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CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JANUARY 2014 SESSION

SUBJECT CODE	:	**FSB33303**
SUBJECT TITLE	:	**ARTIFICIAL INTELLIGENCE**
LEVEL	:	**BACHELOR**
TIME / DURATION	:	**3 HOURS**
DATE	:	

INSTRUCTIONS TO CANDIDATES

1. **Please read the instructions given in the question paper CAREFULLY.**
2. **This question paper is printed on both sides of the paper.**
3. **Please write your answers on the answer booklet provided.**
4. **Answer should be written in blue or black ink except for sketching, graphic and illustration.**
5. **This question paper consists of TWO (2) sections, Section A and B. Answer ALL questions in Section A. For Section B, answer two (2) questions only.**
6. **Answer all questions in English.**
7. **Graph paperis appended.**

THERE ARE 10 PRINTED PAGES OF QUESTIONS, ONE PAGE OFAPPENDIX ANDONE PAGE OF GRAPH PAPER EXCLUDING THIS PAGE

SECTION A(Total: 40 marks)

INSTRUCTION: Answer ALL questions.

Please use the answer booklet provided.

Question 1

(a) Explain briefly the following artificial intelligence branches:

i. Neural Networks

(2 marks)

ii. Genetic Algorithm

(2 marks)

(b) Draw the basic model structure of rule-based expert system

(5 marks)

(c) Define "Conflict Resolution" and give two methods used to solve it in an Expert System.

(3 marks)

(d) Figure 1 shows a hybrid intelligent system which consists of two artificial intelligence techniques. Name these two techniques.

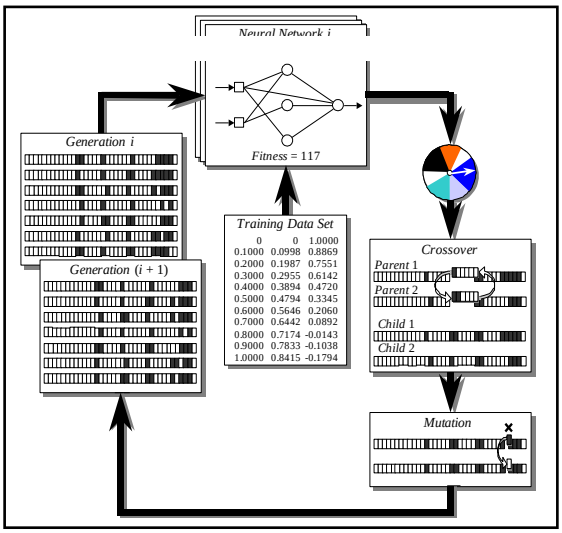


Figure 1: Hybrid Intelligent System

(2 marks)

(e) Given the Rule-based expression:

"If the temperature of the room is more than 50 degree Celcius then turn on the blower to 80% of its capacity"

Modify the expression by adding Fuzzy Logic to represent Linguistic Imprecision.

(2 marks)

(f) List four (4) steps to solve fuzzy inference in Mamdani' style and Sugeno's style

(4 marks)

Question 2

(a) Define meta-knowledge and its metarules

(5 marks)

(b) Table 1 below shows the Prior and Conditional Probabilities with Hi as hypothesis and E1, E2 and E3 are evidences.

Table 1: Prior and Conditional Probabilities

	Hypothesis		
Probability	**i = 1**	**i = 2**	**i = 3**
p(Hi)	0.3	0.4	0.3
p(E1|Hi)	0.2	0.1	0.5
p(E2|Hi)	0.9	0.1	0.2
p(E3|Hi)	0.1	0.3	0.8

Given below the general equation of probability of multiple evidences and multiple hypothesis:

$$p(H_i|E_1 E_2 \ldots E_n) = \frac{p(E_1|H_i) \times p(E_2|H_i) \times \ldots \times p(E_n|H_i) \times p(H_i)}{\sum_{k=1}^{m} p(E_1|H_k) \times p(E_2|H_k) \times \ldots \times p(E_n|H_k) \times p(H_k)}$$

i. By observing evidence E3, calculate the probability of hypothesis H for i = {1,2,3}. What can be said on the belief in H1 compared to belief in H2 and H3?

(4 marks)

ii. Now, evidence E1 is observed, calculate the probability of hypothesis H for i = {1,2,3}. What can be said on the belief of H3 compared to belief in H2 and H1?

