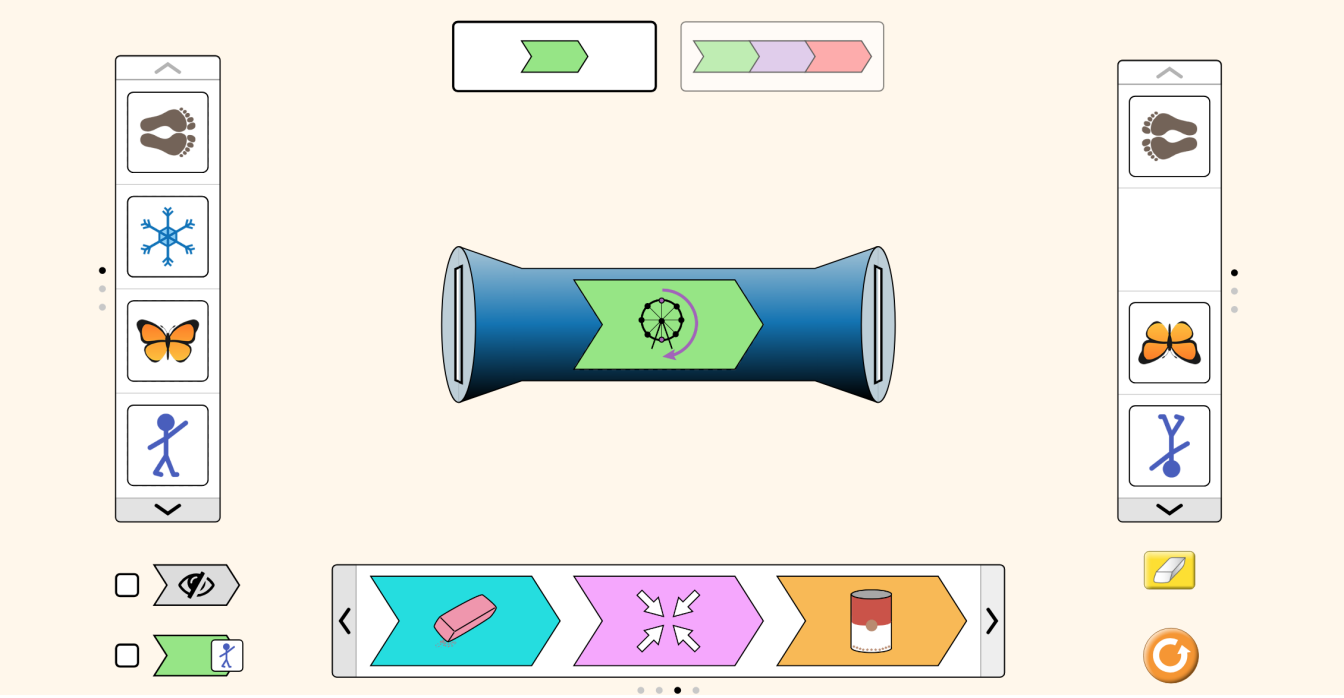
Image Processing Mini-Project

Image representation on a computer is deceptive. Whenever we use Instagram, take digital photos, and edit these photos we have the experience that we are manipulating the images themselves, not large sets of numbers. Modern computer and LED screens hide the tiny building blocks of pixels that we know are the foundation of any image.

Here is an educational app that demonstrates functions
https://phet.colorado.edu/sims/html/function-builder-basics/latest/function-builder-basics_en.html

Try out the app by selecting functions from the tube and then dragging the images through. What kind of transformations are created? What do the mystery functions do?

