TEL 519E – Image Processing

Fall 2010

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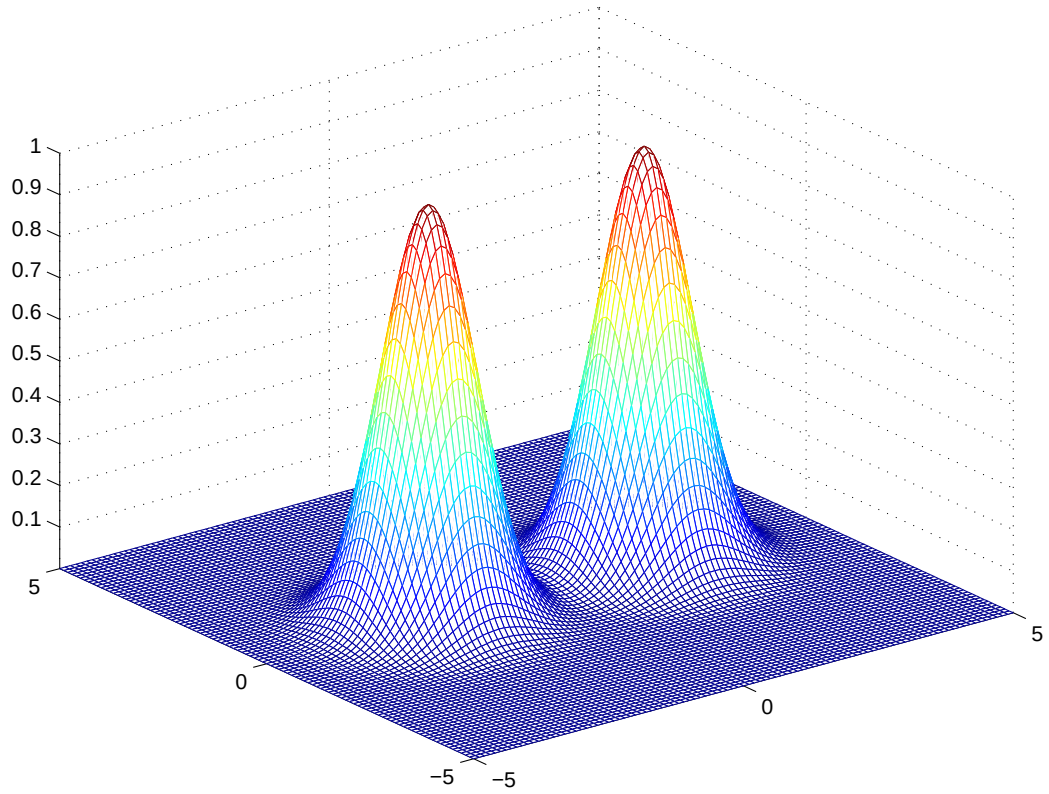
What is an Image?

An image is a two-dimensional function, $f(x, y)$.



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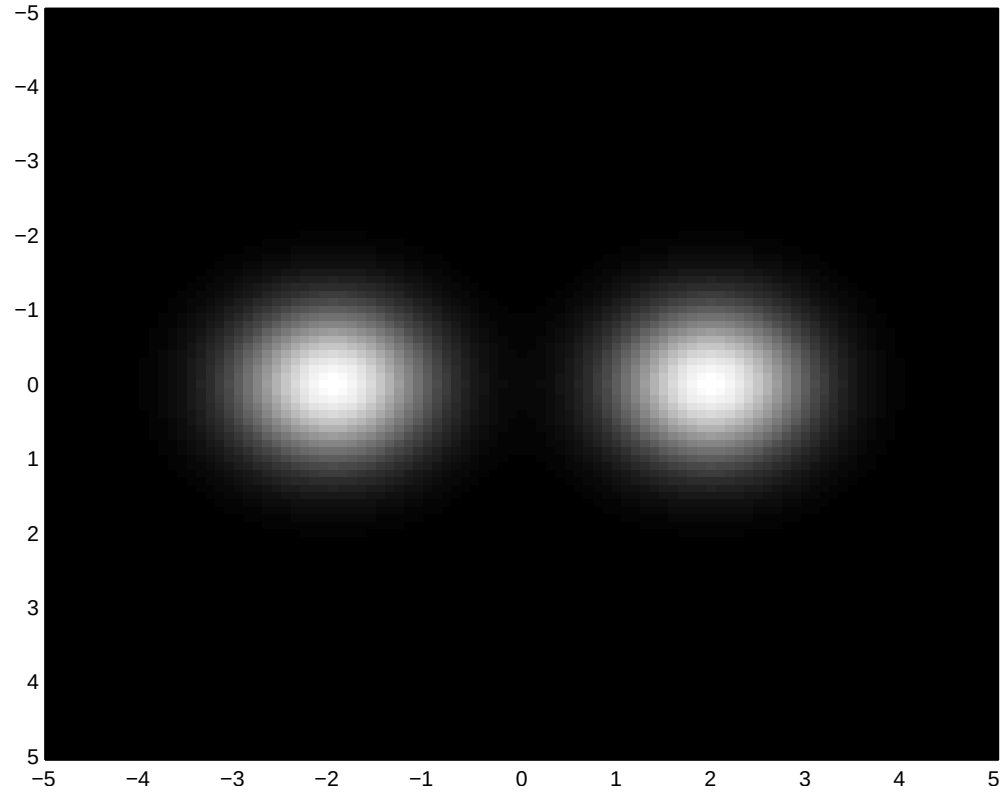
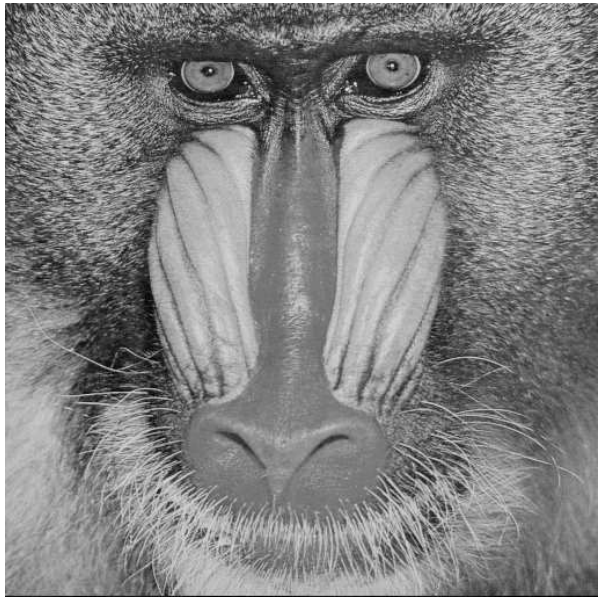
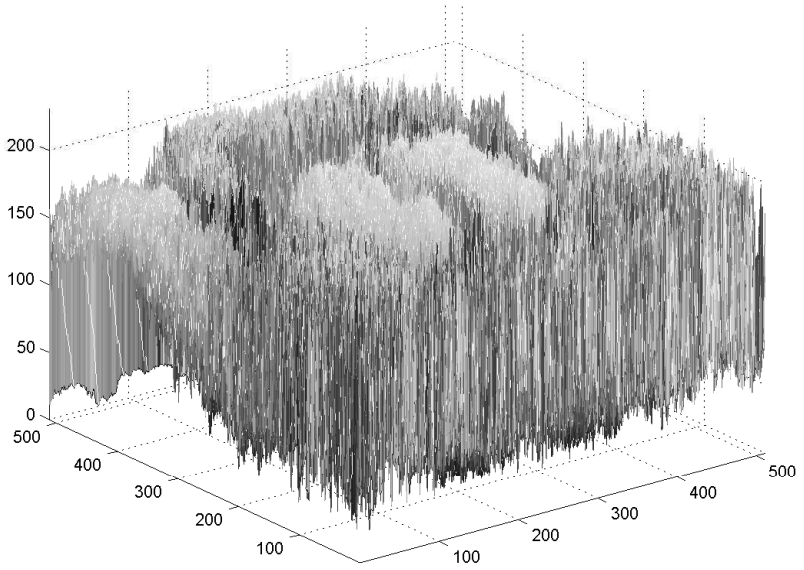


