LAPORAN PRAKTIKUM PENGOLAHAN CITRA DIGITAL
7. HISTOGRAM EQUALIZATION AND SPECIFICATION

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TUTORIAL : HISTOGRAM EQUALIZATION AND SPECIFICATION

Goal

The goal of this tutorial is to learn how to use the IPT for (global and local) histogram equalization and histogram specification (matching).

Objectives

- Explore the process of histogram equalization.
- Learn how to use the `histeq` function.
- Learn how to perform histogram specification (matching).
- Explore the Interactive Histogram Matching demo.
- Learn how to perform local histogram equalization with the `adapthisteq` function.

What You Will Need

`ihmdemo.m`—interactive Histogram Matching demo M-file

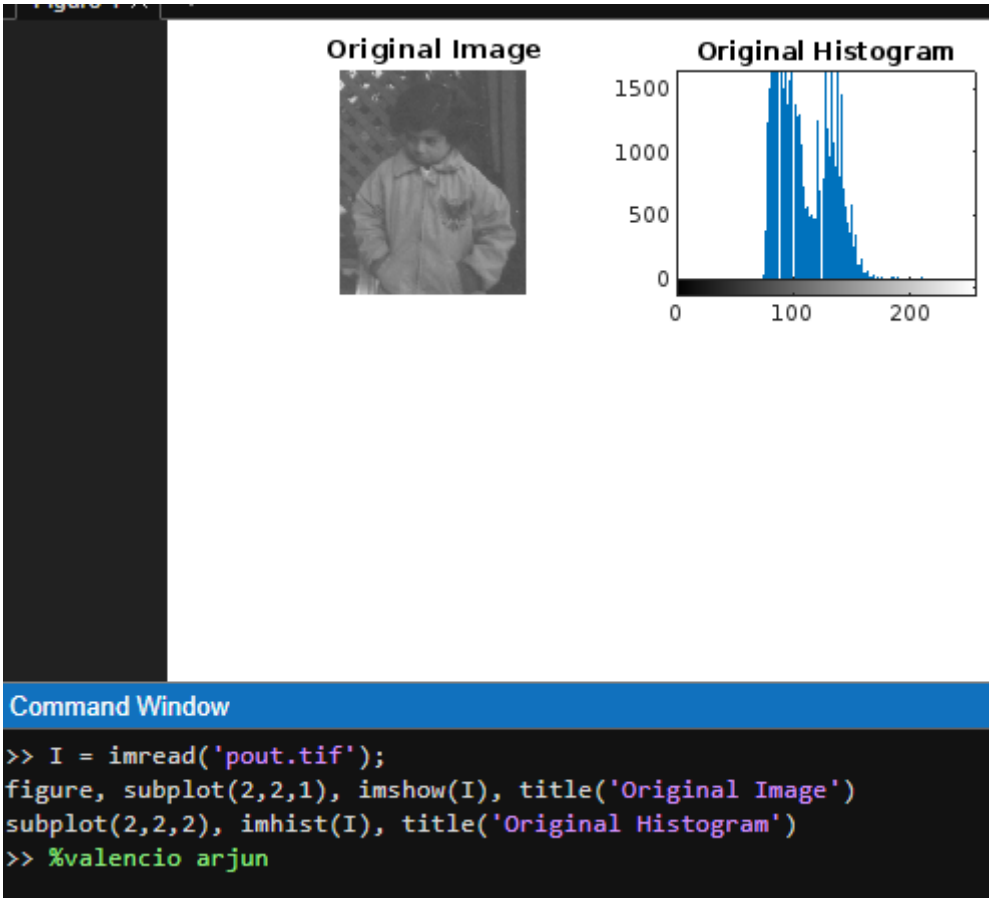
Procedure

Let us begin by using the function `histeq` to perform histogram equalization on our

own images, and by using the `imhist` function, we can view the histogram of the original and the adjusted image.

