

# Homework 3

## Problem 1

a.

Decision levels: [0,0.7625) [0.7625,1.38833) [1.38833,2.08333)  
[2.08333,3)

Reconstruction levels:  $r_0=0.525$ ,  $r_1=1$ ,  $r_2=1.77667$ ,  $r_3=2.39$

b.

Quantized data: [0,0,0,0,1,1,1,1,1,1,1,1,1,1,2,2,2,2,2,2,3,3,3,3,3,3,3]

Dequantized data:

[0.525,0.525,0.525,0.525,1,1,1,1,1,1,1,1,1,1,1.77667,1.77667,1.77667,1.77667,1.77667,1.77667,2.39,2.39,2.39,2.39,2.39,2.39,2.39]

MSE = 0.0357272

c.

Decision levels: [0,1) [1,2) [2,3)

Quantized data: [0,0,0,0,0,0,0,1,1,1,1,1,1,1,1,1,1,1,2,2,2,2,2,2,2]

Dequantized data:

[0.5,0.5,0.5,0.5,0.5,0.5,0.5,1.5,1.5,1.5,1.5,1.5,1.5,1.5,1.5,1.5,1.5,1.5,2.5,2.5,2.5,2.5,2.5,2.5,2.5]

MSE = 0.104115

d.

Decision levels: [0,0.75) [0.75,1.5) [1.5,2.25) [2.25,3)

Reconstruction level:  $r_0 = 0.525$ ,  $r_1 = 1$ ,  $r_2 = 1.8825$ ,  $r_3 = 2.466$

Quantized data: [0,0,0,0,1,1,1,1,1,1,1,1,1,1,2,2,2,2,2,2,2,2,3,3,3,3,3]

Dequantized data:

[0.525,0.525,0.525,0.525,1,1,1,1,1,1,1,1,1,1,1.8825,1.8825,1.8825,1.8825,1.8825,1.8825,1.8825,1.8825,2.466,2.466,2.466,2.466,2.466]

MSE = 0.0419396

e.

MSE(optimal quantizer) < MSE(semi-uniform quantize) < MSE(uniform quantizer)

## Problem 2

a.

The entropy of the river image is 6.617739618282519

b.

Entropy(G') = 2.378872043027084

SNR = 19.419938240233314

The image is shown: [[problem2b.jpg](#)]

c.

Entropy(G') = 2.378872043027084

SNR = 19.510872974668423

The image is shown: [[problem2c.jpg](#)]

d.

Entropy(G') = 2.405483178698946

SNR = 19.566819125946930

The image is shown: [[problem2d.jpg](#)]

e.

Entropy(b) = Entropy(c) < entropy(d)

The image in (b) is similar to the image in (c) except the contrast of (b) is a little higher than that of (c)

The image in (d) is closer to the original image comparing to (b) and (c)

### Problem 3

b.

Entropy1 = 4.693651018117509,

Entropy2 = 4.950794159503234,

Entropy3 = 5.117367195732673,

Entropy4 = 5.092177858646918,

Entropy5 = 5.063869582877490

The group 1 has the lowest entropy

The residual image: [\[problem3b.jpg\]](#)

c.

Entropy(e) = 2.072230056288189;

d.

The image is shown: [\[problem3d.jpg\]](#)

SNR = -4.093905948756089

e.

The image is not recognizable because the quantize level is too small, causing too much information lost.

If we increase the quantizing levels, the quality may be better.

## Problem 4

a.

bitrate: 9/64, compress ratio = 64/9

b.

The image is shown: [[problem4b.jpg](#)]

SNR = 14.157160402680258

c.

The image is shown: [[problem4c.jpg](#)]

SNR = 15.272749740066140

d.

The image is shown: [[problem4d.jpg](#)]

SNR = 15.748858685131538

e.

The image is shown: [[problem4e.jpg](#)]

SNR = 14.925232783485583

f.

bitrates(b) > bitrates(c) > bitrates(d) > bitrates(e)

SNR(d) > SNR(c) > SNR(e) > SNR(a)

Sharpness(b) > Sharpness(c) > Sharpness(d) > Sharpness(e)