Knowledge Representation for Fuzzy Logic

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Abstract— Knowledge Representation is the main component to solve the problems with Programming. Some times incomplete information has to be represented in the programming. In this paper, fuzzy logic is used to deal with uncratin information. The Knowledge Represenation is studied to represent incomplete information. This Knowledge Representation is translated in Predicates for the programming in Prolog.

Index Terms— Fuzzy logic, Fuzzy reasoning and Knowlede representation

1 Introduction

The Knowledge representation is key component to solve the problems. Some time the information available to the system is incomple. The incomplete information has to be represented. Various theories like Probability, Possibility, Fuzzy logc etc are available to to deal with incomplete information. The fuzzy logic deals incomplete information with belief rather than probable[7]. In the following, the knowledge reprenation is studied for fuzzy logic to deal with incomplete information.

2 FUZZY LOGIC AND FUZZY REASONING

Zadeh [6] has introduced Fuzzy set as model to deal with imprecise, inconsistent and inexact information. The Fuzzy set A of X is defined by its membership function μA and take the values in the unit interval [0, 1]

$\mu A: X \square [0, 1]$, where X is Universe of discourse.

For example,

Consider the Fuzzy proposition "x is tall" and The Fuzzy set 'Tall" is defined as

$\mu Tall\ (x) \square [0, 1], x \in X$

$Tall= \mu Tall(x1)/0.6+\mu Tall(x2)/0.75+...+ \mu Tall(x\ n)/0.67$

Fuzzy logic is defined as combination of Fuzzy sets using logical operators. Some of the logical operations are given below

Suppose A, B, C are Fuzzy sets, The operations on Fuzzy sets are given below

$AVB=max(\mu A(x), \mu B(x)\}$ Disjunction

$A\Lambda B=min(\mu A(x), \mu B(x)\}$ Conjunction

$A'=1-\mu A(x)$ Negation

$A\square B=min\ \{1, (1-\mu A(x) +\mu B(x)\}$ Implication

$AoB=min_x\ \{\mu A(x), \mu B(x)\}/x$ Composition

The Fuzzy propositions may contain quantifiers like "Very", "More or Less" ect. These Fuzzy quantifiers may be eliminated as

$\mu Very(x) =\mu A(x)^2$ Concentration $\mu More\ or\ Less(x) = \mu A(x)^{1/2}$ Diffusion

Fuzzy reasoning is drawing conclusions from Fuzzy propositions using fuzzy inference rules[5]. Some of the Fuzzy inference rules are given bellow

R1: x is A
x and y are B

Y is AΛB

R2: x is A
x or y is B

y is AVB

R3: x and y are A
y and z are B

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y and z are B

R4: x or y are A
y or z is B

x or z are B

R5: x is A
if x is A then y is B

y is Ao (A□B)

3 Knowledge Representation for Fuzzy Logic

Knowledge representation for fuzzy logic is a type of module for fuzzy sentence "x is A"and is defined as [A]R(x),
where A is fuzzy set, R is relation and x is individual in the Unverser of discourse X.

For instance

"Rama is tall "represented as

[Tall]Hight(Rama), where "tall" is fuzzy set, "Hight" is relation and "Rama" is individual.

The fuzzy proposition "Elephant is tall" is Modulated as

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[Tall] Height(Elephant)

The Fuzzy proposition “Elephant is big” is modulated as

[Tall](Height(Elephant)Λ Height(Elephant))

where Big = Tall and Weight

Fuzzy module is knowledge representation of the Fuzzy proposition. Fuzzy Modulations are combined with Logical operators.
Let A and B be fuzzy sets.
x is ¬A
[¬A]R(x)
Xxis A or x is B
[A V B]R(x)
x is A and x is B
[A Λ B]R(x)
if x is A then x is B
[A → B]R(x)
Some of the Fuzzy Reasoning rules are

R1: [A]R(x)
[B](R(x) or R(y))

[AΛB]R(y)

R2: [A]R(x)
[B](R(x) or R(y)

[AVB]R(y)

