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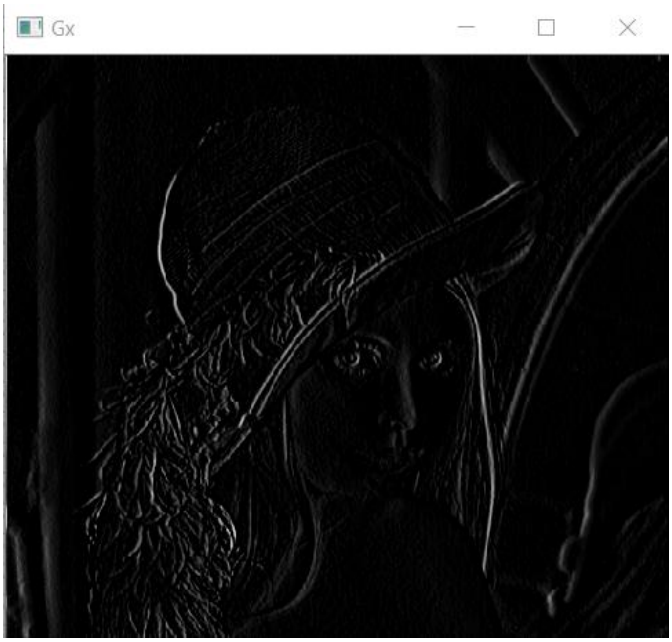
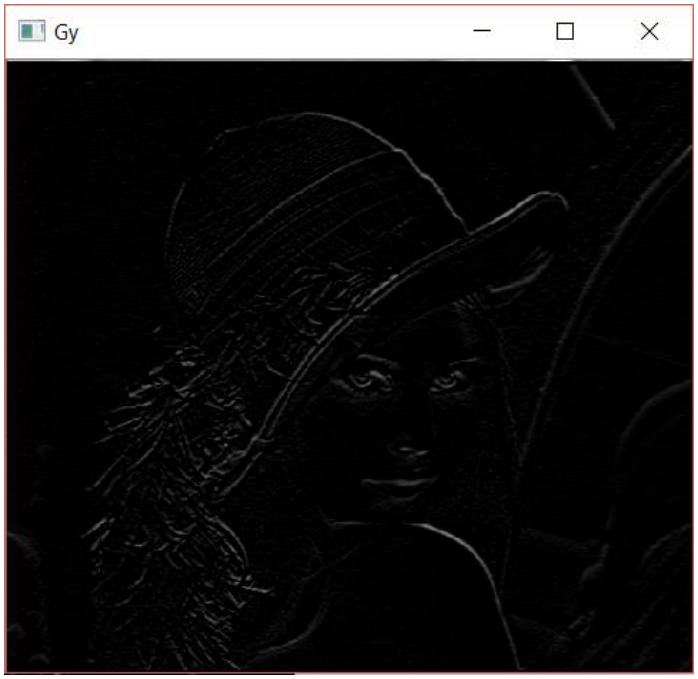
Problem (1) (1D and 2D Convolution on Images):

a) Perform 2D convolution on grayscale Image lena_gray.png **with filters specified above to obtain gradient images G_x and G_y. Include the three images G_x, G_y and G in your report.**

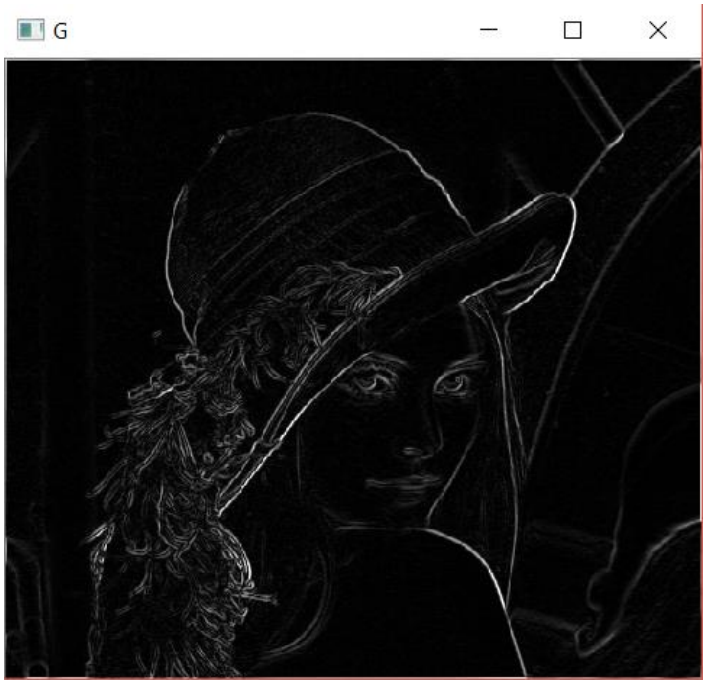
Gx:



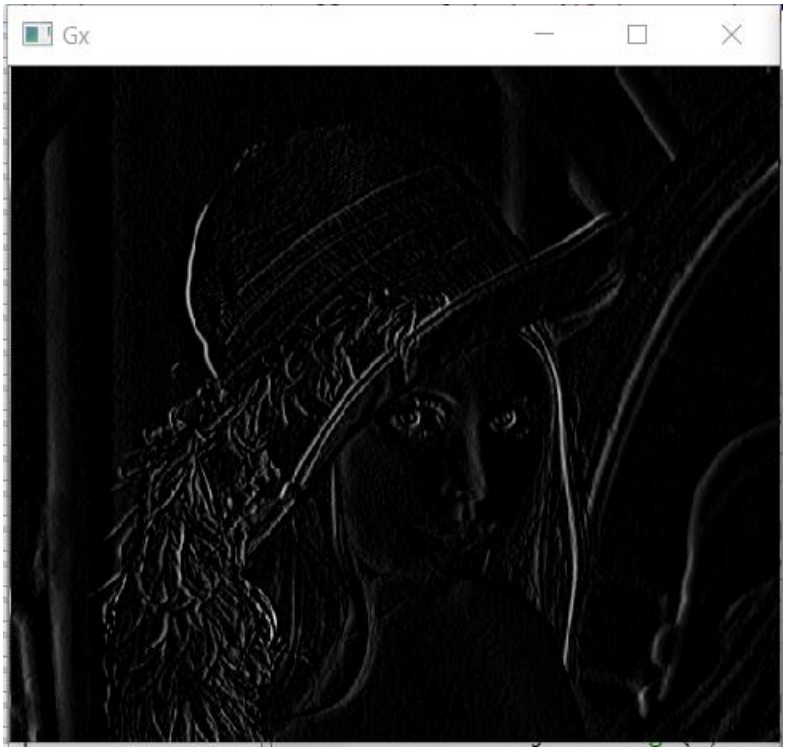
Gy:

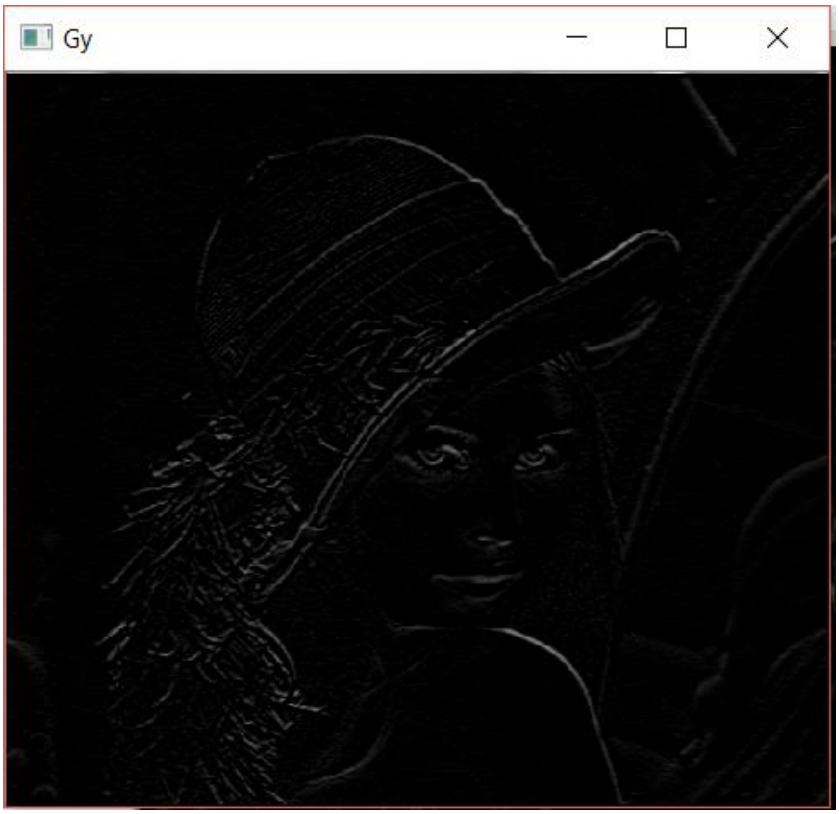


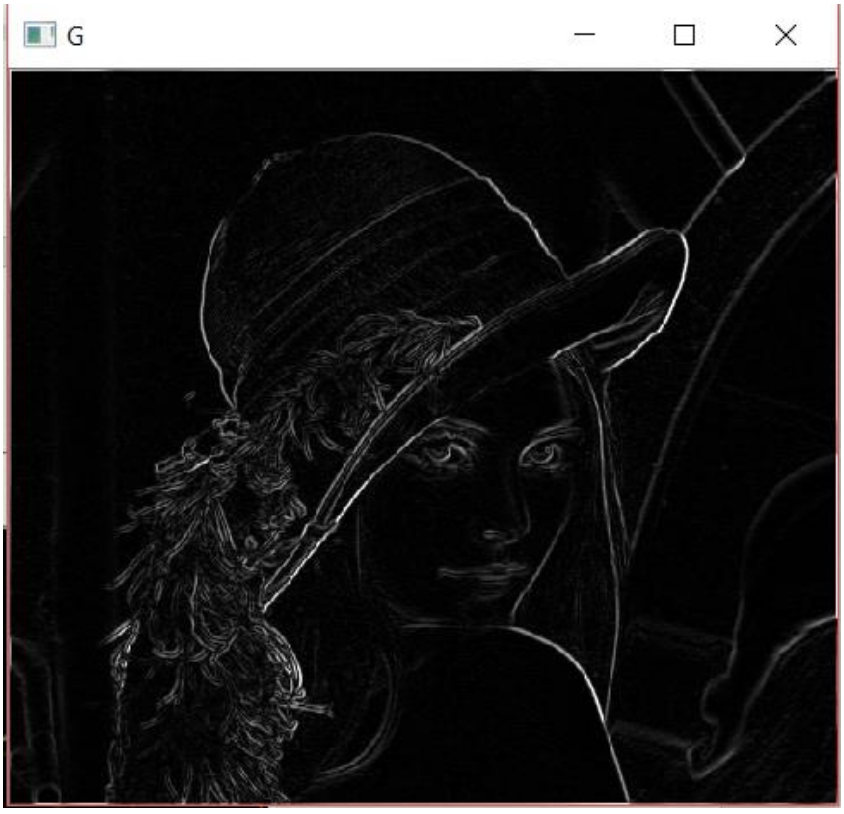
G:



b)Perform 1D convolution on grayscale Image lena_gray.png **with 1D-filters specified above to obtain gradient images G_x and G_y. Include these two images in your report. Verify the result after 1D convolution is same as the one obtained from 2D convolution from (a)**