(4 marks)

iii. Now, the third evidence E2 is observed, calculate the probability of hypothesis H for i = {1,2,3}. Which of the hypothesis is likely to happen? Justify your answer.

(4 marks)

iv. Give conclusions on all hypothesis calculated in Question 2 (b)(i – iii).

(5 marks)

SECTION B(Total: 60 marks)

INSTRUCTION: Answer TWO (2) questions only.
Please use the answer booklet provided.

Question 3

(a) DetermineCentre Of Gravity (COG) for the following output membership functions in Figure 2. Show your calculations.

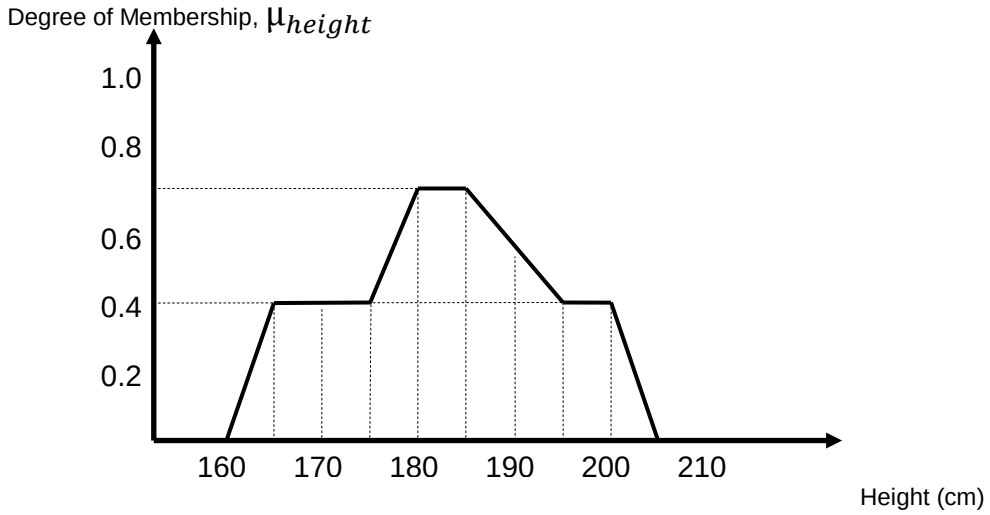


Figure 2: Graph of membership function

(5 marks)

(b) Determine the mathematical expressions of the membership functions C1 & C2 in Figure 3. Show your calculations.

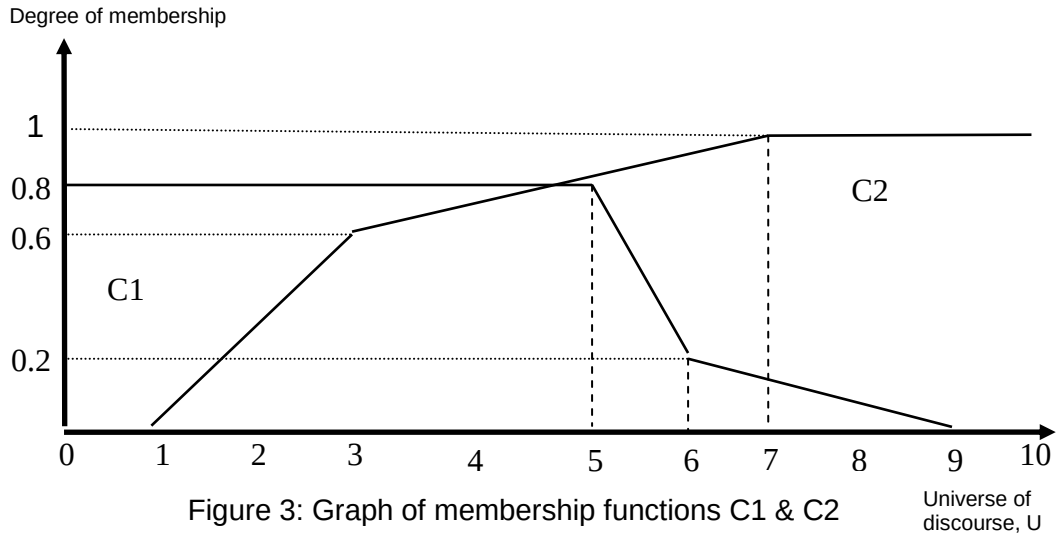


Figure 3: Graph of membership functions C1 & C2

(15 marks)

(c) The two graphs in Figure 4 represent the membership functions for **strong_wind** and **high_altitude**.