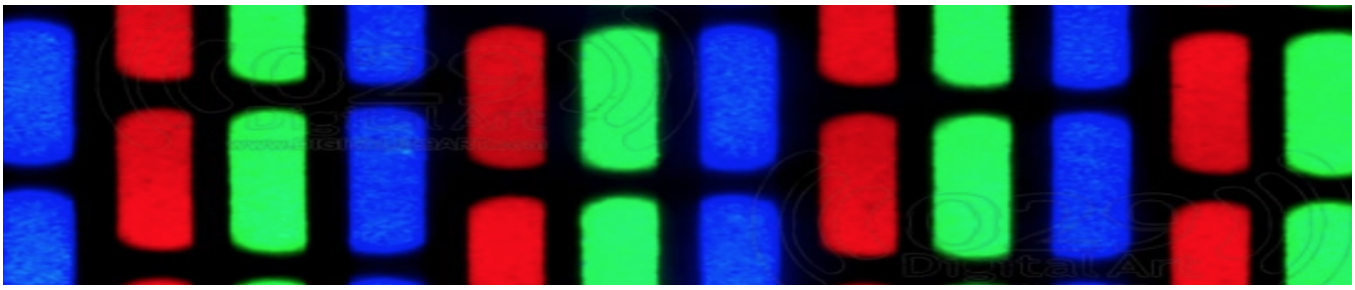


On the bottom of the screen are functions you can drag onto the tube. As you drag the card from the left into the tube, they change. Some rotate, some become black and white. This is similar to photo editing where we can edit photos and by adjusting colors and rotating and manipulating the image. But what are we really doing with photos and images? It feels like we are actually manipulating images, but just like photo editing, we know it's really all about numbers.

If we look at an image on a computer, we see colors and images.

If we zoom in with a viewing tool, we see small squares that make up the image, and for example, these squares appear purple. This "zooming in" is really just enlarging the purple marble, not really zooming into the pixels that create the colors.

If we could really zoom in, or use a microscope we would see each pixel made up of the three colors of the RGB (Red, Green and Blue) color process. The purple squares are an illusion, made by combining red, blue and green.



What directs the intensity of the RGB colors are numbers. Each of the 3 colors has a range from 0 - 255. Giving 256 options *(What is special about the number 256?)*

2. Simulating Pixels with Spreadsheets

We can make a model of what is happening with a spreadsheet of numbers.
For example, we can create one pixel with 3 numbers. And then build up a collection of "pixels."

RED	255
GREEN	255
BLUE	255

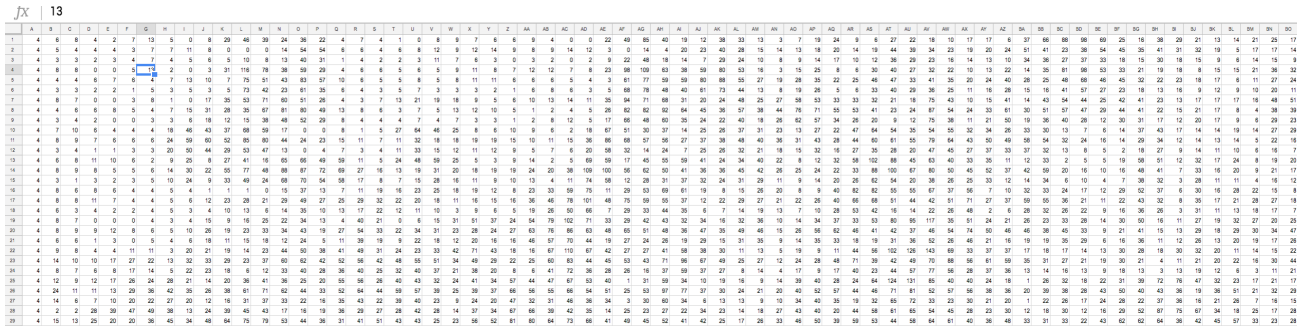
RED	255	255	255
GREEN	255	255	255
BLUE	255	255	255
RED	255	255	255
GREEN	255	255	255
BLUE	255	255	255

In this example, each color is at its max value. Then we can set our conditional formatting to match match the number with the corresponding RGB color. Each number can then be adjusted, making color.

