ELL715
Assignment 2 Report

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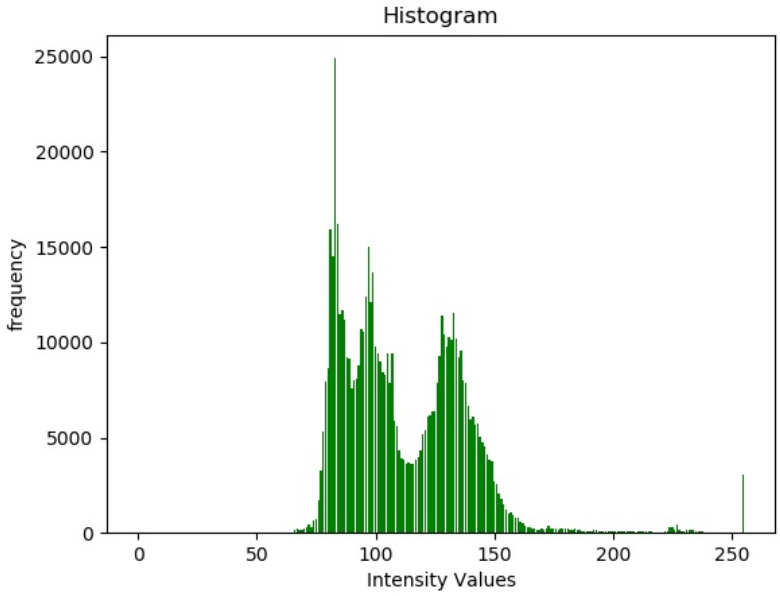
1 Child image

1.1 Histogram



1.2 Statistics

S No.	Statistics Name	Value
1	Mean	111.84
2	Standard Deviation	26.85
3	Energy	0.014
4	Entropy	6.34
5	Skewness	1.38
6	Kurtosis	7.26

Equations Used:

Define

$$\text{hist}[i] = \frac{\text{No. of pixels with intensity } i}{\text{Total no of pixels}}$$

- Mean:

$$\mu = \sum_{i=0}^{255} i * \text{hist}[i]$$

- Standard Deviation:

$$\sigma = \sqrt{\sum_{i=0}^{255} (i-\mu)^2 * \text{hist}[i]}$$

- Energy:

$$e = \sum_{i=0}^{255} \text{hist}[i]^2$$

- Entropy:

$$\text{Entropy} = -\sum_{i \in I} \text{hist}[i] * \log_2(\text{hist}[i])$$

  where $I = \{i : \text{hist}[i] > 0\}$

- Skewness:

$$S = \frac{\sum_{i=0}^{255} (i-\mu)^3 * \text{hist}[i]}{\sigma^3}$$

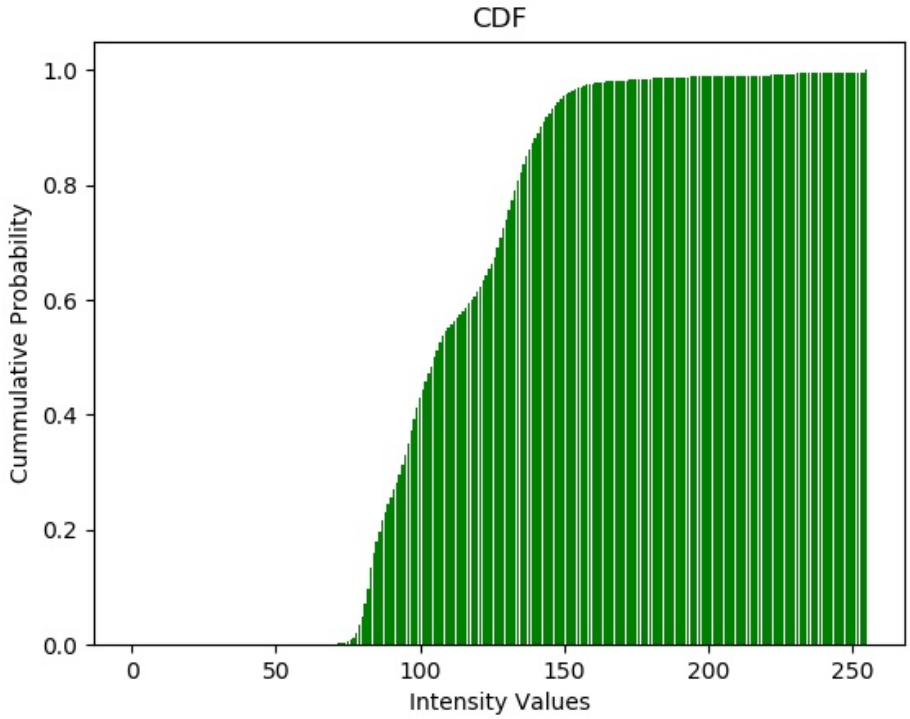
- Kurtosis:

$$K = \frac{\sum_{i=0}^{255} (i-\mu)^4 * \text{hist}[i]}{\sigma^4}$$

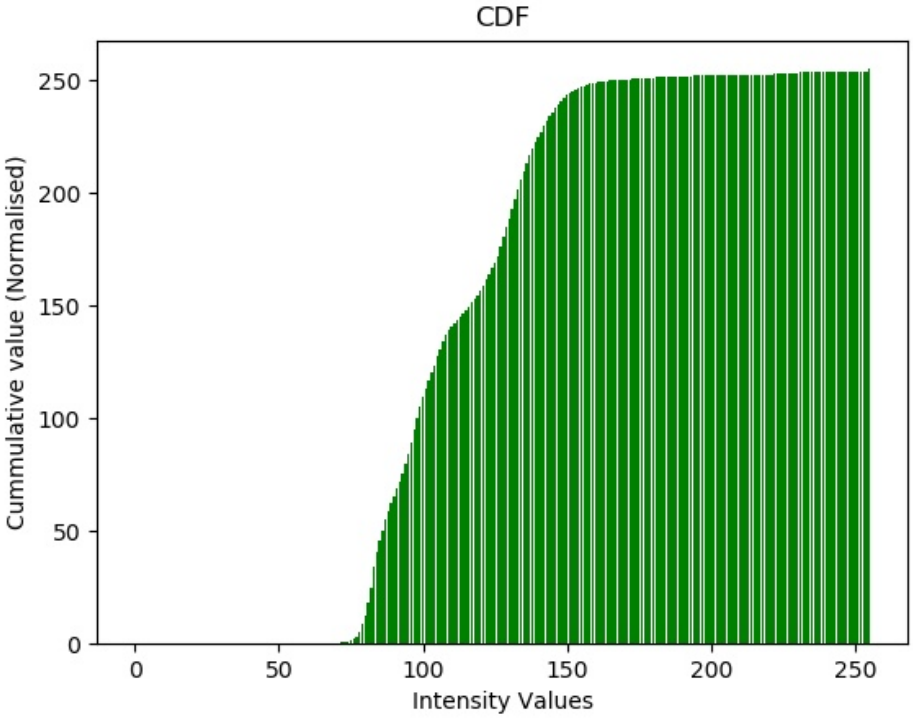
1.3 Observations of Histogram

- Image intensity distribution is approximately centred around 112 intensity value
- Most of the pixels have intensity within range 89 to 140
- As the value of skewness = 1.38 which is greater than 0, So the distribution of image is right skewed(which is also evident from the plot of histogram)
- As the value of kurtosis = 7.26 which is greater than 3 , hence the shape of distribution is Lepto(narrow)

1.4 Cumulative Density Function(Unnormalised)



1.5 Cumulative Density Function(normalised)



1.6 RGB to Gray-scale

We have used the following formula to change a RGB image to Gray-scale image:

$$\text{new}[i][j] = 0.2989 * \text{img}[i][j][0] + 0.5870 * \text{img}[i][j][1] + 0.1140 * \text{img}[i][j][2]$$

1.7 Contrast stretching

Let the value of intensity where the CDF is > a is minintensity and similarly the intensity value at which CDF is > b is maxintensity
Intensity Mapping used:

```
if (x>=minintensity and x<=maxintensity):
    y = 20+((215.0/(maxintensity-minintensity))*(x-minintensity))
if (x<minintensity):
    y = (20.0/minintensity)*(x)
return 255+((20/(255-maxintensity))*(x-255))
```

where x is old intensity and y is the new mapped intensity, $a = 0.15$ and $b = 0.95$