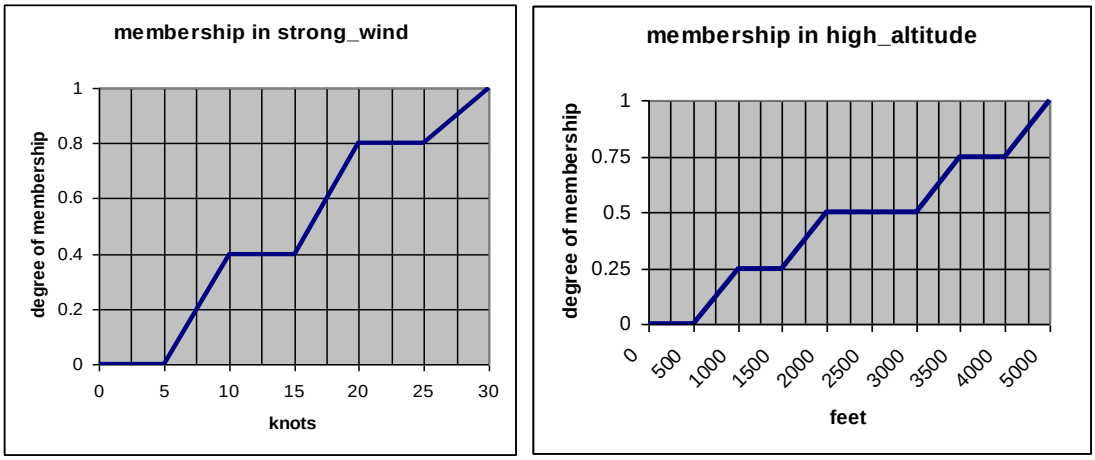


Figure 4: Membership functions for strong_wind and high_attitude

Given the rule as follow:

IF wind is very verystrong_wind OR NOT altitude is less high_altitude THEN condition is bad_turbulence

If the altitude is now 3000 feet and the wind is 22 knots, determine the membership degree value of the current conditions in **bad_turbulence**? Show all your works.

Note: Use Concentration CON(F) equal to square of F to express the hedged value of VERY, LESS using the power of 0.5 and complement for NOT.

(10 marks)

Question 4

(a) Draw and label a multilayer perceptron with an input layer of four neurons, two hidden layers of three neurons each and an output layer of four neurons

(6 marks)

(b) Figure 5 shows the outputs of the perceptrons from three inputs (0.2, 0.3 & 0.9) on the left. The weight of each link (0.1, 0.7 & 0.8) is shown at the link. The function at perceptron P is: *F(in) = in*

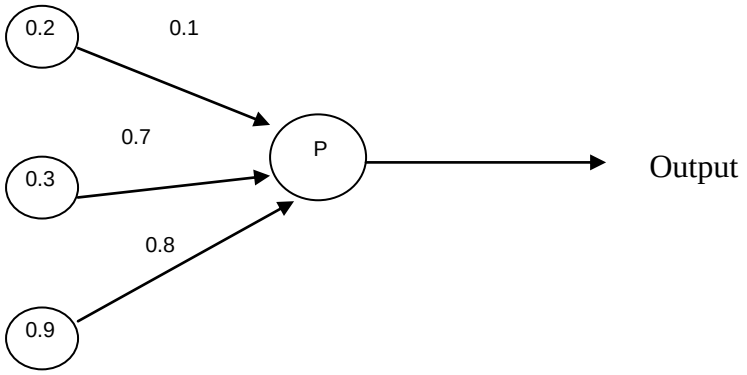


Figure 5: Single layer perceptron

i. What is the output of perceptron P?

