Examiners' commentary 2018–2019

CO2227 Creative computing II: interactive multimedia – Zone B

General remarks

Overall, performance on this paper was reasonable, with an average of a low Second Class mark. About 15 per cent of candidates achieved a First Class mark, and these were all between 70 per cent and 85 per cent. At the other end of the scale, only 10 per cent of candidates failed the exam, showing a stronger than average overall performance.

In any examination, it is very important to read and address the question that is being asked. Little or no credit is given to correct but irrelevant material in an answer, because that irrelevant material does not demonstrate understanding of the material, and actually gives an indication that the candidate may not fully understand some of the concepts.

It is also very important to answer all parts of a question, as there are marks assigned to each part. For example, a question that asks you to describe some concept and give examples requires that you do both: describe and give examples. An answer that omits the examples will not score as well.

What follows is a brief discussion of the individual questions on this paper, with some explanations of the answers expected by the examiners.

Comments on specific questions

Question 1: Colour and light

This was a popular question, answered by almost all candidates, and with mostly straightforward content. Many of those who did choose this gave good responses, with the average being in the Upper Second Class range. There were also a couple of excellent answers given.

a. Part (a) was concerned with hue, saturation and brightness.

   i. Most candidates were able to correctly identify that hue is the colour reflected from or transmitted through an object and is typically referred to as the name of the colour (red, blue, yellow, and so on). *Saturation* is the strength or purity of the colour and represents the amount of grey in proportion to the hue. A 'saturated' colour is pure, and an 'unsaturated' colour has a large percentage of grey. Finally, *brightness* is the relative lightness or darkness of a particular colour, from black (no brightness) to white (full brightness).

   ii. Here, the examiners wanted to see the calculations, to obtain that:

      $H = 2{:}76$, $S = 1{:}0$ and $B = 0{:}8$

      For *H*, answers expressed as degrees or radians were also accepted if the working was clear.

b. Part (b), asked candidates to describe the function of different parts of the human vision system. This was a straightforward bookwork question, but for full marks, more detail about how each of these functions works was required.

i. Candidates were expected to know that the *pupil* allows light to pass into the eye.

ii. *Rod cells* are able to function in less intense light.

c. For part (c), a straightforward description of subtractive mixing and the printing of the specific colours was required. CMYK works by applying pigments to a white page. Pigments are cyan, magenta, yellow, and a key colour, which is usually black. Lighter colours can be created using half-toning. Green is a subtractive mixture of cyan and yellow. Most but not all candidates mentioned that because black is usually the key colour, the K ink is applied to the page. Some were also able to say that mixing in this case would instead produce a muddy colour, making K preferable.

d. Finally, candidates were asked to define *deuteranomaly*. Deuteranomaly is the most common kind of colour blindness, affecting perception of red and green hues. Systems should not rely just on colour, but could use: brightness, saturation, shape, location, and so on, to communicate information.

Question 2: Animation

This was also a popular question, answered by two thirds of candidates, though the quality of the responses was of a lower standard than those of Question 1. There were however some excellent answers from a couple of candidates.

a. The responses for part (a) did not always show the calculations required to obtain the answers. If the final answer was incorrect, no marks could be awarded.

   i. After 0.5 seconds, the position would be (237.5, 468.75).

   ii. After 1.8 seconds, it would be (136, 280).

b. Here, candidates did not always show strong understanding of the essential aspects. Frame rate is the rate at which different images are displayed. For smooth motion to be perceived, this rate needs to be around 16Hz or faster. Flicker rate is the rate at which projection lights are interrupted. It must be as high as the frame rate, or higher (and is usually double or triple the frame rate). When the frame rate is high enough, we experience Beta motion. Both this and persistence of vision should have been explained to obtain full marks.

c. Part (c) asked candidates to describe different animation techniques.

   i. Answers should demonstrate an understanding that stop-motion animation involves creating models out of clay or a similar substance. A series of still images are taken where the model is moved in each frame to create the animation.

   ii. For the second part, candidates were asked to describe how they would choose between stop-motion and flat animation for a particular project. Here, you could discuss whether clay or hand drawing is an appropriate aesthetic, whether flat backgrounds are appropriate, and ways in which workload could be distributed. Both are manually intensive processes, though, so that would not be relevant to the choice of one or the other, and nor is cost.

d. Part (d) concerned the lerp function.

   i. The first part of the question required candidates to demonstrate an understanding that the lerp function is the linear interpolation function for keyframe animation.

   ii. The range of t should be [0,1].

   iii. For part (iii), at frame 4, p0 is 20, p1 is 40 and t is 0.2. The function returns 24. It was important to show this working.

   iv. For the final part, the problems include a jerky trajectory, and discontinuous velocity at keyframes.

Question 3: Audio and music perception

This was a moderately popular question, but resulted in the worst performance of all the questions on the examination paper. The following shows where some of the problems were.

a. For part (a), examiners expected correct descriptions as well as proper labels to be included on the diagram. A couple of candidates did not even provide a diagram, and only described the terms.

b. Most candidates were able to correctly identify that the labels were for:

   i. the ear canal

   ii. the malleus (hammer was also accepted)

   iii. the cochlea.

c. Part (c) was a very straightforward question, and could be well answered simply by using knowledge obtained from the subject guide. The basilar membrane is responsible for frequency analysis of sounds. The mapping is tonotopic, meaning that different regions are stimulated depending on the frequency components of the sound. Examiners also expected the mention of hair cells.

d. In explaining auditory masking, candidates should have demonstrated understanding that a loud tone can obscure a quieter tone that is close in frequency. The quieter tone must be within the critical bandwidth and be approximately 1=10 the amplitude of the masking tone (-20dB).

e. Part (e) required a clear understanding that rhythm is a complex perceptual phenomenon involving the perceptual grouping of sequences of beats or of stronger and weaker pulses.

f. For part (f), candidates were generally able to compare the FFTs given correctly.

g. The final part, was also straightforward. Candidates were able to list three frequencies, but the explanations of why these particular frequencies had been chosen were often lacking.