1.8 Gamma Correction

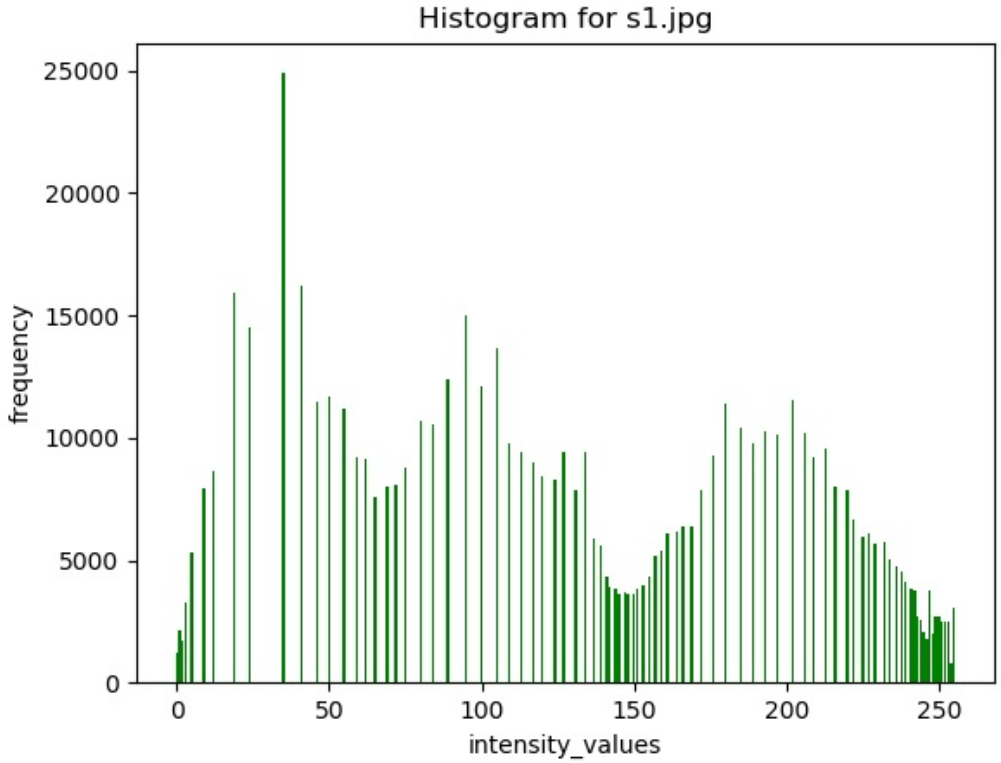
Gamma = 0.833 and 1.2

Gamma = 1.4 and 1.6

1.9 Histogram Equalisation

Transformed image after performing histogram equalisation is shown as below

Transformed Histogram is as shown below



1.10 Unsharp Masking

$$\text{Kernel Used} = \begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

$$\text{Output Image} = \text{Input Image} + 0.5 * (\text{Input Image} - \text{Convoluted Image})$$

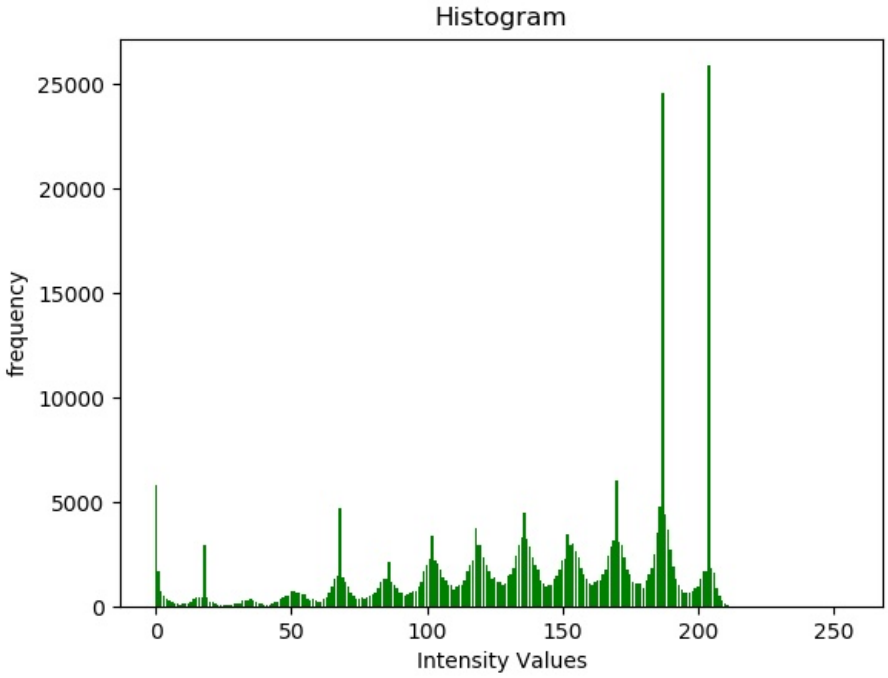
Transformed image:

1.11 Observations

- We can see from the histogram of this image that the intensities do not span whole interval $(0, 255)$, Intensities are concentrated towards the centre and hence does not use the range efficiently.
- Contrast imaging has mapped the intensity to use the whole interval , We can see that we were able to see much finer details (like there is increase in contrast between the white and black object)
- We can see that the image with gamma =1.2 gives best performance for this image , with increase in the gamma value image is turning darker
- It is evident from the histogram of the new image that the distribution of intensity has become more uniform and hence we were able to see much more finer details clearly
- We can see that after performing unsharp masking image has turned less blurry
- In this case contrast stretching is giving better image than other three techniques

