

## Exercises Week #3: Color Images

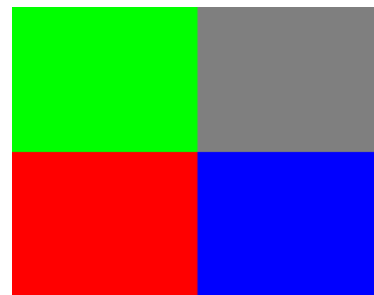
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**Solutions should be submitted via moodle before May 4th, 2021 8.00 a.m. (CET)**

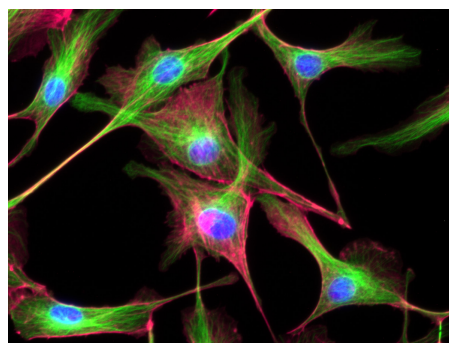
### Exercise 1 – Conversion of RGB to grayscale images (Difficulty level: easy/medium)

RGB images are stored as three-dimensional NumPy arrays. The first two dimensions are the pixel coordinates (the first index is the y coordinate, the second index is the x coordinate). The last index enumerates the three color channels: red (**R**), green (**G**) and blue (**B**). For example, to create a 24-bit rectangular RGB image with a red lower left corner, a green upper left corner, a blue lower right corner and a gray upper right corner, you can do the following:

```
nx, ny = 256, 200
image = np.zeros((ny, nx, 3), dtype='uint8')
# lower left corner red
image[ny//2:, :nx//2] = [255, 0, 0]
# upper left corner green
image[:ny//2, :nx//2] = [0, 255, 0]
# lower right corner blue
image[ny//2:, nx//2:] = [0, 0, 255]
# lower right corner gray
image[:ny//2, nx//2:] = [127, 127, 127]
```



We will study the RGB image [FluorescentCells01.jpg](#) (which should be downloaded from the moodle page and placed in the same folder as the template):

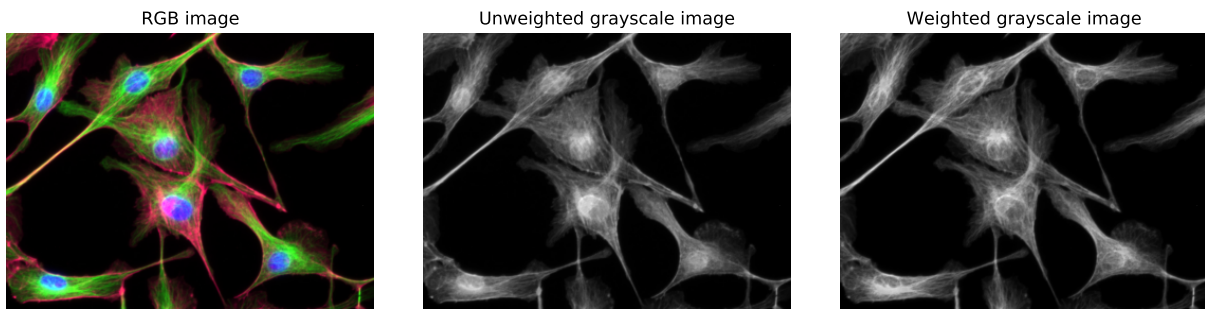


**Task 1A. (Difficulty level: easy)** Read the image [FluorescentCells01.jpg](#) and print some information about it such as the **shape** and **data type** of the image, as well as the **minimum** and **maximum** pixel value.

**Task 1B. (Difficulty level: easy)** Convert the image to a grayscale image by averaging the pixel values of the individual color layers. The data type of the grayscale image should be identical to the data type of the input image.

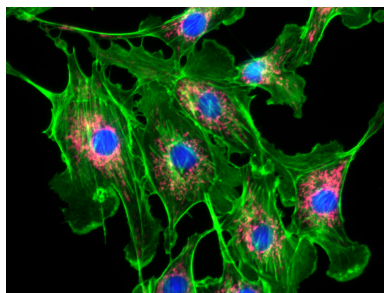
**Task 1C. (Difficulty level: medium)** To account for differences in the sensitivity of the photoreceptors in our retina, a weighted sum of the R, G, and B components should be formed where the weights for the color channels are 0.2989, 0.5870, and 0.1140, respectively.

