Table of Contents

1 - Getting Started

Load the data that we will use.

```
clear;
I = imread('lab1/images/napoleon.png');
Il = imread('lab1/images/napoleon_light.png');
Id = imread('lab1/images/napoleon_dark.png');
Z = imread('lab1/images/zebra.png');
Is = single(I);
B1 = imread('lab1/images/brain1.png');
B2 = imread('lab1/images/brain2.png');
B3 = imread('lab1/images/brain3.png');
W = imread('lab1/images/wrench.png');
D = imread('lab1/images/doggo.jpg');
D2 = imresize(D, [128,128], 'nearest', 'antialiasing', true);
GD2 = rgb2gray(D2);
```

Q1 - Pixel Value

Print out value. We see that it is of type UINT-8 and the value is 89.

```
I(1, 1)         % It prints out 89


ans =

  uint8
```

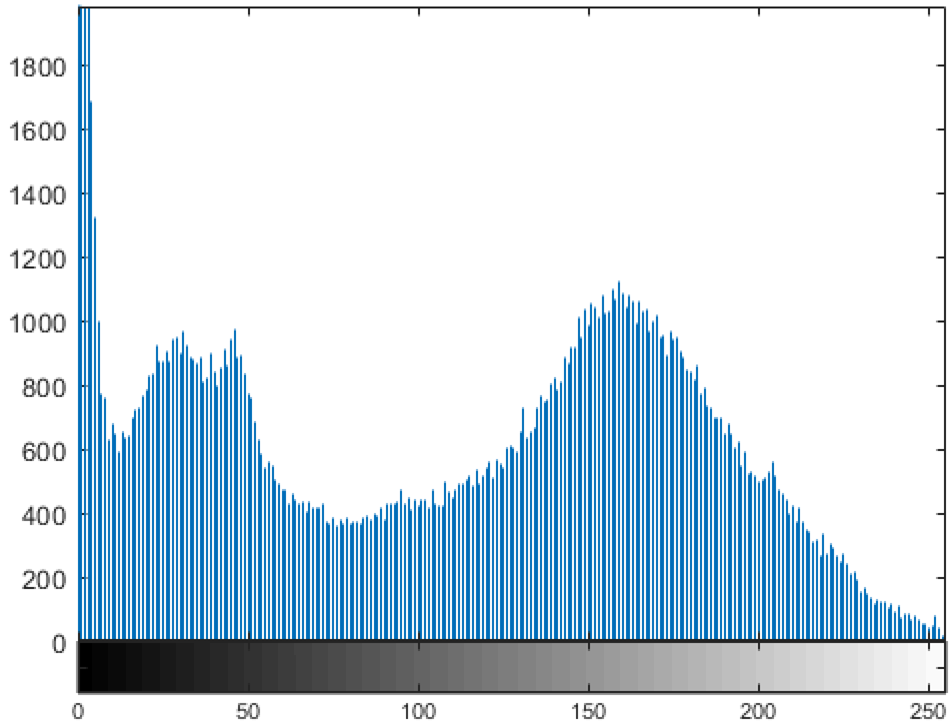
```
89
```

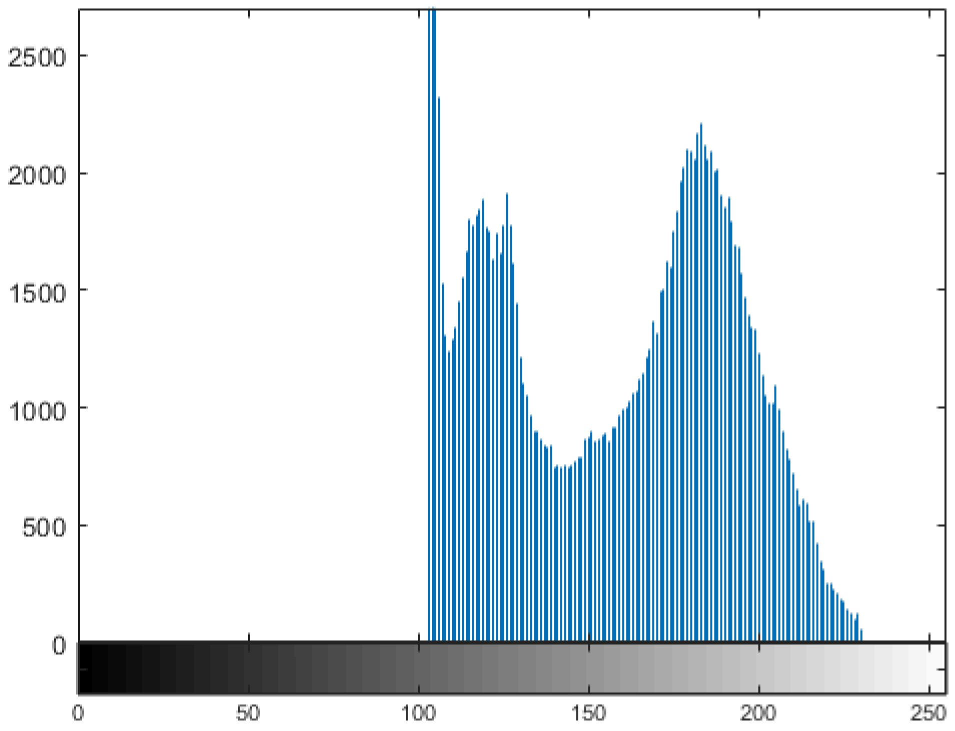
Q2 - Histograms

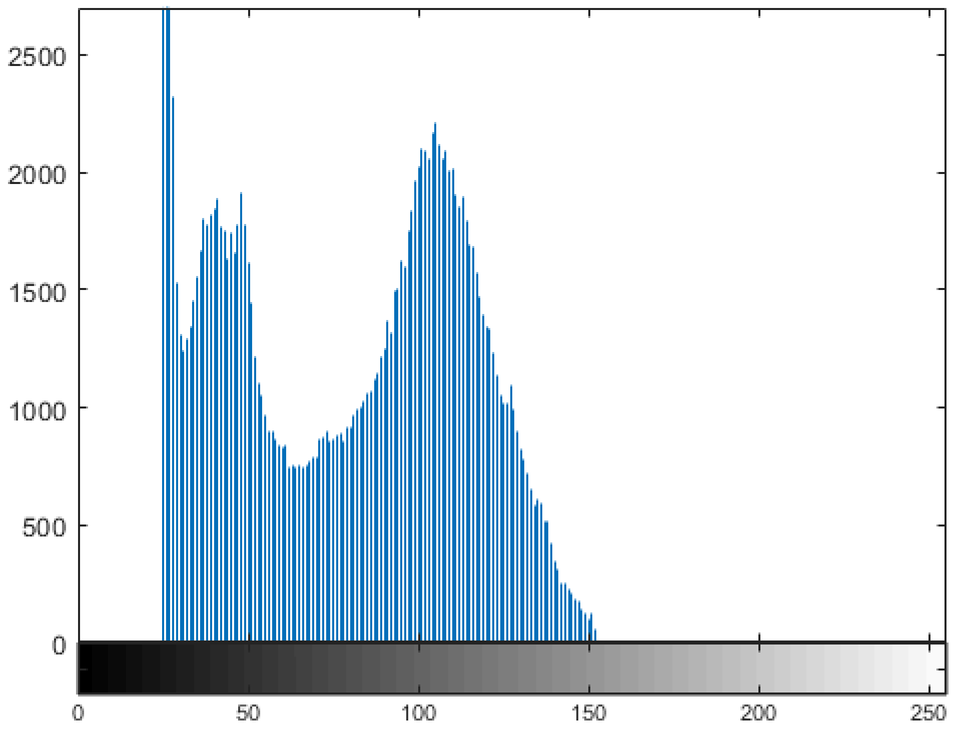
From figure 1, which is the regular image, we see that the pixel values are spread across the domain $\[0, 255\]$. The second figure is skewed towards the lighter pixel values and this image should be the high contrast one. The third histogram shows the third image and how it is skewed in the other direction and is thus the histogram of the low contrast image.

```
Error updating Text.

 String scalar or character vector must have valid interpreter syntax:
$\[0, 255\]$
```

```
figure;
imhist(I);

figure;
imhist(Il);

figure;
imhist(Id);
```




