UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2000/2001

September/October 2000

CSC513 – Artificial Neural Networks

Duration : [3 hours]

INSTRUCTION TO CANDIDATE:

- Please ensure that this examination paper contains **SIX** questions in **FIVE** printed pages before you start the examination.

- Attempt **ALL** questions.

- Return the Question Paper with the Answer Script.

1. Briefly explain the following questions (5-8 lines):

    (a) What is a topographic map (to represent information)?

    (b) In a self-organising environment, why and how does the winning unit increases the activation level of the neighbouring units and decreases the activation level of the units far away from it?

    (c) Briefly describe the three basic processes inherent in a self-organising learning algorithm.

    (d) Briefly describe the two different phases of self-organising learning (typically seen in a Kohonen map learning environment).

    (e) In self-organising learning, why do we want to have a large neighbourhood at the start of learning and then why do we shrink it as learning progresses.

    (f) The LVQ algorithm solves problems in two stages. Briefly describe the two stages.

    (g) What do you understand by the concept of *Density Matching* in a SOM?

    (h) What is a contextual map? (Hint: it is related to SOMs)

    (i) Briefly describe at least three principles of self-organisation in NN.

    (j) Briefly describe the concept of Learning vector quantization.

    (k) In a BP learning method, explain the *early stopping method of training*.

    (l) In a recurrent BP network why do we want to take the feedback from the hidden units and not the output units?

    (m) Give the weight change equations (Hidden-Output & Input-Hidden) for a BP network using momentum.

    (n) When training a BP network, how long is it recommended to train the network? Explain, the reason for your recommendation?

    (40 marks)

2. State whether the given statements are True or False.
(Note: Negative marking applies, i.e. –1 for each incorrect answer.)

		TRUE	**FALSE**
(a)	In BP learning, if the direction of weight changes alternates then the learning rate should be decreased.		
(b)	When using the delta rule, large weight modifications take place on connections that have a small delta value.		
(c)	In a SOM, the learning process transfers the weights of the more active input units to the (weights of the) less active input units.		
(d)	The topology of a learnt SOM represents a discrete output space.		
(e)	In LVQ learning, all the Voronoi vectors closest to the input pattern are modified during learning.		
(f)	In a SOM, to find the best output unit with respect to the input pattern, we calculate the error between the input pattern and output unit's weight vector.		
(g)	In a SOM, small learning rates are used to smoothen the topological regions.		
(h)	In a SOM, the topological neighbourhood attains the maximum value at the winning unit and this value decreases with increasing distance away from the winning unit.		
(i)	The goal of the SOM is to transform both discrete and continuous input into a 1-2 dimension feature map.		
(j)	There exist similarities in the behaviour of the hidden units in a BP network and the output units in a Kohonen Map.		

(10 marks)

3. (a) List at least 6 different learning paradigms and briefly explain at least 4 different learning paradigms?

(4 marks)

(b) After learning a data set the resultant SOM displays four important statistical characteristics of the input space. Identify and discuss these statistical characteristics.

(6 marks)

4. Given below is a BP network. Use the BP through time learning algorithm to learn the given time-series input data (for one cycle only). Show the new weights for the weight matrices.

The time series is as follows: $I_{time} = [(1, -1)_1, (0, 1)_2, (1, 1)_3]$
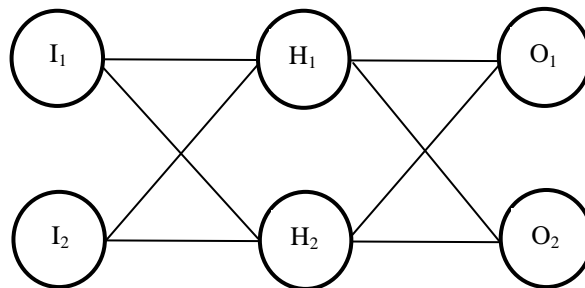
The weight matrices are as follows:

$$W_{I, H} = \begin{matrix} 1 & -1 \\ 0 & 1 \end{matrix}$$

$$W_{H, O} = \begin{matrix} -1 & -1 \\ 1 & 0 \end{matrix}$$

• Use the binary sigmoid function with slope parameter = 0.5

• Using a learning rate = 0.25

(18 marks)

5. Given below is a Self-Organising map with the following weight matrix:

$$W_{10, 3} \quad \begin{matrix} 0.2 & 0.2 & 0.2 \\ 0.3 & 1.0 & 0.4 \\ 0.9 & 0.0 & 0.1 \\ 1.0 & 0.4 & 0.5 \\ 0.4 & 0.4 & 0.6 \\ 0.2 & 0.9 & 0.7 \\ 0.1 & 0.9 & 0.9 \\ 0.9 & 1.0 & 0.0 \\ 1.0 & 0.2 & 0.2 \\ 0.0 & 0.5 & 0.5 \end{matrix}$$

The set of training patterns is

Pattern	Class
[0.1, 0.4, 0.2]	X
[1.0, 0.9, 0.3]	Y
[1.0, 0.7, 0.4]	Z

(a) Use the Kohonen map learning algorithm on the above SOM to learn the training patterns for 2 epochs only. Learning rate = 0.2. Neighbourhood = 2 for first epoch and Neighbourhood = 1 for second epoch.

(7 marks)

(b) Apply the Learning Vector Quantization algorithm (for 1 epoch only) on the learnt SOM to further refine the classification earlier performed by the SOM's. Learning rate = 0.3.

(5 marks)

6. Write a detailed essay, describing the topic of research that you covered for the literature survey. Identify the problem(s) addressed by NN in that particular domain (as per the research papers you surveyed) and provide some explanation of the usage of NN to solve the stated problems.

(10 marks)

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