EDITH COWAN UNIVERSITY PERTH WESTERN AUSTRALIA		**INTERNAL/EXTERNAL** Sample
Unit Code and Title	**CSG2341 Intelligent Systems**	**STANDARD PAPER**
Student Name:		
Student Number:		

Duration	Reading time 5 minutes Working time 2 hours Total time 2 hours 5 minutes
Attempt	Part A: All questions Part B: 1 out of 2 questions
Marks	As indicated on paper Part A: 30 Marks Part B: 20 Marks
Type of Exam	**Closed Book** exam
Special Instructions	• This examination paper consists of 2 parts. • There is a total of 12 pages. • Part A is to be answered **on the paper.** • Part B is to be answered **in the answer book**.

Students are not permitted to write on the examination or any other paper during reading time.

Do not commence the examination until you are told to do so.

Part A - 30 Marks
ANSWER ALL 3 QUESTIONS

There are three questions in this part, each worth 10 marks. Answer all three questions in the spaces provided. If you run out of room, you may write some answers in the answer booklet (make sure you clearly label them).

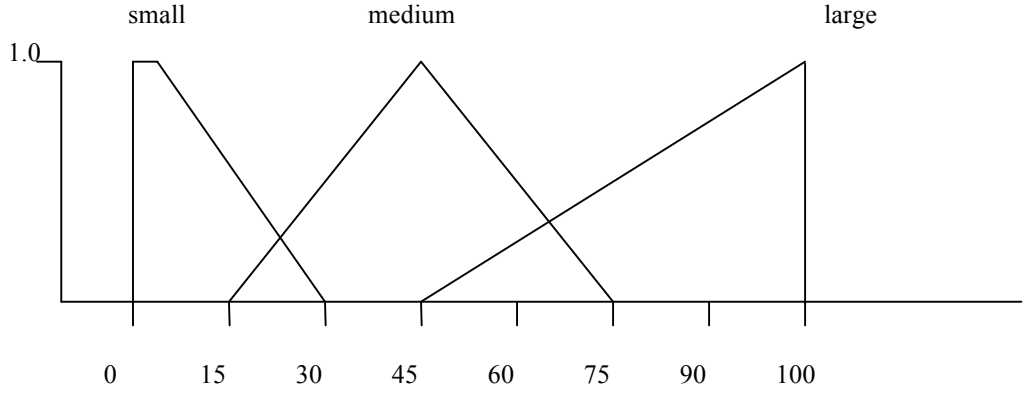
1. **Fuzzy Systems** (10 marks)

   A "street fighting" computer game requires a computer-controlled opponent so that players can practice. You have been given some rules that the computer-controlled player should use, to decide how to behave. The rules take into account the player's health level and the opponent's health level (e.g. 0 to 100 health points), as well as the skill levels of the two players (e.g. 1 dan to 9 dan). The possible actions include "dodge", "attack" and "block".

