# THE UNIVERSITY OF HULL

Department of Computer Science

Level 6 Examination

May, 2015

## Visualization

Wednesday, 27 May, 9.30 am to 11.30 am
(2 hours)

Answer ALL questions
(Each question is out of 20 marks)

***Please use the supplementary sheet to answer question 2(ii) and 2(iii)***

You should answer all compulsory questions. If you do not attempt to answer a compulsory question you will receive a mark of 0 for that question.

If you have a choice of questions and you answer more than you are asked to, your answers will be marked in the order that the questions appear on the examination question paper. Any additional questions that you attempt will not be marked.

You should cross out any questions which you attempt but do not wish to be marked.

Do not open or turn over this exam paper, or start to write anything until told to by the Invigilator. Starting to write before permitted to do so may be seen as an attempt to use Unfair Means.

1 The renowned anthropologist Sir David Clooless is PhotoShop-ing pictures from his latest research trip to Farawayland. He notices something odd about the alternating light and dark stripes on the red skirts worn by the women and girls on ceremonial occasions:

(i) With reference to the arrowed sections of the picture, explain the contribution to this illusion made by the retina's response to light of varying intensity. Name the retinal process involved. Identify two other factors in the composition of the picture or its description that increase the power of the illusion. [4 marks]

(ii) Illusions alter our perception of what is real so deconstructing them requires careful consideration. How would you

(a) *Show* to someone else, with no technical knowledge of colour, the true nature of the arrowed sections? [2 marks]

(b) *Prove* to someone else, with no technical knowledge of colour, that what they see is an illusion? [2 marks]

Explain your strategy carefully in each case.

1 (continued)

(iii) The men of Farawayland also wear skirts during important ceremonies but theirs have light green and dark green stripes. Unfortunately, the person who looks after the costumes has deuteranomaly and in 2014 almost caused an embarrassing incident by issuing men's skirts to some women and *vice versa*.

(a) Explain deuteranomaly at the retinal level. [2 marks]

(b) Name, and explain at the retinal level, a second condition that could have led to the same mistake being made by someone else. [2 marks]

(c) Assuming all of Farawayland's inhabitants watch the ceremony, what proportion of the audience would hardly have noticed the mistake? Explain your reasoning. [2 marks]

(iv) Skirts are made from wool dyed to make the differently coloured panels. The photo on Sir David's laptop, on the other hand, is made from individual pixels. Contrast the processes that lead to the colours seen in these two situations. [3 marks]

(v) Considering the photos on Sir David's laptop, mark on a diagram of the RGB colour space **or** the HSV colour space, the planes on which we would find the colours comprising the women's and men's skirts. [3 marks]

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2 (i) Show, using sketches, how a 'parallel coordinates' visualization is constructed from multivariate data. [2 marks]

(ii) Plot the data in the table below on the template provided. Be sure to put your student number on the template and attach it to your script for collection later. [4 marks]

| **Running cost (£kpw)** | **Number of beds** | **Number of nurses** | **Number of consultants** |
|---|---|---|---|
| 20 | 300 | 250 | 30 |
| 15 | 120 | 200 | 20 |
| 30 | 180 | 300 | 40 |
| 35 | 480 | 350 | 50 |
| 45 | 420 | 400 | 60 |

Four data values given for each one of 5 hospitals

(iii) Describe what is meant by 'brushing and linking' in information visualization. Illustrate its use in the parallel coordinates technique by describing the steps needed to simultaneously identify **only** the rows contained within the strong border in the table. Mark these data objects on your plot. [5 marks]

(iv) As it is normally employed, the parallel coordinates technique chiefly gives attribute visibility, as opposed to object visibility. Define the terms *attribute visibility* and *object visibility.* Describe two multivariate data visualization techniques that chiefly give object visibility. [4 marks]

(v) The variables 'Running cost' and 'Number of consultants' share an approximate relationship that is not immediately evident on the template plot. Identify the relationship and describe how it could be emphasised visually. Include a sketch. What requirement does this place on the technique's implementer? [5 marks]

## Use this table for question 3

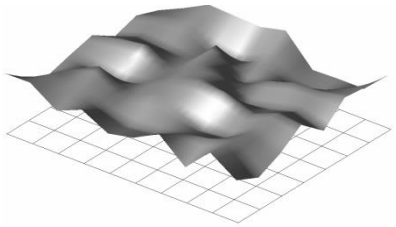
### Module 08347 Exam Performance

| 0 – 9 | 10 – 19 | 20 – 29 | 30 – 39 |
|---|---|---|---|
| 2 | 3 | 3 | 5 |

| 40 – 49 | 50 – 59 | 60 – 69 | 70 – 79 |
|---|---|---|---|
| 3 | 4 | 2 | 3 |

| 80 – 89 | 90 – 100 |
|---|---|
| 2 | 3 |

**a**

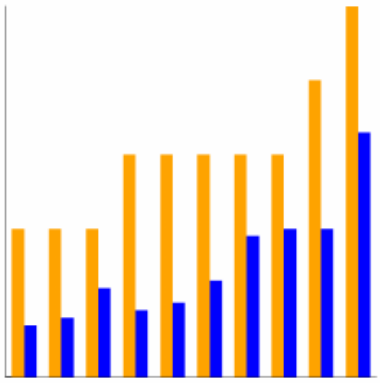


**A**

### Velocities Various Positions

| x | y | u | v |
|---|---|---|---|
| 0.7 | 1.2 | 16.3 | 44.7 |
| 1.1 | 0.6 | 14.7 | 37.8 |
| 0.9 | 2.1 | 12.2 | 8.3 |
| 2.8 | 3.7 | 8.4 | 12.3 |
| 4.1 | 0.8 | 16.8 | 19.7 |
| 5.1 | 1.9 | 27.0 | 32.4 |
| 3.2 | 2.2 | 17.7 | 26.1 |
| ... | ... | ... | ... |