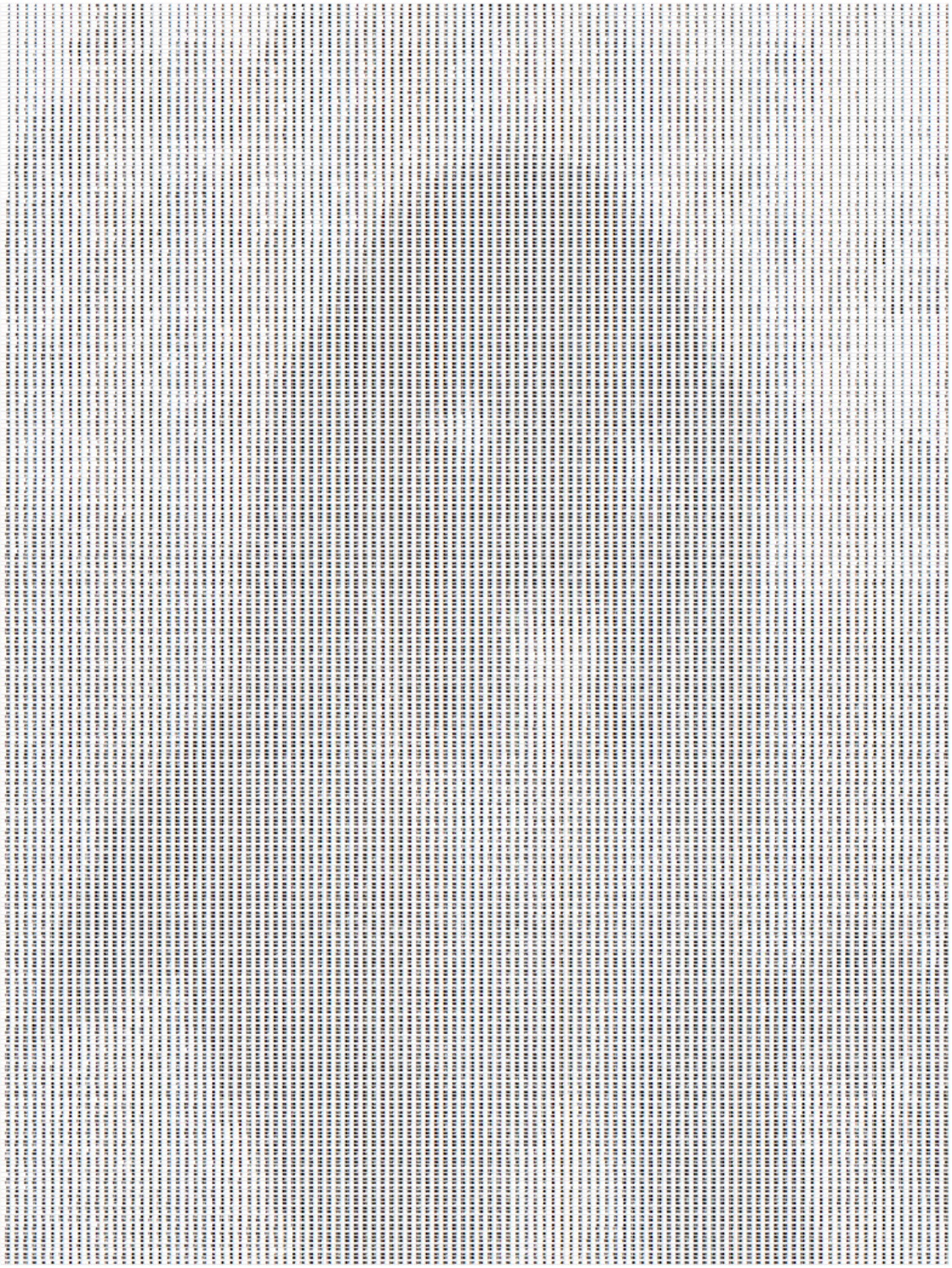
255	255	255
255	255	255
255	255	255
255	255	255
255	255	255
255	255	255

