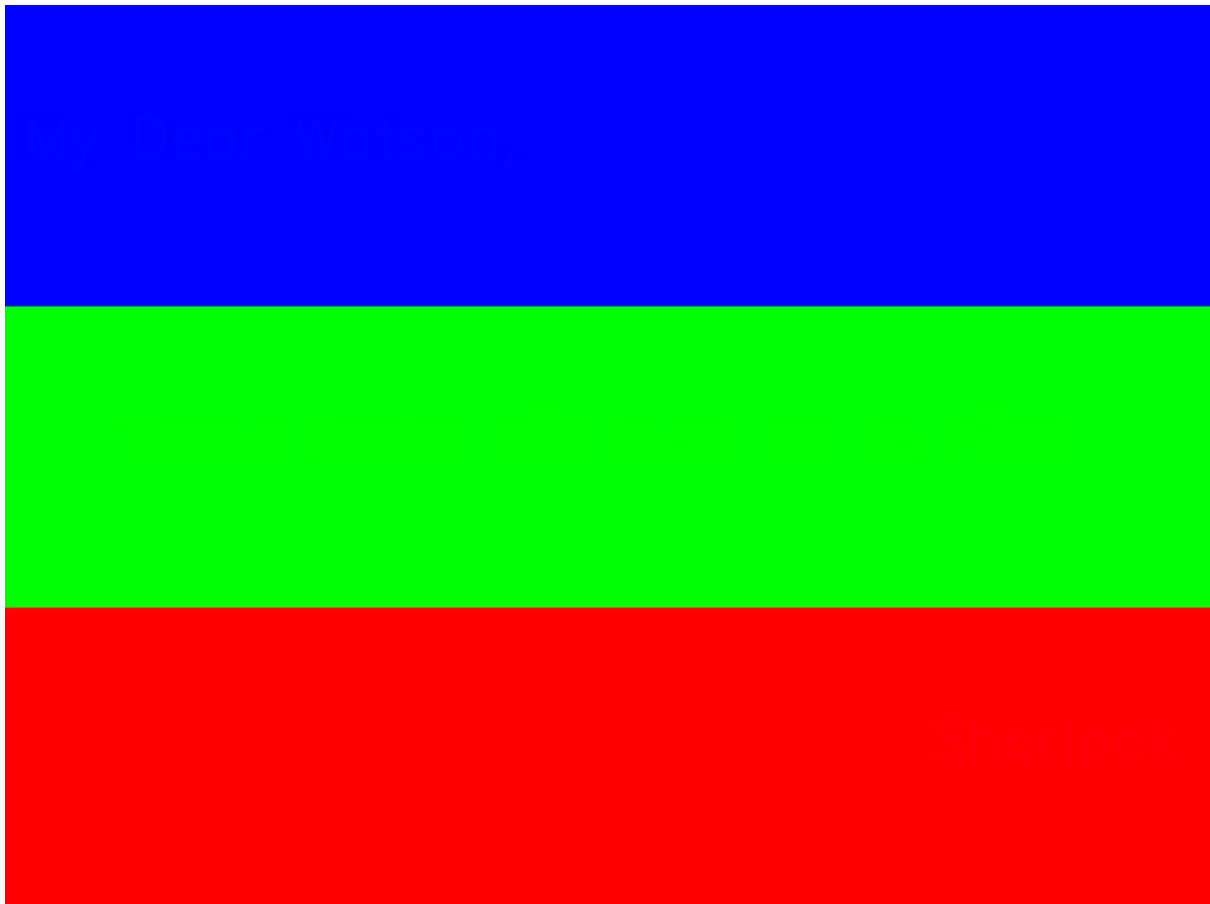


## Task 1: Sherlock's Message (5 points)

It is October 24, 2048. The famed detective, Sherlock Holmes, has been investigating a series of recent autonomous driving incidences related to abnormal malfunctioning of their perception systems. Sherlock traced clues for several months, which inevitably lead him to his archenemy, Professor Moriarty, a notorious cracker, and his acolyte, Colonel Moran, a vicious roboticist wanted by Scotland Yard for a long time. Sherlock believes Moriarty and Moran must have been trying to use an old technique named adversarial attack to tamper with YouDrive, the driverless car system used worldwide. YouDrive is so complicated that almost no one can understand it both holistically and atomistically. To prevent Moriarty and Moran to make more harms and damages, Sherlock decided to study robot perception, the engineering field that enabled YouDrive, to better fight against the sinister gang.

This evening at around 6 pm, Dr. John Watson, Sherlock's roommate and a doctor who is also well-known for pioneering the use of artificial intelligence in his clinical practices, came back their home at 221B Baker Street, London, and found Sherlock missing, who originally initiated the dinner tonight with John and Ms. Irene Adler, the CEO of YouDrive and the frenemy of Sherlock, to discuss about those incidents. However, he seems to have left a secret message for them on the laptop left open on purposely, as shown in Figure 1.



Since neither John nor Irene specializes in robot perception, they came to you, the CTO&CSO of YouDrive. The image has been saved as the **for\_watson.png** file. Can you please **write some code** and **report** the decode the message from Sherlock?

## Solution:

For this Problem, the message is encoded within the picture given above by enforcing varying magnitudes of the same colour as of the background picture. However, it is not visible by naked eye, as I cannot differentiate between the intensities of the pure colours. Therefore, in order to decode the message I need to find out the values of Red, Green and Blue intensities of each pixel.

In order to solve the Problem, I use the Open CV Library. My Python code reads each pixel of the image and from there finds out the R-G-B values of each pixel. It forms a matrix of  $640 \times 480 \times 3$ , where  $640 \times 480$  symbolizes the dimension of the image with respect to number of pixels and three represents the values of Red, Green and Blue intensities in those pixels. From the extracted values, I check if a specific pixel has the intensity of 0, 255, or some different value and carry out this procedure for every other pixel. Zero signifies the absence of that colour and 255 signifies the highest intensity of that colour. Therefore, the encoded message must have a different pixel value other than these two for at least one of the colours in every pixel. If a pixel carries any other value of Red, Blue or Green other than 0 or 255, I record that value for that specific pixel and carry it out for all the pixels. To print out my result, I use a white image where all the coefficients of Red, Blue and Green are kept as high as 255. Then after, I add those recorded pixel values to the output image. Therefore, in the output white image I get the decoded message printed.

The message is:

My Dear Watson,

These tasks will lead us to him!

Sherlock

I can see that the first two lines of the message are written in the same colour as the background colour and that is why it was hard to figure them out. In addition, the third line had a combination of colours other than just pure Red unlike the other two lines, which had pure Blue and Green. This makes the colour of the third line Yellow.