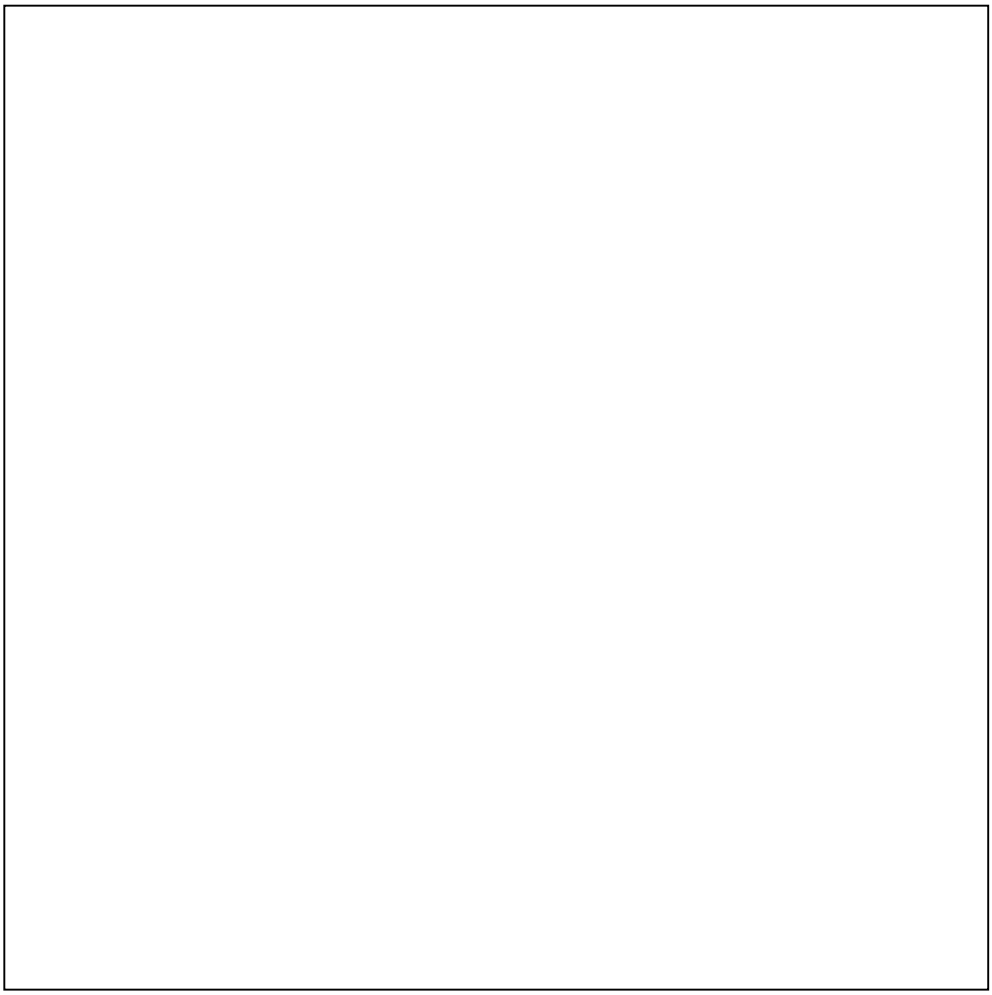
   a. One input variable for the fuzzy system might be **the player's health** (call this **player_health**). What other input variable(s) might the fuzzy system use? (1 mark)

   b. What would be the output (control) variable(s) of the fuzzy system? (1 mark)

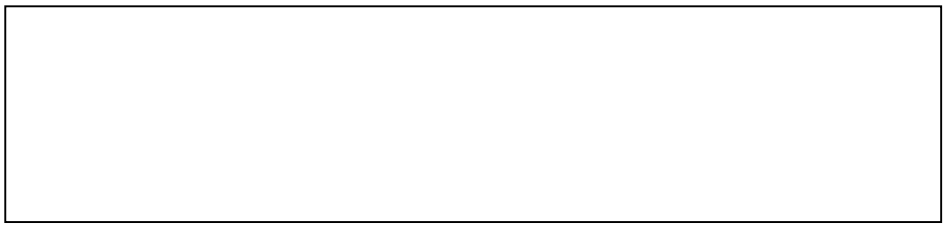
   c. The following diagram shows a possible set of linguistic values for **player_health**. Use this diagram to show how to calculate the membership value in the fuzzy set **medium** of the crisp value 4kg. (1 mark)



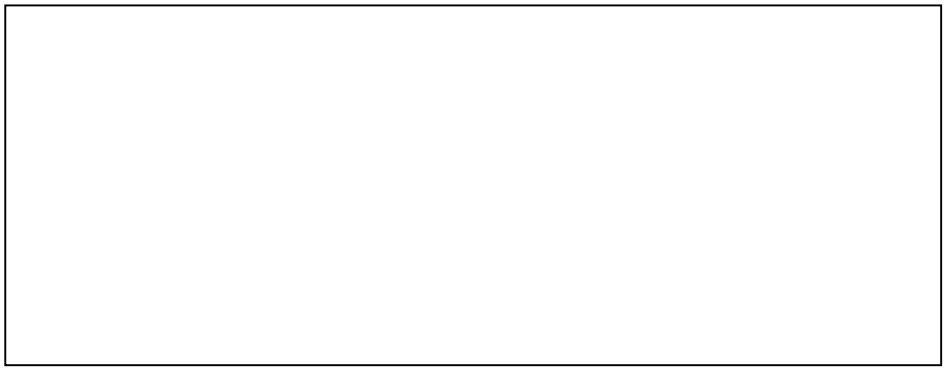
d. Draw diagrams showing possible sets of linguistic values for the other input variables(s) and the output variable(s). (2 marks)



