

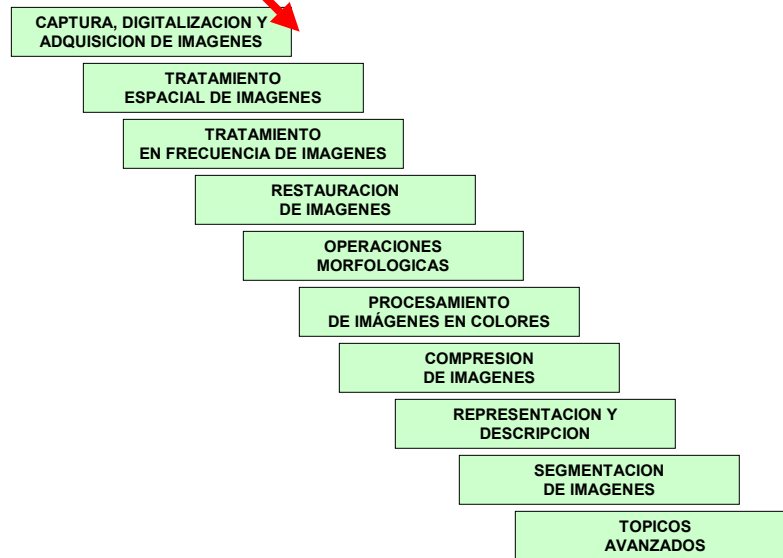
# Procesamiento Digital de Imágenes

Pablo Roncagliolo B.

Nº 4



## Orden de las clases...

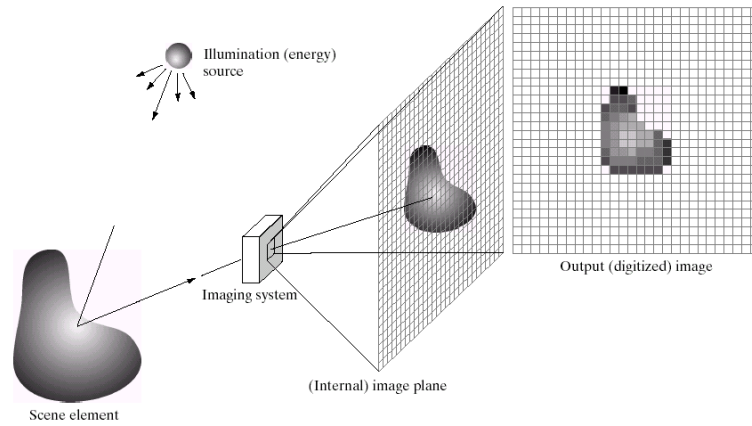


prb

2



# ADQUISICION & DIGITALIZACION



a b c d e

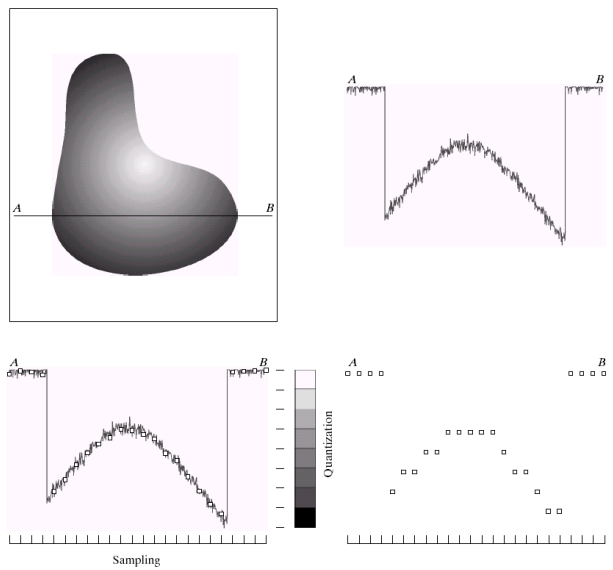
**FIGURE 2.15** An example of the digital image acquisition process. (a) Energy ("illumination") source. (b) An element of a scene. (c) Imaging system. (d) Projection of the scene onto the image plane. (e) Digitized image.

