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SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
SEPTEMBER 2014 SESSION

SUBJECT CODE	:	**FSB33303**
SUBJECT TITLE	:	**ARTIFICIAL INTELLIGENCE**
LEVEL	:	**BACHELOR**
TIME / DURATION	:	**9.00 AM – 12.00 PM (3 HOURS)**
DATE	:	**5 JANUARY 2015**

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 paper is appended.**

THERE ARE 11 PRINTED PAGES OF QUESTIONS, ONE PAGE OF APPENDIX AND ONE 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) Based on the conversation below, state the most suitable Artificial Intelligence technique that could be used to solve the problem under discussion. Justify your answer.

Mechanic: Hello, how may I help?
Driver: My car wouldn't start.
Mechanic: What happens when you turn the key in the ignition to try to start the car?
Driver: It turns over OK, but it just won't start.
Mechanic: Have you checked that you aren't out of petrol?
Driver: I'm not certain the tank is empty.
Mechanic: Based on what you've told me, I'm almost certain your car is out of petrol.
Driver: Thanks for the advice. Mind telling me how you reached your conclusion?
Mechanic: As you crank the starter, do you smell petrol?
Driver: No, I turned it over for a long time, but didn't smell anything.
Mechanic: When a car won't start my initial suspicion is that the battery is dead, the starter has failed or some other electrical problem exists.

(2 marks)

(b) Draw and label the complete structure of a rule-based expert system.

(5 marks)

(c) List and explain the roles of three (3) expert system development team members.

(3 marks)

(d) Table 1 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)	0.8	0.7	0.6
p(E1|Hi)	0.1	0.7	0.2
p(E2|Hi)	0.4	0.1	0.5
p(E3|Hi)	0.3	0.7	0.9

The general equation of probability of multiple evidences and multiple hypothesis is given as below:

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

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, H2 and H3? Justify your answer.

(4 marks)

ii. In addition to observation of E3, evidence E1 is now being observed. Determine the probability of hypothesis H for i = {1,2,3}. Which hypothesis is now most likely to occur? Justify your answer.

(4 marks)

iii. With E3 and E1 observed, the third evidence E2 is now being observed. Calculate the probability of hypothesis H for i = {1,2,3}. What can be concluded on H1, H2 and H3? Justify your answer.

(4 marks)

iv. Give conclusions on all hypothesis calculated in Question 1 (c) (i – iii).

(3 marks)

Question 2

(a) List the four steps to solve fuzzy inference in Mamdani' style and Sugeno's style.

(4 marks)

(b) Give one example of termination criteria in Genetic Algorithm.

(1 mark)

(c) The two graphs in Figure 1 represent the membership functions for *strong_wind* and *high_altitude.*

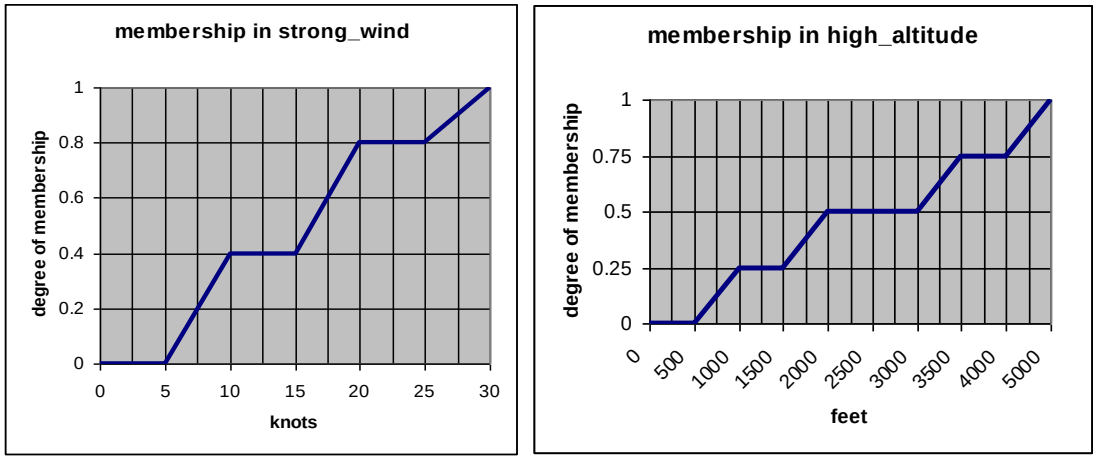


Figure 1: Membership functions for strong_wind and high_attitude

Given the rule as follow:

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

If the altitude is now 4000 feet and the wind is 12 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)

SECTION B (Total: 60 marks)

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

Question 3

(a) Three persons, Haron, Khairul and Amin are going to purchase new notebooks. Each of them has their own interest towards the processor type, reliability and price of the notebooks. Their interests are shown in Table 2.

Table 2: Interest on notebooks

Buyer/Feature	Processor Type (Pt)	Reliability (Rb)	Price (Pr)
Haron (H)	Important	Very Important	Not Important
Khairul (K)	Very Important	Important	Important
Amin (A)	Not Important	Very Important	Rather Important

The three types of interests above have been classified in terms of fuzzy membership degree as shown in Table 3.

Table 3: Fuzzy membership degree

Interests	Fuzzy Membership
Most Important	1.0
Very Important	0.8
Rather Important	0.5
Important	0.3
Not Important	0.1

In a survey done on the internet, the popularity of four popular notebooks [Dell, Compaq, Toshiba, and Acer] according to the 3(three) features (processor type, reliability, and price) is given in Figure 2.

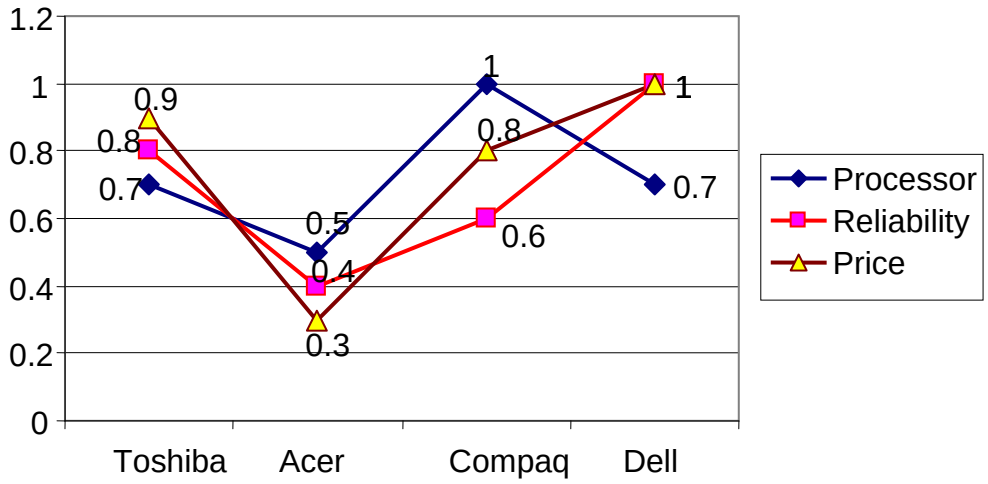


Figure 2: Popularity of four notebooks

Therefore, three different sets: B, F and M defined as the following:

- Set of Buyers: B = {Haron, Khairul, Amin}
- Set of Features: F = {Pt, Rb, Pr} = {processor, reliability, price}
- Set of Notebooks: N = {Dl, Cq, Tb, Ac} = {Dell, Compaq, Toshiba, Acer}

i. Using the given information in Table 2, write down the fuzzy relation Buyer-Feature, P(B,F).

(3 marks)

ii. Using the given information in Figure 3, write down the fuzzy relation Feature-Notebooks, Q(F,N).

(3 marks)

iii. Develop the max-min composition $P \circ Q$ of the two fuzzy relations of P(B,F) and Q(F,N), which can help the buyer to choose the proper cars. Show your calculations.

(7 marks)

iv. From the results in (a)(iii), what type of notebook should Haron, Khairul and Amin buy? Justify your answer.