170	200	200
157	253	120
243	249	251
254	255	255
253	253	253
249	250	254

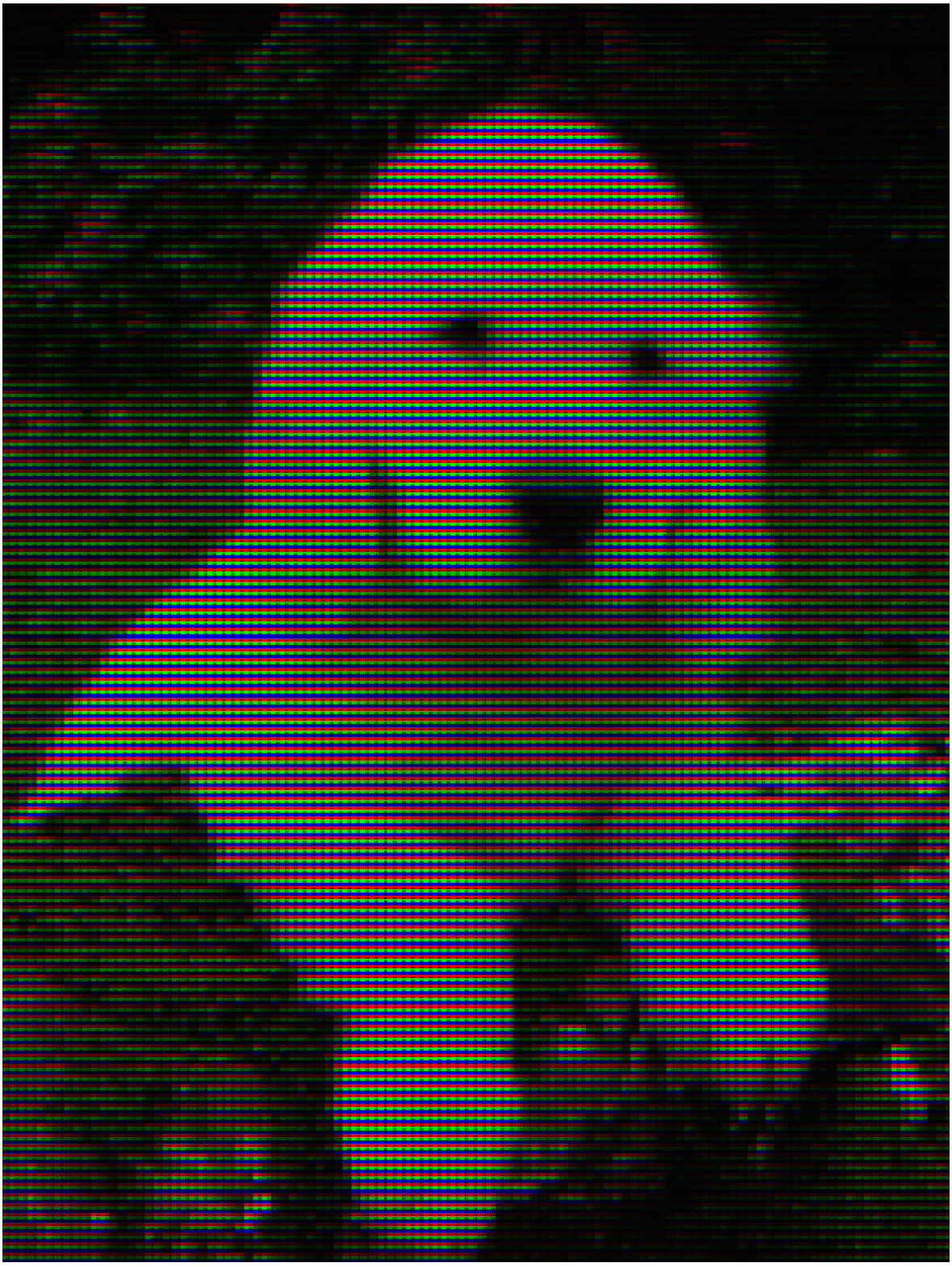
This creates a model of how pixels work on a computer screen. It is not obvious that these make color or images until we zoom out on a large set of numbers. Consider this spread this spreadsheet of numbers:



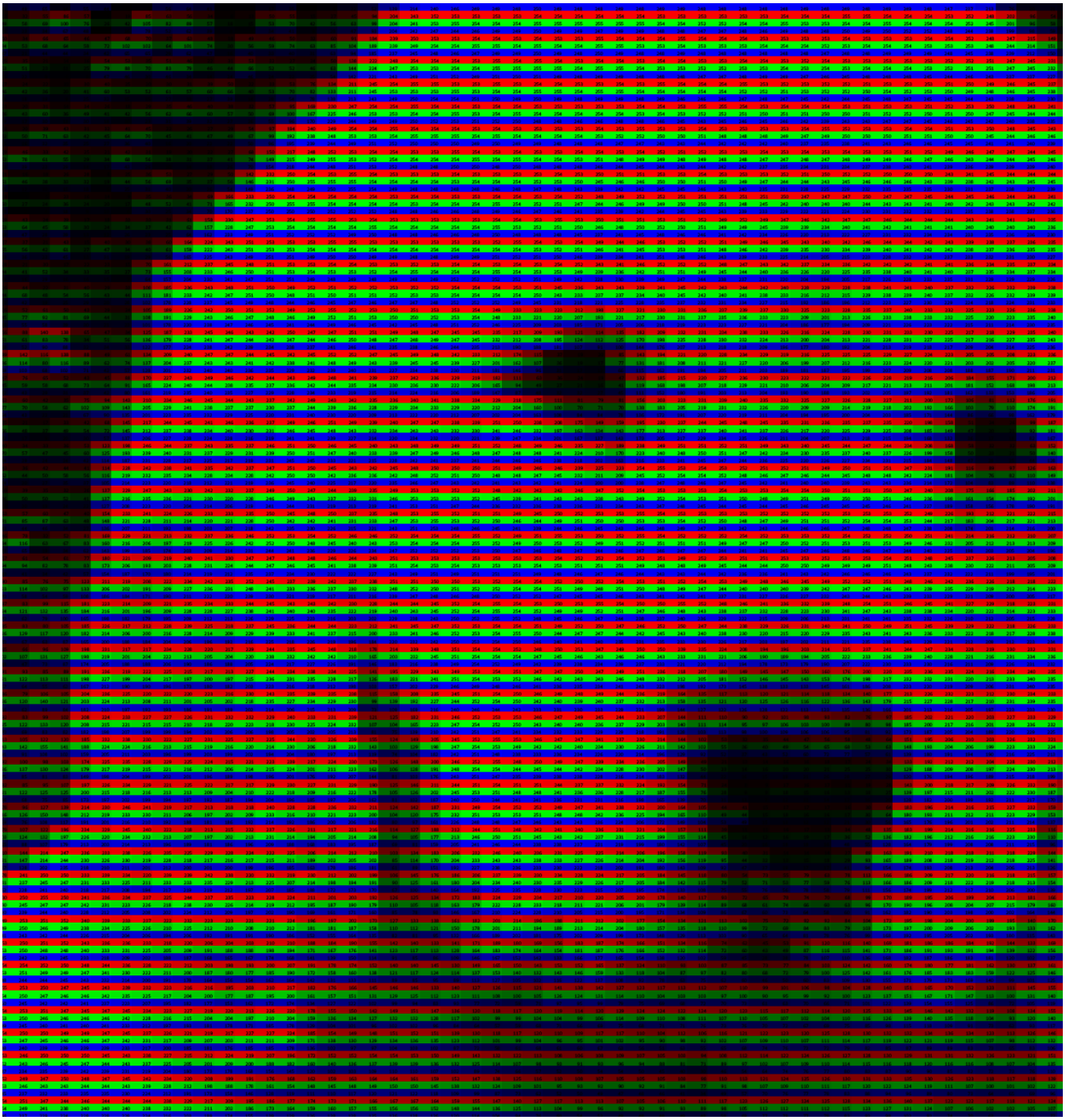
If we zoom out we just look at the numbers, ZOOM out to 25% or 50% - what do you see?

