

CS462 Image Processing

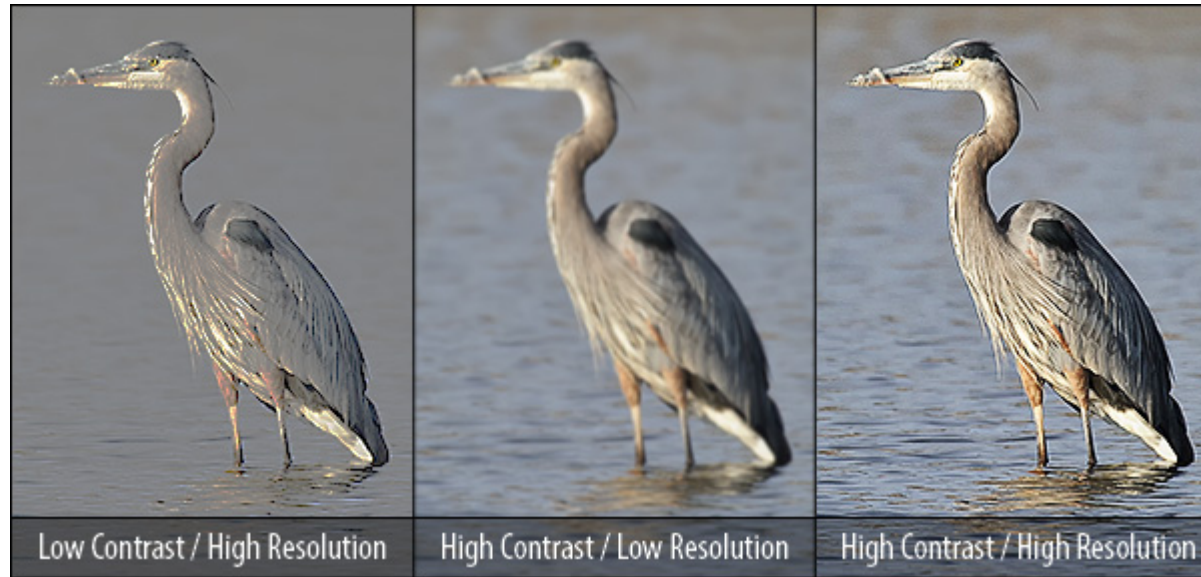
Chapter 3

Image Characteristic Part II

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Computer Science MJU



Good photograph and Bad photograph



Exposure Correction



Brightness



Contrast



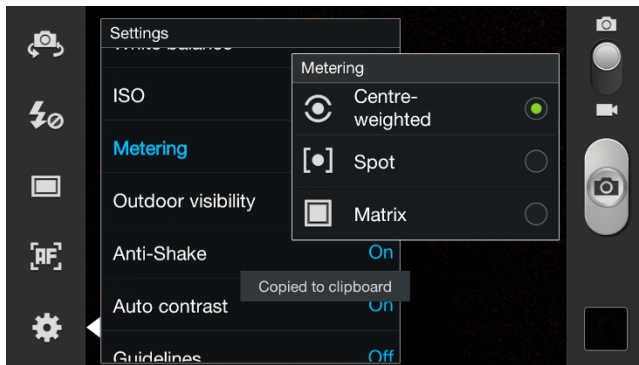
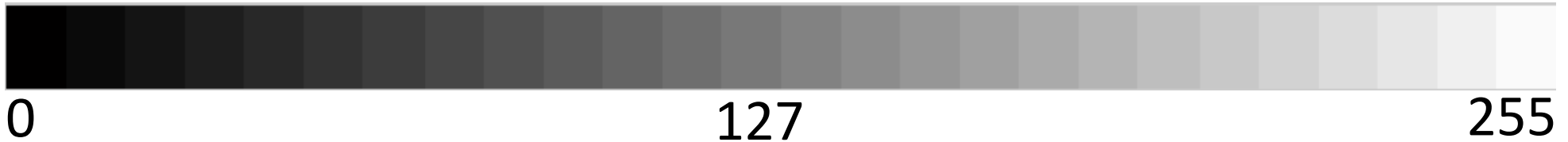
Gamma



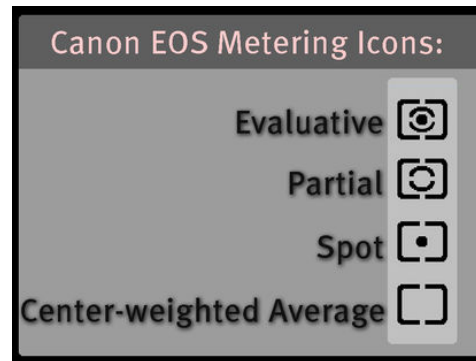
What is the good brightness and contrast ?

Too dark

Too bright



Galaxy S3



Canon EOS

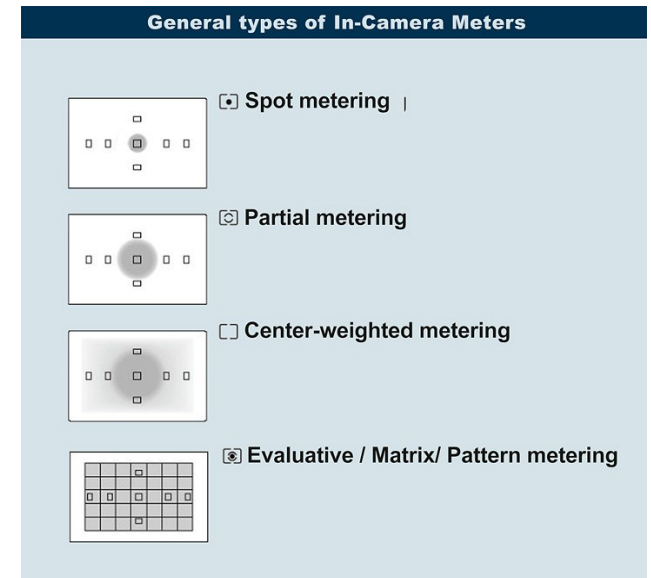
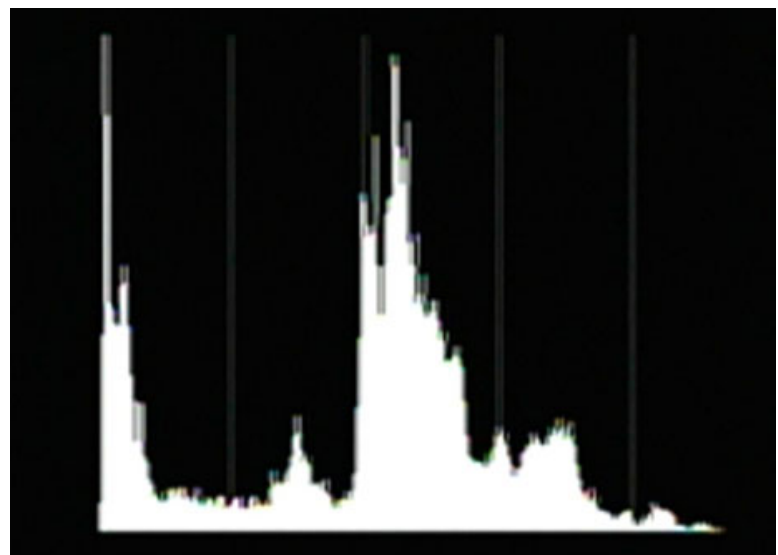
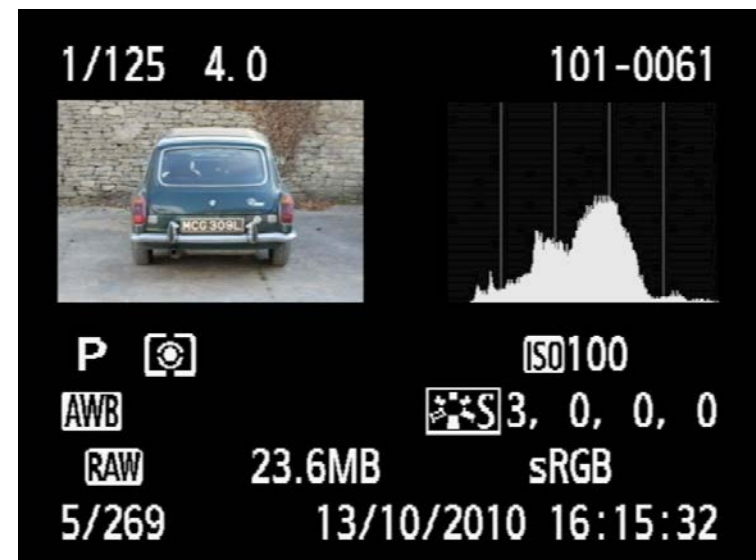
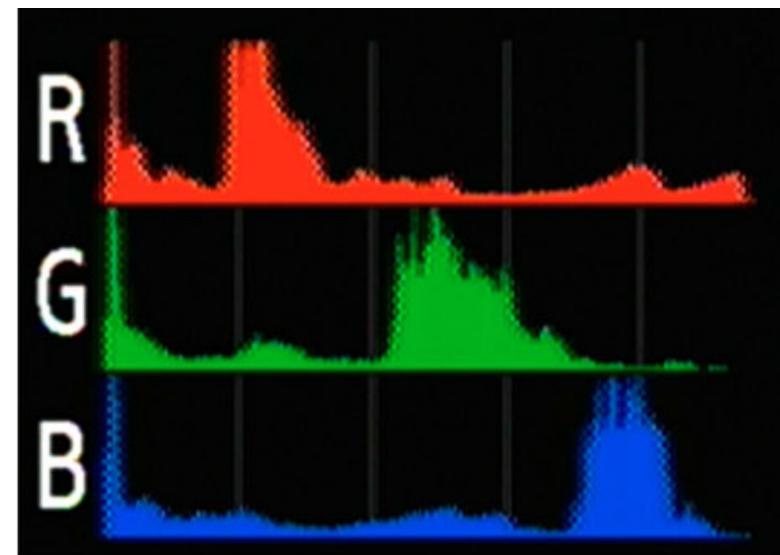
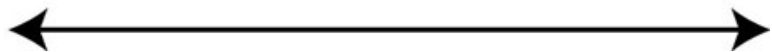


Image Histogram



Shadows

Highlights



Less Saturated

More Saturated

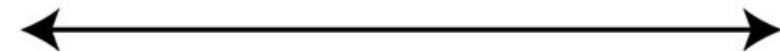


Image Histogram

An **image histogram** is a type of [histogram](#) that acts as a [graphical representation](#) of the [tonal](#) distribution in a [digital image](#).^[1] It plots the number of [pixels](#) for each tonal value.

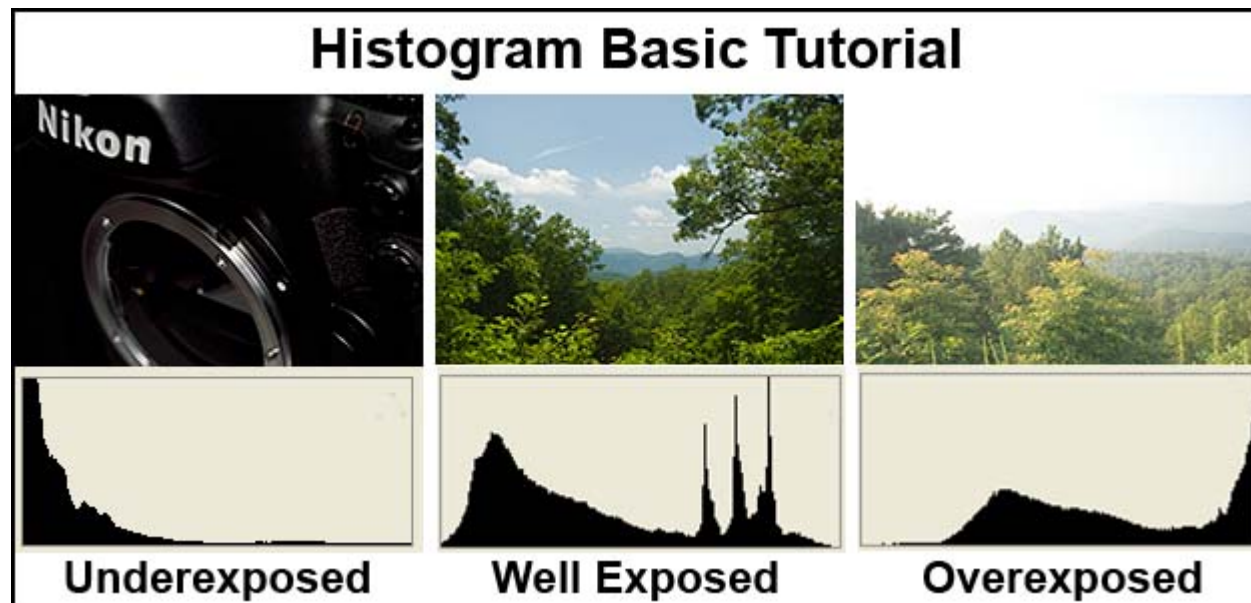


Image Histogram

A histogram is a function m_i that counts the number of observations that fall into each of the disjoint categories (known as *bins*),

