UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 1999/2000

September 1999

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.
- **YOU ARE REQUIRED TO RETURN BACK THE QUESTION PAPER WITH THE ANSWER SCRIPT.**

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

   (a) Give at least 5 NN learning tasks.

   (b) What is the difference between a learning algorithm and a learning paradigm?

   (c) In terms of pattern association learning, what is meant by auto association and hetero association?

   (d) Briefly explain the objective of the predication learning task.

   (e) When initialising a BP network, why is it recommended to avoid too large and too small weights?

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

   (g) Why does the generalisation capability of a BP network usually improves when we reduce the size of the hidden layer?

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

   (i) What are context units in a recurrent BP network? Illustrate them architecturally and briefly explain their purpose in the network.

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

   (k) 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?

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

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

   (n) 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?

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

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

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

(35 marks)

2. State whether the given statements are true or false.

[Note: Negative marking applies, i.e. -1 for each incorrect answer. Answer the question on the question paper in the space provided.]

		TRUE	FALSE
(a)	In Perceptron learning, the search starts from a random initial state and then moves towards the solution.	_____	_____
(b)	The Adaline learning algorithm minimises the mean square error between the unit's activation and its connection weights.	_____	_____
(c)	In BP learning, if the direction of weight changes alternates then the learning rate should be decreased.	_____	_____
(d)	Error minimisation in a NN is achieved by changing the connection weights according to the input patterns.	_____	_____
(e)	Usually, the output produced by a NN is not equal to the desired output because the processing of a NN is probabilistic in nature.	_____	_____
(f)	BP networks can implement a memory by the introduction of time-delays into the connection weights.	_____	_____
(g)	In a BP network, the deltas of the hidden units are used to change the connection weights of the units in the next layer (i.e. the next layer in a forward direction).	_____	_____
(h)	When using the delta rule, large modifications take place on connections that have a small delta value.	_____	_____
(i)	In a Kohonen map, the input and output units act as feature detectors.	_____	_____
(j)	In a competitive network, modifications in connections weights tend to compete with each other.	_____	_____
(k)	In a SOM, the learning process transfers the weights of the more active units to the (weights of the) less active units.	_____	_____
(l)	In LVQ learning, all the Voronoi vectors closest to input pattern are modified during learning.	_____	_____
(m)	In a SOM, higher density patterns occupy a large region of the map.	_____	_____
(n)	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.	_____	_____
(o)	In a SOM, small learning rates smooth the topological regions.	_____	_____

		TRUE	FALSE
(p)	The BP through time NN, feed backs the activation of the output units to the input units (for the next cycle).	_____	_____
(q)	In a BP through time NN, the weight change for the network is based on the weight changes recommended for the last (duplicated) BP network in the series.	_____	_____

(17 marks)

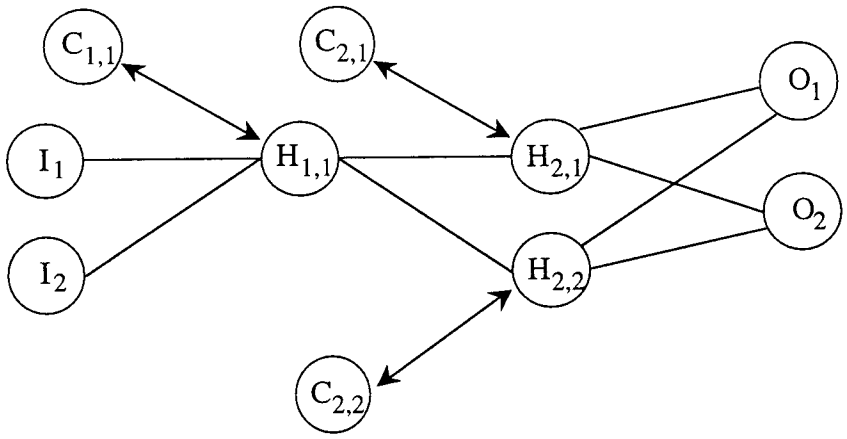
3. (a) List at least 6 different learning paradigms and briefly explain at least 4 different learning paradigms?

(5 marks)

(b) Neural networks learning is influenced by the learning task that a NN is required to perform. Identify 5 different learning tasks and briefly explain each one of them, especially the purpose and procedure of the learning task.

(7 marks)

4. Given below is a recurrent BP network with two hidden layers.



The weight matrices are as follows:

$$W_{I,H1} = \begin{matrix} 1 \\ 0 \end{matrix}$$

$$W_{H1,H2} = \begin{matrix} -1 & -1 \end{matrix}$$

$$W_{H2,O} = \begin{matrix} 1 & -1 \\ 0 & 1 \end{matrix}$$

The connection weights from the context units (C) to the hidden units is always equal to 1.

Use the above NN to learn the time series Itime = [(1, -1), (0, 1)]

Use the bipolar sigmoid function with slope parameter = 1

Using a learning rate = 0.2

(12 marks)

5. (a) Given is a Maxican Hat neural network with 8 units (arranged in a single row) in the output layer.

Specifications of the NN are as follows:

Radius = 4

Inner radius = 2

C1 (activation level of unit with +ve lateral connection) = 0.8

C2 (activation level of unit with -ve lateral connection) = -0.2

The activation function is

$$F(x) = \begin{cases} 0 & \text{if } x < 0 \\ x & \text{if } 0 \le x \le 2 \\ 2 & \text{if } x > 2 \end{cases}$$

Input pattern = (0.0, 0.2, 0.5, 1.0, 0.8, 0.5, 0.0 , 0.4)

Apply the Maxican Hat learning algorithm for 2 cycles and show the final activation level of the units.

(8 marks)

(b) Discuss the three basic principles of self-organisation in a neural network?

(4 marks)

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

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

The set of training patterns is

Pattern	**Class**
[0.2, 0.4, 0.1]	A
[1.0, 1.0, 0.2]	B
[1.0, 0.5, 0.5]	C

(a) Use the Kohonen map learning algorithm on the above SOM to learn the training patterns for 1 epoch only.

Learning rate = 0.2 Neighbourhood = 1

(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 = 0.25

(5 marks)

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