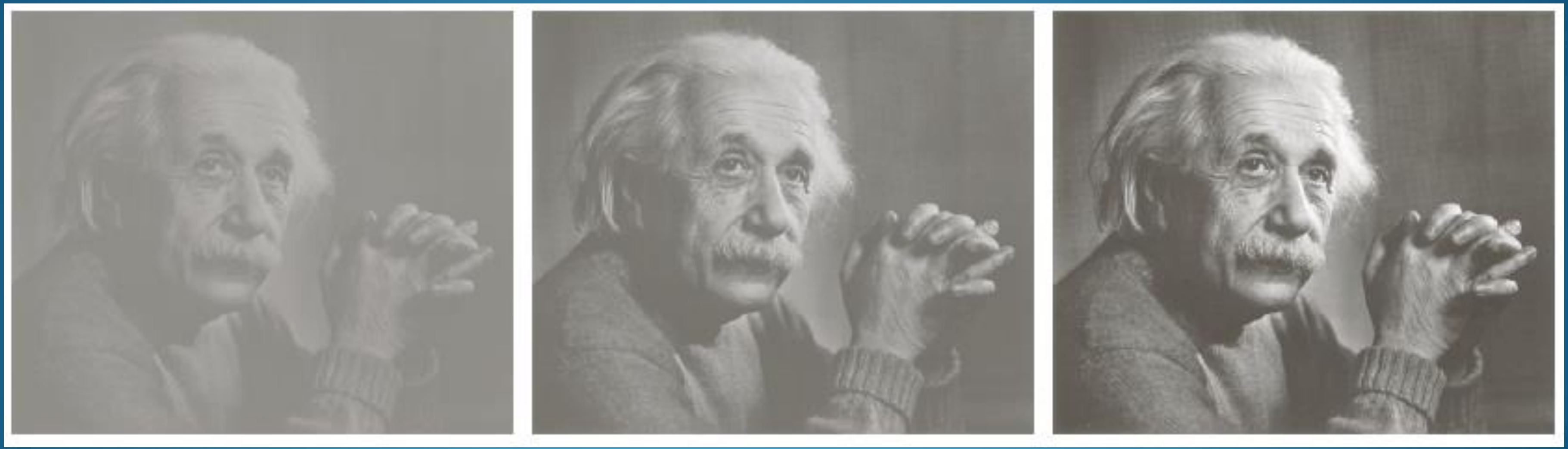
More Contrast Issues



Contrast Stretching:

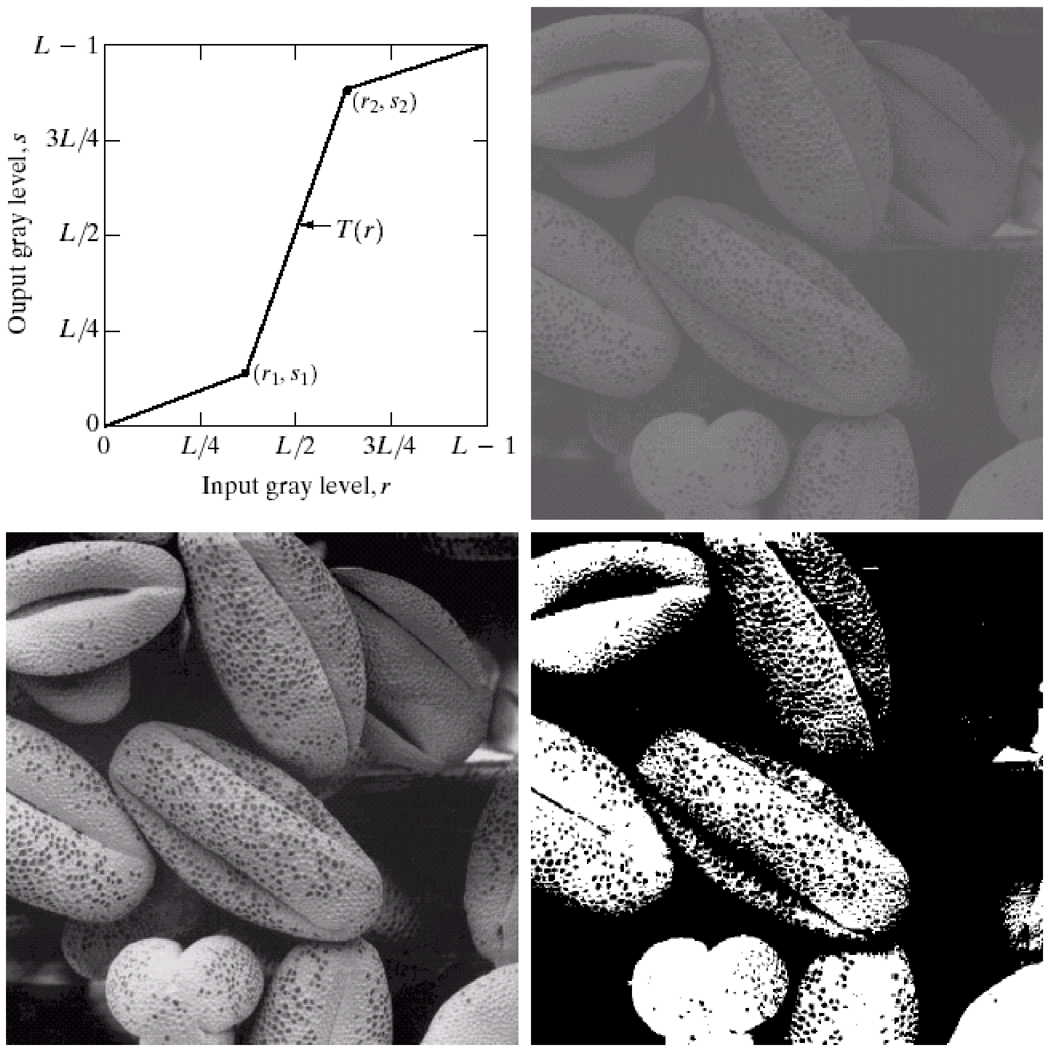
- **Simplest piecewise linear functions.**