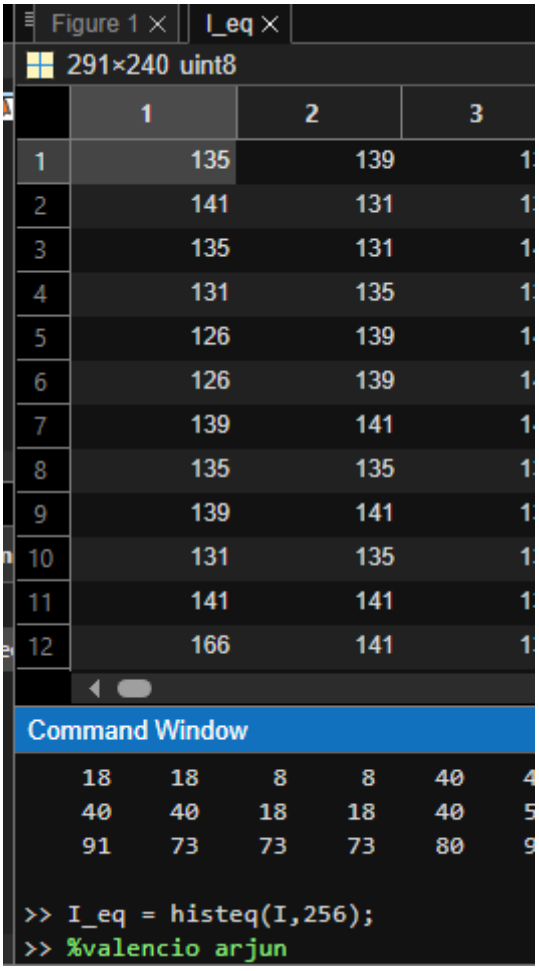
1. Display the image pout and its histogram.

```
I = imread('pout.tif');
figure, subplot(2,2,1), imshow(I), ...
    title('Original Image')
subplot(2,2,2), imhist(I), ...
    title('Original Histogram')
```



2. Use the `histeq` function to perform histogram equalization.

```
I_eq = histeq(I,256);
```



Question 1 Why must we include the second parameter (256) in the `histeq` function call?

specify the number of intensity levels (or bins)

3. Display the equalized image and its histogram.

```
subplot(2,2,3), imshow(I_eq), title('Equalized Image')
subplot(2,2,4), imhist(I_eq), title('Equalized Histogram')
```

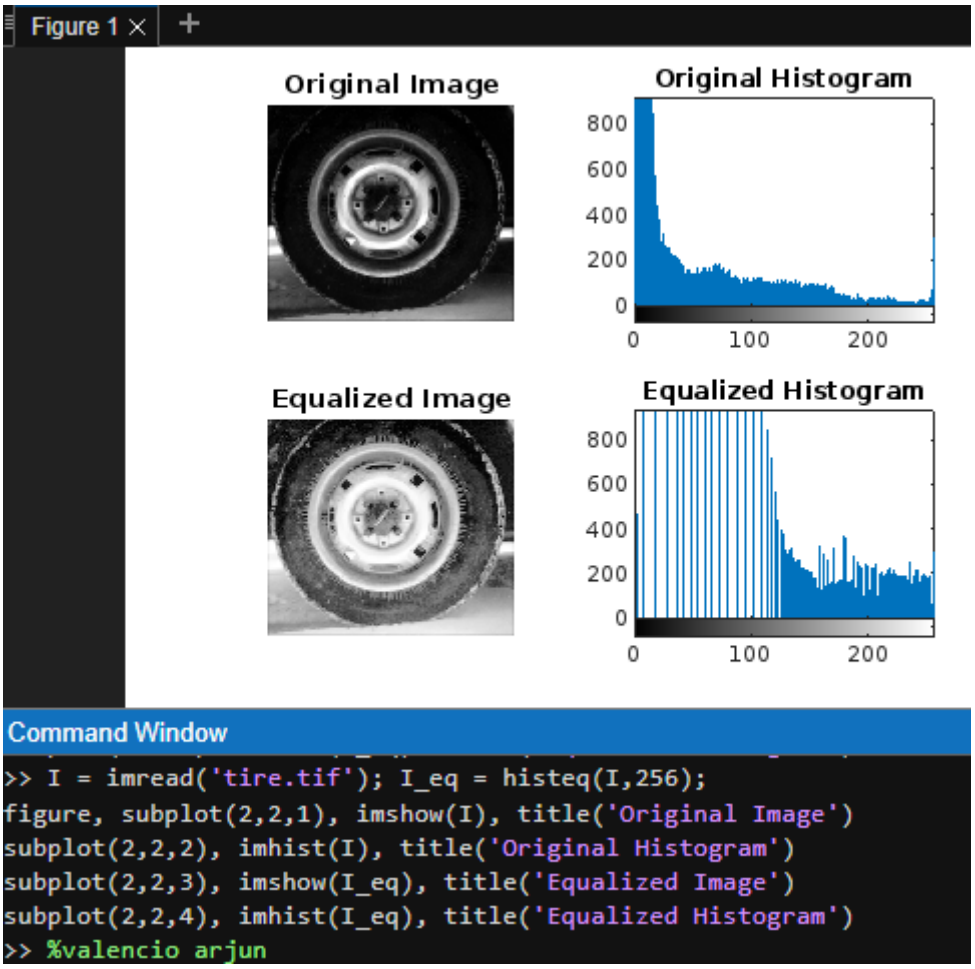
Question 2 What is the effect of histogram equalization on images with low contrast?