2500
2000
1500
1000
500
0
0
50
100
150
200
250


2500
2000
1500
1000
500
0
0
50
100
150
200
250

Q3 - Explain differences

The problem here is that when imshow gets passed a uint image it is able to adjust the visualisation range between 0 and 255 but when it gets passed a single precision matrix, which has values from 0 to 255, it tries to plot it as a image with values between 0 and 1. Therefore it needs to be normalised to be plotted correctly. Below we have plotted the difference between the original image and the examples from the assignment. We see that in the UINT8 one there is considerable difference between the two and this is related to doingh arithmetic on UINT8 variables.

```
imshow(I - (I/64)*64);
imshow((I/64)*64);

imshow((Is/255) - (Is/64)*64/255);
imshow((Is/64)*64/255);
```

Q4 - Make images brighter

To make images brighter. The take the original image $f(x,y)$ and apply the trasform $T = f(x,y) + C$ where $C > 1$.

```
imshow(I + 50);
imshow(I);
```

Q5 - Make images lower contrast

To make the image lower contrast we apply the transform $T = f(x, y) \times C$ where $C < 1$

```
imshow(I);
imshow(I * 0.5);
```

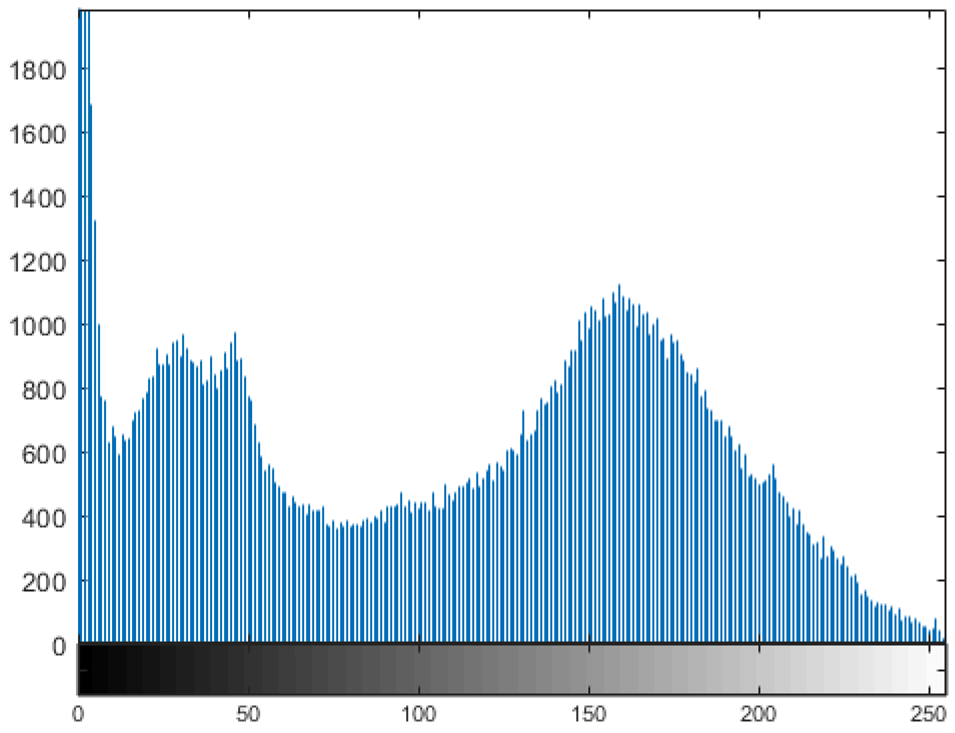
Q6 - Pixel Wise Transforms

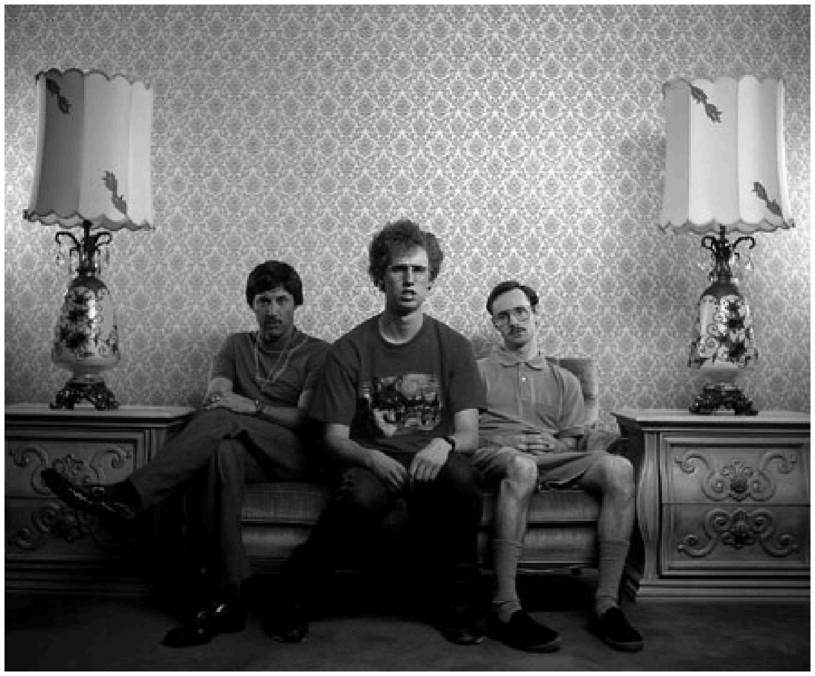
Below we have perfomred a gamma transform which is $T = C \times f(x,y)^{\gamma}$ where $C = 1$ and $gamma \in {0.5, 2$. We also compare this with the original image.

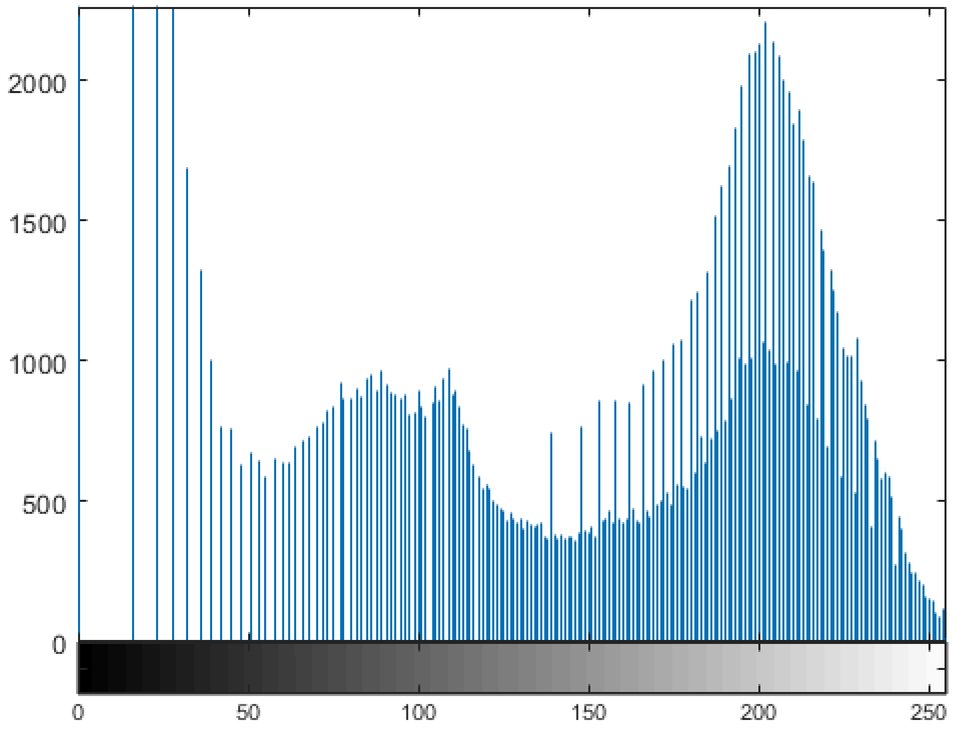
```
        Error updating Text.

         String scalar or character vector must have valid interpreter syntax:
        $gamma \in {0.5, 2$
```

