

# Histogram Equalization

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# Histograms

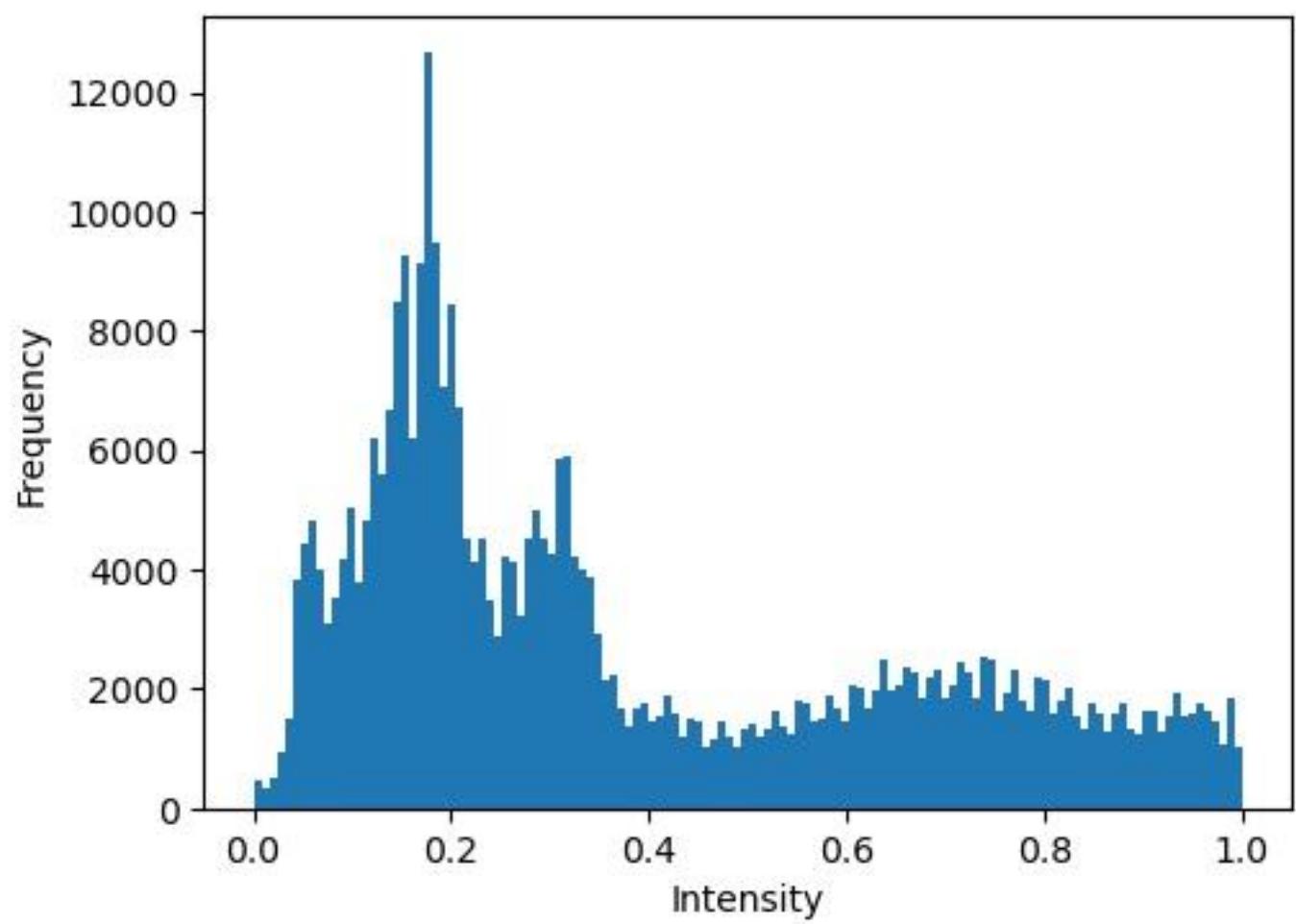
## Definition

A histogram is a graphical representation of the distribution of a variable

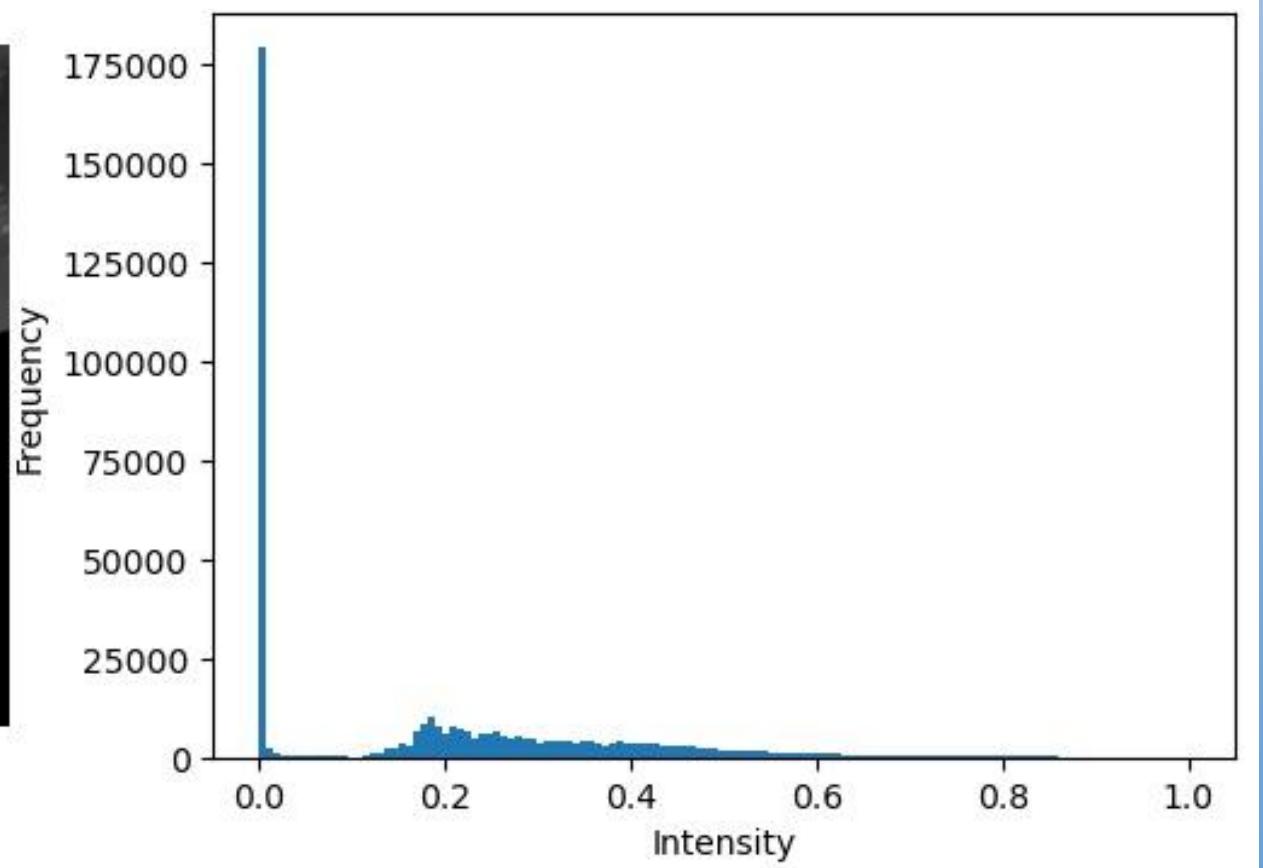
To create a histogram, we divide the variable range into a set of intervals and count how many values of the variable fall in each interval