**b**



**B**

### Temperatures Various Positions

| | | | | |
|---|---|---|---|---|
| 16 | 14 | 12 | 8 | ... |
| 12 | 13 | 10 | 6 | ... |
| 10 | 10 | 9 | 3 | ... |
| 6 | 5 | 3 | 1 | ... |
| ... | ... | ... | ... | |

**c**

**C**

### Income after Tax and Tax Paid (Several Coded Employees)

| Income £K | 2.0 | 3.0 | 3.0 | 5.0 | ... |
|---|---|---|---|---|---|
| Tax £k | 1.2 | 2.0 | 1.9 | 3.3 | ... |
| Code | M | N | P | Q | ... |

| | | | | |
|---|---|---|---|---|
| ... | 2.0 | 3.0 | 2.0 | 3.0 |
| ... | 0.8 | 1.3 | 0.7 | 0.9 |
| ... | W | X | Y | Z |

**d**

**D**

3 (i) Name each of the visualization techniques A – D and match each one, with reasons, to one of the data tables a – d. [8 marks]

(ii) For each of the data tables a – d, identify, with reasons, the dimension and type of the independent variable(s) i.e. whether 1D, 2D or 3D, ordinal, aggregated or nominal. [4 marks]

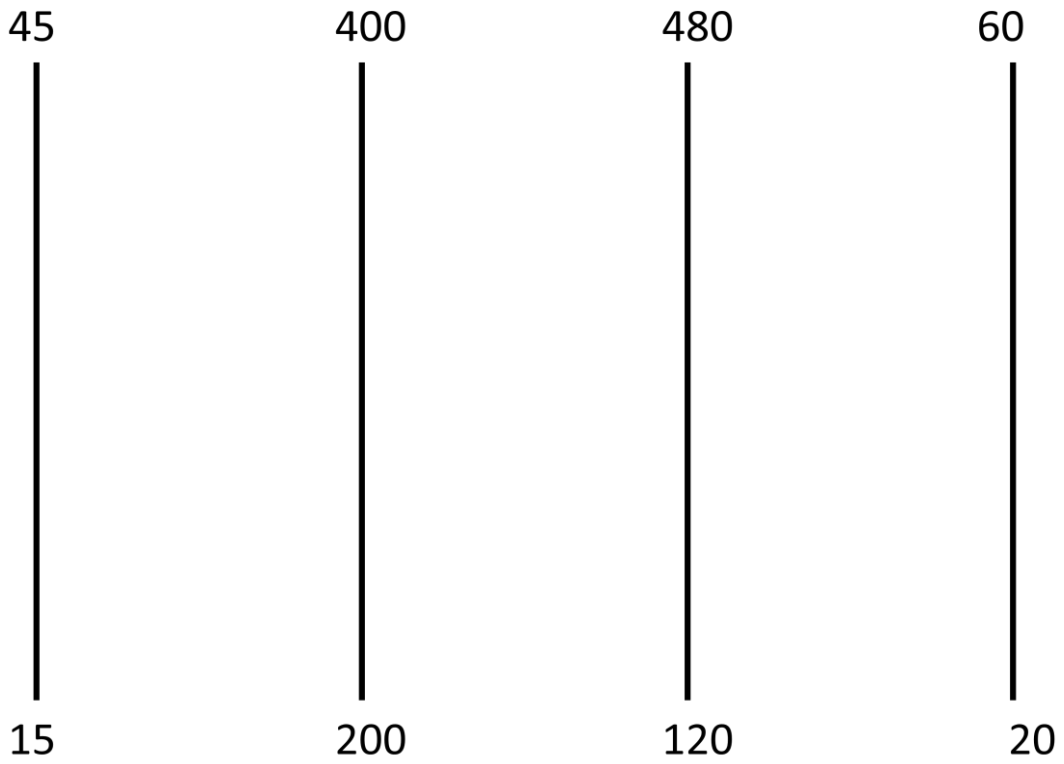
(iii) Devise and sketch a visualization for data table d that shows the variables as given, *plus* each employee's gross income, i.e. their income *before* tax deduction. Compare its effectiveness with the visualization you originally chose for this data, in (i). [2 marks]

(iv) Describe a total of *four* different ways you could use colour in visualizations A and D. What advantages or disadvantages arise in each case? [4 marks]

(v) Identify and critique two alternative visualization techniques, one to replace A and one to replace D, that could be applied to the data you matched A and D with originally, in (i). [2 marks]

Student number

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |




Supplementary sheet for question 2(ii) and 2(iii)