2 X-ray image

2.1 Histogram



2.2 Statistics

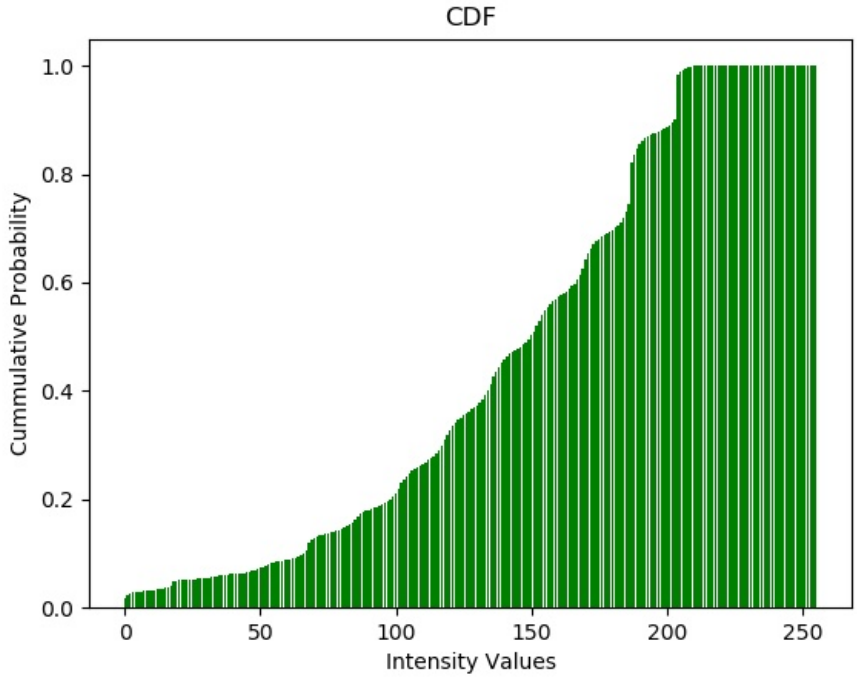
S No.	Statistics Name	Value
1	Mean	139.34
2	Standard Deviation	53.31
3	Energy	0.018
4	Entropy	6.88
5	Skewness	−0.82
6	Kurtosis	2.99

2.3 Observations of Histogram

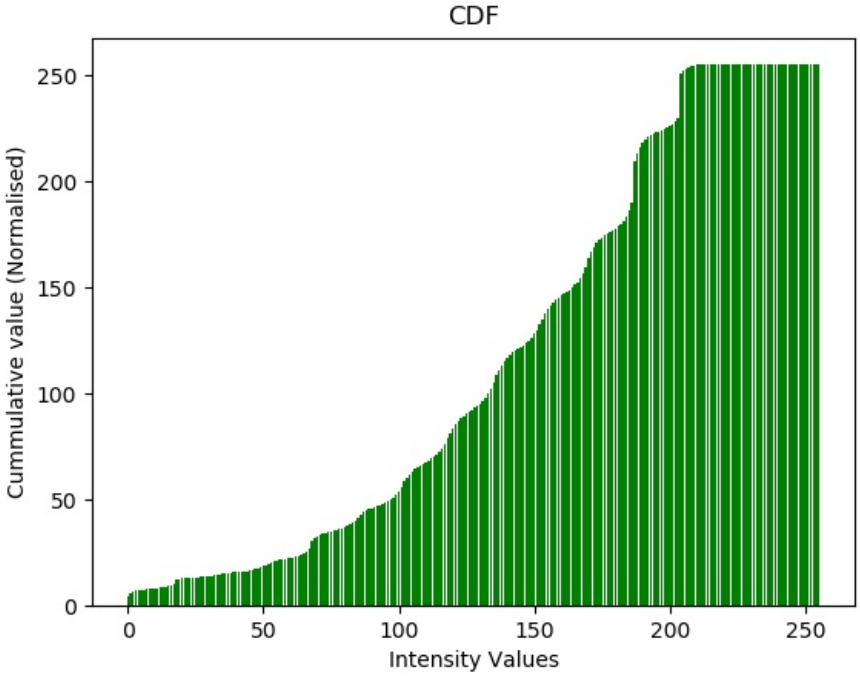
- Image intensity distribution is approximately centred around 139 intensity

- Most of the pixels have intensity within range 86 to 192.6
- As the value of skewness = -0.82 which is less than 0, the distribution of image is left skewed
- As the value of kurtosis = 2.99 which is less than 3, the shape of distribution is Meso

2.4 Cumulative Density Function(Unnormalised)



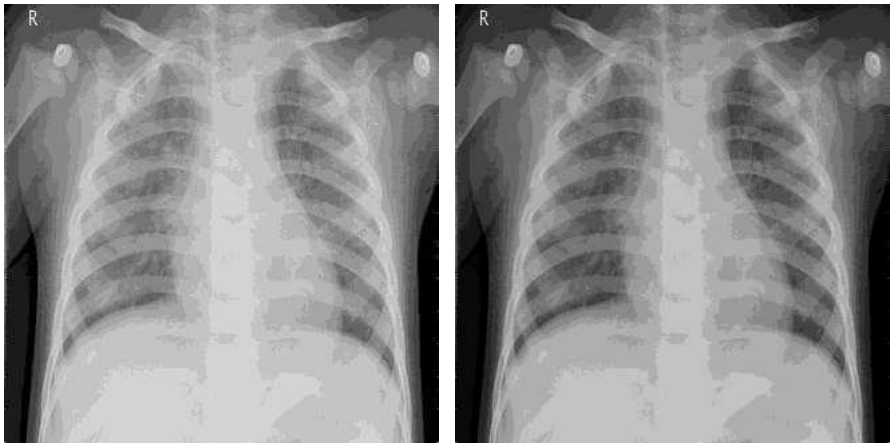
2.5 Cumulative Density Function(normalised)



