UNIVERSITY OF LONDON

GOLDSMITHS COLLEGE

B. Sc. Examination 2012

Department of Computing

IS52020B Perception and Multimedia Computing

Duration: 3 hours

Date and time:

There are six questions in this paper. You should answer no more than four questions. Full marks will be awarded for complete answers to a total of four questions. Each question carries 25 marks. The marks for each part of a question are indicated at the end of the part in [.] *brackets.*

There are 100 marks available on this paper.

This is a practical examination; each answer requiring code or other computational material should be named according to question number, part and sub-part: for example, `Q5_b_2.pde` *for a Processing sketch in answer to part (b) sub-part (ii) of question 5. Save your answer to the exam submission folder. You are responsible for ensuring that your answers have been saved in the correct location.*

THIS PAPER MUST NOT BE REMOVED
FROM THE EXAMINATION ROOM

Question 1 Colour

(a) Name two device-dependent colour spaces, giving for each an example of a situation where they are most useful. [6]

(b) Describe qualitatively how to compute the sRGB coordinates of a mixture of two coloured lights expressed in sRGB colour coordinates. You need not give numerical details of conversions between colour spaces, but should specify any other colour spaces you use. [4]

(c) Construct a *Processing* sketch to illustrate the mixture of equal amounts of the sRGB colours {255, 0, 0} and {0, 170, 85} for colour averaging by area. [4]

(d) By direct calculation or otherwise, showing your working, compute the resulting sRGB colour from mixing the sRGB colours {255, 0, 0} and {0, 170, 85}. [6]

(e) Name the principal types of colour blindness and their cause, and describe a way of specifying the colours which are typically confused by colour-blind sufferers. [5]

Question 2 Audio Signal Processing

(a) In the context of systems and signal processing, define the following terms:

i. impulse response; [3]

ii. a linear system; [3]

iii. a time-invariant system. [3]

(b) Describe how the impulse response of a Linear Time-Invariant system can be used to compute the effect of that system on any input signal. [2]

(c) A particular system is implemented in two ways:

- by direct calculation from the impulse response, taking 2.5s to compute the response to a signal of 1024 samples for a system with impulse-response also of 1024 samples, and
- using the Fast Fourier Transform, taking 0.03s for the same inputs.

Calculate how long each of the implementations would take if the input signal and impulse response were of length 4096 samples. [6]

(d) Define the *echo* and *reverberation* responses of a room, including their typical timescales. With reference to these timescales and to typical recording sampling rates, explain why the computation using direct calculation of a system's response to an input signal is not practical. [8]

Question 3 Sound and Music

Write a short essay on **each** of the following topics: [25]

i. Pitch, harmony and the ear;

ii. Audio compression for digital music.

Each essay is worth half the marks for this question.

Question 4 Information Retrieval

(a) i. Define the terms **true positive**, **false negative** and **false positive**, and use those terms to explain the **precision** and **recall** performance measures of an Information Retrieval system. [6]

ii. An Information Retrieval system retrieves 20 items for a given query. If 8 of those items are relevant results, and there were another 2 relevant items which were not retrieved, compute the precision and recall of the system for this query. [4]

iii. A piece of software purports to perform image retrieval over personal photo collections. Which of precision and recall would you consider more important in evaluating the software? Explain your answer. [3]

(b) An eccentric wishes to create a searchable database of triangles. In order to do so, he defines a feature for each triangle as the triple made up of the angles (expressed in degrees) in the triangle, in descending order.

i. Compute the value of this feature for the 3,4,5 triangle. [3]

ii. Suggest a suitable distance measure to use with these features to find closely-related triangles. [2]

iii. Using the distance measure suggested, compute the distance between the 3,4,5 triangle and an equilateral triangle. [3]

iv. Is this a good combination of feature and distance measure? Explain your reasoning. [4]

Question 5 Ambiguity

(a) Give an example of ambiguity in **each** of

i. language,

ii. image, and

iii. sound,

explaining in each case the nature of the ambiguity. [9]

(b) i. Sinusoidal waves can be characterised as having amplitude and frequency. Name a third property which can distinguish between two sinusoidal waves having the same amplitudes and frequencies. [1]

ii. Draw, on labelled axes, a square wave of amplitude 1 and frequency 1Hz over a time interval of 8 seconds. [5]

iii. State the sampling frequency for which the Nyquist frequency is 1Hz. [1]

iv. Tabulate the values of the square wave at the following time points: 0.1s, 0.85s, 1.6s, 2.35s, 3.1s, 3.85s, 4.6s, 5.35s, 6.1s. [4]

v. Hence, or otherwise, state the frequency of the square wave which would be reconstructed from sampling a 1Hz square wave every 0.75s, and explain your answer. [5]

Question 6 Gestalt perception

(a) Name and briefly describe **two** Gestalt principles of grouping visual stimuli. [4]

(b) Describe the perceptual effect known as the *phi phenomenon*, including the typical response elicited, the characteristic timescale, and the relationship with the Gestalt school of perception. [7]

(c) Construct a *Processing* sketch illustrating at least one of the Gestalt Principles of grouping. Include, either in a written answer or in a comment section in your sketch the principle(s) illustrated, and how your sketch illustrates them. [9]

(d) Describe, with an explanation, aspects of grouping in music which could be said to follow the Gestalt principles. [5]