Examiners’ commentaries 2015–16

CO3325 Data compression – Zone A and Zone B

General remarks

The best way to attempt the Data compression examination can be summarised in a three-word cycle process: what – how – first.

What

Data compression is a technical subject and the examination questions tend to be specific. It is very important that you read the questions carefully to ensure that you understand what is required. Check subparts to review what you will need to do to provide a complete answer. The mark breakdown will also give an indication of the depth of coverage required.

How

The examination can be viewed as a one-to-one written communication between you and the examiner. As such communication is also highly constrained by time, you need to demonstrate your knowledge of the subject in the most efficient manner. For example, consider whether it would be appropriate to provide a diagram with annotation, instead of writing descriptive text. Use your judgement, and make sure you have answered the question.

As this is a Level 3/6 examination, you will need to demonstrate your competence in problem solving. This may include sharing your interpretation of given specifics in questions. For example, you may add a note on your script to explain any interpretations or assumptions you have made.

First

You want to secure as many potential marks as possible – and a first class mark requires a grade of 70% and above. To achieve this, you should aim to answer all questions, ensuring that the depth of your answer is proportionate to the marks available. Leave space to add in further details if time permits.

If you follow these guidelines, as well as those in the subject guide and the textbooks, your examination should provide a good opportunity to demonstrate your knowledge.

Comments on specific questions

Zone A

Question 1

(a) This part of the question tests your knowledge of the Kraft–McMillan inequality. There are two explicit subquestions, which should be answered individually.

   i. This subquestion requires a check of the correct codeword–length distribution for a uniquely decodable code.

ii. This subquestion tests whether candidates understand what the implication is when the Kraft–McMillan inequality reaches 1.

(b) There are two implicit subquestions in this part, and answers to cover both should be given. The first expects a simple 'yes' or 'no' to check whether the given code satisfies the Kraft inequality. The second requires justification to explain the flaws in Amenda's claim.

The first implicit subquestion was not well answered, with confusion about the Kraft inequality, the prefix code or the necessary condition for a prefix code.

The second subquestion was very well answered. Most candidates could demonstrate correct encoding output, and explain the meaning of every control symbol used.

(c) This part of the question was well answered. Most candidates could demonstrate correct encoding output, and explain the meaning of every control symbol used.

(d) This part of the question was well answered by most candidates. Unfortunately, some candidates confused the question, reasoning why repeated compression would be ineffective, and therefore lost marks.

Question 2

(a) There are three subquestions in this part of the question; they should be answered in sequence.

i. A good answer to this subquestion would suggest the standard approach of extending the alphabet by grouping two symbols at a time.

ii. The answer to this subquestion required that candidates demonstrate how the suggested approach works.

iii. An easy way to answer this subquestion would simply show that the gap between the entropy and the average code length is reduced for the extended alphabet.

(b) This part of the question requires two implicit tasks. A good answer would first outline the Arithmetic decoding algorithm, and then fill the table with the traced variable values for each step. This question was well answered by most candidates.

(c) This part of the question tests book knowledge about the video compression. However, candidates did not find it as straightforward as expected, perhaps as it involved language/vocabulary skills. In such questions, it is important to understand what the whole paragraph is about. Also note that there is no restriction on the number of words for each text gap, which offers some flexibility in capturing the intended meaning.

Question 3

(a) This part of the question includes two tasks. The first task is to outline the technique of predictive encoding. The second task is to demonstrate how predictive encoding works using the given data as an example. Most candidates answered well for the first two steps of preprocessing; that is, first writing down the predicted matrix P applying the given JPEG rule, and second, giving the residual matrix P–A, the difference between the predicted values P and the source values A. However, many omitted to mention or (better) demonstrate how a prefix coding approach; for example, Huffman coding, or Run-length, may be applied.

(b) This part of the question asked candidates to demonstrate, using the given data as an example, how the dictionary constructed (in the basic LZW encoding algorithm) on the encoding side and the dictionary on the decoding side are actually identical.

Most candidates gave a perfect trace for the values of the variables, showing that the content of the dictionary on both the encoding and decoding sides are the same. The best answers also provided a concluding statement that the two dictionaries contain identical values.

Zone B

Question 1

(a) A good way to answer this part of the question is to present the answer in two explicit sections. The first section should include the description of the two required encoding algorithms; for example, a brief introduction to the Huffman encoding algorithm, followed by a brief introduction to the Shannon–Fano encoding algorithm. The second section should then present labelled traces for the Huffman and Shannon–Fano algorithms, using the given data.

(b) The answer to this part of the question can be divided into two sections. The first section should explain the advantages of the use of the Reflected Gray Code and the second should demonstrate the calculations as well as the values of the four given colour codes.

(c) This part of the question is about the conversion between two colour representation systems, namely RGB and LC. There are three explicit subquestions, and a good answer would consist of the answer to each of the corresponding subquestions.

i. This subquestion simply requires the definition of 'transform'.

ii. A good answer to this subquestion would include a small matrix computation.

iii. The answer to this subquestion would involve a small inverse matrix computation.

Question 2

(a) The answer to this part of the question is straightforward, consisting of a diagram and explanation. The key element to show in the diagram is that the 0-1 binary tree for a prefix code would contain no internal label. In other words, no path is shared in the 0-1 tree between any two codewords. Some candidates forgot about either the diagram or the explanation, and lost marks.

(b) This question consists of three subquestions; these should be answered individually, and labelled accordingly.

i. This subquestion requires a definition in your own words. Be careful not to reuse the term you are defining as part of your answer.

ii. This subquestion tests your understanding of the entropy that can be used to measure the optimisation of the codeword length. State 'true' or 'false' before any justification.

iii. The examiners expected to see a code and its codeword probability distribution.

This was not well answered overall. It requires an understanding of the nature of optimal codes as well as knowledge of the (static) Shannon–Fano and Huffman compression algorithms. The Shannon–Fano algorithm is not optimal in general, and the Huffman algorithm is not optimal unless the probability of every symbol in the alphabet is a negative power of 2.

(c) There are two subquestions in this part, and they should be answered separately. Each requires an explanation, followed by a supportive example. This should have been a straightforward question, but many candidates ignored either explanations or examples and lost marks unnecessarily.

Question 3

(a) This part of the question contains two implicit subquestions. A good answer would address them individually and explicitly, showing first, the gap between the entropy and the average codeword length, and second, that this gap may be reduced if the alphabet is extended by grouping two symbols at a time.

This part of the question was not well answered, which was probably due to the requirement of relatively deep knowledge about the entropy and its application.

(b) There are two implicit subquestions. A good answer to this part of the question would consist of two sections to address both. The first section would show how the array A may be divided into four bitplanes, and the second would show how different compression algorithms may be applied to different bitplanes.

Some candidates lost marks because their answer covered only the first subquestion.

(c) There are three implicit subquestions in this part of the question. A good answer would consist of three sections: providing the definition of the sampling, a diagram showing the frequency spectrum and the computation for the sample rate.