

Digital Image Processing

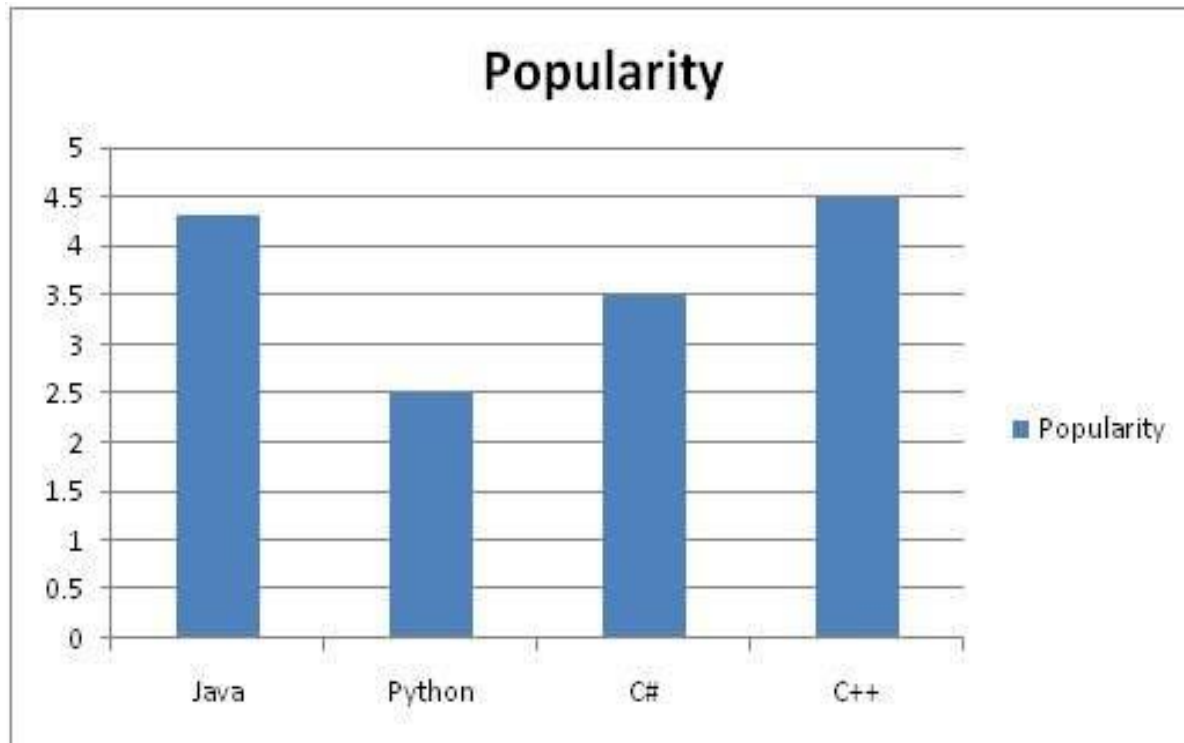
Image Histograms

What is a histogram?

- A histogram is a graph. A graph that shows frequency of anything.
- Usually histogram have bars that represent frequency of occurring of data in the whole data set.
- A histogram has two axis the x axis and the y axis.
- The x axis contains event whose frequency you have to count.
- The y axis contains frequency.
- The different heights of bar shows different frequency of occurrence of data.

Histogram Example

- Example: A histogram indicating the popularity of different programming languages.



