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

Thursday 18 May 2017: 10.00 – 12.15

Duration: 2 hours 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 how problems using artificial neural networks can be thought of as search problems. Illustrate your answer with reference to finding a ***perceptron*** that forms an **AND** gate and one that forms an **XOR** gate.

[5]

b) Define the terms: ***extended truth table***, ***threshold*** and ***recurrent*** in the context of artificial neural networks.

[3]

c) The diagram below (taken from the Guide) shows an *N*-input unit:

Inputs	Weights	Parameters	Form	Value
1	*bias*	*Learning rate*	η	*0.15*
?a	*?*	*Net*	Σ	*??*
?b	*?*	*Activation*	*T(<0,0,1)*	*??*
...	...	...	...	...
?N	*?*			

Write down the formula for ***Net*** and ***Activation*** and state what type of unit this is.

[4]

d) Draw a diagram of a 3-unit ***backpropagation network*** with 2 inputs, showing all of the parameters that one needs to train it against a set of inputs and desired outputs.

[5]

e) Explain how such a network is trained, giving formulae and defining each term in the formulae.

[8]

Question 2

a) Explain the difficulties of having a single unit feeding back its output to its input, giving an example of what might go wrong.

[5]

b) The concept of ***architecture*** has a specific meaning when referring to artificial neural networks. Define this concept, listing five key aspects.

[5]

c) Compare and contrast the architecture of ***perceptron***, ***backpropagation***, ***Kohonen-Grossberg***, ***Boltzmann*** and ***Hopfield*** networks.

[5x3]

Question 3

a) Explain how, given any truth table, it is possible to design a ***multilayer perceptron*** which produces the specified output for all of the inputs in the table.

[7]

b) Illustrate your answer in a) above by designing a two input, ***multilayer perceptron*** that implements the following truth table.

?1	?2	output
0	0	1
0	1	0
1	0	0
1	1	1

[7]

c) In the light of (or despite) your answer to part a) above, explain why it is often necessary to train the many varieties of artificial neural network.

[5]

d) Enhancements to backpropagation include the use of:

i. *momentum terms*
ii. *adaptive learning rates*
iii. *different learning rates for each weight.*

Explain each of these and the problems that they are attempting to overcome.

[6]

Question 4

a) Sketch a diagram showing the layers of a ***Kohonen-Grossberg*** network and its essential parameters.

[3]

b) What are the typical ***net*** and ***activation*** functions of each layer of such a network?

[2]

c) What role does the ***Grossberg*** layer play?

[2]

d) Write down the algorithm for training the ***Kohonen*** layer of a ***Kohonen-Grossberg*** network.

[7]

e) The ***Kohonen*** layer of a ***Kohonen-Grossberg*** network has units:

(-0.3268, 0.0148, 0.0479, 0.4915)

(-0.0936, -0.4467, -0.4671, 0.4760)

(0.0554, 0.2213, -0.2292, -0.3458)

Train the network with one iteration using the example:

(-0.0730, -0.3181, -0.0065, 0.2995)

[8]

f) Explain the strategies that might be used to choose the initial classes in a ***Kohonen*** layer.

[3]

Question 5

a) Describe the process of implementing a 4 unit ***Hopfield*** network using a tool of your choice.

[5]

b) Some of the ***weights*** of a three unit ***Hopfield*** network are given in Table Q5. Complete the table giving an explanation of how you obtained the missing ***weights***.

Weights	Bias	1	2	3
Bias		3.15	1.59	2.65
1			2.70	0.00
2				-3.00
3				

Table Q5

[4]

c) Produce a ***state transition table*** and a ***state transition diagram*** for this network, explaining how you obtained your results.

[16]

Question 6

There are many tools for implementing artificial neural networks.

a) Give the names of two tools with which you are familiar.

[2]

b) Describe the process of implementing a simple network using each of the tools named in a) above.

[2x5]

c) Compare the two tools, giving two advantages and two disadvantages for each, indicating where each tool is preferred.

[4x2]

d) Give example applications of where each tool might best be used and why.

[5]

END OF PAPER