Homework-1 Solutions

Question 1

You are given the following image:

1	2	2	3	3
3	4	4	4	4
5	5	5	5	5

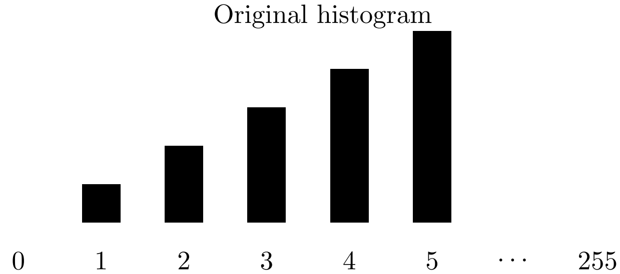
1.

What is the image histogram?

Answer:

$h(i)$	0	1	2	3	4	5	0	0
i	0	1	2	3	4	5	$\cdots$	255

Original histogram



2.

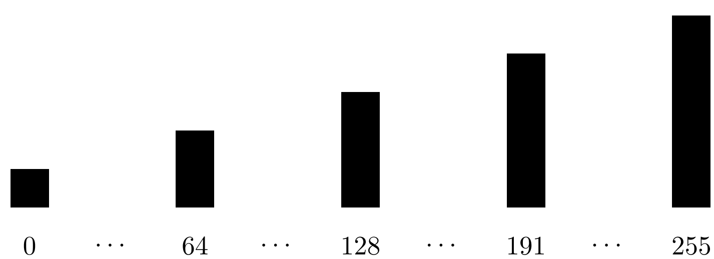
What would be the result of applying linear scaling for stretching the gray levels of the original image to the 0-255 range?

Answer:

$$y = 255 \times \frac{x-1}{5-1} = (x-1) \times 63.75$$

$$1 \Rightarrow 0, \quad 2 \Rightarrow 63.75 \Rightarrow 64, \quad 3 \Rightarrow 127.5 \Rightarrow 127 \text{ OR } 128, \quad 4 \Rightarrow 191.25 \Rightarrow 191 \quad 5 \Rightarrow 255$$

0	64	64	128	128
128	191	191	191	191
255	255	255	255	255



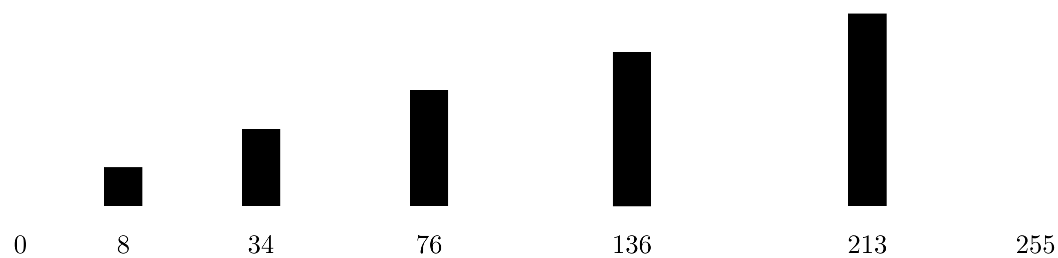
3.

What would be the result (image) of the histogram equalization technique applied to the original image?

Answer:

i	$h(i)$	$f(i)$	$\frac{f(i-1)+f(i)}{2}\frac{256}{15}$	floor	
1	1	1	8.53	8	$1 \to 8$
2	2	3	34.12	34	$2 \to 34$
3	3	6	76.8	76	$3 \to 76$
4	4	10	136.53	136	$4 \to 136$
5	5	15	213.3	213	$5 \to 213$

8	34	34	76	76
76	136	136	136	136
213	213	213	213	213



Question 2

You are given the following 4×5 gray level image:

1	2	3	3	3
1	1	1	1	2
0	3	3	2	1
0	3	3	2	1

a. Compute its histogram.

Answer:

Value	Number of Pixels
0	2
1	7
2	4
3	7

b. What is the 4×5 image obtained by linearly scaling the pixel values to the $0 - 255$ range.

Answer: For linear scaling, we need to compute for each pixel value,x, its new value which is given by:

$$x \to \frac{x-m}{M-m} \times 255$$

where m is the minimum pixel value and M is the maximum pixel value. For this specific picture, $m = 0$ and $M = 3$. So we get:

Original Value	New value
0	0
1	85
2	170
3	255

This produces the following picture:

85	170	255	255	255
85	85	85	85	170
0	255	255	170	85
0	255	255	170	85

c. What is the 4×5 image obtained by histogram equalization to the $0 - 255$ range.

Answer:

i	$h(i)$	$f(i)$	$\frac{f(i-1)+f(i)}{2} \cdot \frac{256}{20}$	floor	
0	2	2	12.8	12	$0 \rightarrow 12$
1	7	9	70.4	70	$1 \rightarrow 70$
2	4	13	140.8	140	$1 \rightarrow 140$
3	7	20	211.2	211	$3 \rightarrow 211$

70	140	211	211	211
70	70	70	70	140
12	211	211	140	70
12	211	211	140	70