Bin	Frequency
0	3
1	4
2	2
3	2
4	2
5	2
6	1
7	5
8	6
9	4
10	5

8	3	10	8	7	7
9	5	5	10	8	0
1	10	8	7	7	3
9	10	1	0	4	0
6	2	4	8	7	1
1	10	9	9	2	8

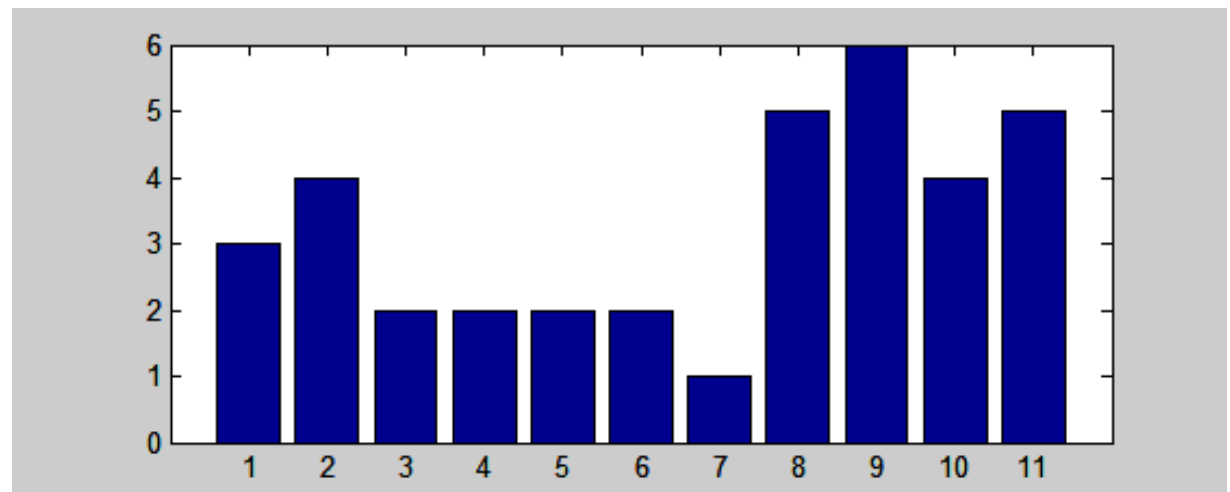


Image Histogram

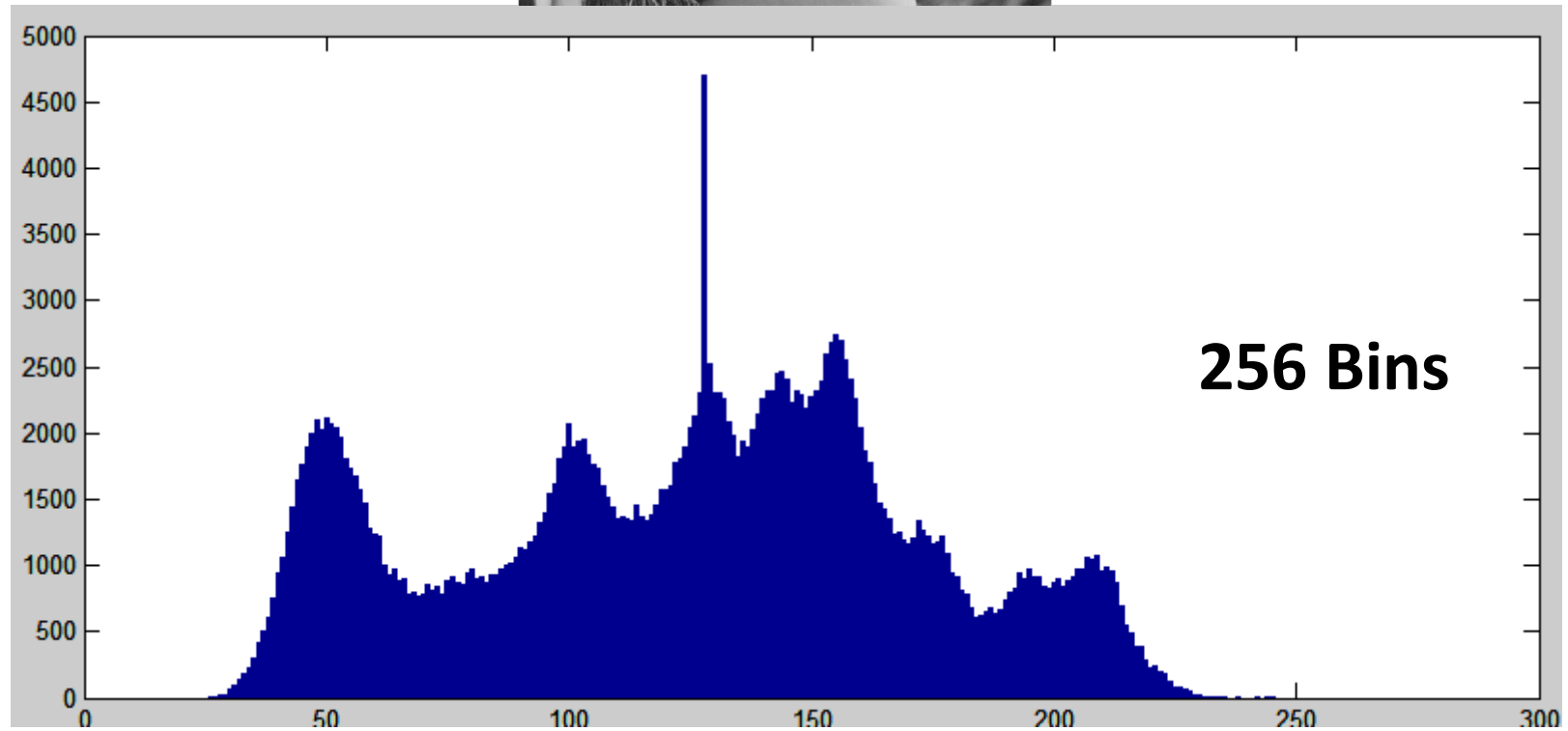


Image Histogram



BIN	Frequency
0	0
28.33333333333333	8053
56.66666666666667	40250
85	32784
113.33333333333333	47103
141.66666666666667	63890
170	40758
198.33333333333333	24344
226.66666666666667	4958
255	4

10 Bins

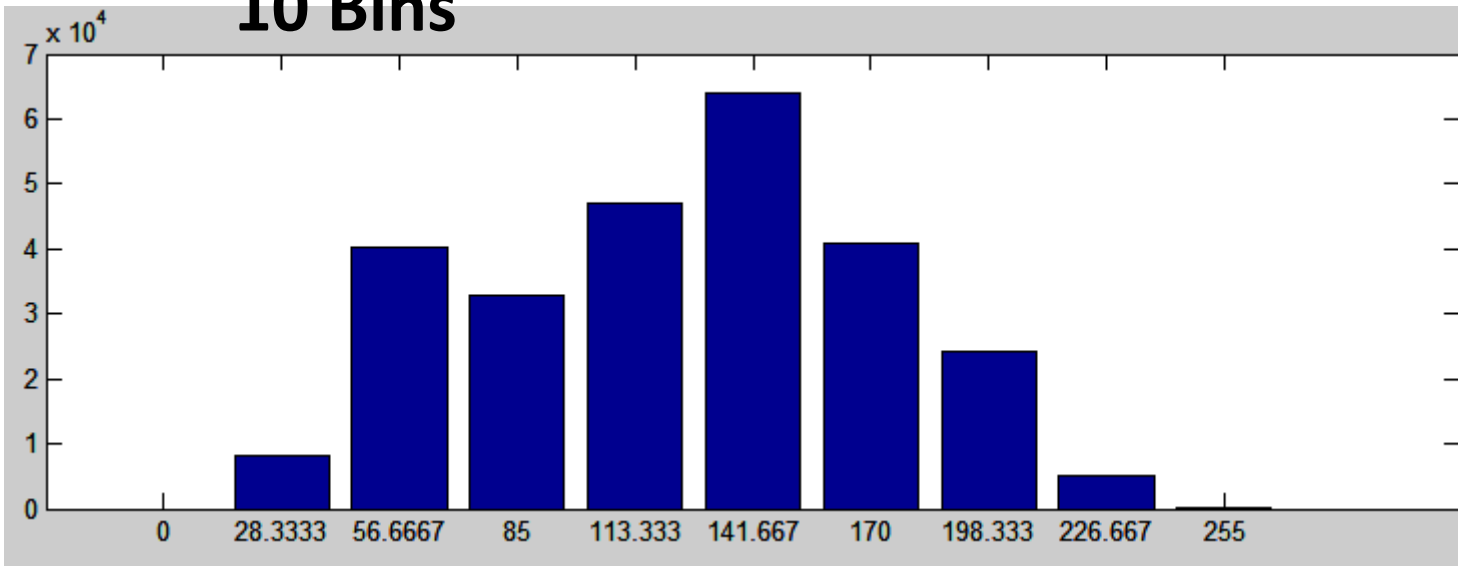


Image Histogram

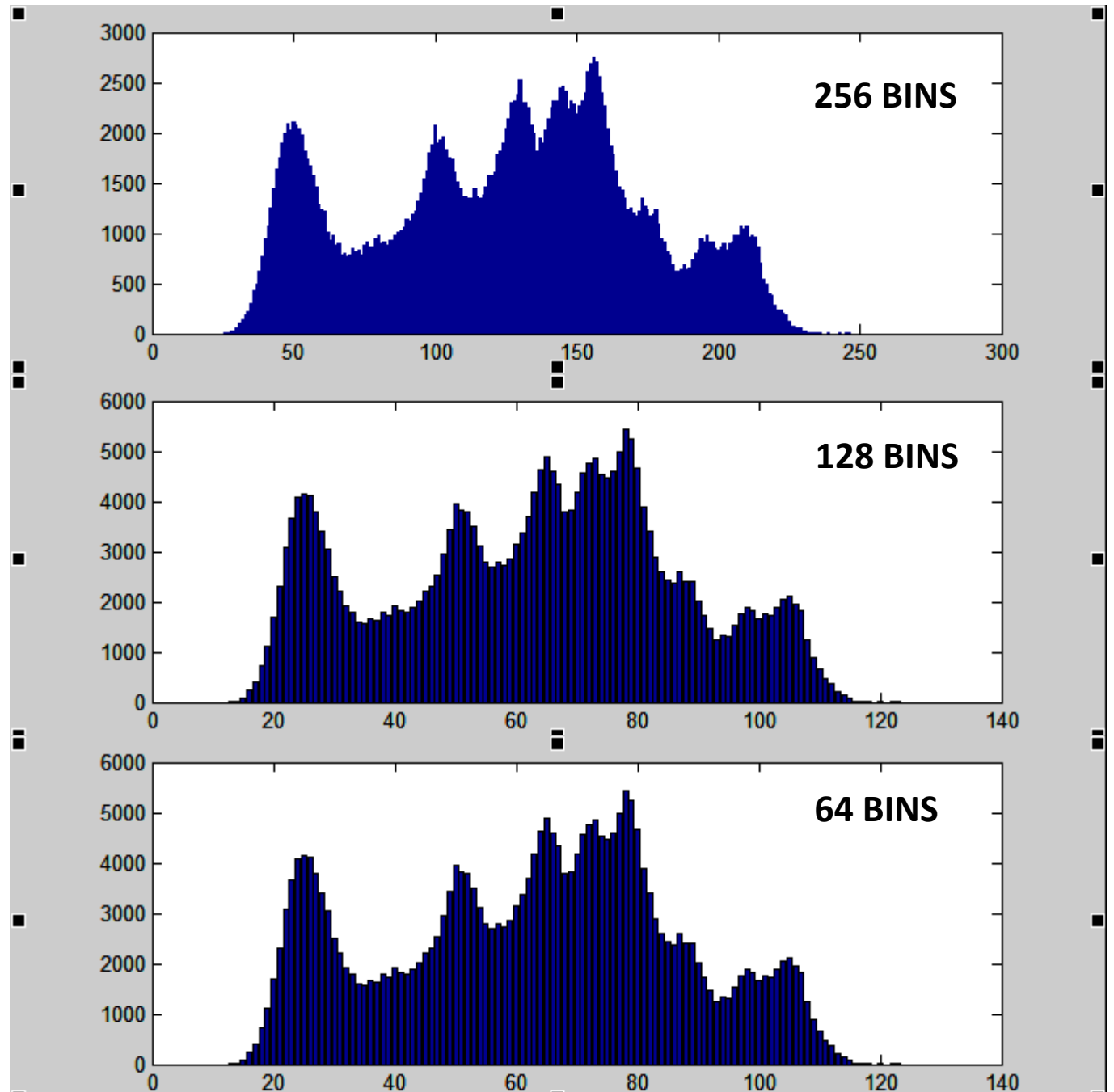


Image Histogram

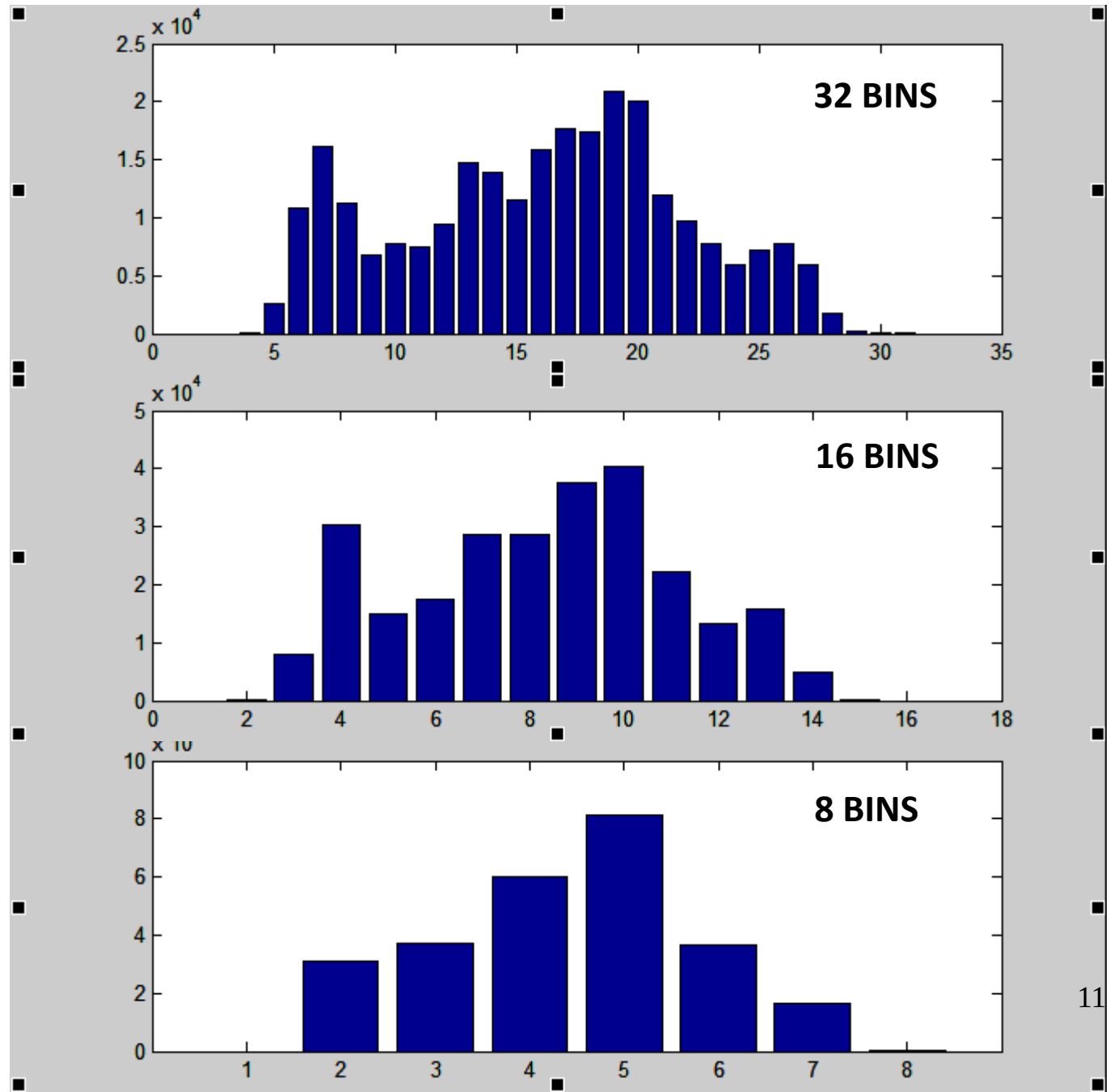
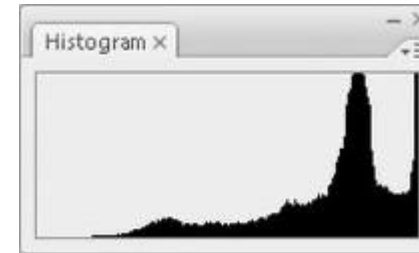
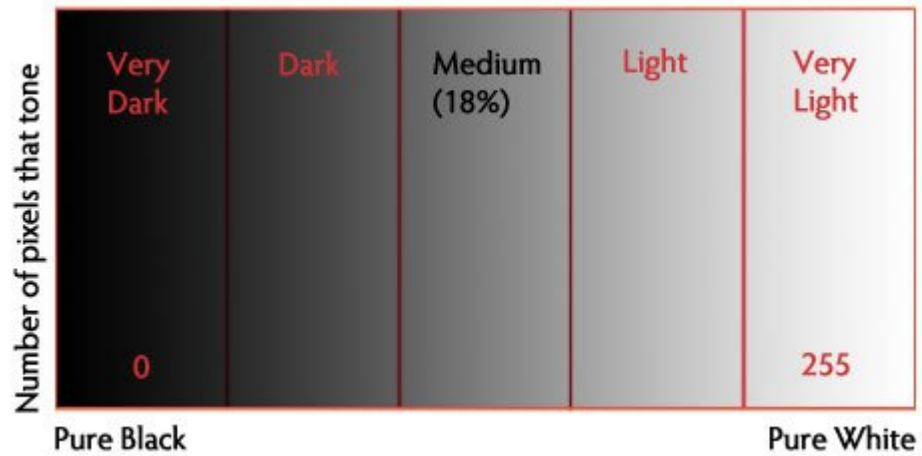
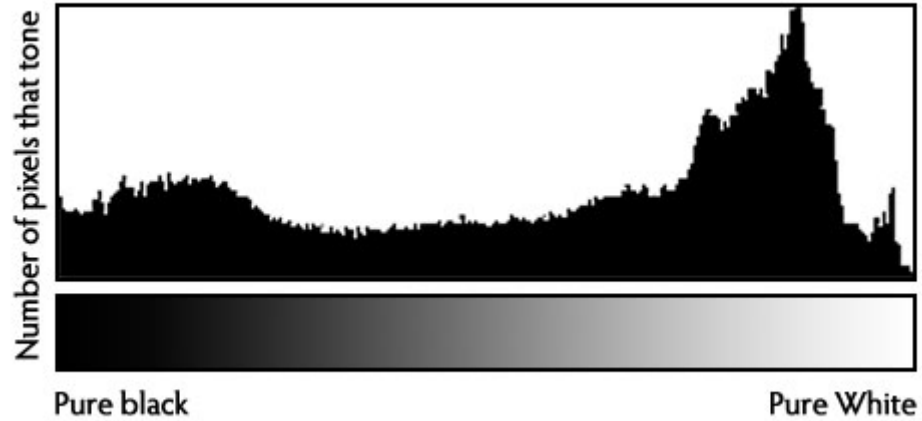
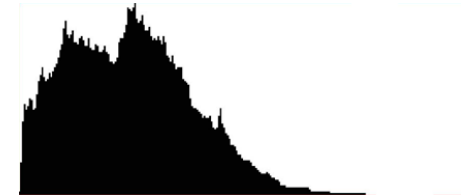