Intensity of the image f, at a particular location (x_0, y_0) is $f(x_0, y_0)$.

Representing Images

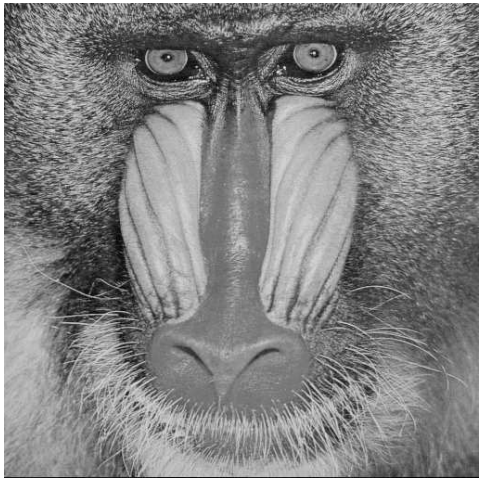




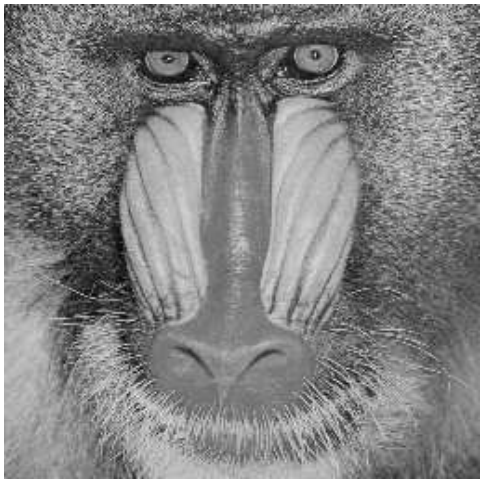
Spatial Resolution

We will take an image as essentially a two-dimensional array $f(n_1, n_2)$, $n_1, n_2 = 1, 2, \ldots, N$.

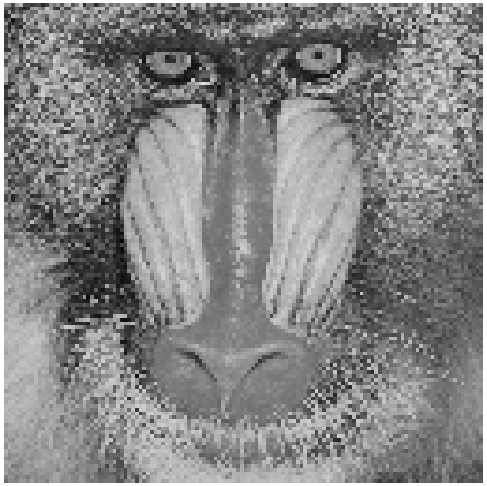
Spatial Resolution : Number of pixels per unit area.



512×512 Pixels



256×256 Pixels



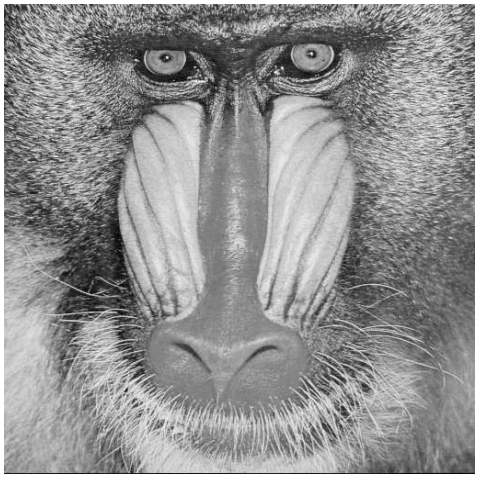
128×128 Pixels

64×64 Pixels

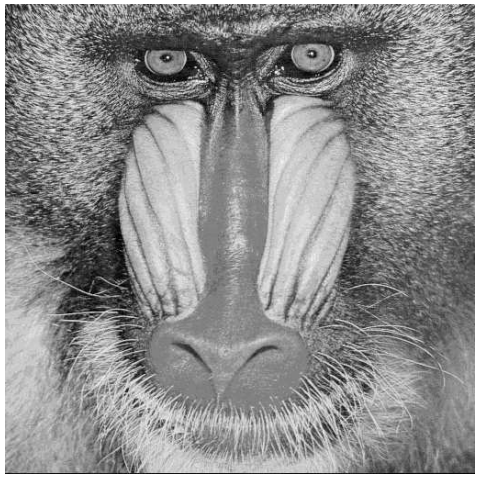
Intensity Resolution

Intensity Resolution : Number of bits used to represent the intensity value at a pixel.

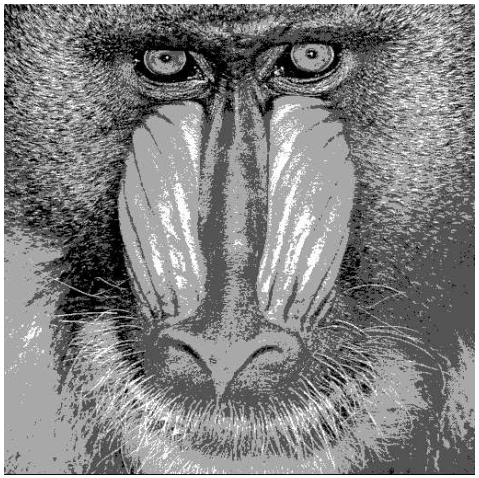
$\Longrightarrow$ Number of bits used to represent an image is at worst $b \times N_1 \times N_2$.