Histogram Example

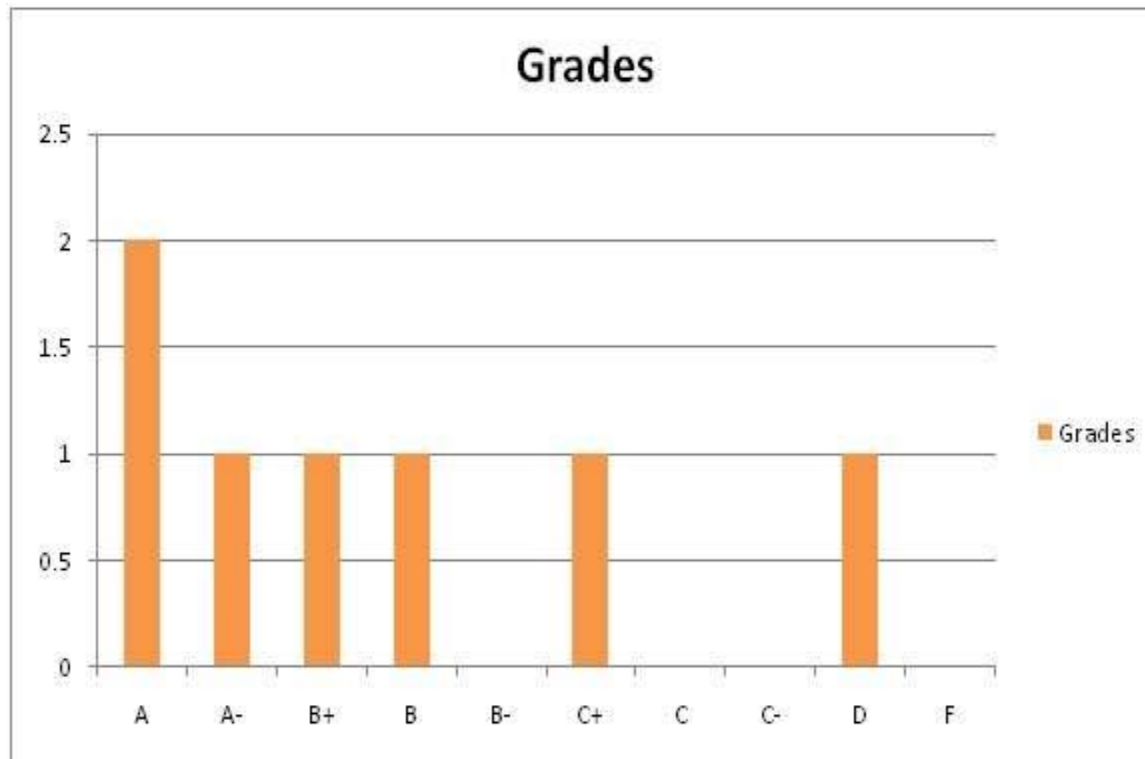
- Consider a class result of programming students studying Java.

Name	Grade
John	A
Jack	D
Carter	B
Tommy	A
Lisa	C+
Derek	A-
Tom	B+

- By the end of the semester, we have to make a histogram of the result, showing the overall frequency of occurrence of grades in specific class.

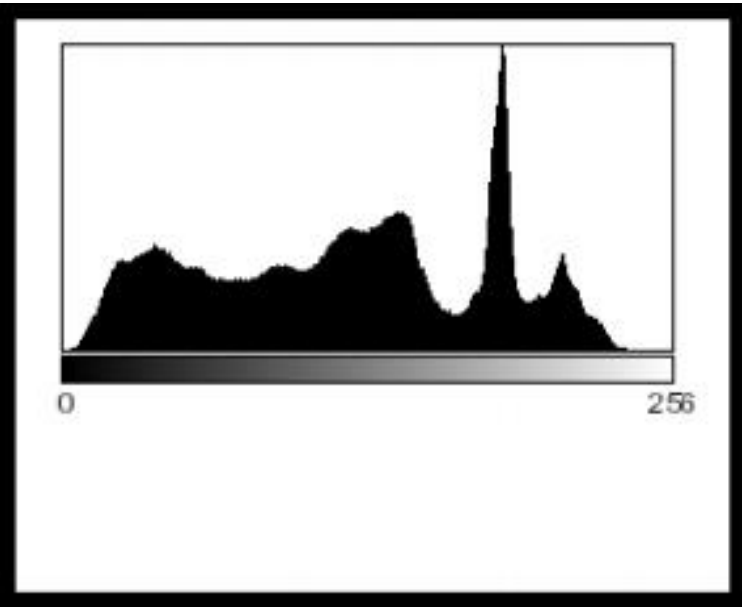
Histogram Example

- There is one thing to be sure, that y axis contains the frequency, so what comes on the x axis. X axis contains the event whose frequency has to be calculated. In this case x axis contains grades.