(2 marks)

(b) Given a fuzzy system with the following two rules:

Rule 1:	Rule 2:
IF *x* is *A1*	IF *x* is *A2*
AND *y* is *B1*	OR *y* is *B2*
THEN *z* is *C1*	THEN *z* is *C2*

Suppose x_0 and y_0 are the sensor reading for linguistic input variables *x* and *y* and the following membership functions for fuzzy sets A1, A2, B1, B2, C1 and C2 are given:

$$\mu_{A1}(x) = \begin{cases} \frac{x-2}{3} & 2 \le x \le 5 \\ \frac{8-x}{3} & 5 < x \le 8 \end{cases} \qquad \mu_{A2}(x) = \begin{cases} \frac{x-3}{3} & 3 \le x \le 6 \\ \frac{9-x}{3} & 6 < x \le 9 \end{cases}$$

$$\mu_{B1}(y) = \begin{cases} \frac{y-4}{3} & 4 \le y \le 7 \\ \frac{10-y}{3} & 7 < y \le 10 \end{cases} \qquad \mu_{B2}(y) = \begin{cases} \frac{y-5}{3} & 5 \le y \le 8 \\ \frac{11-y}{3} & 8 < y \le 11 \end{cases}$$

$$\mu_{C1}(z) = \begin{cases} \frac{z-1}{3} & 1 \le z \le 4 \\ \frac{7-z}{3} & 4 < z \le 7 \end{cases} \qquad \mu_{C2}(z) = \begin{cases} \frac{z-3}{3} & 3 \le z \le 6 \\ \frac{9-z}{3} & 6 < z \le 9 \end{cases}$$

Further assume that at time t_1 we obtain the following sensor readings:
$x_0(t_1) = 3$ and $y_0(t_1) = 7$

From the information given above,

i. Sketch the membership functions A1, A2, B1, B2, C1 and C2 for *x, y* and *z*

(7 marks)

ii. Determine the final output of the fuzzy system using ***Mamdani's*** style inference. Show all your calculations

(8 marks)

Note: You are required to perform all graphical illustrations using graph paper attached

Question 4

(a) Sketch the three-layer back propagation neural networks.

(6 marks)

(b) Figure 3 shows the outputs of the perceptrons with four inputs (0.3, 0.4, 0.7 & 0.5). The weight w1, w2, w3 and w4 of each link (0.3, 0.2, 0.1 & 0.1) are respectively shown at the link. The function at perceptron P is: *F(in) = in*

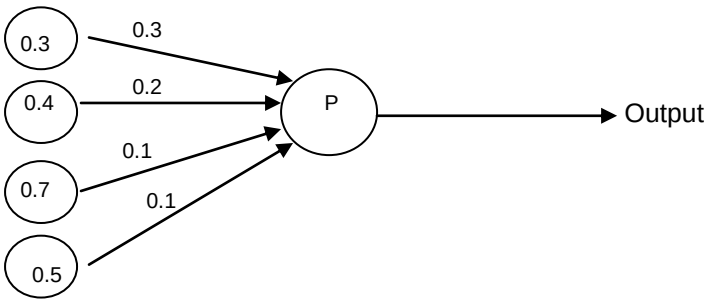


Figure 3: Single layer perceptron

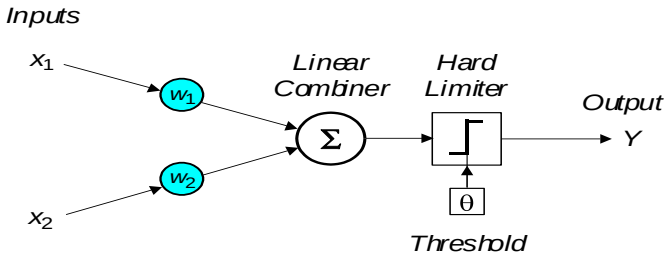
i. What is the output of perceptron P?

(3 marks)

ii. Given that the actual output is 1.0 and the learning rate k is equal to 0.1, calculate the new adjusted weights w1, w2, w3 and w4 of all links.

(6 marks)

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



Step activation function

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

Figure 4: Single-layer two-input perceptron

Step 1: Initialisation

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

Step 2: 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.