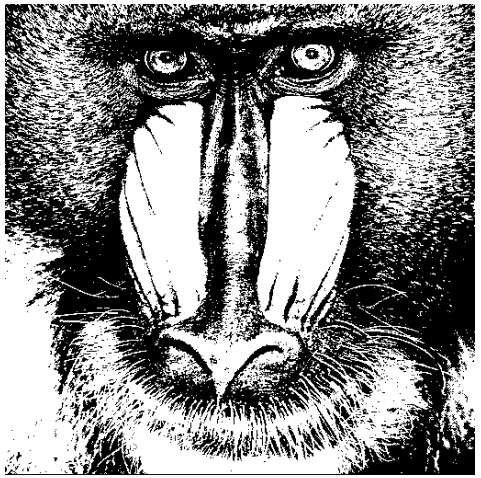
8 Bits



4 Bits



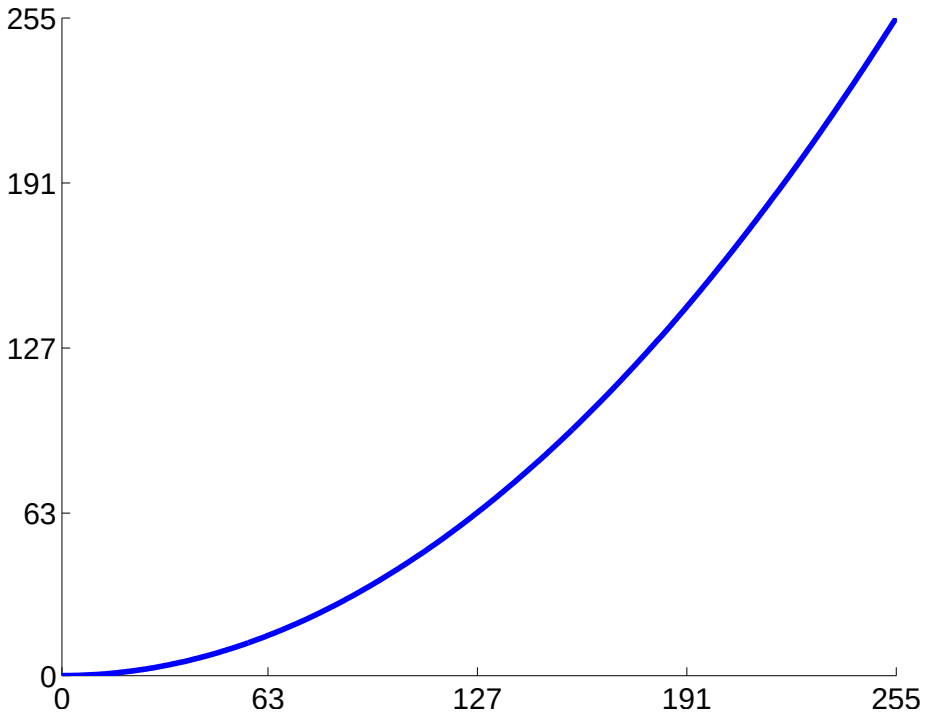
2 Bits



1 Bit

Point Operations

Let $T(\cdot)$ be a 1D mapping.

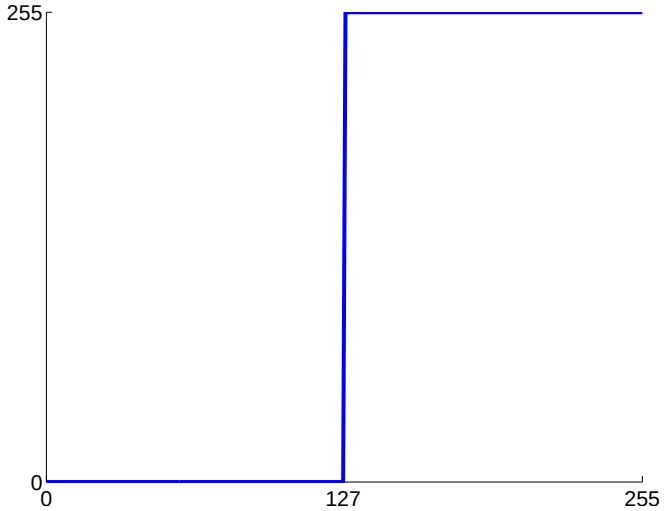


We take a point operation on $f(x, y)$ as the application of some $T(\cdot)$.

