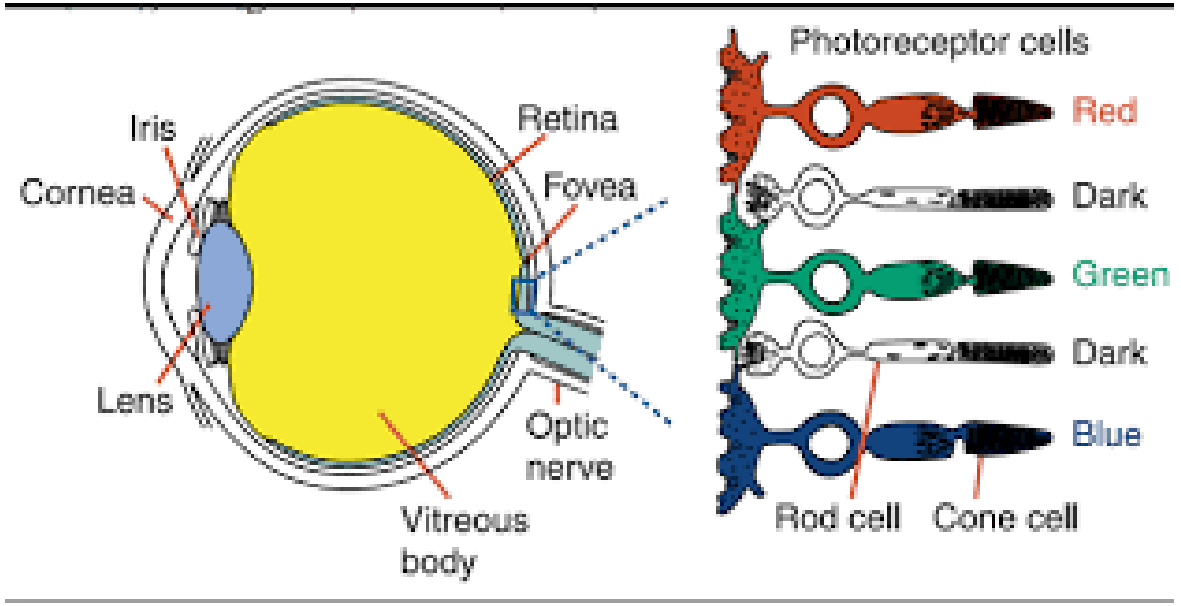
This evening primrose flower appears pure yellow to our eyes, but ultraviolet photography brings out nectar guides only insects can see. Photo: Bjorn Roslett

How the human eye works

Humans see color through a special kind of cells (cone cells) in the eye.

There are three types of cone cells:

- Red-sensing cones (60 %)
- Green-sensing cones (30 %)
- Blue-sensing cones (10 %)



People see red, green and blue

- In summary people see three main colors – red, green and blue.
- All other colors are a mixture of these three.

