

# Digital Image Processing - CS 663

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# 1 Foreground Mask

For an input image, mask is generated of same matrix size as input image, where mask entry is 1 for pixel value  $>$  threshold, and 0 for pixel value  $<$  threshold. Here threshold can be a user input parameter. The purpose of foreground masking is to be able to see foreground distinctly from the background.

We have chosen the threshold as **mean** of the input image.

```
1 thres = mean(orig_img,'all'); %computes mean across all elements of matrix  
2 bin_mask = orig_img>thres; %returns a boolean matrix  
3 masked_img = orig_img .* bin_mask;
```

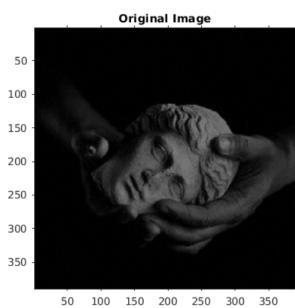


Figure 1: original image

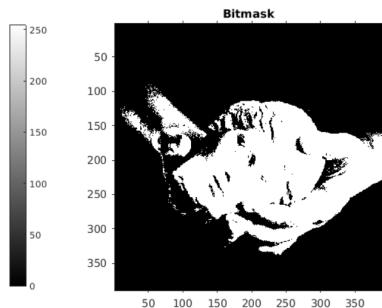


Figure 2: bitmask

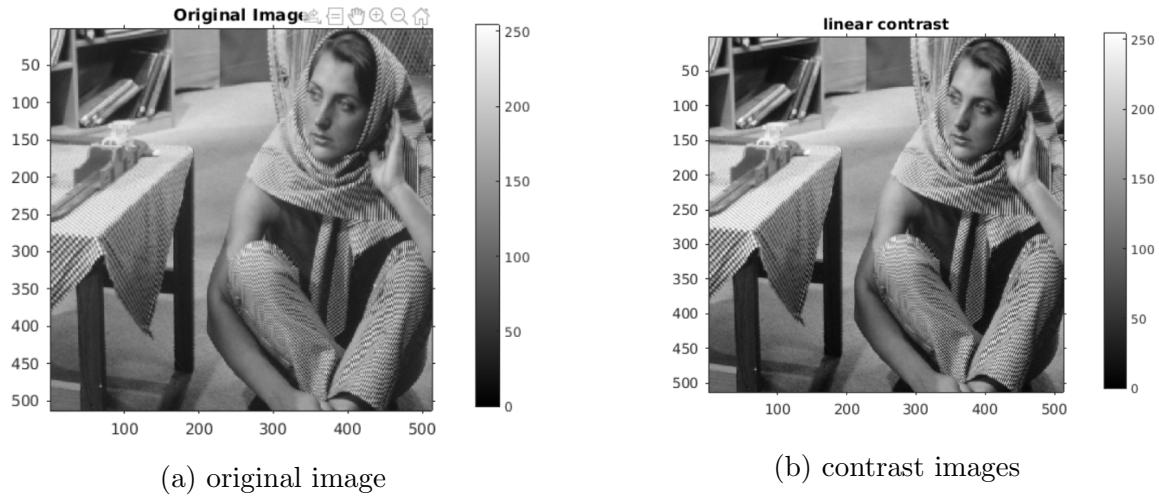


Figure 3: masked image

# 2 Linear Contrast Stretching

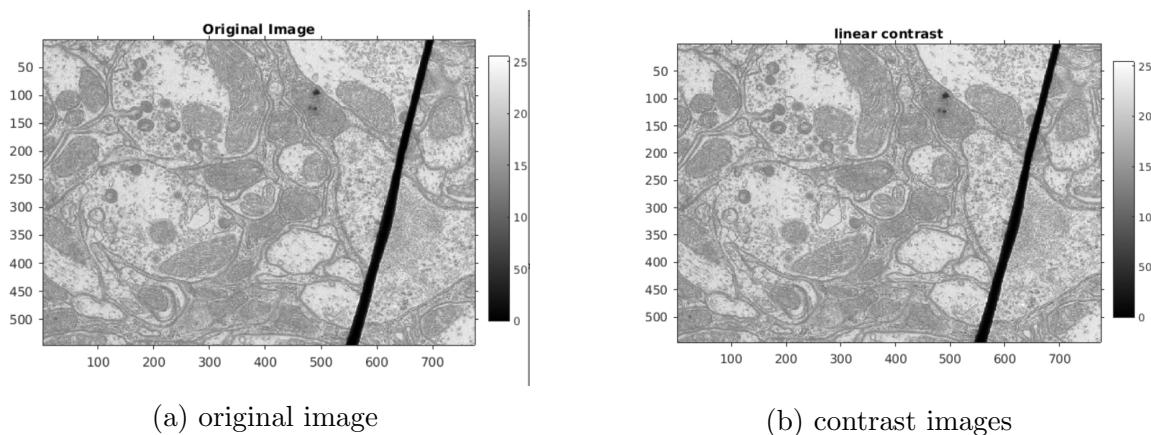
In linear stretching, we modify the pixel intensity values such that they occupy the maximum and minimum possible intensity. In our case, if original image had pixel intensities in range  $[n,m]$ , it is mapped to 0 to 255 linearly. Here  $0 \leq n \leq m \leq 255$

```
1 max_val = (max(orig_img,[],'all'));  
2 min_val = (min(orig_img,[],'all'));  
3  
4 fin_img = (orig_img - min_val) / (max_val - min_val);  
5 fin_img = fin_img .* 255;
```