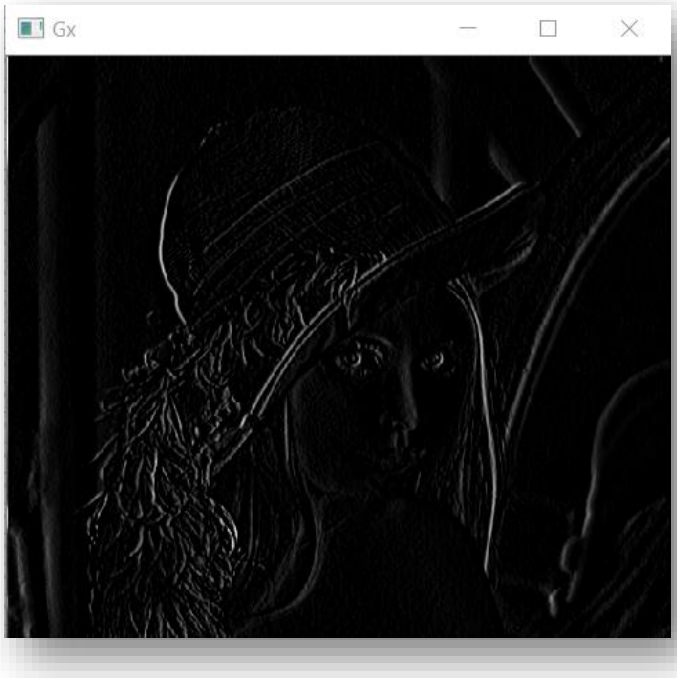



Gy

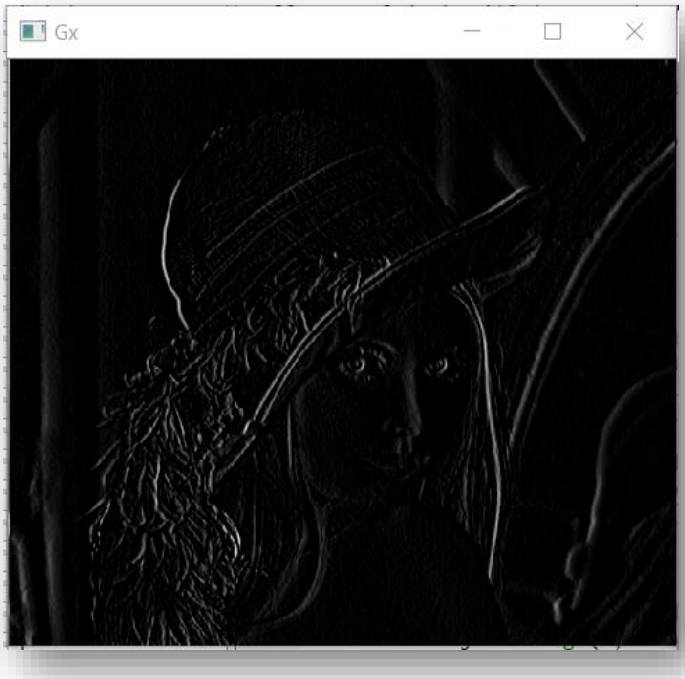

G

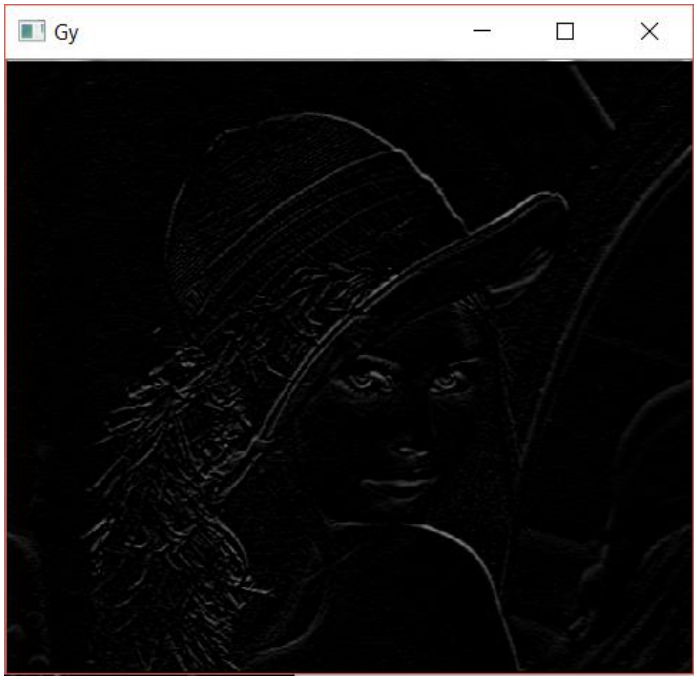
Comparing both the convolutions:

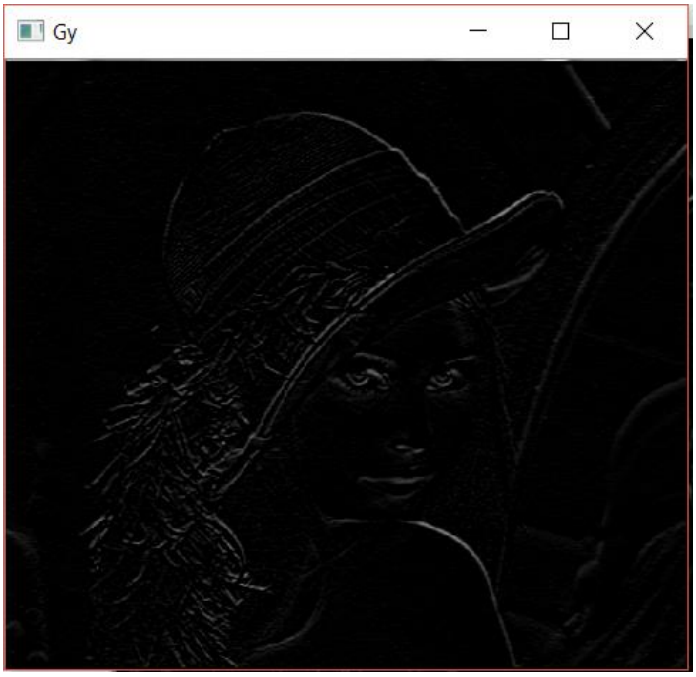
2D convolution

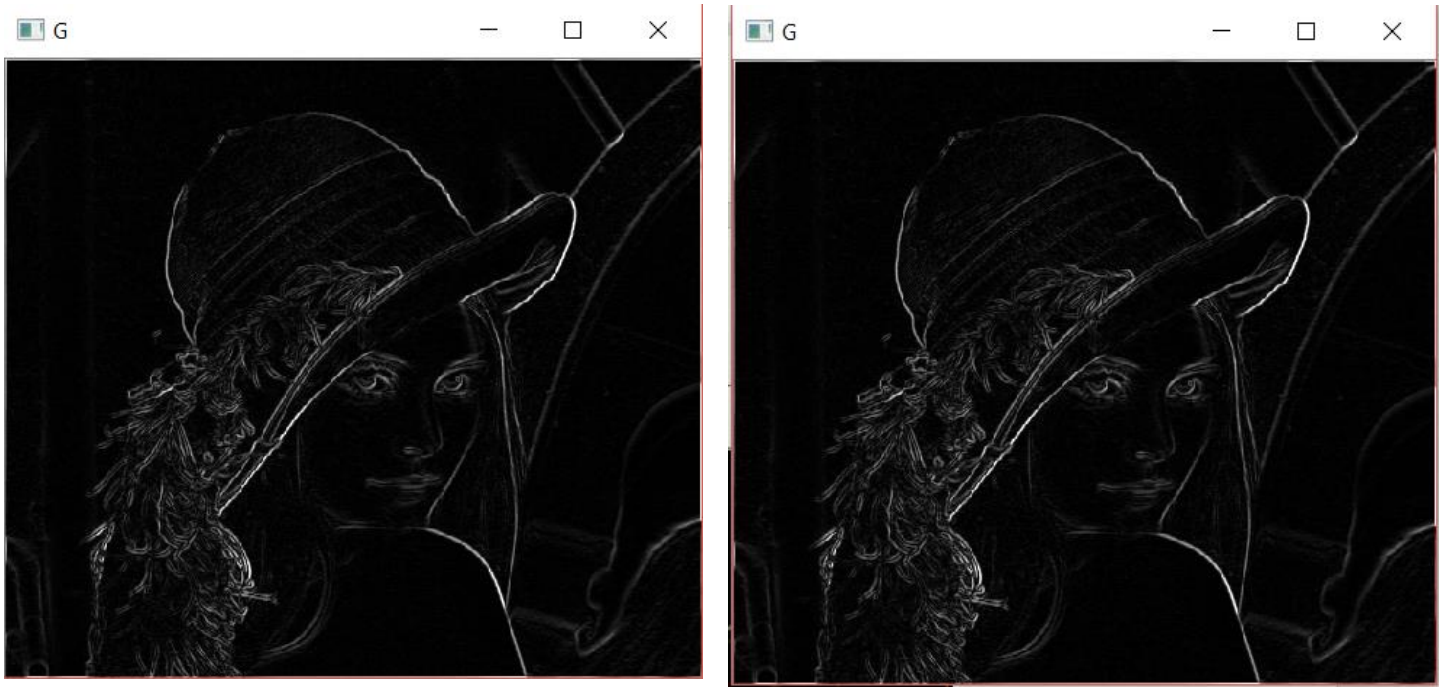


One D convolution









(c) Given an MxN Image and a PxQ filter, compute and report the computational complexity of performing 2D convolution vs using separable filters with 1D convolution.

Soln : For an MxN image and a PxQ filter the compute and report the computational complexity of performing :