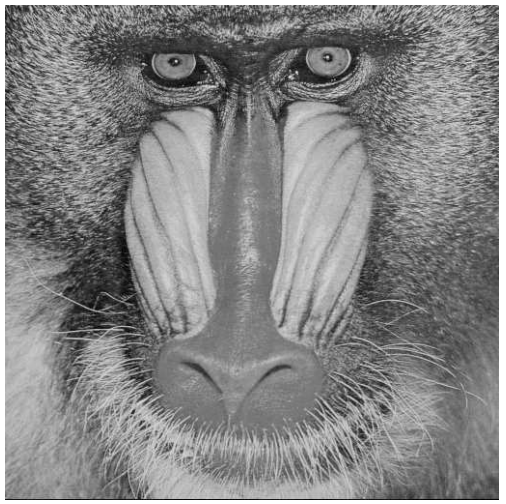
$$g(x, y) = T\big(\, f(x, y)\,\big)$$

Point Operations

$T(\cdot)$



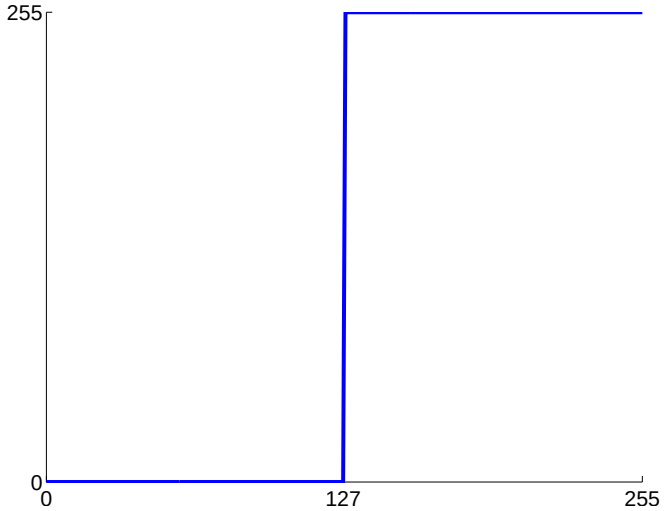
$f(x, y)$



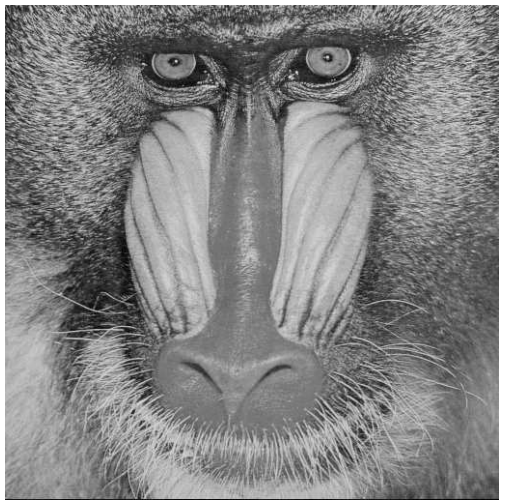
$g(x, y) = T\big(\, f(x, y)\,\big)?$

Point Operations

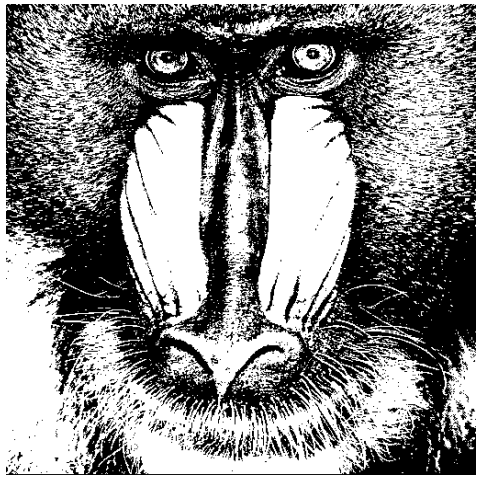
$T(\cdot)$



$f(x,y)$

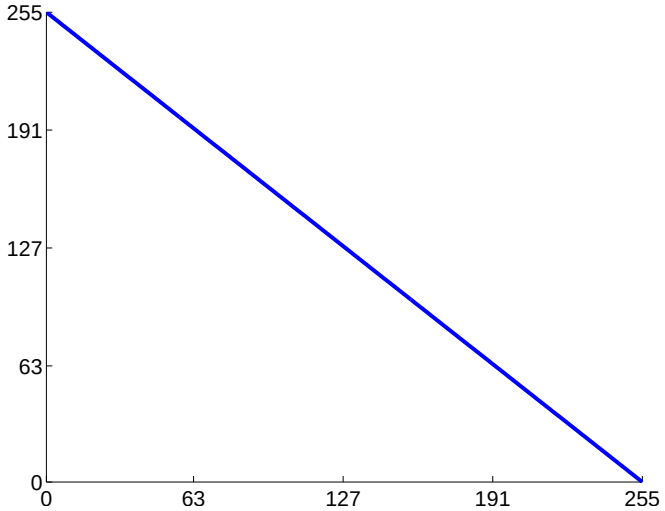


$g(x,y) = T\big(\, f(x,y) \,\big)$

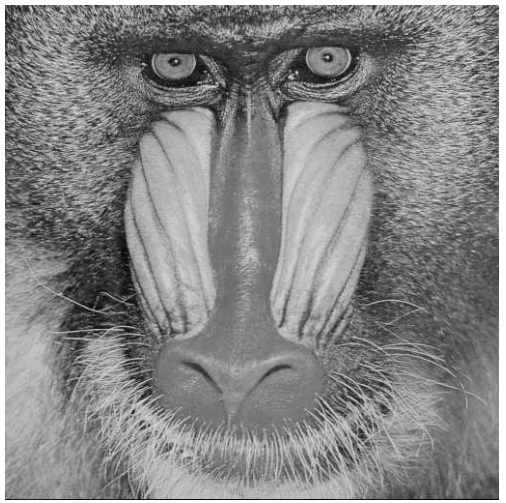


Point Operations

$T(\cdot)$



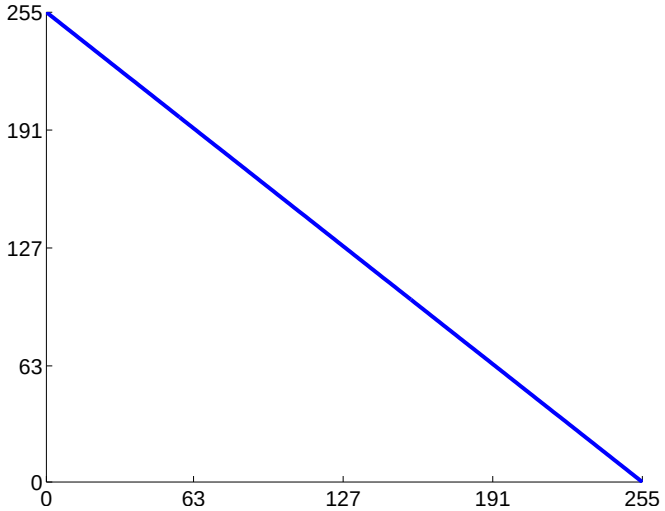
$f(x, y)$



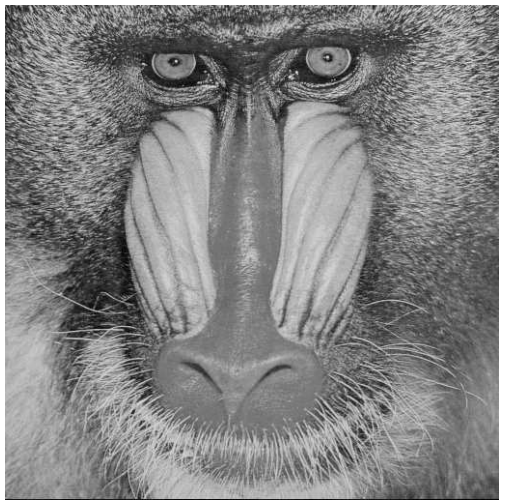
$g(x, y) = T\big(\, f(x, y)\,\big)?$

Point Operations