The quality become better and the histogram chart on Equalized Histogram rapidly increasing in range

4. Close any open figures and clear all workspace variables.

5. Execute the following code to perform histogram equalization on the tire image.

```
I = imread('tire.tif'); I_eq = histeq(I,256);
figure, subplot(2,2,1), imshow(I), title('Original Image')
subplot(2,2,2), imhist(I), title('Original Histogram')
subplot(2,2,3), imshow(I_eq), title('Equalized Image')
subplot(2,2,4), imhist(I_eq), title('Equalized Histogram')
```



Question 3 Based on the tire image's original histogram, what can be said about its overall brightness?

the overall brightness is low.

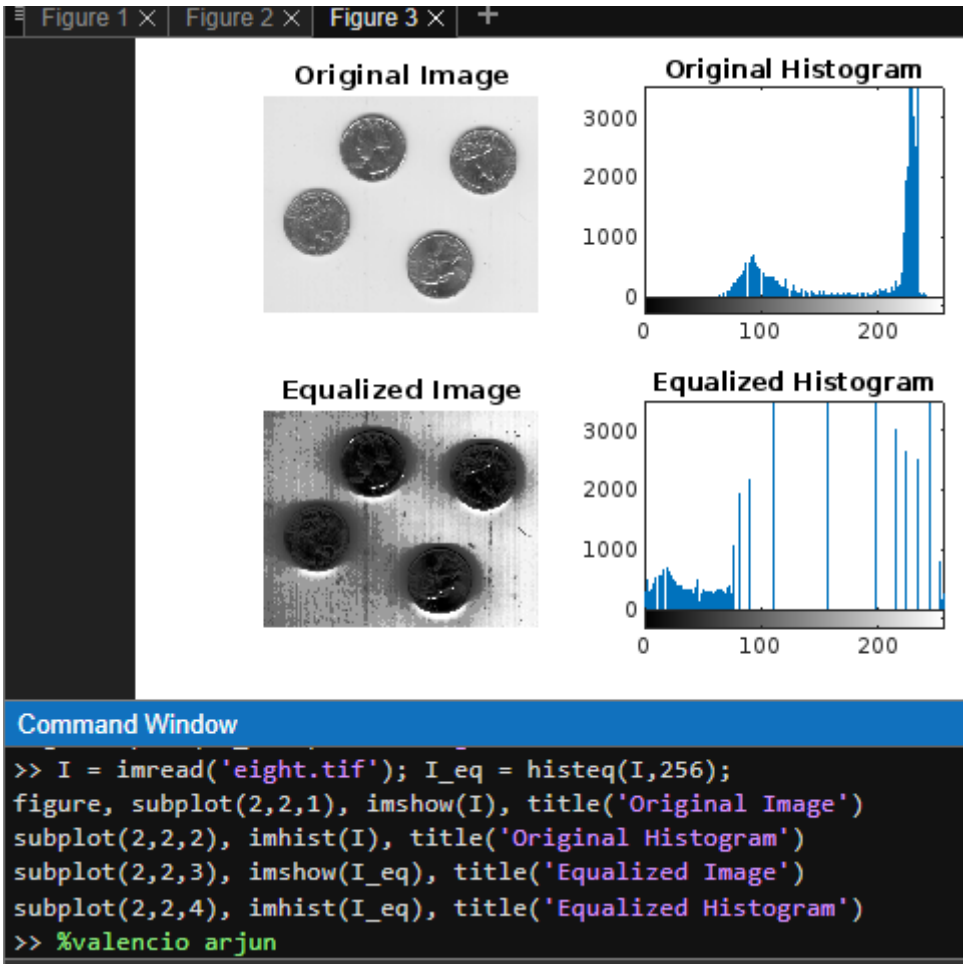
Question 4 How did histogram equalization affect the overall image brightness in this case?

Histogram equalization increased the overall image brightness and contrast of the 'tire.tif' image

Histogram equalization does not always perform well. As we will see in the next steps, it depends on the original image.

