Indian Institute of Technology Kharagpur

Department of Mechanical Engineering

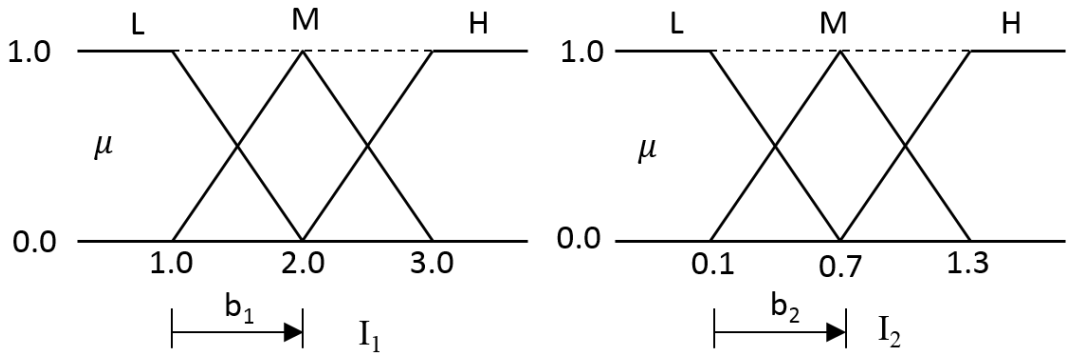
Instructions: Answer all the questions. Each question carries two marks. There is no negative marking for wrong answer. There is no part marking for the questions.

Third Test (2020-2021); Date: 13.11.2020; Total Marks: 20

Subject: ME60353: Knowledge-based Systems in Engineering; Maximum Time: 1 hour

Name:	Roll No.

Q. To model input-output relationships of a process having two inputs and one output, let us use a fuzzy reasoning tool with Mamdani approach. Let us also assume three linguistic terms, namely Low (L), Medium (M) and High (H) to represent each of two inputs: I_1, I_2 and one output O. The membership function distributions of the inputs and output are shown in Fig. 1, which are assumed to be symmetrical triangles.



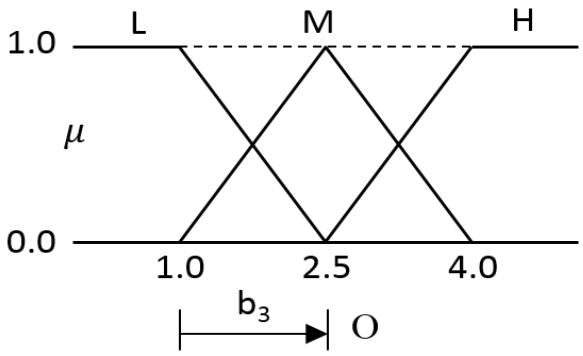


Fig. 1. Membership function distributions of the variables.

A binary-coded genetic algorithm will be used to evolve the optimized data base (DB) and rule base (RB) of the fuzzy reasoning tool. The base-widths of the triangles are decided by the b values. A typical GA-string is shown below, where five bits are used to represent each of the b values and nine bits are utilized to represent the RB (where 1 and 0 represent the presence and absence of the rules, respectively).

$$\underbrace{10111}_{b_1}\quad\underbrace{01111}_{b_2}\quad\underbrace{10101}_{b_3}\quad\underbrace{100111101}_{RB}$$

The RB of the fuzzy reasoning tool is shown below.

		I_2		
		L	M	H
I_1	L	L 1	L 0	M 0
	M	L 1	M 1	H 1
	H	M 1	H 0	H 1

Corresponding to the above GA-string, the modified RB is given below.

		I_2		
		L	M	H
I_1	L	L 1		
	M	L 1	M 1	H 1
	H	M 1		H 1

Take the ranges of b_1, b_2 and b_3 as follows:

$$0.5 \le b_1 \le 1.5,$$
$$0.3 \le b_2 \le 0.9,$$
$$1.0 \le b_3 \le 2.0$$

Let us consider a training scenario as follows: $I_1 = 1.8$, $I_2 = 0.9$, and target output $T_0 = 3.0$.