In computer vision we are often interested in the distribution of intensity levels in an image

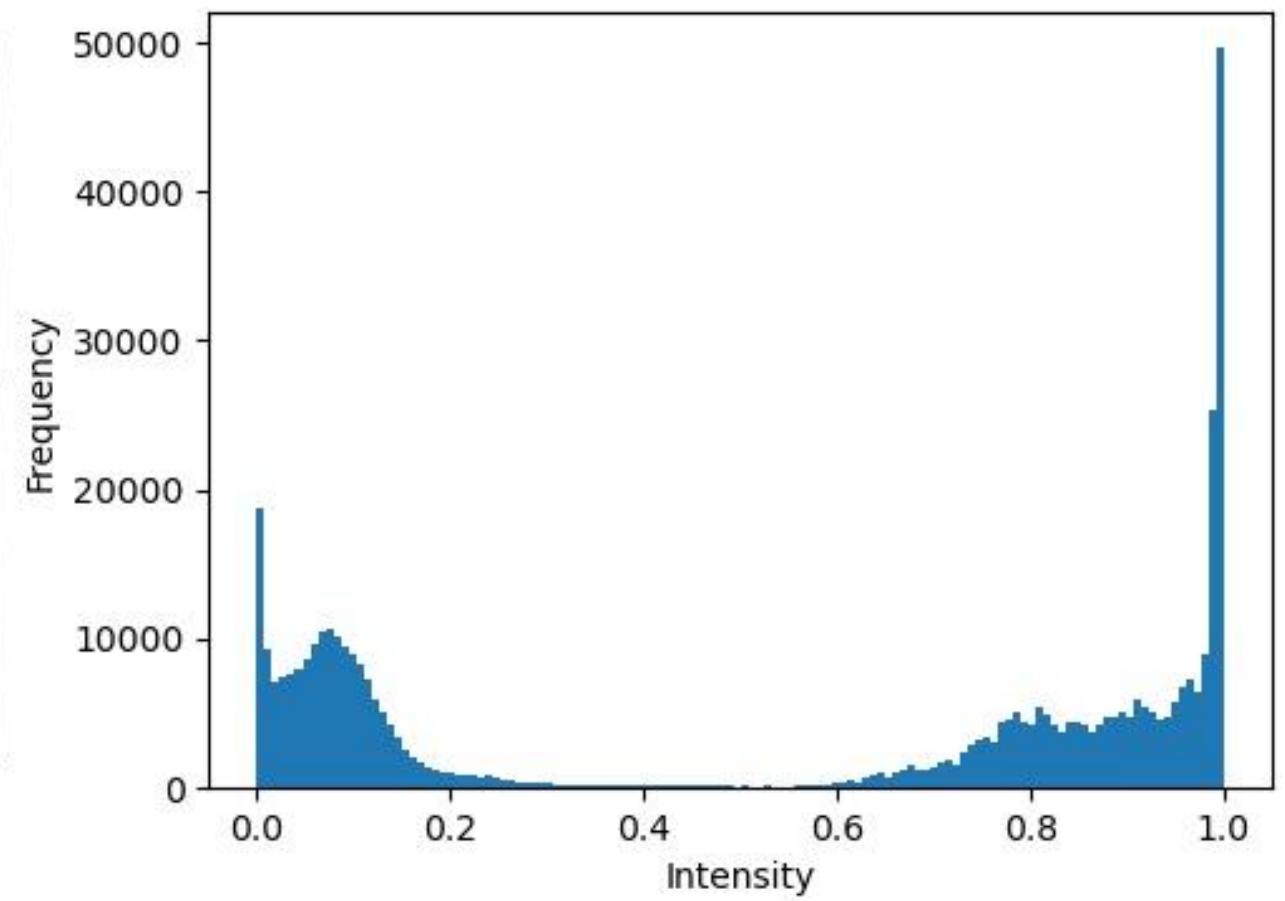
# Intensity Histograms



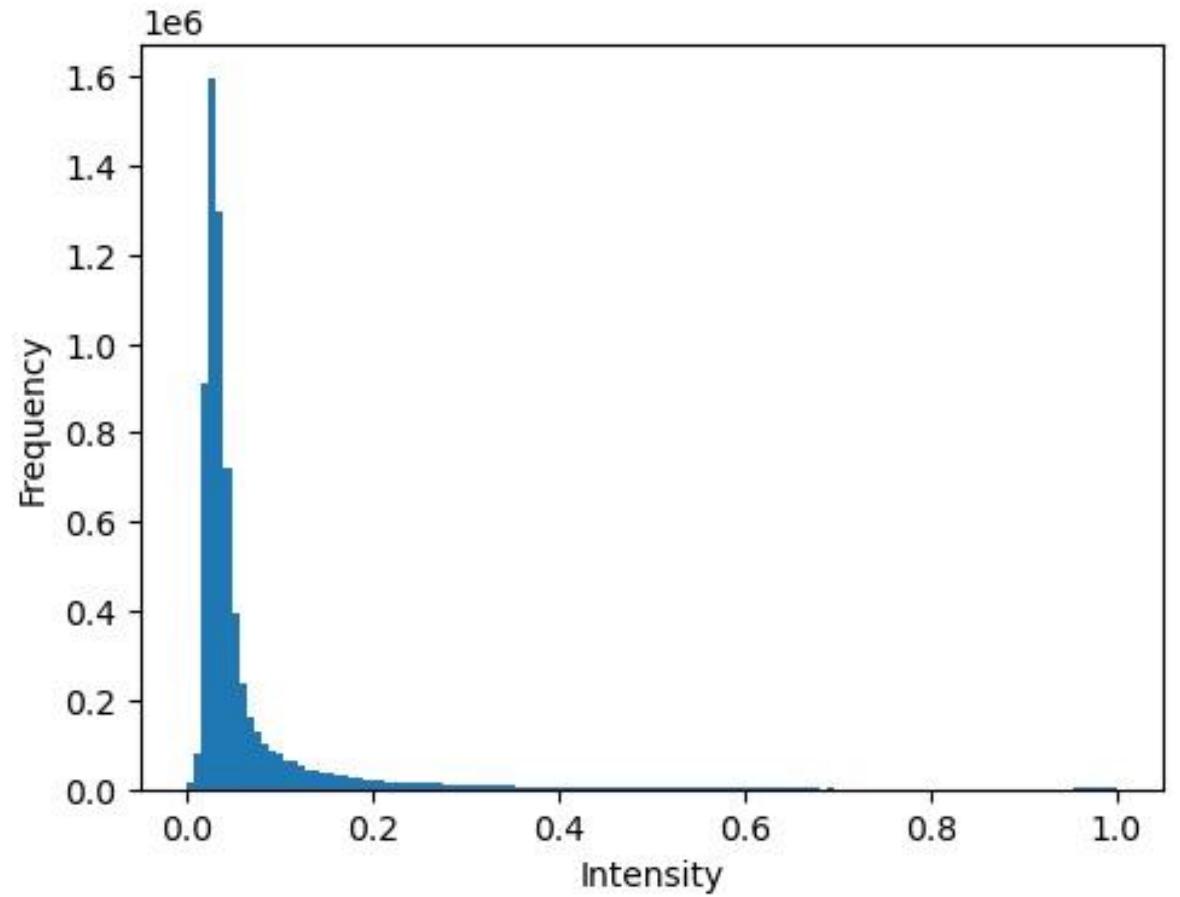
# Intensity Histograms



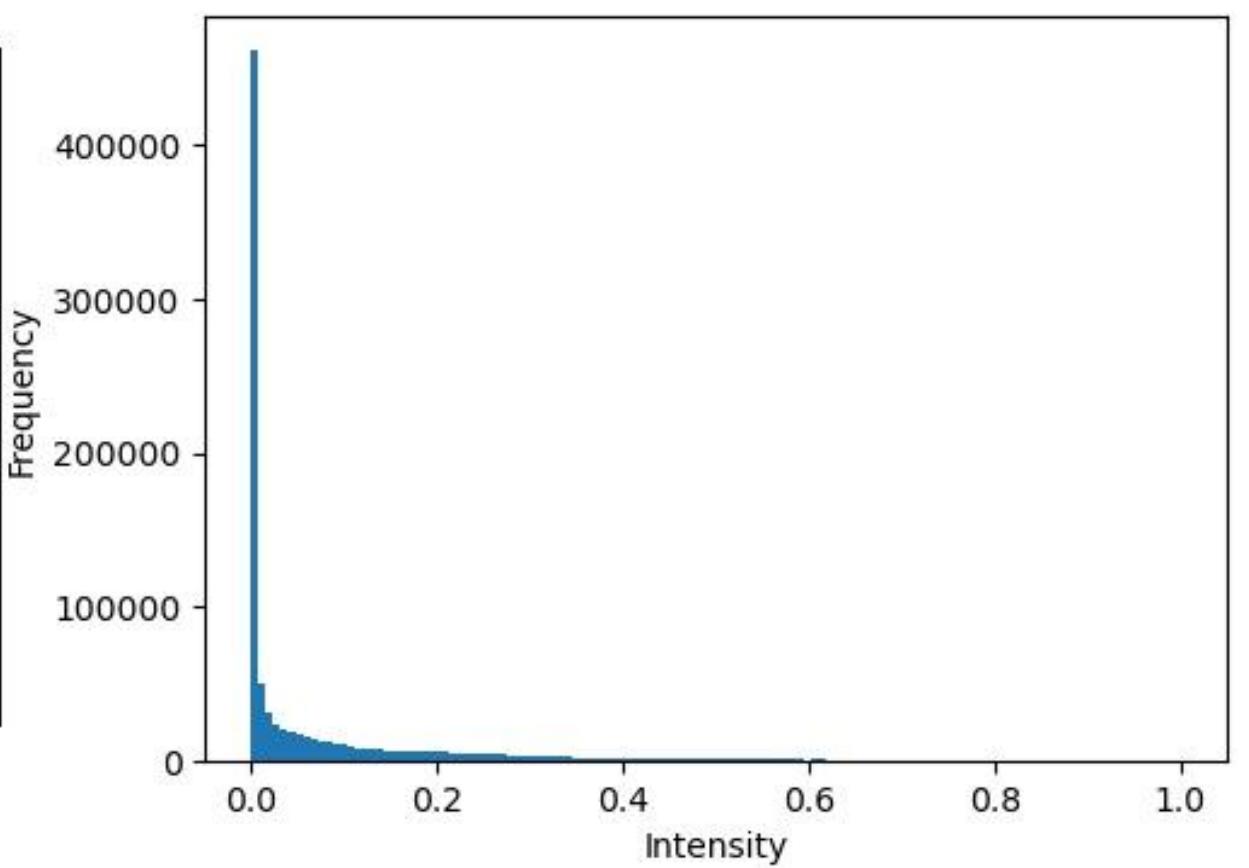