R3: [A](R(x) and R(y))
[B](R(y) and R(z))

[AΛ B](R(x) and R(z))

R4: [A](R(x) or R(y))
[B](R(y) or R(z))

[AV B](R(x) or R(z))

R5: : [A]R(x)
if [A]R(x) then [B]R(y)

[[Ao (A → B)]R(y)

Patient has Cold
If Patient has Cold then Patient has Headache
The inference is given as Using the above Fuzzy fact and Fuzzy rule
[Cold] Symptom(Patient, Cold)
if [Cold]Symptom(Patient, Cold) than THEN [Headache]Symptom(Patient, Headache)

The Fuzzy reasoning is given as using Fuzzy Knowledge Base
[Cold] ^[Cold → Headache] Symptom (Patient, Headache
Fuzzy logic and Fuzzy reasoning are discussed in the following for the Fuzzy modulations . These Fuzzy modulations are used to study the Fuzzy Reasoning Systems (FRS).

Sita is young
If Sita is young then Gita is very young

Using the above Fuzzy fact and Fuzzy rule may be modulated as

[Young] Age (Sita)
If [Young] Age (Sita) then [Very Young] Age [Gita]

The Fuzzy reasoning using Fuzzy modulations for Fuzzy agent in FRS are given as

[[Young] Λ [Young→ Very Young] Gita

FRS1 consists of the following Fuzzy modulations

F1:[Tall] Height(Rama)
F2: [Approximately equal] (Height (Rama) and Height (Krishna))
F3: [Young] Age (Gita)

F4: [Tall] (Height (Krishna) or Height (Sita))
F5: [Small] (Height (Sita) or Height (Gita))
F6: [Approximately equal] (Height (Sita) and Height (Gita))
F7: if [Young] Age (Sita) then [very Young] Age (Gita)

The Fuzzy Agent in FRS2 is reasoning as

F8: [Tall Λ Approximately equal] Height (Krishna) using F1, F2 and R1

F9:[Tall V Small]Height(Krishna) V Height(Gita)) using F4, F5 and R2

FRS1 and FRS2 give the reasoning in the distributed environment as

F10: [Tall Λ Approximately equal] V [Tall V Small] Height(Gita) using F8, F9 and R2

F11: [Approximately equal Λ Young] Age(Sita) using F3 and F6 and R1

F12: [Approximately equal Λ Young] Λ
[Young → Very Young] Age(Gita)

Using F11, F7 amd R5 , The Fuzzy interference for “ What about Gita’s height and age” is given as

[Tall Λ Approximately equal] V [Tall V Small] Height(Gita) Λ
[Approximately equal Λ Young] Λ
[Young->Very Young] Age(Gita)

The Prolog is a Logic Programming language. It contains mainly predicates and Clauses.
A predicate is a relation with name of the relation and

arguments . The arguments may be contain variables or constants.

for instance

father(x,y)

father(raama, dasaradha)

where father is name of the relation, x and y are variables, and raama and dasaradha are constants.

A clause is combination of and or more predicates for the rules.

For instance

taata(X, Z) :- naayana(X, Y) , naayana (Y, Z)

Suppose, we have following facts and rules

Raama is father of Lava

Raama is father of Kusha

Dasaradha is father of Raama

If X is father of Y and Y is father of Z then X is Grand father of Z

Suppose, we want to find grand children of Dasaradha

The Prolog programming may be written as

```
predicates
father(lava, raama).
 father (kusa raama).
 father (raama, dasaradha).
clauses
grandfather(X, Z) :- father (X, Y) , father (Y, Z).
```

run the system for

grandfather(?, ?)

which give

lava

kusa

4 Conclusion

The Fuzzy modulations are proposed based on Predicate logic These Fuzzy modulations are used for reasoning by Fuzzy Agents in the AFRS system for AI fuzzy problem and the Fuzzy Agents are to be cooperated and co-ordinated in the Distributed environment. An example is discussed to study AFRS. Fuzzy Expert systems are the main applications for AFRS system.

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