UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2009/2010

April 2009

EEE 551 – INTELLIGENT SYSTEMS

Duration: 3 hours

INSTRUCTION TO CANDIDATE:

Please check that this examination paper contains **SEVEN (7)** pages of printed material before you begin the examination.

This paper contains **SIX (6)** questions.

Instructions: Answer **FIVE (5)** questions.

Answer to any question must start on a new page.

Distribution of marks for each question is given accordingly.

All questions must be answered in English.

1. (a) What triggered interests in the field of Artificial Intelligence (AI)? Explain machine learning in relation to AI.

(20%)

(b) Briefly explain the procedures required for the development of an expert system.

(25%)

(c) Identify six applications areas where reasoning under conditions of uncertainty is necessary and explain briefly why.

(30%)

(d) Pick one of the areas in (c) above and design four inference rules that might be used for reasoning in that domain (Hint: you may recall, use and state the conditions that you encountered while preparing your group project during the semester).

(25%)

2. (a) Determine whether goal-driven or data-driven search would be preferable for solving each of the following problems. Justify your answers.

(i) a knowledge base system to assist a human in classifying tropical trees by species, genus etc.

(ii) to build a system that would be able to examine sonar readings, interprete them and then be able to distinguish between a whale from a school of fish.

(iii) diagnosing mechanical problems in a space travel machine.

(30%)

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(b) Consider the following rule base. Perform backward chaining to get to the goal, the final attribute of which is ‘status’, with the aid of diagrams showing working space and rules that are fired.

R1: IF temperature is high THEN pressure is high
R2: If pressure is high AND fluid is high THEN status is dangerous
R3: IF chiller is on THEN temperature is high
R4: IF status is dangerous THEN chiller is on

(40%)

(c) What are the two different approaches in dealing with uncertainties? Explain in detail for each, giving examples of past real applications for the two.

(30%)

3. (a) Assume that A and B are fuzzy sets. X is the universe of discourse. C is the union of A and B while D is the intersection of A and B.

(i) Represent C and D using appropriate normal set notations

(ii) Represent C and D using notations in fuzzy set theory

(20%)

(b) Describe the principle difference between the so-called Mamdani inference method and the Sugeno inference method.

(20%)

(c) Toshiba is contemplating a new DVD product – and has created the following FAM Table to relate Demand and Manufactured Cost to Price:

Price

	Manufactured Cost	
Demand	Cheap	Expensive
Small	Low	Medium
Large	Medium	High

The product manager has estimated the following trapezoidal/triangular normalized membership functions:

Demand (in millions of units annually)

Small $\{100, 1 \quad 300, 0\}$ Large $\{150, 0 \quad 350, 1\}$

Manufactured Cost (in yen per unit)

Cheap $\{10, 1 \quad 20, 0\}$ Expensive $\{12, 0 \quad 24, 1\}$

Price (in cost in yen per unit)

Low $\{20, 1 \quad 35, 0\}$ Medium $\{25, 0 \quad 35, 1 \quad 45, 0\}$ High $\{35, 0 \quad 50, 1\}$

(i) Create the rule base for this situation. (20%)

(ii) Graph the membership functions for Demand, Manufactured Cost and Price.

(20%)

(iii) If the Demand Forecast = 250 and the Manufactured Cost Forecast = 15, decide upon Price using the max min technique and centroid defuzzification (you can estimate the centroid location).

(10%)

(iv) If the Demand Forecast = 300 and the Manufactured Cost Forecast = 18, decide upon Price using the max min technique and centroid defuzzification (you can estimate the centroid).

(10%)

4. (a) Explain *two* different learning methods of artificial neural networks. For each learning method, discuss an application example that is suitable for the corresponding method.

(30%)

(b) Table 1 shows four patterns that belong to two classes. Illustrate how the Adaline can be used to categorise the four patterns into two separate classes.

Input Pattern	Class
(0.35, 0.75)	1
(0.15, 0.95)	1
(0.85, 0.35)	-1
(0.75, 0.25)	-1

Table 1

The initial weight vector is

$$\boldsymbol{w}(0) = \begin{bmatrix} 0.35 \\ 0.83 \\ -0.55 \end{bmatrix}$$

Assume that the learning rate is 1.0, and the threshold is 0.0. Calculate the net inputs, error signals, and weight vectors of the four patterns for the first cycle.

(70%)

5. (a) Draw a diagram to illustrate the structure of a simple artificial neuron. Given an m-dimensional input vector, $\boldsymbol{x} = (x_1, \cdots, x_m)$, describe the operations that are needed in processing the input signal until an output signal is obtained using the simple artificial neuron.

(30%)

(b) By using a suitable example, describe how Perceptrons can be assembled to form a Multi-layer Perceptron network to solve linearly non-separable classification problems.

(35%)

(c) By using an illustration, list and label the main components of the attentional sub-system and the orienting sub-system in a generic unsupervised Adaptive Resonance Theory (ART) neural network.

(35%)

6. (a) What is a genetic algorithm? Explain the step-by-step procedure of a genetic algorithm in tackling a constrained optimization problem.

(30%)

(b) Discuss two main properties of a genetic algorithm that have made the method popular for solving optimization problems.

(30%)

(c) Explain the following terminologies with regard to a genetic algorithm

(i) elitism
(ii) deterministic sampling
(iii) crossover
(iv) mutation

(40%)

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