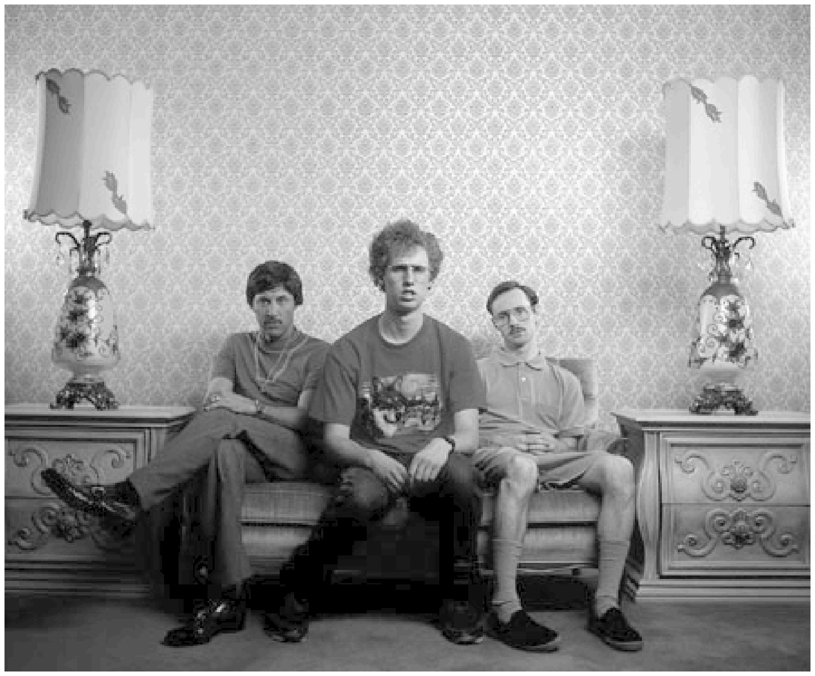
```
figure;
imhist(I);

figure;
imshow(I);

g = 0.5;
L = double(I).^g;
out = uint8(L .* (255/max(max(L))));

figure;
imhist(out);

figure;
imshow(out);
```

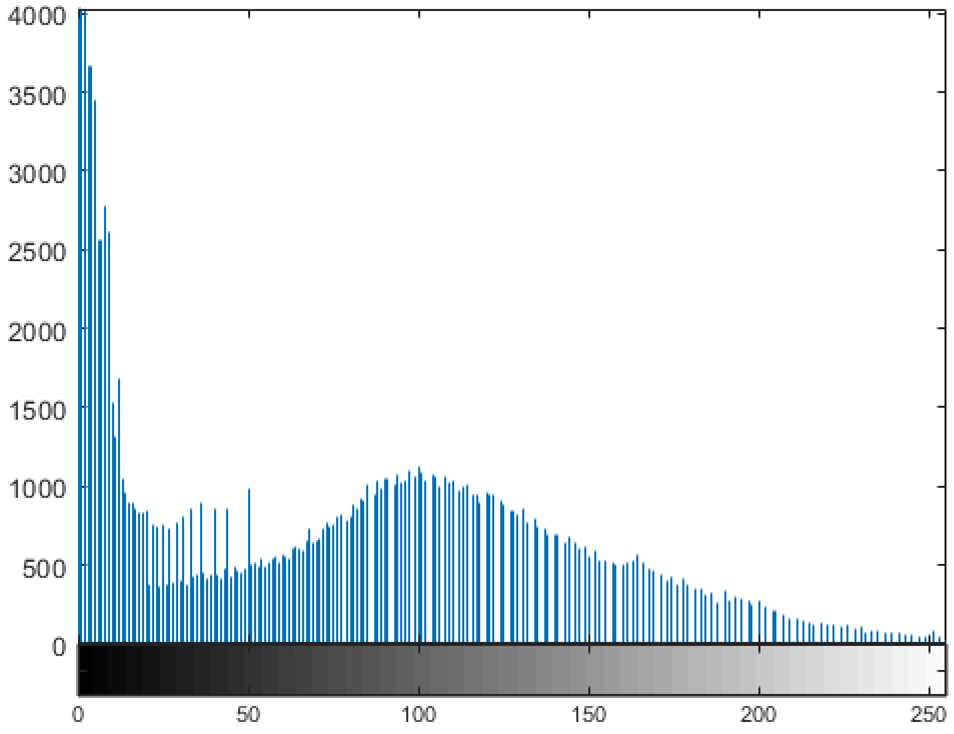
```
g = 2;
L = double(I).^g;
out = uint8(L .* (255/max(max(L))));

figure;
imhist(out);

figure;
imshow(out);
```