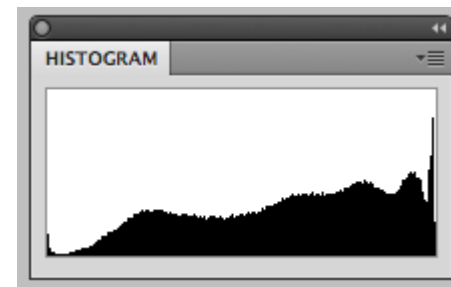
Image Histogram



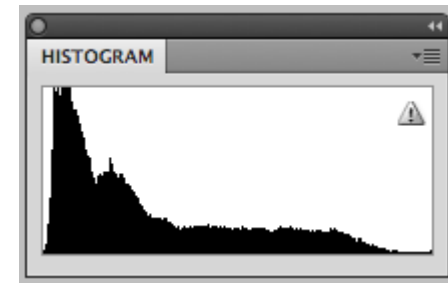
Too bright



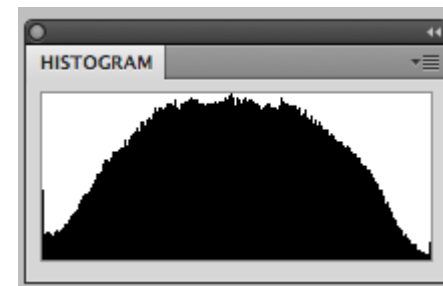
Too dark



Bright

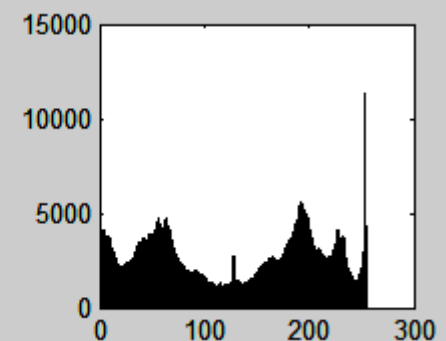
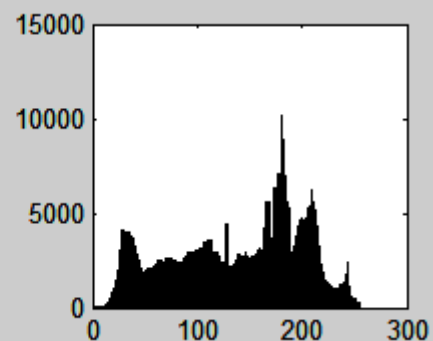
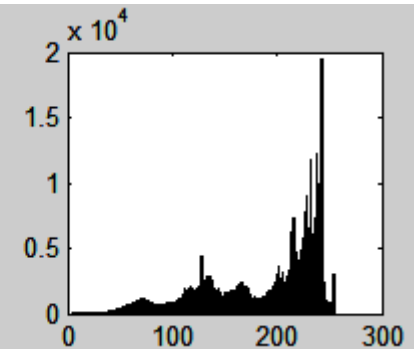
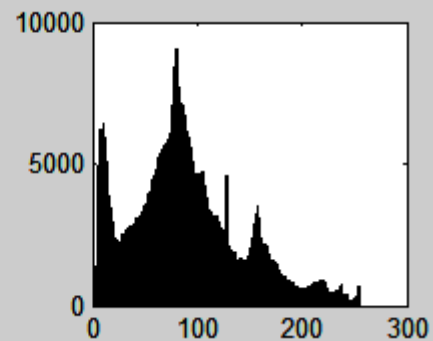
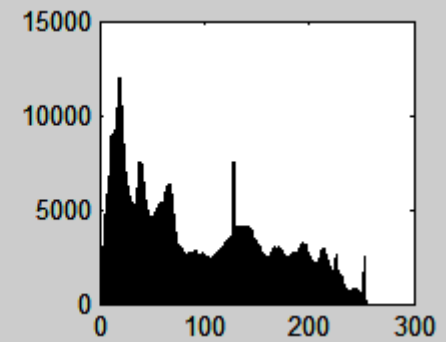
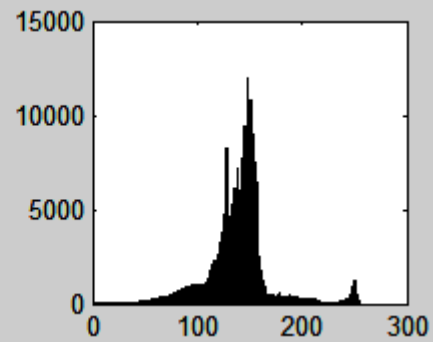


Dark



Ideal

Image Histogram



Question !

207 24 40 36 167
230 71 247 107 9
32 139 244 233 216
232 244 123 202 238
161 246 204 244 173

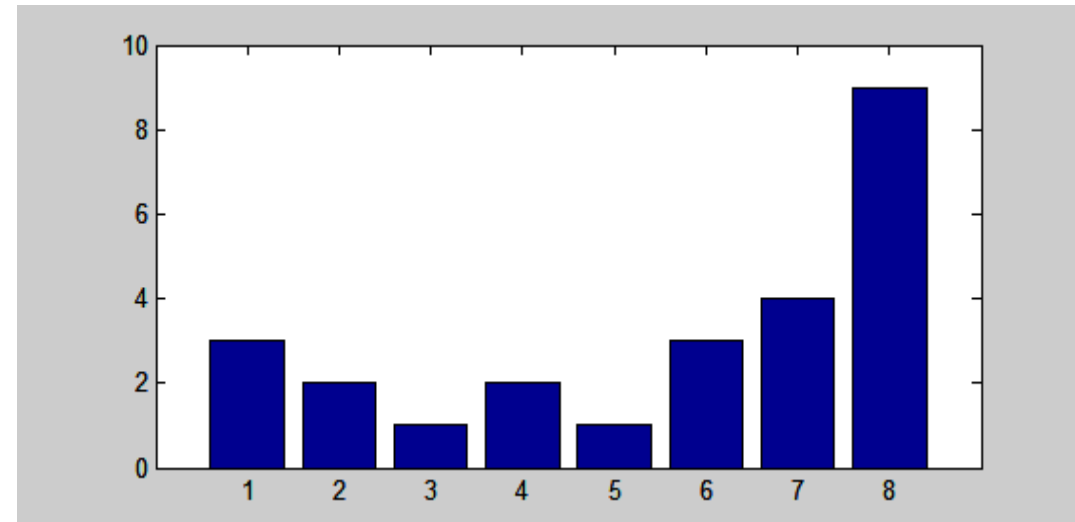
I

Image **I** is represented in Uint8.
Please determine the
8 bins histogram ?

Bins=8

Bin size=256/8
=32

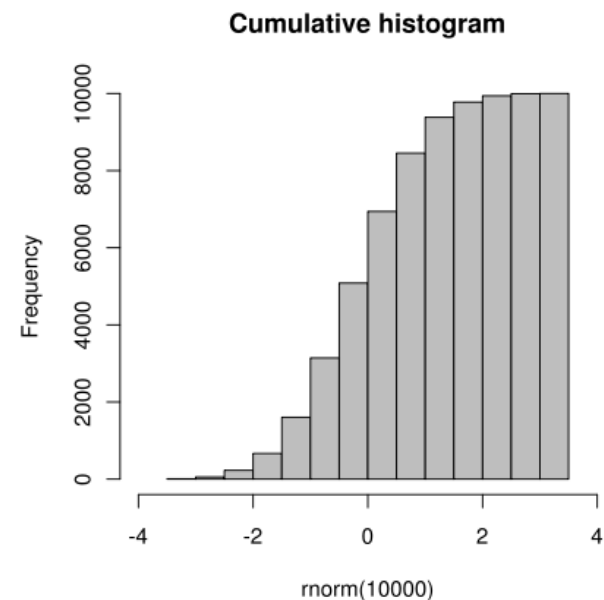
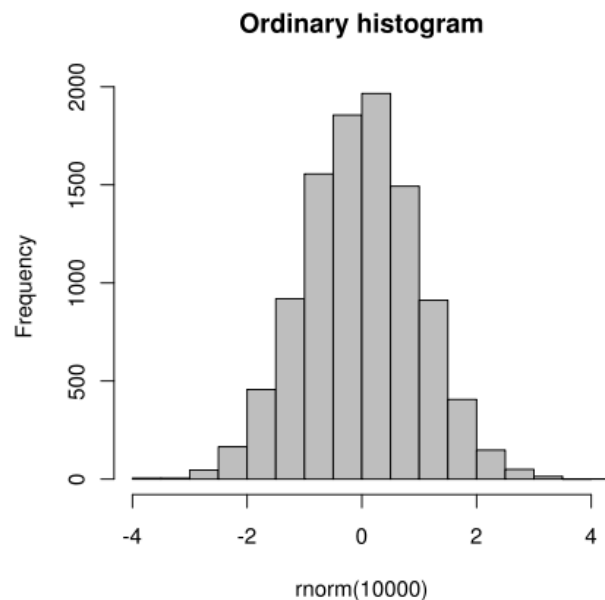
Bin	Frequency
32	3
64	2
96	1
128	2
160	1
192	3
224	4
255	9



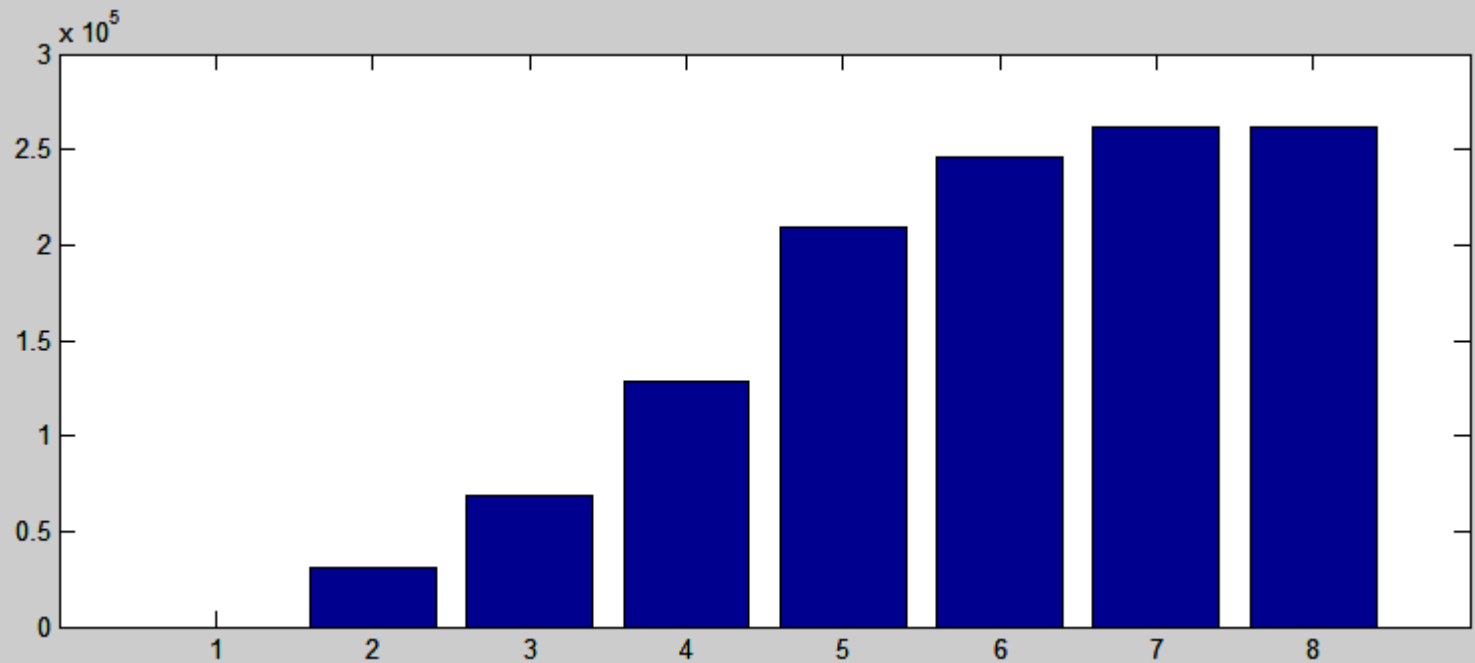
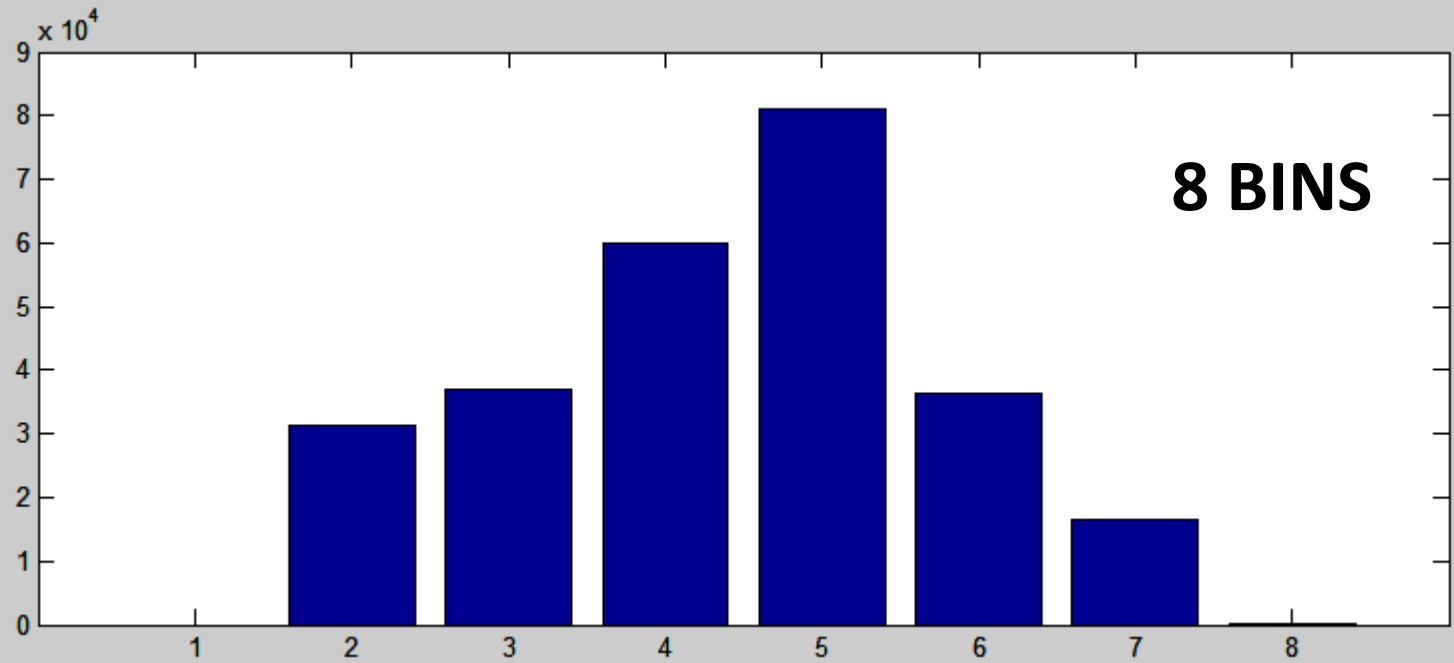
Cumulative Histogram