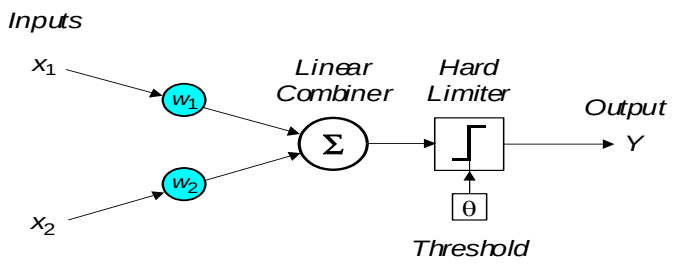
(3 marks)

ii. Given that the actual output is 1.0 and the learning rate multiplier k is equal to 0.2, calculate the new adjusted weights w1, w2 and w3 of all links.

(6 marks)

(c) Figure 6 shows a single-layer two input perceptron while Step 1 to step 4 below indicate the perceptron learning process.

Single-layer two-input perceptron



Step activation function

$$Y^{step} = \begin{cases} 1, \text{ if } x \geq 0 \\ 0, \text{ if } x < 0 \end{cases}$$

Figure 6: Single-layer two-input perceptron

<u>Step 1</u>: Initialisation

Initialization of weights w_1, w_2,…,$w_n$and threshold θ to random numbers in the range [-0.5, 0.5].

<u>Step 2</u>: Activation

Activation of the perceptron by applying inputs $x_1(p)$, $x_2(p)$,…,$x_n(p)$ and desired output $Y_d(p)$. Calculation of the actual output at iteration p = 1

$$Y(p) = step\left[\sum_{i=1}^{n} x_i(p)\, w_i(p) - \theta\right]$$

where*n* is the number of the perceptron inputs, and *step* is a step activation function.

<u>Step 3</u>: Weight training

Updating weights of the perceptron, $w_i(p+1) = w_i(p) + \Delta w_i(p)$, where $\Delta w_i(p)$ is the weight correction at iteration p. The weight correction is computed by the **delta rule**:

$$\Delta w_i(p) = \alpha \times x_i(p) \times e(p)$$

where the error, $e(p) = Y_d(p) - Y(p)$

<u>Step 4</u>: Iteration

Increment of iteration *p* by one, go back to *Step 2* and repeat the process until convergence.

Using the given information in Question 5(c), you are required to complete Table 2 in **Appendix 1** in order to demonstrate the neural network function to perform the basic Boolean logic operation X_1 **AND** X_2 using learning rate, α = 0.1 and threshold, θ = 0.2.

Show your details calculations for *Epoch 1* (where inputs are **(x1=1 AND x2=0)** and **(x1=1 AND x2=1)**) and then complete Table 2.

Note: *Attach completed Table 2 in Appendix 1 to your answer booklet.*

(15 marks)

Question 5

In an electronics circuit board manufacturing system, laser beam will be used to drill the holes on electronics board. Number of the holes, *n* depends on the different type of electronics board applications. For each electronics board type, laser system will be at the position of all the holes (*Hole-1, Hole-2,…., Hole-n*). Starting with position at *Hole-1*, laser beam will drill hole and then move to next hole's position. The process repeats until the last hole (*Hole-n*) is drilled. Once the process is completed, the laser system will *reposition itself* at the initial position which is Hole-1 and the system is ready for the next circuit board. The movement of this laser system throughout all the holes can be represented in the form of single path or trajectory.