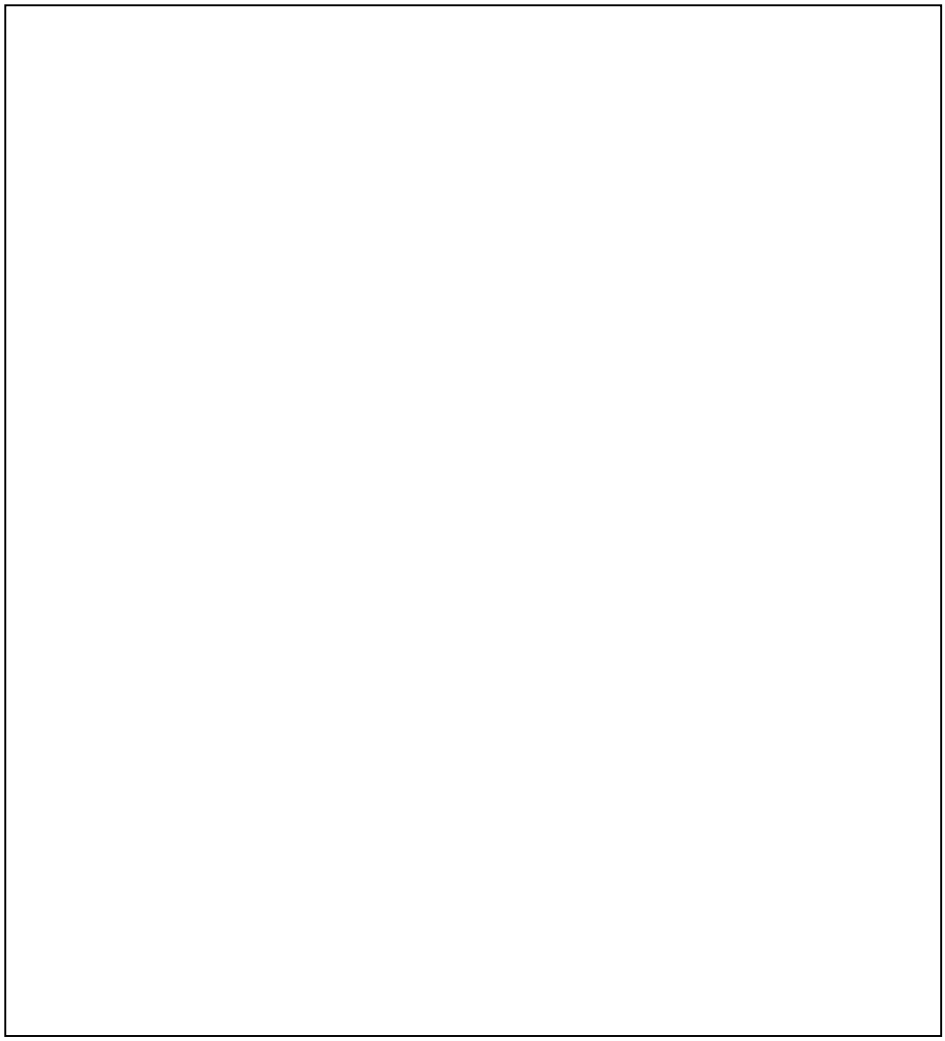
e. Give an example, in the form of an if-then rule, of one fuzzy rule that might be used in your fuzzy control system. (1 mark)



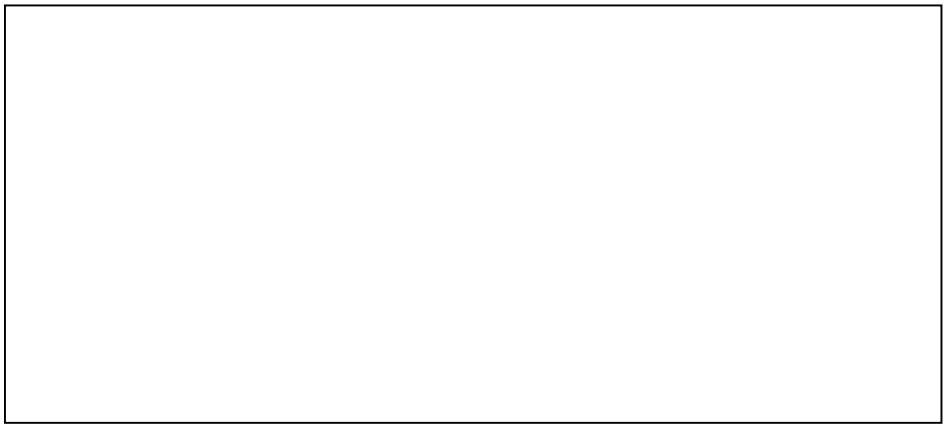
f. Draw a diagram showing how to calculate the firing strength of this rule. (1 mark)



g. Draw a possible fuzzy associative matrix (FAM) of rules for your control system. (2 marks)