A cumulative histogram is a mapping that counts the cumulative number of observations in all of the bins up to the specified bin. That is, the cumulative histogram M_i of a histogram m_j is defined as:

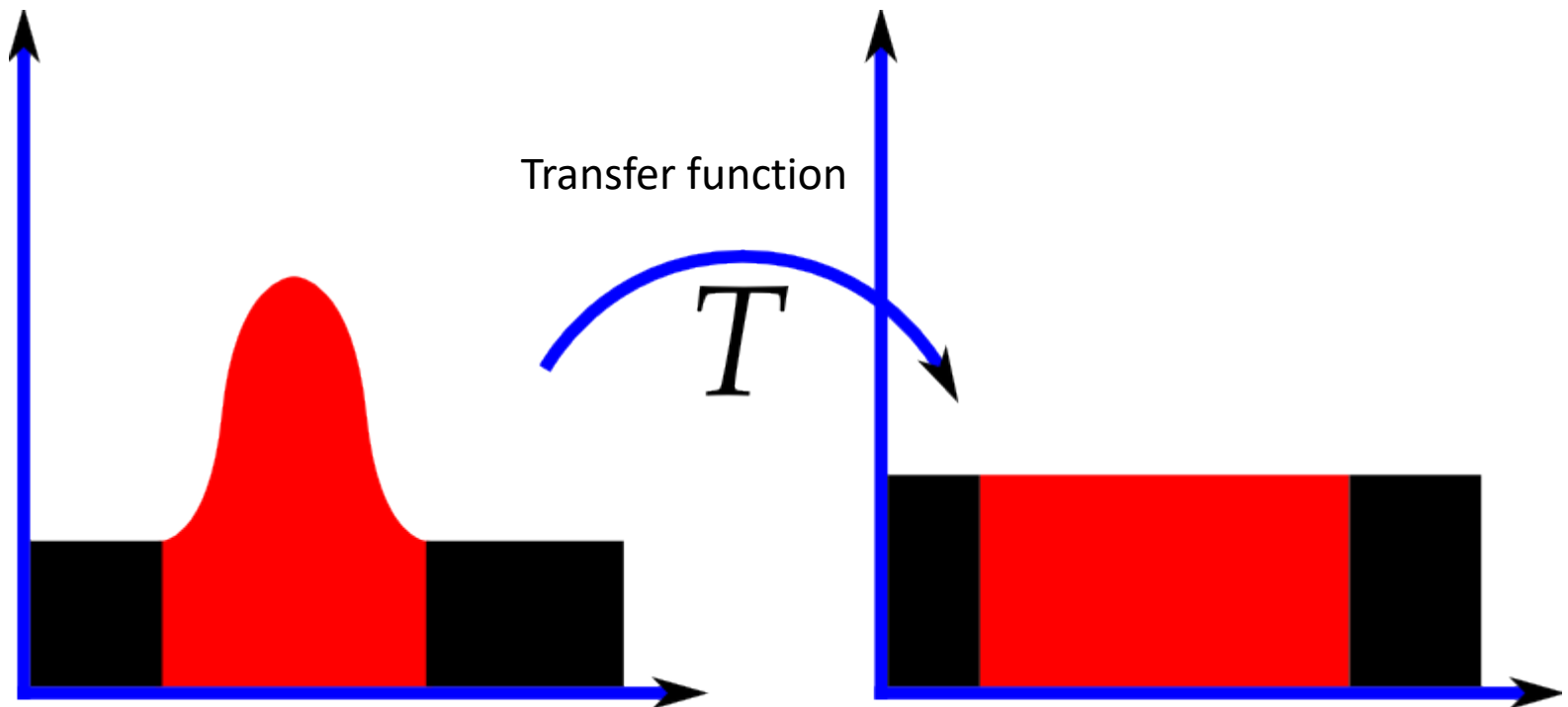
$$M_i = \sum_{j=1}^i m_j$$



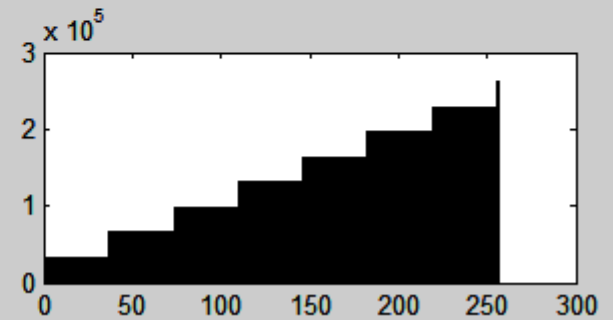
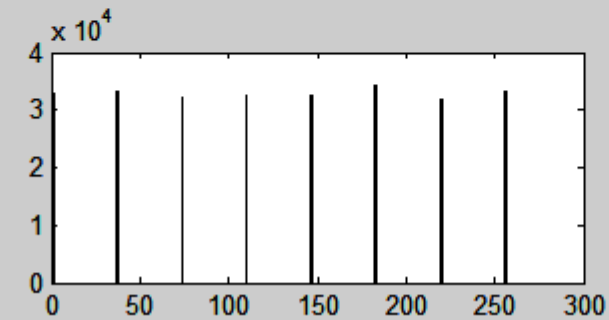
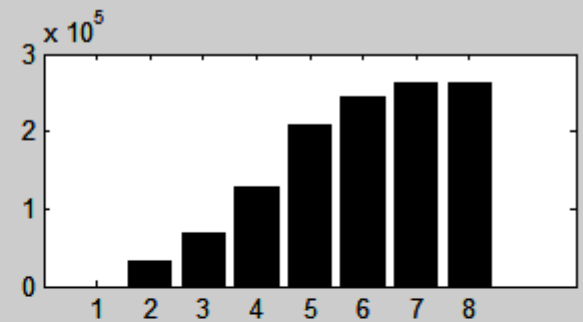
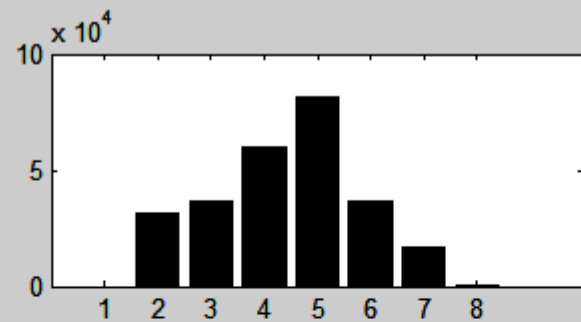
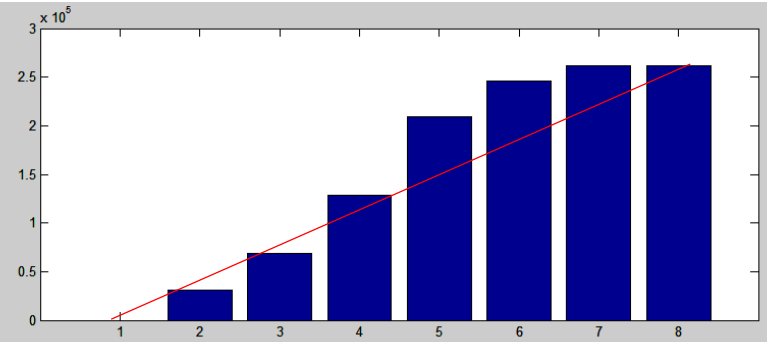
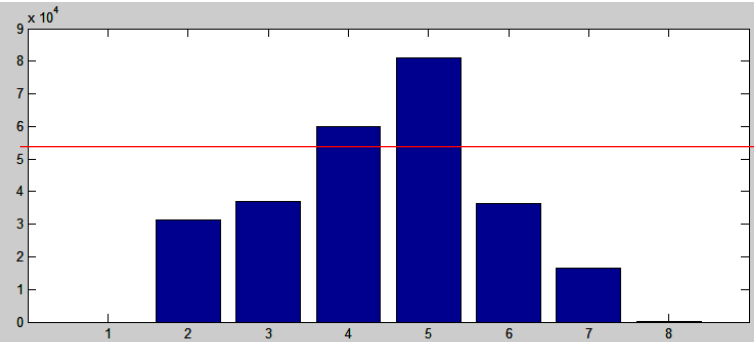
Cumulative Histogram



Histogram Equalization



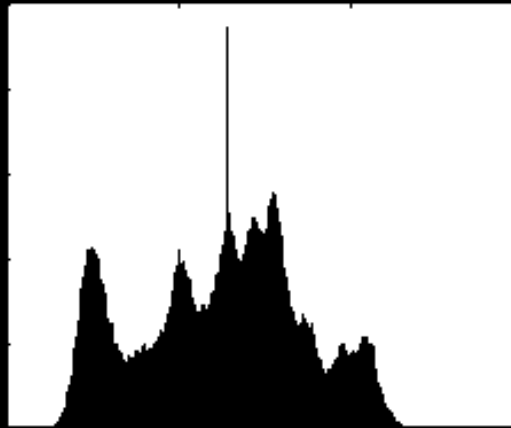
Histogram Equalization



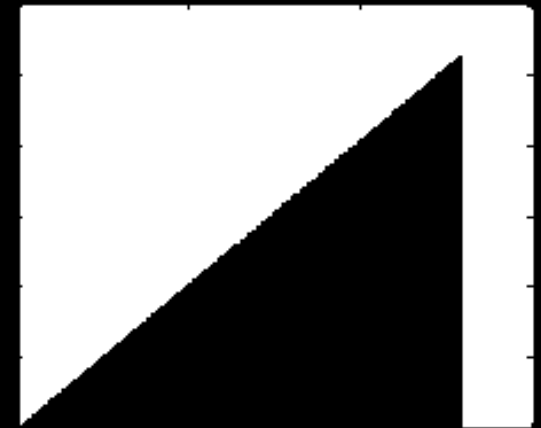
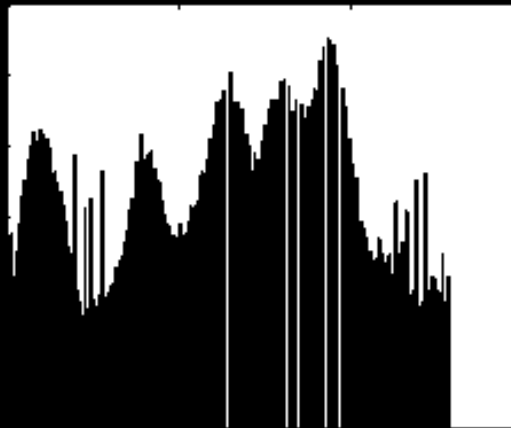
Histogram Equalization



Original

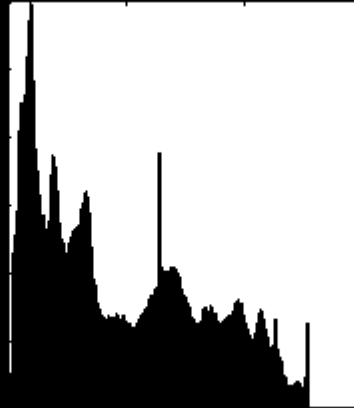


Equalized

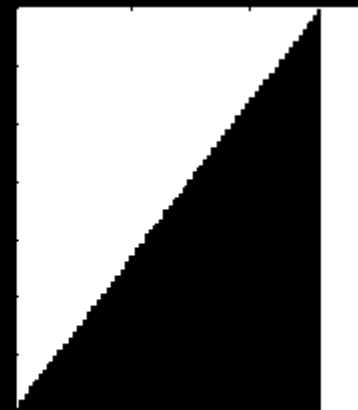
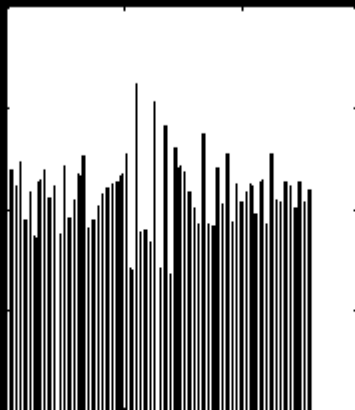
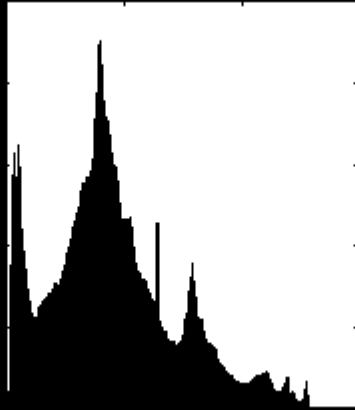