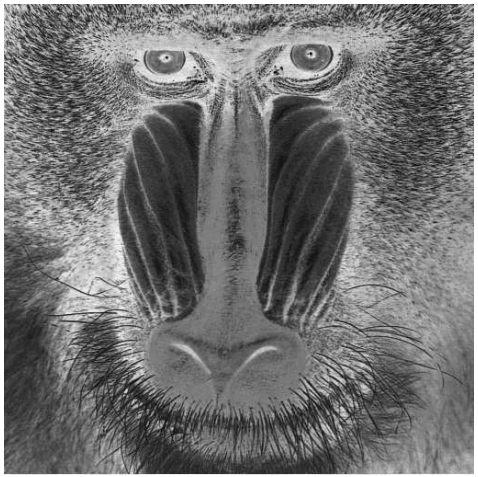
$T(\cdot)$



$f(x, y)$

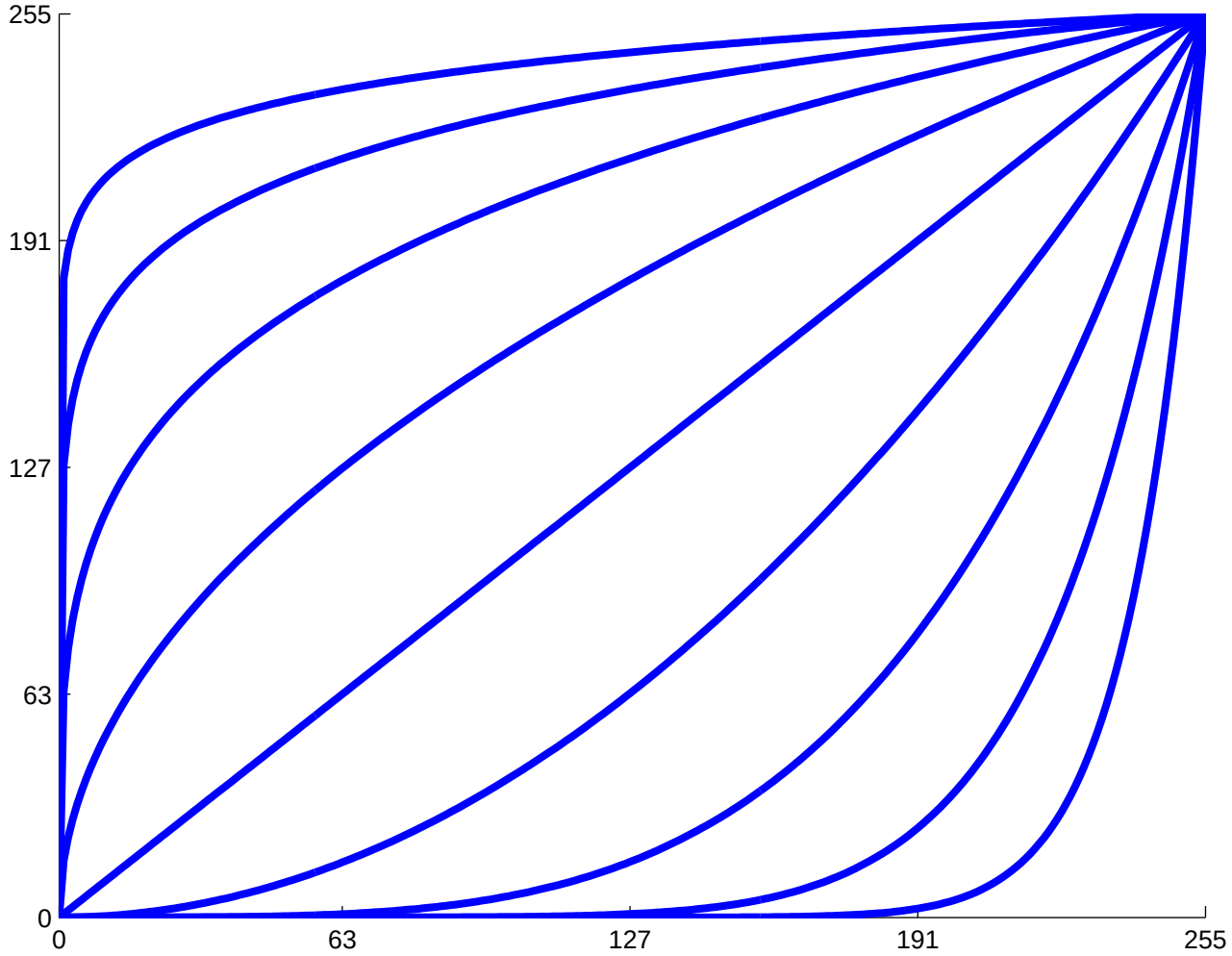


$g(x, y) = T\big(\, f(x, y)\,\big)$



Point Operations

Gamma Correction : $T(z) = c\, z^{\gamma}$



Point Operations

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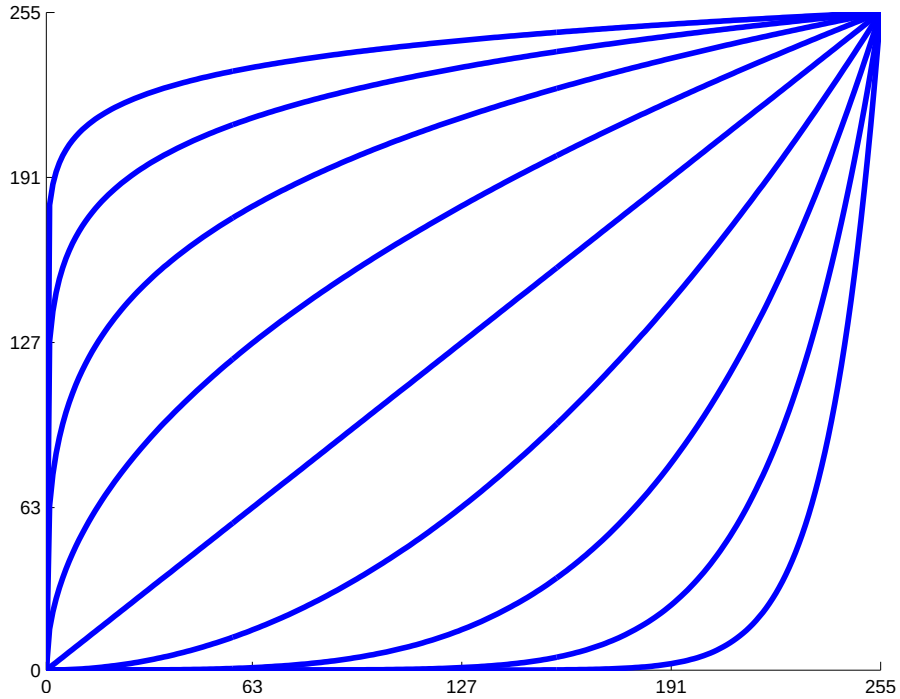


Which γ values should be chosen? $\gamma > 1$? $\gamma < 1$?

Gamma Correction : $T(z) = c\, z^{\gamma}$

Original

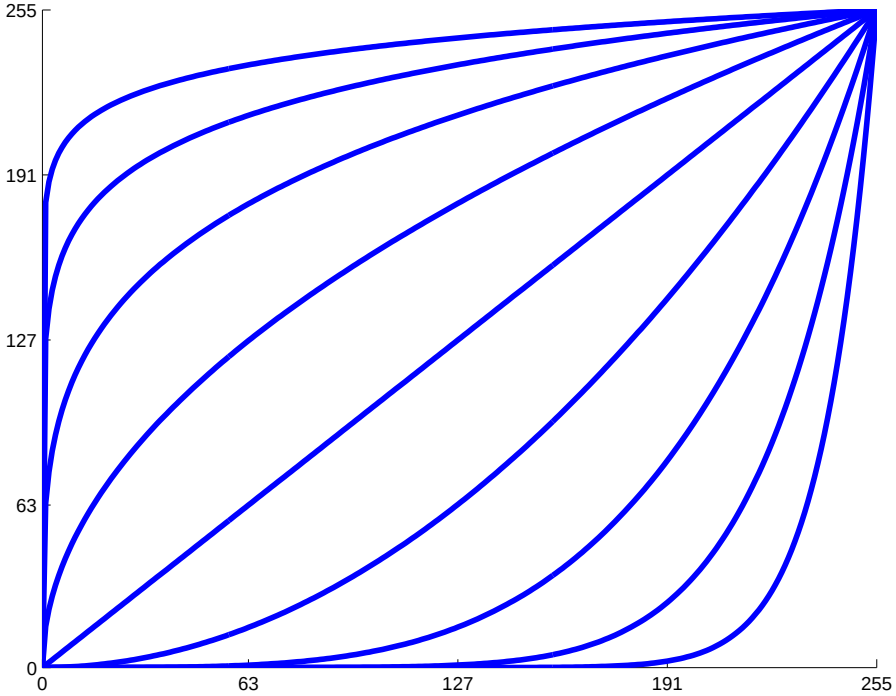
$\gamma = 0.6$

$\gamma = 0.45$

$\gamma = 0.3$

Point Operations

Gamma Correction : $T(z) = c\, z^{\gamma}$



Which γ values should be chosen? $\gamma > 1$? $\gamma < 1$?

