UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2008/2009

April - May 2009

EEE 551 – INTELLIGENT SYSTEM

Duration: 3 hours

Please check that this examination paper consists of NINE pages of printed material before you begin the examination.

This paper contains SIX 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) Can robots think? (30%)

(b) Explain why experts usually have detailed knowledge of a limited area of a specific domain.

(30%)

(c) What is an expert system shell? With reference to the expert system shell that you have chosen to be of use in your group project, explain how it has dramatically reduced the development time of your project.

(40%)

2. (a) When can knowledge be inexact and data incomplete or inconsistent? Give an example of inexact knowledge.

(20%)

(b) Why was the PROSPECTOR team able to apply the Bayesian approach as an uncertainty management technique? What requirements must be satisfied before Bayesian reasoning will be effective?

(20%)

(c) A lecturer who is attached to the University Hospital HUSM/Kubang Kerian has a lot of work to do. Given the following rules, try to prove that the doctor's mood is bad mood, using back word claiming. The initial facts are (i) month is April (ii) year is 2009.

(1) IF (lecturing X)

AND (marking-practicals X)
THEN (overworked X)

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(2) IF (month April)
THEN (lecturing Adam)

(3) IF (month April)
THEN (marking practical Adam)

(4) IF (overworked X)
THEN (bad-mood X)

(5) IF (slept - badly)
THEN (bad-mood X)

(6) IF (month April)
THEN (weather hot)

(7) IF (year 2009)
THEN (economy bad) (35%)

(d) Using the same rules in C, list the sequence of values triggered, assuming that the following are already in the working memory;

(i) lecturing Adam
(ii) month April
(iii) year 2009

(25%)

3. (a) What is the difference between a crisp set and a fuzzy set? Determine fuzzy sets on the universe of discourse for man weights.

(20%)

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(b) What are the main steps in developing a fuzzy expert system. What is the most laborious and tedious part in this process? Why?

(20%)

(c) In making a decision to purchase an airplane, airline managements usually consider the qualities of an airplane's performance. These include the operating costs and reliability. Given the following rules:-

RULE 1 : IF operating cost is excellent
or reliability is good
then performance is high

RULE 2 : IF operating cost is good
Or reliability is fair
Then performance is average

RULE 3 : IF reliability is poor
Then performance is low

($\forall$ means for all)

The membership functions OPERATING COST, RELIABILITY and PERFORMANCE are as follows:-

$\mu^{\text{excellent}}_{\text{OPERATING COST}}(x) = 0, \forall x \le 40$	$\mu^{\text{excellent}}_{\text{OPERATING COST}}(x) = 1, x \ge 60$
$\mu^{\text{good}}_{\text{OPERATING COST}}(x) = 0, \forall x \le 20$ & $\forall x \ge 60$	$\mu^{\text{good}}_{\text{OPERATING COST}}(x) = 1, x = 40$
$\mu^{\text{bad}}_{\text{OPERATING COST}}(x) = 0, \forall x \ge 30$	$\mu^{\text{bad}}_{\text{OPERATING COST}}(x) = 1, x \le 20$
$\mu^{\text{good}}_{\text{RELIABILITY}}(x) = 0, \forall x \le 35$	$\mu^{\text{good}}_{\text{RELIABILITY}}(x) = 1, x \ge 40$
$\mu^{\text{fain}}_{\text{RELIABILITY}}(x) = 0, \forall x \le 10$ & $\forall x \ge 50$	$\mu^{\text{fain}}_{\text{RELIABILITY}}(x) = 1, x = 30$
$\mu^{\text{poor}}_{\text{RELIABILITY}}(x) = 0, \forall x \le 20$	$\mu^{\text{poor}}_{\text{RELIABILITY}}(x) = 1, \forall x \le 10$
$\mu^{\text{high}}_{\text{PERFORMANCE}}(x) = 0, \forall x \le 40\%$	$\mu^{\text{high}}_{\text{PERFORMANCE}}(x) = 1, \forall x \ge 60\%$
$\mu^{\text{average}}_{\text{PERFORMANCE}}(x) = 0, \forall x \le 20\%$ & $\forall x \ge 60\%$	$\mu^{\text{average}}_{\text{PERFORMANCE}}(x) = 1, \quad 30\% \le x \le 50\%$
$\mu^{\text{low}}_{\text{PERFORMANCE}}(x) = 0, \forall x \ge 40\%$	$\mu^{\text{low}}_{\text{PERFORMANCE}}(x) = 1, \forall x \le 20\%$