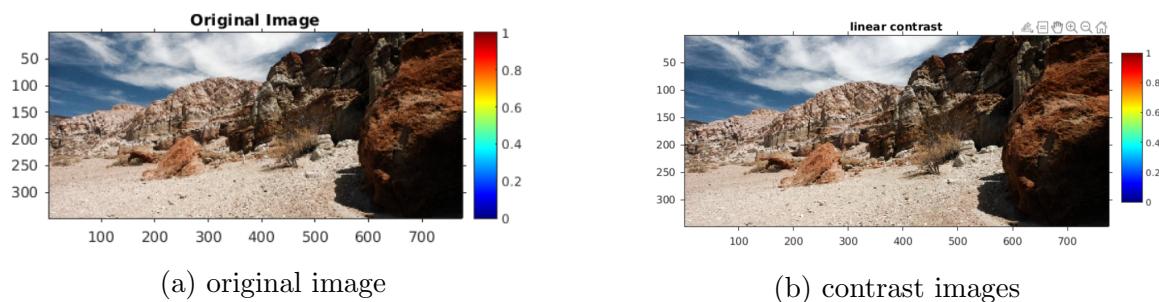
(a) original image

(b) contrast images



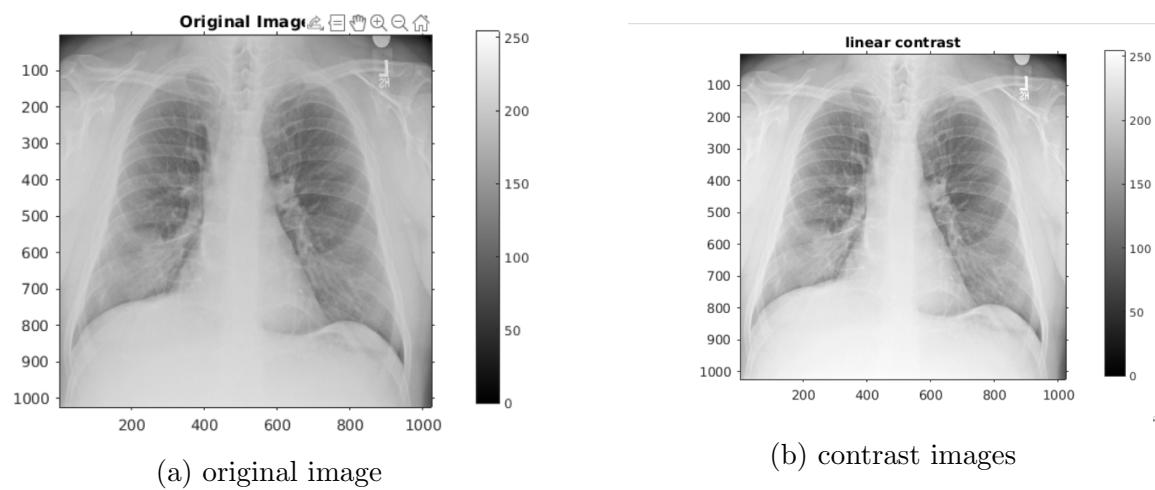
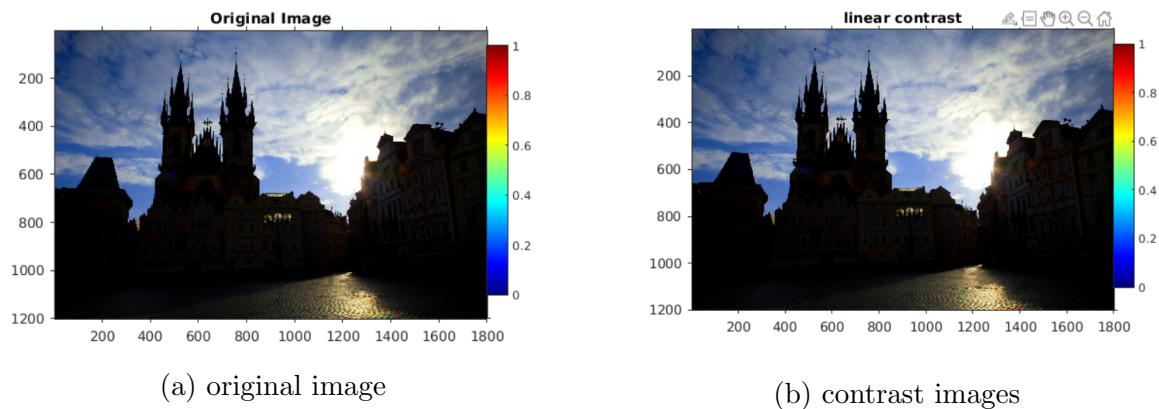
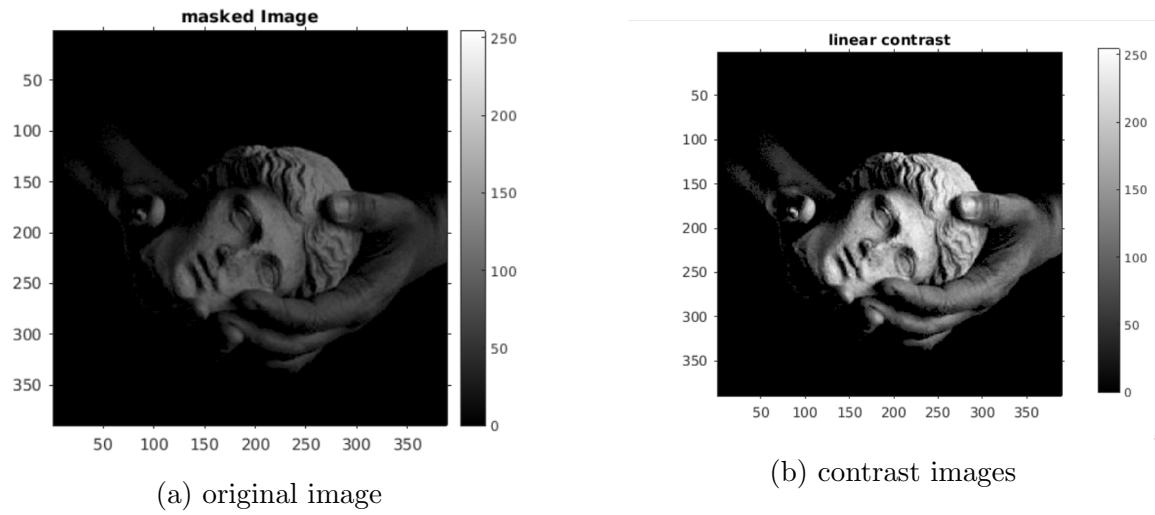
(a) original image

(b) contrast images



(a) original image

(b) contrast images



**Explain your observations after applying contrast stretching on image (5). Why do you think contrast stretching is or isn't effective here?**

The maximum and minimum pixel intensity in image(5) has reached the maximum bounds (255 and 0 respectively). We can say this by observing that there are extremely bright and dull sections in the images. Hence, linear contrast, which stretches the intensity range between 0 to 255 is not effective.

### 3 Histogram Equalization

Histogram Equalization is a computer image processing technique used to improve contrast in images. It accomplishes this by effectively spreading out the most frequent intensity values, i.e. stretching out the intensity range of the image.