# Intensity Histograms



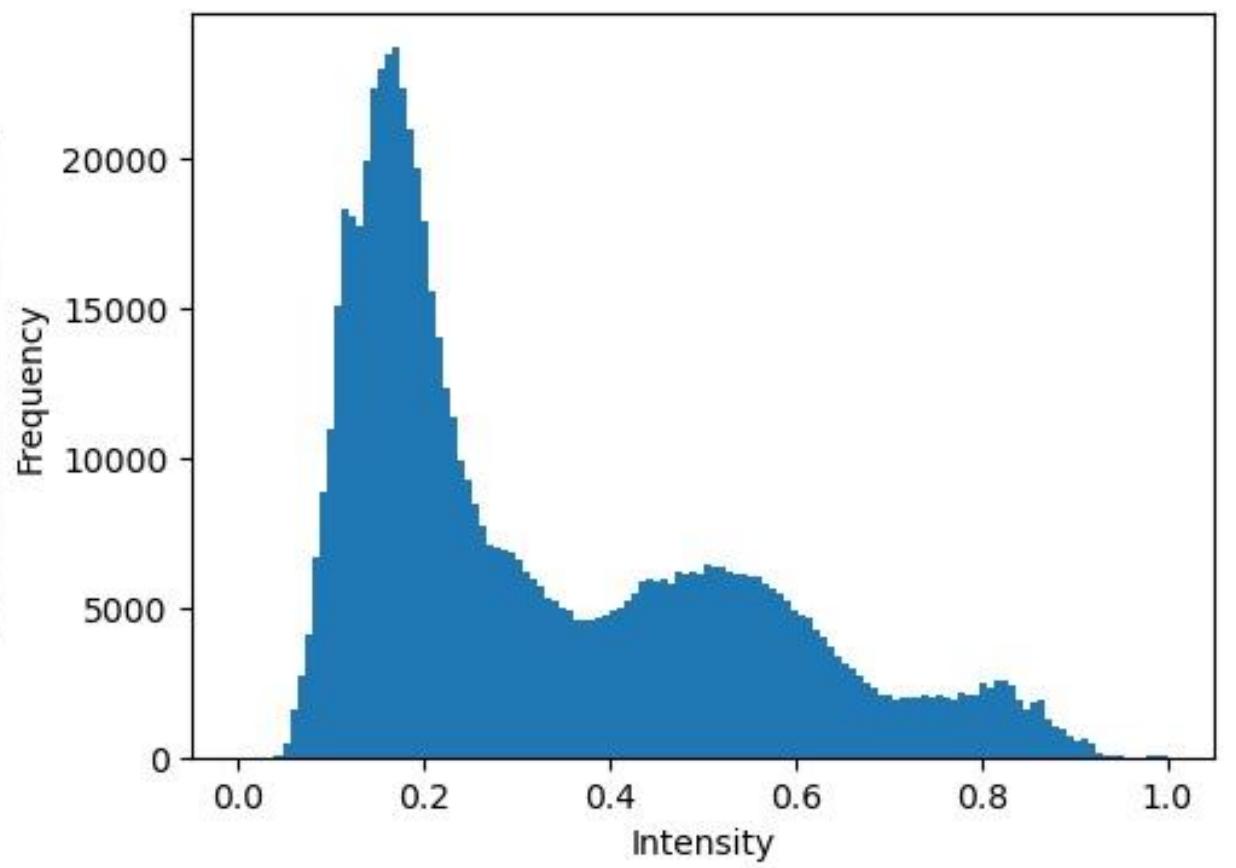
# Intensity Histograms



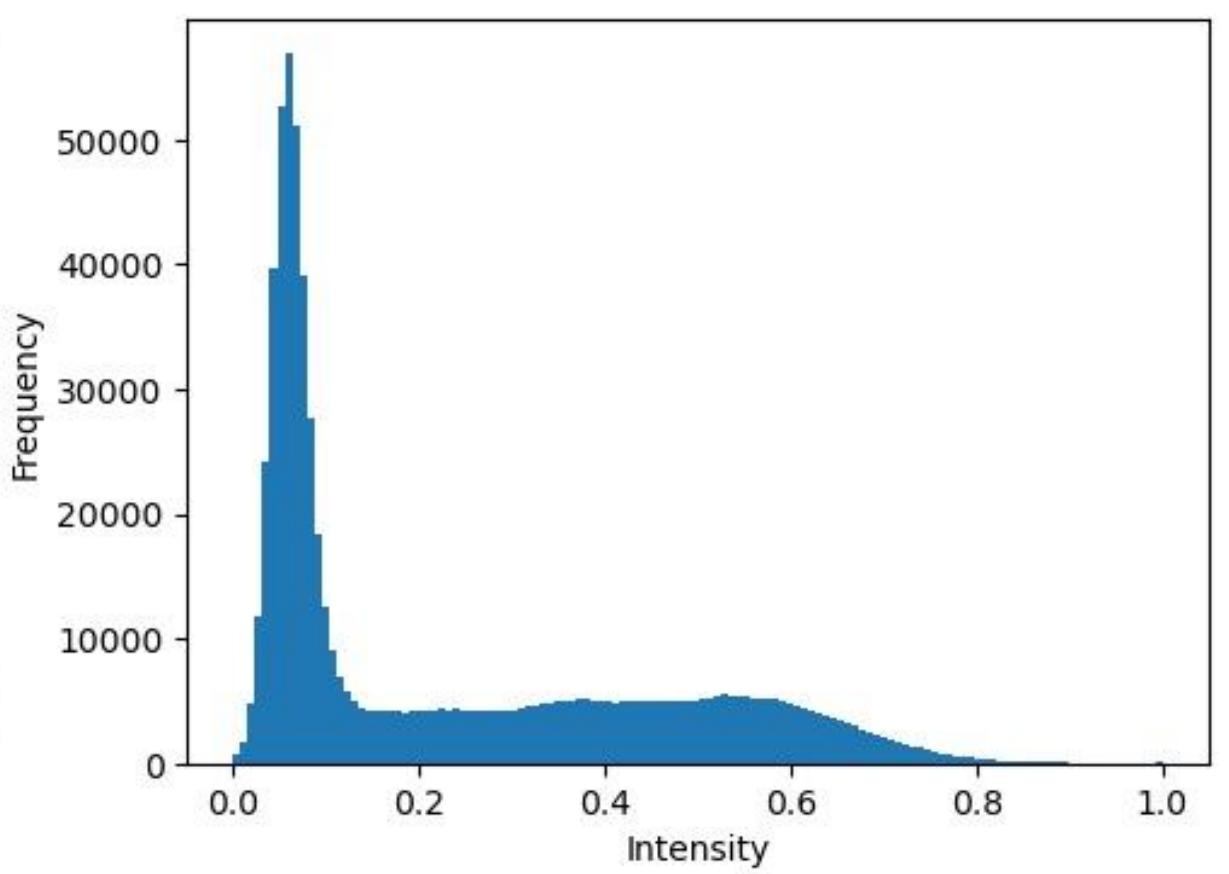
# Intensity Histograms



# Intensity Histograms



# Intensity Histograms



# Histogram Equalization

Histogram equalization is a transformation to the intensity of an image to make its resulting histogram flat

$$f(x) = \text{rank}(x, I) / (\text{size of } I - 1)$$

where  $\text{rank}(x, I)$  is the position of  $x$  when  $I$  is sorted in ascending order

thus the rank of the darkest pixel is 0, the rank of the second darkest is 1, and so on