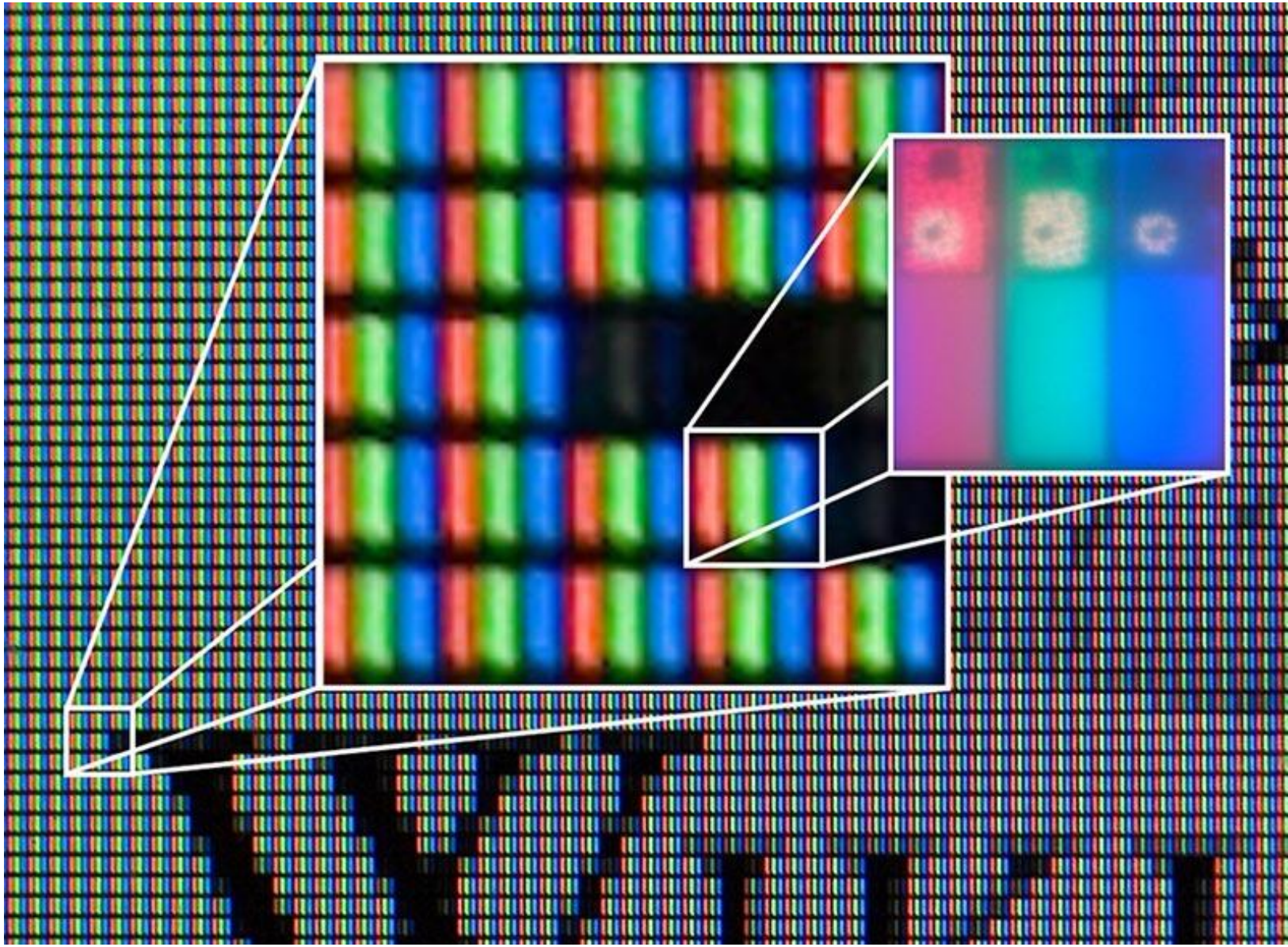
Colors in visualization

- Similarly, the colors we see on our screens are combinations of different intensities of red, green and blue.
- Every image on a display is composed of many pixels.