Step 3: 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, $e(p) = Y_d(p) - Y(p)$

Step 4: 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 4 in **Appendix 1** in order to demonstrate the neural network function to perform the basic Boolean logic operation ***X₁* OR *X₂*** using learning rate, α = 0.1 and threshold, θ = 0.2.

Show your details calculations for *Epoch 1* (where inputs are **(x1=1 OR x2=0)** and **(x1=1 OR x2=1)**) and then complete Table 4.

Note: Attach completed Table 4 in Appendix 1 to your answer booklet.

(15 marks)

Question 5

A company, MyTech Sdn. Bhd. was created in 2013. In 2014, the management of the company has targeted to launch their first manufactured product from their newly completed manufacturing plant in Cyberjaya. The plant is currently at its final stage to be fully operational and all its systems are being tested in details. However, in this plant, the engineers and the workers are facing problem to optimize the maintenance schedule for several number of manufacturing units. All these units are situated in one of the plant's clean room and they realize that it is very crucial for them to produce an optimized maintenance schedule without jeopardizing the operational and the productivity of the clean room and the plant.

From the information and data gathered, the team has the following inputs and problem constraints:

- There are only three (3) equal time intervals available in 24 hours for the maintenance purposes. The first interval starts at 8.00 am.
- The maximum loads expected during the three intervals are 90, 100 and 80 Megawatt (MW) respectively.
- Maintenance of any unit starts at the beginning of an interval and finishes at the end of the same or adjacent interval. The maintenance cannot be aborted or finished earlier than scheduled.
- The net reserve of the power system in this clean room must be greater or equal to zero at any interval. Therefore, the optimum situation is that the clean room's power system should have the maximum net reserve at any maintenance period
- The requirement and data of the units is shown in Table 5:

Table 5: Unit Data and maintenance requirements

Unit Number	Unit Capacity(Mw)	Number of Interval Required for unit maintenance
1	20	2
2	30	2
3	15	1
4	10	1
5	35	1
6	25	1
7	15	1
8	30	1

An engineer has been requested by his team's superior to produce the maintenance schedule for these units in this clean room. With the instruction given, the engineer study, analyze, calculate and estimate the most appropriate maintenance schedule. However, he realizes that the number of possible solutions is extremely huge and it is not possible for him to find it within a short period of time. As part of the team, you have been asked to provide useful inputs on how to tackle this problem. After team discussion, it is decided that artificial intelligence technique of Genetic Algorithm to be used to solve this problem.

Your task is to propose the best maintenance schedule of this clean room to the engineer and the team. Realizing that the search space of all possible solutions is huge, you will have to implement *Genetic Algorithm* (GA) to find the best maintenance schedule. The following questions are very important to your understanding and creativity in order to solve this problem.

(a) State and explain each step involved in Genetic Algorithm.

(9 marks)

(b) Calculate the total output produced (MW) when they are all operating simultaneously.

(2 marks)

(c) Produce a pool of genes for each unit available in this problem.

(3 marks)

(d) Describe with illustration the structure of a single chromosome.

(2 marks)

(e) Calculate the power lost for each interval based on your chromosome in Question 6 (d).

(6 marks)

(f) From the information in Question 6(e), calculate the actual power capacity and its maximum load produced by the units in the clean room for each interval.

(6 marks)

(g) From the information in Question 6(d) and Question 6(e), explain briefly the fitness function that you propose. Justify your answer.

(2 marks)

END OF QUESTION

APPENDIX 1

Table 4: Perceptron Learning

Epoch	p	Inputs		Desired output	Initial weights		Output before activation	Actual output	Error	Final weights	
		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	0.2	-0.2	-0.2	0	0.0	0.2	-0.2
	2	0	1	1	0.2	-0.2	-0.4	0	1.0	0.2	-0.1
	3	1	0	1							
	4	1	1	1							
2	5	0	0	0							
	6	0	1	1							
	7	1	0	1							
	8	1	1	1							
3	9	0	0	0							
	10	0	1	1							
	11	1	0	1							
	12	1	1	1							
4	13	0	0	0							
	14	0	1	1							
	15	1	0	1							
	16	1	1	1							

Threshold:	θ =	0.2
Learning Rate:	α =	0.1