THE UNIVERSITY OF NEW SOUTH WALES

Sample Exam

COMP 9444 NEURAL NETWORKS
COMP 9844 EXTENDED NEURAL NETWORKS

(1) TIME ALLOWED – 3 HOURS
(2) TOTAL NUMBER OF QUESTIONS – 14
(3) COMP9444 CANDIDATES SHOULD ATTEMPT QUESTIONS 1-7 and 9-13
    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 180, AND FOR COMP9844 STUDENTS IS
    200.

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 1-8 (Ask Alan Blair)
PART B - Answer in the spaces on this question paper.

Question 9 – Temporal Processing (18 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 10 – Elman and Jordan nets, etc. (18 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 $W_{ih}$, and that the weight matrix for connections from the hidden layer to the output layer is $W_{ho}$.

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 11 – Tensor Product Networks  (18 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 12 - Self-Organising Systems (18 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 13 – Hopfield Nets, BSB (18 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
    \( \boldsymbol{\xi}_1 = [1, -1, -1, 1] \) 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
    \( \beta \), and activation vector \( \mathbf{x} \).
   Answer:
Question 14 – 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

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