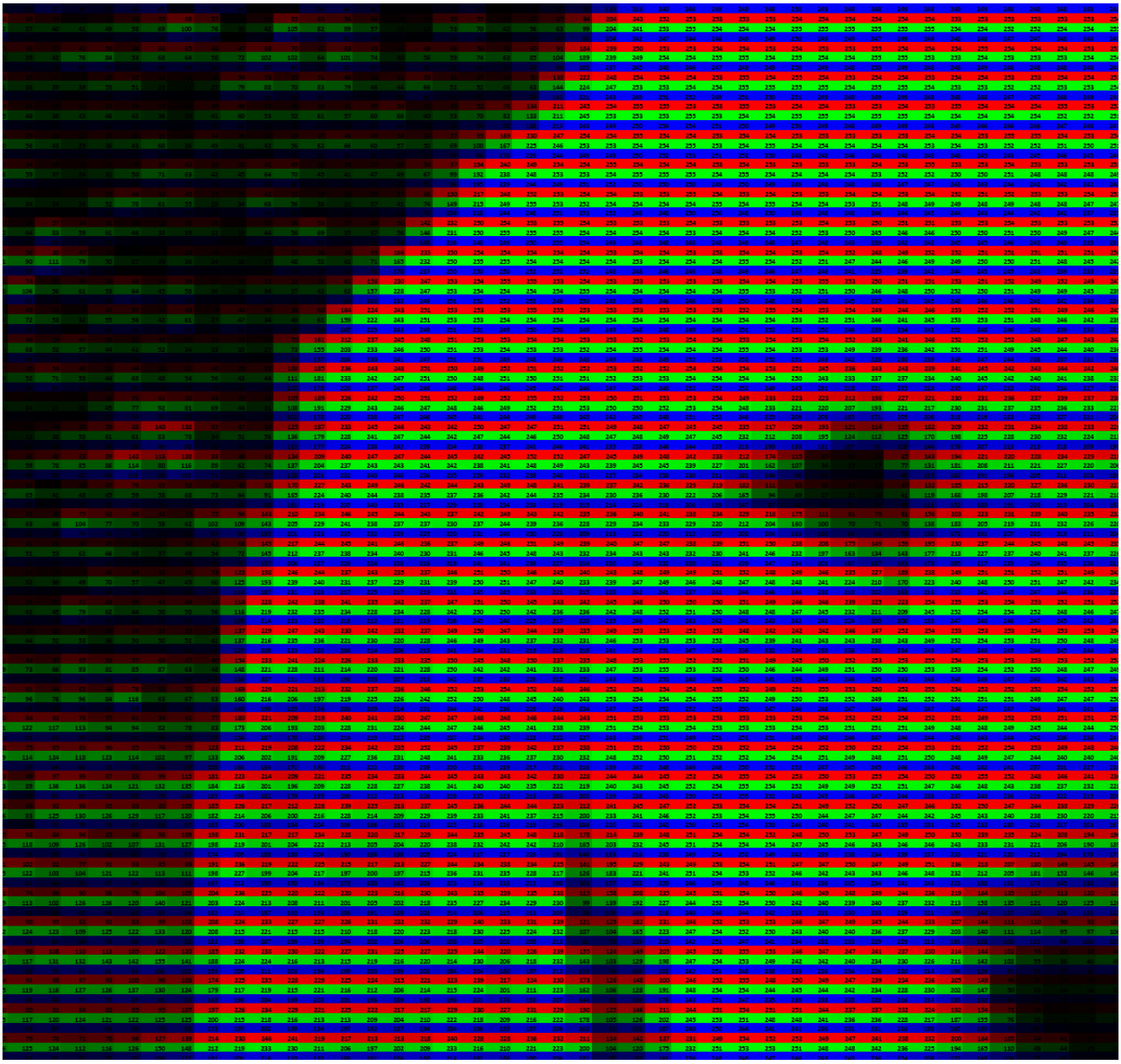


Now, add the color rules.

