

# Point Processing

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15-463: Computational Photography  
Alexei Efros, CMU, Spring 2010

# Image Processing

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image filtering: change **range** of image

$$g(x) = h(f(x))$$

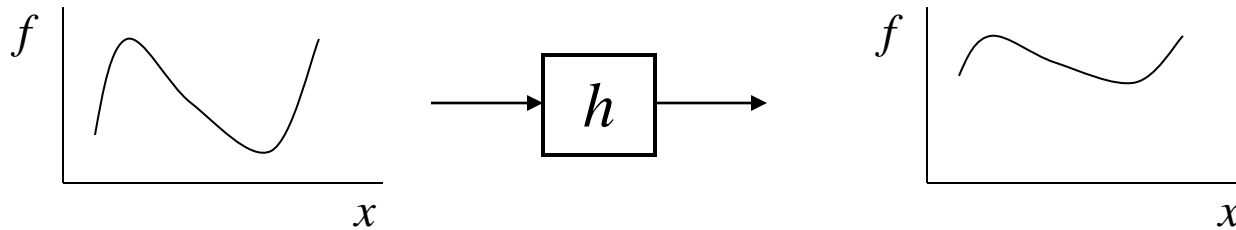
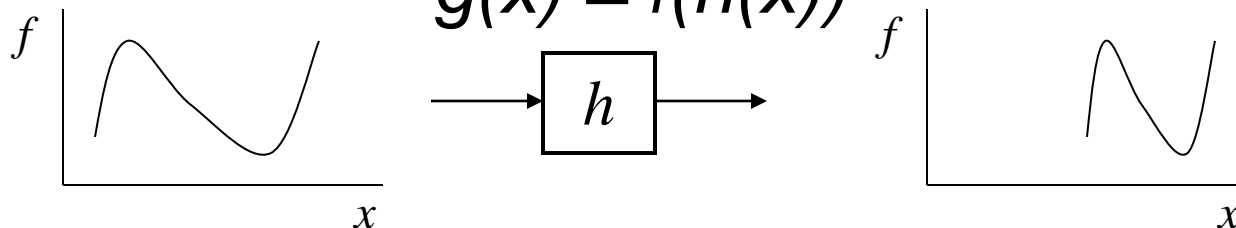


image warping: change **domain** of image

$$g(x) = f(h(x))$$



# Image Processing

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image filtering: change **range** of image

$$g(x) = h(f(x))$$

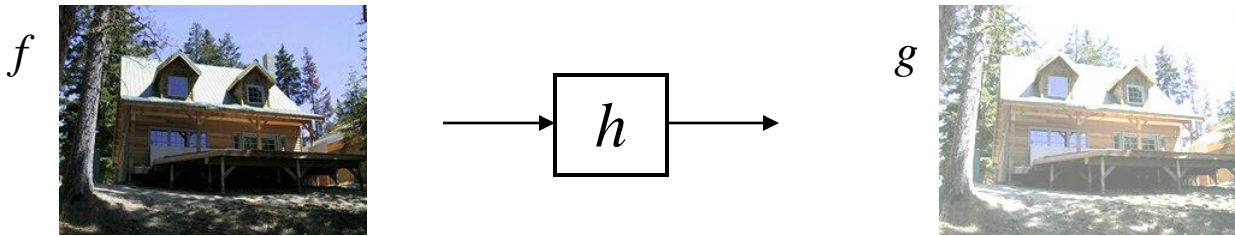
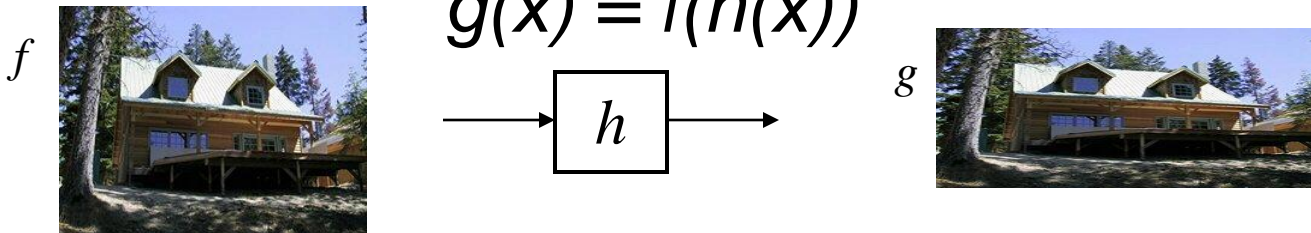


image warping: change **domain** of image

$$g(x) = f(h(x))$$



# Point Processing

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The simplest kind of range transformations are these independent of position  $x,y$ :

$$g = t(f)$$

This is called point processing.

