Computer Sciences
University of Technology

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Time: 3 hours
Lecturer: Dr. Alia Karim

Final Exam. 2011-2012
First trail

Subject: Fuzzy logic
Class:2nd year
Branch : AI

Note: Answer 6 question only, For each question 10 marks

Q1 Consider two fuzzy subsets of the set X, X = {a, b, c, d, e } referred to as A and B
A = {1/a, 0.3/b, 0.2/c 0.8/d, 0/e} and B = {0.6/a, 0.9/b, 0.1/c, 0.3/d, 0.2/e}
Find
1) support 2) core 3) cardinality 4) complement, 5)union, 6)intersection 7) α -cut for each set where α =0.5, and α =0.3

Q2
a) What are the basic conditions that the fuzzy expression should satisfy to be a fuzzy logic.
b) What is the difference between Triangular fuzzy number and Trapezoidal fuzzy number?
c) Describe with example the four methods of expressing the relation between sets A and B.

Q3 a) Compute the simple disjunctive sum, disjoint sum, simple difference, and bounded difference of the sets:
A = {(x, 0.5), (y, 0.4), (z, 0.9), (w, 0.1)}
B = {(x, 0.4), (y, 0.8), (z, 0.1), (w, 1)}

b) Evaluate the following fuzzy logic formula $P \rightarrow Q$, $P \wedge (P \rightarrow Q)$, $P \wedge (P \rightarrow Q) \rightarrow Q$,where P=1and Q=0

Q4 a) Define linguistic variable? What are the fuzzy linguistic variable basic parts? Define components for the linguistic variable X whose name is temperature?
b) Determine the truth value of the following propositions P1 and P2. P1 = "P is very true",P2 = "P is false", where
P = "30 is high", the truth value of P is 0.3, $\mu_{very\ true} = (\mu_{true})2$

Q5 Consider a fuzzy set A and a crisp set B :
A = {(x, 0.4), (y, 0.9), (z, 1.0), (w, 0.1)}, B = {a, b, c}
Determine a fuzzy set B' ⊆ B induced by A and the relation R ⊆ A × B

R	a	b	c
x	0	0.4	0.8
y	0.9	0.9	0.7
z	1	0	0.5
w	0	0.1	0.8

Q6 Define FLC, the FLC is useful in two cases what are they? What are the advantages of FLC, Describe FLC architecture?

Q7 There is a fuzzy rule, R : if u is A and v B then w is C, where A=(0, 2, 4), B=(3, 4, 5) and C=(3, 4, 5)
a) Find inference result C' when input is u0 =3, v0=4 by using Larsen method.
b) Find inference result C' when input is A=(0, 1, 2) and B=(2, 3, 4) by using larsen method.

Answer

Q1 Consider two fuzzy subsets of the set X, X = {a, b, c, d, e } referred to as A and B

A = {1/a, 0.3/b, 0.2/c 0.8/d, 0/e} and B = {0.6/a, 0.9/b, 0.1/c, 0.3/d, 0.2/e}

Find

1) support A = {1/a, 0.3/b, 0.2/c 0.8/d.} and B = {0.6/a, 0.9/b, 0.1/c, 0.3/d, 0.2/e}
2) core A = {1/a.} and B = {}
3) cardinality A = 2.3 and B = 2.3
4) complement, A = {0/a, 0.7/b, 0.8/c 0.2/d, 1/e} and B = {0.4/a, 0.1/b, 0.9/c, 0.7/d, 0.8/e}
5)union = {1/a, 0.9/b, 0.2/c 0.8/d, 2/e} and
6)intersection {0.6/a, 0.3/b, 0.1/c, 0.3/d, 0/e}
7) α -cut

α =0.5, A = {1/a, 0.8/d } and B = {0.6/a, 0.9/b}

α =0.3 A = {1/a, 0.3/b, 0.8/d } and B = {0.6/a, 0.9/b, 0.3/d }

Q2 a)What are the basic conditions that the fuzzy expression should satisfy to be a fuzzy logic.

i) Truth values, 0 and 1, and variable x_i ($\in[0,1]$, i = 1, 2, …, n) are fuzzy expressions.
ii) If f is a fuzzy expression, ~f is also a fuzzy expression.
iii) If f and g are fuzzy expressions, f ∧ g and f ∨ g are also fuzzy expressions. □

b)What is the difference between Triangular fuzzy number and Trapezoidal fuzzy number?

Triangular fuzzy number	Trapezoidal fuzzy number
Have 3point	Have 4point
One peak value	two peak value
Triangular shape	square shape
TFN+(-)TFN=TFN	TZN+(-)TZN=TZN
TFN/(*)TFN=not TFN	TZN/(*)TZN=not TZN

c) Describe with example the four methods of expressing the relation between sets A and B.

There are four methods of expressing the relation between sets A and B.

(1) Bipartigraph
The first is by illustrating A and B in a figure and representing the relation by drawing arcs or edges (Fig 3.7).

(2) Coordinate diagram
The second is to use a coordinate diagram by plotting members of A on x axis and that of B on y axis, and then the members of $A \times B$ lie on the space. Fig 3.8 shows this type of representation for the relation R, namely $x^2 + y^2 = 4$ where $x \in A$ and $y \in B$.

(3) Matrix
The third method is by manipulating relation matrix. Let A and B be finite sets having m and n elements respectively. Assuming R is a relation between A and B, we may represent the relation by matrix $M_R = (m_{ij})$ which is defined as follows

$$M_R = (m_{ij})$$

$$m_{ij} = \begin{cases} 1, & (a_i, b_j) \in R \\ 0, & (a_i, b_j) \notin R \end{cases}$$

$$i = 1, 2, 3, \ldots, m$$
$$j = 1, 2, 3, \ldots, n$$

(4) Digraph

The fourth method is the directed graph or digraph method. Elements are represented as nodes, and relations between elements as directed edges.