prb

Imágenes: Gonzalez&Wood

3

# ADQUISICION & DIGITALIZACION



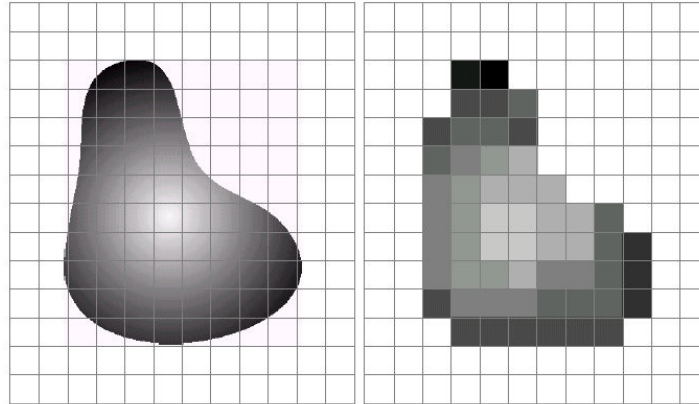
a b c d

**FIGURE 2.16** Generating a digital image. (a) Continuous image. (b) A scan line from A to B in the continuous image, used to illustrate the concepts of sampling and quantization. (c) Sampling and quantization. (d) Digital scan line.

prb

4

## ADQUISICION & DIGITALIZACION



a b

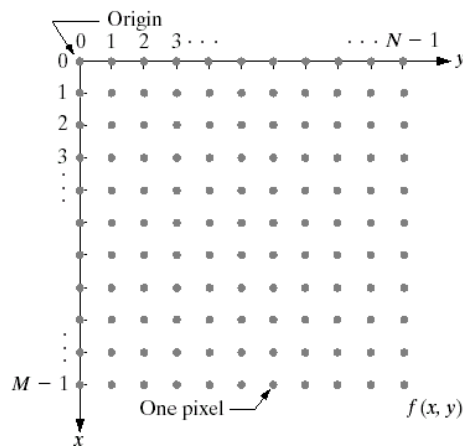
**FIGURE 2.17** (a) Continuous image projected onto a sensor array. (b) Result of image sampling and quantization.

prb

Imágenes: Gonzalez&Wood

5

## ADQUISICION & DIGITALIZACION



**FIGURE 2.18**  
Coordinate convention used in this book to represent digital images.

prb

Imágenes: Gonzalez&Wood

6

# ADQUISICION & DIGITALIZACION



**TABLE 2.1**

Number of storage bits for various values of  $N$  and  $k$ .

| $N/k$ | 1 ( $L = 2$ ) | 2 ( $L = 4$ ) | 3 ( $L = 8$ ) | 4 ( $L = 16$ ) | 5 ( $L = 32$ ) | 6 ( $L = 64$ ) | 7 ( $L = 128$ ) | 8 ( $L = 256$ ) |
|-------|---------------|---------------|---------------|----------------|----------------|----------------|-----------------|-----------------|
| 32    | 1,024         | 2,048         | 3,072         | 4,096          | 5,120          | 6,144          | 7,168           | 8,192           |
| 64    | 4,096         | 8,192         | 12,288        | 16,384         | 20,480         | 24,576         | 28,672          | 32,768          |
| 128   | 16,384        | 32,768        | 49,152        | 65,536         | 81,920         | 98,304         | 114,688         | 131,072         |
| 256   | 65,536        | 131,072       | 196,608       | 262,144        | 327,680        | 393,216        | 458,752         | 524,288         |
| 512   | 262,144       | 524,288       | 786,432       | 1,048,576      | 1,310,720      | 1,572,864      | 1,835,008       | 2,097,152       |
| 1024  | 1,048,576     | 2,097,152     | 3,145,728     | 4,194,304      | 5,242,880      | 6,291,456      | 7,340,032       | 8,388,608       |
| 2048  | 4,194,304     | 8,388,608     | 12,582,912    | 16,777,216     | 20,971,520     | 25,165,824     | 29,369,128      | 33,554,432      |
| 4096  | 16,777,216    | 33,554,432    | 50,331,648    | 67,108,864     | 83,886,080     | 100,663,296    | 117,440,512     | 134,217,728     |
| 8192  | 67,108,864    | 134,217,728   | 201,326,592   | 268,435,456    | 335,544,320    | 402,653,184    | 469,762,048     | 536,870,912     |

