UNIVERSITI TUNKU ABDUL RAHMAN

ACADEMIC YEAR 2017/2018

DECEMBER EXAMINATION

UEMH3163 / UECS2053 / UECS2153 ARTIFICIAL INTELLIGENCE

SATURDAY, 16 DECEMBER 2017 TIME : 9.00 AM – 11.00 AM (2 HOURS)

BACHELOR OF ENGINEERING (HONS) MECHATRONICS ENGINEERING
BACHELOR OF SCIENCE (HONS) SOFTWARE ENGINEERING
BACHELOR OF SCIENCE (HONS) APPLIED MATHEMATICS WITH COMPUTING

Instructions to Candidates :

This question paper consists of **FIVE (5)** questions.

ANSWER FOUR (4) out of **FIVE (5)** questions in this paper.

EACH question carries **25 MARKS**.

Should a candidate answer more than four (4) questions, marks will only be awarded for the first four (4) questions in the order that the candidate submits the answers. This ignores any questions or sections which the candidate has clearly cancelled out.

Answer questions only in the answer booklet provided.

Q1. (a) Illustrate the basic structure of a rule-based expert system in a block diagram. Explain the function of each structure in the diagram. (13 marks)

(b) Identify FOUR differences between expert systems and conventional programs. (8 marks)

(c) List down TWO advantages and TWO disadvantages of the rule-based expert systems. (4 marks)

[Total : 25 marks]

Q2. (a) Figure 2.1 shows the eight puzzle problem. Recommend a state-space representation for this problem. (4 marks)

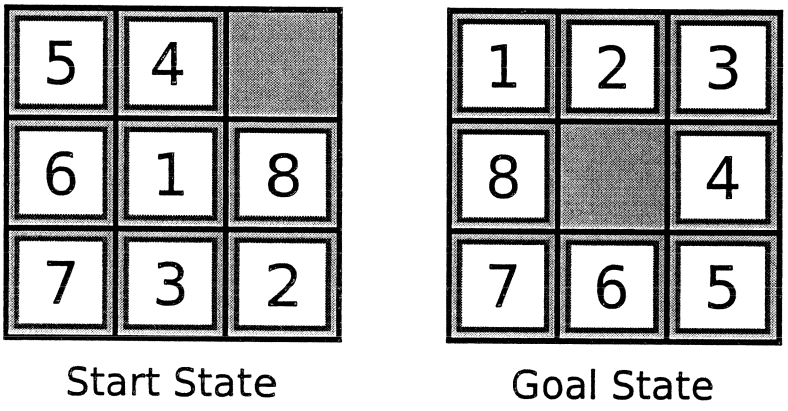

Figure 2.1: Eight puzzle problem

(b) Using breadth-first search, determine the search progress for at least 2 iterations for the problem in Figure 2.1. (6 marks)

(c) Explain the Encoding, Fitness Function, Selection, Elitism, Crossover and Mutation features of Genetic Algorithms (GA) in your own words. (6 marks)

(d) Use the following objective function where each of the genes can be any number between 0 to 9, and the objective is to maximize $f(x)$.
$f(x) = (a-b) + (b-c) + (c+1) - (d-a) + (e-f) - (g+h)$
Perform genetic algorithm for the problem mentioned for 1 generation only. Show all your steps and state all your assumptions necessary. Minimum population size would be 4. (9 marks)

[Total : 25 marks]

Q3. You are tasked with developing a basketball analytics fuzzy inference system to predict a player's chances of scoring (**C**). The inputs considered are distance from the basket (**D**) and player skill (**S**).

Your fuzzy inference system uses triangular (3-point) and trapezoidal (4-point) linear fit membership functions for the following fuzzy sets:-

Input linguistic variable **D**, measured in feet:-
Close – [0 0 10]
Middle – [0 14 22]
Far – [15 28 30 30]

Input linguistic variable **S**, measured on a scale of 0 to 100:-
Poor – [0 0 60]
Average – [15 45 60 90]
Great – [75 100 100]

Output linguistic variable **C**, measured on a percentage basis:-
Low – [0 0 20 50]
Medium – [25 55 80]
High – [55 80 100 100]