'm' and 'n' are the dimensions of image, hence their product correspond to total number of pixels. Equations are:-

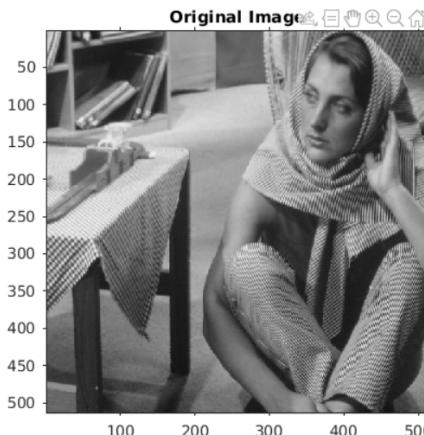
$$h(v) = \text{round} \left( \frac{cdf(v) - cdf_{min}}{(M \times N) - cdf_{min}} \times (L - 1) \right)$$

In the code, the array C represents cdf of the image based on intensity and x represents minimum non zero pdf.

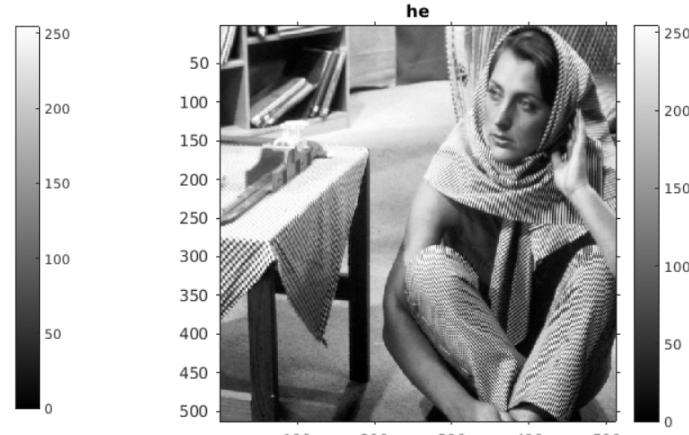
```

1 for i = ind:256
2     C(i,2) = round((255 * (C(i,1) - x))/(m*n - x));
3 end
4 for i = 1:m %row
5     for j = 1:n %col
6         fin_img(i,j,1) = C(orig_img(i,j,1) + 1 ,2);
7     end
8 end

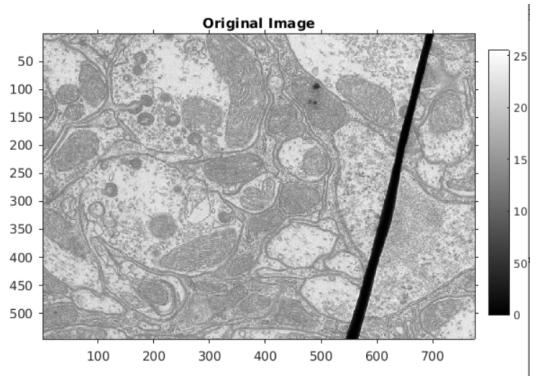
```