Depending on how we break ties, histogram equalization can yield significantly varying results

Commonly used tie-breaking strategies:

'min' - Assign to the set of pixels with identical intensities the minimum rank in the set

'max' - Assign to the set of pixels with identical intensities the maximum rank in the set

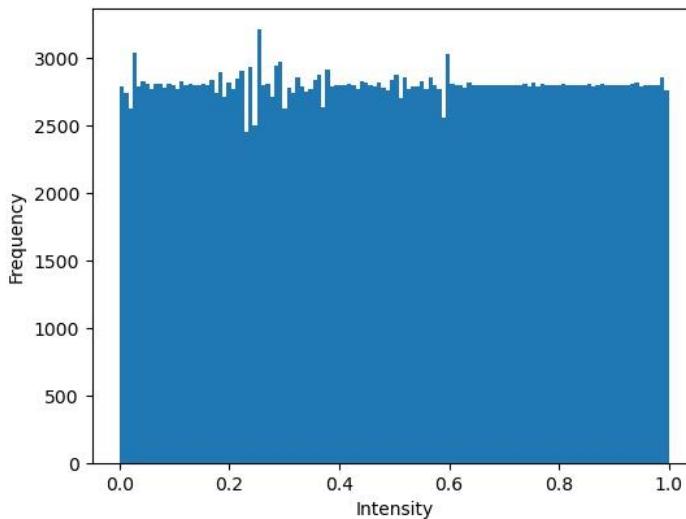
'average' - Assign to the set of pixels with identical intensities the mean rank in the set

# Histogram Equalization

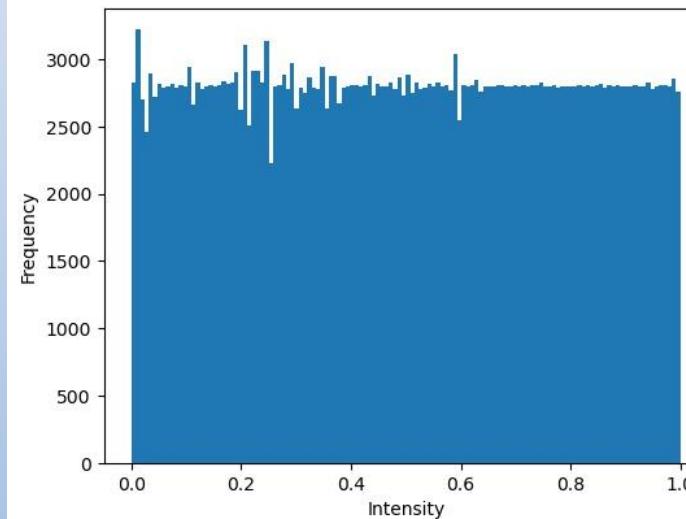
```
from scipy.stats import rankdata  
tiebreak = 'max' # 'min' or 'average' are other valid options  
im_h = rankdata(im.reshape(-1),method = tiebreak).reshape(im.shape)  
im_h = im_h/npamax(im_h)
```

# Histogram Equalization

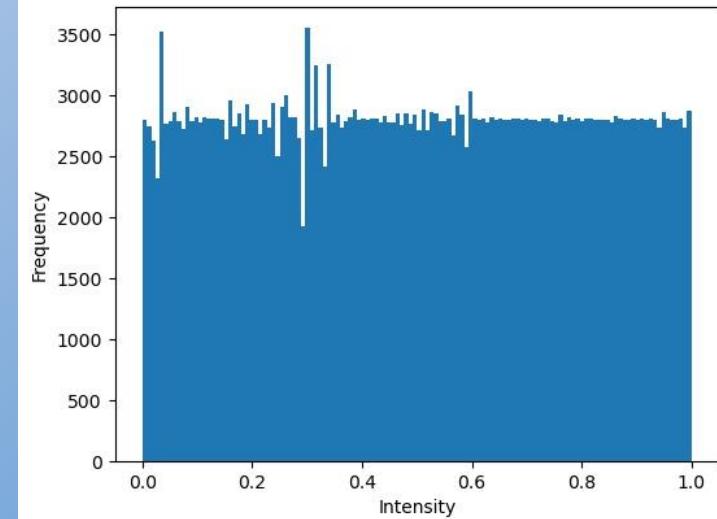
Histogram equalization, rank tiebreak = average



