Written Exam of Intelligent Systems (DVA439)

Date	2018-03-22
Time	14:10 – 17:30
Allowed material	None
Examiner	Ning Xiong (Phone 151716)

Good Luck!!!

1. Fuzzy Control (2+3+3p)

Assume a simple fuzzy controller with input x and output y. The membership functions of fuzzy sets for the input and output are described in Figs. 1 and 2 respectively. The set of initial (non-optimal) fuzzy control rules are as follows:

R1: If x is *Low* then y is F_1

R2: If x is *Medium* then y is F_2

R3: If x is *High* then y is F_3

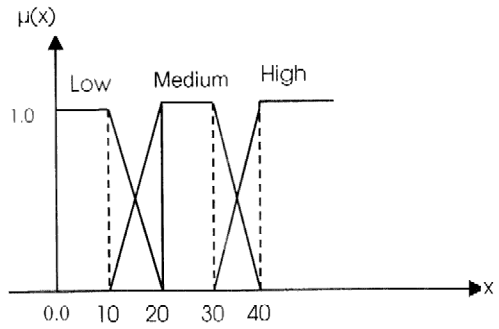

Fig. 1. Fuzzy sets membership functions for input x

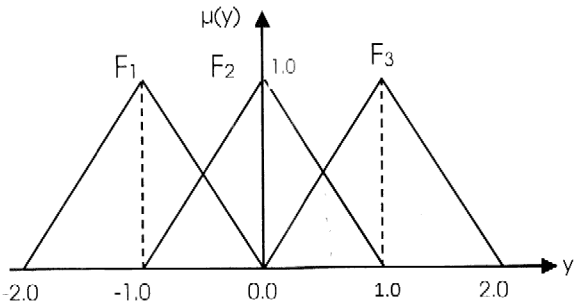

Fig. 2. Fuzzy sets membership functions for output y

Suppose the current value of input x is equal to 15

(1) Which fuzzy rules are fired, and what are their firing strengths?

(2) What are the implied output fuzzy sets of the fired fuzzy rules?
(3) What is the concrete value of y by doing defuzzification?

2. Fuzzy reference model learning control (adaptive fuzzy control, 4+3+2p)

Consider the same fuzzy controller as in problem 1 (with completely same fuzzy rules and input/output membership functions). After executing a control action as specified by the fuzzy controller output y, the inverse fuzzy model is employed in the next time step to estimate the correction value. Suppose a situation in which the correction value is -0.2 and only rules R2 and R3 need to be revised in terms of this correction value.

(1) What is the range of input x in the preceding time step and why?
(2) How should the rules R2 and R3 be revised?
(3) Assuming the firing strengths of rules R2 and R3 to be 0.2 and 0.8 respectively in the preceding time step, what the fuzzy controller output would be in the preceding time step if using the revised rules?

3. Decision analysis (3+2+3p)

Suppose an object has two possible classes: A and B, with the equal probability. The utility of making a right classification is always z. The utility (cost) of wrong classification is x when class A is true and y when class B is true.

(1) How can you formulate the task of classification as a decision analysis problem? Please draw the decision tree.
(2) In which condition will you prefer to classify the object as class A according to the Bayesian decision theory?
(3) Give a vision of you about how sensor measurement can be utilized to enhance the decision making (more informed decision making).

4. Information and Decision Fusion (4+4p)

(1) Assume an object which has two probable classes: A and B. The initial estimates of probabilities are 50% for both class A and class B. Now this object is classified by a neural network as class A. But the neural network is not perfect. The probabilities for it to make right judgments are 80% when class A is true and 90% when class B is true. Please revise the probability distribution of classes for the object by using the information from the neural network.

(2) Assume this object is later classified by a case-based reasoning system. The result of classification is again class A. Generally, the case-based reasoning system makes wrong decisions with the probability of 10% when class A is true and the probability of 20% when

class B is true. How can you derive the final probability estimates by integrating the results from both the neural network and case-based reasoning system.

5. Case-Based Reasoning (4+3p)

Given a query problem Q=(0, 0, 0), suppose that the following three cases have been retrieved as most similar cases.

C_1=(-8, 5, -3, solution A)

C_2=(3, 5, 9, solution B)

C_3=(10, -5, 9, solution C)

(1) Please explain how you can define suitable similarity metrics to affect the ranking between cases C_1 and C_2?

(2) Is it possible to change the ranking of case C_3 by adapting the similarity function, and why?