Histogram Processing

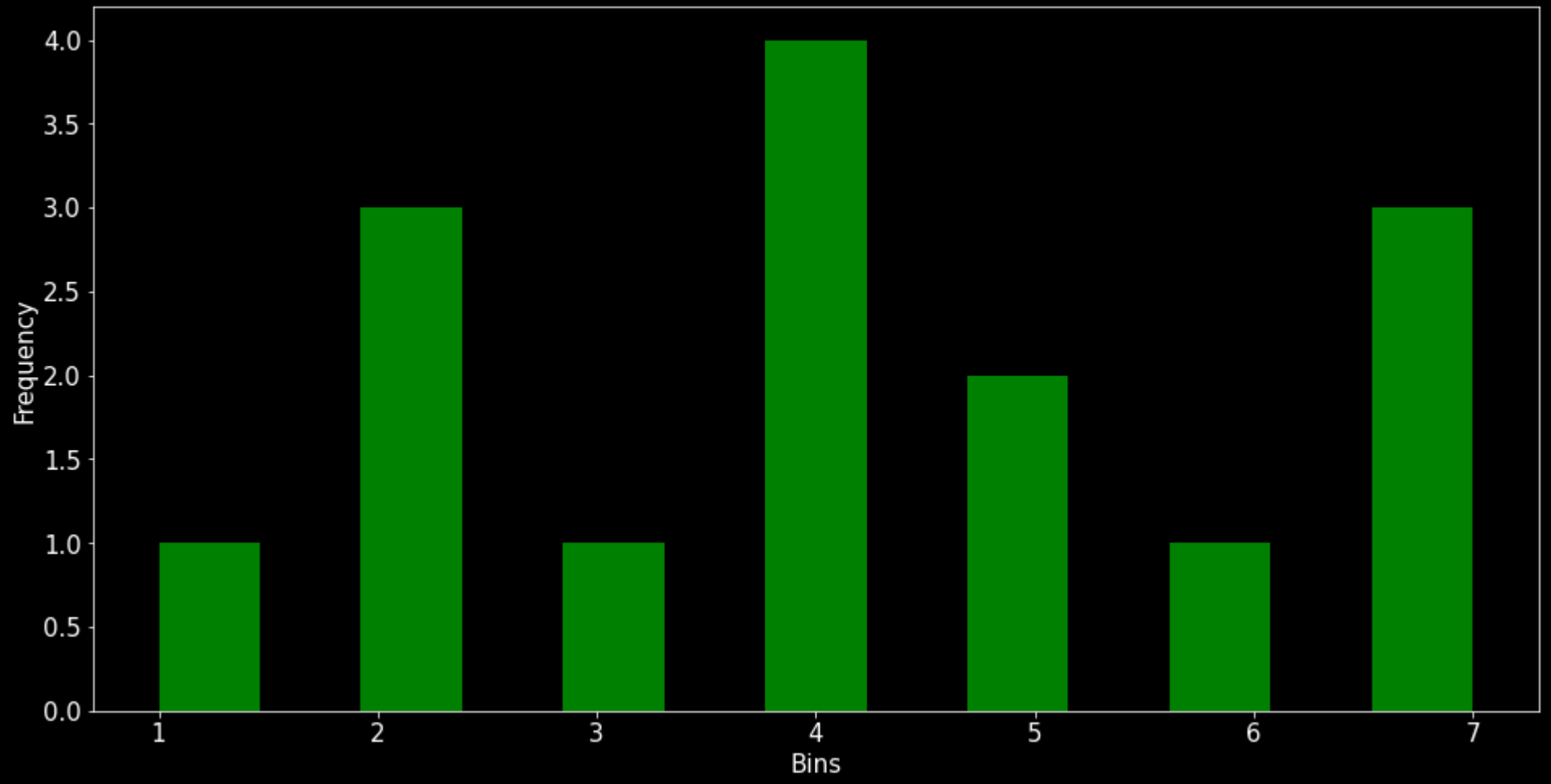
Topics to be covered

- Histogram
- Histogram of Gray Level Image
- Histogram of Color Image
- Histogram Equalization

