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1 2010 Question 1

(a) Draw a flow chart to outline the general stages for developing a compression algorithm. [5] (b) Discuss the absolute limit of lossless compression with the aid of an example. Explain why only a proportion of the files of size n can be compressed by one byte. What is the percentage of the files that can be compressed by one byte? [5] (c) Consider a source (A, B, C, D) with a probability distribution (0.4, 0.3, 0.2,0.1). Discuss whether each of the following statements is true or false. Provide supporting arguments or evidence to justify your answer. [8]

i. The binary tree representing a fixed length binary code is not optimal.

ii. The ShannonFano code for the given source in the question is optimal.

(d) Explain and demonstrate how the compression efficiency of the ShannonFano encoding can be improved by alphabet extension. Use a binary alphabet (A, B) with the probability of A being 0.3 as an example. [7]

2 2010 Question 2

(a) Consider the alphabet (A, B, C, D) of a source. Discuss the possibility of finding: [5]

i. A uniquely decodable binary code in which the codeword for A is of length 2, that for B of length 1 and for both C and D of length 3.

ii. A shorter variable length prefix code than the one described in (a)i.

Provide evidence or justification for your answers.

(b) Consider a segment of bitmap image that is represented by the array of characters below: [10]

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A D D B B
C D C A A
C C C B A
D D D A A
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i. Compute the probability distribution of the characters.

ii. What is the minimum length of the encoded file for the segment? Show all your work and assumptions.

ii. Assume that the whole image is represented in the same distribution as that of the segment, and is stored in a text file. What is the minimum number of bits per character on average?

(c) Explain sc = Q + (S T) / 2, a predictive rule of JPEG. Demonstrate, with the aid of a small example, how this rule can be applied in preprocessing. Assume the pixel layout as follows: [5] T S El X?

(d) Consider a binary code that is not a prefix code. Can we conclude that the code is therefore not uniquely decodable'? Explain your answer. Give one example to support your answer. [5]

3 2010 Question 3

(a) Derive the reflected Grey code for the decimal numeral 12. [5]

(b) Draw a Howchart to outline the adaptive Huffman algorithm for encoding. [5] (c) Draw a diagram to outline the LZ77 decoding algorithm. [10]

Following the approach of the LZ77 algorithm, decode the tokens (O ,ASCII (A)) , (0,AscI1(A)¿, ¡0,Asc1I(B)), ¡0,Asc1r(A)¿, ¡0,Asc11(c¿), ¡0,Asc1I(c¿¿, (5,2) , (6,2), (O,ASCII(A)) , (8,3), (O,ASCII(C)).
Assume that the length of the history buffer is H = 8 and of the lookahead buffer is L : 6.
The history butler is empty initially.

(d) Explain what each of the variables L, z, s1, p2 represents in the segment of the Arithmetic decoding algorithm below. Demonstrate how the algorithm works with the aid of a small example.
Assume a source (A, B) with a. probability distribution (0.2, 0.8).
Hint: You may trace variable values at the end of each iteration 0-5 for an input 0.43 as suggested in the table below.
Use iteration O to describe the initial state and add necessary assumptions for a specific source. Finally, derive the decoded text. [5]