(i) Use the rule base to make the mappings to compute performance of the airplane. Using the Centre of Area (COA) method in the defuzzification stage. Show clearly the stages in the calculation how you arrive at the answer, given that the factors for the operation cost and reliability are 30 and 40 respectively.

(30%)

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(ii) Compute again, this time using the min-max composition method. (20%)

(iii) Comment on any difference between the results of the calculation in (i) and (ii). (10%)

4. Answer the following terminology questions:

(a) Explain the term *overfitting* in artificial neural network training process, i.e. what is it, how it occurs and how to prevent it. (20%)

(b) Explain how the problem of *overtraining* can be eliminated. (10%)

(c) What is meant by *generalization* in artificial neural network, why is it important and how do we ensure that generalization is achieved? (30%)

(d) Explain the problem of *linearly non-separable*. Name an artificial neural network model and an elementary logical function that make a good example for such a problem. Use a diagram to illustrate the phenomenon. Then, name an artificial neural network model which can be used to solve such a problem. (40%)

5. Answer the following questions:

(a) Differentiate a Self-Organizing Feature Map from a Hopfield neural network in terms of their:

(i) architecture,
(ii) learning scheme, and
(iii) speed, memory capacity and efficiency of learning (15%)

(b) A company requests you to solve a failure detection problem of a control system given by the following conditions:

Machine Conditions				**Machine State**
Temperature, T > 100°C	Pressure, P > 100kPa	Liquid Level, L > 1 m	Power Dissipation, D > 1000kW	
No	No	No	No	Good
No	No	No	Yes	Good
Yes	No	Yes	No	Fail
No	No	Yes	No	Good
No	No	Yes	Yes	Fail
No	Yes	No	No	Good
No	Yes	No	Yes	Fail
Yes	No	No	No	Good
Yes	Yes	Yes	Yes	Fail

You decided to use a Multi-Layer Perceptron (MLP) neural network to solve the problem.

(i) What would be the machine's state if the T=Yes, P=Yes, L=No, D=Yes?

(5%)

(ii) Draw the schematic diagram of the MLP neural network, complete with the correct numbers of input and output nodes, biases and their connection links. Use two hidden nodes.

(25%)

(iii) Suppose you decide to use the value of 0.5 for all initial weights and 1.0 for all biases, calculate the MLP output values.

(50%)

(iv) Using a logarithmic sigmoidal activation function, determine the final output values.

(5%)

6. Assume we want to produce a string to solve a binary search problem involving 11 choices, and that the optimal solution to the problem is a string of eleven 1's. Consider the following population of four chromosomes A, B, C and D:

A	01101100110
B	11001000111
C	01110101011
D	10000111011

(a) Write an appropriate fitness function and determine the fitness rating of each chromosome.

(25%)

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(b) Give the probabilities that a Roulette wheel selection method would assign to each chromosome.

(15%)

(c) Suppose spinning the wheel yields A and C as a breeding pair, and that we apply two point crossover at bits four and eight. What are the two chromosomes that results?

(25%)

(d) Purely, in terms of fitness, which chromosomes would be passed on to the next generation in the population above? Justify your answer.

(25%)

(e) Given the starting population, is it possible to obtain an optimal solution using crossover alone? Why or why not?

(10%)

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