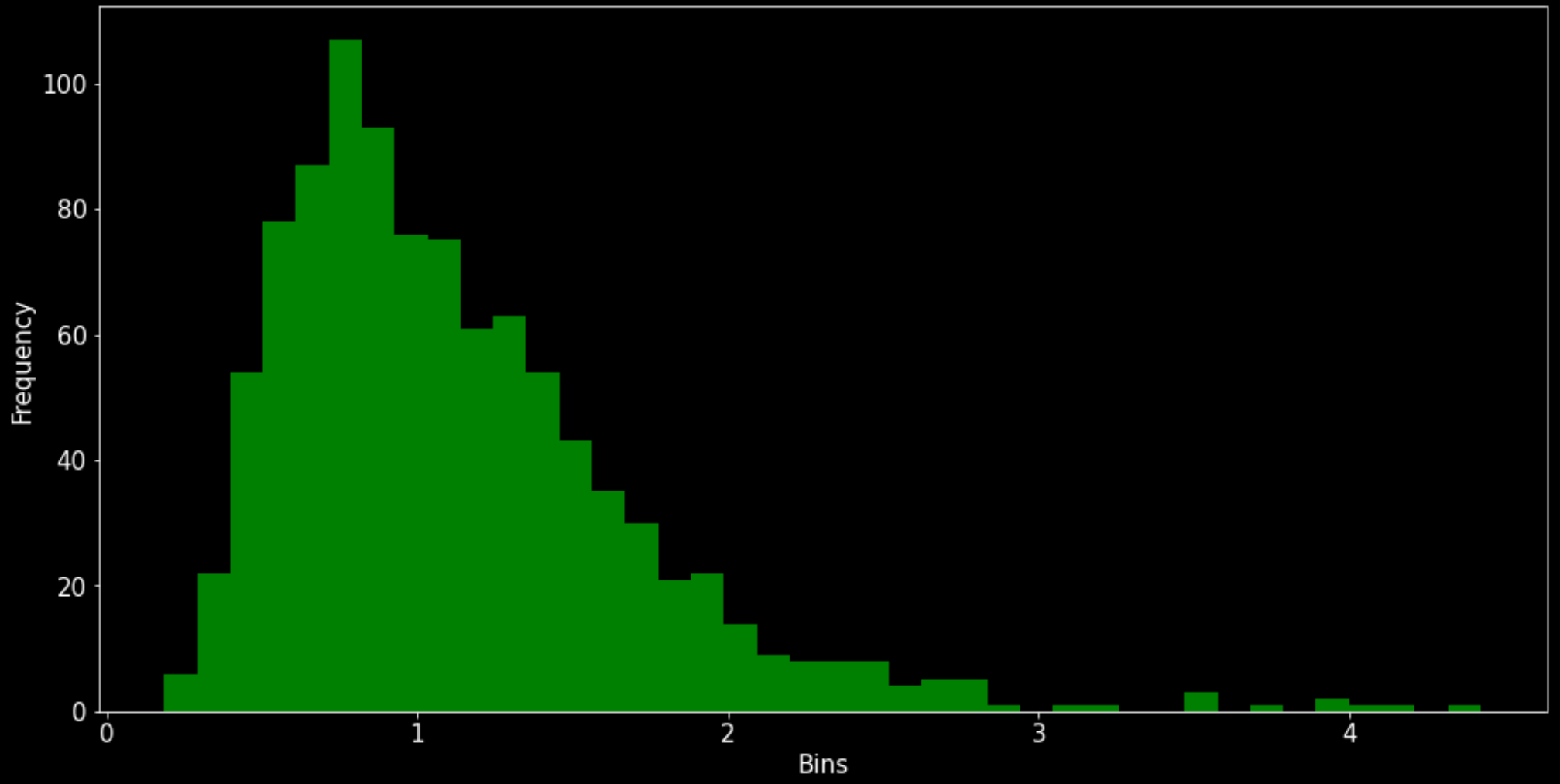
Histogram

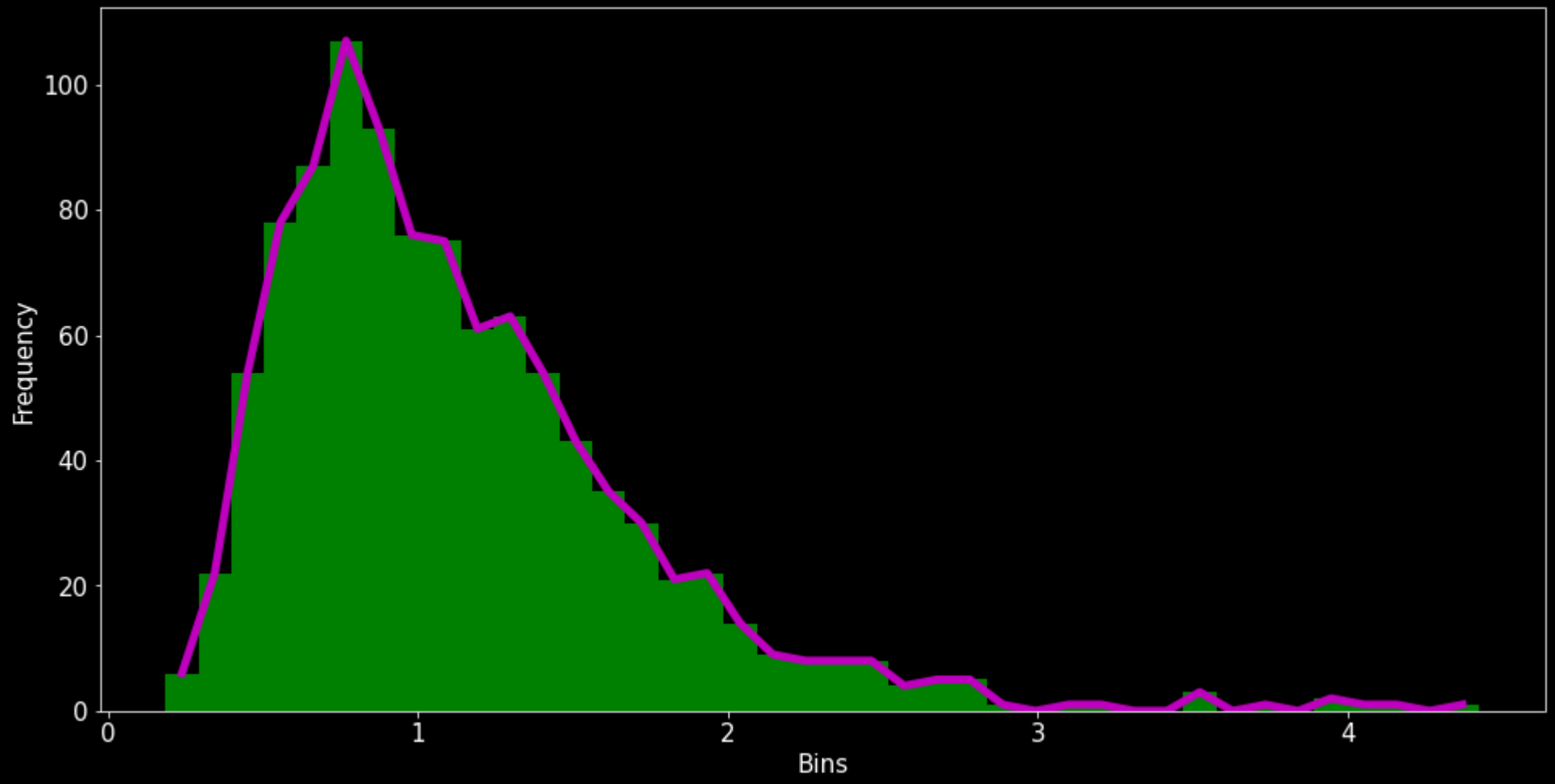
Histogram is a visual or graphical distribution of the frequency of occurence of continuous features OR events.