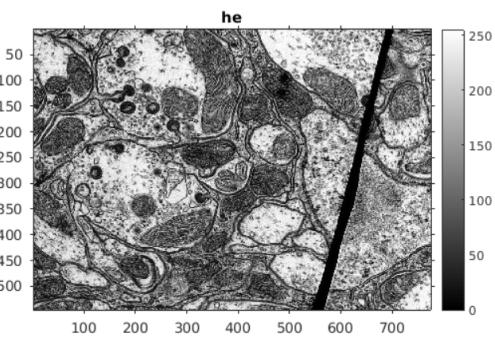
(a) original image



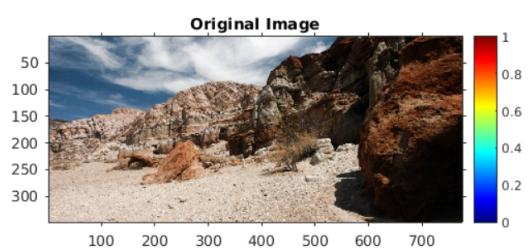
(b) histogram images



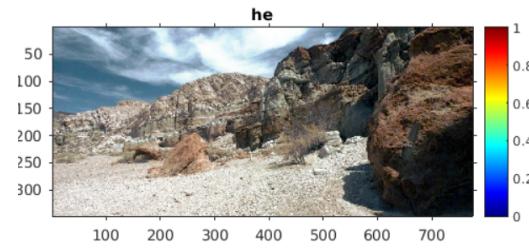
(a) original image



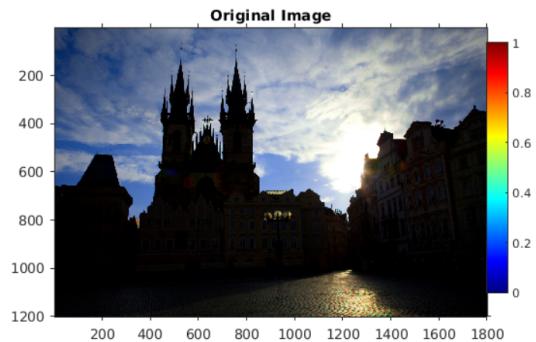
(b) histogram images



(a) original image



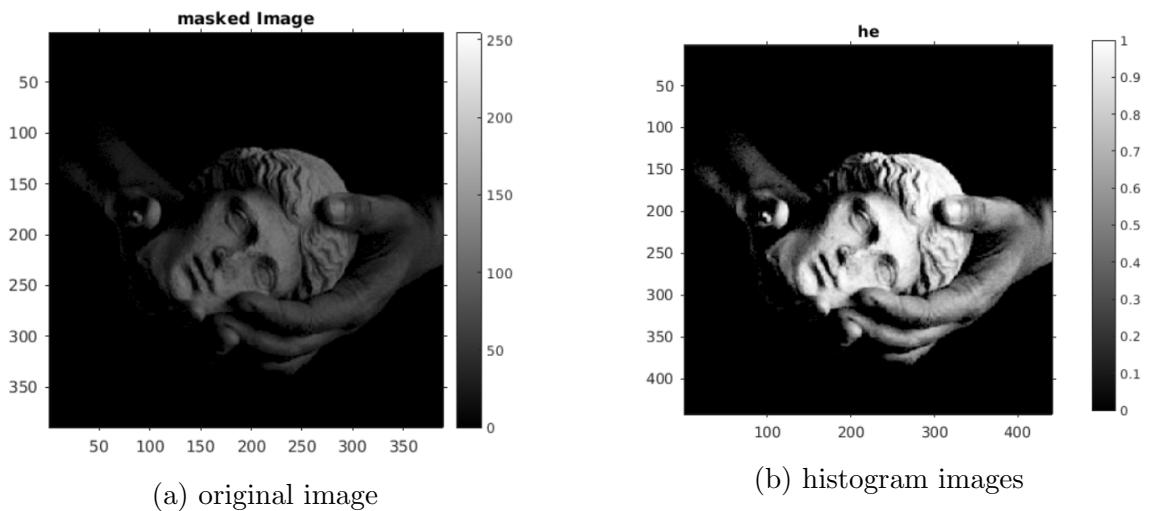
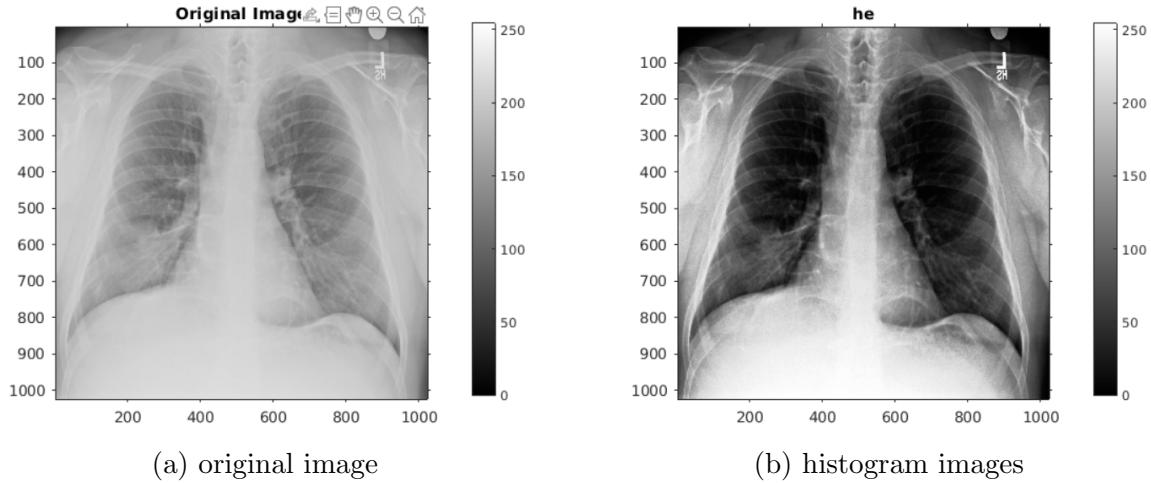
(b) histogram images



(a) original image



(b) histogram images



**Explain your observations after applying HE on image (5). Which one would you prefer to improve image (5)- HE or contrast stretching?**

As can be seen in histogram equalizer the image can be seen clearly and we can see features that were not seen easily in input image. The equaliser transforms the image to have linear cdf and stretches its original transform to occupy all intensities.