2000
1500
1000
500
0
0
50
100
150
200
250

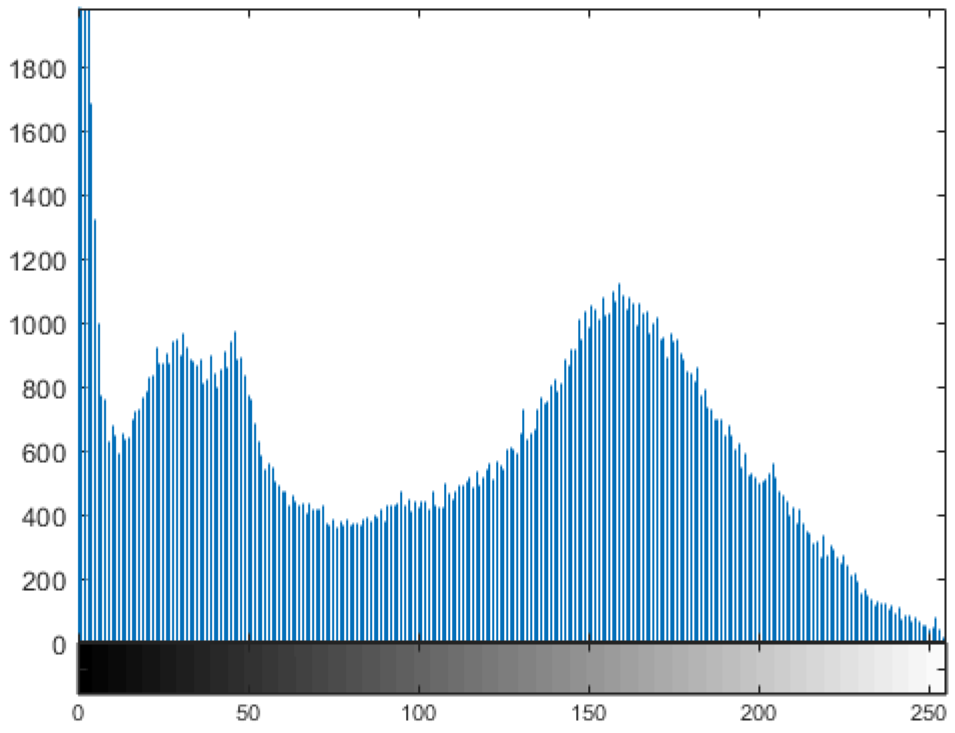



4000
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150
200
250

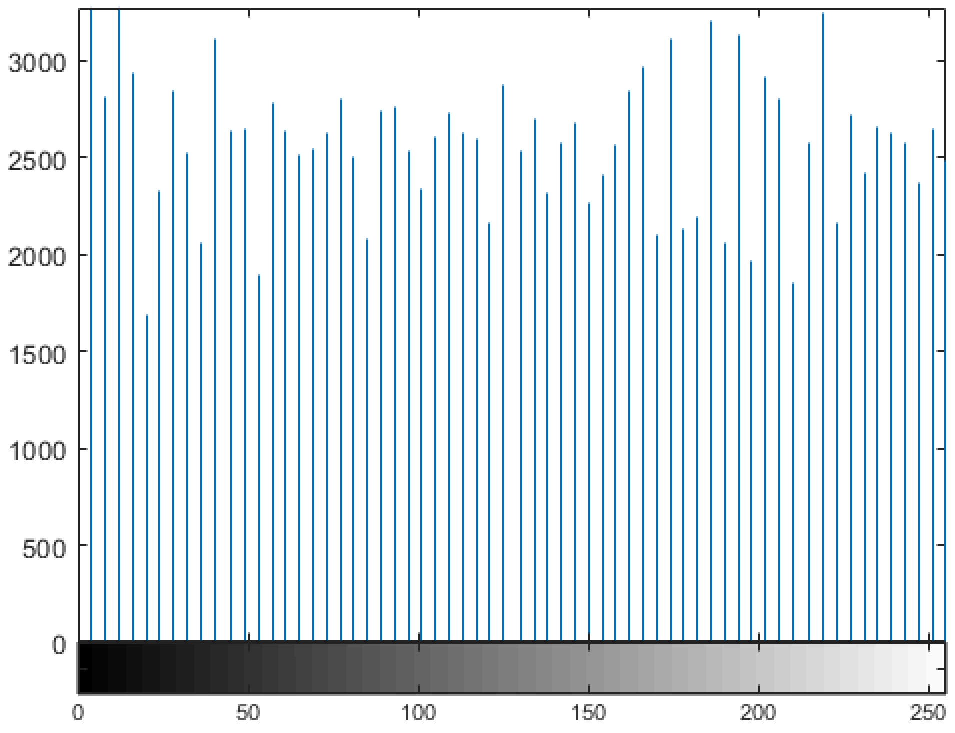
Q7 - Histogram Equalization napoleon - Histogram

Below is the histograms of the original image, and the original, light and dark image and their equalized histograms.

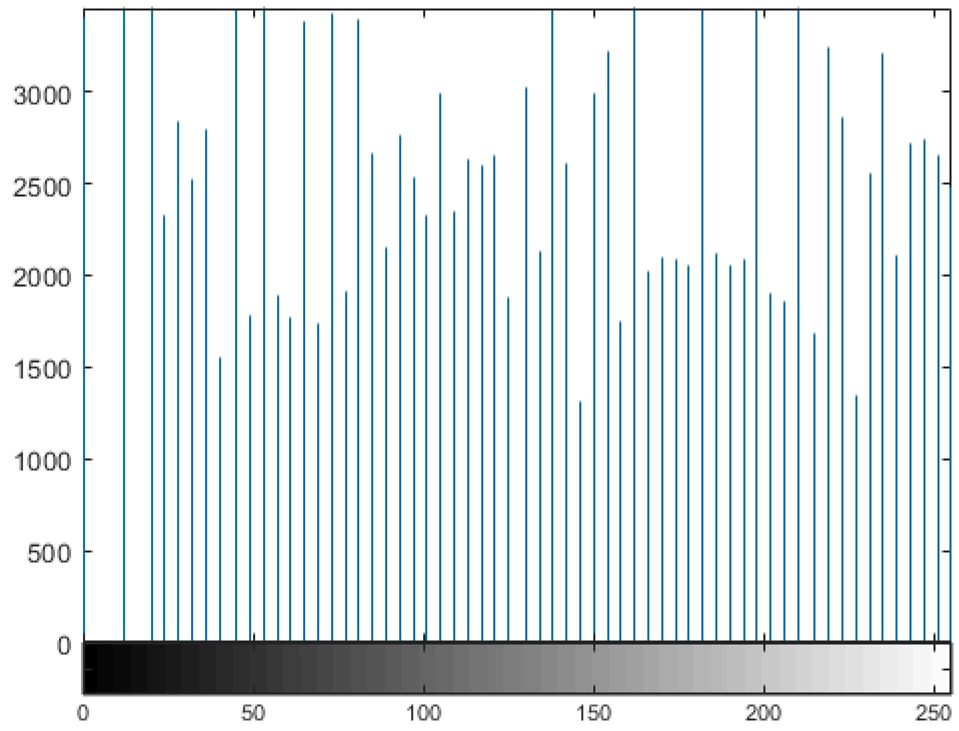
```
figure;
imhist(I);

figure;
imhist(histeq(I));

figure;
imhist(histeq(Il));

figure;
imhist(histeq(Id));
```

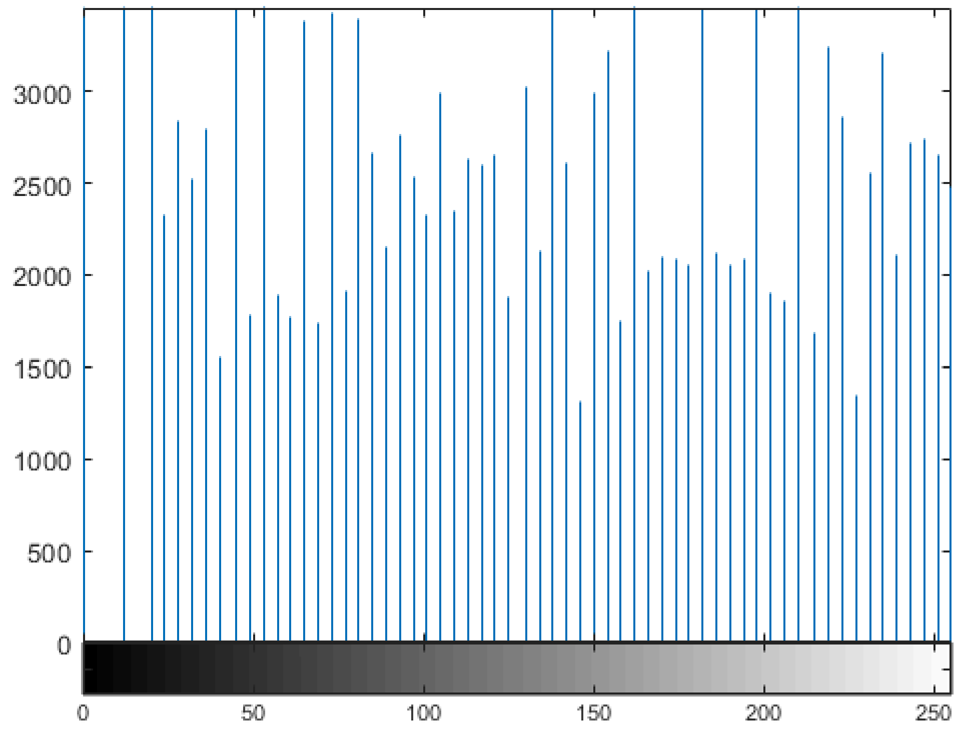


1800
1600
1400
1200
1000
800
600
400
200
0
0
50
100
150
200
250



3000
2500
2000
1500
1000
500
0
0
50
100
150
200
250

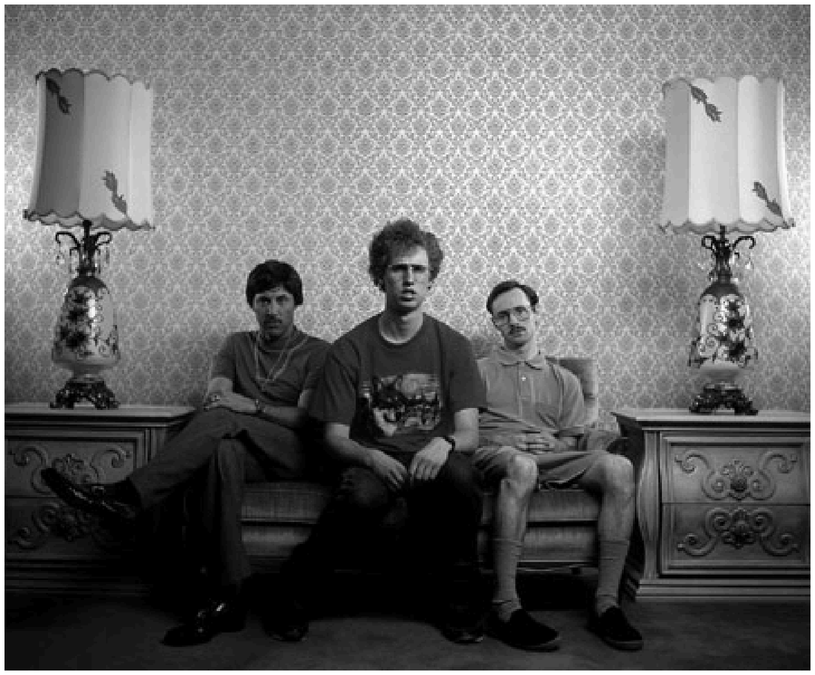

0
500
1000
1500
2000
2500
3000
0
50
100
150
200
250


0
500
1000
1500
2000
2500
3000
0
50
100
150
200
250

Q7 - Histogram Equalization napoleon - Images

Here we show the equalised images.