What is an Image Histogram?

- Image histograms plots how many times (frequency) each intensity value in image occurs.
- Example:
 - Image (left) has 256 distinct gray levels (8 bits)
 - Histogram (right) shows frequency (how many times) each gray level occurs



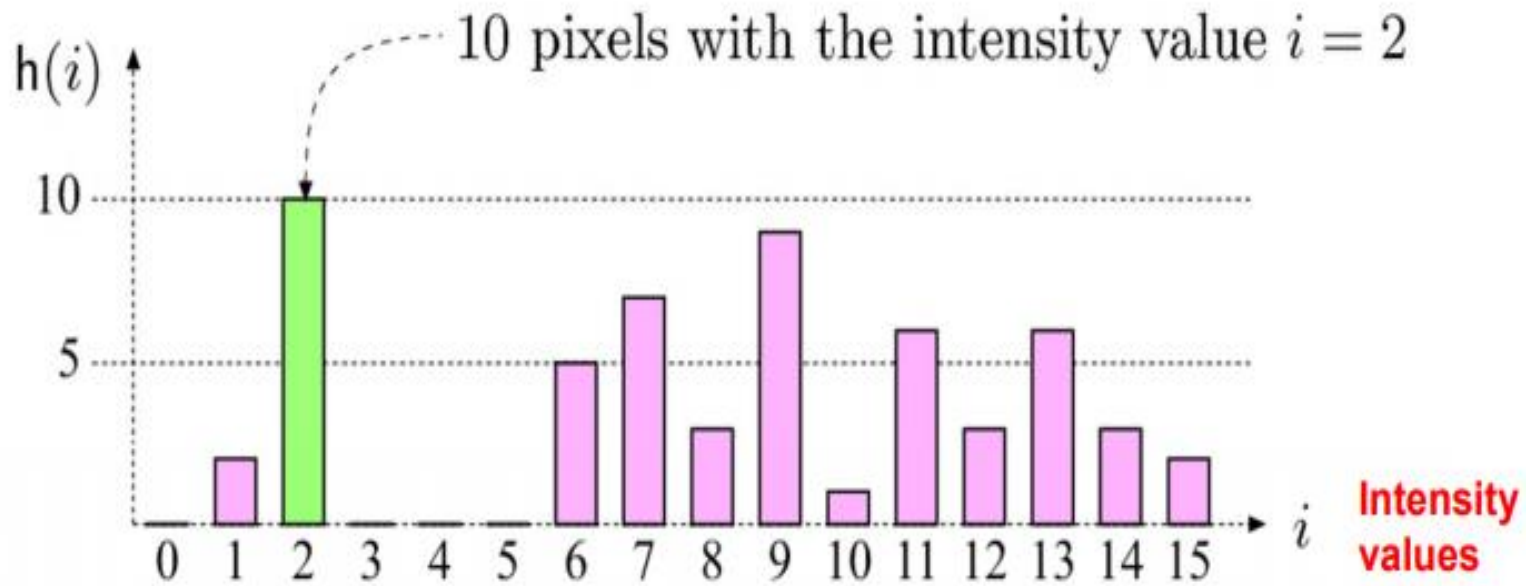
Advantages

- Many cameras display real time histograms of scene.
- Helps avoid taking over-exposed pictures.
- Also easier to detect types of processing previously applied to image.