## 4 Histogram Matching

Histogram Matching is the transformation of an image so that its histogram matches a specified histogram from a reference image. This is done by calculating cdf of both histograms doing a simple transformation as seen in the code below.

The inverse cdf calculated here is approximate

```

1 for i = 1:m1
2     for j = 1:n1
3         cdf_tem = B1(orig_img(i,j,1)+1,1);
4         closeval = min(abs(B2-cdf_tem));
5         idx = find(abs(B2-cdf_tem)==closeval,1,'first');
6         fin_img(i,j,1) = (idx-1);
7     end
8 end

```

B2 represents cdf.

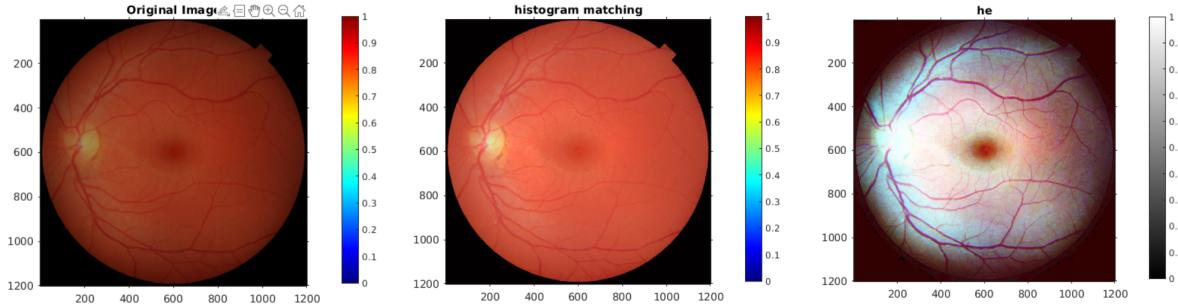


Figure 16: original image

**State your observations**

Figure 17: hist match

Figure 18: hist eq

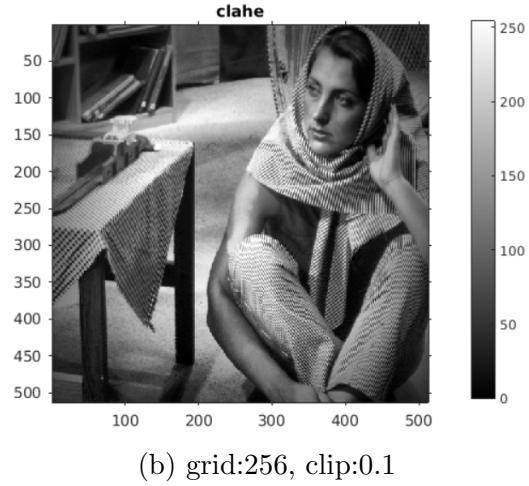
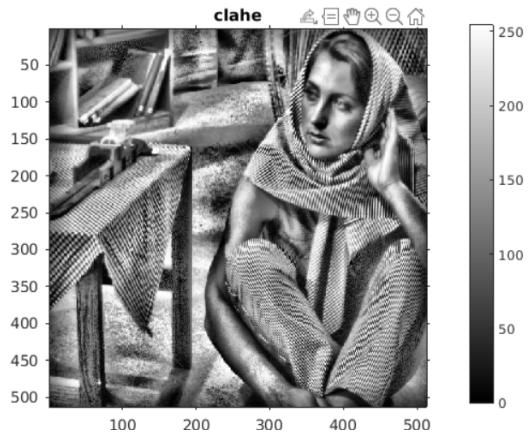
Histogram Matching has brightened the image without losing the color in the image whereas histogram equalization has changed the histogram so much, that although we can see the veins (or the small lines) clearly, the colour of the retina has got been lost.