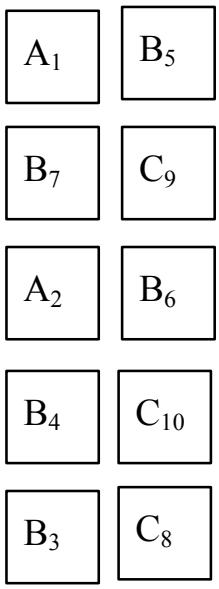
h. Suppose that two rules in your fuzzy system fire at the same time. Draw a diagram showing how to aggregate and defuzzify to calculate a crisp value for your output variable. (1 mark)



2. **Evolutionary Computation** (10 marks)

Genetic algorithms can be used to solve combinatorial optimisation problems like this one:

Ten boxes, all the same size, each packed with a particular product, product A, B, or C, are to be loaded onto a truck. Different products have different weights. Each side of the truck has room for 5 boxes. For safety reasons, the two sides of the truck should carry about the same weight. Given a set of boxes, say 2 A's, 5 B's, 3 C's and no D's, the problem is to find the best way to arrange the boxes on the truck. For example, the diagram below shows one way to load these boxes:



This could be represented by giving each box a number between 1 and 10 (as shown in the diagram), and using permutations for genomes. E.g. the arrangement above could be represented by the genome

1,7,2,4,3,5,9,6,10,8

a. Using this representation, give an example to show how the *inversion* mutation operator would work. (1 mark)

b. Give an example showing the *insertion* mutation operator. (1 mark)

c. Give an example showing the *exchange* mutation operator. (1 mark)

d. Give an example showing the *shift* mutation operator. (1 mark)

e. Give an example to show that ordinary 2-point crossover does not work properly for this type of genome. (1 mark)

f. Give an example showing the PMX crossover operator. (2 marks)

g. What would be a suitable fitness function to use for this problem? (1 mark)

h. Suppose that there is a safety rule stating that an A box must never be loaded next to a B box. So the first and third rows in the example would not be allowed. Using the representation described above, mutation and crossover operators could create invalid genomes. Describe one way to overcome this difficulty. (2 marks)

3. **Artificial Neural Networks** (10 marks)

One source of knowledge about climate change is the analysis of ice cores drilled in Antarctica. Layers of snow and ice build up over the millennia, trapping bubbles of air. By analysing these air bubbles, we can obtain data like the concentration of CO_2, methane, and the proportion of isotopes of hydrogen and oxygen in the atmosphere in the distant past. The proportion of deuterium (an isotope of hydrogen), for example, can be used to deduce the average temperature of the air when a bubble was formed.

