Computer Sciences
University of Technology

Date: 7 / 6 / 2012
Time: 3 hours
Lecturer: Dr. Alia Karim

Final Exam. 2011-2012
First trail

Subject: Fuzzy logic
Class: 4th year
Branch : AI

Note: Answer 6 question only for each question 10 marks

Q1 Consider the fuzzy sets : short, middle, tall

cm	short	middle	tall
140	1	0	0
150	1	0	0
160	0.9	0.1	0
170	0.7	1	0
180	0.3	0.8	0.3
190	0	0	1

Find for each set 1) support 2) core 3) cardinality 4) complement, 5)union of the sets, 6)intersection of the sets 7) α -cut for each set where α =0.5.

Q2

a) Let A = {(x1, 0.2), (x2, 0.7), (x3, 1), (x4, 0)} and B = {(x1, 0.5), (x2, 0.3), (x3, 1), (x4, 0.1)}
Find A ⊕B , A∆ B, A- B, A⊖ B

b) There are two intervals A and B, A = [3, 5], B = [–2, 7] , Find :
1) A(+)B 2) A(-)B 3)A(•)B 4)A(/)B 5)B^{-1}

Q3

a) Let R and S be two fuzzy relations defined as shown below, Find the result of R o S max-min composition.

R=

	Y1	Y2	Y3
X1	0.1	0.5	0.2
X2	0.7	0.8	1

S=

	Z1	Z2	3Z
Y1	0.1	0.8	0.2
Y2	0.4	0.7	0.9
Y3	0.3	0.1	0.8

b) Given
A = {(x1, 0.4), (x2, 0.8), (x3, 1), (x4, 0)}, B = {(x1, 0.4), (x2, 0.3), (x3, 0), (x4, 0)}, Find Hamming distance; Euclidean distance, Minkowski distance with w=2.

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, $\mu_{\text{very true}} = (\mu_{\text{true}})2$

Q5

a) Explain why TSK method no need for defuzzification process for result?
b) Show the design procedure of FLC with example.

Q6

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

Q7

The output can be affected by quality of camera, as well as the quality of film. A possible Universe of camera rating is X = {1, 2, 3, 4, 5}, where 1 represents the highest camera rating. A possible universe of picture ratings is Y = {1, 2, 3, 4, 5}, where once again, 1 is the highest rating for pictures. Two fuzzy sets A = “above average camera” = {0.7/1 , 0.9/2 , 0.2/3 , 0/4 , 0/5} and B = “above average picture quality” = {0.6/1,0.8/2,0.5/3,0.1/4,0/5}.
(a) From the proposition, IF A THEN B, find the relation using Mamdani implication,
(b) Suppose the camera manufacturer wants to improve camera and film sales by improving the quality of the camera. A new camera is rated as follows:
A' = “new and improved camera” = {0.8/1,0.8/2,0.1/3,0/4,0/5} What might be resulting picture rating from this new camera?

NASWERS

Q1 Consider the fuzzy sets : short, middle, tall

cm	short	middle	tall
140	1	0	0
150	1	0	0
160	0.9	0.1	0
170	0.7	1	0
180	0.3	0.8	0.3
190	0	0	1

Find for each set

1) support

short=={140/1,150/1,160/0.9,170/0.7,180/0.3}

middle={160/0.1,170/1,180/0.8}

tall={180/0.3,190/1}

2) core short={160/0.1,170/1}

middle={170/1 }

tall={190/1}

3) cardinality

short=3.9

middle=1.9

tall=1.3

4) complement,

short={140/0,150/0,160/0.1,170/0.3,180/0.7,190/1}

middle={140/1,150/1,160/0.9,170/0,180/0.2,190/1}

tall={140/1,150/1,160/1,170/1,180/0.7,190/0}

5)union of the sets,={140/,150/1,160/0.9,170/0.7,180/0.8,190/1}

6)intersection of the sets ={140/0,150/0,160/0,170/0,180/0.3,190/0}

7) α -cut for each set where α =0.5.

short=={140/1,150/1,160/0.9,170/0.7}

middle={170/1,180/0.8}

tall={,190/1}

Q2

a) Let A = {(x1, 0.2), (x2, 0.7), (x3, 1), (x4, 0)} and B = {(x1, 0.5), (x2, 0.3), (x3, 1), (x4, 0.1)}

Find A ⊕B , A∆ B, A- B, A⊖ B

A ⊕B ={(x1, 0.2), (x2, 0.7), (x3, 1), (x4, 0)}, A∆ B={(x1, 0.2), (x2, 0.7), (x3, 1), (x4, 0)},

, A- B={(x1, 0.2), (x2, 0.7), (x3, 1), (x4, 0)},, A⊖ B={(x1, 0.2), (x2, 0.7), (x3, 1), (x4, 0)},

b) There are two intervals A and B, A = [3, 5], B = [–2, 7] , Find :

1) A(+)B= [3, 5], 2) A(-)B= [3, 5], 3)A(•)B= [3, 5], 4)A(/)B = [3, 5], 5)B^{-1}= [3, 5],

Q3

a) Let R and S be two fuzzy relations defined as shown below, Find the result of R o S max-min composition.