What can they do?

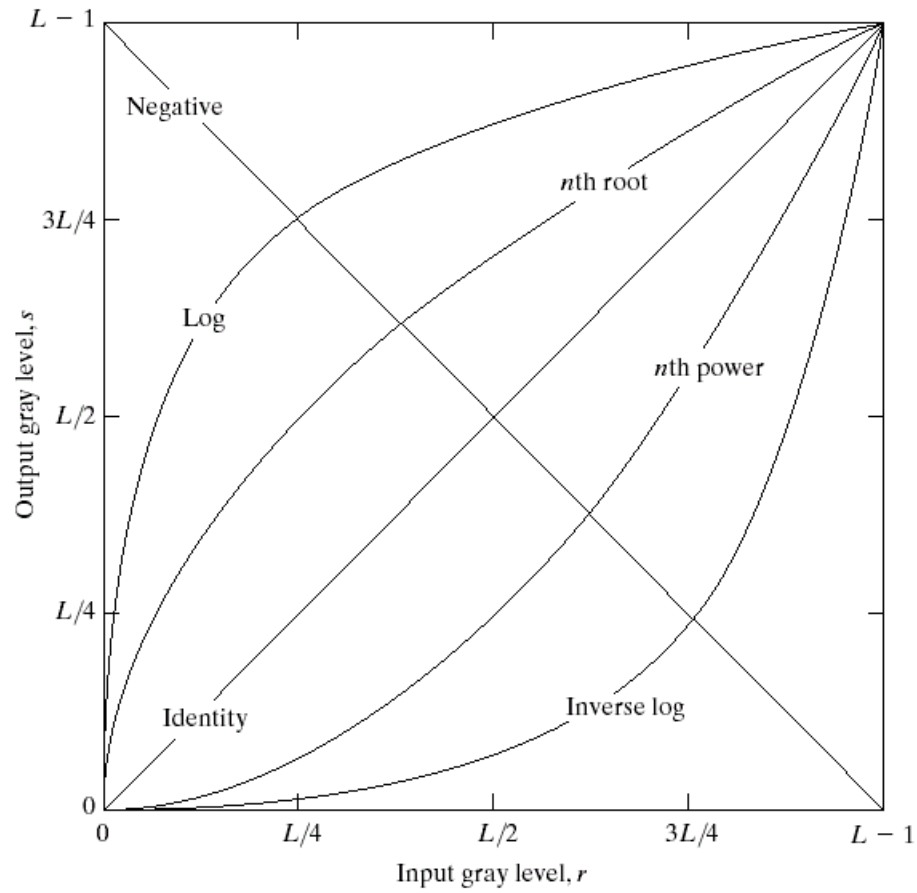
What's the form of  $t$ ?

**Important:** every pixel for himself – spatial information completely lost!

# Basic Point Processing

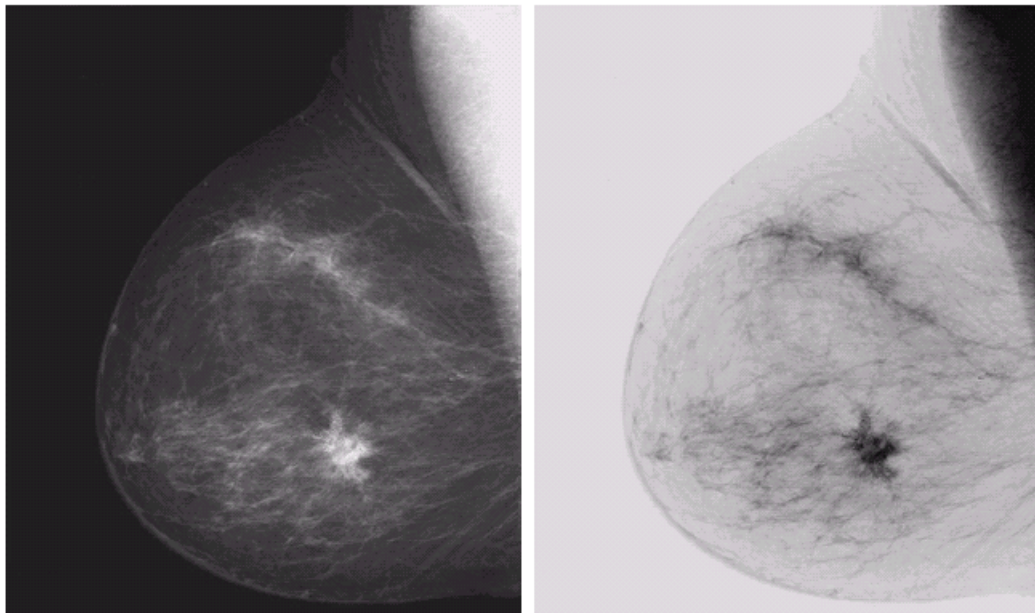
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**FIGURE 3.3** Some basic gray-level transformation functions used for image enhancement.