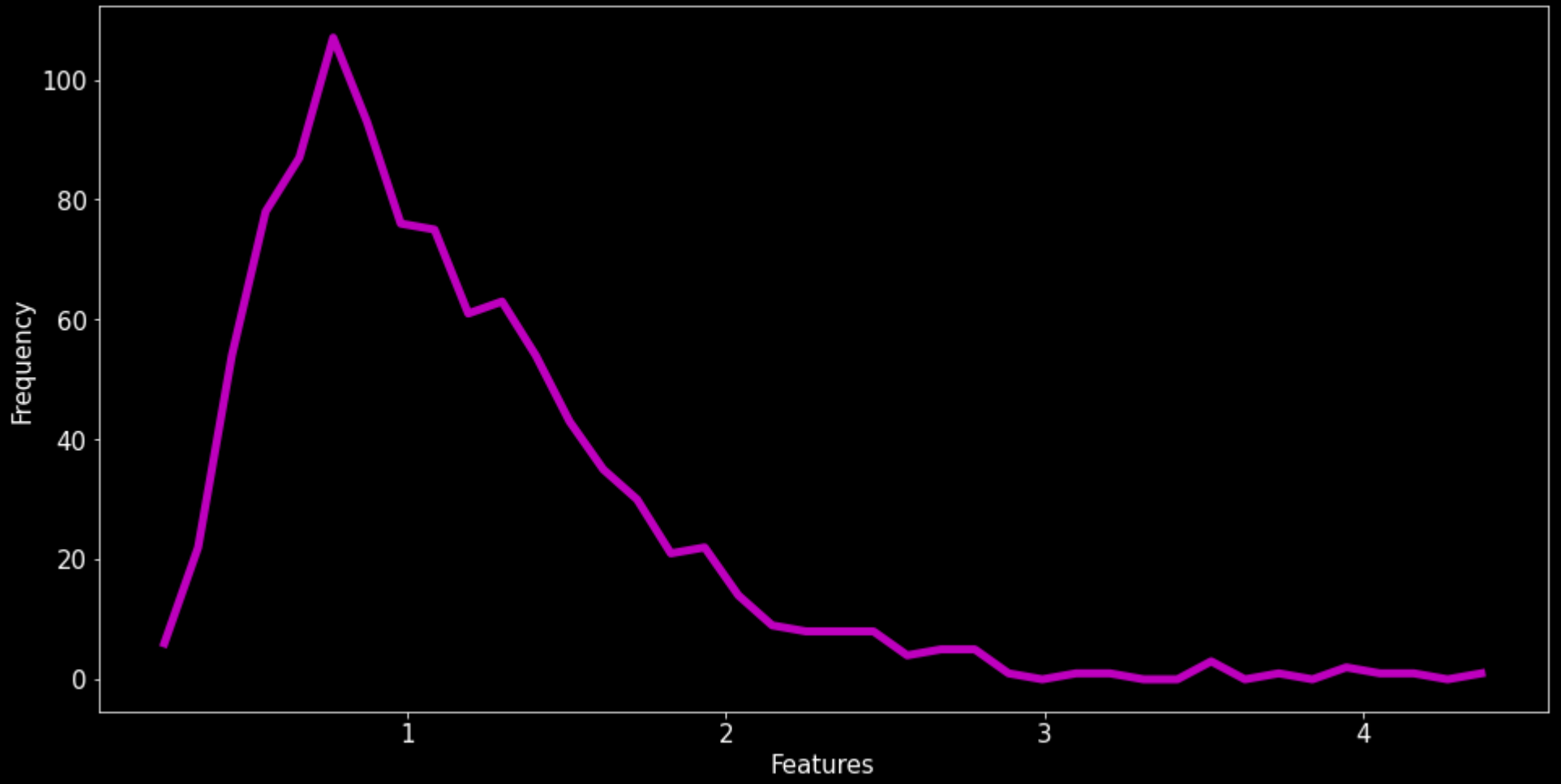
Data = [1, 2, 2, 2, 3, 4, 4, 4, 4, 5, 5, 6, 7, 7, 7]