`Im2=histeq(im,bins)`

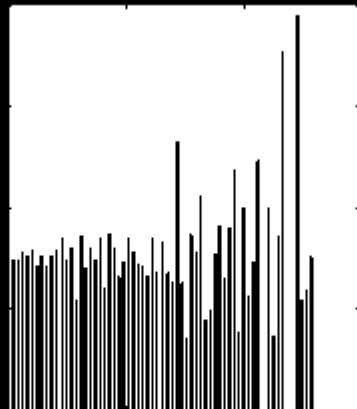
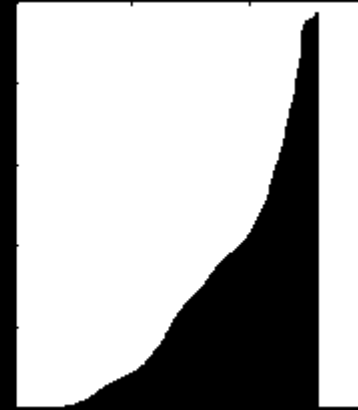
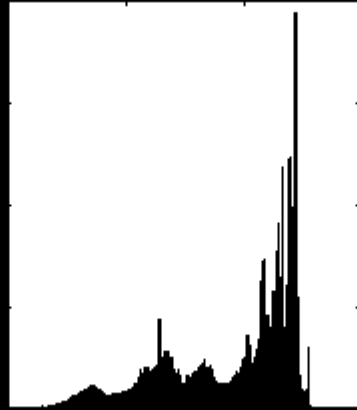
Histogram Equalization



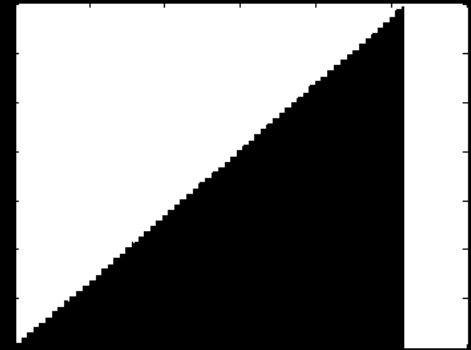
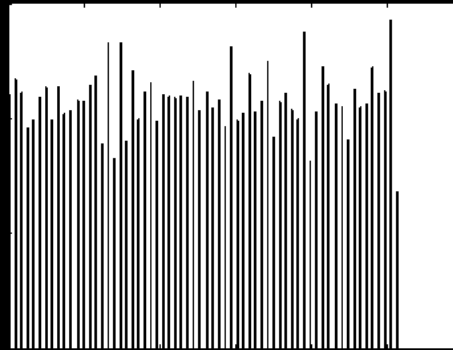
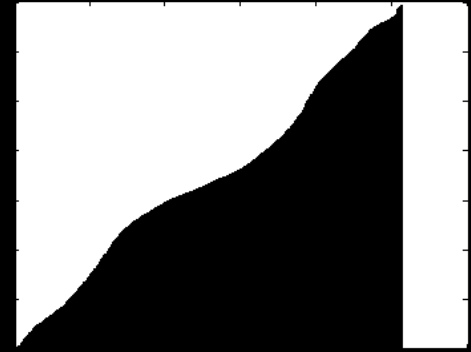
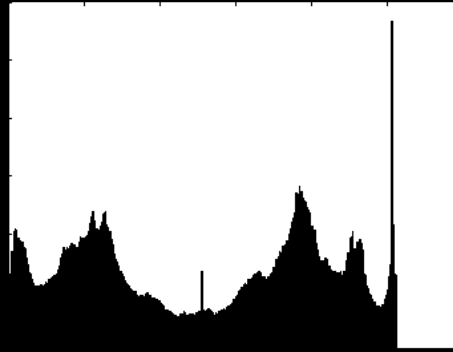
Histogram Equalization



Histogram Equalization



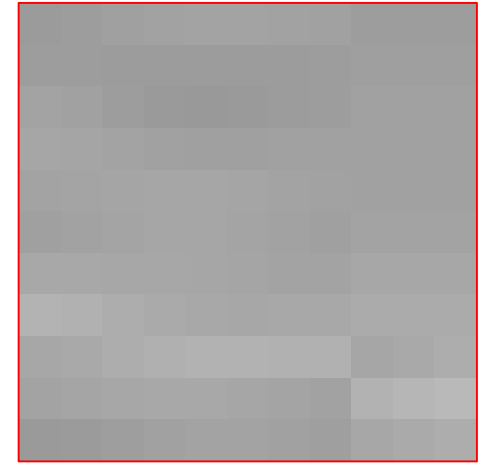
Histogram Equalization



Histogram Equalization

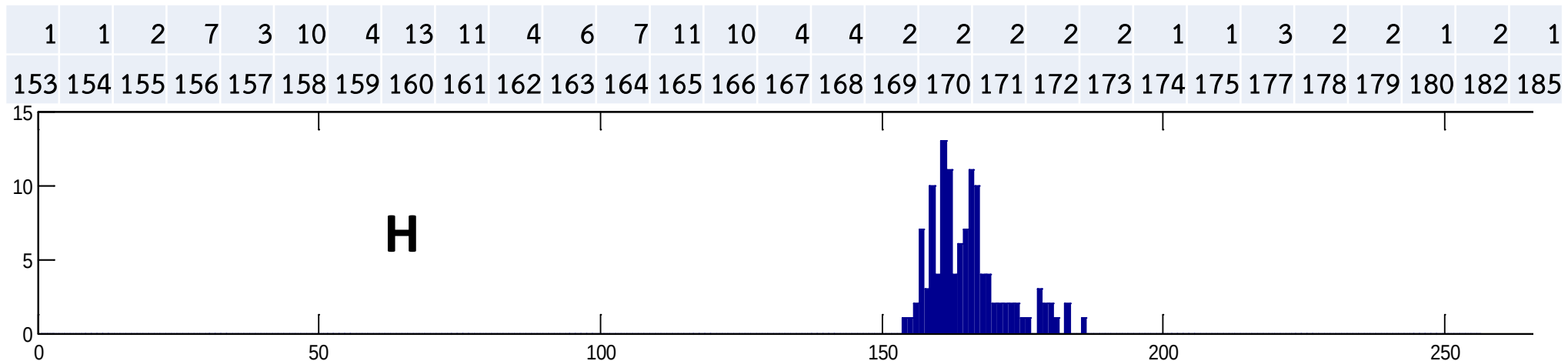
158	158	158	161	164	161	160	158	157	156	156
156	154	155	158	159	163	162	160	159	158	158
165	161	159	156	153	156	157	159	160	160	160
168	167	164	160	158	156	158	160	161	160	160
161	166	165	165	168	166	166	166	164	162	162
162	164	165	166	166	168	161	160	165	166	161
165	164	163	161	160	161	163	167	171	171	167
178	178	177	172	166	168	170	169	166	166	170
163	165	173	179	182	177	179	180	177	175	173
165	164	165	165	163	161	160	164	174	182	185
156	155	157	161	165	167	160	158	163	169	172

IM



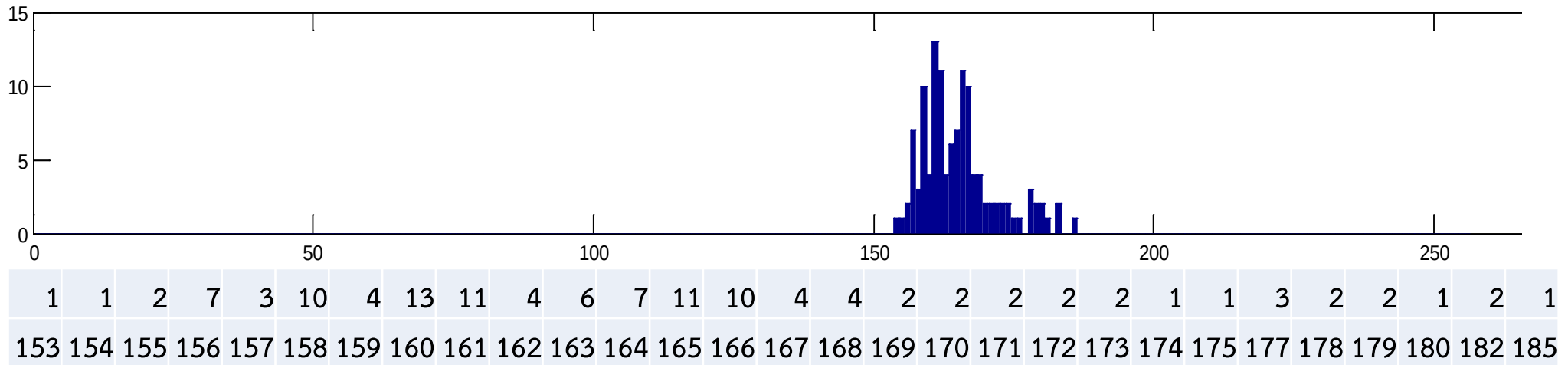
STEP 1: Find the histogram (256 bins)

$H = \text{Histogram}(IM, 256)$



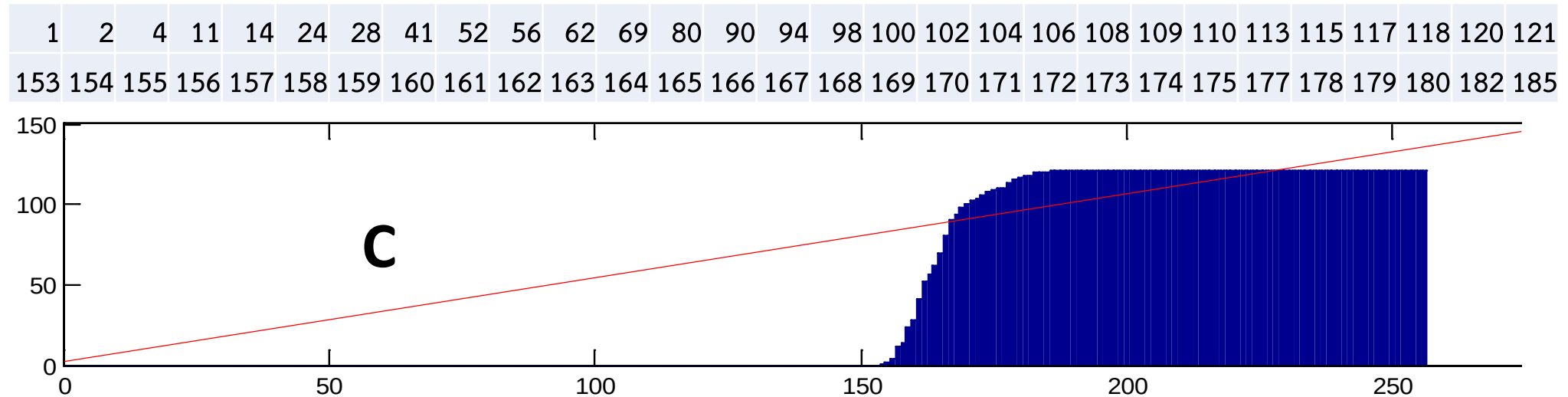
Histogram Equalization

STEP 1: Find the histogram (256 bins)



STEP 2: Find the cumulative histogram

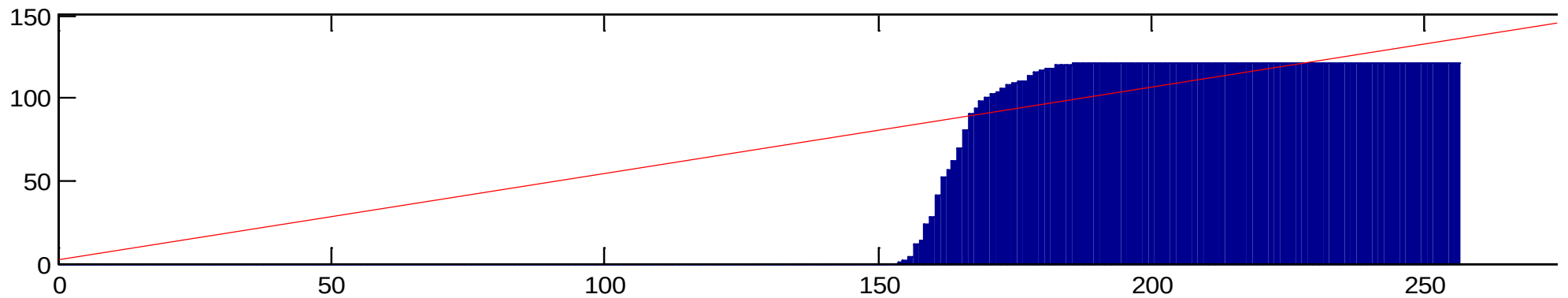
$$C_i = \sum_{j=1}^i H_j$$



Histogram Equalization

STEP 2: Find the cumulative histogram

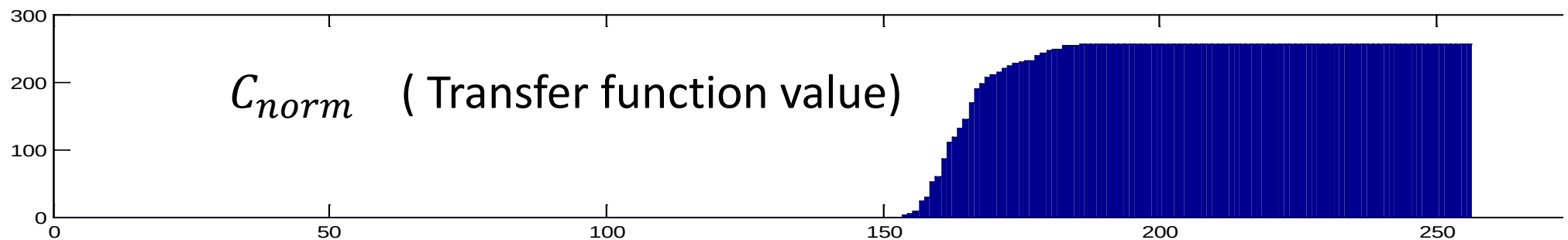
1	2	4	11	14	24	28	41	52	56	62	69	80	90	94	98	100	102	104	106	108	109	110	113	115	117	118	120	121
153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	177	178	179	180	182	185



STEP 3: Normalizing the cumulative histogram

$$C_{norm} = \frac{C}{\max(C)} \times 255$$

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	177	178	179	180	182	185



Histogram Equalization

158	158	158	161	164	161	160	158	157	156	156
156	154	155	158	159	163	162	160	159	158	158
165	161	159	156	153	156	157	159	160	160	160
168	167	164	160	158	156	158	160	161	160	160
161	166	165	165	168	166	166	166	164	162	162
162	164	165	166	166	168	161	160	165	166	161
165	164	163	161	160	161	163	167	171	171	167
178	178	177	172	166	168	170	169	166	166	170
163	165	173	179	182	177	179	180	177	175	173
165	164	165	165	163	161	160	164	174	182	185
156	155	157	161	165	167	160	158	163	169	172

IM

STEP 4: Applying transferred values for each pixels

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	177	178	179	180	182	185

Pixel value (0 to 255)

C_{norm} (Transfer function value)

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	178	179	180	181	183	186

Array Index (1 to 256)

Histogram Equalization

158	158	158	161	164	161	160	158	157	156	156
156	154	155	158	159	163	162	160	159	158	158
165	161	159	156	153	156	157	159	160	160	160
168	167	164	160	158	156	158	160	161	160	160
161	166	165	165	168	166	166	166	164	162	162
162	164	165	166	166	168	161	160	165	166	161
165	164	163	161	160	161	163	167	171	171	167
178	178	177	172	166	168	170	169	166	166	170
163	165	173	179	182	177	179	180	177	175	173
165	164	165	165	163	161	160	164	174	182	185
156	155	157	161	165	167	160	158	163	169	172

IM

STEP 4: Applying transferred values for each pixels

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	178	179	180	181	183	186

C_{norm} (Transfer function value)