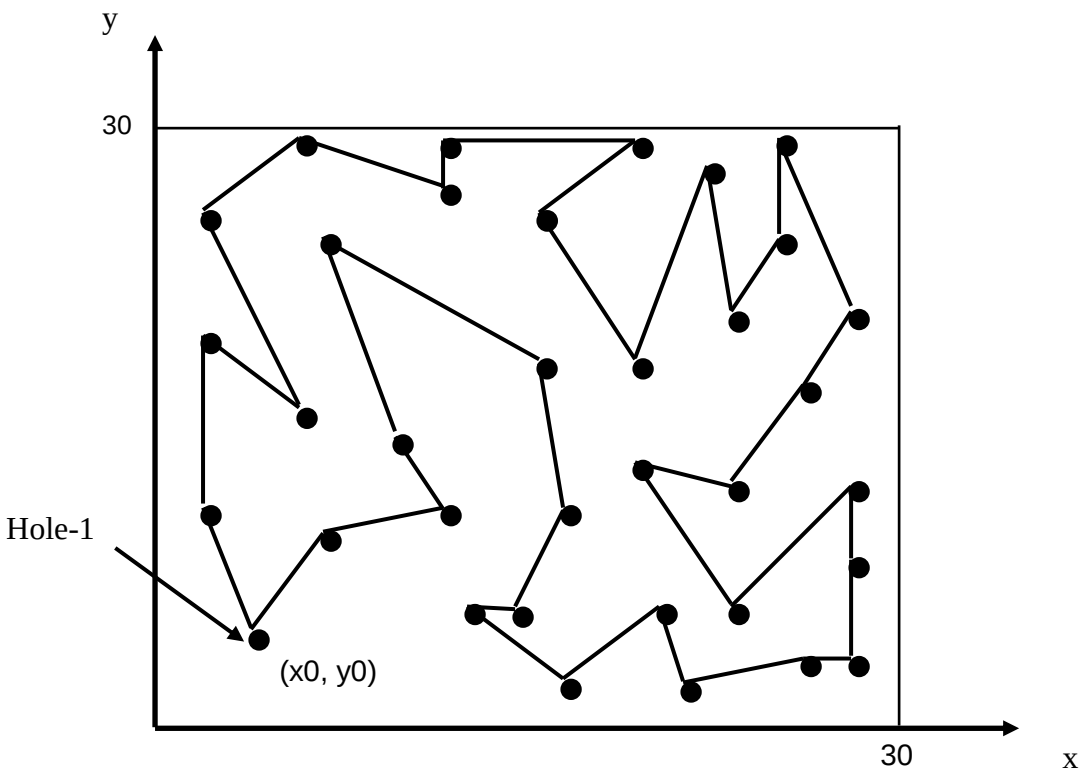


Figure 7: Trajectory of laser system to drill 35-holes circuit board

Figure 7 shows a set of **35 positions** of the holes to be punched by a laser beam on the surface of an electronic board. The **width** and **length** of each board is **30 cm** respectively, therefore it can be represented in two dimensional x, y plane axes with $0 \le x \le 30$ and $0 \le y \le 30$. The values of **x** and **y** are in centimeter units. The best distance between two holes can be calculated as the shortest straight line between these holes. In the same Figure 6, an example of a single trajectory which has gone through all these 35 holes is shown.

An engineer has been requested by his employer to find the shortest trajectory for the laser system to drill all the holes on any circuit board. With this shortest trajectory, the company could save a lot of money by reducing the time and power consumption of the laser system. So, with the instruction given, the engineer study, calculate and estimate the shortest trajectory for the system. However, he realizes that the number of solutions in term of possible trajectories is extremely huge and it is not possible for him to find it within a short time.

Your task is to propose to this engineer the shortest trajectory. Realizing that the search space of all possible solutions is huge, you will have to implement *Genetic Algorithm* (GA) to

find the shortest trajectory for this *35 holes* circuit board as in Figure 6. The following questions are very important to your understanding and creativity in order to solve this problem.

(a) Give mathematical definition of distance D between two points (x, y).

(2 marks)

(b) How many genes can be created in a single chromosome?

(2 marks)

(c) What represents a single chromosome?

(2 marks)

(d) State the fitness function and justify your answer

(2 marks)

(e) By using illustrated figures and an example of population size equal to 10, explain in detail the process of *Roulette-Wheel* Selection Scheme that you are going to use in your GA.

(10 marks)

(f) By using illustrated figures, explain in details how the Genetic Algorithm works for its first two generations.

(10 marks)

(g) When GA finishes, does the engineer now has the shortest trajectory of the laser system? Justify your answer.

(2 marks)

END OF QUESTION

APPENDIX 1

Table 2: Perceptron Learning

		Inputs		Desired output	Initial weights		Output before activation	Actual output	Error	Final weights	
Epoch	**p**	x_1	x_2	Y_d	w_1	w_2		$Y(p)$	e	$w_1(p+1)$	$w_2(p+1)$
1	1	0	0	0	0.4	0.1	-0.2	0	0.0	0.4	0.1
	2	0	1	0	0.4	0.1	-0.1	0	0.0	0.4	0.1
	3	1	0	0							
	4	1	1	1							
2	5	0	0	0							
	6	0	1	0							
	7	1	0	0							
	8	1	1	1							
3	9	0	0	0							
	10	0	1	0							
	11	1	0	0							
	12	1	1	1							
4	13	0	0	0							
	14	0	1	0							
	15	1	0	0							
	16	1	1	1							

Threshold:	θ =	0.2
Learning Rate:	α =	0.1