Question 4: Digital media signals and their representations

About three quarters of the candidates answered this question, with average performance

on it overall. It comprises many sub-parts, each worth a few marks each, so it was possible to achieve a reasonable mark just by making sure to respond to each sub-part.

a. For part (a), the Nyquist frequency is 96kHz, which is the highest frequency that can be reliably reproduced. To calculate the storage space, candidates had to convert to bits, and include both channels, to obtain an answer of around 329.6 MB. Showing your working is an important aspect of exam strategy, as it is possible to obtain some marks through demonstrating understanding, even if the final answer is not actually correct.

b. Part (b) was bookwork and could be answered if candidates had read the basic information provided in the subject guide on FLAC.

   i. Not all candidates were familiar with the material from the subject guide, and as a result were not able to say that n is the current sample time, while $n-1$ and $n-2$ are the previous two sample times, and instead gave actual sample values which was not asked for.

   ii. $e_2(n)$ is the residual, or the difference between predicted sample n and the actual value.

   iii. To explain how compression is achieved, candidates needed to demonstrate understanding that residuals are typically smaller in magnitude than the original signal, so fewer bits are needed to encode them at the same accuracy.

c. Part (c) concerned *compression*.

   i. The first sub-part asked for a distinction between *lossy* and *lossless* compression. A simple answer could have been that a lossless compression algorithm allows the original digital signal to be perfectly reconstructed, while a lossy compression algorithm removes information from the signal and does not allow perfect reconstruction. Other explanations that were appropriate were also accepted.

   ii. Here, an actual example was required, rather than just a generic statement that lossy is preferred when you want a smaller representation. Examples could be that lossy algorithms may be preferable for contexts such as streaming over the internet or listening on personal music players, where having a smaller file size is more important than being able to perfectly reconstruct the original signal.

d. Again, for part (d), the material from the subject guide is sufficient to provide a good answer. However, candidates needed to show understanding, rather than just providing a few key words. Comparison of how both MP3 and FLAC work was expected.

e. Part (e) concerned *aliasing.*

   i. The first sub-part required a diagram, as well as an explanation that for any frequency above the Nyquist frequency, there exists a unique frequency between 0Hz and the Nyquist rate that is indistinguishable from it, and that this is its alias.

   ii. For part (ii), aliasing can be avoided by applying a low-pass filter with a cut-off frequency at (or below) the Nyquist before sampling.

f. Most candidates were able to rank the audio file format sizes correctly for part (f).

Question 5: Signals and systems

This question was only answered by only a small number of candidates, but the marks obtained were relatively high, and there were some very clear, correct responses.

a. For part (a), candidates were expected to identify that this is a blur kernel, and that its effect will be localised, and it will have square edges (or be non-Gaussian).

b. Most candidates could name other effects that can be achieved through an image kernel, as required for part (b). Other possible image effects could include: echo, edge detection, motion blur, low-pass filter, high-pass filter and Gaussian blur.

c. Part (c) required candidates to fill in the blanks. The correct answers were:

   i. i multiplying

   ii. time invariance

   iii. linearity

   iv. LTI (linear time invariant)

   v. the impulse response of the system

   vi. the same signal.

d. Part (d) concerned the creation of a new music visualiser program.

   i. For (i), a good approach could be to name pitch histogram as a good feature, explaining that this feature will capture information about what notes (and therefore what chord) is currently playing. Also important was a description of how you would compute something like a pitch histogram from, say, an FFT.

   ii. The second part of this question was related to the approach suggested for musical features in (i). For example, assuming the answer given, it could fail if there is prominent un-pitched content (e.g. drums) in the signal, or if there is silence, or if instruments are out of tune, or if the FFT size is not big enough.

iii. For the final part, a description of RMS was expected.

Question 6: Information retrieval

This question was answered by about two thirds of candidates, with reasonably good performance overall.

a. Part (a) concerned a collection of image files stored on a disk.

   i. For part (i), an appropriate data structure could probably have the files and their colour representations (a numerical triple) stored as a pair in a vector (or an array). To retrieve the image closest to a query colour specification, you would be required to iterate over all of the entries in the vector, computing the Euclidean distance between the image's colour specification and the query colour, finally returning the image whose colour distance from the query colour was a minimum. Other approaches were acceptable, but a clear description of iterating over any linear data structure, minimising Δ in L*a*b* space, was a basic expectation.

   ii. The efficiency of this algorithm is linear and wouldn't scale very well to large collections of music.

   iii. Indexing is also difficult. The Δ values between the query and the data set are: [70.3372, 154.5813, 35.1468, 87.4329], so file03.png should be returned. Examiners expected candidates to show their working. Other approaches to the data structure and algorithm were accepted if they were appropriate.

b. For part (b), it was essential to relate the answers to the particular scenario as well as defining the terms themselves.

   i. It was not sufficient to simply say what *precision* is. It would be important to understand that precision is a measurement of how good the recommendations are – whether the user will rate the recommended books highly (or with high confidence).

   ii. A system with high recall would return a larger percentage of books from the database that might appeal to the user.

   iii. A good answer for the importance of recall vs precision should discuss the trade-offs between them, and again relate it to the context. Since reading a book takes substantial time, precision is probably more important in this case. However, very low recall would mean that few or no books would be recommended, which is also undesirable.

c. The final part required knowledge of the features listed, as well as the kinds of uses that could be made of them. Some candidates did not answer this fully, though most candidates did know what the different features were.