- Every pixel has 3 subpixels – one red, one green and one blue.
- Different amounts of energy is sent

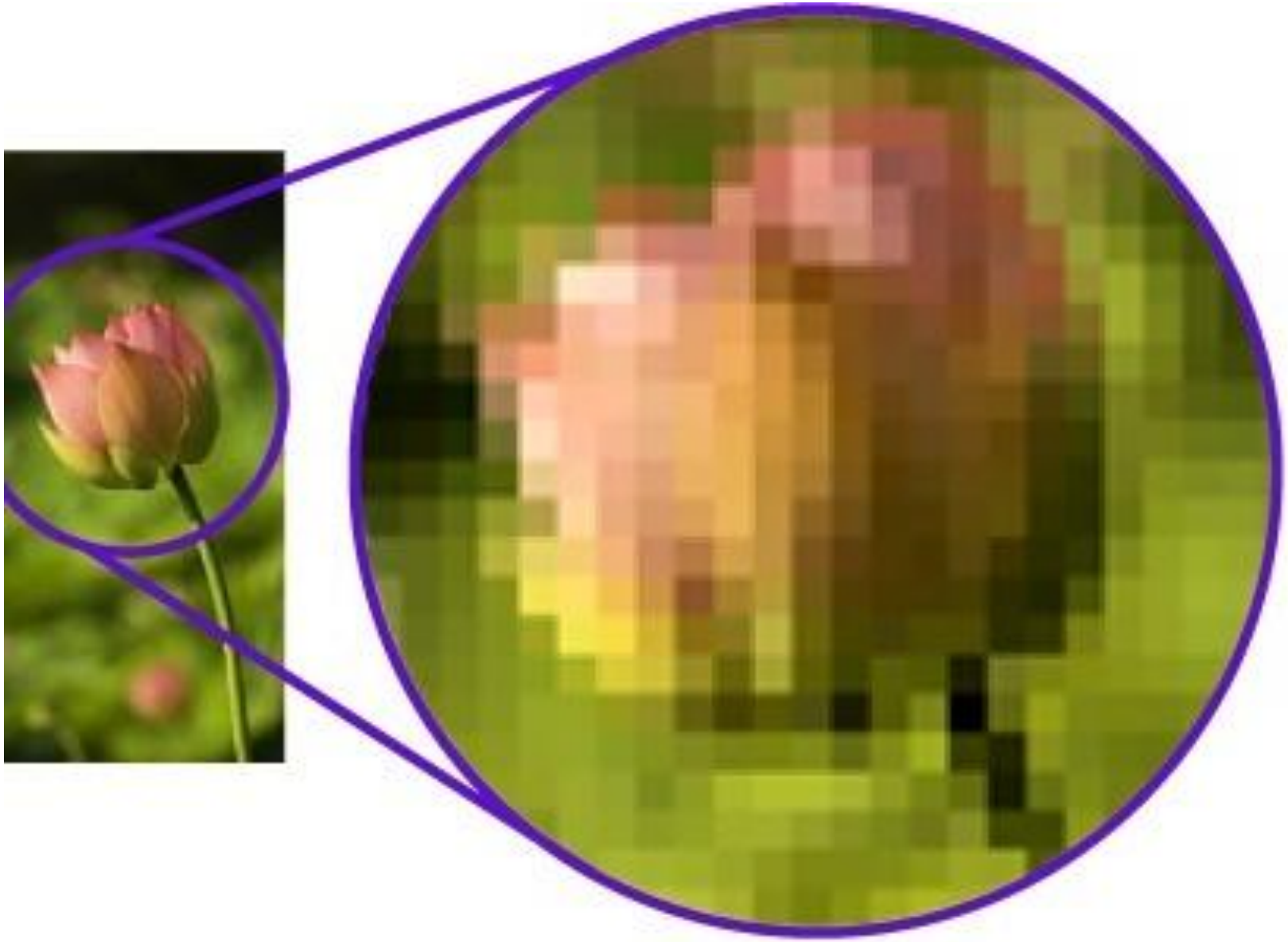
to each subpixel to activate it and create the pixel color.