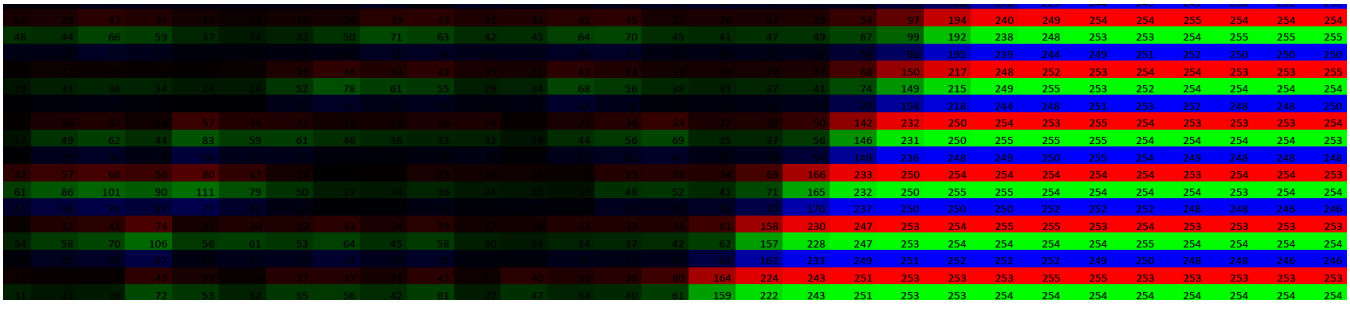


Zooming in we see this is still just our spreadsheet.





What may be surprising is that what appears to us as white is really just a combination of Red, Green and Blue.

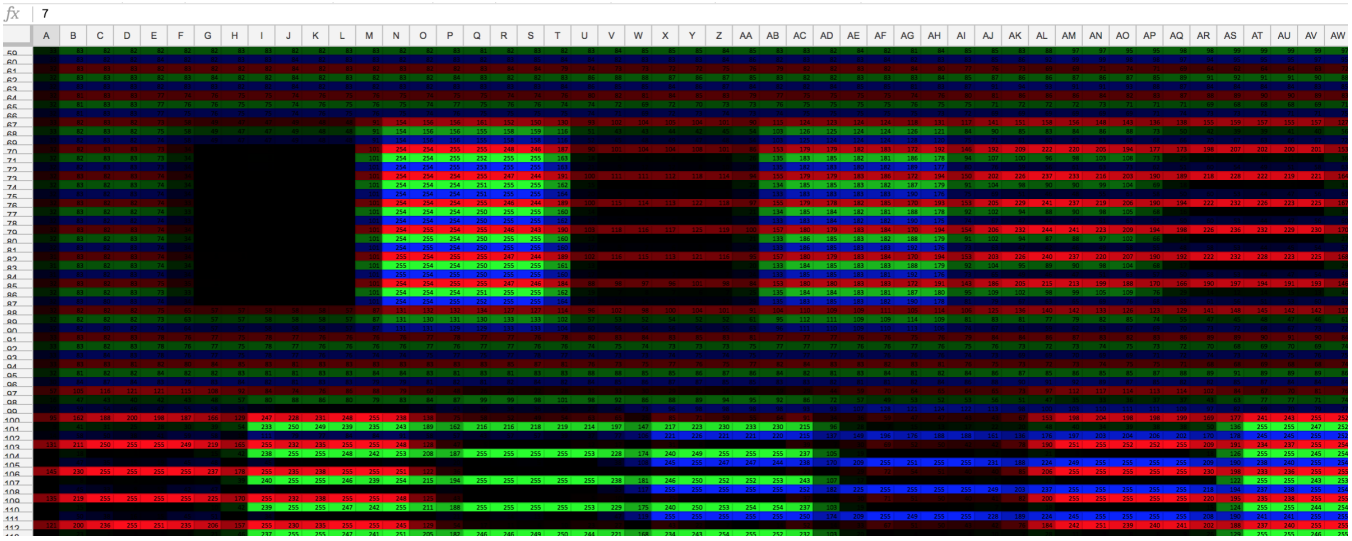


RGB has different color mixing rules from what you learned in art class using paint. To know how to mix RGB to make colors, let's look at a color swatch.