$A = \{1, 2, 3, 4\}$ and $R = \{(1, 1), (1, 2), (2, 1), (2, 2), (1, 3), (2, 4), (4, 1)\}$ for instance. (Fig 3.9) shows the directed graph corresponding to this relation. When a relation is symmetric, an undirected graph can be used instead of the directed graph.

Q3 b) Compute the simple disjunctive sum, disjoint sum, simple difference, and bounded difference of the sets:

A = {(x, 0.5), (y, 0.4), (z, 0.9), (w, 0.1)}

B = {(x, 0.4), (y, 0.8), (z, 0.1), (w, 1)}

simple disjunctive sum={(x, 0.4), (y, 0.6), (z, 0.8), (w, 0.9)}

, disjoint sum= {(x, 0.1), (y, 0.4), (z, 0.8), (w, 0.9)}

simple difference= {(x, 0.5), (y, 0.2), (z, 0.9), (w, 0)}

bounded difference={(x, 0.1), (y, 0), (z, 0.8), (w, 0)}

b) Evaluate the following fuzzy logic formula $P \to Q$, $P \wedge (P \to Q)$, $P \wedge (P \to Q) \to Q$,where P=1and Q=0

$$P \to Q = 0 \ , \quad P \wedge (P \to Q) = 0, \ P \wedge (P \to Q) \to Q = 1$$

Q4 a) Define linguistic variable? What are the fuzzy linguistic variable basic parts? Define components for the linguistic variable X whose name is temperature?

When we consider a variable, in general, it takes numbers as its value. If the variable takes linguistic terms, it is called "linguistic variable".

Definition (Linguistic variable) The linguistic variable is defined by the following quintuple.

Linguistic variable = (x, T(x), U, G, M)

x: name of variable

T(x): set of linguistic terms which can be a value of the variable

U: set of universe of discourse which defines the characteristics of the variable

G: syntactic grammar which produces terms in T(x)

M: semantic rules which map terms in T(x) to fuzzy sets in U □

X.=temp

Temp(X)={high,very high,…}

U:[0. .100]

G: Ti+1=very +Ti

M: set of rules for mapping syntactic terms in U.

b) Determine the truth value of the following propositions P1 and P2. P1 = "P is very true",P2 = "P is false", where

P = "30 is high", the truth value of P is 0.3, $\mu_{very\ true} = (\mu_{true})2$

P1=0.09

P2=0.7

Q5 Consider a fuzzy set A and a crisp set B :

A = {(x, 0.4), (y, 0.9), (z, 1.0), (w, 0.1)}, B = {a, b, c}

Determine a fuzzy set $B' \subseteq B$ induced by A and the relation $R \subseteq A \times B$

R	a	b	c
x	0	0.4	0.8
y	0.9	0.9	0.7
z	1	0	0.5
w	0	0.1	0.8

B' = {1/a,0.9 b,0.7 c}

Q6 Define FLC, the FLC is useful in two cases what are they? What are the advantages of FLC, Describe FLC architecture?

Fuzzy logic is much closer in spirit to human thinking and natural language than the traditional (classical) logical systems. Basically, it provides an effective means of capturing the approximate, inexact nature of the real world. Therefore, the essential part of the fuzzy logic controller (FLC) is a set of linguistic control strategy based on expert knowledge into an automatic control strategy.

The FLC is considered as a good methodology because it yields results superior to those obtained by conventional control algorithms. In particular the FLC is useful in two cases.

(1) The control processes are too complex to analyze by conventional quantitative techniques.

(2) The available sources of information are interpreted qualitatively, inexactly, or uncertainly.

Indeed, the advantage of FLC can be summarized as follows.

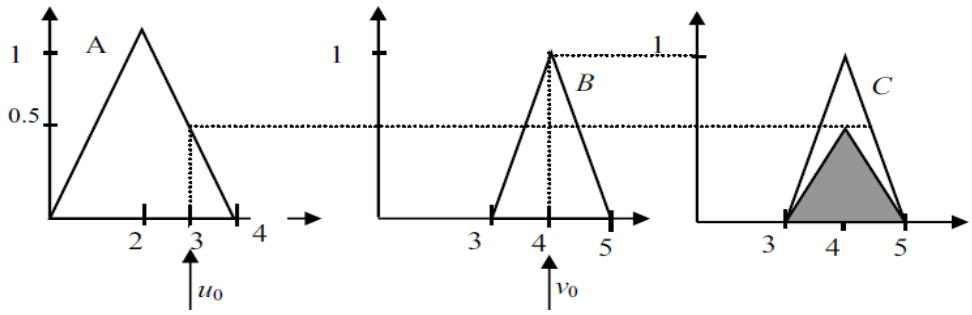
(1) Parallel or distributed control: in the conventional control system, a control action is determined by single control strategy like $\mu = f(x_1, x_2, \ldots, x_n)$. But in FLC, the control strategy is represented by multiple fuzzy rules, and thus it is easy to represent complex systems and nonlinear systems.

(2) Linguistic control: the control strategy is modeled by linguistic terms and thus it is easy to represent the human knowledge.

(3) Robust control: there are more than one control rule and thus, in general, one error of a rule is not fatal for the whole system.

Q7 There is a fuzzy rule, R : if u is A and v B then w is C, where A=(0, 2, 4), B=(3, 4, 5) and C=(3, 4, 5)

a) Find inference result C' when input is u0 =3, v0=4 by using Larsen method.



b) Find inference result C' when input is A=(0, 1, 2) and B=(2, 3, 4) by using larsen method.