Another Example




100
80
60
40
20
0
Frequency
0
1
2
3
4
Bins


100
80
60
40
20
0
Frequency
1
2
3
4
Features

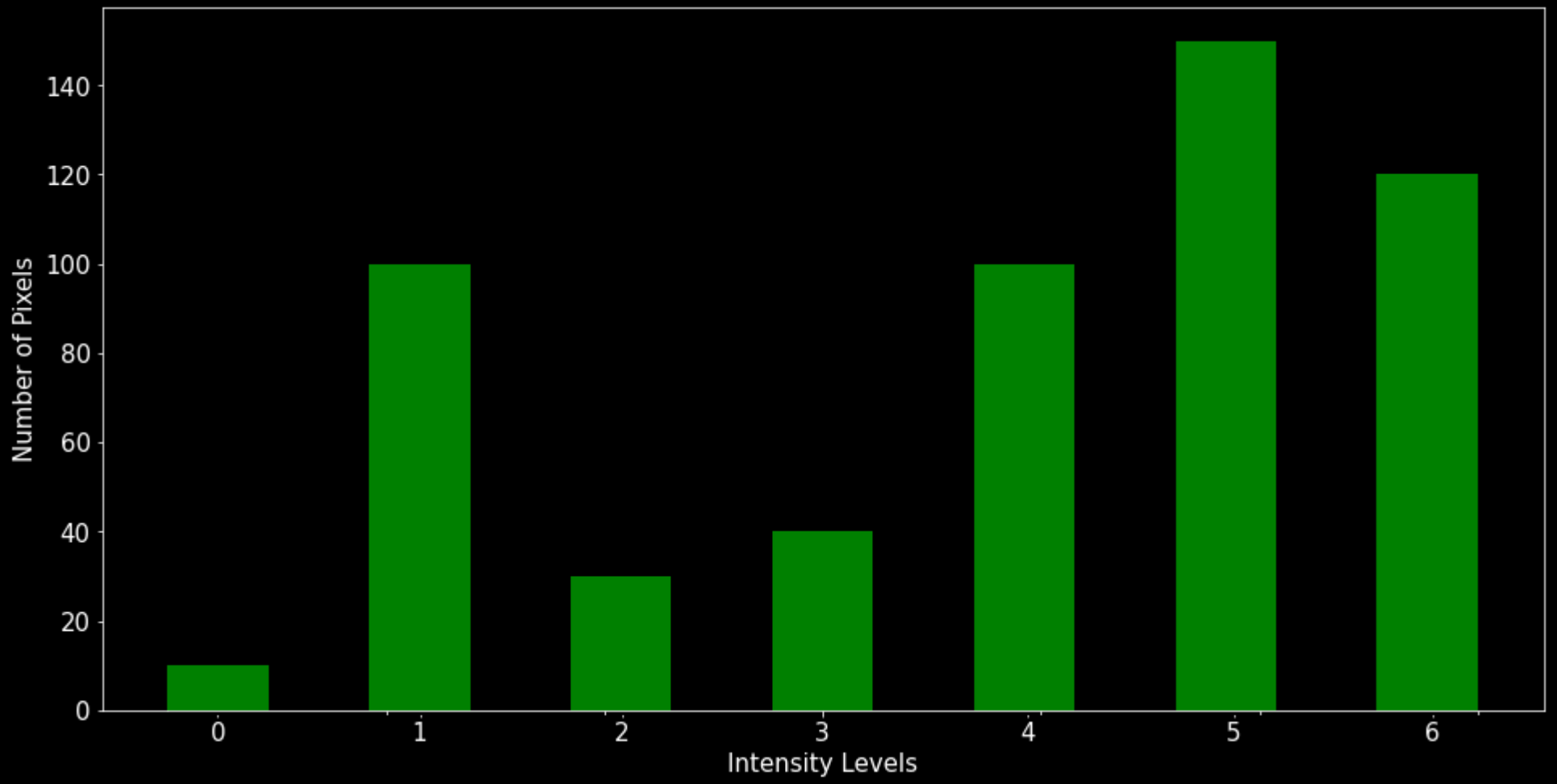
Histogram of a Gray Level Image

The range of intensity levels for gray scale image is between 0 and 255 i.e $(0 - 255)$.