Histogram equalization, rank tiebreak = min

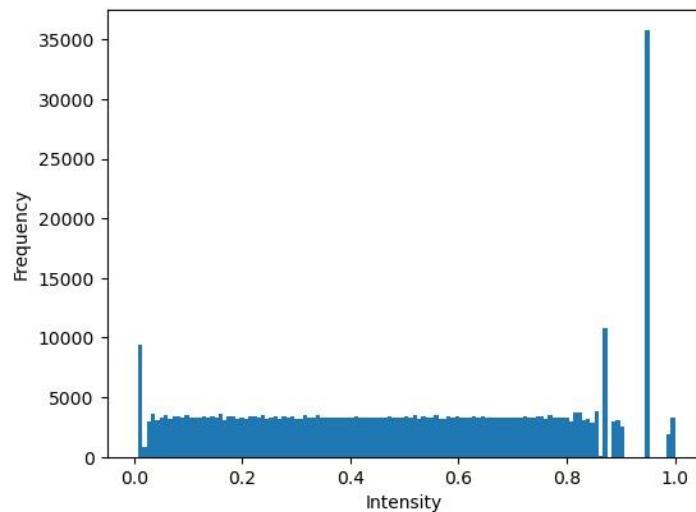


Histogram equalization, rank tiebreak = max

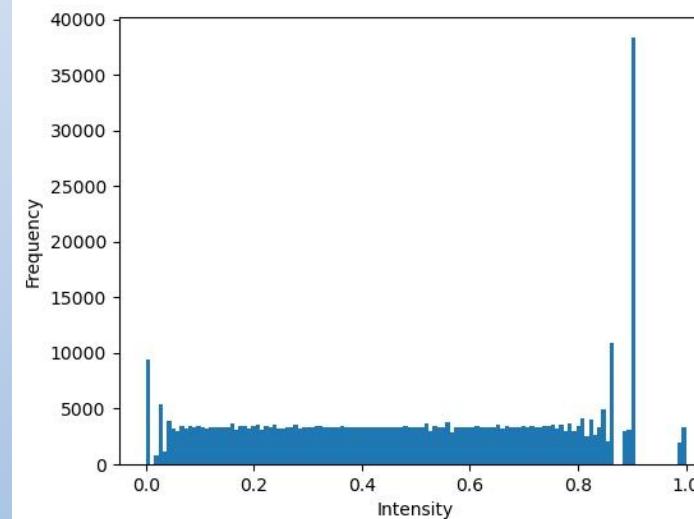


# Histogram Equalization

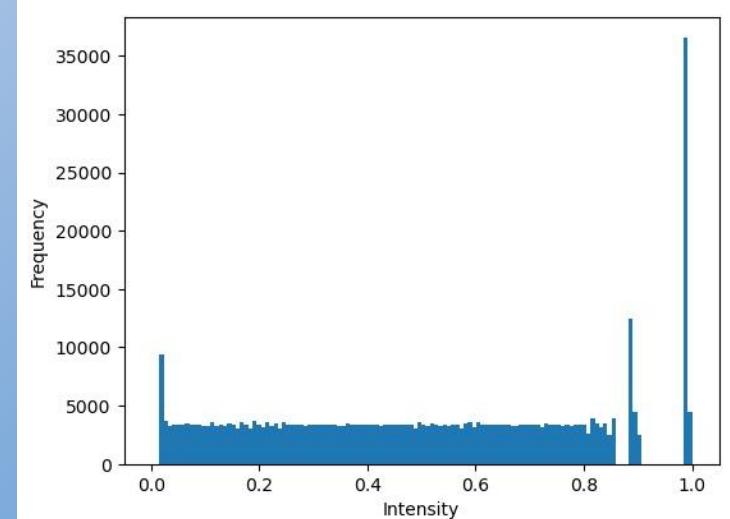
Histogram equalization, rank tiebreak = average



Histogram equalization, rank tiebreak = min

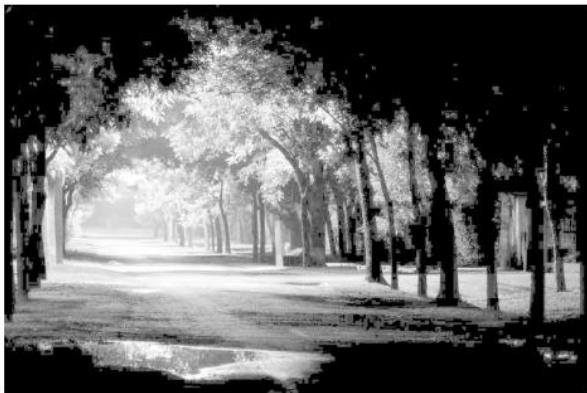


Histogram equalization, rank tiebreak = max



# Histogram Equalization

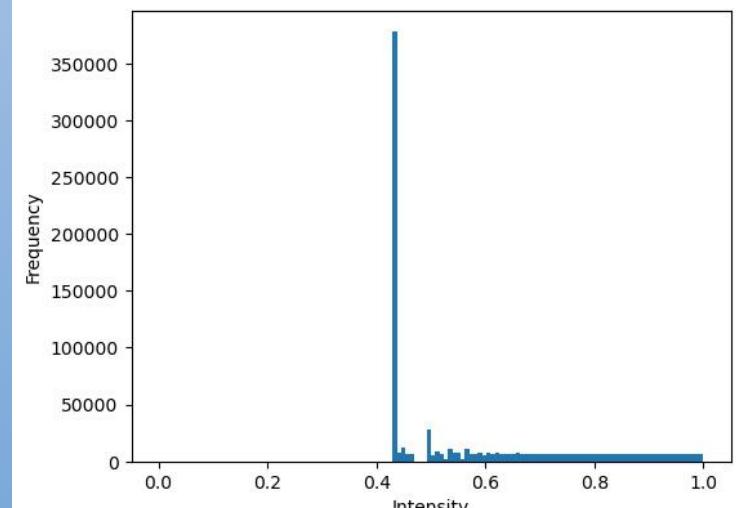
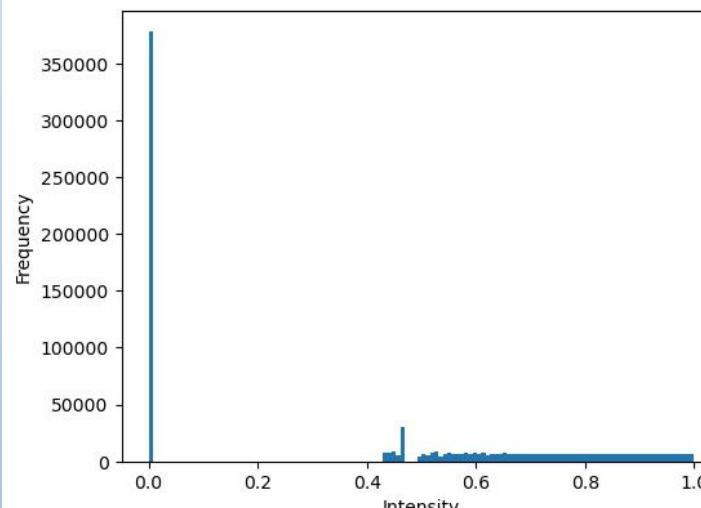
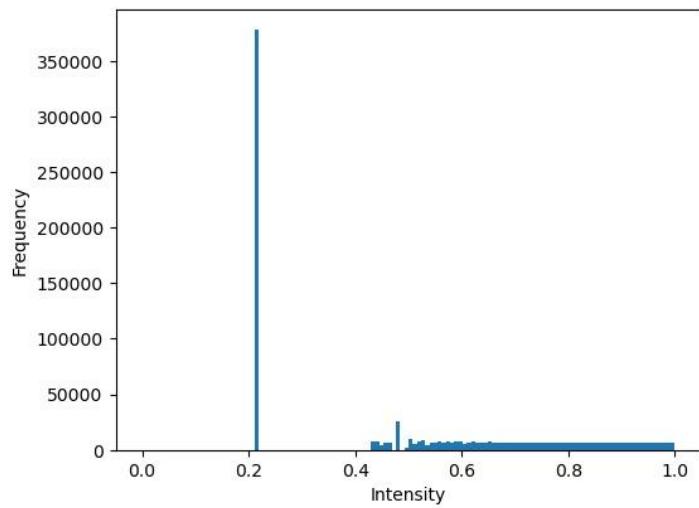
Histogram equalization, rank tiebreak = average