## 5 Contrast-Limited Adaptive Histogram Equalization

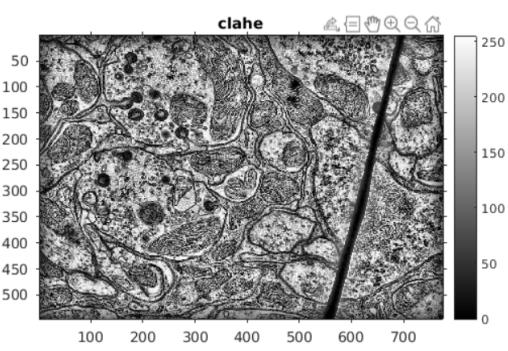
CLAHE is a variant of Adaptive histogram equalization (AHE) which takes care of over-amplification of the contrast. It is a modification to AHE with one increased parameter namely clip limit. This helps in reducing noise generated in image.

Increased grid size means more pixels in each bin and more spread original cdf and hence reducing contrast. With lower clip limits, you further reduce contrasts, so that the histograms don't have marked peaks anywhere. The contrast amplification is nothing but the slope of cdf So the higher the slope of the cdf, the higher the contrast.

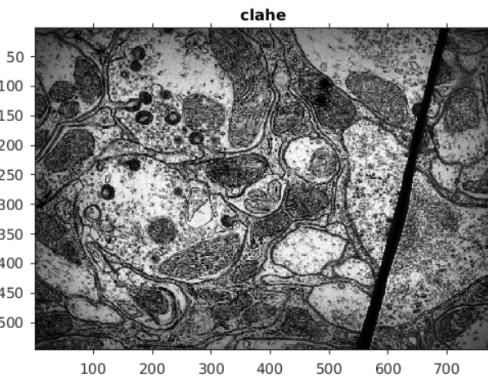