Image Histogram: A source of Statistical Information

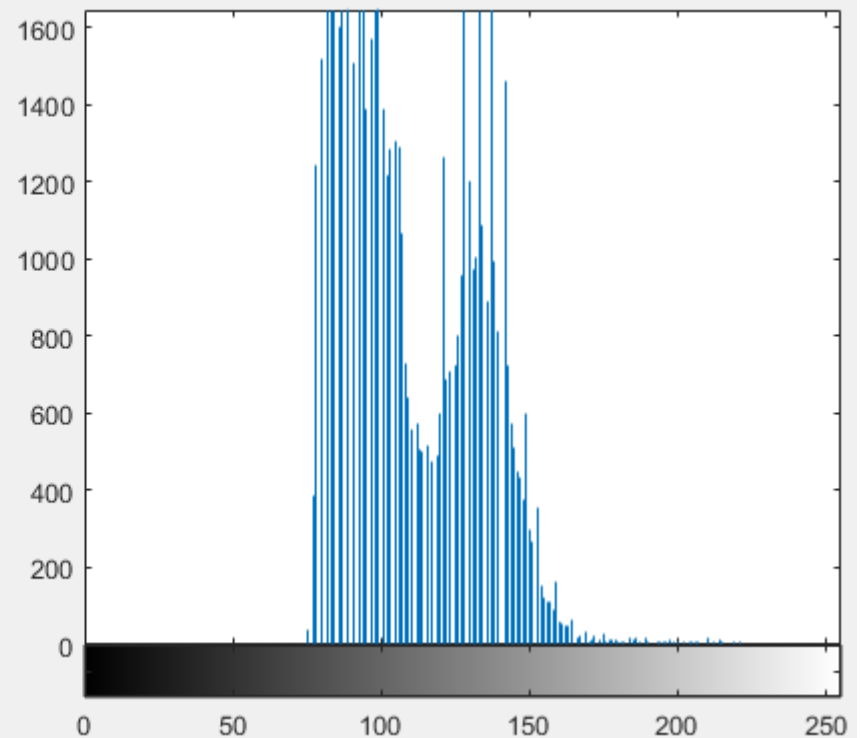
- Image histograms gives only statistical information.
- No indication of location of pixels.



$h(i)$	0	2	10	0	0	0	5	7	3	9	1	6	3	6	3	2
i	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Matlab Command – Image Histogram

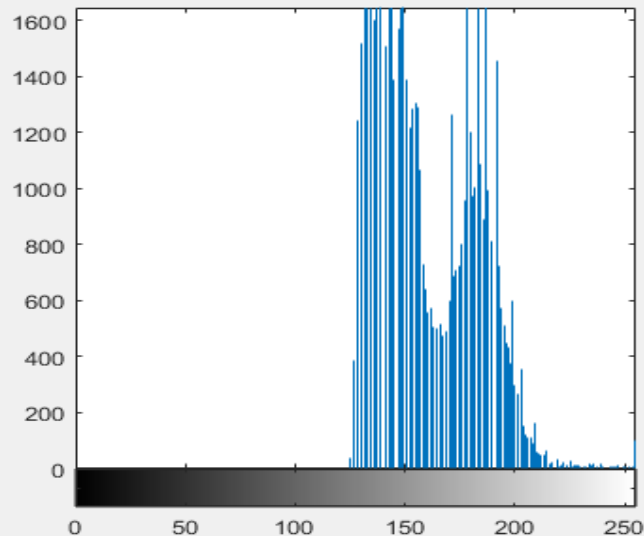
```
a = imread('pout.tif');  
subplot(1,2,1), imshow(a)  
subplot(1,2,2), imhist(a)
```



Histogram Sliding

- In order to increase the brightness of the image we can slide the histogram using point operations (addition)

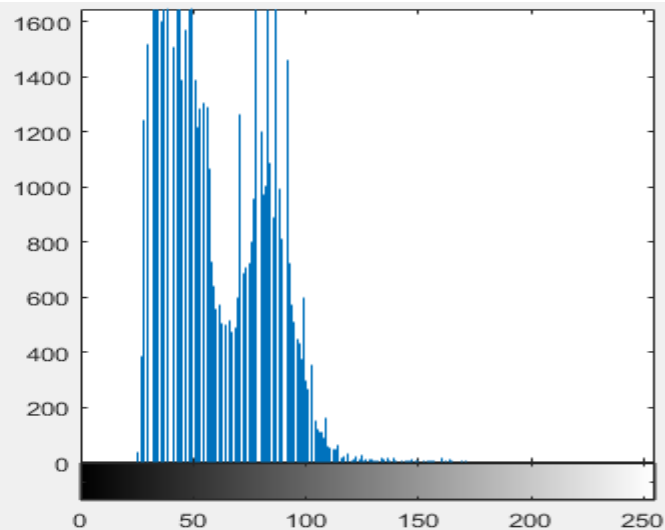
```
a = imread('pout.tif');  
b = a+50; %contrast = 50  
subplot(1,2,1), imshow(b)  
subplot(1,2,2), imhist(b)
```