6. Close any open figures and clear all workspace variables.
7. Perform histogram equalization on the eight image.

```
I = imread('eight.tif'); I_eq = histeq(I,256);
figure, subplot(2,2,1), imshow(I), title('Original Image')
subplot(2,2,2), imhist(I), title('Original Histogram')
subplot(2,2,3), imshow(I_eq), title('Equalized Image')
subplot(2,2,4), imhist(I_eq), title('Equalized Histogram')
```



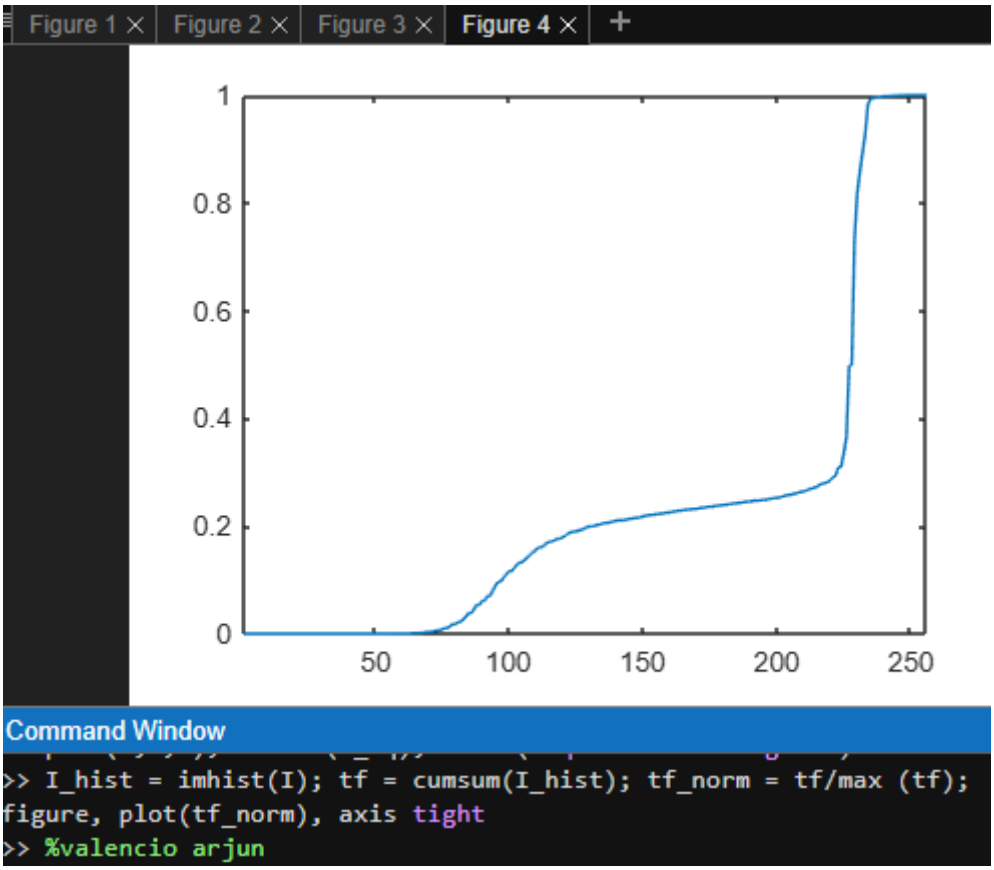
Question 5 Why was there such a loss in image quality after histogram equalization?

due to over-enhancement or distortion of intensity values

The transformation function for histogram equalization is simply the cdf of the original image.

8. Display the normalized cdf for the `eight.tif` image.

```
I_hist = imhist(I); tf = cumsum(I_hist); tf_norm = tf / max(tf);
figure, plot(tf_norm), axis tight
```