# Negative

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a b

**FIGURE 3.4**

(a) Original digital mammogram.  
(b) Negative image obtained using the negative transformation in Eq. (3.2-1).  
(Courtesy of G.E. Medical Systems.)

# Log

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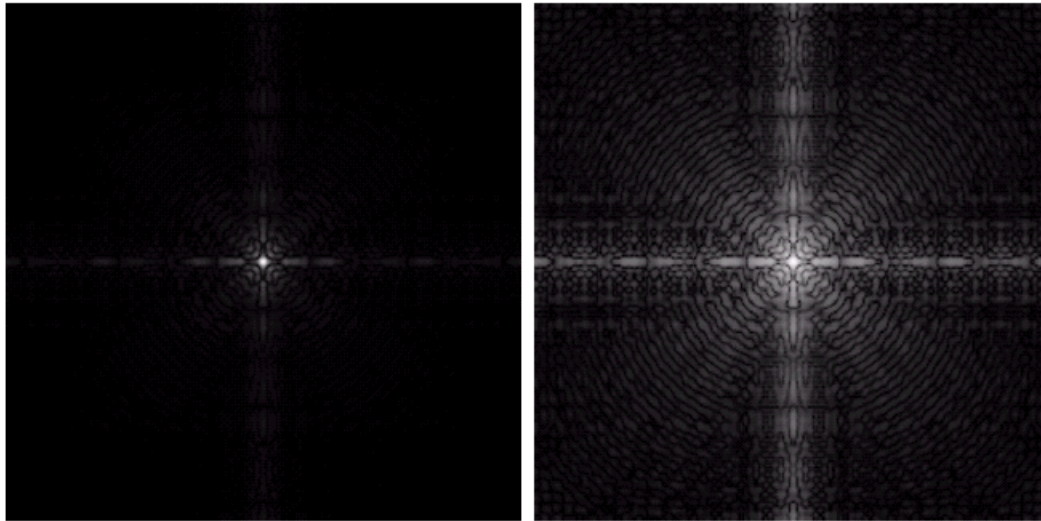
a b

**FIGURE 3.5**

(a) Fourier spectrum.