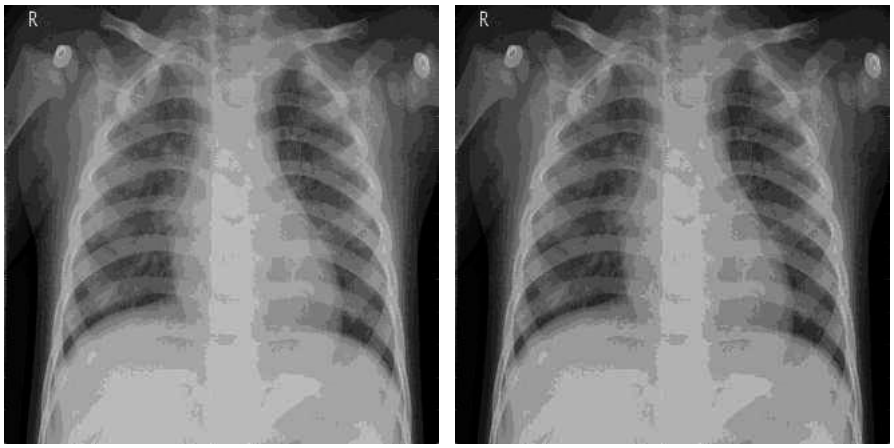
2.6 Contrast stretching

For this image, $a = 0.15$ and $b = 0.85$.

2.7 Gamma Correction



Gamma = 0.833 and 1.2

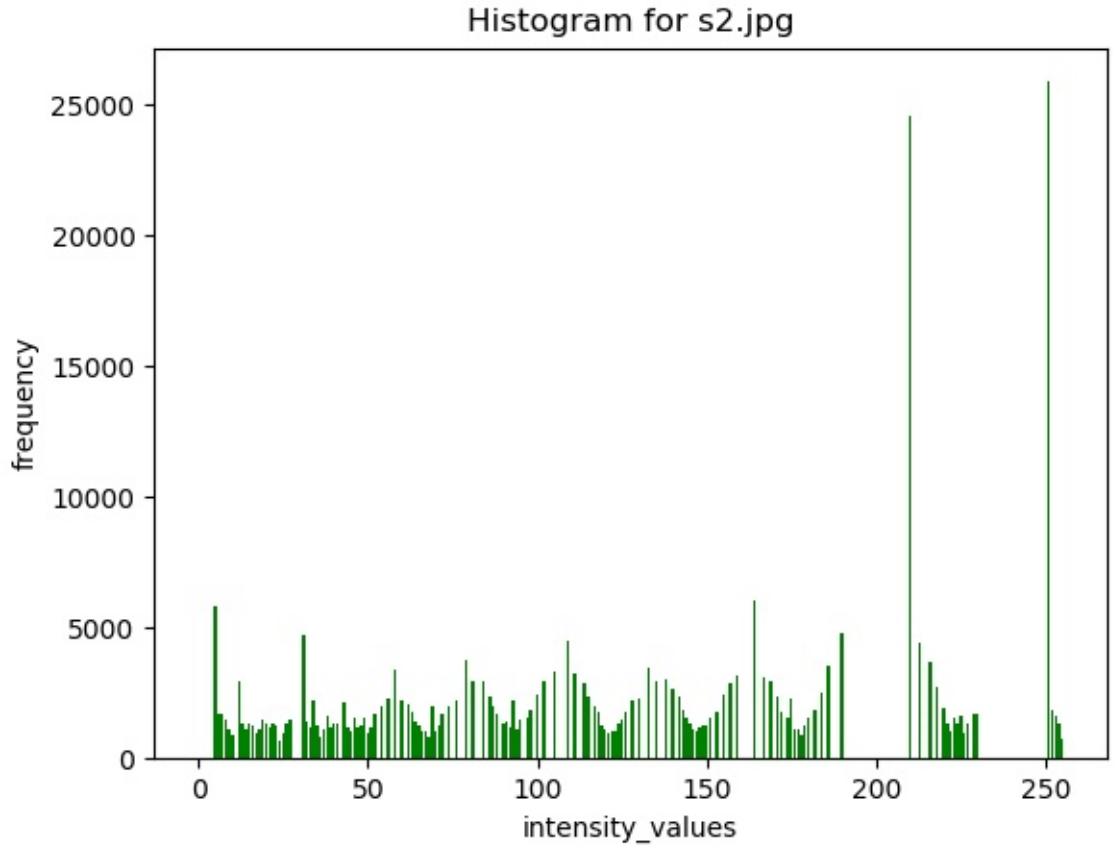


Gamma = 1.4 and 1.6

2.8 Histogram Equalisation

Transformed image after performing histogram equalisation is shown as below

Transformed Histogram is as shown below:



2.9 Unsharp Masking

$$\text{Kernel Used} = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

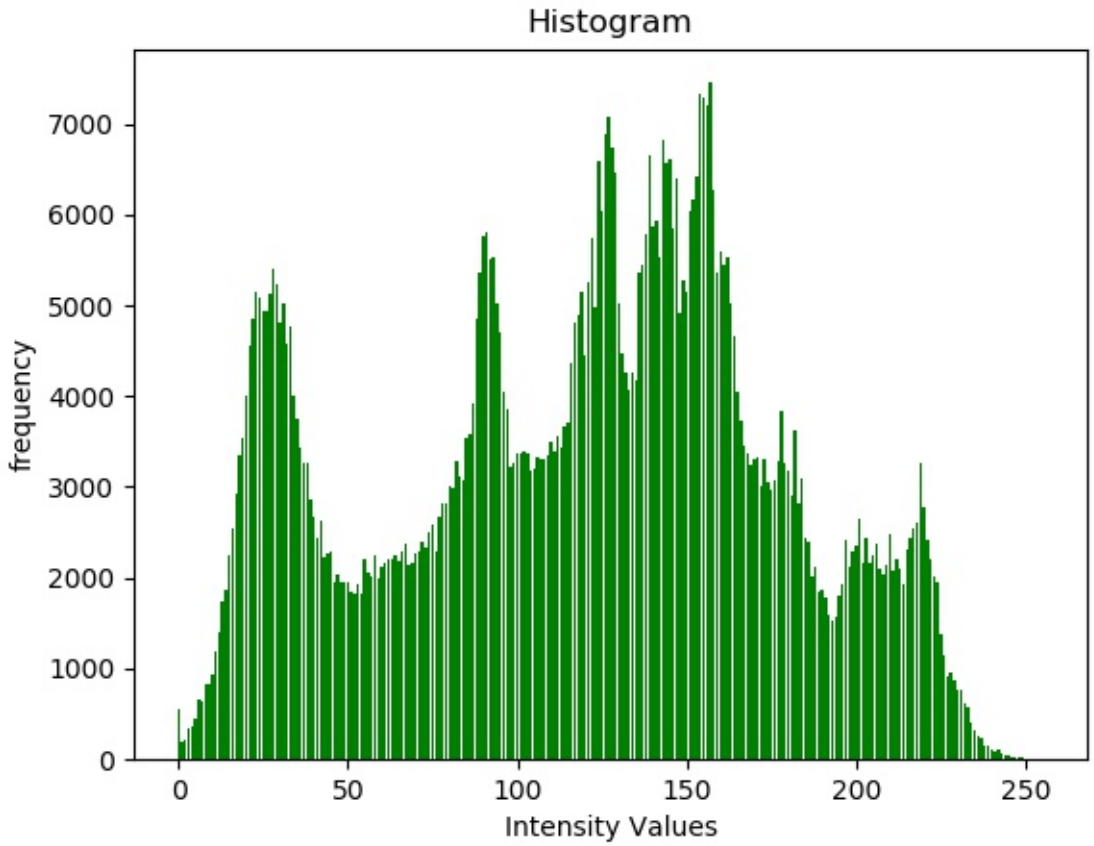
$$\text{Output Image} = \text{Input Image} + 0.5 * (\text{Input Image} - \text{Convoluted Image})$$

2.10 Observations

- We can see from the histogram of this image that the intensities are not spanning the range efficiently , Although its distribution is more uniform than the previous image
- Contrast imaging has mapped the intensity to use the whole interval , We can see that we were able to see much finer details (like there is contrast between the foreground(rib cage) and background is increased)
- We can see that the image with gamma =1.6 gives best performance for this image
- It is evident from the histogram of the new image that the distribution of intensity has become more uniform and hence we were able to see much more finer details clearly
- We can see that after performing unsharp masking image has turned less blurry
- In this case Histogram Equalisation is giving better image than other three techniques . We can see that the contrast between spinal cord and other parts has increased (spinal chord has turned whiter) , while in images formed using other techniques boundaries of spinal chord are not completely visible

