

CSc 461/561: Multimedia Systems (Spring 2006)

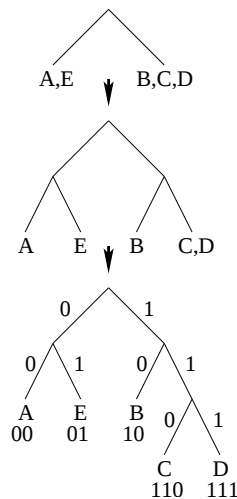
Solution for Assignment 2

To be discussed in class on February 15, 2006

1. An information source has 5 symbols with the following probability of appearance

Symbol	A	B	C	D	E
Probability to appear in input	0.35	0.17	0.17	0.16	0.15

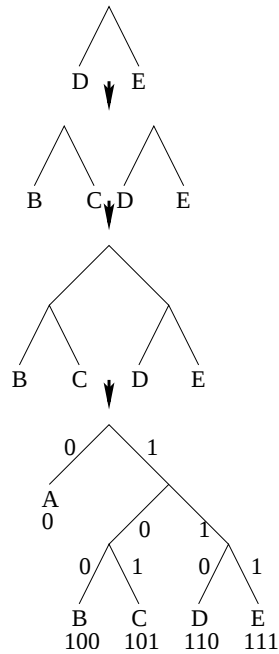
- (a) What is the entropy of this information source?
 $-0.35 \log_2 0.35 - 0.17 \log_2 0.17 - 0.17 \log_2 0.17 - 0.16 \log_2 0.16 - 0.15 \log_2 0.15$
- (b) If Shannon-Fano entropy encoding is applied, please write down the process of building the coding tree and assigning the code word.



Please also write down the average code word length per symbol of this information source with Shannon-Fano encoding.

$$2 * 0.35 + 2 * 0.17 + 3 * 0.17 + 3 * 0.16 + 2 * 0.15 = 2.33$$

- (c) If Huffman entropy coding is applied, please write down the process of building the coding tree and assigning the code word.



Please also write down the average code word length per symbol of this information source with Huffman encoding.

$$1 * 0.35 + 3 * .17 + 3 * 0.17 + 3 * 0.16 + 3 * 0.15 = 2.30$$

2. Given an initial dictionary

Symbol	A	B	C	D	E
Code in the dictionary	1	2	3	4	5

Please write down the output process of the input ABCDEABCDE with LZW compression.

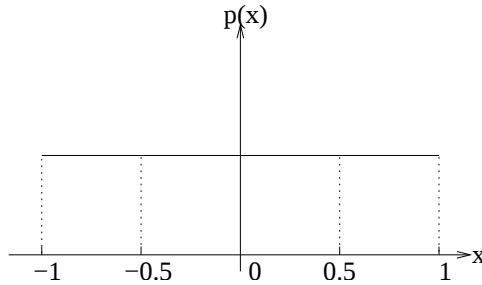
s	c	output	code	string
			1	A
			2	B
			3	C
			4	D
			5	E
A	B	1	6	AB
B	C	2	7	BC
C	D	3	8	CD
D	E	4	9	DE
E	A	5	10	EA
A	B			
AB	C	6	11	ABC
C	D			
CD	E	8	12	CDE
E	(EOF)	5		

Please also write down the expanded dictionary after parsing the input.

Symbol	A	B	C	D	E	AB	BC	CD	DE	EA	ABC	CDE
Code in the dictionary	1	2	3	4	5	6	7	8	9	10	11	12

3. Assume we have a quantizer with 2-bit output precision, i.e., corresponding to 4 quantization steps, which can be either uniform or nonuniform.

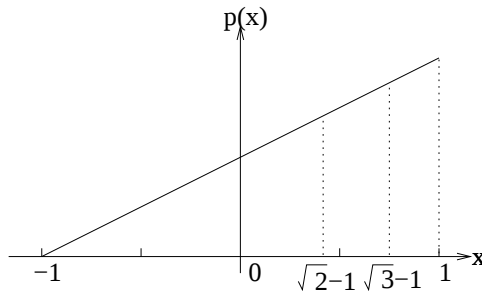
- (a) If the signal x appears in the range of $[-1,1]$ with uniform probability $p(x) = 0.5$, please write down the range of each uniform quantization step.



Please also write down the mean square error due to this uniform quantization.

$$\frac{0.5^2}{12}$$

- (b) If the signal x appears in the range of $[-1,1]$ with probability $p(x) = (x + 1)/2$, please write down the range of each nonuniform quantization step to minimize the quantization error.



Please also write down the best value to represent each quantization step.

$$\frac{\sqrt{2}}{2} - 1; \frac{\sqrt{6}}{2} - 1; \frac{\sqrt{10}}{2} - 1; \frac{\sqrt{14}}{2} - 1$$

4. Please explain the purpose of having chroma subsampling and discrete cosine transform, and how they are used in JPEG lossy image compression. *To be discussed in class*
5. Please explain the effect of temporal masking and frequency masking, and how they are used in MP3 lossy audio compression. *To be discussed in class*
6. For a group of pictures: $I_1B_1B_2P_1B_3B_4P_2B_5B_6I_2$, please write down the order in which these pictures arrive at the decoder.

$I_1P_1B_1B_2P_2B_3B_4I_2B_5B_6$

Please also explain the reason of such arrangement. *To be discussed in class*