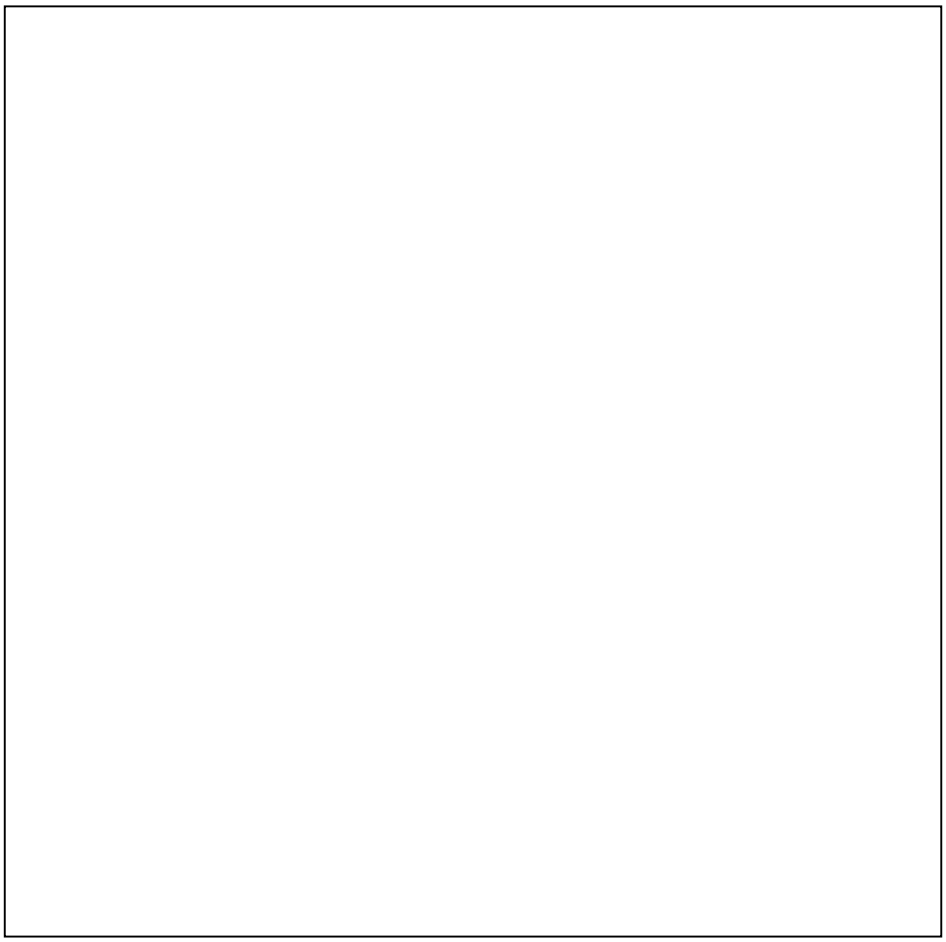
We believe that CO_2 concentration, methane concentration, and temperature (and other things) are interconnected and can affect each other via a number of systems such as ocean currents, plant growth and so on. Some of these systems are vast and can introduce time delays of hundreds of years between cause and effect.

Suppose that you are working for an agency that is studying this ice core data to try to understand these interactions better. A colleague has proposed a theory that suggests it should be possible to predict CO_2 concentration, methane concentration, and temperature at any point of time from the temperature 1000 years previous, the methane concentration 500 years previous, and CO_2 concentration 20 years previous.

Your colleague asks you to try to create a model to do this prediction, using an artificial neural network.

a. What would be the inputs to the model? (1 mark)

b. Explain what *pre-processing* you would do on the input data (Hint: are the data categorical, discrete, or continuous?). (2 marks)



c. How many i*nput neurons* would you use in the neural network? (1 mark)

d. How many *output neurons* would you use in the neural network and what would they represent? (1 mark)

e. You decide to use a network with one hidden layer. How would you go about determining the *best* number of *hidden units* to use in this layer? (2 marks)

f. How would you *test* the system to determine its performance in terms of how well it predicts temperature? (2 marks)

g. A graph of error rate versus epochs for a neural network on both a training set and a testing set during training can show when *overtraining* occurs (be careful: overtraining, not overfitting). Draw a graph showing the shapes you would expect to see if overtraining does occur. (1 mark)

End of Part A

Part B - 20 Marks
ANSWER ANY 1 OF THESE 2 QUESTIONS

There are two questions in this part. Choose one of the two questions in this part and write your answer in the answer booklet.

1. Exploration geologists sometimes look for rock types on the surface that might indicate the presence of valuable minerals under the ground. These "indicator" rock types cannot easily be distinguished from other, similar rock types that are not associated with mineral deposits. The only way to tell is to take samples back to the laboratory for chemical analysis. In the laboratory, each sample is tested to measure the number of parts per million of each of 20 elements. Experienced geologists are able to tell, with reasonable accuracy, by looking at these numbers, whether the sample is an indicator or not.

   The company that you work for has a large database of such samples taken over the past 10 years. About 5% of these samples, which is still a large number, have been classified by hand as being indicators or not indicators. Your company wants to build an automated system to classify the other 95% of the samples (and any future samples that may be collected), to identify any potential mineral deposits that may have been missed in the past.

   a) Which computational intelligence technology(s) (neural networks, evolutionary computing, fuzzy logic) or other methods would you use to create such a system? Justify your answer **by referring to the particular strengths and weaknesses of each technology**. You will need to give at least 5 good reasons. (10 marks)

   b) List and explain the steps you would go through in creating the system. (10 marks)

2. Insert another scenario here!

   a) Which computational intelligence technology(s) (neural networks, evolutionary computing, fuzzy logic) or other methods would you use to create such a system? Justify your answer **by referring to the particular strengths and weaknesses of each technology**. You will need to give at least 5 good reasons. (10 marks)

   b) List and explain the steps you would go through in creating the system. (10 marks)

END OF EXAMINATION PAPER