3 Lenna (Extra Credits)

3.1 Histogram



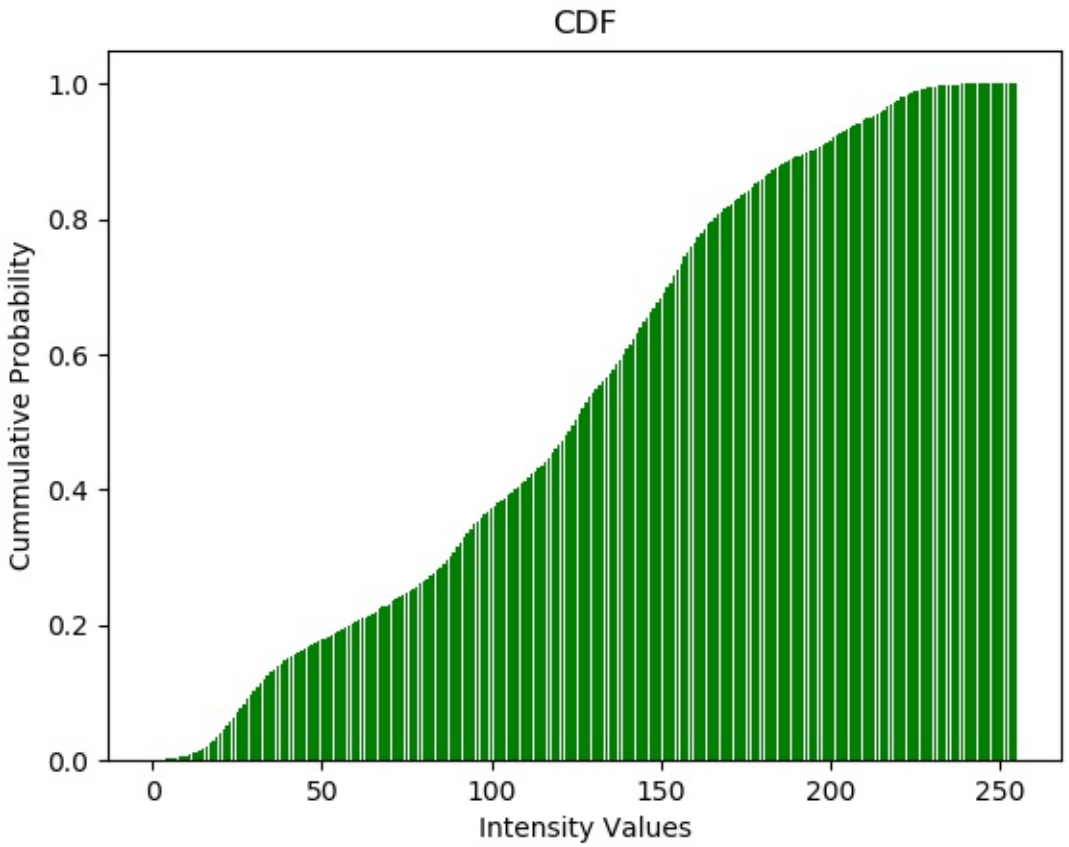
3.2 Statistics

S No.	Statistics Name	Value
1	Mean	118.02
2	Standard Deviation	57.56
3	Energy	0.0053
4	Entropy	7.70
5	Skewness	-0.14
6	Kurtosis	2.14