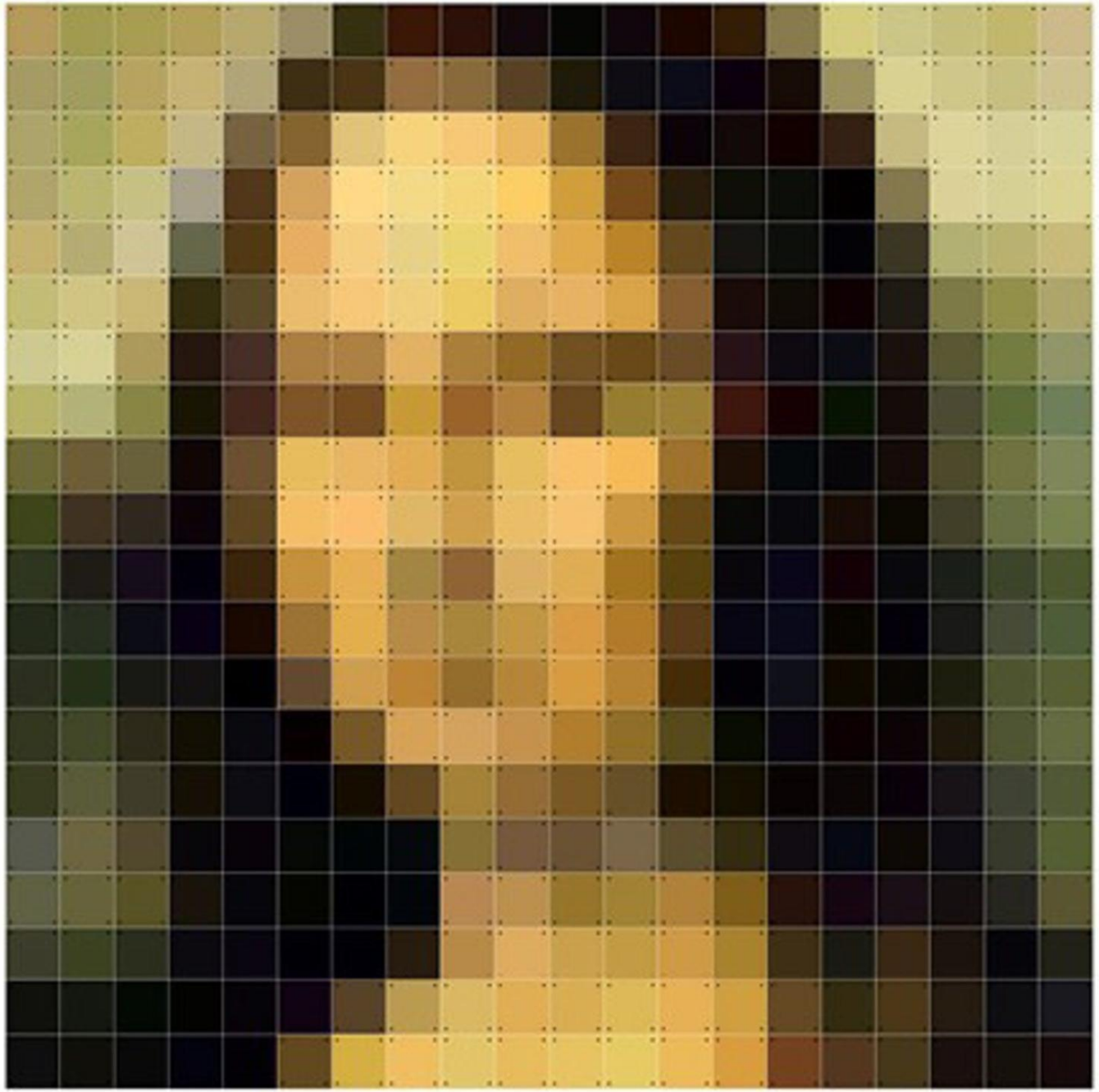
This is a close-up of an LCD display.