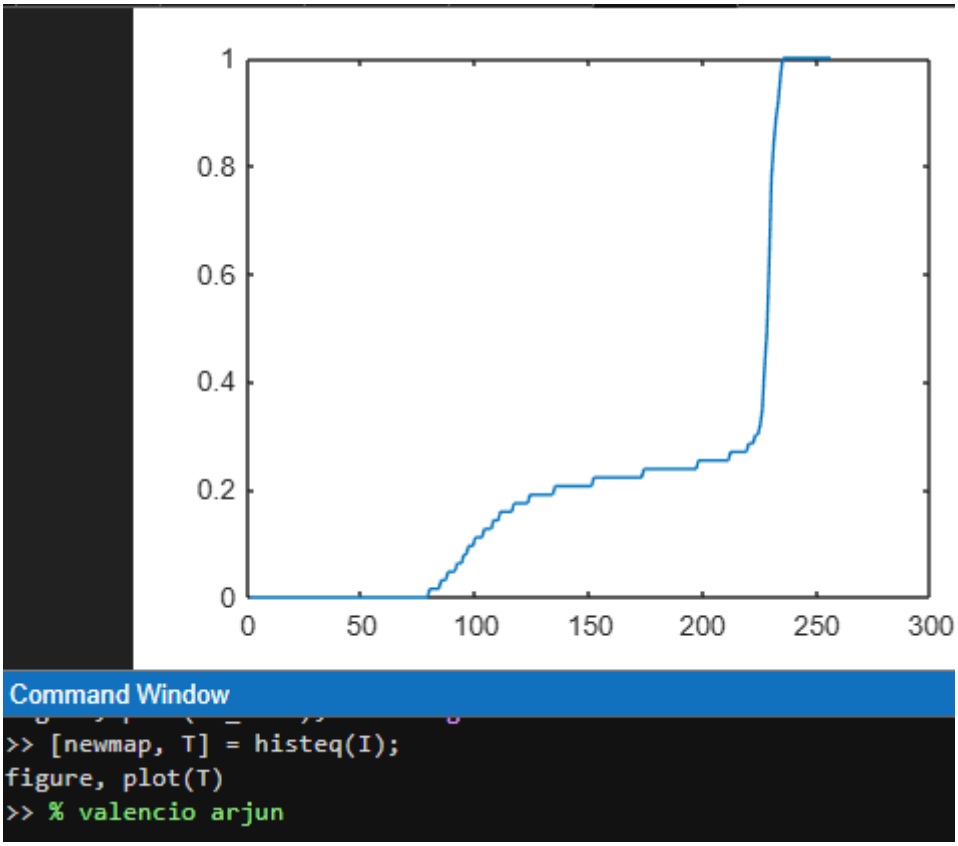


Question 6 What does the cumsum function do in the previous step?

computes the cumulative sum of the input array

9. The transformation function can also be obtained without using the cumsum function.

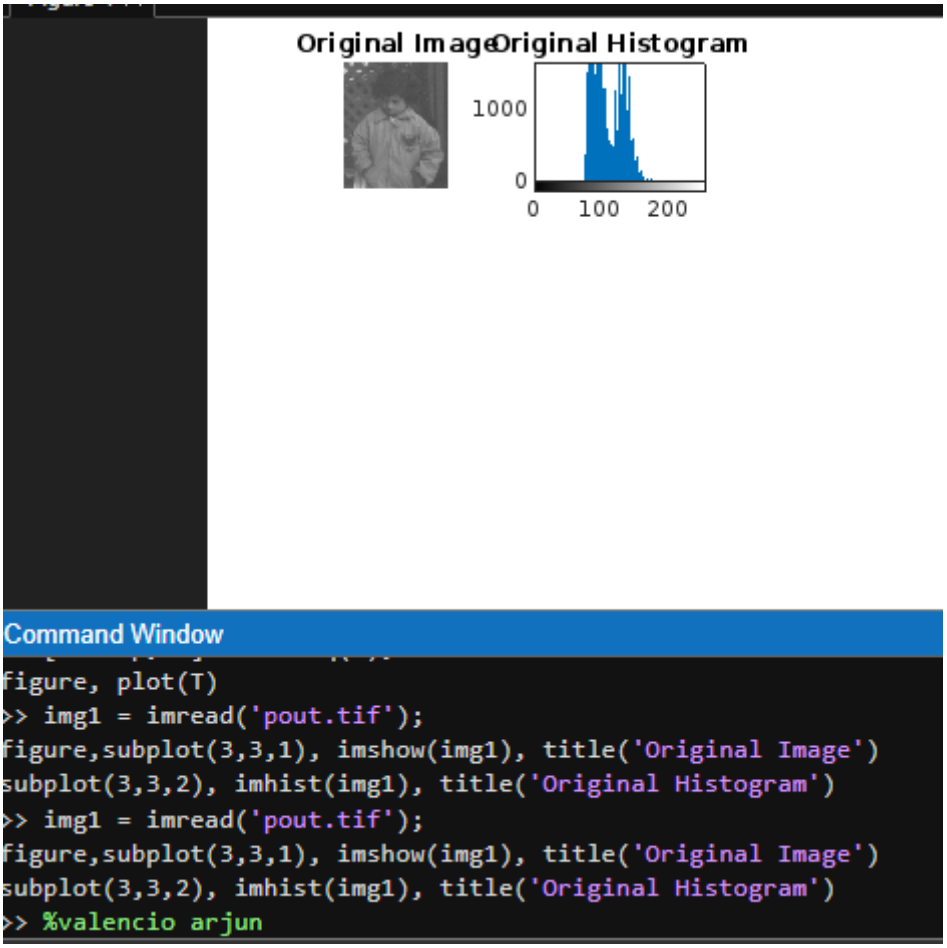
```
[newmap, T] = histeq(I);
figure, plot(T)
```



As we have learned, the histogram equalization process attempts to flatten the image histogram. Histogram specification (also known as histogram matching) tries to match the image histogram to a specified histogram. The `histeq` function can also be used for this operation.

