



**UNIVERSITY
OF LONDON**

CO3311 ZB

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.

Question 1

The Perceptron and its learning algorithm were developed as a model of biological (natural) neurons:

- a) List the major features of both Perceptrons and natural neurons. [8]
- b) Explain the main differences in their operation. [6]
- c) A single threshold unit has 5 inputs **a**, **b**, **c**, **d**, and **e** as well as a **bias**. Give an expression for its activation in terms of these 6 parameters and any others needed. [2]
- d) Building models of natural systems is just one of the main motivations for artificial intelligence. Describe all three motivations. [9]

Question 2

- a) Sketch a Perceptron with bias **b** and inputs **m** and **n**. [3]
- b) Give the formulae for the net and activation of this Perceptron. [2]
- c) A triangle has vertices at (0, -1), (-1, 1) and (1, 1). Design a Perceptron network that gives the value of 0 for points inside the triangle and 1 for those on or outside the triangle. [9]

- d) It is possible to approximate a circle by using a number of straight lines. Illustrating your answer with a diagram, explain how you could use this fact to produce a Perceptron network that approximates one that gives an output of 1 for points inside the circle and 0 for those outside it.

[11]

Question 3

- a) A three-input Backpropagation network has three units in the hidden layer and one unit as output. Sketch a diagram showing these four units, labelling all the important features of it.

[5]

- b) Give the learning algorithm for the network described in a) above, giving a description of the use of all the parameters and all the equations needed for learning.

[10]

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

[8]

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

Figure 1

- d) Giving reasons for your answer, do you think that a Perceptron unit or a Backpropagation unit would be effective at learning to model the examples given?

[2]

Question 4

- a) Describe the applications of Kohonen Grossberg networks.
[3]
- b) Normalisation is often used during training of such a network. Describe what normalisation is, how it is used and under what circumstances it should be omitted.
[9]
- c) Give, in detail the algorithm for training the Kohonen layer.
[6]
- d) How are the initial classes of a Kohonen Grossberg network chosen?
[4]
- e) What strategies can be used to determine the number of units needed for a particular application of Kohonen Grossberg networks?
[3]

Question 5

- a) Giving examples of each, describe how recurrent neural networks differ from non-recurrent ones.

[2]

- b) Give, in detail, the algorithm used to determine the state transition table of a Hopfield network.

[8]

- c) A number of terms were introduced in the guides for dealing with aspects of Hopfield networks that differed from those normally found in Backpropagation networks. Describe three of these not previously mentioned in this question.

[6]

- d) Figure 2 shows an incomplete table of weights of a Hopfield network. Showing all your working, calculate the state transition table and diagram for the network.

weights	bias	1	2	3
bias		-1.00	1.00	-1.00
1			-1.00	1.00
2				-1.00
3				

Figure 2

[9]

Question 6

In the last decade (2009-2019) there have been many developments in Artificial Neural Network architecture and the ranges of parameters used in applications.

From your work on this course and especially the reading and coursework aspects describe:

- a) The main architectural changes that have occurred. Include in your answer an explanation of what is meant by architecture in the context of an ANN. [10]
- b) The advances in technology that have made possible the changes that you described in part a). [5]
- c) The consequent changes in applications that have taken place. [10]

END OF PAPER