prb

Imágenes: Gonzalez&Wood

7

# ADQUISICION & DIGITALIZACION



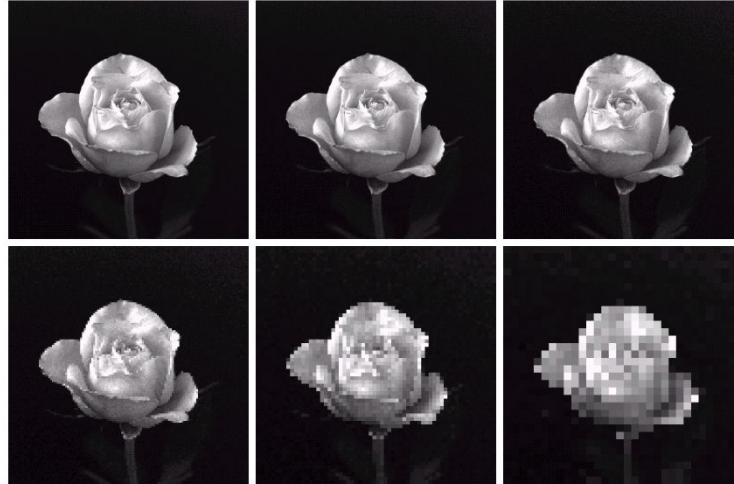
**FIGURE 2.19** A  $1024 \times 1024$ , 8-bit image subsampled down to size  $32 \times 32$  pixels. The number of allowable gray levels was kept at 256.

prb

Imágenes: Gonzalez&Wood

8

## 'Muestreo' sin interpolación (resampled): Res. Espacial

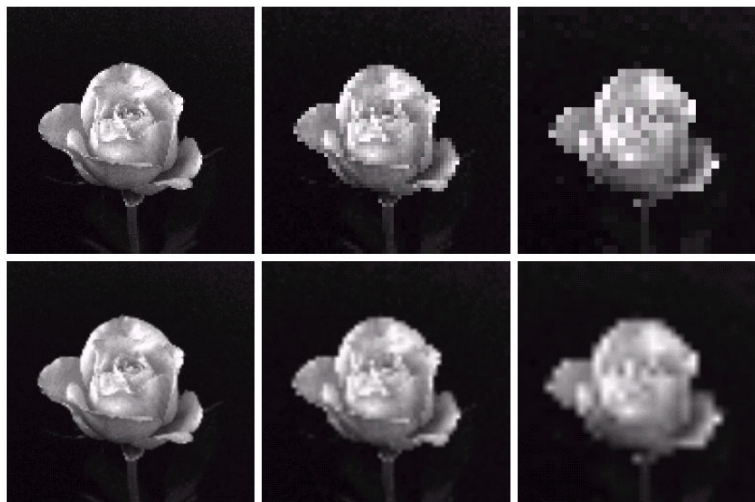


a b c  
d e f

**FIGURE 2.20** (a)  $1024 \times 1024$ , 8-bit image. (b)  $512 \times 512$  image resampled into  $1024 \times 1024$  pixels by row and column duplication. (c) through (f)  $256 \times 256$ ,  $128 \times 128$ ,  $64 \times 64$ , and  $32 \times 32$  images resampled into  $1024 \times 1024$  pixels.