Histogram Equalization

158	158	158	161	164	161	160	158	157	156	156
156	154	155	158	159	163	162	160	159	158	158
165	161	159	156	153	156	157	159	160	160	160
168	167	164	160	158	156	158	160	161	160	160
161	166	165	165	168	166	166	166	164	162	162
162	164	165	166	166	168	161	160	165	166	161
165	164	163	161	160	161	163	167	171	171	167
178	178	177	172	166	168	170	169	166	166	170
163	165	173	179	182	177	179	180	177	175	173
165	164	165	165	163	161	160	164	174	182	185
156	155	157	161	165	167	160	158	163	169	172

IM

STEP 4: Applying transferred values for each pixels

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	178	179	180	181	183	186

C_{norm} (Transfer function value)

Histogram Equalization

30	158	158	161	164	161	160	158	157	156	156
156	154	155	158	159	163	162	160	159	158	158
165	161	159	156	153	156	157	159	160	160	160
168	167	164	160	158	156	158	160	161	160	160
161	166	165	165	168	166	166	166	164	162	162
162	164	165	166	166	168	161	160	165	166	161
165	164	163	161	160	161	163	167	171	171	167
178	178	177	172	166	168	170	169	166	166	170
163	165	173	179	182	177	179	180	177	175	173
165	164	165	165	163	161	160	164	174	182	185
156	155	157	161	165	167	160	158	163	169	172

IM

STEP 4: Applying transferred values for each pixels

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	178	179	180	181	183	186

C_{norm} (Transfer function value)

Histogram Equalization

30	158	158	161	164	161	160	158	157	156	156
156	154	155	158	159	163	162	160	159	158	158
165	161	159	156	153	156	157	159	160	160	160
168	167	164	160	158	156	158	160	161	160	160
161	166	165	165	168	166	166	166	164	162	162
162	164	165	166	166	168	161	160	165	166	161
165	164	163	161	160	161	163	167	171	171	167
178	178	177	172	166	168	170	169	166	166	170
163	165	173	179	182	177	179	180	177	175	173
165	164	165	165	163	161	160	164	174	182	185
156	155	157	161	165	167	160	158	163	169	172

IM

STEP 4: Applying transferred values for each pixels

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	178	179	180	181	183	186

C_{norm} (Transfer function value)

Histogram Equalization

30	158	158	161	164	161	160	158	157	156	156
156	154	155	158	159	163	162	160	159	158	158
165	161	159	156	153	156	157	159	160	160	160
168	167	164	160	158	156	158	160	161	160	160
161	166	165	165	168	166	166	166	164	162	162
162	164	165	166	166	168	161	160	165	166	161
165	164	163	161	160	161	163	167	171	171	167
178	178	177	172	166	168	170	169	166	166	170
163	165	173	179	182	177	179	180	177	175	173
165	164	165	165	163	161	160	164	174	182	185
156	155	157	161	165	167	160	158	163	169	172

IM

STEP 4: Applying transferred values for each pixels

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	178	179	180	181	183	186

C_{norm} (Transfer function value)

Histogram Equalization

30	30	158	161	164	161	160	158	157	156	156
156	154	155	158	159	163	162	160	159	158	158
165	161	159	156	153	156	157	159	160	160	160
168	167	164	160	158	156	158	160	161	160	160
161	166	165	165	168	166	166	166	164	162	162
162	164	165	166	166	168	161	160	165	166	161
165	164	163	161	160	161	163	167	171	171	167
178	178	177	172	166	168	170	169	166	166	170
163	165	173	179	182	177	179	180	177	175	173
165	164	165	165	163	161	160	164	174	182	185
156	155	157	161	165	167	160	158	163	169	172

IM

STEP 4: Applying transferred values for each pixels

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	178	179	180	181	183	186

C_{norm} (Transfer function value)

Histogram Equalization

30	30	158	161	164	161	160	158	157	156	156
156	154	155	158	159	163	162	160	159	158	158
165	161	159	156	153	156	157	159	160	160	160
168	167	164	160	158	156	158	160	161	160	160
161	166	165	165	168	166	166	166	164	162	162
162	164	165	166	166	168	161	160	165	166	161
165	164	163	161	160	161	163	167	171	171	167
178	178	177	172	166	168	170	169	166	166	170
163	165	173	179	182	177	179	180	177	175	173
165	164	165	165	163	161	160	164	174	182	185
156	155	157	161	165	167	160	158	163	169	172

IM

STEP 4: Applying transferred values for each pixels

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	178	179	180	181	183	186

C_{norm} (Transfer function value)

Histogram Equalization

30	30	30	161	164	161	160	158	157	156	156
156	154	155	158	159	163	162	160	159	158	158
165	161	159	156	153	156	157	159	160	160	160
168	167	164	160	158	156	158	160	161	160	160
161	166	165	165	168	166	166	166	164	162	162
162	164	165	166	166	168	161	160	165	166	161
165	164	163	161	160	161	163	167	171	171	167
178	178	177	172	166	168	170	169	166	166	170
163	165	173	179	182	177	179	180	177	175	173
165	164	165	165	163	161	160	164	174	182	185
156	155	157	161	165	167	160	158	163	169	172

IM

STEP 4: Applying transferred values for each pixels

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	178	179	180	181	183	186

C_{norm} (Transfer function value)

Histogram Equalization

30	30	30	161	164	161	160	158	157	156	156
156	154	155	158	159	163	162	160	159	158	158
165	161	159	156	153	156	157	159	160	160	160
168	167	164	160	158	156	158	160	161	160	160
161	166	165	165	168	166	166	166	164	162	162
162	164	165	166	166	168	161	160	165	166	161
165	164	163	161	160	161	163	167	171	171	167
178	178	177	172	166	168	170	169	166	166	170
163	165	173	179	182	177	179	180	177	175	173
165	164	165	165	163	161	160	164	174	182	185
156	155	157	161	165	167	160	158	163	169	172

IM

STEP 4: Applying transferred values for each pixels

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	178	179	180	181	183	186

C_{norm} (Transfer function value)

Histogram Equalization

30	30	30	86	164	161	160	158	157	156	156
156	154	155	158	159	163	162	160	159	158	158
165	161	159	156	153	156	157	159	160	160	160
168	167	164	160	158	156	158	160	161	160	160
161	166	165	165	168	166	166	166	164	162	162
162	164	165	166	166	168	161	160	165	166	161
165	164	163	161	160	161	163	167	171	171	167
178	178	177	172	166	168	170	169	166	166	170
163	165	173	179	182	177	179	180	177	175	173
165	164	165	165	163	161	160	164	174	182	185
156	155	157	161	165	167	160	158	163	169	172

IM

STEP 4: Applying transferred values for each pixels

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	178	179	180	181	183	186

C_{norm} (Transfer function value)

Histogram Equalization

30	30	30	86	164	161	160	158	157	156	156
156	154	155	158	159	163	162	160	159	158	158
165	161	159	156	153	156	157	159	160	160	160
168	167	164	160	158	156	158	160	161	160	160
161	166	165	165	168	166	166	166	164	162	162
162	164	165	166	166	168	161	160	165	166	161
165	164	163	161	160	161	163	167	171	171	167
178	178	177	172	166	168	170	169	166	166	170
163	165	173	179	182	177	179	180	177	175	173
165	164	165	165	163	161	160	164	174	182	185
156	155	157	161	165	167	160	158	163	169	172

IM

STEP 4: Applying transferred values for each pixels

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	178	179	180	181	183	186

C_{norm} (Transfer function value)

Histogram Equalization

30	30	30	86	131	86	59	30	23	8	8
8	2	4	30	51	118	110	59	51	30	30
145	86	51	8	153	156	157	159	160	160	160
168	167	164	160	158	156	158	160	161	160	160
161	166	165	165	168	166	166	166	164	162	162
162	164	165	166	166	168	161	160	165	166	161
165	164	163	161	160	161	163	167	171	171	167
178	178	177	172	166	168	170	169	166	166	170
163	165	173	179	182	177	179	180	177	175	173
165	164	165	165	163	161	160	164	174	182	185
156	155	157	161	165	167	160	158	163	169	172

IM

STEP 4: Applying transferred values for each pixels

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	178	179	180	181	183	186

C_{norm} (Transfer function value)

Histogram Equalization

30	30	30	86	131	86	59	30	23	8	8
8	2	4	30	51	118	110	59	51	30	30
145	86	51	8	153	156	157	159	160	160	160
168	167	164	160	158	156	158	160	161	160	160
161	166	165	165	168	166	166	166	164	162	162
162	164	165	166	166	168	161	160	165	166	161
165	164	163	161	160	161	163	167	171	171	167
178	178	177	172	166	168	170	169	166	166	170
163	165	173	179	182	177	179	180	177	175	173
165	164	165	165	163	161	160	164	174	182	185
156	155	157	161	165	167	160	158	163	169	172

IM

STEP 4: Applying transferred values for each pixels

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	178	179	180	181	183	186

C_{norm} (Transfer function value)

Histogram Equalization

30	30	30	86	131	86	59	30	23	8	8
8	2	4	30	51	118	110	59	51	30	30
145	86	51	8	0	156	157	159	160	160	160
168	167	164	160	158	156	158	160	161	160	160
161	166	165	165	168	166	166	166	164	162	162
162	164	165	166	166	168	161	160	165	166	161
165	164	163	161	160	161	163	167	171	171	167
178	178	177	172	166	168	170	169	166	166	170
163	165	173	179	182	177	179	180	177	175	173
165	164	165	165	163	161	160	164	174	182	185
156	155	157	161	165	167	160	158	163	169	172

IM

STEP 4: Applying transferred values for each pixels

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	178	179	180	181	183	186

C_{norm} (Transfer function value)

Histogram Equalization

30	30	30	86	131	86	59	30	23	8	8
8	2	4	30	51	118	110	59	51	30	30
145	86	51	8	0	8	23	51	59	59	59
198	190	131	59	30	8	30	59	86	59	59
86	169	145	145	198	169	169	169	131	110	110
110	131	145	169	169	198	86	59	145	169	86
145	131	118	86	59	86	118	190	215	215	190
238	238	232	219	169	198	211	207	169	169	211
118	145	223	242	249	232	242	247	232	230	223
145	131	145	145	118	86	59	131	228	249	253
8	4	23	86	145	190	59	30	118	207	219

IM

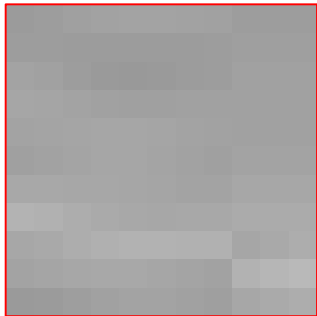
STEP 4: Applying transferred values for each pixels

2	4	8	23	30	51	59	86	110	118	131	145	169	190	198	207	211	215	219	223	228	230	232	238	242	247	249	253	255
154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	178	179	180	181	183	186

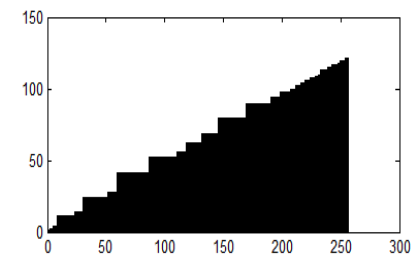
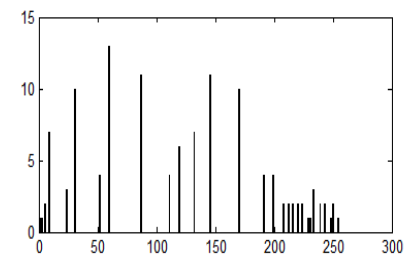
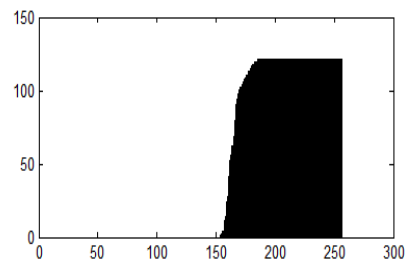
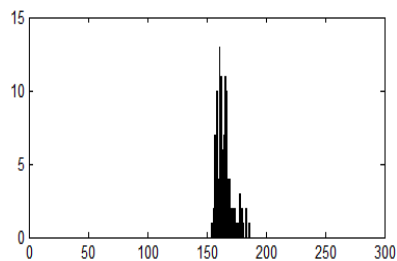
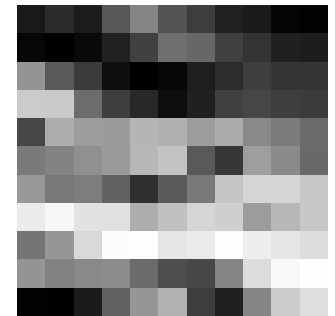
C_{norm} (Transfer function value)

Histogram Equalization

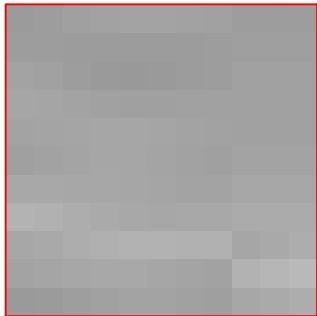
30	30	30	86	131	86	59	30	23	8	8
8	2	4	30	51	118	110	59	51	30	30
145	86	51	8	0	8	23	51	59	59	59
198	190	131	59	30	8	30	59	86	59	59
86	169	145	145	198	169	169	169	131	110	110
110	131	145	169	169	198	86	59	145	169	86
145	131	118	86	59	86	118	190	215	215	190
238	238	232	219	169	198	211	207	169	169	211
118	145	223	242	249	232	242	247	232	230	223
145	131	145	145	118	86	59	131	228	249	253
8	4	23	86	145	190	59	30	118	207	219