Pixels



Pixels

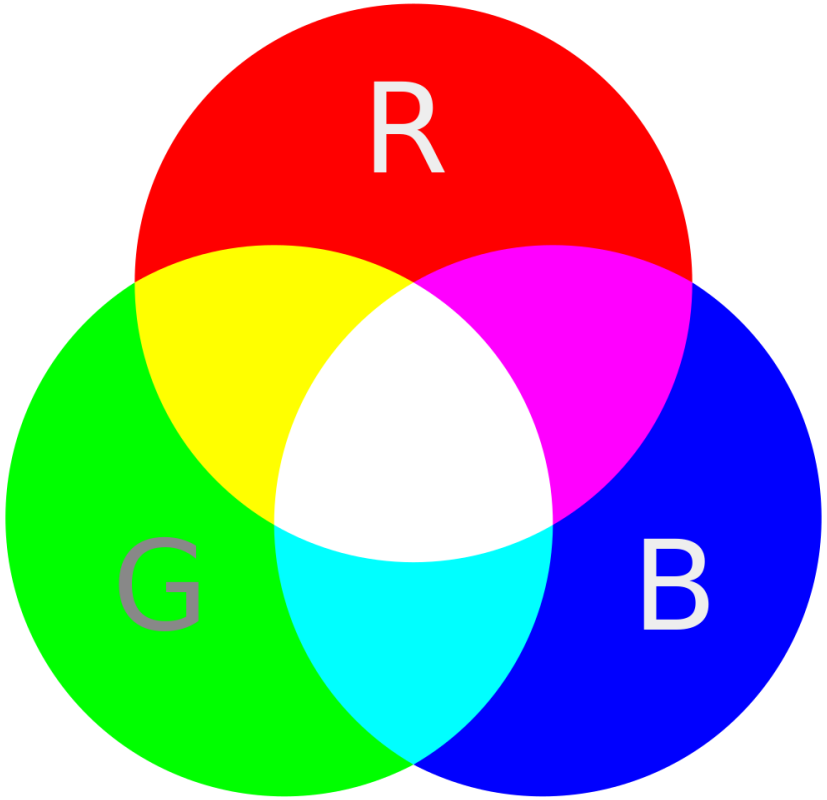




Pixels

Color value in RGB model

- In visualization, colors are represented as combinations of different values of red, green and blue and this is known as the **RGB model.**



Computer bits (binary system)

- Most often computers represent each color – red, green or blue with 8 bits.
- A bit is the smallest unit in computer memory - it takes the value of 0 or 1.
- When you have 8 bits that means there are $2^8 = 256$ possible combinations of 0s and 1s.
  - Example:

1	1	1	1	1	1	1	1
0	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0
1	0	1	0	1	0	1	0

RGB values in decimal system

With the decimal system (using digits 0-9) there are:

- 256 possible values for red
- 256 possible values for green
- 256 possible values for blue

The range for the values to select is from 0 through 255.

For example, this color  is (50, 82, 168).

RGB values in hexadecimal (hex)

It is also common to see color represented as some combination of numbers and/or letters. They use the hex system.

For example, this color is #**ffcc99** in hex.

The decimal RGB value of the same colors is (255, 204, 153).

The letters are a way to denote numbers larger than 9 with a single character -> a = 10, b = 11, c = 12, d = 13, e = 14, f = 15.

In hex 00 = 0 and ff = 255.

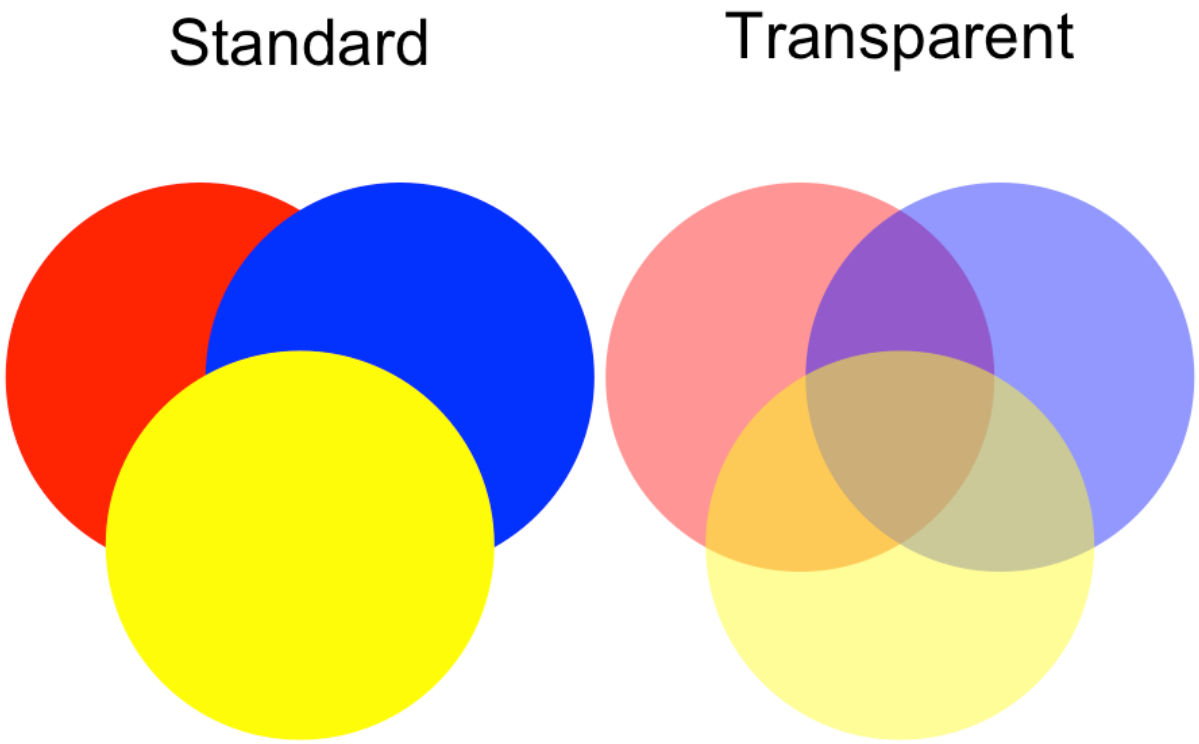
Decimal system is base 10, Hex is base 16.