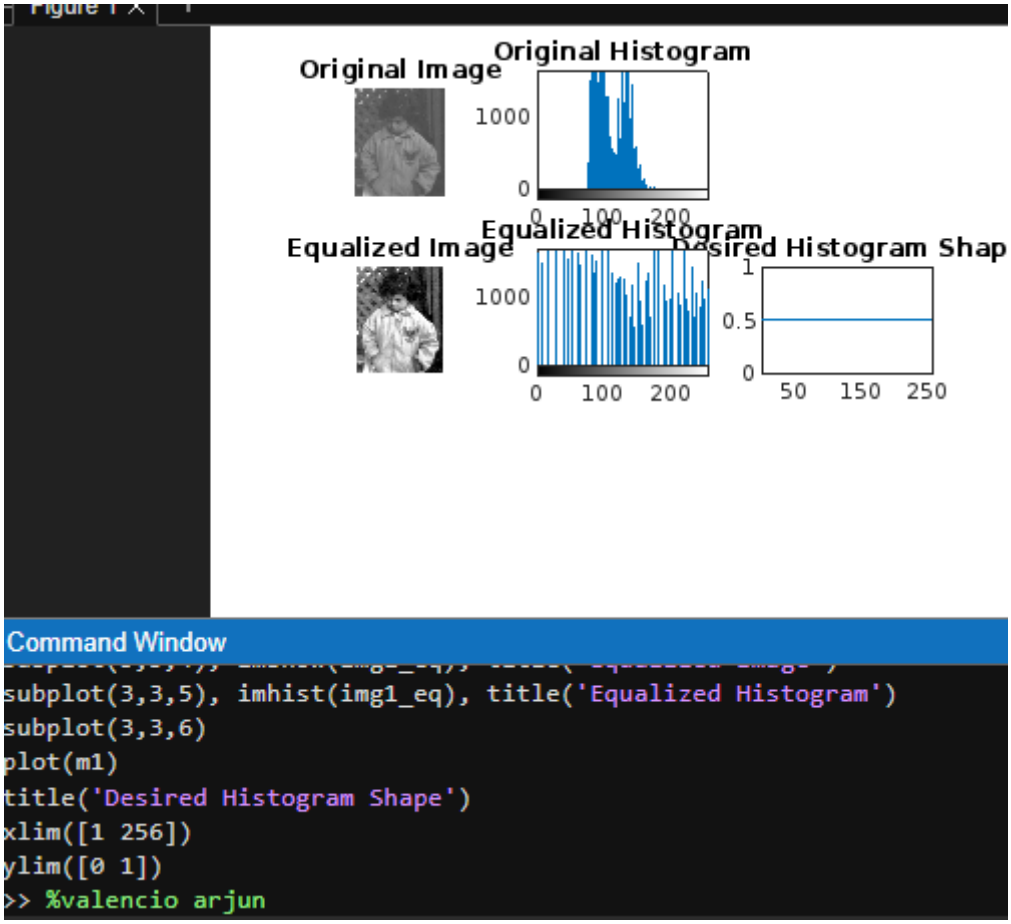
10. Close any open figures and clear all workspace variables.
11. Prepare a subplot and display original image and its histogram.

```
img1 = imread('pout.tif');
figure, subplot(3,3,1), imshow(img1), title('Original Image')
subplot(3,3,2), imhist(img1), title('Original Histogram')
```



