FAMILY NAME	
OTHER NAMES	
STUDENT ID	
SIGNATURE	

THE UNIVERSITY OF NEW SOUTH WALES

Sample Exam

COMP 9444 NEURAL NETWORKS
COMP 9844 EXTENDED NEURAL NETWORKS

(1) TIME ALLOWED – 2 HOURS

(2) TOTAL NUMBER OF QUESTIONS – **12**

(3) **COMP9444** CANDIDATES SHOULD ATTEMPT QUESTIONS **1-11**
COMP9844 CANDIDATES SHOULD ATTEMPT **ALL** QUESTIONS

(4) QUESTIONS ARE NOT OF EQUAL VALUE

(5) THIS PAPER MAY NOT BE RETAINED BY THE CANDIDATE

(6) QUESTIONS CARRY THE NUMBER OF MARKS INDICATED. THE TOTAL NUMBER OF MARKS FOR COMP9444 IS 120, AND FOR COMP9844 STUDENTS IS 140.

PLEASE ANSWER PART A IN YOUR EXAMINATION BOOKLET

PLEASE ANSWER PART B IN THE SPACES ON THIS QUESTION PAPER

ANSWERS MUST BE WRITTEN CLEARLY IN INK. EXCEPT WHERE THEY ARE EXPRESSLY REQUIRED, PENCILS MAY ONLY BE USED FOR DRAWING, SKETCHING OR GRAPHICAL WORK

PART A - Answer in your exam booklet.

Questions 1-6 (See separate Part A sample questions)

PART B - Answer in the spaces on this question paper.

Question 7 – Temporal Processing (*12 marks*)

(a) With a supervised learning algorithm, we can specify target output values, but we may never get close to those targets at the end of learning. *Give two reasons* why this might happen.

Answer:

(b) Describe the *architecture* and the *computational task* of the NetTalk neural network.

Answer:

(c) Why does a time-delay neural network (TDNN) have the same set of incoming weights for each column of hidden units?

Answer:

(d) Distinguish between a *feedforward network* and a *recurrent network*.

Answer:

Question 8 – Elman and Jordan nets, etc. (*12 marks*)

(a) Draw the weight matrix for a feedforward network, showing the partitioning. You can assume that the weight matrix for connections from the input layer to the hidden layer is $\mathbf{W}_{ih}$, and that the weight matrix for connections from the hidden layer to the output layer is $\mathbf{W}_{ho}$.

Answer:

(b) In a Jordan network with i input neurons, h hidden layer neurons, and o output neurons: (a) how many neurons will there be in the state vector, and (b) if $i = 4$, $h = 3$, and $o = 2$, draw a diagram showing the connectivity of the network. Do not forget the bias unit.

Answer:

(c) Draw a diagram illustrating the architecture of Elman's simple recurrent network that performs a temporal version of the XOR task. How are the two inputs to XOR provided to this network?

Answer:

(d) Briefly describe the use of cluster analysis in Elman's lexical class discovery experiments, and one of his conclusions from this.

Answer:

Question 9 – Tensor Product Networks (*12 marks*)

(a) Draw an architectural diagram of a rank 2 tensor product network where the dimensions of the input/output vectors are 3 and 4. You do not need to show the detailed internal structure of the binding units.

Answer:

(b) Draw a diagram of a *single binding unit* in a rank 2 tensor product network illustrating the internal operation of the binding unit in *teaching* mode.

Answer:

(c) Define the concepts of *dense* and *sparse random representations*. How do their properties compare with those of an orthonormal set of representation vectors.

Answer:

(d) What is a Hadamard matrix? Describe how a Hadamard matrix can be used to produce suitable distributed concept representation vectors for a tensor product network. What are the properties of the Hadamard matrix that makes the associated vectors suitable?

Answer:

Question 10 - Self-Organising Systems (*12 marks*)

(a) In a 2-D self-organising map with input vectors of dimension m, and k neurons in the map, how many weights will there be?

Answer:

(b) Describe the *competitive* process of the Self-Organising Map algorithm.

Answer:

(c) Briefly explain the concept of a Voronoi cell.

Answer:

(d) Briefly explain the term *code book* in the context of vector quantisation.

Answer:

Question 11 – Hopfield Nets, BSB (*12 marks*)

(a) Write down the *energy function* of a discrete Hopfield net.

Answer:

(b) Compute the weight matrix for a 4-neuron Hopfield net with the single fundamental memory $\xi_1 = [1,-1,-1,1]$ stored in it.

Answer:

(c) Briefly describe two types of *attractor* in a dynamical system.

Answer:

(d) Write down the energy function of a BSB network with weight matrix $\mathbf{W}$, feedback constant β, and activation vector $\mathbf{x}$.

Answer:

Question 12–COMP9844 Students Only (*10 marks*)

(a) Describe the training regime used in Cascade Correlation learning. Why is it advantageous to have more than one candidate unit when training?

(b) Describe the architecture of a competitive learning system. What is the constraint on the weights incoming to (non-input) unit *j*.

(c) What is a radial basis function node? Describe in your answer the parameters of an RBF node, and their significance.

(d) What is an annealing schedule? What is its purpose in simulated annealing?

(e) Outline the learning procedure for the Boltzmann machine. It is not necessary to give the detailed equations for the correlations in the clamped and free-running conditions.

END OF EXAMINATION

Part B Examiner's Use Only

7	Time Representation and TDNNs		
8	Elman/Jordan, BPTT		
9	Tensor product nets		
10	Self-organising systems		
11	Hopfield, BSB		
12	COMP9844-only question		