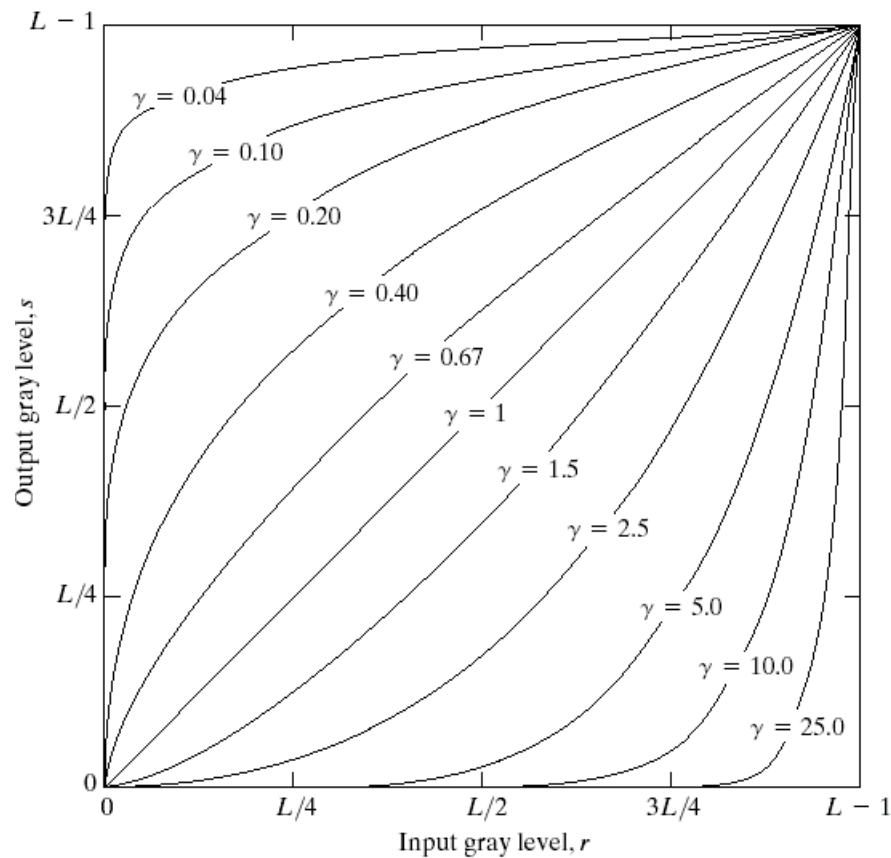
(b) Result of applying the log transformation given in Eq. (3.2-2) with  $c = 1$ .

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# Power-law transformations

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**FIGURE 3.6** Plots of the equation  $s = cr^\gamma$  for various values of  $\gamma$  ( $c = 1$  in all cases).

$$s = cr^\gamma$$



# Image Enhancement

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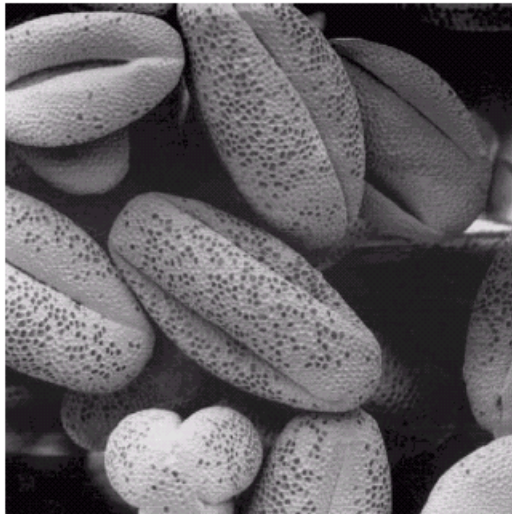
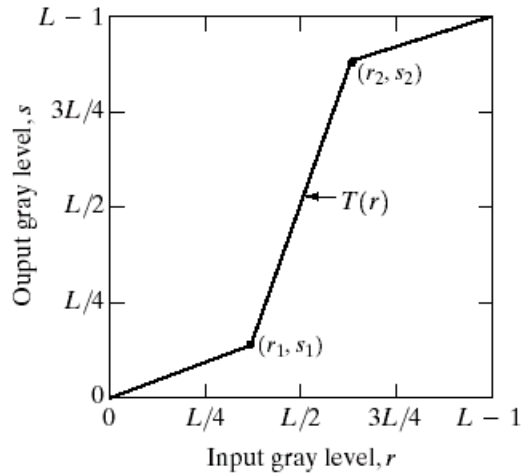
a b  
c d

**FIGURE 3.9**

(a) Aerial image.  
(b)–(d) Results of applying the transformation in Eq. (3.2-3) with  $c = 1$  and  $\gamma = 3.0, 4.0,$  and  $5.0,$  respectively. (Original image for this example courtesy of NASA.)



