2910325 Data compression

Examiner's report: Zone A

General remarks

CIS325 examination papers cover typically the most important topics of the course material. As an examination candidate, you are expected to have fully understood issues and techniques learnt from the course.

To achieve a good grade, you need to demonstrate successfully the required knowledge and skills in the examination. It is hence essential for you to be able to present the solutions in the best possible way. For example, the answers on scripts should be written in logical and coherent steps. You should demonstrate the entire process of deriving a final result in the answer. The corresponding question numbers (e.g. Question 1, Question 3) and part numbers (e.g. (a), (b), ii, iii.) of your answers should be clearly marked. The solution to each question should begin on a new page if possible. The handwriting should be easy to read. You may use pens of any natural dark colour preferably black or blue, but never red or green which are reserved for marking your exam scripts. It is a good practice sometimes to leave a note for the marker to clarify or highlight things, especially when solutions to some parts of a question are presented in different places. Most importantly, candidates need to read questions **carefully**.

Good timing in an examination is critical for your success. You should therefore make a plan quickly at the beginning of the examination to allocate the time for each question. This is to avoid the situation that you spend too much time on one question and do not have enough time for another. Similar timing approaches should be applied to each sub-question or part of the question.

There are a total of five questions in this year's exam paper. Candidates are required to attempt three out of the five. We discuss the questions one-by-one in the following paragraphs:

Specific remarks

Question 1

a. A good answer to this part of the question would consist of two paragraphs. The first would offer a concise explanation why data compression techniques are necessary especially for sound files. The second would present an example to support your arguments in the first paragraph.

b. There are two requirements in this part of the question. The first requires a discussion on the possibility of finding two codes and the second asks for a justification and one example. A good answer would consist of two sections. The first is for a uniformly decodable binary code and the second is for a shorter prefix code.

The challenge here is to understand the 'unseen' question. The mistakes made by candidates this year are various, from misunderstanding the questions to confusing different concepts. For example, in part (i) the question asks whether it is possible to find a uniquely decodable code of the given lengths but some candidates answered that the given code is uniquely decodable. Another common mistake made was to have confused the concept of a short code with that of a better compression. Some candidates forgot to give an example.

c. An easy way to answer this part of the question is to first state the purpose of the segment of the algorithm in one paragraph. In the second paragraph, explain the function of each of the variables x, s1, p2 and L. Then give an example to support your statement and explanation earlier.

d. A good way to answer this part of the question is to focus on the given situation where the alphabet is small and the probabilities are imbalanced. It should then be easy for you to recall one solution learnt from the course, which is to extend the small alphabets by grouping the two or more letters together. Next you should consider how to demonstrate this method with an example. An easy way to do this is to first outline your approach and then give a small example. A bi-element alphabet is an obvious choice. A good answer would then show step-by-step how to derive an extended alphabet and the Huffman code, how the gap between the entropy and the average length can be reduced, and finally give your conclusion.

Question 2

a. This part of the question is 'unseen' and few candidates attempted it. This is a pity because it is not that difficult to get the solution once you understand the question. An easy approach is first to write out the entropy expressions for H_P and H_Q. Then write and compute the difference H_P-H_Q. If the difference greater than 0, you can conclude the H_P is greater than H_Q. Otherwise if the difference smaller than 0, then H_Q is greater.

b. A good answer to this part of the question would consist of four sections. The first section would show the decoding process step by step. The second would explain the meaning of all the control symbols used. The third section would compute the compression ratio and the fourth compute the entropy. Few candidates attempted the entropy part this year.

c. There are two requirements in this part of the question and your answer should consist of two sections accordingly. The first is to show how the image can be pre-processed by decomposing an array into a number of bi-level bit-planes. The second is to show how a better compression ratio may be achieved. Most candidates this year realised the need to convert the given character entries of array A to the binary before the decomposition for the bi-planes. However, few candidates did actually attempt the encoding on each bit-planes. They did not realise that, without the code, the compression ratio cannot be computed.

Question 3

a. A good answer to this part of the question would consist of two paragraphs. The first paragraph would give a brief explanation of the continuous-tone image. The second would show an example as required.

b. A good approach for this part of the question is to explain the predictive rule first and then support your explanation by a small example. A common mistake made by candidates this year was to have misunderstood the question.

c. This part of the question continues the previous part (b). It requires a computation of the mean squared error on the given matrix. You need to show all the steps of your work, which is more important than the final numerical result itself.

d. A good answer to this part of the question would consist of two sections. The first section would describe briefly the adaptive Huffman encoding algorithm. The second section would give an example to show your understanding of the algorithm. A common mistake made by candidates this year was to have missed out the algorithm, example or explanation.

Question 4

a. This part of the question tests your general knowledge of compression algorithm design. It is 'unseen' but stages for general algorithm design can be adopted for compression algorithm design. You should not hesitate to demonstrate your relevant experience and knowledge.

b. A good answer to this part of the question is to explain briefly the concept of I picture and then give an example to demonstrate your understanding.

c. You may organise your answer in two sections to this part of the question. A good answer would highlight the distinct characteristics of the two algorithms, Shannon-Fano and static Huffman encoding, and then show a small example.

d. A good answer to this part of the question would not only give an example showing how the two dictionaries are identical in LZW encoding and decoding algorithms, but also include a short introduction at the beginning and a conclusion at the end of your answer. An example alone would be insufficient and some candidates lost marks for giving no explanation in their answers this year.

Question 5

a. A good answer to this part of the question would consist of two sections. The first section would explain in one paragraph the differences between a lossy and lossless data compression, and the next paragraph would give the aim of a lossy compression. The second section would show an example of real data that are suitable for lossless compression.

b. Few candidates attempted this part this year but the question is in fact straightforward. You only need to find the frequency of the sine wave and double it according to the Nyquist theorem.

c. A good answer to this part of the question would consist of steps of decoding the given tokens by LZ77 algorithm. You should also give the final decoded message at the end of your answer.

d. This part of the question requires candidates to explain and demonstrate with an example how a tree data structure may be used to represent a binary code, and how to distinguish a prefix code from non-prefix code based on the tree structure. You should give three tree examples at least as suggested in the Hint.

Summary

Good performance in the examination depends not only upon your sound knowledge covering all the required topics but also upon effective ways to demonstrate your knowledge, your understanding and analytical skills. The importance of understanding questions in the examination cannot be emphasised more. Examinees are, again, advised to read the questions **carefully**. You should make sure that you fully understand what is required and what parts or sub-questions are involved for each question explicitly and implicitly. You are encouraged to take notes, if necessary, while reading or attempting the questions. Above all, you should be completely familiar with the course materials. Good students should prepare to solve problems in some unseen form by applying their knowledge gained from the course.