- **Low contrast images can result from poor illumination, lack of dynamic range in the imaging sensor, or even the wrong setting of a lens during the image acquisition.**

Contrast Stretching is a process that expands the range of intensity levels in an image so that it spans the full intensity range of the recording medium or display device.

- Contrast stretching (often called normalization) is a simple image enhancement technique that attempts to improve the contrast in an image by `stretching' the range of intensity values it contains to span a desired range of values.

Piecewise-Linear Transformation Functions
Case 1: Contrast Stretching



a b
c d

FIGURE 3.10 Contrast stretching. (a) Form of transformation function. (b) A low-contrast image. (c) Result of contrast stretching. (d) Result of thresholding. (Original image courtesy of Dr. Roger Heady, Research School of Biological Sciences, Australian National University, Canberra, Australia.)

Contrast Stretching

- Figure 3.10(a) shows a typical transformation used for contrast stretching. The locations of points (r_1, s_1) and (r_2, s_2) control the shape of the transformation function.

- If $r_1 = s_1$ and $r_2 = s_2$, the transformation is a linear function that produces no changes in gray levels.

- If $r_1 = r_2$, $s_1 = 0$ and $s_2 = L-1$, the transformation becomes a *thresholding function* that creates a binary image.

- Intermediate values of (r_1, s_1) and (r_2, s_2) produce various degrees of spread in the gray levels of the output image, thus affecting its contrast.