# Contrast Stretching

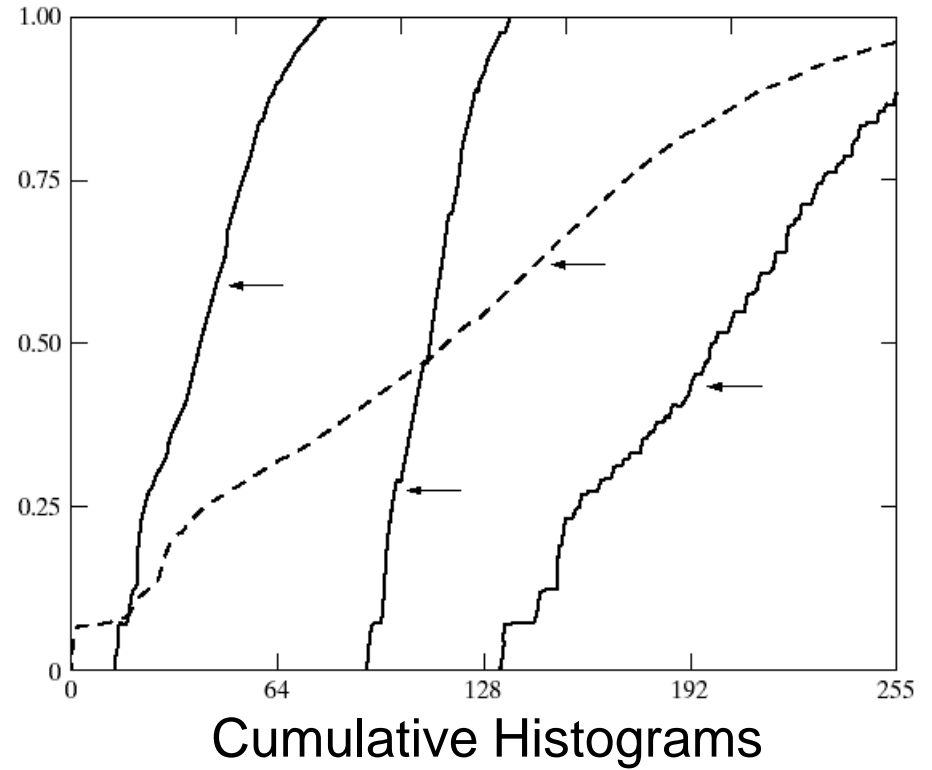
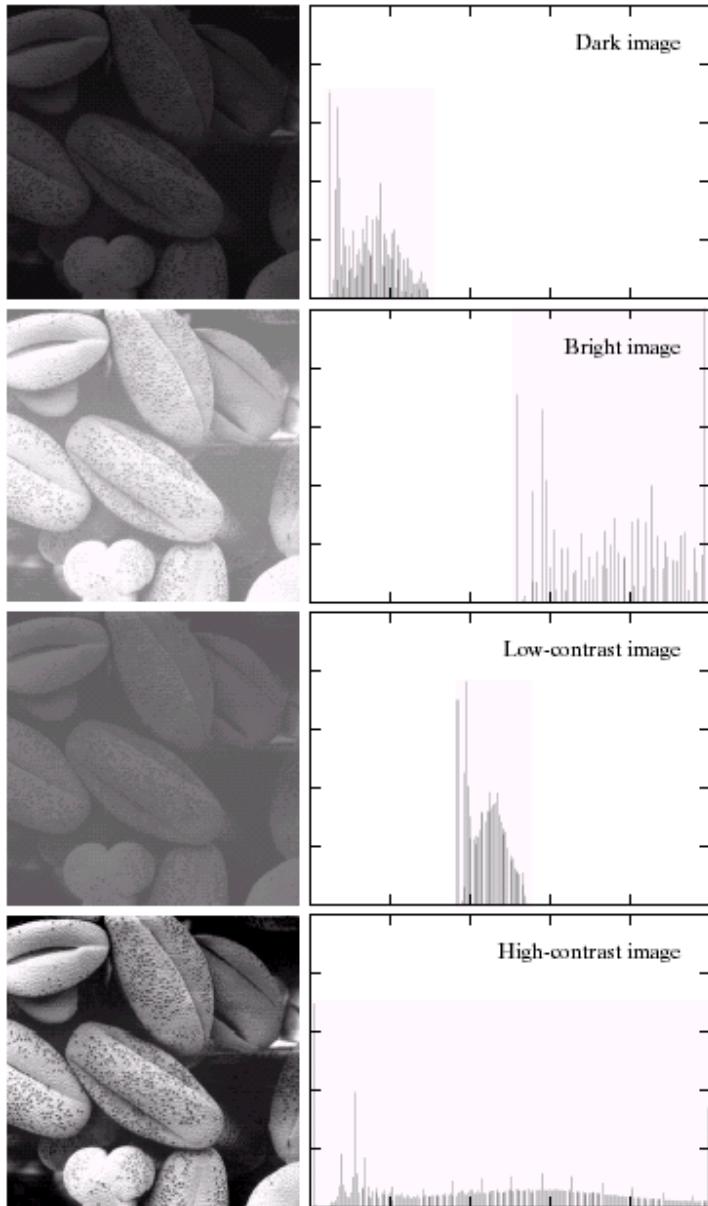