Histogram equalization



Histogram Equalization



Histogram equalization

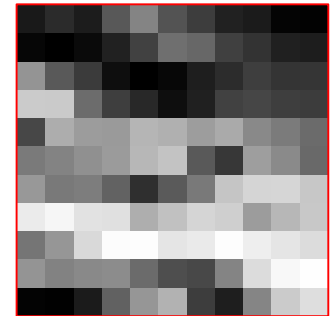


Image distance measurement

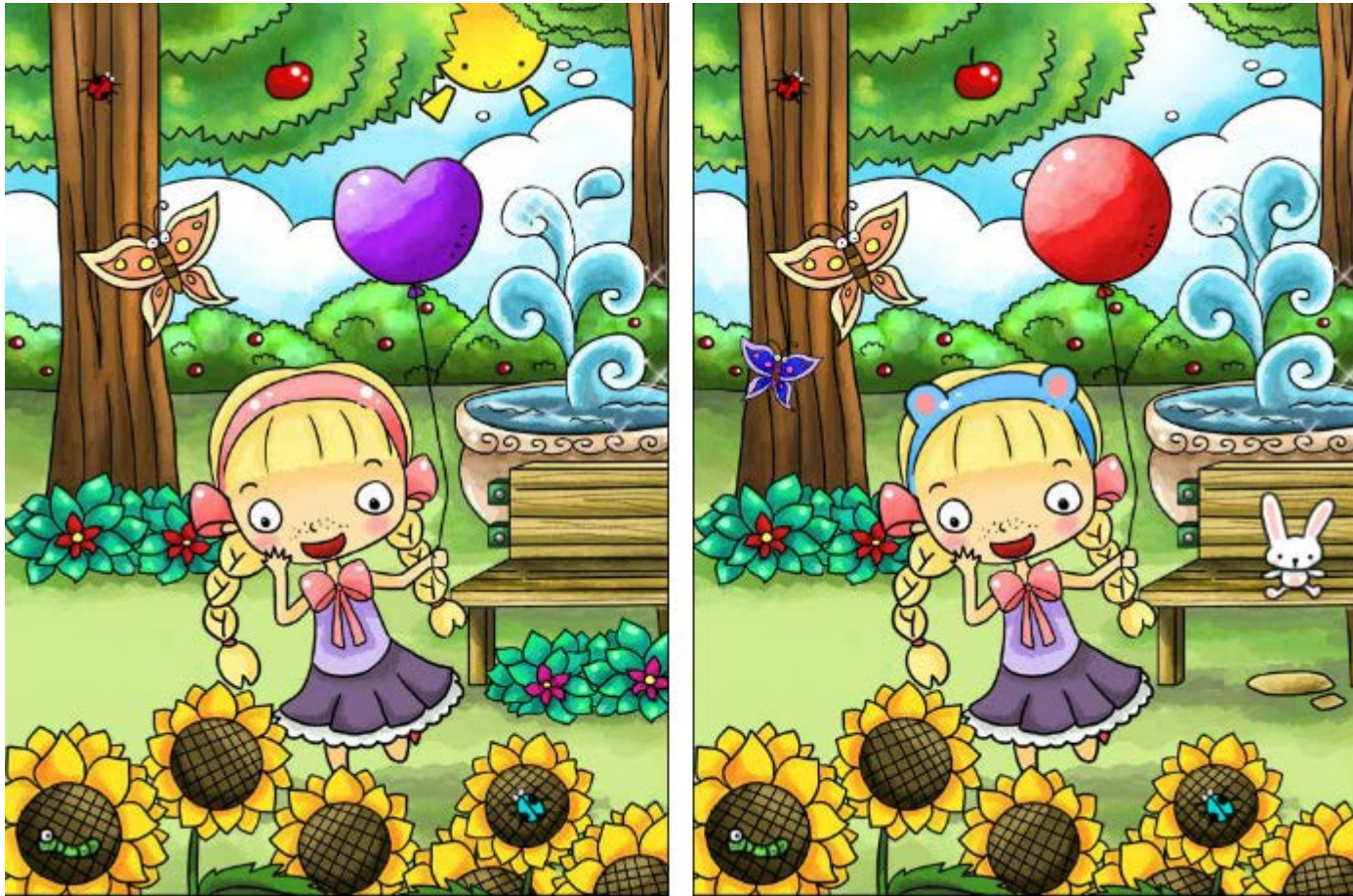
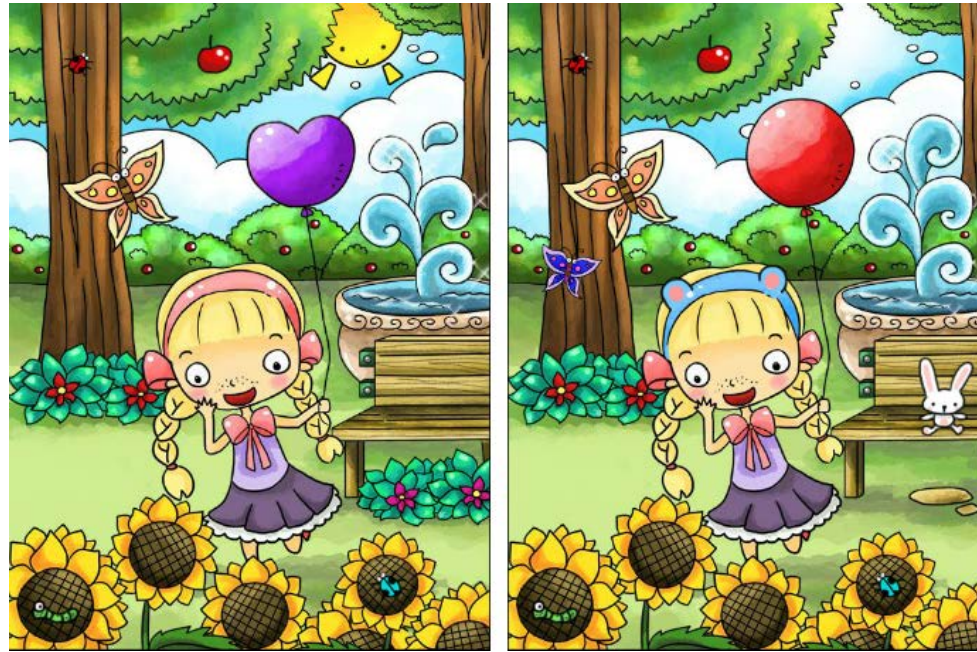


Image Difference

Absolute Image Difference



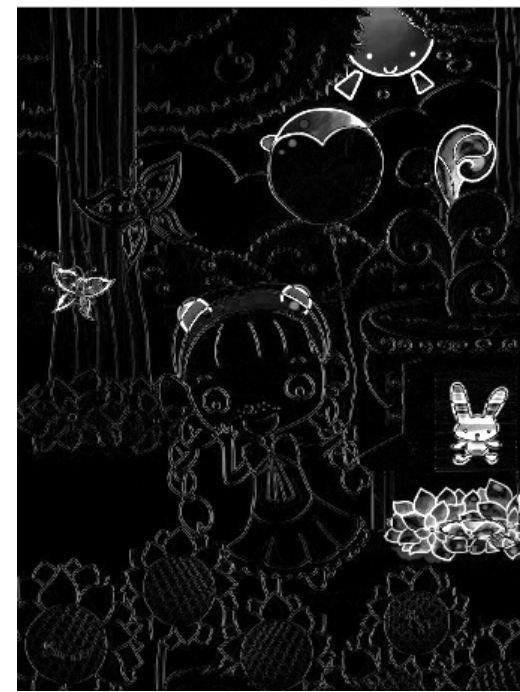
$$I_{diff} = |I_1 - I_2|$$

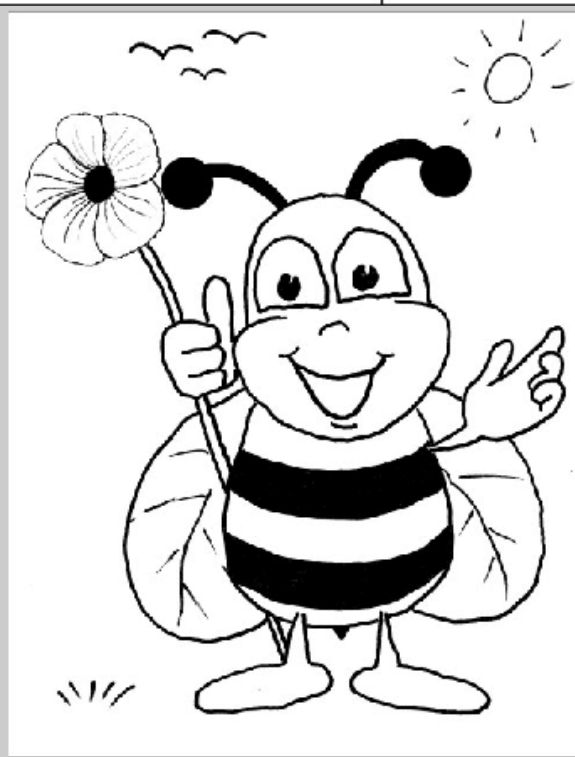
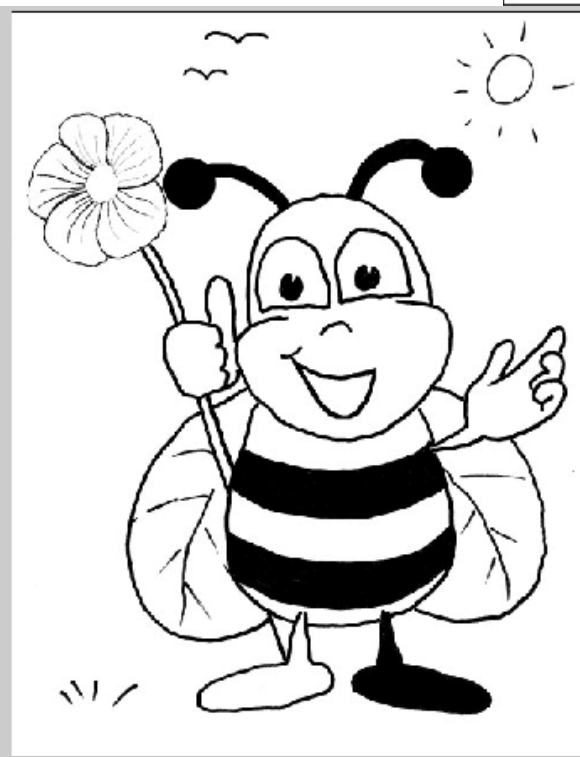
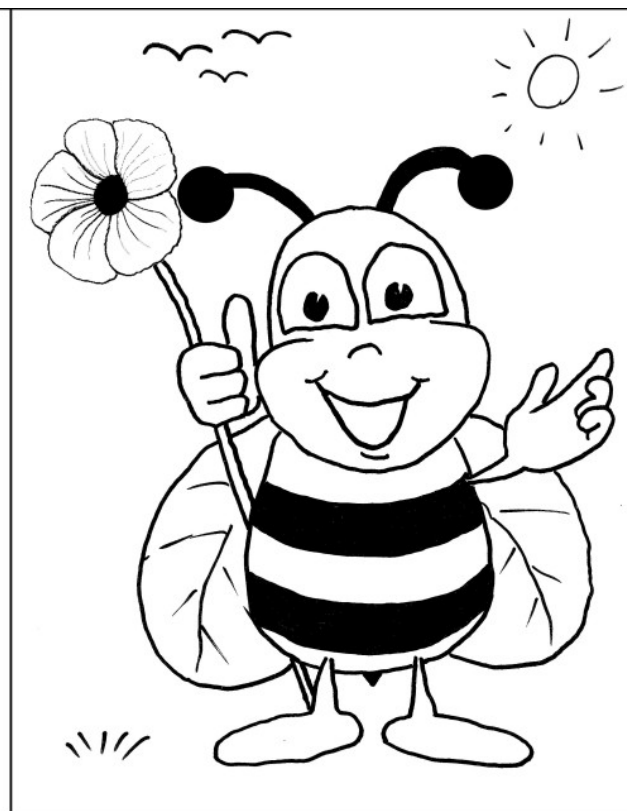
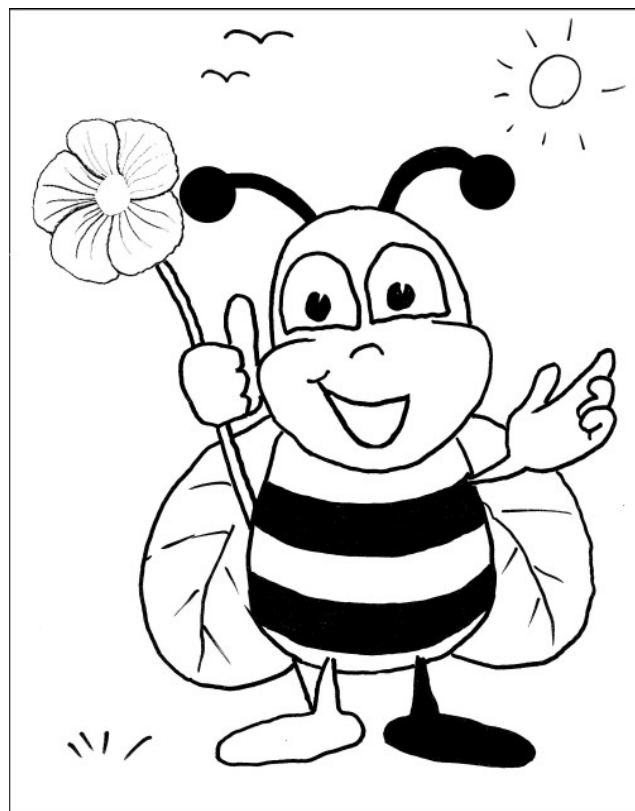


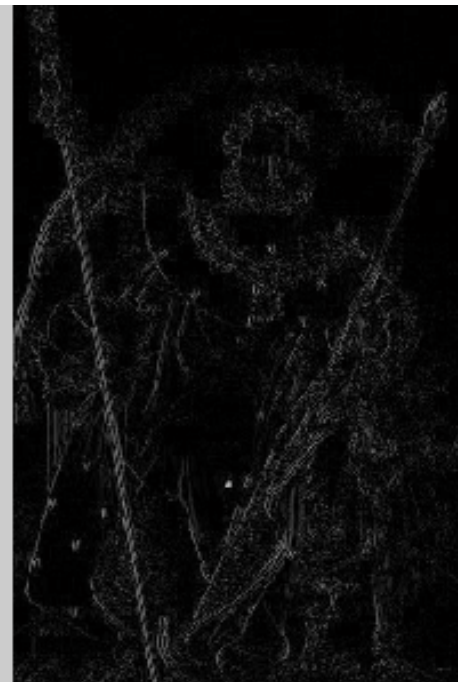
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Question !

207	24	40	36	167
230	71	247	107	9
32	139	244	233	216
232	244	123	202	238
161	246	204	244	173

I_1

207	24	40	36	167
230	71	247	107	9
32	0	152	233	216
232	244	123	202	238
161	75	204	244	74

I_2

Image I_1 and I_2 are represented in Uint8.

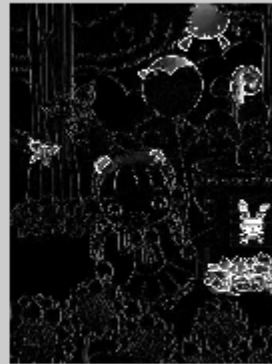
Please determine the differences between two images?