RGB values for main colors

COLOR	Decimal RGB	Binary RGB	Hexadecimal RGB (HEX)
Black	(0, 0, 0)	(00000000,00000000,00000000)	#000000
White	(255, 255, 255)	(11111111,11111111,11111111)	#ffffff
Red	(255, 0, 0)	(11111111, 00000000, 00000000)	#ff0000
Green	(0, 255, 0)	(00000000,11111111, 00000000)	#00ff00
Blue	(0, 0, 255)	(00000000, 00000000,11111111)	#0000ff
Cyan	(0, 255, 255)	(00000000,11111111,11111111)	#00ffff
Magenta	(255, 0, 255)	(11111111, 00000000,11111111)	#ff00ff
Yellow	(255, 255, 0)	(11111111,11111111, 00000000)	#ffff00
Gray	(128, 128, 128)	(10000000,10000000,10000000)	#808080
Light Gray	(200, 200, 200)	(11001000, 11001000, 11001000)	#c8c8c8
Dark Gray	(50, 50, 50)	(00110010, 00110010, 00110010)	#323232

Alpha color

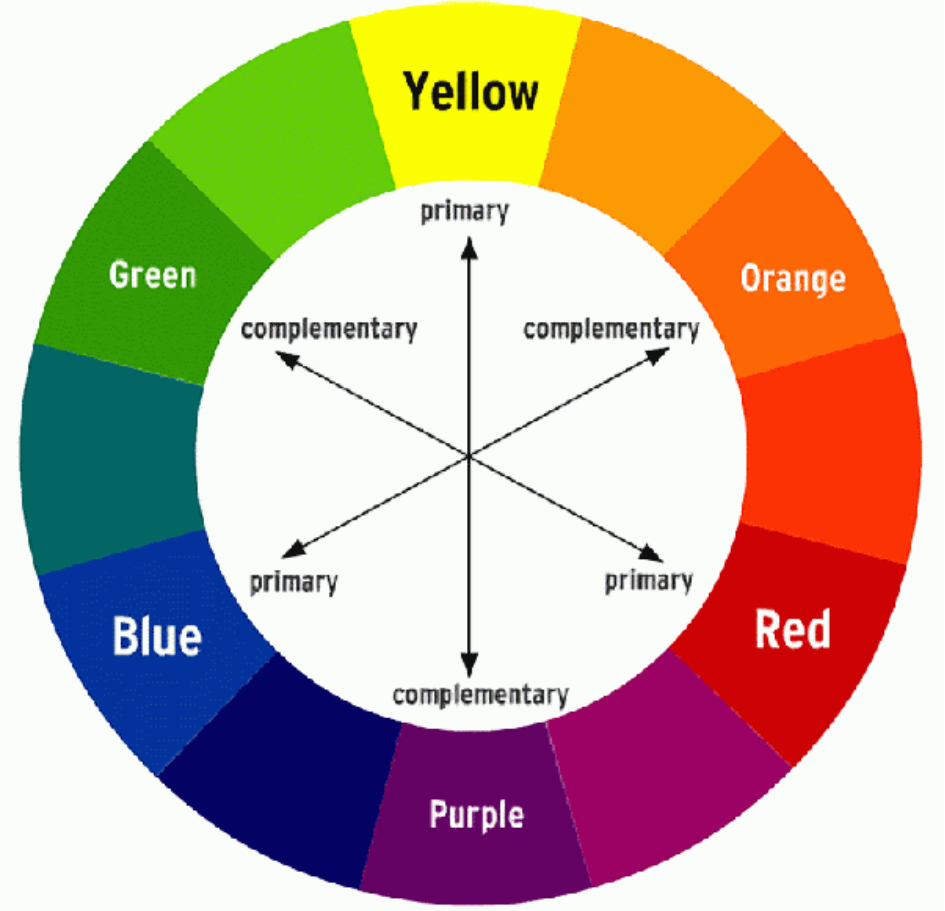
- The alpha color (or alpha channel) is a color component that represents the degree of transparency.
- Think of it as a 4th “color” in addition to the red, green and blue.
- Its value is represented as 8 bits (1 byte).
- 32-bit color systems have RGBA instead of RGB.