9

## 'Muestreo' con interpolación



a b c  
d e f

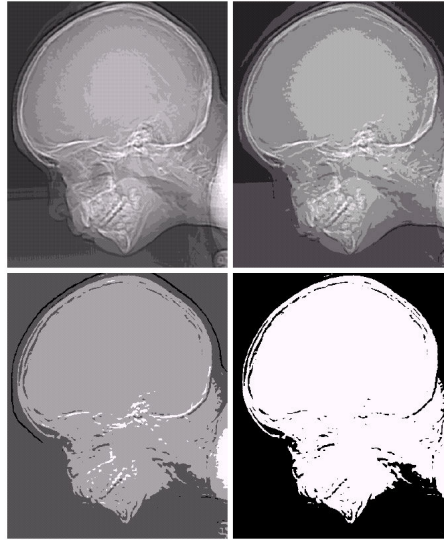
**FIGURE 2.25** Top row: images zoomed from  $128 \times 128$ ,  $64 \times 64$ , and  $32 \times 32$  pixels to  $1024 \times 1024$  pixels, using nearest neighbor gray-level interpolation. Bottom row: same sequence, but using bilinear interpolation.

10

## Resolución en Frecuencia

c f  
g h

**FIGURE 2.21**  
(Continued)  
(e)–(h) Image  
displayed in 16, 8,  
4, and 2 gray  
levels. (Original  
courtesy of  
Dr. David  
R. Pickens,  
Department of  
Radiology &  
Radiological  
Sciences,  
Vanderbilt  
University  
Medical Center.)