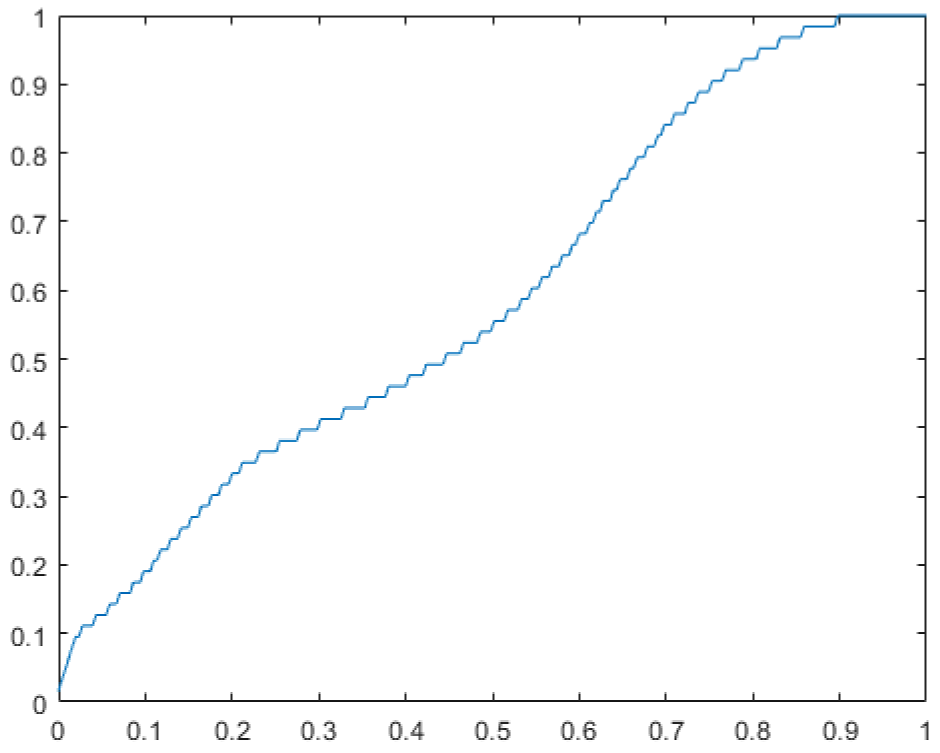
```
figure;
imshow(I);

figure;
imshow(histeq(I));

figure;
imshow(histeq(Il));

figure;
imshow(histeq(Id));
```

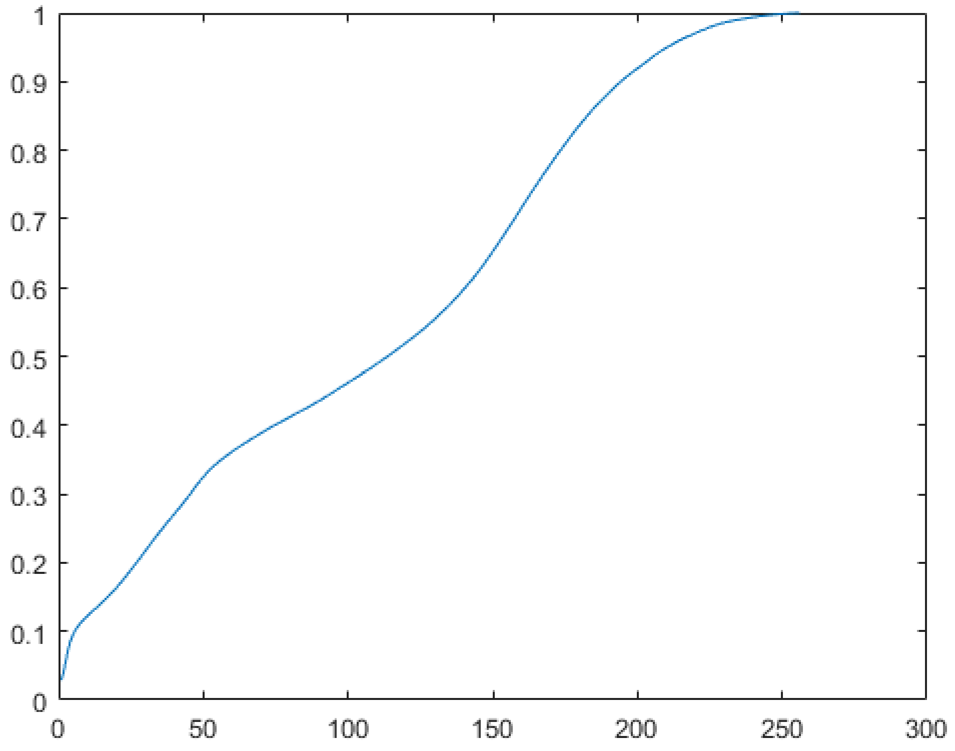


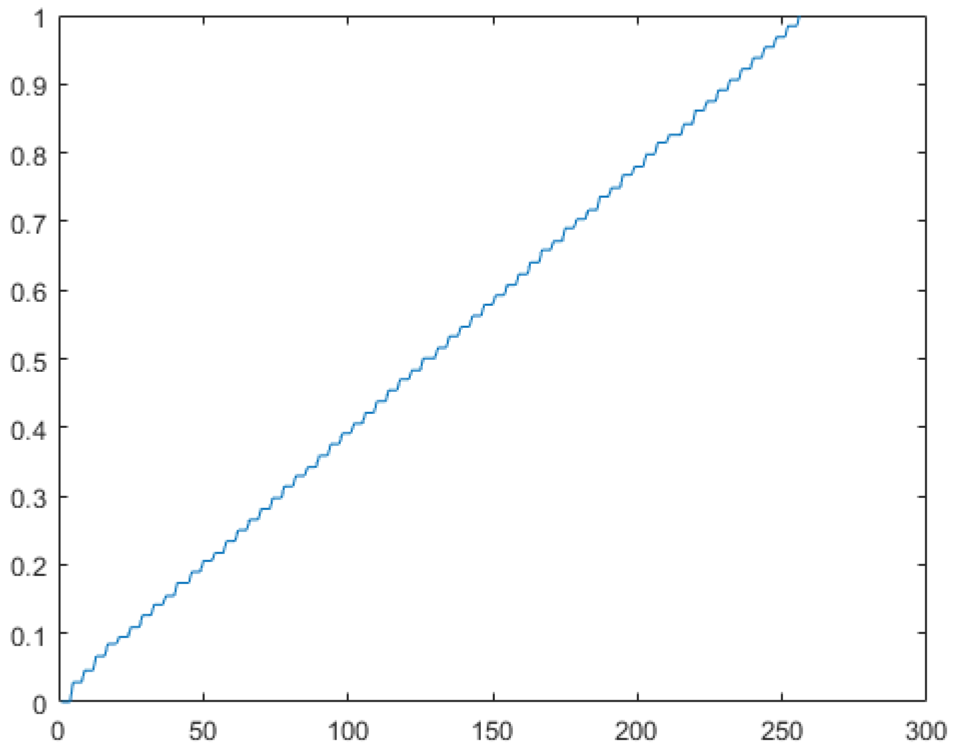
Q7 - Histogram, transform and cumulative histogram - Regular Image