2D convolution --- O(MNPQ)

1D convolution---O(MN(P+Q))

Derivation:

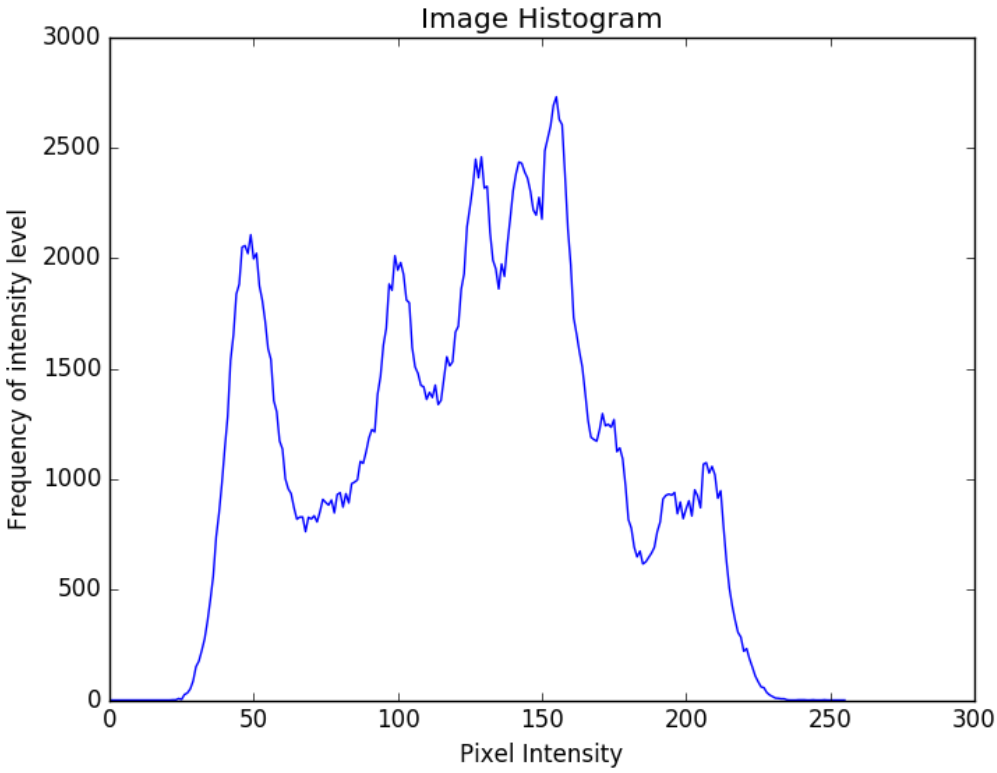
For 2D convolution, we have to iterate over M rows and N columns of the image matrix, while doing so, we have to iterate and compute computation over P rows and Q columns of Kernel matrix. Thus the complexity O(MNPQ)

