THIS PAPER IS NOT TO BE REMOVED FROM THE EXAMINATION HALLS

UNIVERSITY OF LONDON **CO3311 ZA**

BSc Examination

COMPUTING AND INFORMATION SYSTEMS, CREATIVE COMPUTING and COMBINED DEGREE SCHEME

Neural Networks

Friday 18th May 2018: 10.00 – 12.15

Duration: 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) Compare and contrast the units that we learnt about in this course with biological neurons. Give diagrams to illustrate your answer.

[5]

b) Define the terms ***unit***, ***weight***, ***activation*** and ***net*** as they relate to ANNs.

[4]

c) In our study of the different types of unit, we come across a number of different activation functions. List **THREE** of these and give a formula for the activation and the types of network in which they are found.

[9]

d) Compare and contrast Hebb's Rule and the Widrow-Hoff rule.

[7]

Question 2

a) Using examples and a diagram explain how one might think of a Perceptron unit as dividing the plane into two parts.

Using a single threshold unit, illustrate your answer by modelling the line $y = mx + c$ showing clearly the meaning of m and of c.

[8]

b) Given an arbitrary truth table, we can always build a network of Perceptrons that has the same input/output relationship as the truth table. Explain the process that can be used to do this. Illustrate your answer using the truth table of an exclusive OR function.

[8]

c) Design a two-input network of Perceptrons (threshold units) which produces an output of 1 if and only if both of its inputs are between 0.5 and 1.5. Explain how it achieves its design goal.

[9]

Question 3

a) Describe the essential features of a Backpropagation network. Include a labelled diagram in your answer.

[7]

b) Give the algorithms and formulae for forward and backward propagation, explaining each term that occurs in the formulae.

[10]

c) A single Backpropagation unit has weights as shown in Figure A3. Calculate the weights after training with the examples shown.

learning rate h =		0.25					
epoch	1	?a	?b	target	bias	wa	wb
0	1	1	2	2	0.1	0.2	0.3
	1	2	2	4			
	1	3	2	6			
	1	4	2	8			

Figure A3

[8]

Question 4

a) Illustrating your answer with a suitable example and diagram, explain why the choice of scale is important in the application of Kohonen-Grossberg networks.

[5]

b) What is the role of normalisation in the training of Kohonen-Grossberg networks? In what circumstances does it not apply?

[4]

c) Why is the Grossberg layer often omitted from applications of these networks?

[2]

d) Giving all the formulae needed, give the algorithm for training the Kohonen layer of such a network.

[6]

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

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

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

[8]

Question 5

a) Describe the main differences between the architecture and use of Backpropagation Networks and Hopfield networks.

[8]

b) How are the weights of a Hopfield network determined in a typical application?

[4]

c) The weight table of a three-unit Hopfield network is included in Figure A5. Showing all your working, calculate the state transition table for the network.

					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	-0.20	-0.20	-0.20	4	1	0	0
1	-0.20	0.00	0.20	-0.20	5	1	0	1
2	-0.20	0.20	0.00	0.20	6	1	1	0
3	-0.20	-0.20	0.20	0.00	7	1	1	1

Figure A5

[8]

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

[5]

Question 6

a) Different Neural Network types have different applications. Giving suitable examples, describe how the type of input data can affect the type of unit that is appropriate for a given application.

[5]

b) People are often misled into thinking that an Artificial Neural Network is performing better than it actually is. Describe two naïve predictors of time series against which to measure any proposed neural network predictor.

[4]

c) Neural networks have been applied to many areas of human activity. Describe a possible application of each of the following types of Artificial Neural Networks:

i) Multi-layered feed-forward networks

[8]

ii) Kohonen-Grossberg counterpropagation networks

[8]

In each case, explain the aims and objectives of the application, the form that the input and the output take and the criteria used to measure the success of the application.

END OF PAPER