Histogram Sliding

- In order to decrease the brightness of the image we can slide the histogram using point operations (subtraction)

```
a = imread('pout.tif');  
b = a-50; %contrast = 50  
subplot(1,2,1), imshow(b)  
subplot(1,2,2), imhist(b)
```



Conclusion

- Clearly seen from the new histograms that all the pixels values has been shifted towards right when we increase the brightness and towards left when we decrease the brightness; both effects can be seen in the new images formed.

Histogram Stretching

- Histogram stretching is performed to increase the contrast of an image
- The formula for stretching the histogram of the image to increase the contrast is

$$g(x,y) = \frac{f(x,y)-f_{\min}}{f_{\max}-f_{\min}} * 2^{\text{bpp}}$$

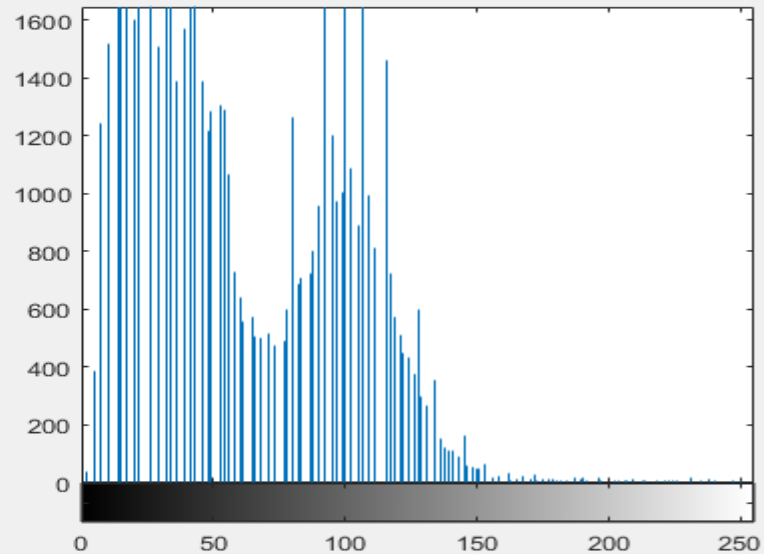
- The formula requires finding the minimum and maximum pixel intensity multiply by levels of gray. In our case the image is 8bpp, so levels of gray are 256. The minimum value is 0 and the maximum value is 225. So the formula is

$$g(x,y) = \frac{f(x,y)-0}{225-0} * 255$$

- where $f(x,y)$ denotes the value of each pixel intensity.

Histogram Stretching

```
img = imread('pout.tif');  
img=double(img);  
img=(img-min(img(:)))/(max(img(:))-min(img(:)))*255  
img1 = uint8(img)  
subplot(1,2,1), imshow(img1)  
subplot(1,2,2), imhist(img1)
```



Histogram Stretching

- The formula fails on some cases. Those cases include images with when there is pixel intensity 0 and 255 are present in the image.
- Because when pixel intensities 0 and 255 are present in an image, then in that case they become the minimum and maximum pixel intensity which ruins the formula like this.

$$g(x,y) = \frac{f(x,y)-f_{\min}}{f_{\max}-f_{\min}} * 2^{bpp}$$

$$g(x,y) = \frac{f(x,y)-0}{255-0} * 255$$

$$g(x,y) = \frac{f(x,y)}{255} * 255$$

$$g(x,y) = f(x,y)$$

- That means the output image is equal to the processed image meaning that there is no effect of histogram stretching on this image.