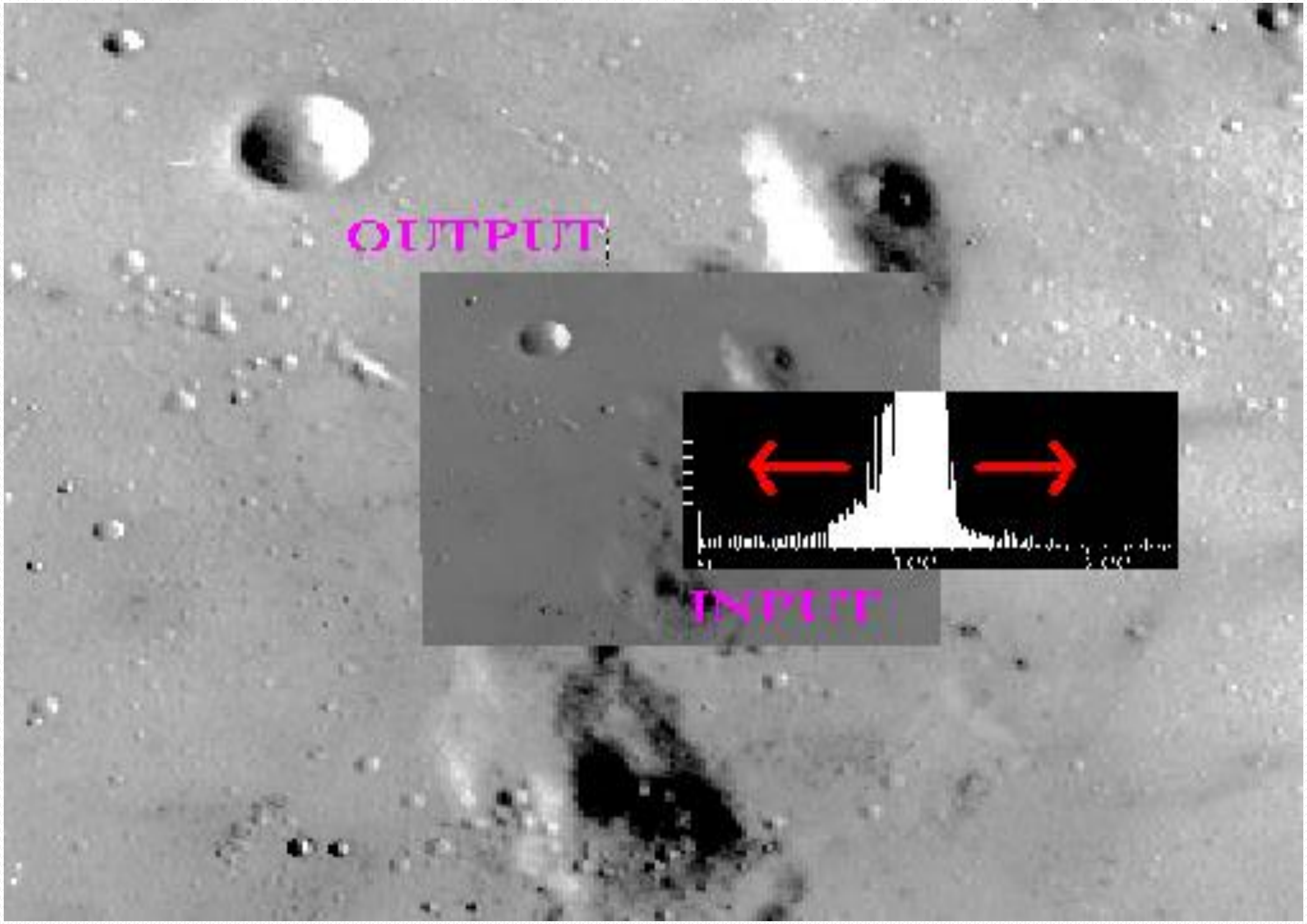
- In general, $r_1 \le r_2$ and $s_1 \le s_2$ is assumed, so the function is always increasing.

Contrast Stretching

- Figure 3.10(b) shows an 8-bit image with low contrast.

- Fig. 3.10(c) shows the result of contrast stretching, obtained by setting $(r1, s1) = (r_{min}, 0)$ and $(r2, s2) = (r_{max}, L-1)$ where r_{min} and r_{max} denote the minimum and maximum gray levels in the image, respectively. Thus, the transformation function stretched the levels linearly from their original range to the full range [0, L-1].

- Finally, Fig. 3.10(d) shows the result of using the *thresholding function* defined previously, with $r1=r2=m$, the mean gray level in the image.


OUTPUT
INPUT

Example :

- **for 8-bit graylevel images the lower and upper limits might be 0 and 255. Call the lower and the upper limits *a* and *b* respectively.**

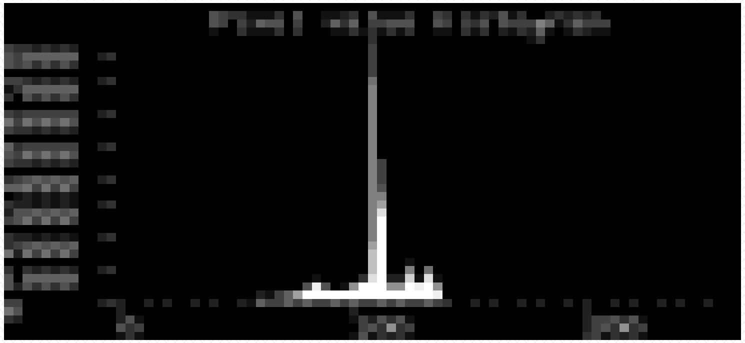
- **Find the lowest and highest pixel values currently present in the image. Call these *c* and *d*.** Then each pixel *P* is scaled using the following function:

$$P_{out} = (P_{in} - c)\left(\frac{b-a}{d-c}\right) + a$$

- **Values below 0 are set to 0 and values about 255 are set to 255.**

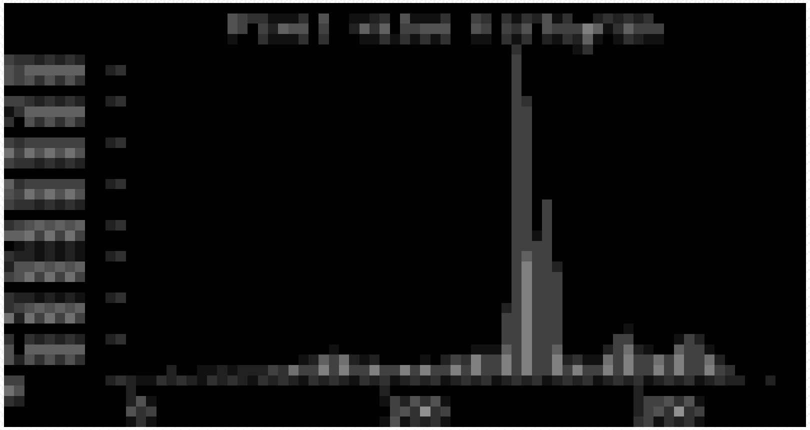
- We begin by considering an image

which can easily be enhanced by the most simple of contrast stretching implementations because the intensity histogram forms a tight, narrow cluster between the graylevel intensity values of 79 - 136, as shown in



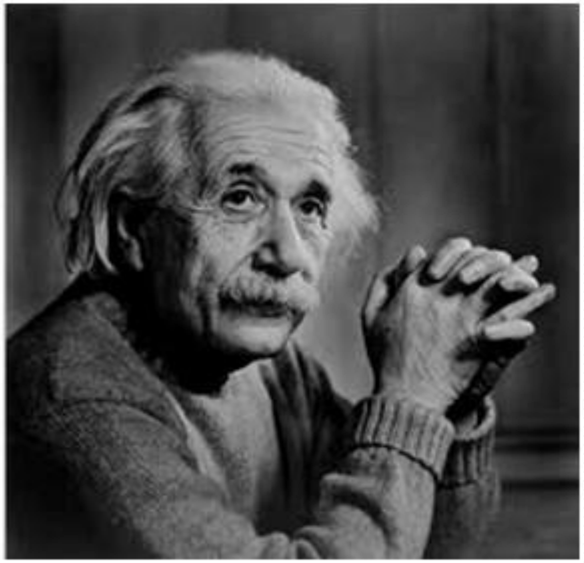
- After contrast stretching, using a simple linear interpolation between $c = 79$ and $d = 136$, we obtain

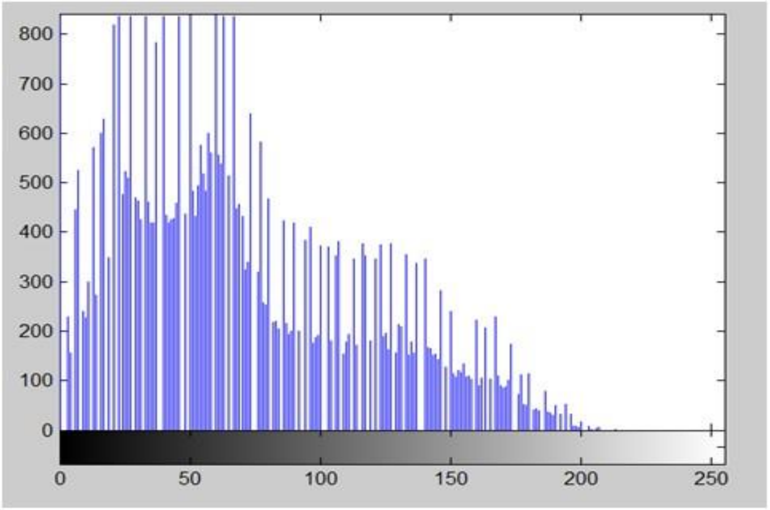
- Compare the histogram of the original image with that of the contrast-stretched version



- While this result is a significant improvement over the original, the enhanced image itself still appears somewhat flat. Histogram equalizing the image increases contrast dramatically, but yields an artificial-looking result

- **Contrast.**
- Contrast is the difference between maximum and minimum pixel intensity.
- Contrast = 225.





- **Increasing the contrast of the image:**
- The formula for stretching the histogram of the image to increase the contrast is

$$g(x,y) = \frac{f(x,y)-fmin}{fmax-fmin} * 2^{bpp}$$

- 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 in our case is

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

- where f(x,y) denotes the value of each pixel intensity. For each f(x,y) in an image

The following image appear after applying histogram stretching.
The histogram is now stretched or in other means expand.