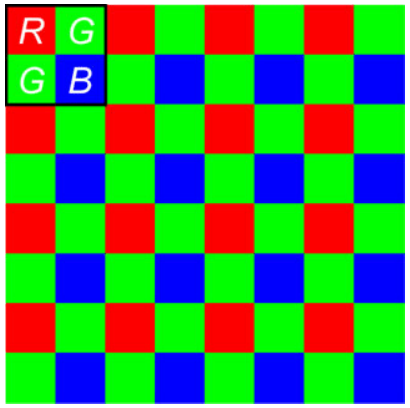
# CS 682

## HW1: Practice with Convolutions, Demosaicing

The goal of the assignment is to get started with image processing in Python by implementing a very simple demosaicing algorithm. Please **download the starter code and data here**. You are provided some images and an ipython notebook for getting started.

The "mosaic" image was created by taking the original color image and keeping only one color component for each pixel, according to the standard Bayer pattern:

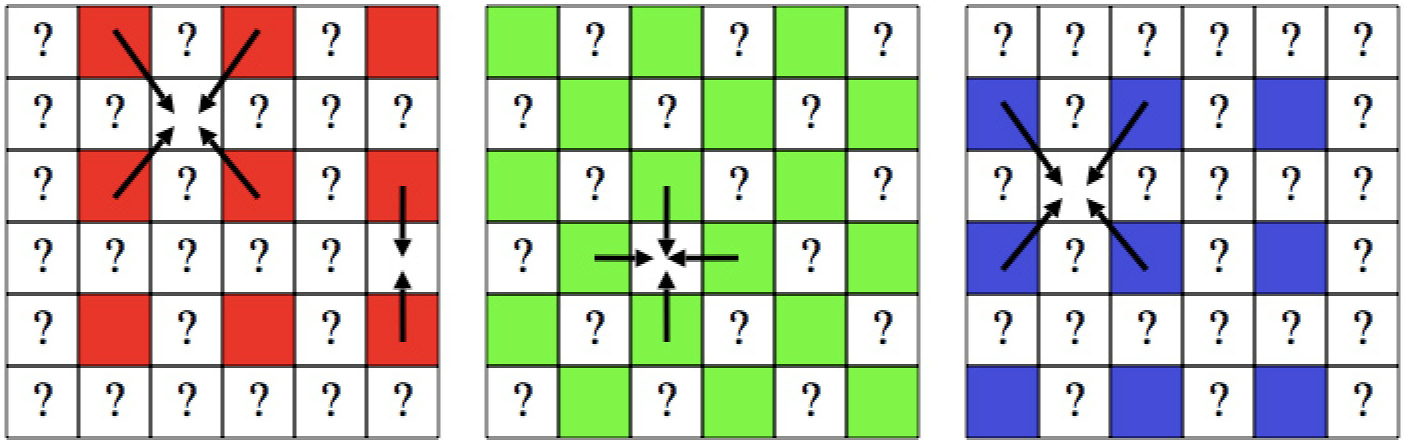


Source

So, once you read the "mosaic" image into a matrix, entry (1,1) will be the value of the "red" component for pixel (1,1), entry (1,2) will be "green", etc.

### (10 pts) Part 1: Linear Interpolation

Implement a very simple *linear interpolation* approach to demosaicing: for each pixel, fill in the two missing channels by averaging either the four or the two neighboring known channel values:



The above method, being very simple, does not work perfectly. You can see where it makes mistakes by computing a map of squared differences (summed over the three color components) between the original and reconstructed color value for each pixel. Compute such a map and display it using the `skimage.io.imshow` or `cv2.imshow` or `matplotlib.pyplot.imshow` . In addition, compute the average and maximum per-pixel errors for the image. Finally, show a close-up of some patch of the reconstructed image where the artifacts are particularly apparent and explain the cause of these artifacts. You need to implement the `get_solution_image` function and the `compute_errors` function for this part in the ipython notebook provided to you.

## (5 pts) Part 2: The Freeman Method

In 1985, Bill Freeman proposed an improvement of the simple bilinear interpolation approach. Since the G channel is sampled at a higher rate than the R and B channels, one might expect interpolation to work better for G values. Then it would make sense to use the interpolated G channel to modify the interpolated R and B channels. The improved algorithm begins with linear interpolation applied separately to each channel, just as you have already done above. The estimated G channel is not changed, but R and B channels are modified as follows. First, compute the difference images R-G and B-G between the respective interpolated channels. Mosaicing artifacts tend to show up as small "splotches" in these images. To eliminate the "splotches", apply *median filtering* (`scipy.signal.medfilt2d` command in Python) to the R-G and B-G images. Finally, create the modified R and B channels by adding the G channel to the respective difference images.

Implement the above algorithm and visualize the quality of the results in the same way as for Part 1 by displaying the error image and computing average and maximum error. Compare the output to that of Part 1. Are there visible improvements (especially in the close-up patch selected in Part 1)? You need to implement the `get_freeman_solution_image` function function for this part in the ipython notebook provided to you.

## (3 pts) Part 3: Practive with image operations (not in the provided notebook)

This is additional Python warmup. Import the same module as in the previous part. Load image `notes_color.jpg` provided in the images directory and do the following operations. Load image `notes_color.jpg` provided in the images directory and do the following operations.

- Load the above image and resize the image by factor of 4 (make it 4 times smaller using cv2.resize)
- Create a new gray level image `gray = cv2.cvtColor(image, cv2.COLOR_BGR2GRAY)`
- Display histogram of gray level image intensities with 20 bins `cv2.calcHist(), np.histogram()`
- Create binary image by setting all the pixels which have intensity greater the 125 to 255 and the ones that are less then 125 to 0. Use the histogram of the gray level image to choose (by hand) better threshold to make the notes in the binary image readable;
- Create a negative of the obtained gray level image;
- Submit ipython notebook showing the run and the results of the operations.

## IPython

The first part of the assignment is given to you in the `hw1.ipynb file.` If you are using a local machine, ensure that ipython is installed (https://ipython.org/install.html). You may then navigate the assignment directory in terminal and start a local ipython server using the `jupyter notebook` command.

## Submission Instructions

You must upload three files to **GMU Blackboard**.

1. Your code **in two Python files**. The files should be **netid_hw1_code.ipynb** or correspondig .py files
2. Your ipython notebook with output cells converted to **PDF format**. The filename should be **netid_hw1_output.pdf**
3. A brief report in PDF format. The filename should be **netid_hw1_report.pdf**. Use this template to create your report for part 1-2.

### Useful Python Links

1. skimage io
2. cv2 io
3. matplotlib api