Example

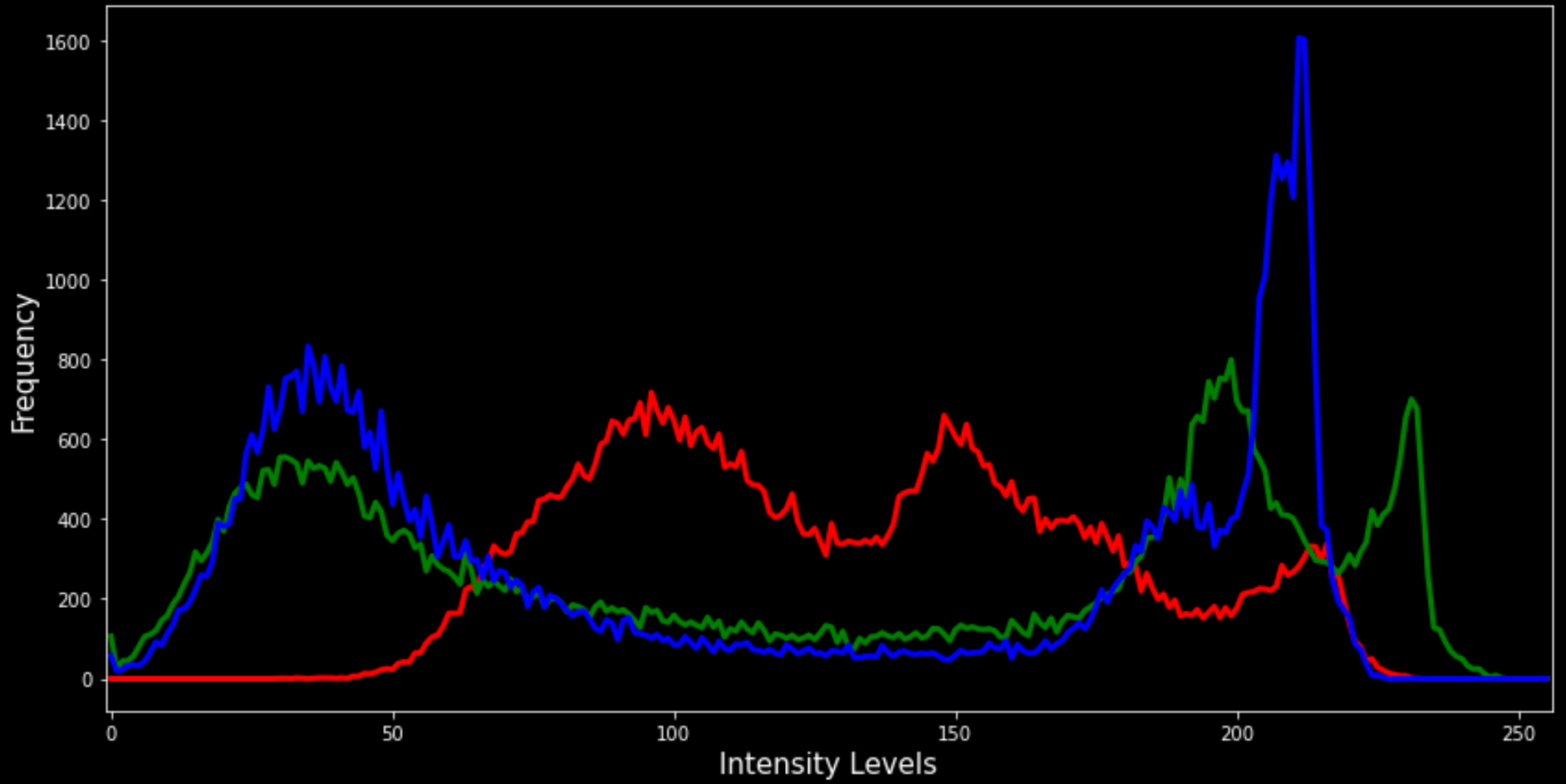
Intensity Levels	Number of Pixels
0	10
1	100
2	30
3	40
4	100
5	150
6	120

Histogram of Seven Intensity Levels of Gray Scale Image



Color Image Histogram

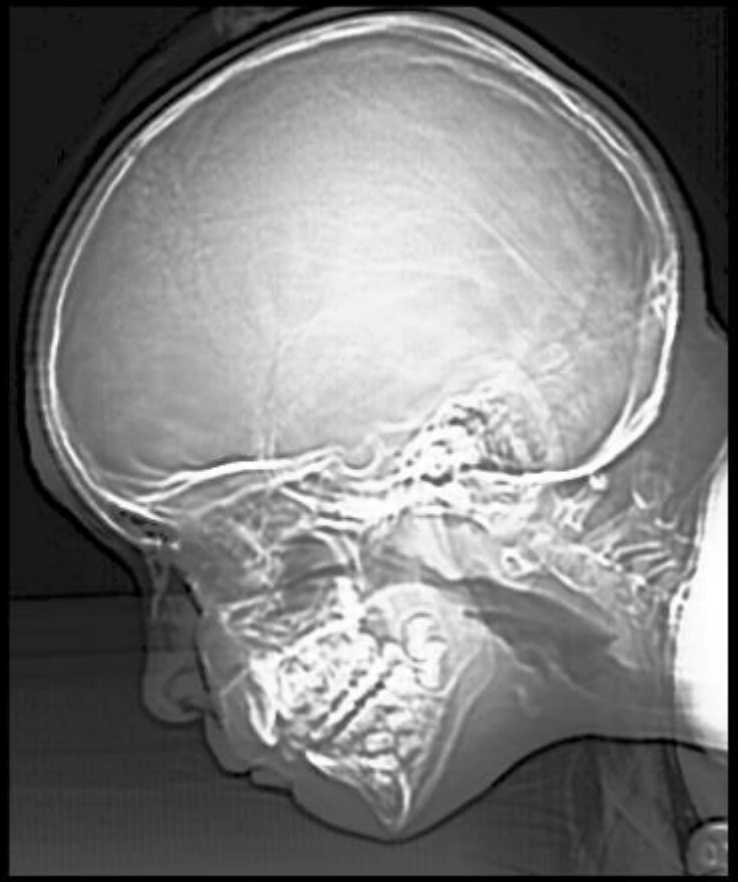
- For color images we can distribute the frequency of the values of colors.
- Since color image has three channels (RGB) and has values between $(0-255)$, therefore, we can plot three histograms on top of each other to represents the frequency of values of each color.


1600
1400
1200
1000
800
600
400
200
0
Frequency
0
50
100
150
200
250
Intensity Levels

Histogram Equalization

Histogram equalization is a technique in which we try to distribute the intensity of an image in such a way as to obtain a uniform (flat) resulting histogram, in which the percentage of pixels of every intensity value is the same. This is done to obtain a better image which has more details than the input image.

