THIS PAPER IS NOT TO BE REMOVED FROM THE EXAMINATION HALLS

UNIVERSITY OF LONDON **CO3311 ZB**

BSc Examination

COMPUTING AND INFORMATION SYSTEMS, CREATIVE COMPUTING and COMBINED DEGREE SCHEME

Neural Networks

Friday 18th May 2018: 10.00 – 12.15

Time allowed: 2 hours and 15 minutes

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

a) Explain the **THREE** motivations given in the subject guide for studying ANNs.

[6]

b) Define the terms ***network***, ***weight***, ***activation function*** and ***bias*** as they relate to ANNs.

[4]

c) Describe the features of a neural network that we need to specify when giving an architecture.

[7]

d) Compare and contrast supervised and unsupervised learning. Give examples of where each is appropriate and the types of network that each type of learning can be applied to.

[8]

Question 2

a) Using examples and a diagram, explain the limitations of a single Perceptron.

[8]

b) Despite the limitations hinted at in part a) above, Networks of Perceptrons are in some sense 'universal'. Explain what this means and illustrate your answer by means of the XOR function as an example.

[8]

c) Design a two-input network of Perceptrons (threshold units) which produces an output of 0 if and only if both of its inputs are between -0.7 and 0.7. Explain how it achieves its design goal.

[9]

Question 3

a) Compare and contrast **THREE** activation functions that we have met during this course, giving a diagram showing their form and an expression for each.

[9]

b) Briefly describe network paralysis and overfitting and the steps that can be taken to avoid or overcome these problems.

[8]

c) A Backpropagation network has weights as shown in Figure B3. Calculate the weights after training with the examples shown.

learning rate =		0.5					
epoch	1	?a	?b	target	bias	wa	wb
0	1	3	1	3	0.1	0.2	0.3
	1	3	2	6			
	1	3	3	9			
	1	3	4	12			

Figure B3

[8]

Question 4

a) Explain how Kohonen Networks differ from Perceptron Networks.

[5]

b) Why is normalisation often necessary in the training of Kohonen Networks? What may go wrong if this is not done?

[4]

c) Give the algorithm for training the Kohonen layer of such a network.

[6]

d) What is the function and form of the Grossberg layer of a Kohonen-Grossberg Network?

[2]

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

(1, 0, 0), (0, 1, 0), (0, 0, 1)

Showing all your working, calculate the resulting network after training with vectors (1, 1, .1), (1, .1, 1), (.1, 1, 1) and (.1, .2, .3) using a learning rate of 0.5.

[8]

Question 5

a) Define the terms ***state***, ***predecessor, energy*** and ***synchronous*** in the context of Hopfield networks.

[8]

b) Describe the firing scheme used for Hopfield nets.

[2]

c) State the conditions on weights that ensure that a Hopfield Network will have a stable state.

[2]

d) The weight table of a three unit Hopfield network is given in Figure B5. Giving all your working, calculate the state transition table for the network, marking the stable states.

					State		Before		
							3	*2*	*1*
					0		0	0	0
					1		0	0	1
					2		0	1	0
weights	bias	1	2	3	3		0	1	1
bias	0.00	0.10	-0.20	-0.10	4		1	0	0
1	0.10	0.00	0.10	0.00	5		1	0	1
2	-0.20	0.10	0.00	0.10	6		1	1	0
3	-0.10	0.00	0.10	0.00	7		1	1	1

Figure B5

[8]

e) Draw a state transition diagram for the table you gave as your answer to part c) above.

[5]

Question 6

Three applications of Artificial Neural Networks might be:

i) Predicting the weather at a particular location.
ii) Classifying a new type of plant
iii) Finding patterns in data on purchases made at a chain of supermarkets.

For each of these scenarios:

a) List and describe the sort of data likely to be available and in what quantities.

[9]

b) Give the pros and cons of using each of Perceptron, Backpropagation, Kohonen-Grossberg or Hopfield networks in each of these applications.

[16]

END OF PAPER