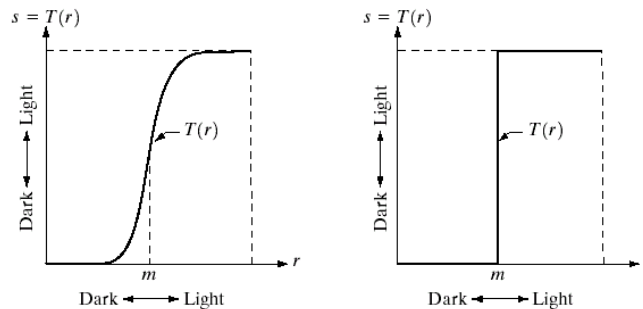


prb

Imágenes: Gonzalez&Wood

11

## Tratamiento de Imágenes: funciones sobre el nivel de gris o “funciones de contraste”



a b

**FIGURE 3.2** Gray-  
level  
transformation  
functions for  
contrast  
enhancement.

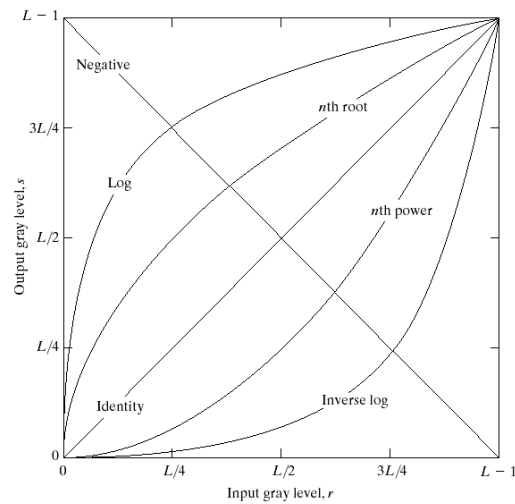
prb

Imágenes: Gonzalez&Wood

12

## Tratamiento de Imágenes: funciones sobre el nivel de gris o “funciones de contraste”

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

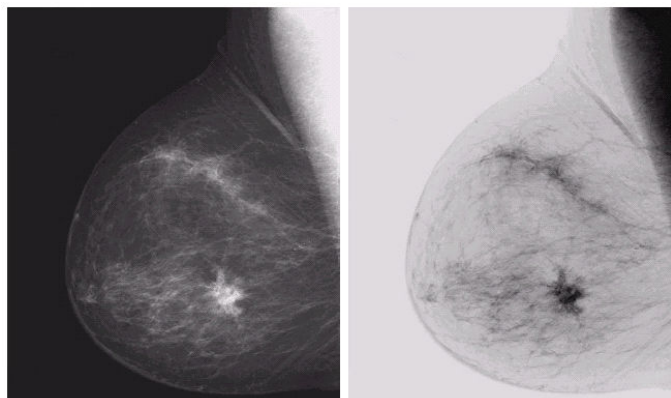


prb

Imágenes: Gonzalez&Wood

13

## Tratamiento de Imágenes: funciones sobre el nivel de gris o “funciones de contraste”



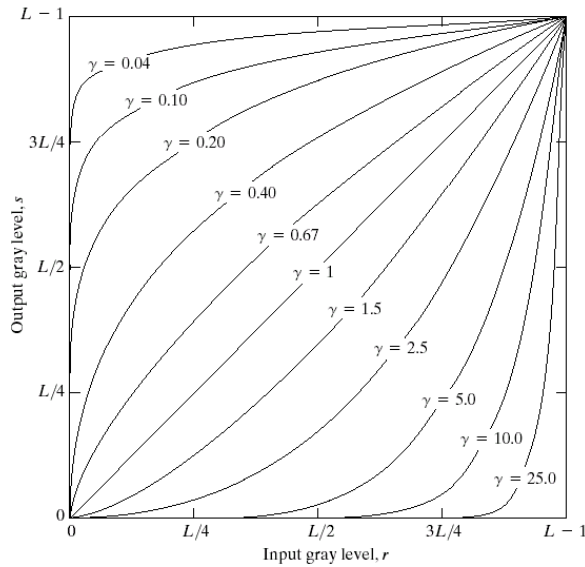
**FIGURE 3.4**  
(a) Original digital mammogram.  
(b) Negative image obtained using the negative transformation in Eq. (3.2-1).  
(Courtesy of G.E. Medical Systems.)

prb

Imágenes: Gonzalez&Wood

14

## Tratamiento de Imágenes: funciones de corrección Gamma



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

**Matlab:**

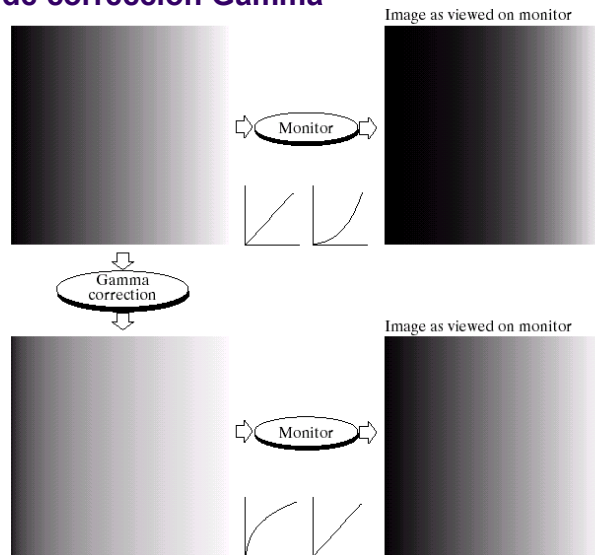
```
B=imadjust(A,[ ],[ ],gamma)
```

15

## Tratamiento de Imágenes: funciones de corrección Gamma

a b  
c d

**FIGURE 3.7**  
(a) Linear-wedge gray-scale image.  
(b) Response of monitor to linear wedge.  
(c) Gamma-corrected wedge.  
(d) Output of monitor.