Finding color combinations for your visualizations

Disclaimer: I am a data scientist, not an artist. My best advise on color combinations may not be the best solution.

The complimentary colors and the color wheel

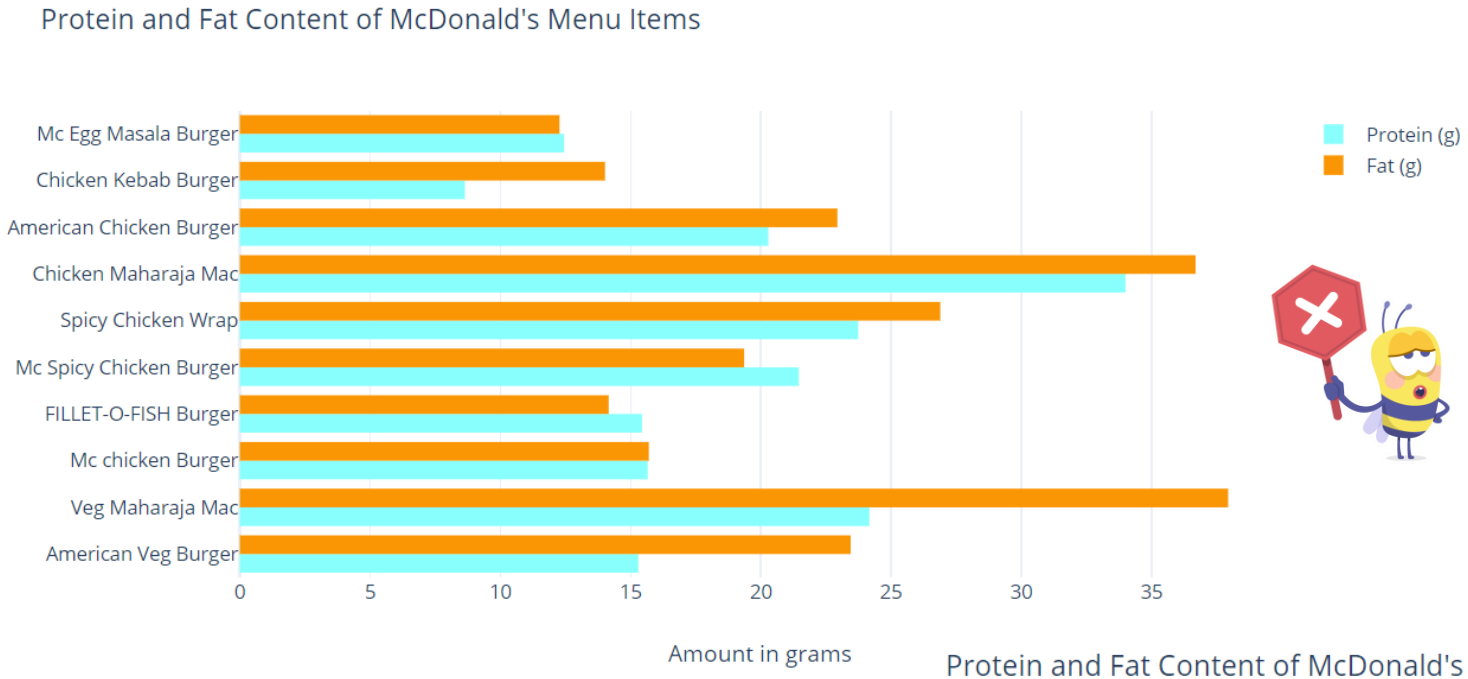


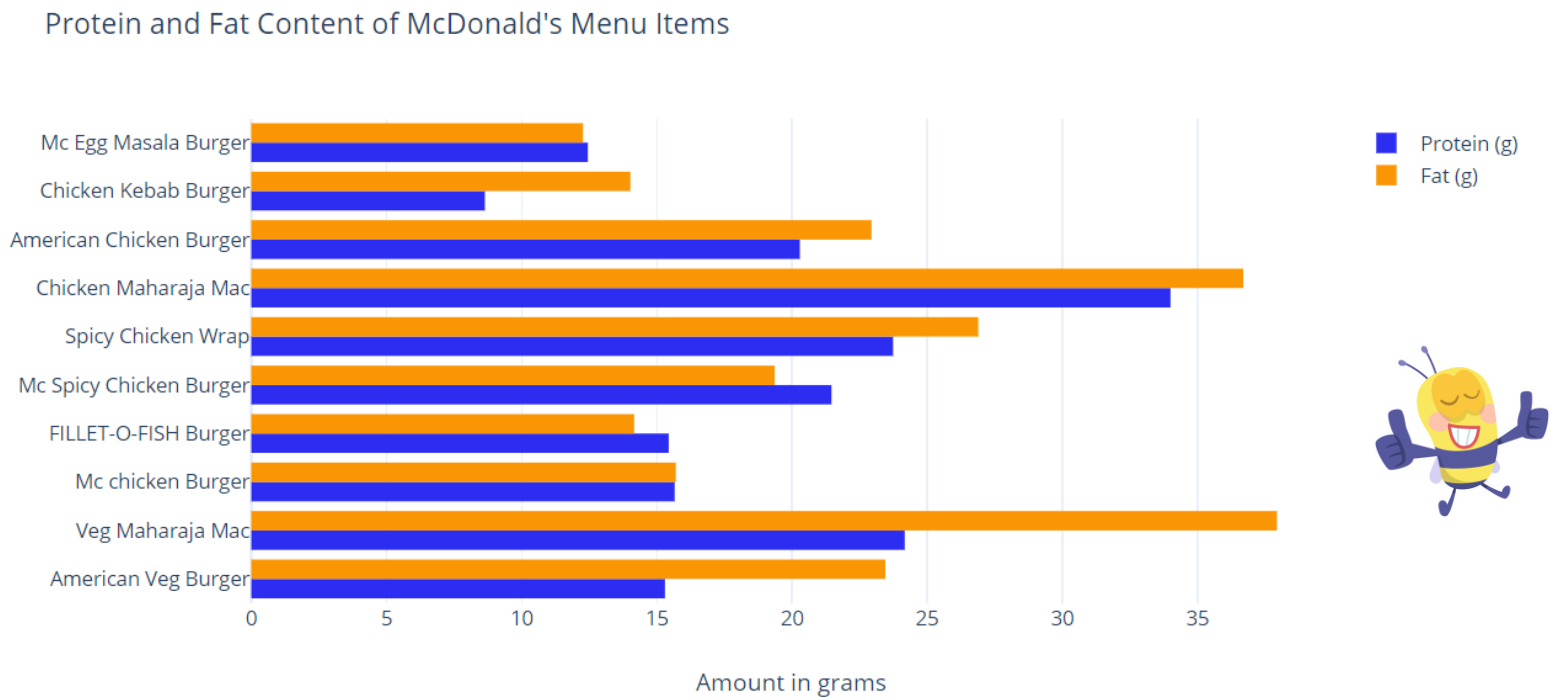
- Blue-orange
- Yellow-purple – not pinkish purple
- Red-green – be careful with that one.