Input Image

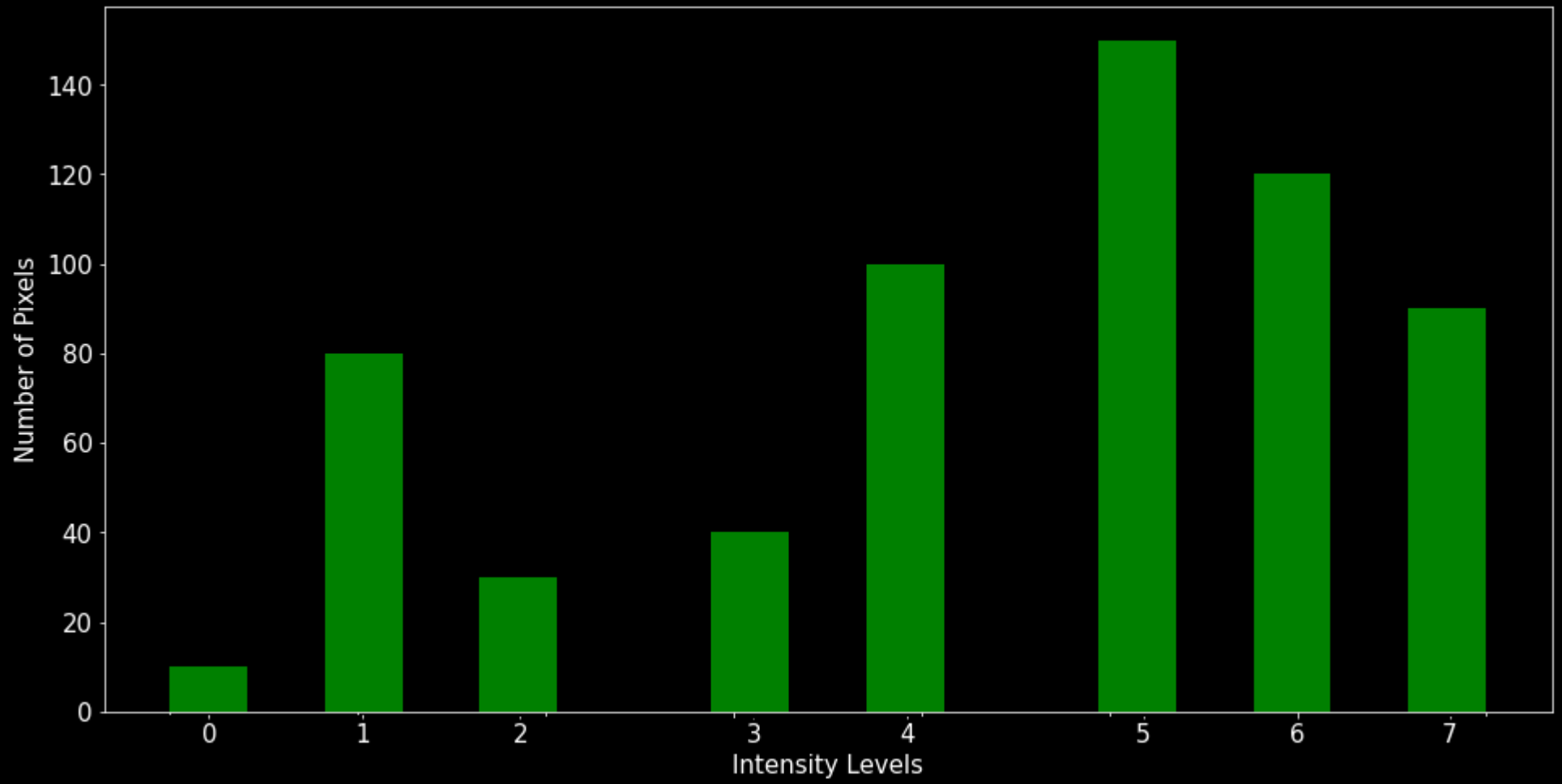


Histogram Equalized

Numerical Example

Intensity Levels (r_k)	Number of Pixels	Probability Distribution $p_k = \frac{r_k}{n}$
0	10	0.016
1	80	0.129
2	30	0.048
3	40	0.064
4	100	0.161
5	150	0.242
6	120	0.193
7	90	0.145

$$n = 620$$


Number of Pixels
0
20
40
60
80
100
120
140
0
1
2
3
4
5
6
7
Intensity Levels

Histogram Equalization

The commonly used function for histogram equalization is commulative distribution function (cdf).

$$s_k = T(r_k) = \sum_{j=0}^{k} p(r_j)$$

$$s_0 = T(r_0) = \sum_{j=0}^{0} p(r_j) = p(r_0) = 0.016$$

$$s_1 = T(r_1) = \sum_{j=0}^{1} p(r_j) = p(r_0) + p(r_1) = 0.145$$

Similarly,

$s_2 = 0.193$

$s_3 = 0.257$

Intensity Levels (r_k)	**Number of Pixels**	**Probability Distribution** $p_k = \frac{r_k}{n}$
0	10	0.016
1	80	0.129
2	30	0.048
3	40	0.064
4	100	0.161
5	150	0.242
6	120	0.193
7	90	0.145