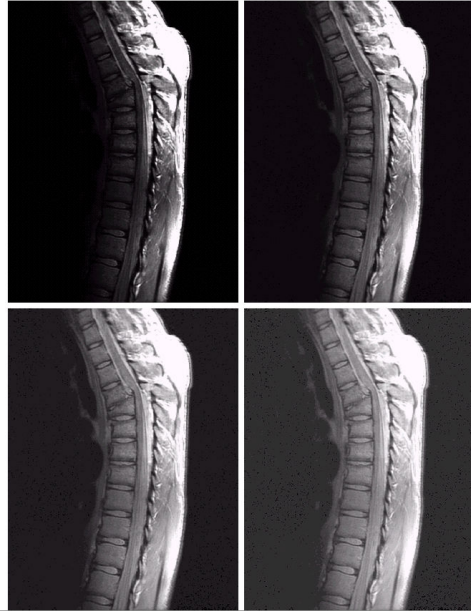


prb

Imágenes: Gonzalez&Wood

16

## Tratamiento de Imágenes: funciones de corrección Gamma



**FIGURE 3.8**  
(a) Magnetic resonance (MR) image of a fractured human spine. (b)–(d) Results of applying the transformation in Eq. (3.2-3) with  $c = 1$  and  $\gamma = 0.6, 0.4,$  and  $0.3$ , respectively. (Original image for this example courtesy of Dr. David R. Pickens, Department of Radiology and Radiological Sciences, Vanderbilt University Medical Center.)

prb

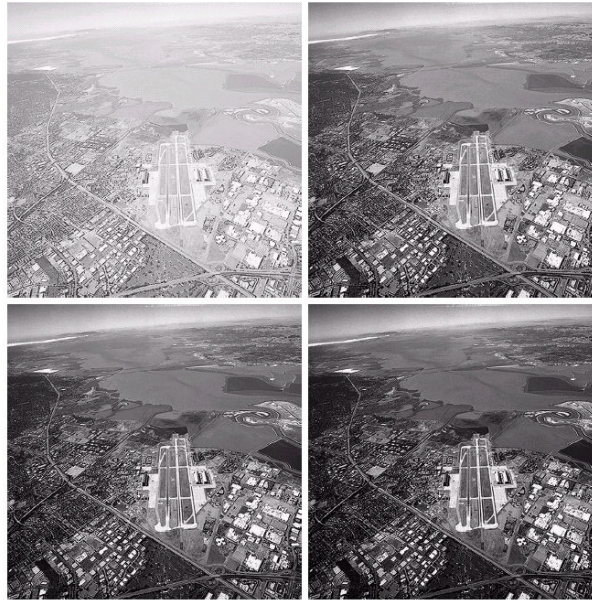
17

## Tratamiento de Imágenes: funciones de corrección Gamma



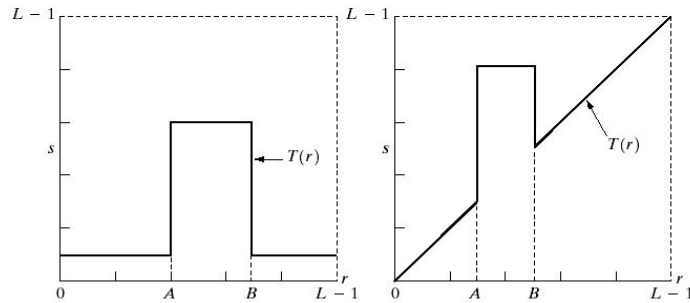
a b  
c d

**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.)



18

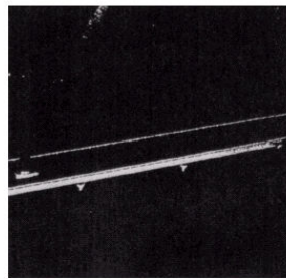
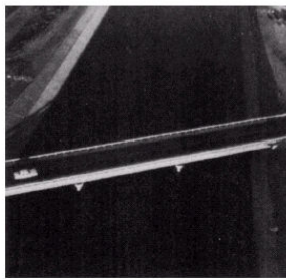
## Tratamiento de Imágenes: funciones específicas sobre el contraste