a b  
c d

**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.)

# Image Histograms

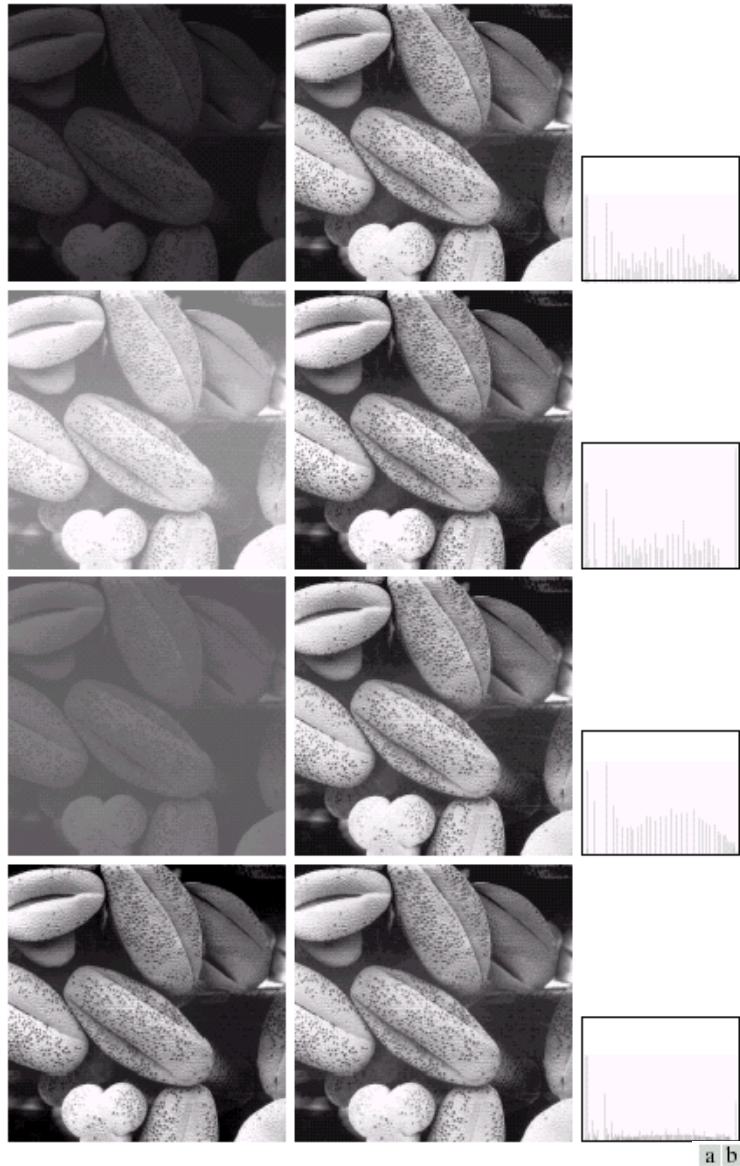


$$s = T(r)$$

a b

**FIGURE 3.15** Four basic image types: dark, light, low contrast, high contrast, and their corresponding histograms. (Original image courtesy of Dr. Roger Heady, Research School of Biological Sciences, Australian National University, Canberra, Australia.)

# Histogram Equalization



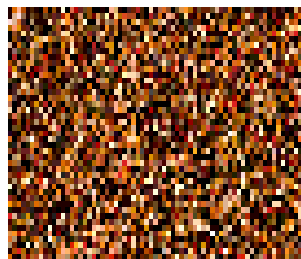
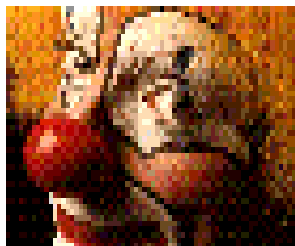
a b c

**FIGURE 3.17** (a) Images from Fig. 3.15. (b) Results of histogram equalization. (c) Corresponding histograms.

# Limitations of Point Processing

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Q: What happens if I reshuffle all pixels within the image?



A: It's histogram won't change. No point processing will be affected...