Blue and orange

Yellow and purple

Red and green


Protein and Fat Content of McDonald's Menu Items
Mc Egg Masala Burger
Chicken Kebab Burger
American Chicken Burger
Chicken Maharaja Mac
Spicy Chicken Wrap
Mc Spicy Chicken Burger
FILLET-O-FISH Burger
Mc chicken Burger
Veg Maharaja Mac
American Veg Burger
0
5
10
15
20
25
30
35
Amount in grams
Protein (g)
Fat (g)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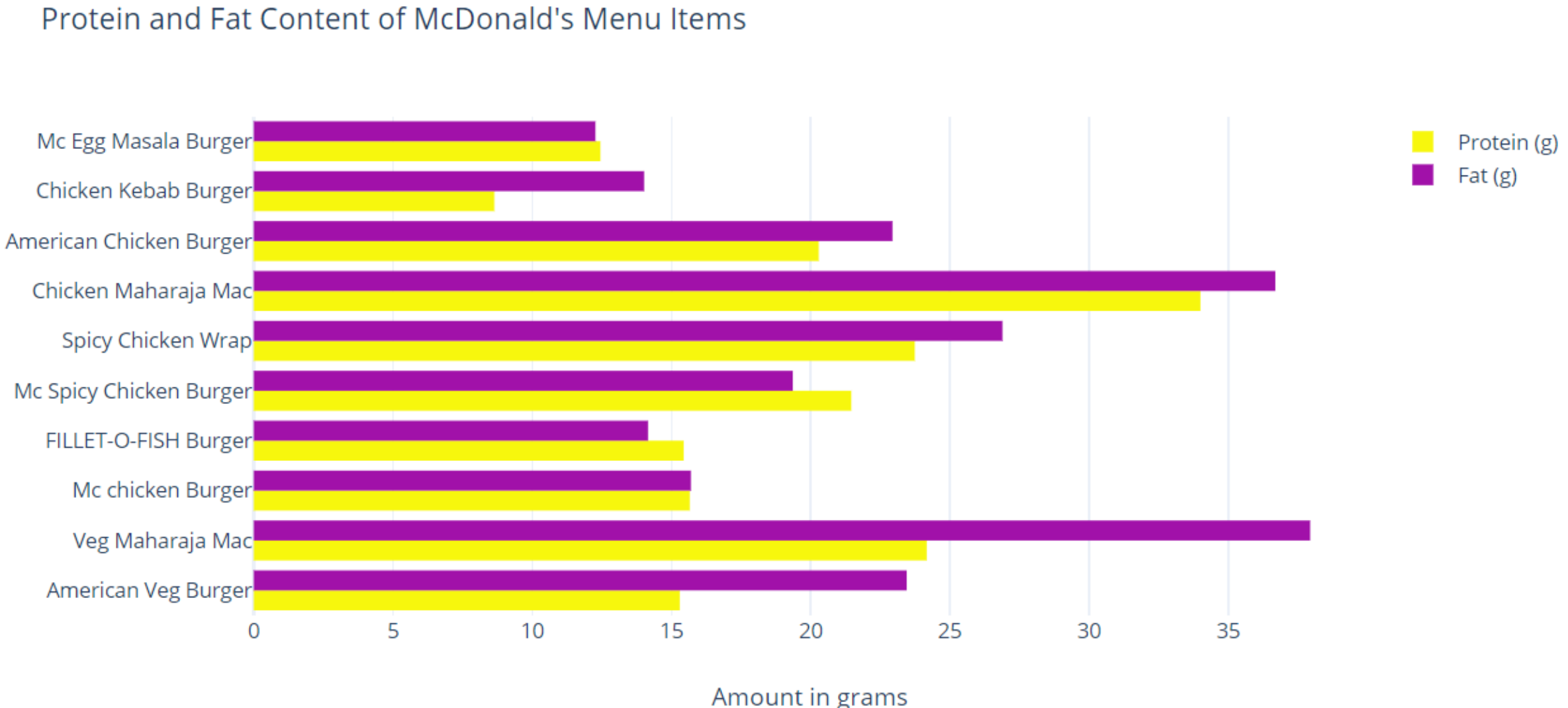
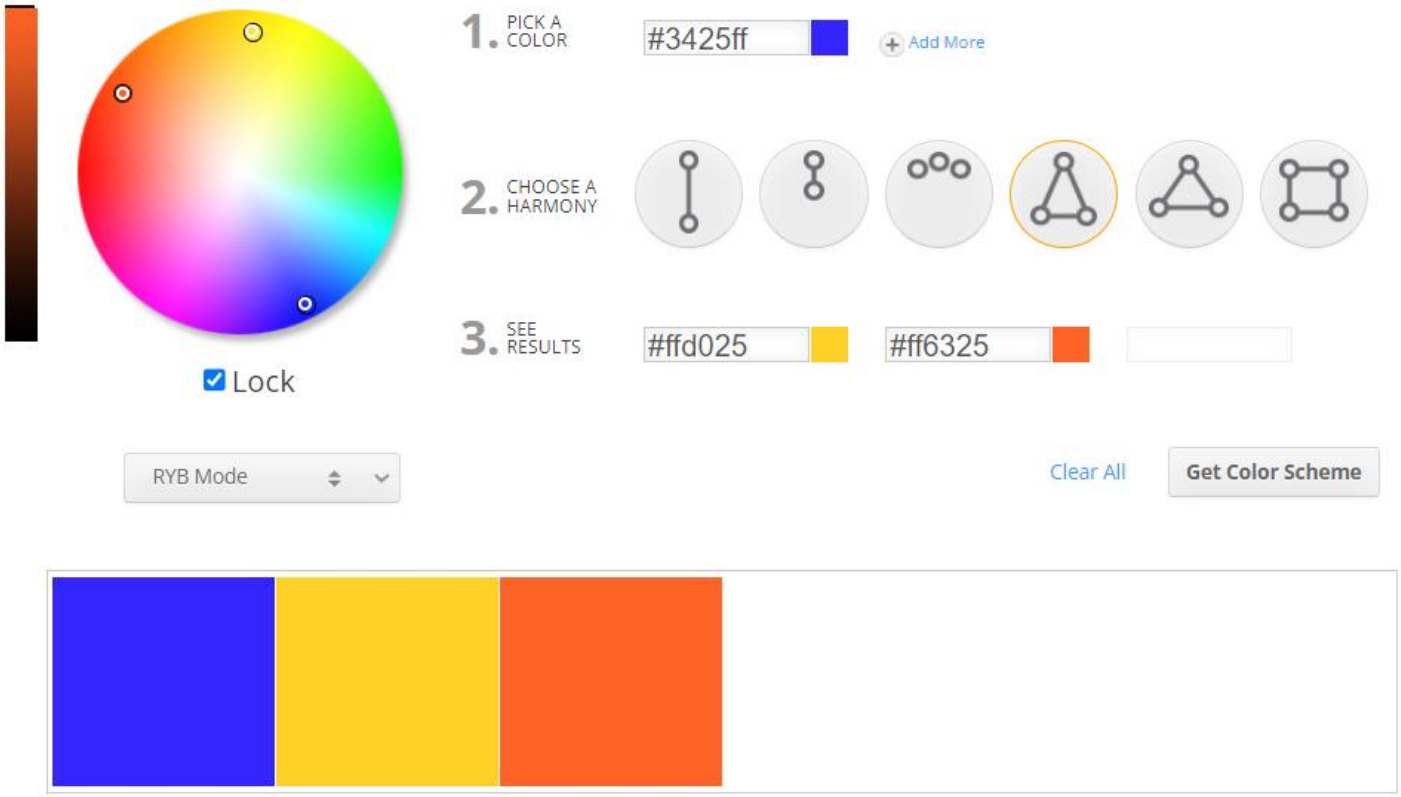
It’s hard to make yellow stand out as much as other colors especially on a white background



https://www.sessions.edu/color-calculator/



Other color combination ideas

- https://looka.com/blog/color-combinations/
- https://colorhunt.co/