a b  
c d

**FIGURE 3.11**

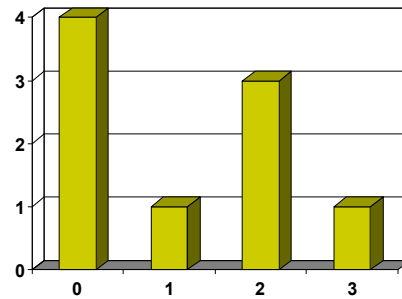
(a) This transformation highlights range  $[A, B]$  of gray levels and reduces all others to a constant level.  
 (b) This transformation highlights range  $[A, B]$  but preserves all other levels.  
 (c) An image.  
 (d) Result of using the transformation in (a).



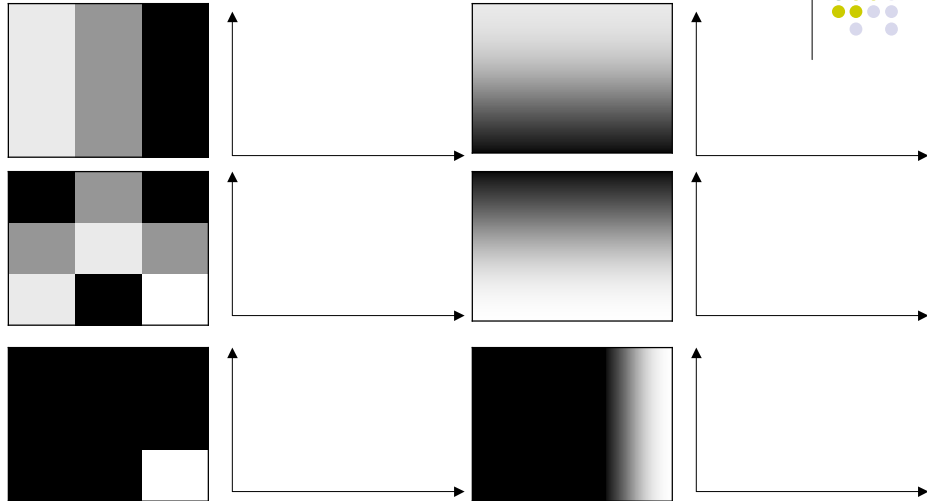
## HISTOGRAMA



|   |   |   |
|---|---|---|
| 0 | 2 | 2 |
| 3 | 0 | 2 |
| 0 | 0 | 1 |



## HISTOGRAMA: Ejercicios



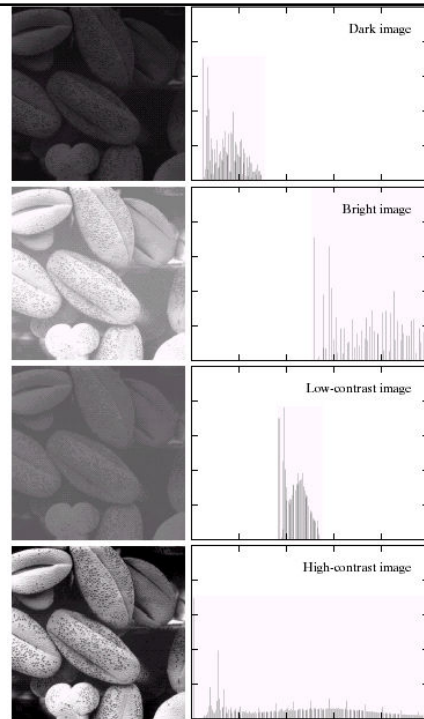
prb

Imágenes: Gonzalez&Wood

21

## Tratamiento de Imágenes: Ecuación del Histograma

```
%En Matlab con Toolbox
H=imhist(A,256);
```



prb

Imágenes: Gonzalez&Wood