And here is the cumulative histograms. According to the textbook, to equalize a image, you have to take the CDF of the image and use that to transform the pixel values. This is estimated by calculating the cumulative histogram and using that as an approximation for the CDF. If we use the histeq function and compare it to the normalied histogram calculated manually, we see that these are the same.

```
[J,T] = histeq(I);

figure
plot((0:255)/255,T);

figure
plot(cumsum(imhist(I)) / sum(imhist(I)));

figure
plot(cumsum(imhist(J)) / sum(imhist(J)));
```


0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

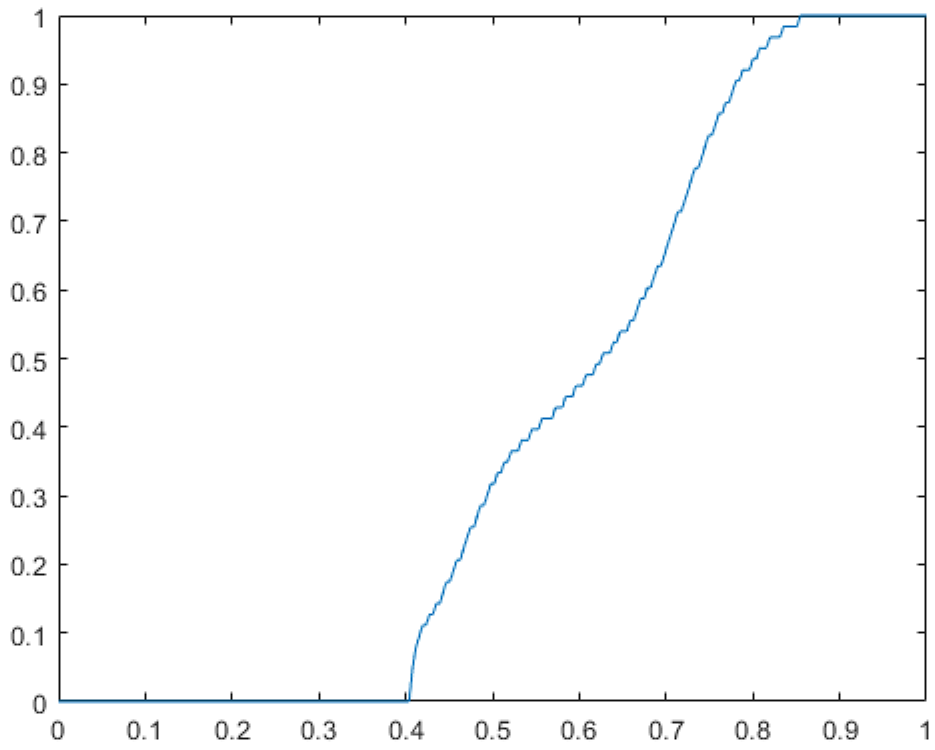

0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
50
100
150
200
250
300

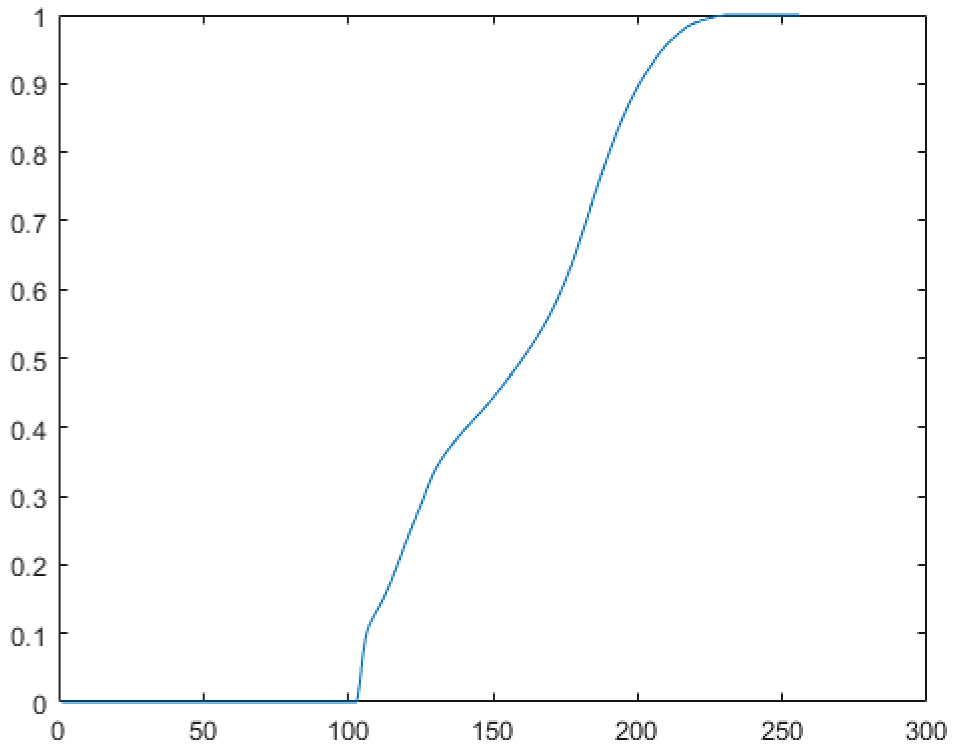


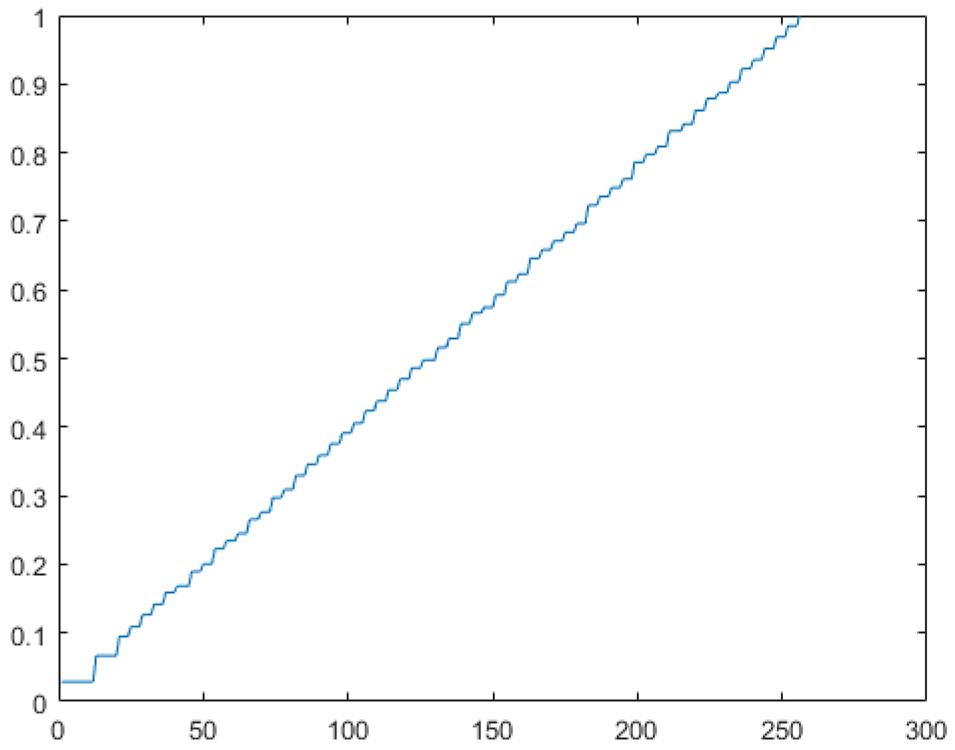
Q7 - Histogram, transform and cumulative histogram - Light

Same as above but for the light image.

```
[J,T] = histeq(Il);

figure
plot((0:255)/255,T);

figure
plot(cumsum(imhist(Il)) / sum(imhist(Il)));

figure
plot(cumsum(imhist(J)) / sum(imhist(J)));
```