**Task 1D. (Difficulty level: easy)** Show the original RGB image and both grayscale images.

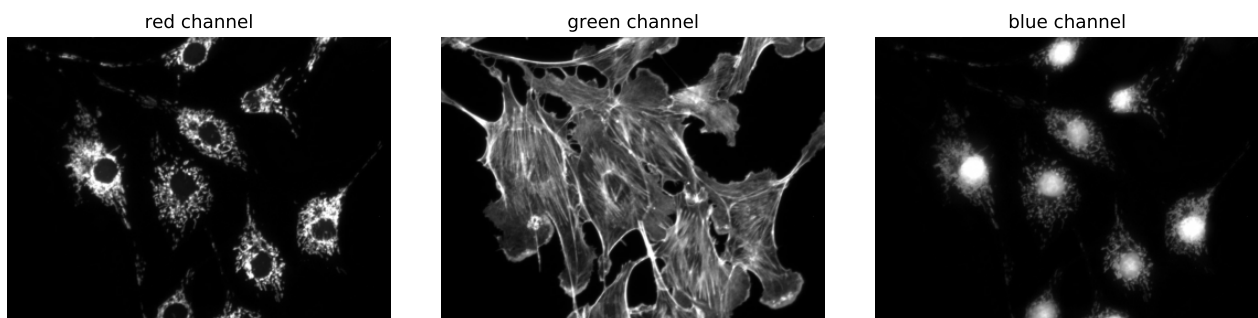


**Exercise 2 – Showing under/overflow in a color image (Difficulty level: easy/medium)**

This exercise studies the image [FluorescentCells03.jpg](#) (available on the moodle page):

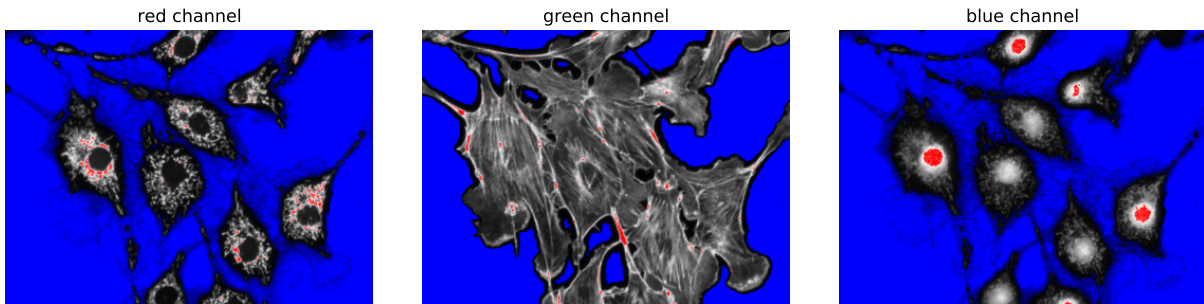


**Task 2A. (Difficulty level: easy)** Read the image and show the individual layers as grayscale images.



**Task 2B. (Difficulty level: medium)** For each channel show, pixels with intensity

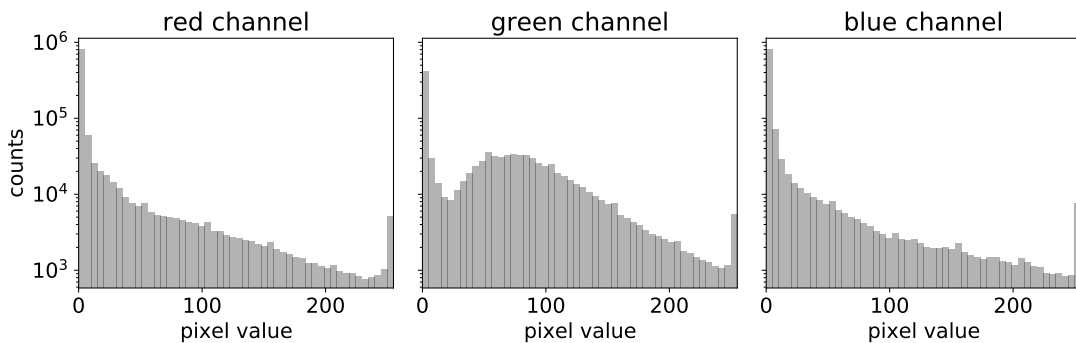
- smaller than 1% of the maximum intensity in blue (*underflow*)
- greater than 99% of the maximum intensity in red (*overflow*)
- and all others in gray



**Exercise 3 – Image histograms (Difficulty level: medium)**

Now we study the distribution of pixel values in the RGB image [FluorescentCells03.jpg](#).

**Task 3A. Image histograms (Difficulty level: medium)** Read the image and show histograms of the pixel values of the individual layers. Use a logarithmic scale for the counts.



**Task 3B. (Difficulty level: medium)** Show image histograms for the individual layers excluding the intensities of pixels suffering from under- or overflow (as defined in 2B).