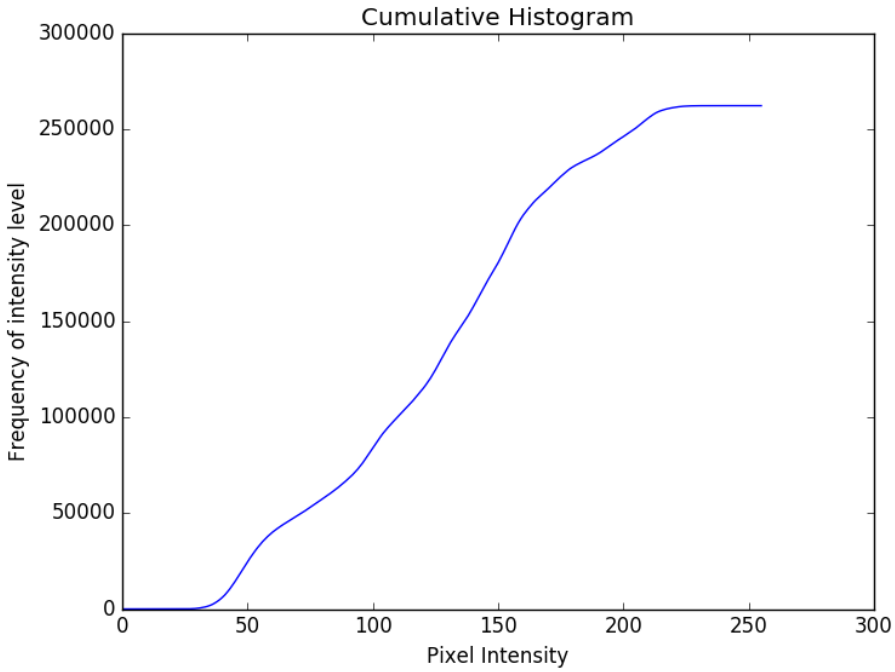
For 1D convolution, we have to iterate over M rows and N columns of the image matrix, while doing so, we have to iterate and compute computation over P elements of one part of Kernel, thereafter over Q elements of other part of Kernel matrix. Thus the complexity O(MN(P+Q)).

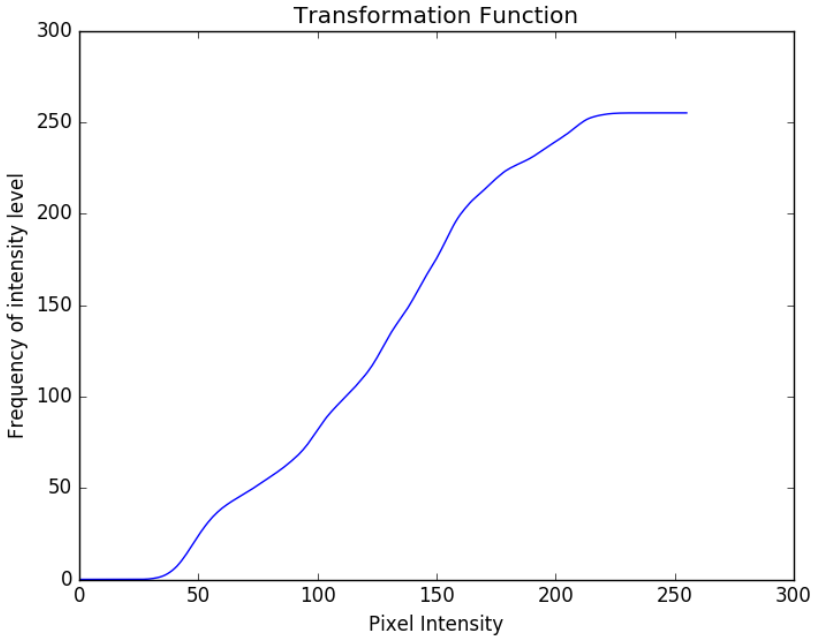
Complexity is reduced because we are getting rid of the row with all zeros in 2D kernel matrix thus reduce in computation from P*Q to P+Q.

