THIS PAPER IS NOT TO BE REMOVED FROM THE EXAMINATION HALL

UNIVERSITY OF LONDON

CO3311 ZA

BSc EXAMINATION

COMPUTING AND INFORMATION SYSTEMS, CREATIVE COMPUTING and COMBINED DEGREE SCHEME

Neural Networks

Tuesday 21 May 2019: 10.00 – 12.15

Time allowed: 2 hours and 15 minutes

DO NOT TURN OVER UNTIL TOLD TO BEGIN

There are **SIX** questions on this paper. Candidates should answer **FOUR** questions. All questions carry equal marks and full marks can be obtained for complete answers to **FOUR** questions. The marks for each part of a question are indicated at the end of the part in [ ] brackets.

Only your first **FOUR** answers, in the order that they appear in your answer book, will be marked.

There are 100 marks available on this paper.

A handheld calculator may be used when answering questions on this paper but it must not be pre-programmed or able to display graphics text or algebraic equations. The make and type of machine must be stated clearly on the front cover of the answer book.

UL19/0322

Question 1

a) Describe the action of a biological neuron, giving a sketch of its parts as part of your description.

[5]

b) Sketch a single Perceptron unit and contrast its action with that of the biological neuron you described in your answer to part a) above.

[5]

c) Describe the limitations of a single unit Perceptron.

[4]

d) Some of these limitations can be circumvented by using a network of Perceptrons (threshold units) but others cannot. Giving examples, explain which can and how.

[6]

e) Give the learning algorithm used for training a single unit Perceptron.

[5]

Question 2

a) Given the line $y = mx - c$, write down the weights for a Perceptron, in terms of m and c, needed to separate the (x, y) plane into points on or above the line (activation 1) and those below the line with (activation 0). Explain your reasoning and sketch the Perceptron which achieves this.

[5]

b) A triangle has vertices at (0, 1), (-1, -1) and (1, -1). Design a Perceptron network that gives the value of 1 for points inside the triangle and 0 for those on or outside the triangle. Show your working.

[9]

c) Explain how you would tackle a problem where instead of the triangle in part b) above we had an ***n*** sided polygon.

[11]

Question 3

a) Compare and contrast a Backpropagation network with a Perceptron network.

[6]

b) What is Hebb's rule and how does it differ from Widrow-Hoff's rule?

[6]

c) What sort of learning is used to train a Backpropagation network?

[1]

d) A Backpropagation unit has weights as shown in Figure 1. Calculate the weights after training with the examples shown.

learning rate η =		0.1					
epoch	1	?a	?b	target	bias	w_a	w_b
0	1	0	0	0	0.5	0.2	0.6
	1	0	1	2			
	1	1	0	0			
start	1	1	1	-2			

Figure 1

[10]

e) Explain why a Backpropagation unit cannot learn the target given in Figure 1.

[2]

Question 4

a) Giving suitable examples, compare and contrast supervised and unsupervised learning.

[4]

b) Give one example of an ANN that uses supervised and one using unsupervised learning.

[2]

c) Describe the main features of a Kohonen-Grossberg neural network.

[5]

d) Explaining each step and giving appropriate formulae, describe how the Kohonen layer is trained.

[6]

e) The weights of a four unit Kohonen-Grossberg network are:

(1, 0, 0), (1, 1, 0), (1, 1, 1), (1, 1, -1).

Showing all your working, calculate the resulting network after training with vectors (1, 0.4, 0.4) and (1, 0.4, 0) using a learning rate of 0.25.

[8]

Question 5

a) Using the notation for units introduced in the guides, draw a labelled diagram showing a four unit Hopfield network.

[3]

b) Explain the function and use of the components labelled in your answer to part a).

[4]

c) Describe the algorithm used to produce a state transition diagram from the state transition table of a Hopfield network.

[4]

d) The weight table of a three-unit Hopfield network is included in Figure 2. Showing all your working, calculate the state transition table for the network.

					State	Before	After	State after firing
					0			
					1			
					2			
weights	bias	1	2	3	3			
bias		1.00	-1.00	1.00	4			
	1		-1.00	-1.00	5			
	2			1.00	6			
	3				7			

Figure 2

[9]

e) A state transition table is just one way of presenting the action of a Hopfield network. Describe and produce another that can be derived from the table that you gave as your answer to part d) above.

[5]

Question 6

In your study of the module you should have read much about applications of Artificial Neural Networks and how developments have changed through time.

a) Choose one of these applications that you know in detail and describe the aims and objectives of that application.

[7]

Explain the development of the application through the period from 2009 to 2019 in terms of:

b) The different architectures that have been used.

[6]

c) The progress made towards solving the problems posed by the application.

[6]

d) The problems still outstanding in the area.

[6]

END OF PAPER