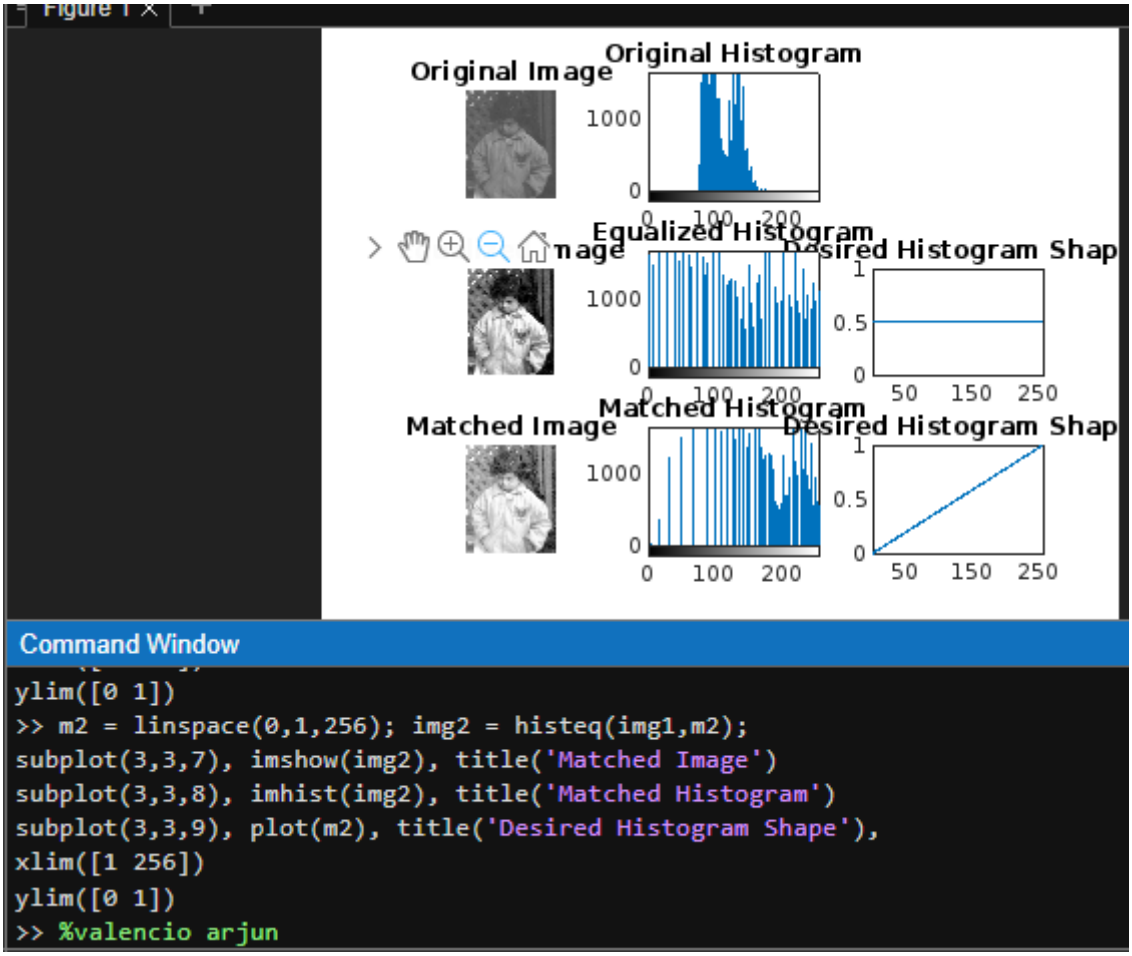
12. Display the image after histogram equalization for comparison.

```
img1_eq = histeq(img1); m1 = ones(1,256)*0.5;
subplot(3,3,4), imshow(img1_eq), title('Equalized Image')
subplot(3,3,5), imhist(img1_eq), title('Equalized Histogram')
subplot(3,3,6), plot(m1), title('Desired Histogram Shape'), ...
    ylim([0 1]), xlim([1 256])
```



13. Display matched image where the desired histogram shape is a straight line from (0, 0) to (1, 1).

```
m2 = linspace(0,1,256); img2 = histeq(img1,m2);
subplot(3,3,7), imshow(img2), title('Matched Image')
subplot(3,3,8), imhist(img2), title('Matched Histogram')
subplot(3,3,9), plot(m2), title('Desired Histogram Shape'), ...
    ylim([0 1]), xlim([1 256])
```



As we can see from the previous steps, performing histogram specification means we must generate a function that represents the shape of the desired histogram. The Interactive Histogram Matching demo (developed by Jeremy Jacob and available at the book's companion web site) shows us how creating a desired histogram shape can be an interactive process.

14. Close any open figures and clear all workspace variables.
15. Run the Interactive Histogram Matching demo.

```
ihmdemo
```

16. Experiment with creating your own desired histogram shape. To create new points on the function curve, click the curve at the desired location. To move a point, press and drag the point. To delete a point, simply click it.