R=		Y1	Y2	Y3
	X1	0.1	0.5	0.2
	X2	0.7	0.8	1

S=		Z1	Z2	3Z
	Y1	0.1	0.8	0.2
	Y2	0.4	0.7	0.9
	Y3	0.3	0.1	0.8

b) Given

A = {(x1, 0.4), (x2, 0.8), (x3, 1), (x4, 0)}, B = {(x1, 0.4), (x2, 0.3), (x3, 0), (x4, 0)}, Find Hamming distance; Euclidean distance, Minkowski distance with w=2.

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, $\mu_{\text{very true}} = (\mu_{\text{true}})2$

P1=0.09

P2=0.7

Q5

a) Explain why TSK method no need for defuzzification process for result?

Since each rule infers a crisp result, the Tsukamoto fuzzy model aggregates each rule's output by the weighted average method. Therefore, it avoids the time-consuming process of defuzzification.

b) Show the design procedure of FLC with example.

When we decided to design a fuzzy logic controller, we can follow the following design procedure

(1) Determination of state variables and control variables In general, the control variable is determined depending on the property of process to be controlled. But we have to select the state variables. In general, state, state error and error difference are often used. The state variables are input variables, and the control variables are output of our controller to be developed.

(2) Determination of inference method We select one method among four inference methods described in the previous section. The decision is dependent upon the properties of process to be studied.

(3) Determination of fuzzification method It is necessary to study the property of measured data of state variables. If there is uncertainty in the data, the fuzzification is necessary, and we have to select a fuzzification method and membership functions of fuzzy sets. If there is no uncertainty, we can use singleton state variables.

(4) Discretization and normalization of state variable space In general, it is useful to use discretized and normalized universe of discourse. We have to decide whether it is necessary and how we can do.

(5) Partition of variable space. The state variables are input variables of our controller and thus the partition is important for the structure of fuzzy rules. At this step,partition of control space (output space of the controller) is also necessary.

(6) Determination of the shapes of fuzzy sets It is necessary to determine the shapes of fuzzy sets and their membership functions for the partitioned input spaces and output spaces.

(7) Construction of fuzzy rule base Now, we can build control rules. We determined the variables and corresponding linguistic terms in antecedent part and consequent part of each rule. The architecture of rules is dependent upon the inference method determined in step 2).

(8) Determination of defuzzification strategy In general, we use singleton control values and thus we have to determine the method.

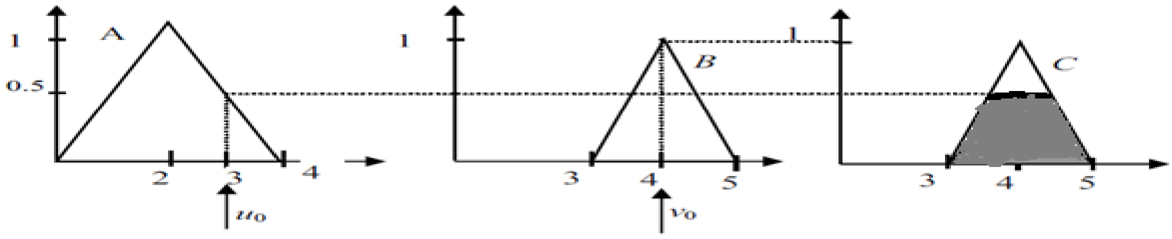
(9) Test and tuning It is almost impossible to obtain a satisfactory fuzzy controller without tuning. In general it is necessary to verify the controller and tune it until when we get satisfactory results.

(10) Construction of lookup table If the controller shows satisfactory performance, we have to decide whether we use a lookup table instead of using the inference system. The lookup table is often used to save computing the time of the inference and defuzzification. The lookup table shows the relationships between a combination of input variables and control actions.

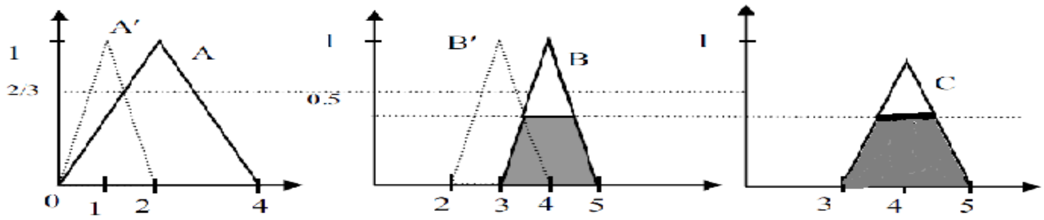
Q6

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 *u*0 =3, *v*0=4 by using mamdani method.



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



Q7

The output can be affected by quality of camera, as well as the quality of film. A possible Universe of camera rating is X = {1, 2, 3, 4, 5}, where 1 represents the highest camera rating. A possible universe of picture ratings is Y = {1, 2, 3, 4, 5}, where once again, 1 is the highest rating for pictures. Two fuzzy sets A = "above average camera" = {0.7/1 , 0.9/2 , 0.2/3 , 0/4 , 0/5} and B = "above average picture quality" = {0.6/1,0.8/2,0.5/3,0.1/4,0/5}.

(a) From the proposition, IF A THEN B, find the relation using Mamdani implication,

0.4	0.5	0.5
0.4	0.7	0.8

(b) Suppose the camera manufacturer wants to improve camera and film sales by improving the quality of the camera. A new camera is rated as follows:

A' = "new and improved camera" = {0.8/1,0.8/2,0.1/3,0/4,0/5} What might be resulting picture rating from this new camera?

B'= resulting picture rating = {0.6/1,0.8/2,0.5/3,0.1/4,0/5}