Next, I take this jpeg and run it through the Pixel spreadsheet app at

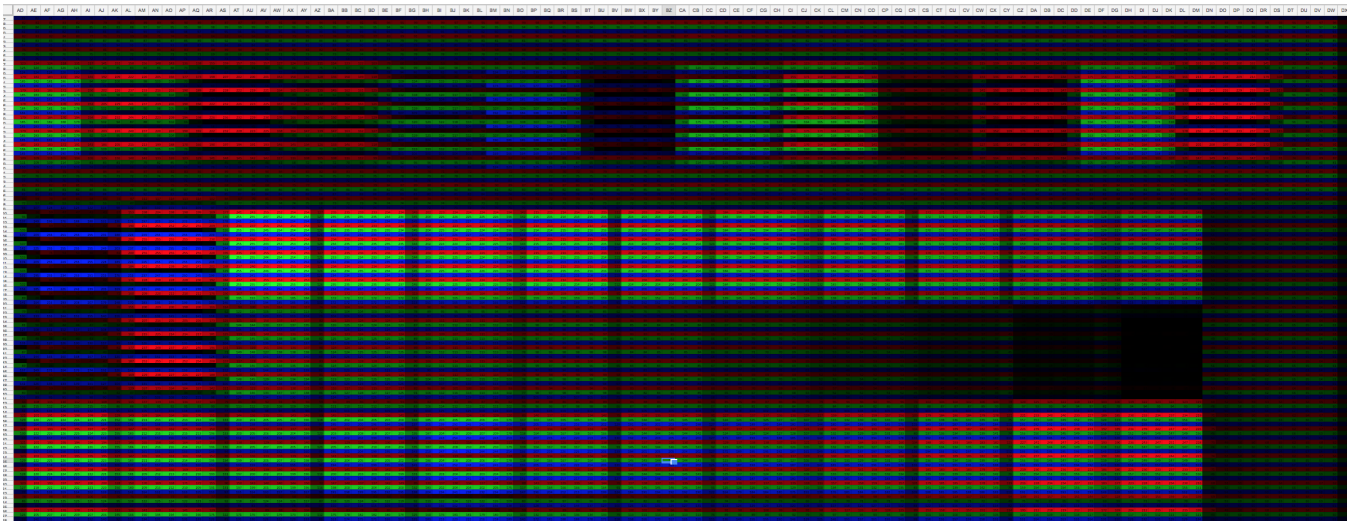
https://think-maths.co.uk/spreadsheet (which is where this idea and images came from. To try with your own photos, pick lowish resolutions. It worked for me with Chrome and a mac, but you may have issues. I converted the excel sheets it gave me to Google sheets.)

This is a screen shot of the first 2 rows.

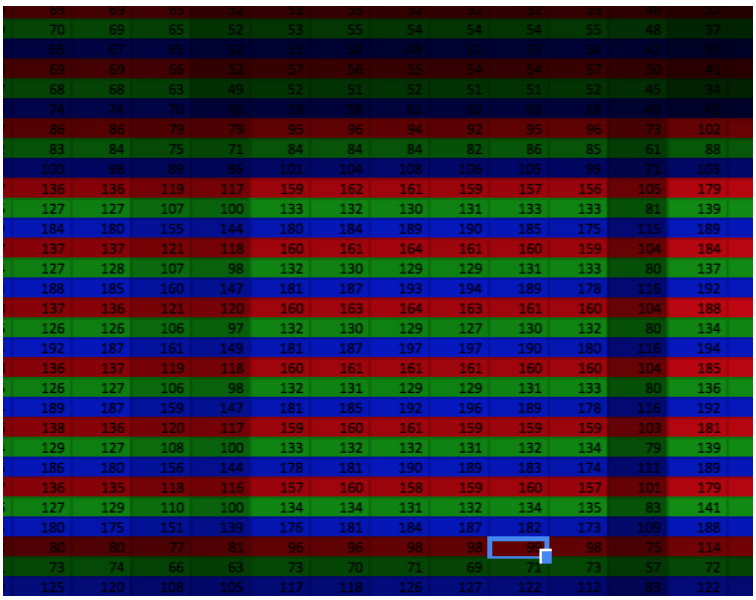


From here we can find the recipes for colors. Notice what numbers correspond to red, yellow, and green in the second row. Notice, this yellow comes from the absence of blue (set to 0). And turquoise, the 4th block over, second row, comes from an absence of red (red = 0.)

To find the purple color from the first marble image I used above, I need to look over to the right side of the chart.



And then zoom in. The recipe for purple is Red = 162, Green = 129, Blue = 190.



For more about color and pixels, and animals vision read:
https://jakubmarian.com/the-illusion-of-rgb-screens/
You can play with all of these images by copying files from:
https://drive.google.com/drive/folders/1l_JWvAp1gkHM8J09HDKTnmJ_2JoEXgG7?usp=sharing
(Pixel spreadsheet folder)