Answer the following five questions (Q1 to Q5).

Q1. $I_1 = 1.8$ corresponds to L and M with approximate membership values of

(a) 0.5500, 0.4500

(b) 0.8565, 0.1435

(c) 0.3548, 0.6452

(d) 0.7520, 0.2480

Q2. $I_2 = 0.9$ corresponds to M and H with approximate membership values of

(a) 0.644, 0.356

(b) 0.755, 0.245

(c) 0.815, 0.185

(d) 0.455, 0.545

Q3. Firing strength of the first fired rule present in the rule base (i.e., if I_1 is M AND I_2 is M then Output O is M) is approximately calculated as

(a) 0.350

(b) 0.250

(c) 0.895

(d) 0.644

Q4. . Firing strength of the second fired rule present in the rule base (i.e., if I_1 is M AND I_2 is H then Output O is H) is approximately calculated as

(a) 0.856

(b) 0.952

(c) 0.356

(d) 0.752

Q5.Crisp output corresponding to the set of inputs (I_1=1.8, I_2 =0.9) is found to be approximately equal to

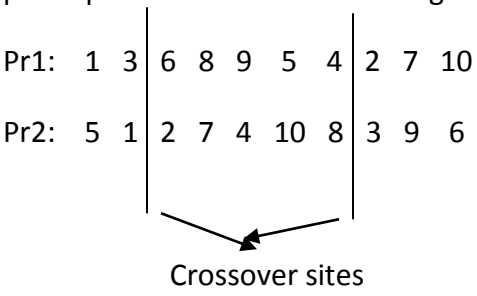
(a) 2.92

(b) 16.85

(c) 9.85

(d) 10.86

Q6. In a Traveling Sales Person Problem (TSP) involving 10 cities, two parents are going to participate in order crossover as given below.



Children solutions are found to be as follows

(a) 1 3 2 7 4 10 8 6 9 5
3 1 6 8 9 5 4 2 7 10

(b) 1 6 2 7 4 10 8 3 9 5
3 2 6 8 9 5 4 1 7 10

(c) 9 5 2 7 4 10 8 1 3 6
7 10 6 8 9 5 4 3 1 2

(d) 6 3 2 7 4 10 8 1 5 9
2 1 6 8 9 5 4 3 10 7

Q7. The concept of Boltzmann-probability distribution is used in Simulated Annealing to ensure that

(a) the probability of selecting bad solutions is more initially but it decreases as the iteration proceeds

(b) the probability of selecting bad solutions is less initially but it increases as the iteration proceeds

(c) the algorithm becomes computationally faster

(d) the algorithm becomes easier to understand

Q8. Simulated Annealing is used to solve a minimization problem as given below.

$$\text{Minimize} \quad y = E(X) = f(x_1, x_2) = x_1 - x_2 + x_1^2 + x_2^2$$
$$\textit{subject to} \qquad 1.0 \le x_1, x_2 \le 6.0$$

Assume initial temperature of molten metal $T_0 = 3600^0$ K , initial solution selected at random $X_0 = \begin{Bmatrix} 2.0 \\ 2.0 \end{Bmatrix}$. Let us assume the random numbers as follows: 0.4, 0.8, 0.6, 0.7, etc.

The mod-value of change in energy (δE) at the end of first iteration is calculated as

(a) 10.5

(b) 3.0

(c) 15.0

(d) 24.0

Q9. In comparison with a Genetic Algorithm, Particle Swarm Optimization (PSO) is expected to be

(a) more efficient and computationally faster

(b) less efficient but computationally faster

(c) more efficient but computationally slower

(d) less efficient and computationally slower

Q10. During optimization, Particle Swarm Optimization (PSO) caries out

(a) local search only

(b) global search only

(c) both local and global searches simultaneously

(d) neither local nor global search

Name: Roll No.

ANSWER KEYS

Q. 1 ; Q. 2 ; Q. 3 ; Q. 4 ; Q. 5

Q. 6 ; Q. 7 ; Q. 8 ; Q. 9 ; Q. 10