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

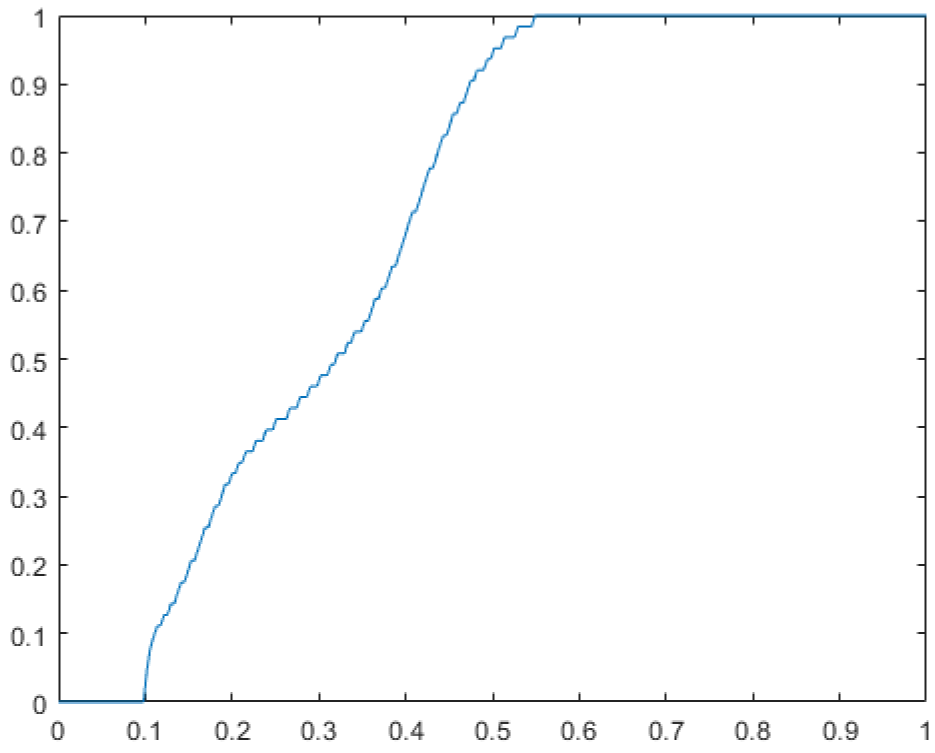

1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
50
100
150
200
250
300



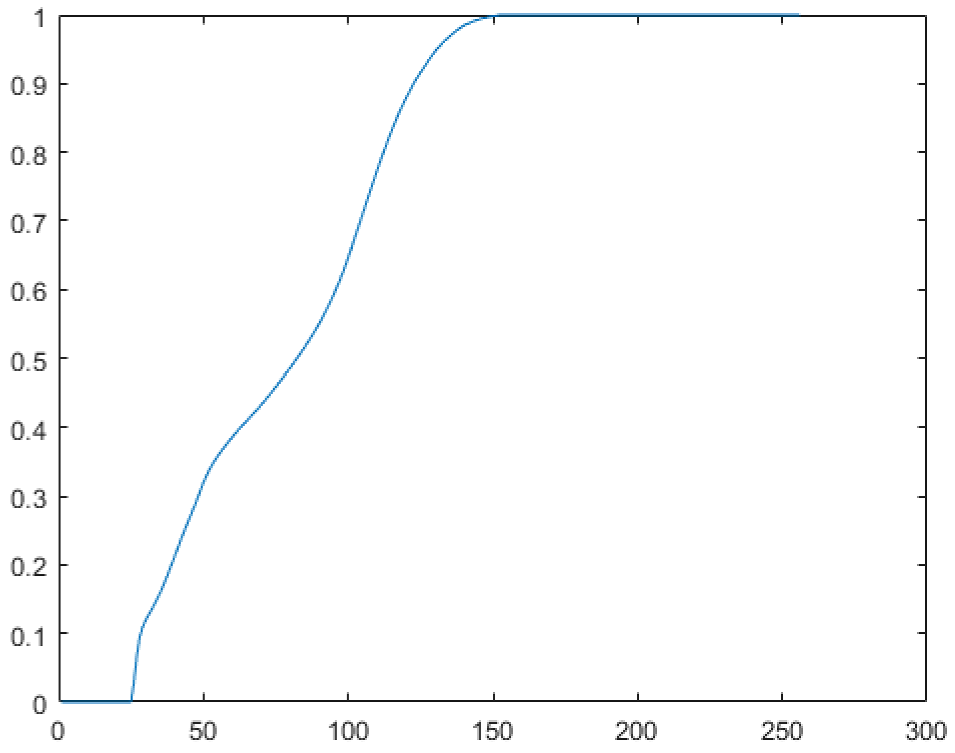
Q7 - Histogram, transform and cumulative histogram - Dark

Same as above but for the dark image.

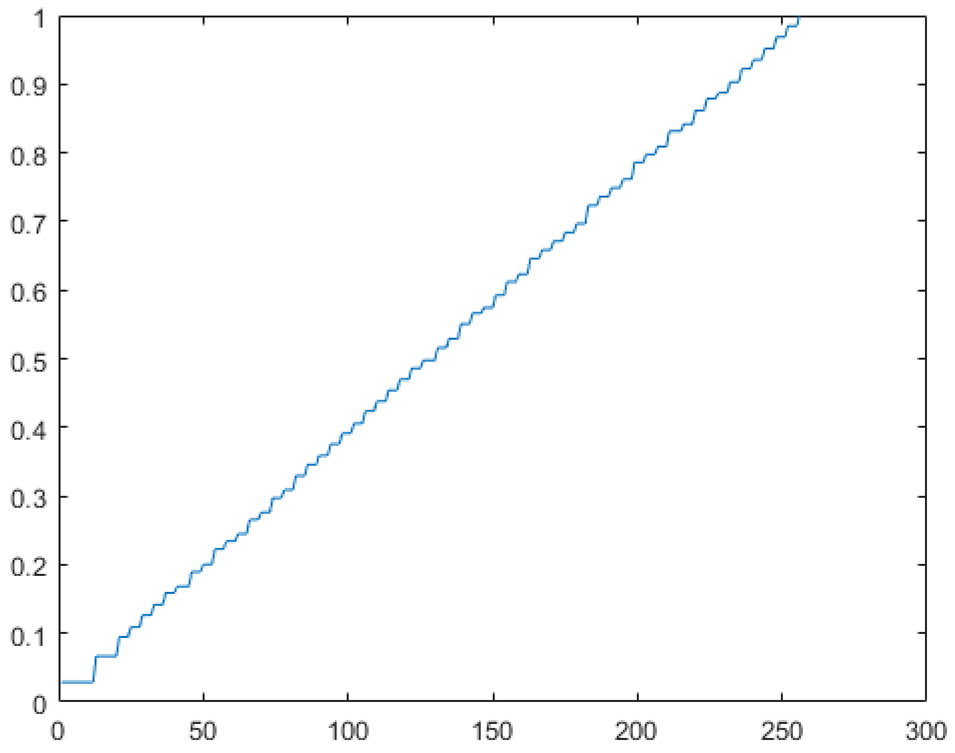
```
[J,T] = histeq(Id);

figure
plot((0:255)/255,T);

figure
plot(cumsum(imhist(Id)) / sum(imhist(Id)));

figure
plot(cumsum(imhist(J)) / sum(imhist(J)));
```



0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1



0
50
100
150
200
250
300
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1



Q8 - Interpolation and low-pass filter

The difference between the interpolation methods are not very significant but the difference between performing a low pass filter is quite significant. The backround of the image without the use of a low pass filter is quite noisy whereas with antialiasing the the background is more homogenous and resembles the original image better.

