The process of converting an RGB (Red, Green, Blue) image to grayscale using matrix operations and properties.

RGB Images

- They are made up of pixels, each pixel represents the intensity of 3 colors : Red(R) Green(G) and Blue(B)

Grayscale Images

- They are too made up of pixels but, each pixel represent a single brightness value - that falls in some shade of gray

Conversion

- Thus, for conversion of each pixel from RGB to grayscale and thus, then the entire image, the splitted color information into 3 brightness channels of R,G and B has to be combined into single brightness value

Weighted Combination

- For the conversion - weighted average approach is applied
- Weights are assigned to each color channel as per the human perception
- Green>Red>Blue in terms of Weight Given

Matrix Operation

- These weights are applied to each pixel of RGB image using concept of matrix multiplication
- Each pixel in the matrix is multiplied by the corresponding R, G, and B values with their respective weights.
- These weighted values are summed up to get the brightness value for the grayscale image.

Result

- After performing matrix operations for all pixels, a single grayscale matrix is obtained.
- Each element in this matrix represents the brightness level of the corresponding pixel in the original image.

This grayscale matrix forms the basis for the grayscale image, where each pixel represents a shade of gray determined by the weighted combination of the original RGB colors.

Example

- Consider the following 3×3 RGB image:
    - [(255, 0, 0), (0, 255, 255), (128, 0, 128)]
    - [(0, 128, 0), (255, 255, 0), (0, 0, 255)]
    - [(255, 128, 0), (128, 128, 128), (0, 255, 128)]

- Weights Used: Red (0.299), Green (0.587), Blue (0.114).

- For the first pixel (255, 0, 0):
    - Grayscale value = 255 × 0.299 + 0 × 0.587 + 0 × 0.114 = 76.245
- For the second pixel (0, 255, 255):
    - Grayscale value = 0 × 0.299 + 255 × 0.587 + 255 × 0.114 = 173.784
- For the third pixel (128, 0, 128):
    - Grayscale value = 128 × 0.299 + 0 × 0.587 + 128 × 0.114 = 54.366
- For the fourth pixel (0, 128, 0):
    - Grayscale value = 0 × 0.299 + 128 × 0.587 + 0 × 0.114 = 50.367
- For the fifth pixel (255, 255, 0):
    - Grayscale value = 255 × 0.299 + 255 × 0.587 + 0 × 0.114 = 226.794
- For the sixth pixel (0, 0, 255):
    - Grayscale value = 0 × 0.299 + 0 × 0.587 + 255 × 0.114 = 29.07
- For the seventh pixel (255, 128, 0):
    - Grayscale value = 255 × 0.299 + 128 × 0.587 + 0 × 0.114 = 202.971
- For the eighth pixel (128, 128, 128):
    - Grayscale value = 128 × 0.299 + 128 × 0.587 + 128 × 0.114 = 128
- For the ninth pixel (0, 255, 128):
    - Grayscale value = 0 × 0.299 + 255 × 0.587 + 128 × 0.114 = 139.034

- Grayscale matrix (rounded to nearest integer):
    - [76, 174, 54]
    - [50, 227, 29]
    - [203, 128, 139]