[1] The following table shows the intensity distribution of a 3-bit image (L=8) of size 64 x 64 (MN =4096). Perform histogram equalization to transform it into a histogram equalized image. where r_k is the kth intensity value and n_k is the number of pixels in the image with intensity r_k

r_k	n_k
$r_0 = 0$	790
$r_1 = 1$	1023
$r_2 = 2$	850
$r_3 = 3$	656
$r_4 = 4$	329
$r_5 = 5$	245
$r_6 = 6$	122
$r_7 = 7$	81

$$s_0 = T(r_0) = 7\sum_{j=0}^{0} p_r(r_j) = 7 \times 0.19 = 1.33 \rightarrow 1$$

$$s_1 = T(r_1) = 7\sum_{j=0}^{1} p_r(r_j) = 7 \times (0.19 + 0.25) = 3.08 \rightarrow 3$$

$$s_2 = 4.55 \rightarrow 5 \qquad s_3 = 5.67 \rightarrow 6$$

$$s_4 = 6.23 \rightarrow 6 \qquad s_5 = 6.65 \rightarrow 7$$

$$s_6 = 6.86 \rightarrow 7 \qquad s_7 = 7.00 \rightarrow 7$$

[2] Given the following image and structuring element, perform an opening operation. Assume the origin of the structuring element is in the center. Ignore cases where the structuring element extends beyond the image. OPENING -> Erosion then Dilation

STRUCTURING ELEMENT

$$\begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

IMAGE

$$\begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 1 & 0 & 0 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 0 & 0 & 1 & 1 & 1 \end{bmatrix}$$

Solution

After Erosion: $\begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 1 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 & 1 & 1 & 1 \end{bmatrix}$

After Dilation: $\begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 1 \\ 1 & 1 & 1 & 0 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 & 1 & 1 & 1 \\ 1 & 1 & 0 & 0 & 1 & 1 & 1 \end{bmatrix}$

[3] Given the following feature vectors, with two classes:

Class 1: $\left\{ F_1 = \begin{bmatrix} 5 \\ 8 \\ 6 \end{bmatrix} F_2 = \begin{bmatrix} 7 \\ 6 \\ 1 \end{bmatrix} F_3 = \begin{bmatrix} 6 \\ 7 \\ 2 \end{bmatrix} \right\}$ Class 2: $\left\{ F_1 = \begin{bmatrix} 1 \\ 8 \\ 7 \end{bmatrix} F_2 = \begin{bmatrix} 3 \\ 6 \\ 8 \end{bmatrix} F_3 = \begin{bmatrix} 2 \\ 7 \\ 6 \end{bmatrix} \right\}$

a) Using the Nearest Neighbor classification method, and the absolute value distance metric, classify the following unknown sample vector as Class 1 or Class 2:

$$F = \begin{bmatrix} 4 \\ 6 \\ 9 \end{bmatrix}$$

Class 1: d1= 6, d2 = 11, d3 = 10; Class 2: d1=7, d2= 2, d3=6

Smallest distance is 2, therefore Class 2.

b) Use K Nearest Neighbor, with K = 3

The closest 3 have distances of 2 (class2), 6 (class2) and 6 (class1), therefore answer is Class 2.