Histogram equalization, rank tiebreak = min

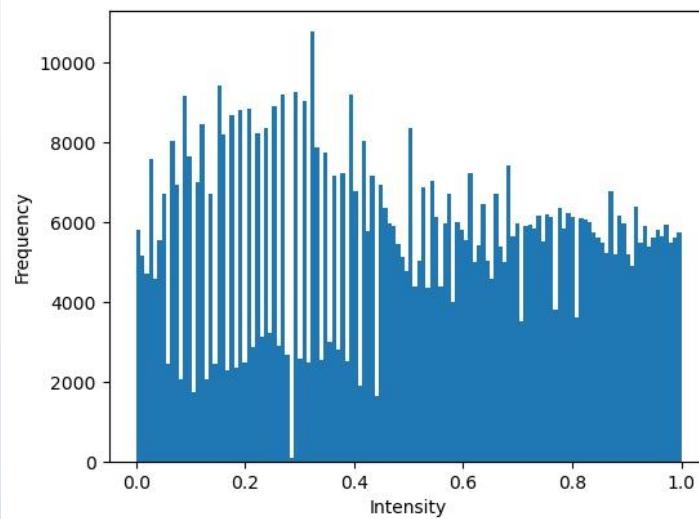


Histogram equalization, rank tiebreak = max

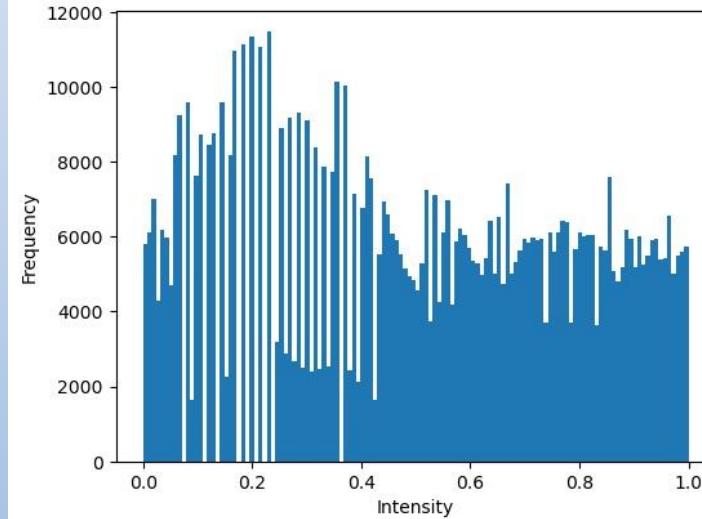


# Histogram Equalization

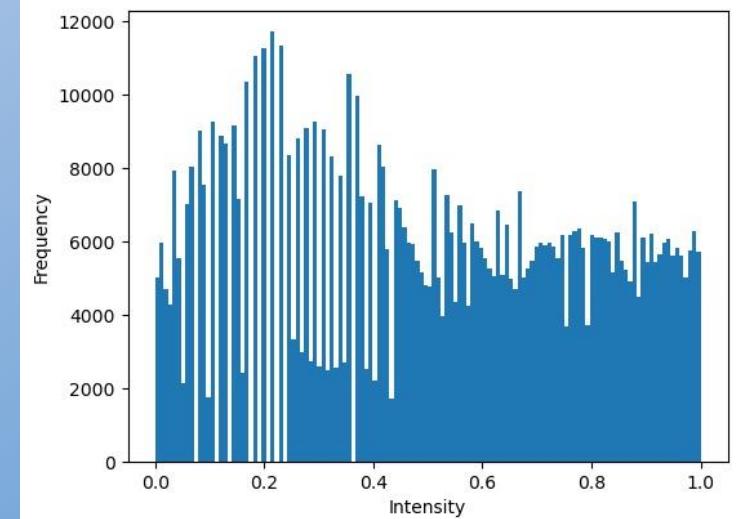
Histogram equalization, rank tiebreak = average



Histogram equalization, rank tiebreak = min

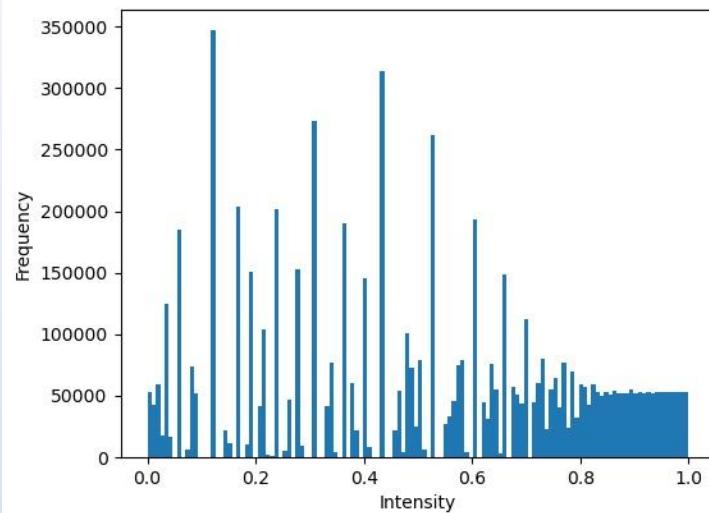
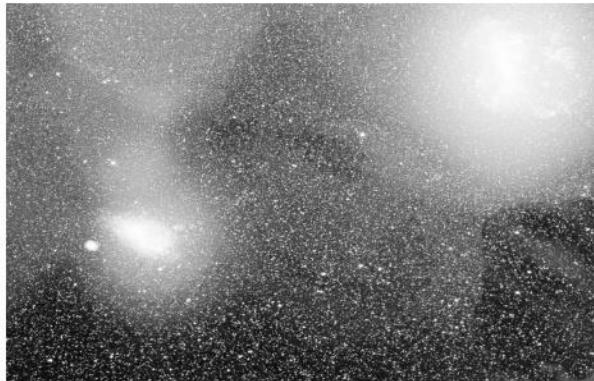