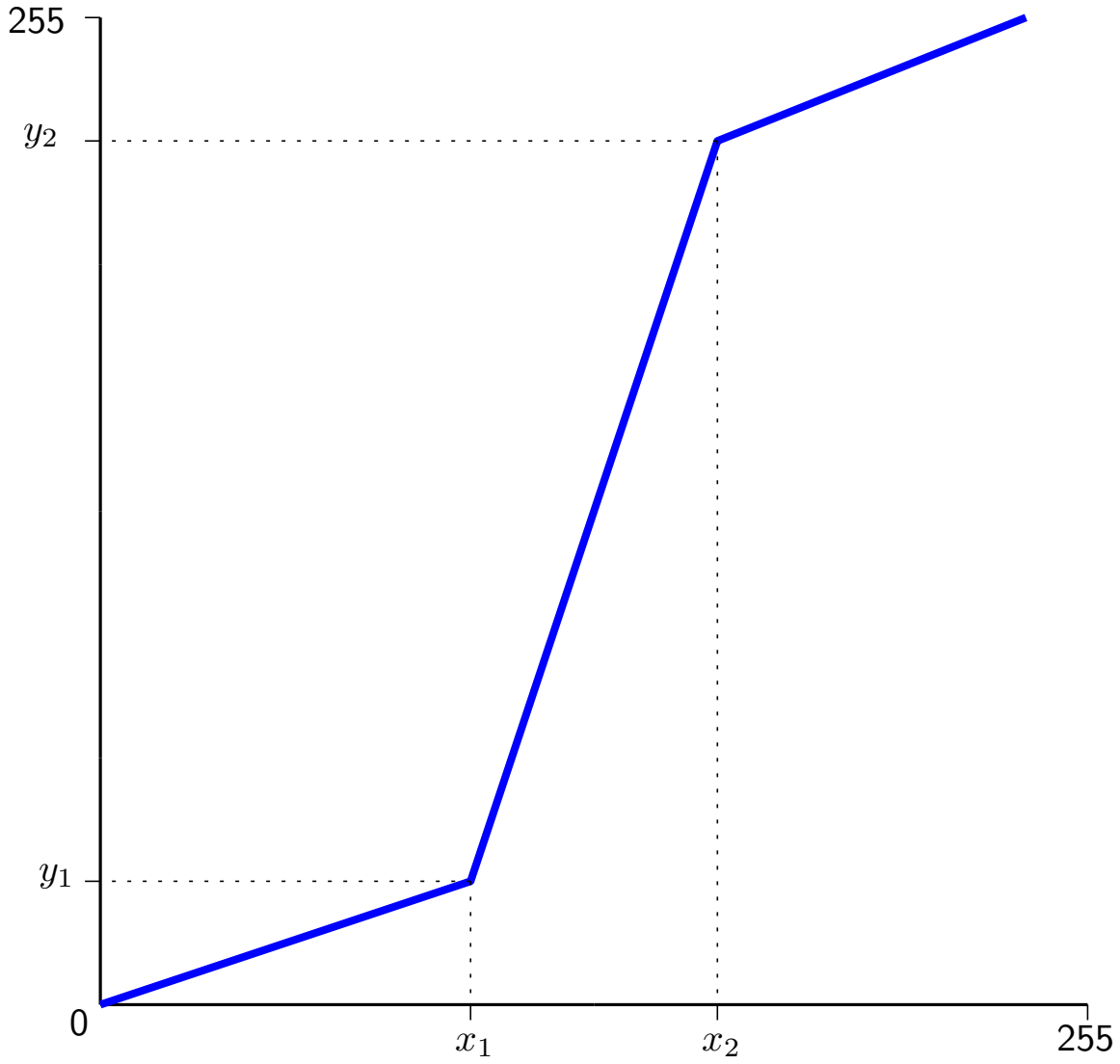
Original

$\gamma = 3$

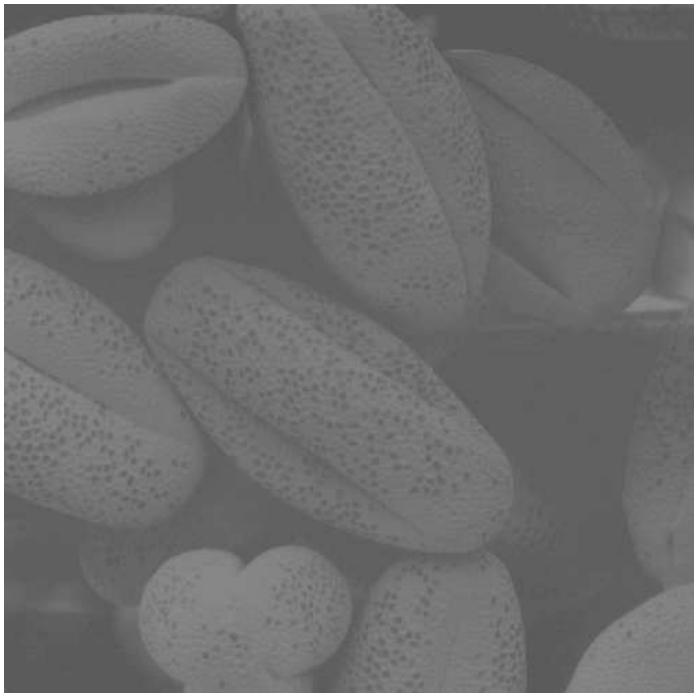
$\gamma = 4.5$

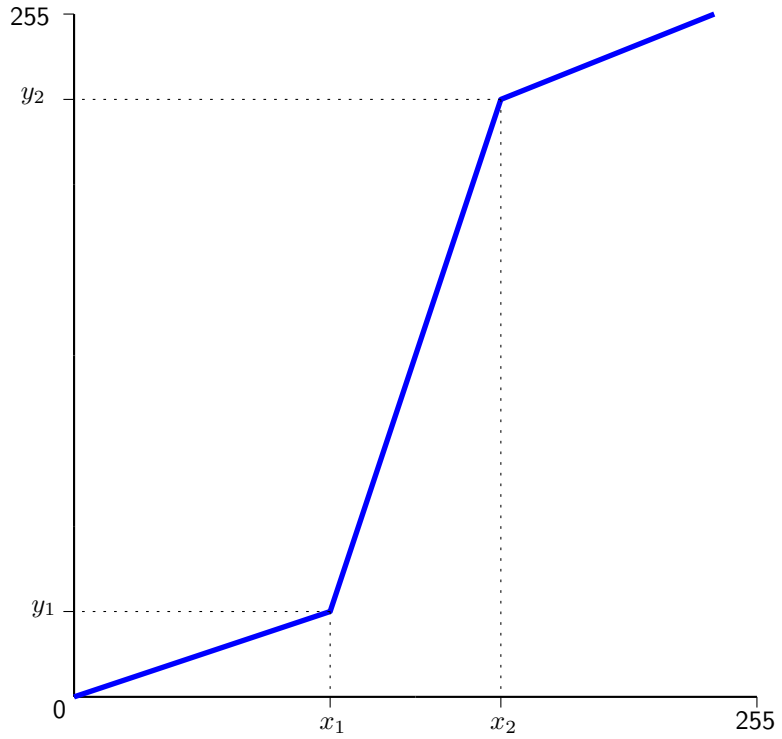
$\gamma = 6$

Contrast Stretching