Sol. $I_{diff} = |I_1 - I_2|$

0	0	0	0	0
0	0	0	0	0
0	139	92	0	0
0	0	0	0	0
0	171	0	0	99

Sum of Absolute Difference (SAD)

$$I_{diff} = \sum_X \sum_Y |I_1(x, y) - I_2(x, y)|$$



SAD=1576954



SAD=0

Image distance measurement on difference size Image

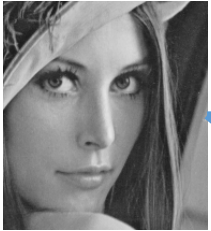
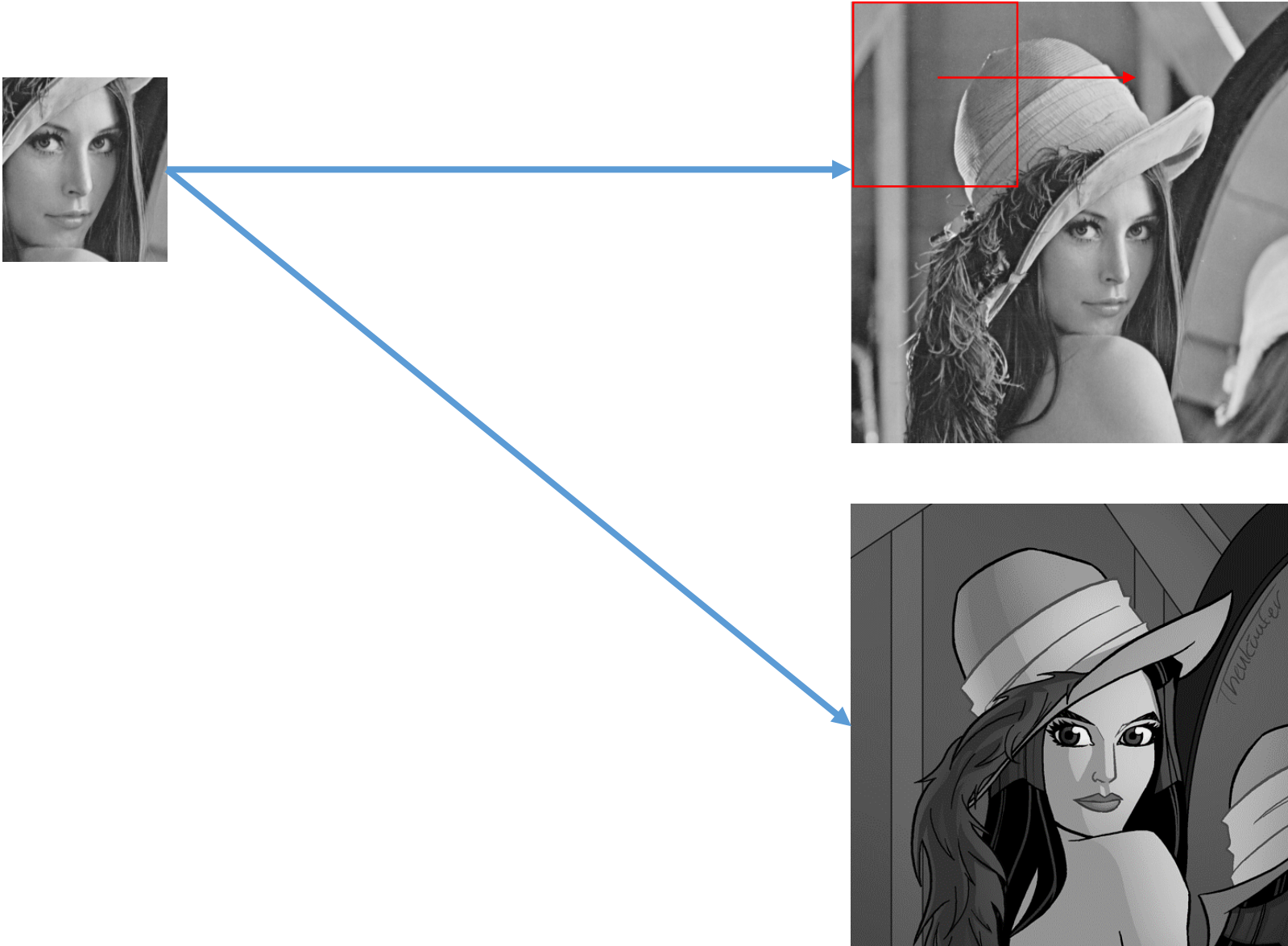
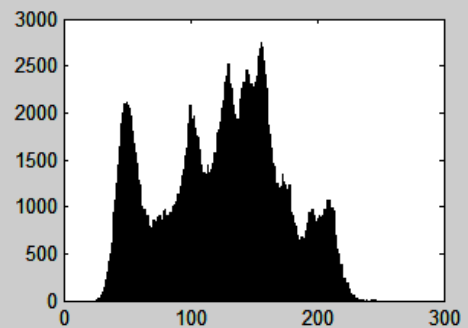
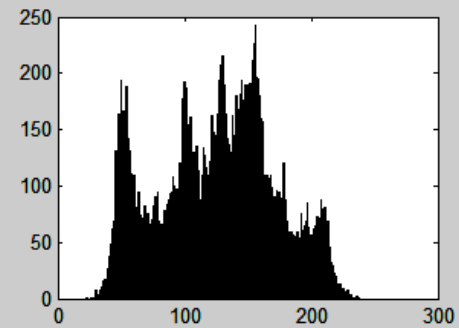
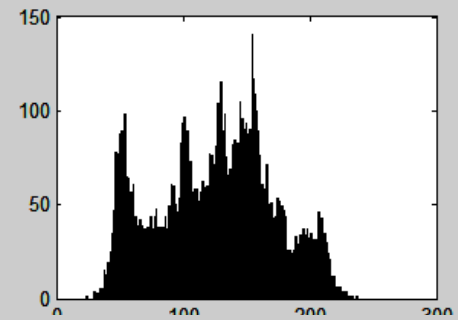
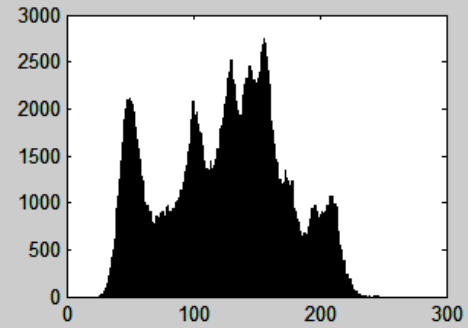


Image distance measurement on difference size Image

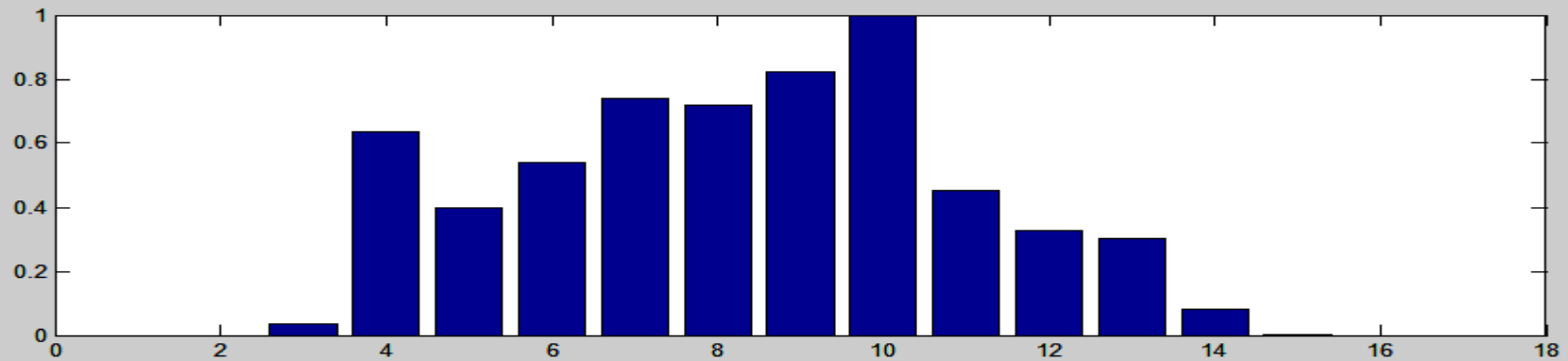
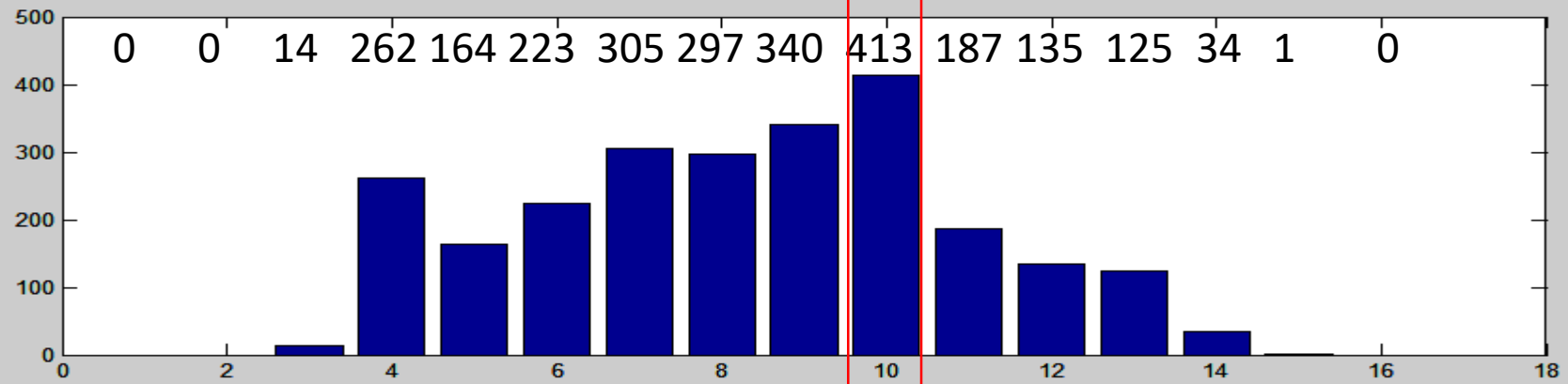


Histogram Matching

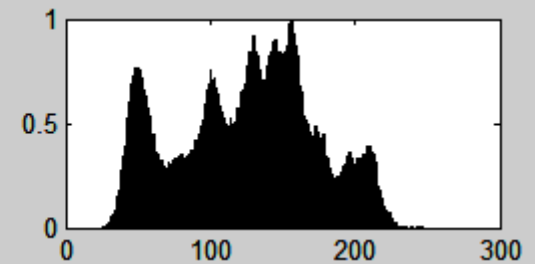
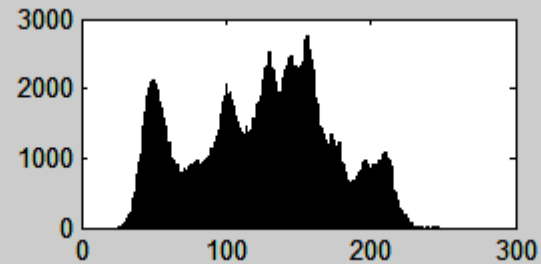
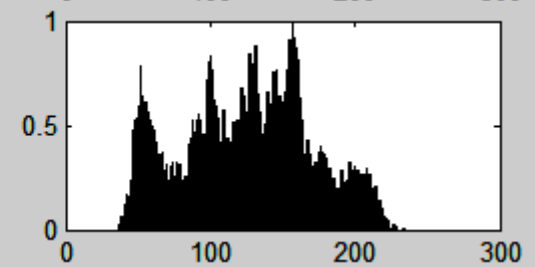
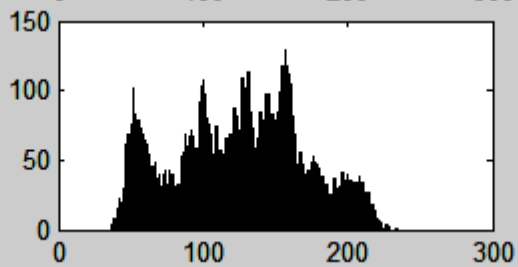
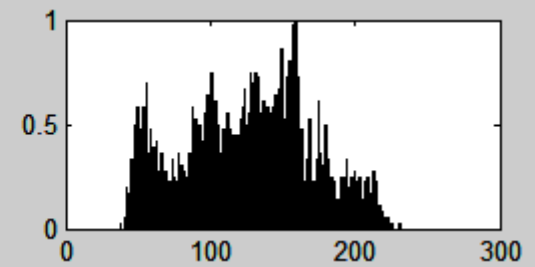
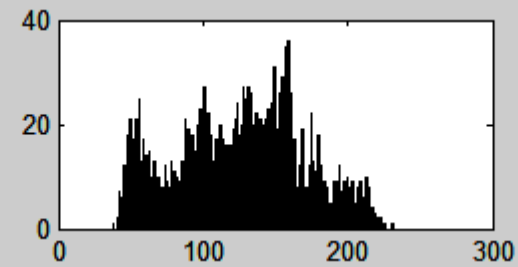
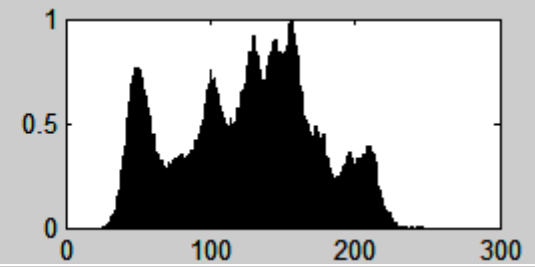
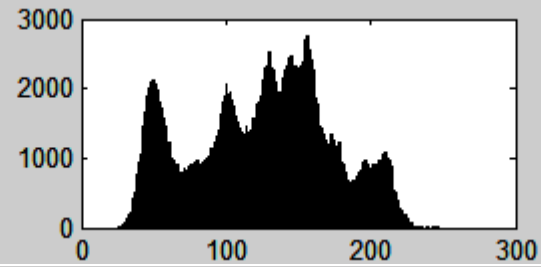


Scale Normalization

$$M_{normalized} = \frac{M}{Max(M)}$$

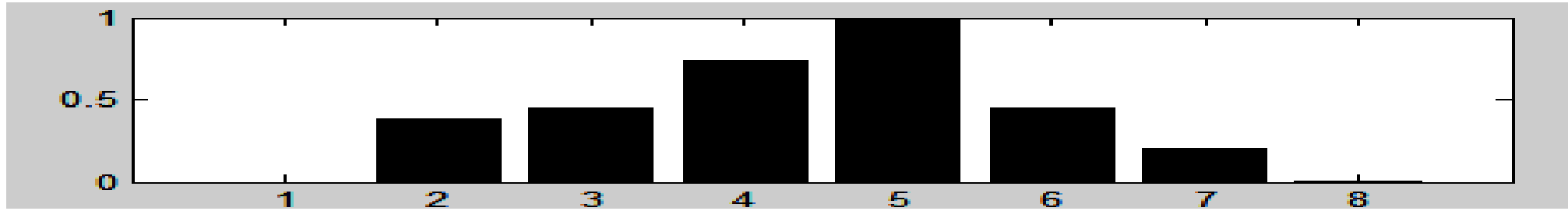


Scale Normalization



Histogram Matching

$$d = \sum |M_1 - M_2|$$



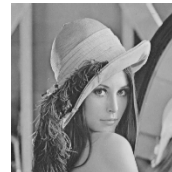
$M_1 =$ 0 0.3845 0.4566 0.7394 1.0000 0.4480 0.2035 0.0001



$M_2 =$ 0.0278 0.0075 0.0166 0.0490 0.2443 0.0426 0.0968 1.0000

$|M_1 - M_2| =$ 0.0278 0.3770 0.4400 0.6904 0.7557 0.4054 0.1067 0.9999

$d = 3.8029$



Question !

Given histogram $M=[4,4,8,8,2,5,4,6,7, 8]$, which histogram is closest to M ?

A) $[8, 9, 1, 9, 6, 1, 3, 5, 10, 10]$

B) $[2, 10, 10, 5, 8, 1, 4, 9, 8, 10]$

C) $[7, 0, 8, 9, 7, 8, 7, 4, 7, 2]$

Sol.

$$|M-A|=4, 5, 7, 1, 4, 4, 1, 1, 3, 2=32$$

$$|M-B|=2, 6, 2, 3, 6, 4, 0, 3, 1, 2=29$$

$$|M-C|=3, 4, 0, 1, 5, 3, 3, 2, 0, 6=27$$

The Answer is C

Matlab image processing function

Histogram:

```
[F I]=hist(M,bins);
```

Image Histogram:

```
[F I]=imhist(im,bins);
```

Image Histogram Equalization:

```
im2=histeq(im,bins);
```

Bar chart:

```
bar(F);
```

Image absolute difference:

```
im3=imabsdiff(im1,im2);
```

Find maximum value:

```
[v i]=max(M)
```

Distance Measurement Methods

<https://en.wikipedia.org/wiki/Distance>