Histogram equalization, rank tiebreak = max

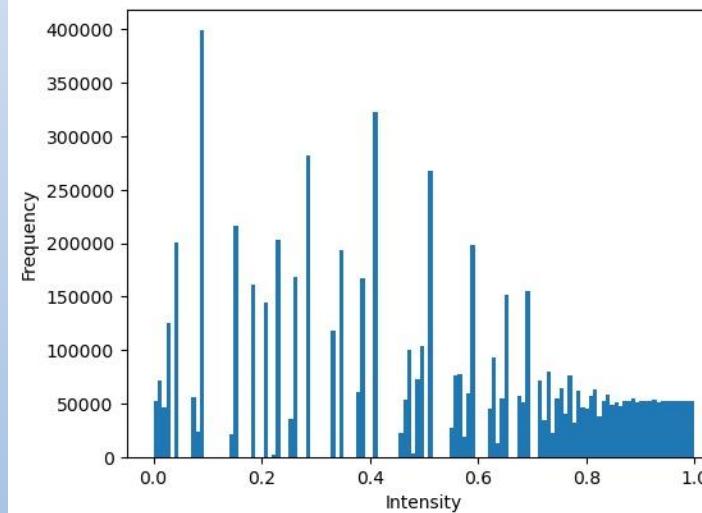


# Histogram Equalization

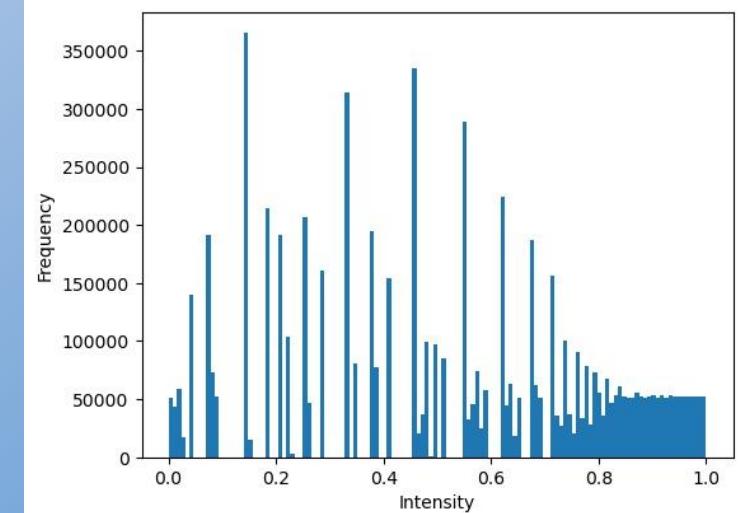
Histogram equalization, rank tiebreak = average



Histogram equalization, rank tiebreak = min



Histogram equalization, rank tiebreak = max



# Adaptive Histogram Equalization

Similar to normal histogram equalization, but the color of each pixel is estimated individually from the distribution of the pixels in its neighborhood (for example, 9-by-9), not in the full image

# Adaptive Histogram

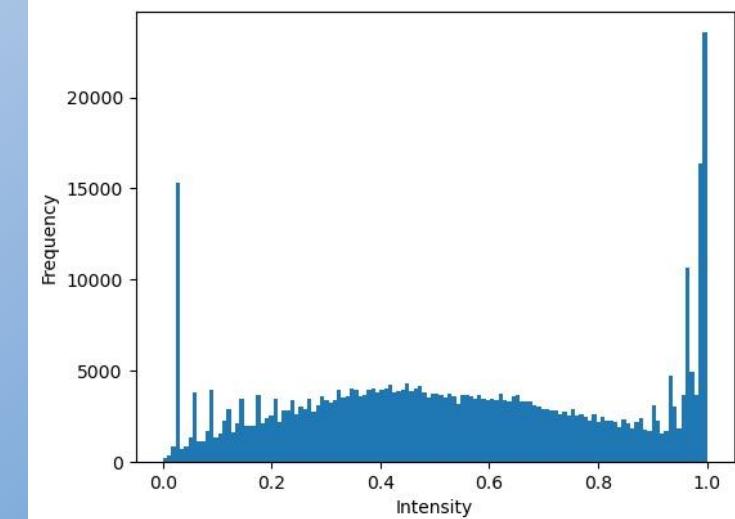
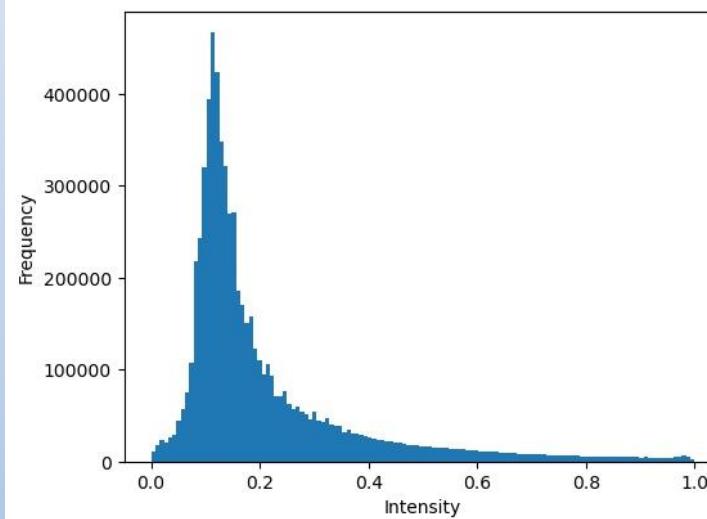
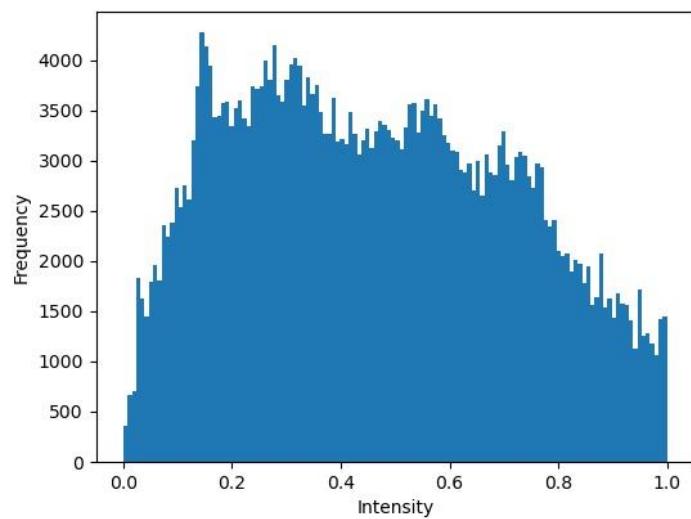
Adaptive Histogram equalization



Adaptive Histogram equalization



Adaptive Histogram equalization



# Adaptive Histogram

Adaptive Histogram equalization



Adaptive Histogram equalization



Adaptive Histogram equalization

