

**Source Coding Homework #1 (H.-M. Hang, Sept. 2011)**

[25%] (1) Entropy: Given an alphabet  $A=\{a,b,c,d\}$ , find the first-order entropy of the following cases: ((Sayood, pbm2, p.38))

[8%] (1.a)  $P(a)=P(b)=P(c)=P(d)=0.25$ .

[8%] (1.b)  $P(a)=0.5, P(b)=0.25, P(c)=0.125, P(d)=0.125$ .

[9%] (1.c)  $P(a)=0.505, P(b)=0.25, P(c)=0.125, P(d)=0.12$ .

[25%] (2) Code: Determine whether the following codes are uniquely decodable: ((Sayood, pbm7, p.39))

[6%] (2.a)  $\{0, 01, 11, 111\}$

[6%] (2.b)  $\{0, 01, 110, 111\}$

[6%] (2.c)  $\{0, 10, 110, 111\}$

[7%] (2.d)  $\{1, 10, 110, 111\}$

[50%] (3) Quantizer: We like to examine the rate-distortion performance of various quantizers. You may need to use computer programs to do the calculation and to generate the plots. ((Sayood, pbm9, p.271))

[10%] (3.a) Plot the rate-distortion function  $R(D)$  for a Gaussian source with zero mean and variance  $\sigma^2=2$ .

[20%] (3.b) What is the 2-level, 4-level, and 8-level pdf-optimized non-uniform quantizers for this Gaussian source in (3.a)? Specify the decision boundaries and representation levels. Assuming fixed length codewords (that is, 3 bits for 8-levels), plot their (rate, distortion) pairs on the same plot of (3.a) using symbol "x". ((Hint: Use the table on p.256 of Sayood, or on p.32 of Notes.))

[20%] (3.c) For the 4-level and 8-level quantizers, compute their entropies and plot their (entropy, distortion) pairs on the same plot of (3.a) using symbol "o".

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**DUE (in class): October 13, 2011**