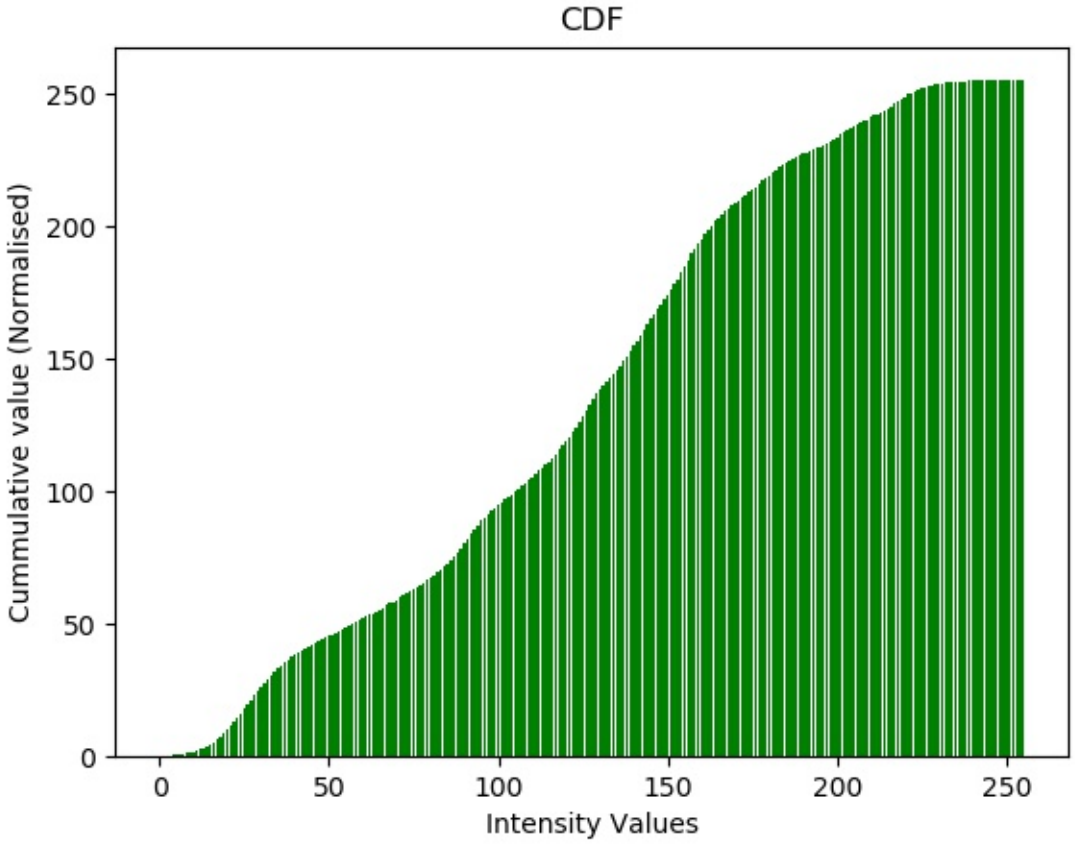
3.3 Observations of Histogram

- Image intensity distribution is approximately centred around 112 intensity value
- Most of the pixels have intensity within range 60.3 to 175.5
- As the value of skewness = -0.14 which is greater than 0, So the distribution of image is left(which is also evident from the plot of histogram)
- As the value of kurtosis = 2.14 which is greater than 3 , Hence the shape of distribution is Platy(broad)

3.4 Cumulative Density Function(Unnormalised)



3.5 Cumulative Density Function(normalised)



3.6 Contrast stretching

For this image, $a = 0.15$ and $b = 0.85$.

3.7 Gamma Correction

Gamma = 0.71 and 0.833

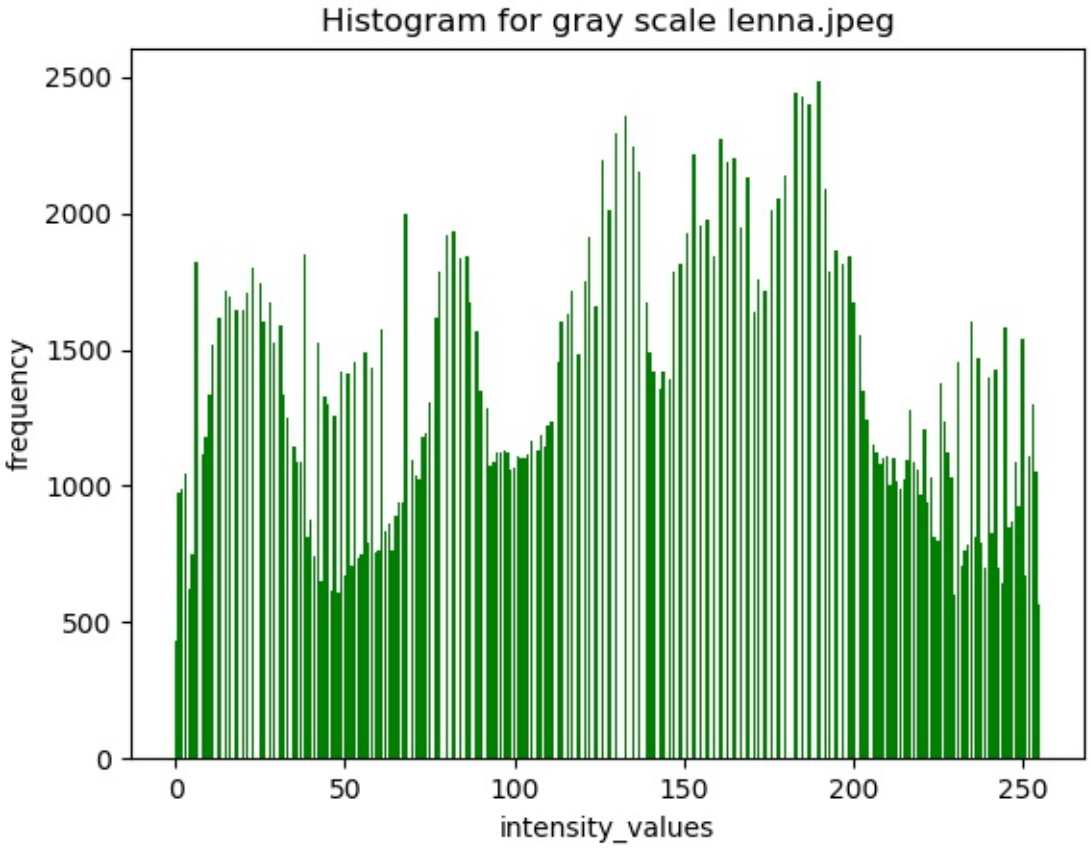
Gamma = 1.2 and 1.4

Gamma = 1.6 and 1.8

3.8 Histogram Equalisation

Transformed image after performing histogram equalisation is shown as below:

Transformed Histogram is as shown below:



3.9 Unsharp Masking

$$\text{Kernel Used} = \begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

$$\text{Output Image} = \text{Input Image} + 0.5 * (\text{Input Image} - \text{Convoluted Image})$$

4 References

- https://stackoverflow.com/questions/4562801/what-is-energy-in-image-processing
- https://en.wikipedia.org/wiki/Skewness
- https://en.wikipedia.org/wiki/Kurtosis
- https://en.wikipedia.org/wiki/Unsharp_masking
- https://en.wikipedia.org/wiki/Gamma_correction
- https://inneka.com/programming/python/how-can-i-convert-an-rgb-image-into-grayscale-in-python/