Question 7 What does the Continuous Update checkbox do?

whether the image updates in real time as you modify the desired histogram shape

Question 8 How do the different interpolation methods change the shape of the desired histogram curve?

the interpolation method determines how smoothly the curve is drawn between the control points on the desired histogram shape.

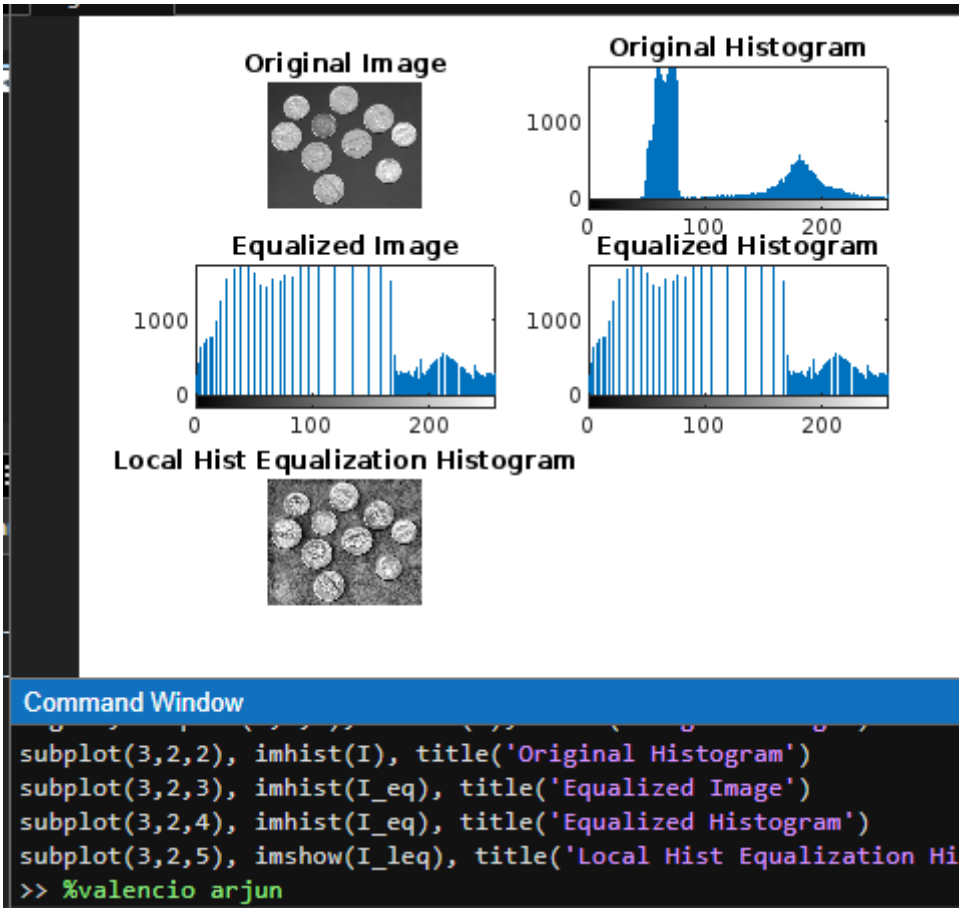
Question 9 How can the demo be loaded with a different image?

To load a different image in the Interactive Histogram Matching demo, you can use the "File" menu or a button within the demo GUI (depending on your MATLAB version).

Local histogram equalization is performed by the adapthisteq function. This function performs contrast limited adaptive histogram equalization (CLAHE) and operates on small data regions (called tiles), whose size can be passed as a parameter.

17. Perform local histogram equalization on the coins image.

```
I = imread('coins.png');
I_eq = histeq(I,256);
I_leq = adapthisteq(I,'ClipLimit',0.1);
figure, subplot(3,2,1), imshow(I), title('Original Image')
subplot(3,2,2), imhist(I), title('Original Histogram')
subplot(3,2,3), imshow(I_eq), title('Equalized Image')
subplot(3,2,4), imhist(I_eq), title('Equalized Histogram')
subplot(3,2,5), imshow(I_leq), ...
    title('Local Histogram Equalization')
subplot(3,2,6), imhist(I_leq), ...
    title('Local Hist Equalization Histogram')
```



The original image's histogram is clearly bimodal, which separates the pixels of the background from the pixels that make up the coins. We have already seen how images with bimodal distribution of pixel shades do not perform well under (global) histogram equalization.

Question 10 What does the `ClipLimit` setting do in the `adapthisteq` function?

it's used to limit contrast amplification in adaptive histogram equalization.

Question 11 What is the default tile size when using `adapthisteq`?

[8 8]