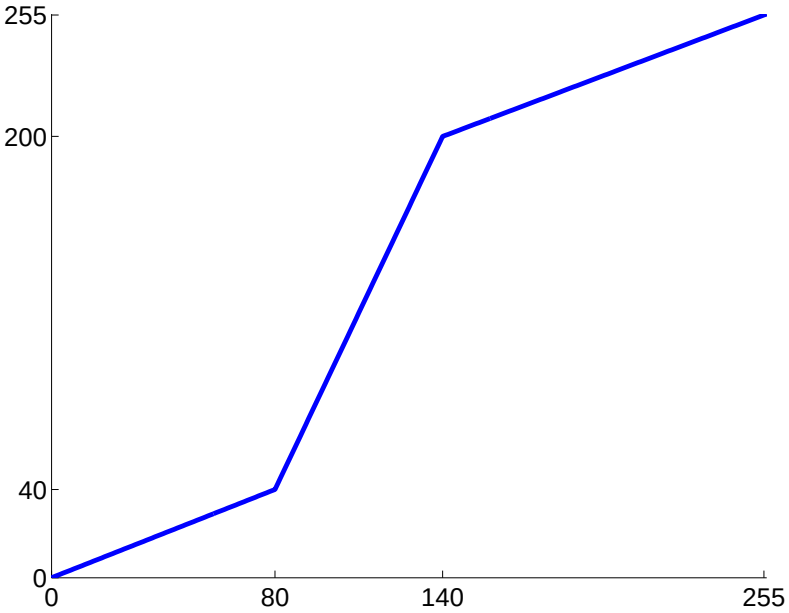


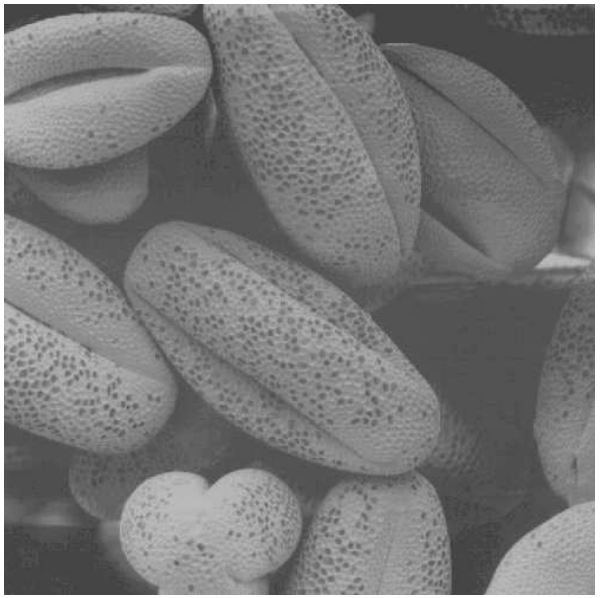
Contrast Stretching

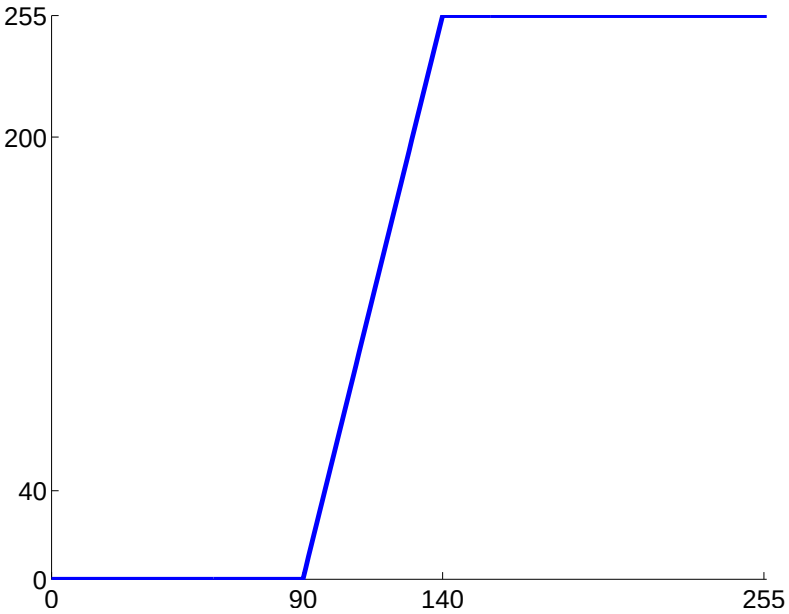




How should we choose x_1, y_1, x_2, y_2?