The fuzzy rules are as follows:-

1. If **D** is *Far* or **S** is *Poor* then **C** is *Low*
2. If **D** is *Middle* or **S** is *Average* then **C** is *Medium*
3. If **D** is *Close* or **S** is *Great* then **C** is *High*

(a) Illustrate the fuzzy sets for both input linguistic variables **D** and **S**, as well as the fuzzy sets for output linguistic variable **C**. (9 marks)

(b) Evaluate the degree of membership in each input linguistic variable when a player with a skill of 65 attempts a layup from 2 feet away from the basket. (6 marks)

(c) Sketch the aggregate output membership function, and estimate the resulting value of output linguistic variable **C** given the degree of membership values calculated in Q3(b). (5 marks)

(d) After comparing the results of this system with that of real basketball games, the value of **C** is found to be overestimated for players with *Great* skill (**S**), and underestimated for shots from a *Close* distance (**D**). Recommend what tweaks you would make to this fuzzy inference system based on the above findings. (5 marks)

[Total : 25 marks]

Q4. Table 4.1 shows the data set that consists of examination result of three subjects (Mathematic, Chemistry and English) for five students:

Table 4.1 Examination result in Mathematics, Chemistry and English.

Students	Mathematics	Chemistry	English
Aaron	90	86	46
Ben	88	68	56
Catherine	54	58	78
Darren	67	76	81
Evan	45	60	95

You are instructed to categorize these five students into two classes based on their examination results of three subjects as shown in the table by using the technique of K-mean clustering. (Please round all output values to two decimal places for this question. You are expected to use Euclidean distance as distance measure). Based on Table 4.1, answer the following questions.

(a) The first initial centroid must be the average value of these three subjects for Aaron and Ben while the second initial centroid must be the average value of these three subjects for Darren and Evan. Determine these initial centroid for first cluster and second cluster. (4 marks)

(b) Determine the Euclidean distance between the examination results of each student and each centroid. (5 marks)

(c) Based on the calculated Euclidean distance in Q4(b), choose a cluster group for each student. (5 marks)

(d) Recalculate a new centroid for each cluster based on the results in Q4(c). (4 marks)

(e) Continue to assign student to cluster group until no change in centroid for each cluster. (7 marks)

[Total : 25 marks]

Q5. (a) Describe briefly the structure of multilayer perceptron and name one learning algorithm used in multilayer perceptron followed by stating one difference between multilayer perceptron and perceptron. (5 marks)

(b) Figure 5.1 shows the basic structure of a neural network.

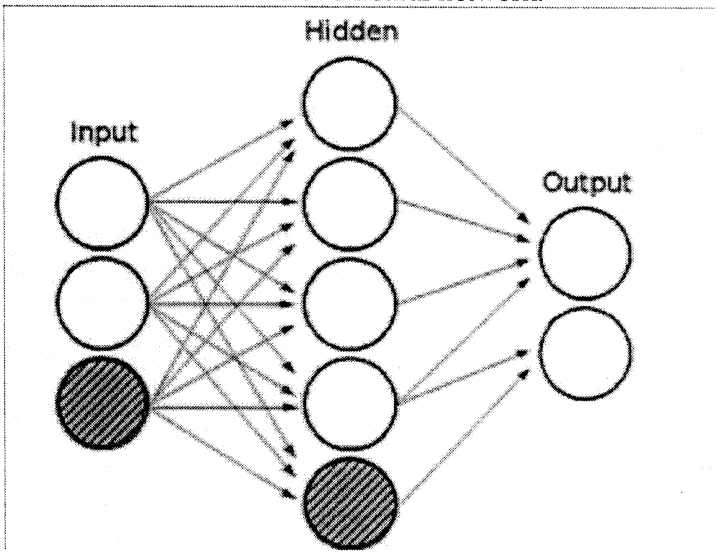

Figure 5.1 : Basic neural network structure

(i) Identify the shaded nodes in the input and hidden layers in the figure 5.1 above. Explain the role of these nodes. (4 marks)

(ii) An activation function is used to generate the output of neural network. Explain how the activation function helps in producing the output. Identify a suitable example of an activation function. (4 marks)

(c) Explain in detail the mechanism of updating weights in multilayer perceptron with two input neurons, two hidden nodes and one output node. Your answer should include all the necessary formulae. (12 marks)

[Total : 25 marks]