## Image1



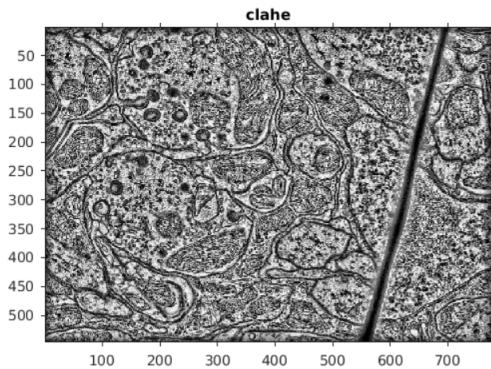
## Image2



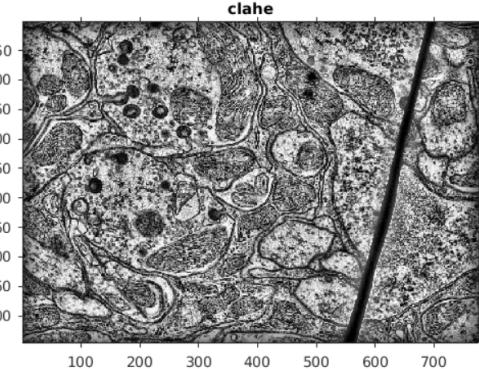
(a) grid:64, clip:0.1



(b) grid:256, clip:0.1

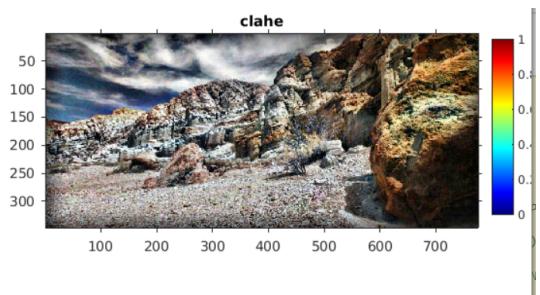


(a) grid:32, clip:0.1

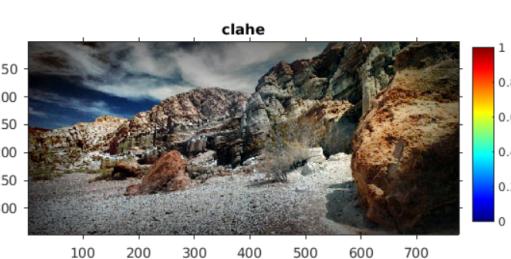


(b) grid:64, clip:0.05

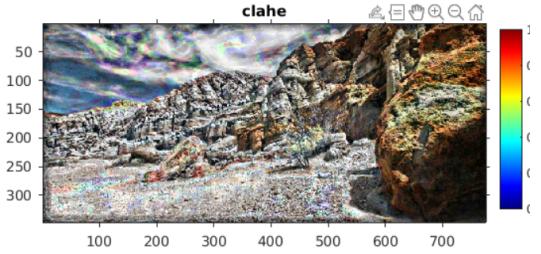
## Image3



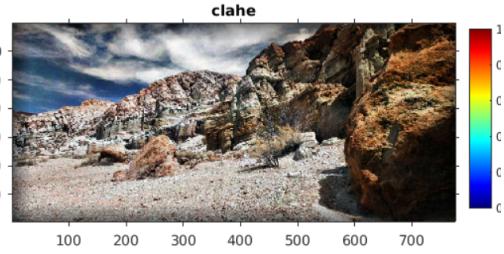
(a) grid:64, clip:0.01



(b) grid:256, clip:0.01

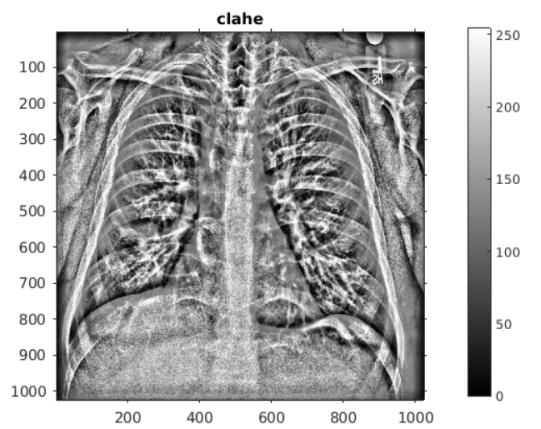


(a) grid:32, clip:0.01

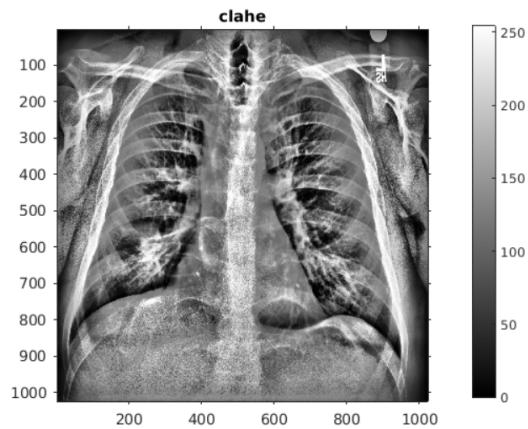


(b) grid:64, clip:0.005

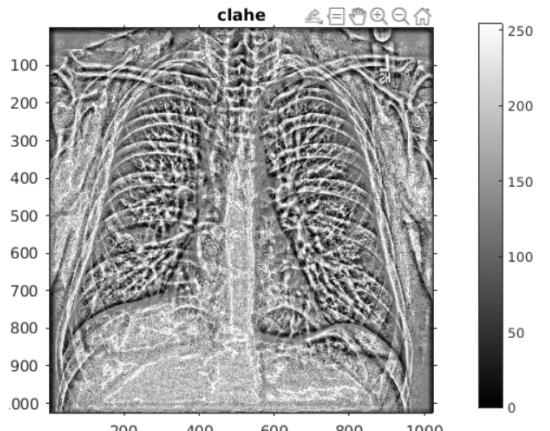
## Image6



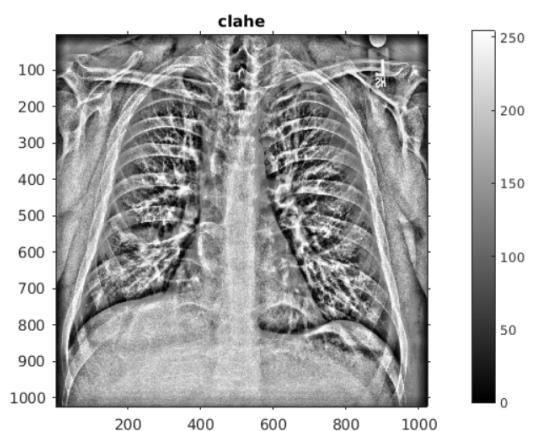
(a) grid:64, clip:0.1



(b) grid:150, clip:0.1



(a) grid:32, clip:0.1



(b) grid:64, clip:0.05