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

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.

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Question 1

a) Define the terms: ***net***, ***step unit***, ***clamped***, ***energy*** and ***bipolar activation*** in the context of artificial neural networks.

[5]

b) Explain how ***perceptrons*** can be used to implement simple logic circuits. Illustrate your answer by designing **AND**, **NAND**, **NOR** and **NOT** gates, giving explanations of how each of these work.

[4x4]

c) What are the uses and the limitations of networks of ***threshold units***?

[4]

Question 2

a) The subject of neural networks is sometimes described as 'biologically inspired'. Compare and contrast how this might be applied in the case of ***perceptrons*** versus ***Boltzman machines***.

[5]

b) Compare and contrast the ***Widrow-Hoff rule*** for learning with ***Hebb's rule***.

[5]

c) State three motivations for studying AI and thus artificial neural networks (ANNs). Giving your reasons, which do you judge is the most important motivation?

[6]

d) Describe the extent to which ANNs contribute to each of the motivations given in your answer to c) above.

[9]

Question 3

a) Define the terms ***overfitting*** and ***network paralysis***.

[4]

b) For each of these explain in detail the strategies that may be used to overcome the problem.

[6]

c) A number of practical problems, other than ***overfitting*** and ***network paralysis***, occur in ANN applications. List **FIVE** of these, and for each give the strategies (if any) that may be used to overcome the issue.

[15]

Question 4

a) Explain the roles of the ***Kohonen*** and of the ***Grossberg*** layers in a typical ***Kohonen-Grossberg*** network.

[4]

b) With the aid of a suitable example, explain the purpose of ***normalization*** in the training of a ***Kohonen-Grossberg*** network.

[5]

c) Explain the process of training such a network. Include in your answer all formulae and an explanation of each term that they contain.

[6]

d) Explain why a unit or example with coordinates *(0, 0, 0)* might give trouble for a typical ***Kohonen-Grossberg*** network and what might be done to remedy this problem.

[2]

e) A simple 3 unit network has units:

(-0.0690, -0.1534, 0.3261, 0.6516)

(0.1205, 0.8031, -0.0510, -0.6783)

(0.8061, 0.3883, 0.2969, -0.4431)

Work through the calculations for training the network with the example:

(-0.8823, -0.1008, 0.0972, 0.3544)

[8]

Question 5

a) Describe the ***architecture*** of a typical ***Hopfield*** network.

[5]

b) What is a 'stable state' in the context of ***Hopfield*** networks?

[2]

c) Explain the term ***energy*** as it is used in ***Hopfield*** nets.

[2]

d) The weight matrix of a ***Hopfield*** network is given in table Q5. Calculate the ***state transition table*** for this network.

weights	bias	1	2	3
bias	0.00	0.75	0.41	-0.18
1	0.75	0.00	-0.51	-0.15
2	0.41	-0.51	0.00	0.95
3	-0.18	-0.15	0.19	0.00

Table Q5

[12]

e) Draw the ***state transition diagram*** for the table that you produced in part d) above.

[4]

Question 6

a) Giving reasons, list **FIVE** features which are most essential in a tool for implementing artificial neural networks.

[10]

b) For any **TWO** named tools of your choice, describe how each performs when the five features listed in a) above are evaluated.

[15]

END OF PAPER