$n = 620$

$$s_4 = 0.418$$

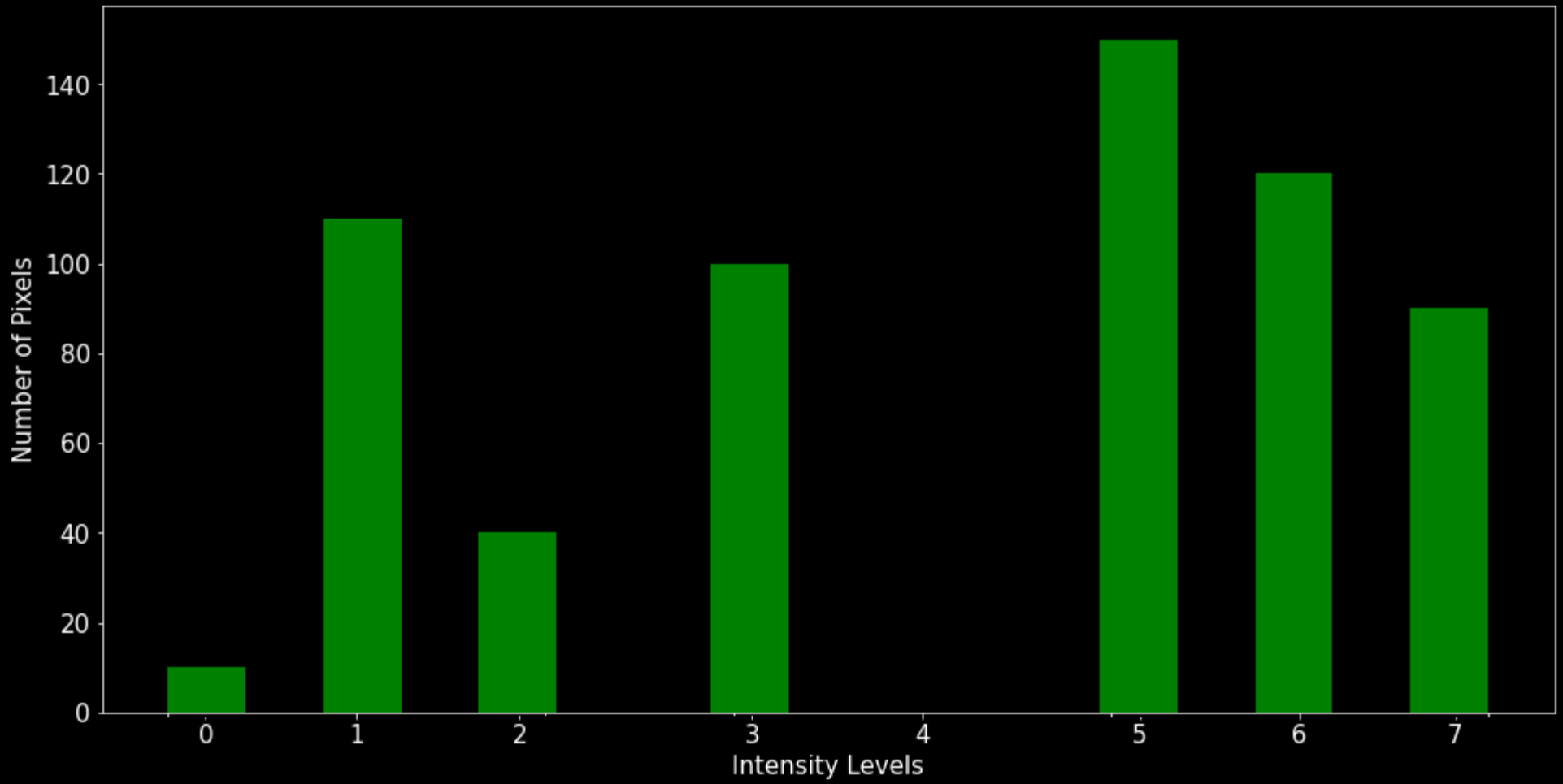
$$s_5 = 0.66$$

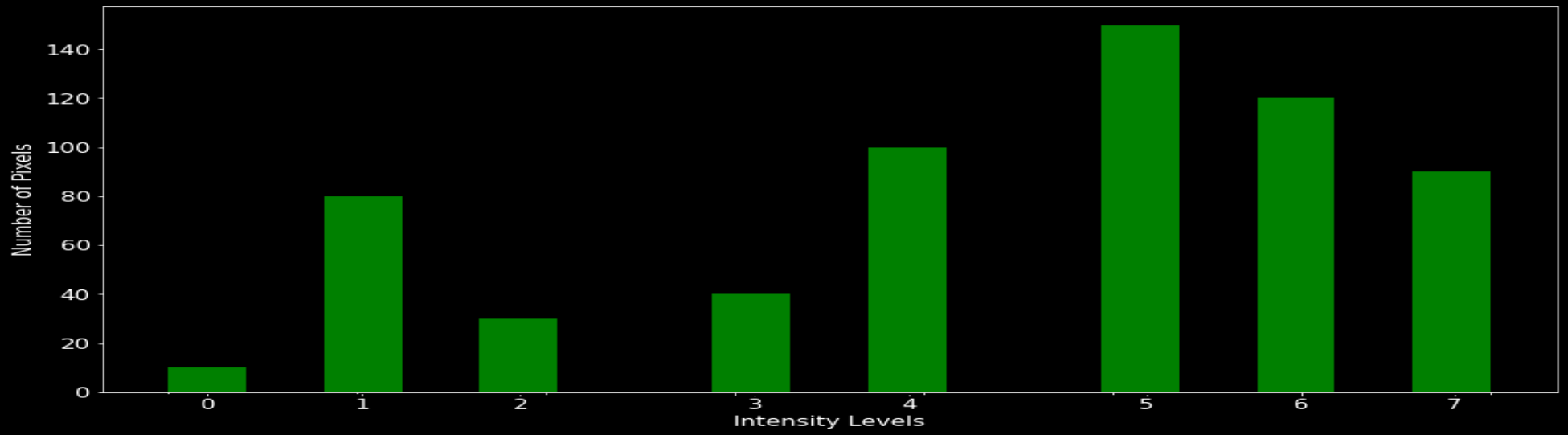
$$s_6 = 0.853$$

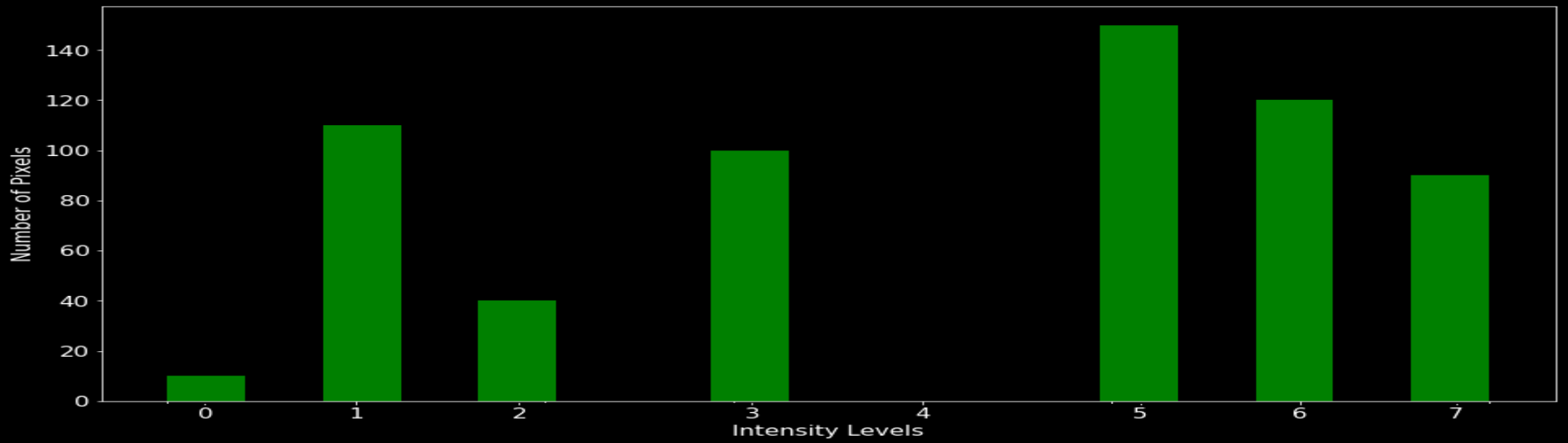
$$s_7 = 1.00$$

Intensity Levels (r_k)	**Number of Pixels**	**Probability Distribution** $p_k = \frac{r_k}{n}$	**Commulative Distribution Function** (s_k)	$(s_k) \times 7$	**New Intensity Levels** (s_k)
0	10	0.016	0.016	0.112	0
1	80	0.129	0.145	1.015	1
2	30	0.048	0.193	1.351	1
3	40	0.064	0.257	1.8	2
4	100	0.161	0.418	2.92	3
5	150	0.242	0.66	4.62	5
6	120	0.193	0.853	5.97	6
7	90	0.145	1.00	7.00	7

New Intensity Levels (s_k)	Number of Pixels
0	10
1	110
2	40
3	100
4	0
5	150
6	120
7	90


Number of Pixels
0
20
40
60
80
100
120
140
0
1
2
3
4
5
6
7
Intensity Levels


Number of Pixels
0
20