255
200
40
0
0
80
140
255

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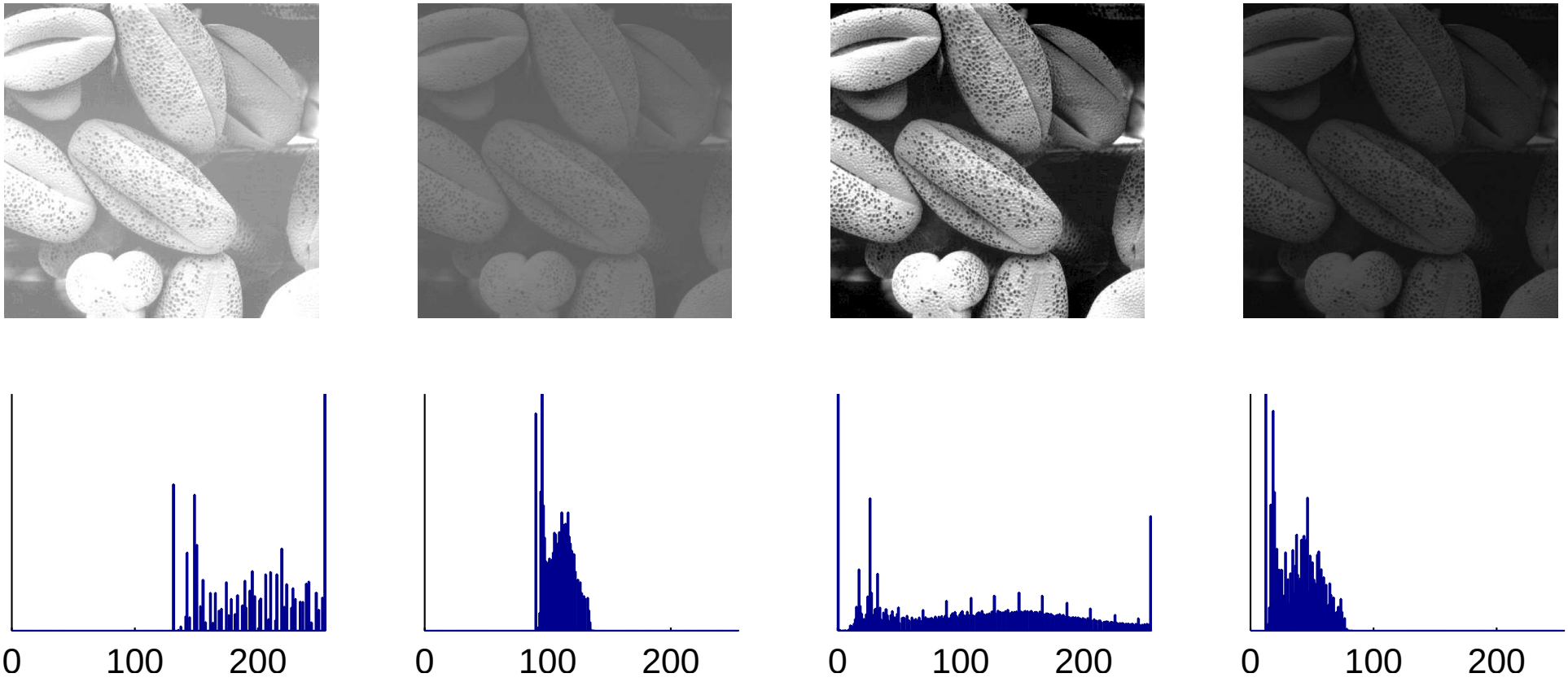
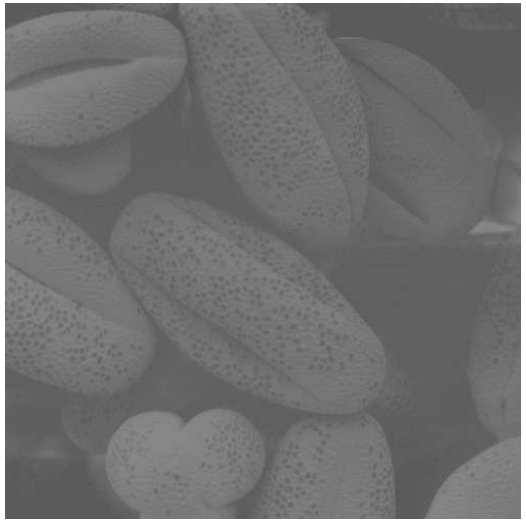
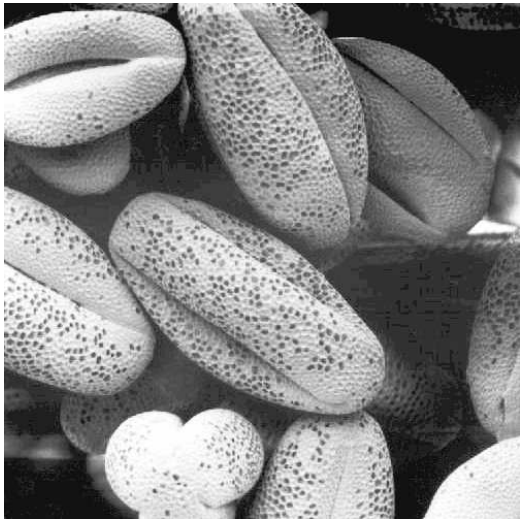
40
0
0
90
140
255

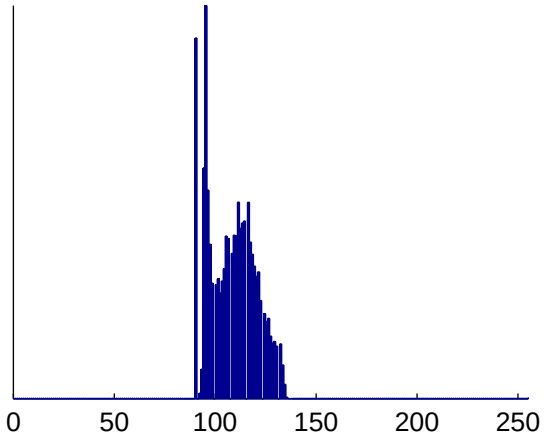
Histogram

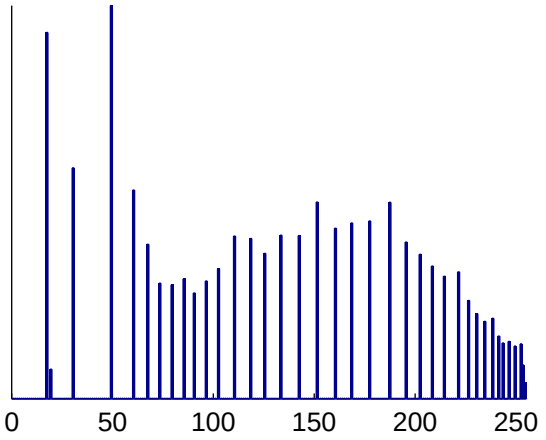


Histogram Equalization

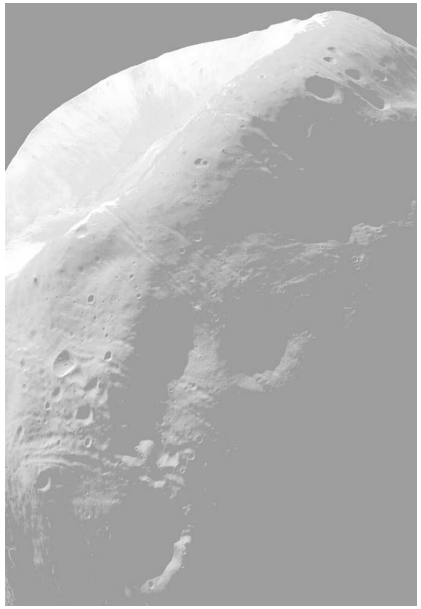


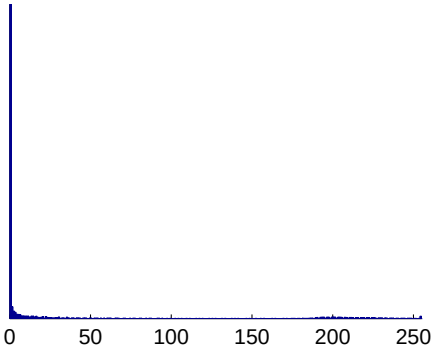


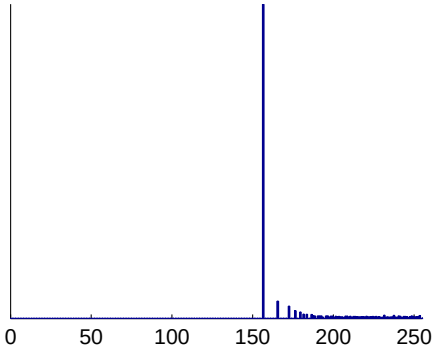




Histogram Equalization







Histogram Modification