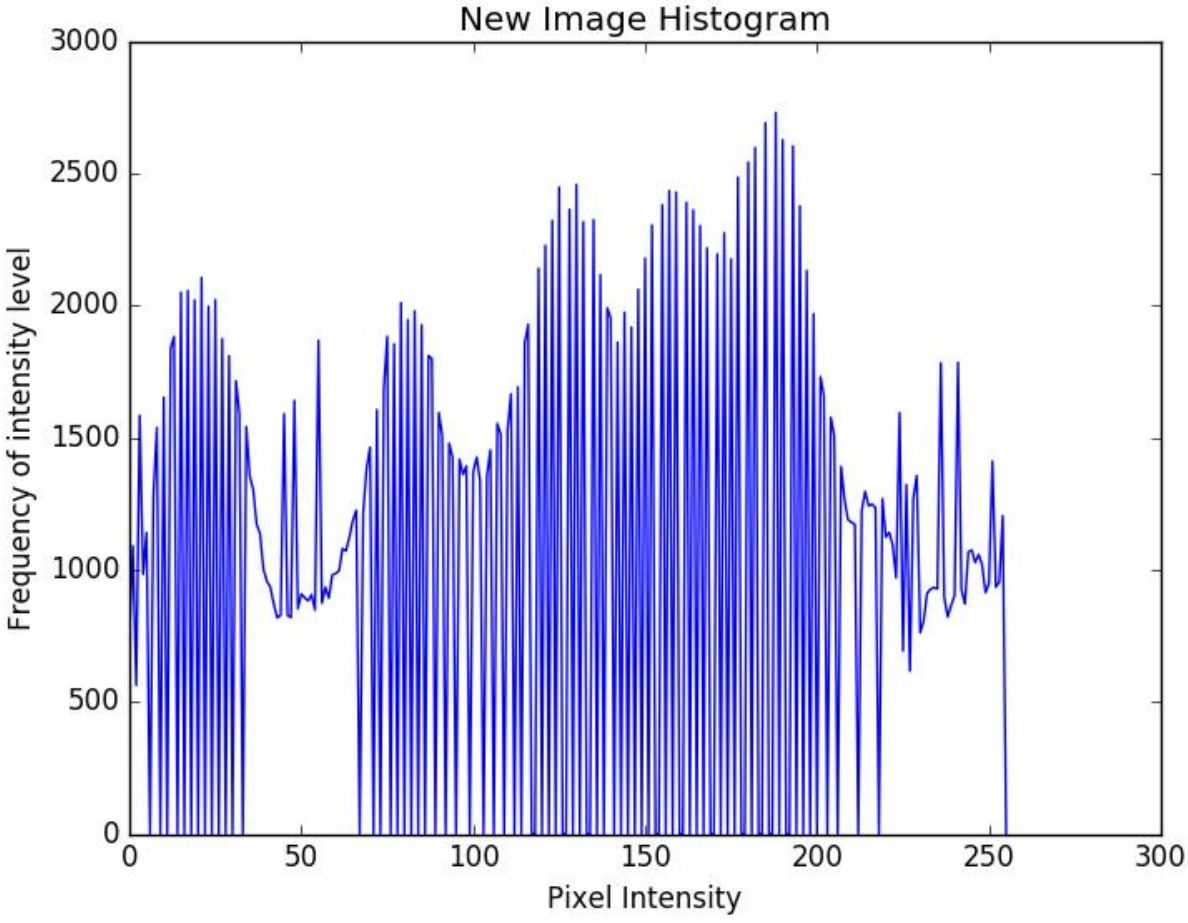
Problem 2:

Histogram Equalization:






Transformation Function
Frequency of intensity level
Pixel Intensity
0
50
100
150
200
250
300


New Image Histogram
Frequency of intensity level
Pixel Intensity
0
500
1000
1500
2000
2500
3000
0
50
100
150
200
250
300

Comparison of original image on the left versus enhanced image on the right.