40
60
80
100
120
140
0
1
2
3
4
5
6
7
Intensity Levels


Number of Pixels
0
20
40
60
80
100
120
140
0
1
2
3
4
5
6
7
Intensity Levels

Histogram Equalization of Color Images

Color Spaces

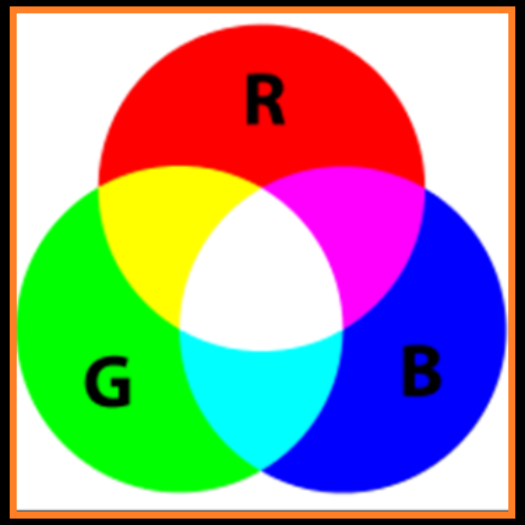
RGB Color Spaces

RGB is an additive color space model that generates colors by combining blue, green and red and different intensities.

Red – Intensity Levels (0–255)

Green – Intensity Levels (0–255)

Blue – Intensity Levels (0–255)



HSV Color Spaces

Hue, Saturation and Value (HSV) is a color space model that represents the colors the way the humans perceive.

It stores color information in a cylindrical representation of RGB color points.

Hue – Color Value (0 – 179)
Saturation – Vibrancy of color (0-255)
Value – Intensity (0-255)