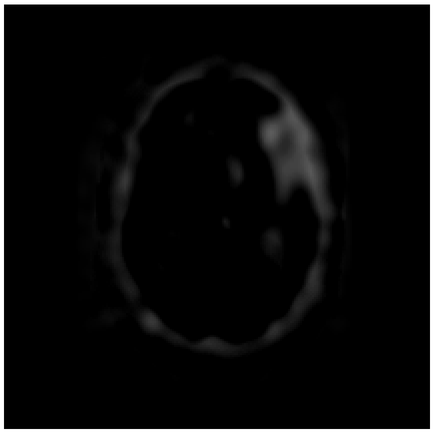
```
Jnf = imresize(I, [78,78], 'nearest', 'antialiasing', false);
Jnt = imresize(I, [78,78], 'nearest', 'antialiasing', true);
Jbf = imresize(I, [78,78], 'bilinear', 'antialiasing', false);
Jbt = imresize(I, [78,78], 'bilinear', 'antialiasing', true);

imshow(Jnf);
imshow(Jnt);
imshow(Jbf);
imshow(Jbt);
```

Q9 - Aliasing

Aliasing is a general problem when sampling a signal and when several signals is indistinguishable when sampled. This could be for example when trying to sample an audiosignal and interpolating it and different possible frequencies are available.

Q10/Q11 - Mean Image

```
Mn = (B1 + B2)/2;
imshow(Mn - B3);
```



Q13 - Geometric Transforms

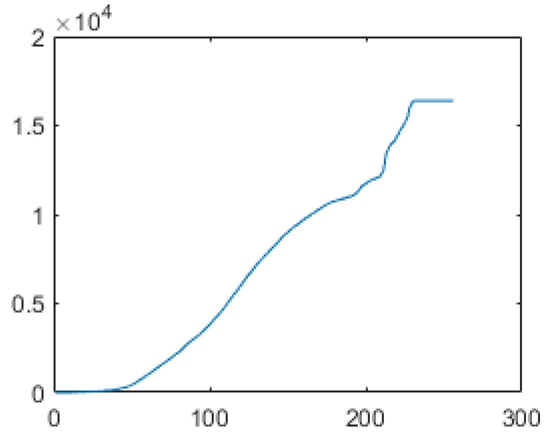
```
J = imrotate(W, 20);
K = imrotate(W, 20, 'bilinear');

imshow(J);
imshow(K);
```

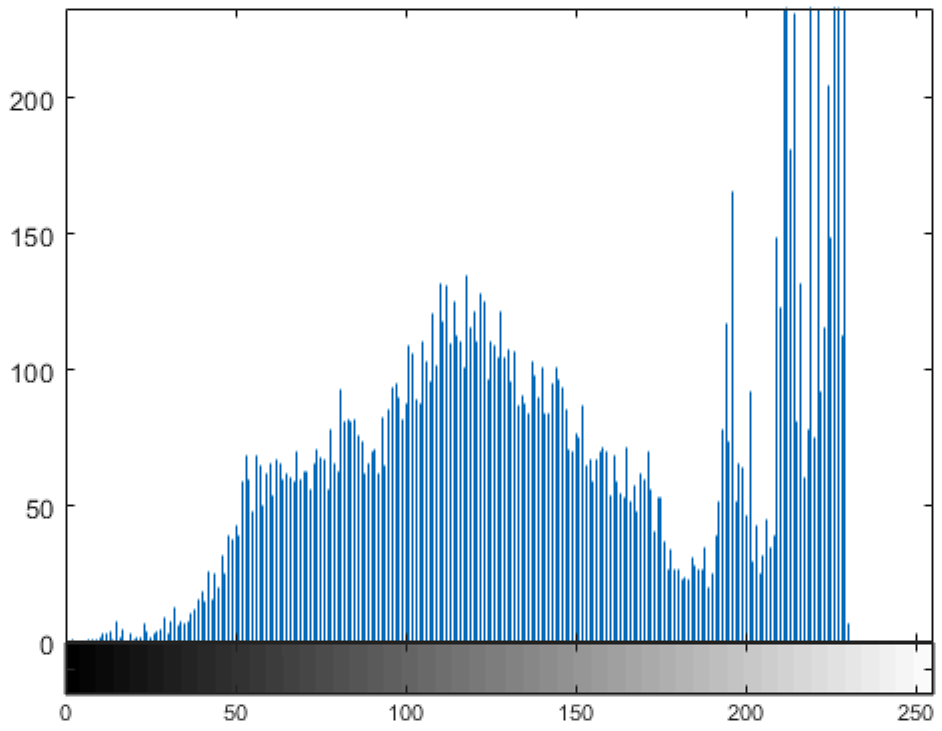
Q15 - Scripting and Looping

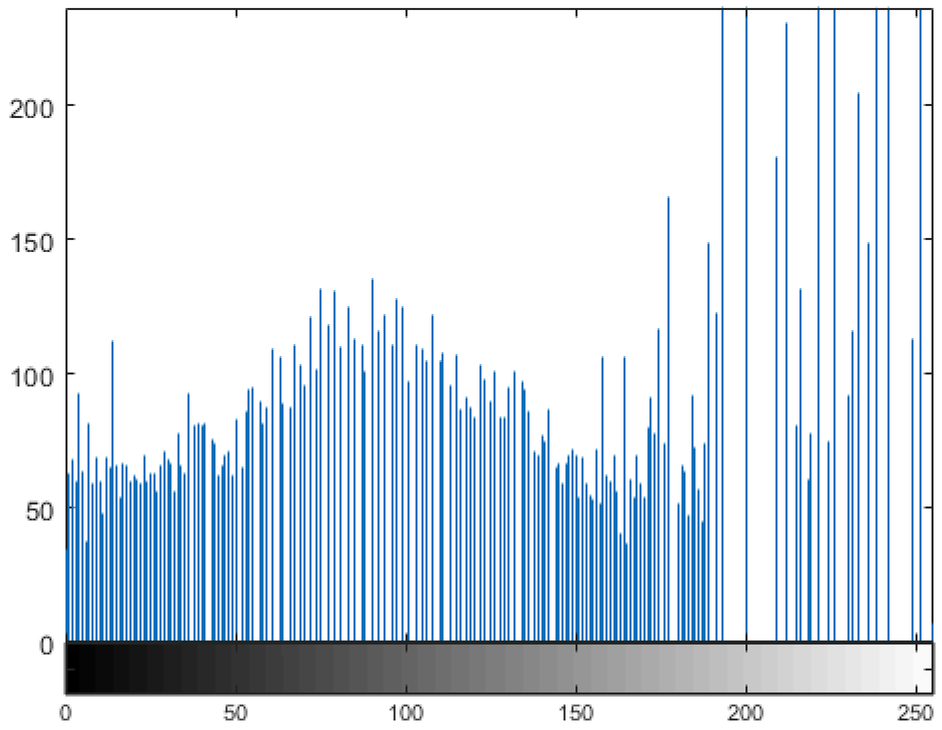
```
newI = zeros(130,130,'uint8');
GD2t = padarray(GD2, [2, 2], 0);

for i = 3:130
    for j = 3:130
        sum = uint16(0);
        for k = 1:5
            for l = 1:5
                sum = sum + uint16(GD2t(i+k-3, j+l-3));
            end
        end
        newI(i,j) = uint8(sum/25);
    end
end

Image = newI(3:130, 3:130);

imshow(GD2);
imshow(Image);
imshow(Image-GD2);
```

Q16 - Histogram Equation

```
f = myhist(GD2);

% Show Original Image
figure;
imshow(GD2);

% Show Equalised Image using myhist
figure;
imshow(f);

% Show Equalized Image histogram using myhist
figure;
imhist(GD2);

% Show Equalized Image histogram using myhist
figure;
imhist(f);

function f = myhist(image)
    Ihist = hist(reshape(image.',1,[]), 0:255);
    T = cumsum(Ihist);
    norm = T(256);
    plot(T);
    Tn = uint8(T*255 / norm);
    f = Tn(image);
end
```


×10^4
2
1.5
1
0.5
0
0
100
200
300


200
150
100
50
0
0
50
100
150
200
250


200
150
100
50
0
0
50
100
150
200
250

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