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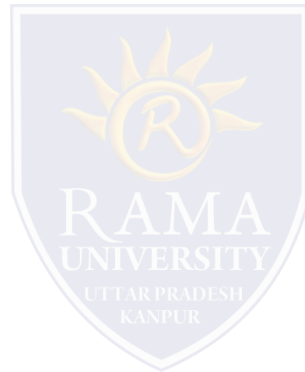
Soft Computing

LECTURE -12

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- **Fuzzy Relationships**

- **Rules and Patches**

- **Reference**

Fuzzy Relationships

In order to understand how two fuzzy subsets are mapped onto each other to obtain a cross product, consider the example of an air-conditioning system. Air-conditioning involves the delivery of air which can be warmed or cooled and have its humidity raised or lowered. An air-conditioner is an apparatus for controlling, especially lowering, the temperature and humidity of an enclosed space. An air-conditioner typically has a fan which blows/cools/circulates fresh air and has cooler and the cooler is under thermostatic control. Generally, the amount of air being compressed is proportional to the ambient temperature. Consider an air-conditioner which has five control switches: cold, cool, pleasant, warm and hot. The corresponding speeds of the motor controlling the fan on the air-conditioner has the graduations: minimal, slow, medium, fast, blast. The rules governing the air-conditioner are as follows:

Rule		Temperature		Speed
1		Cold		Minimal
2		Cool		Slow
3	IF	Pleasant	THEN	Medium
4		Warm		Fast
5		Hot		Blast

Hence, we can regard our rules as the cross product of temperature and speed

Rules and Patches

A Fuzzy Patch is defined by a fuzzy rule: a patch is a mapping of two membership functions, it is a product of two geometrical objects, line segments, triangles, squares etc. In a fuzzy controller, a rule in the rule set of the controller can be visualized as a "device" for generating the product of the input/output fuzzy sets. Geometrically a patch is an area that represents the causal association between the cause (the inputs) and the effect (the outputs). The size of the patch indicates the vagueness implicit in the rule as expressed through the membership functions of the inputs and outputs. The total area occupied by a patch is an indication of the vagueness of a given rule that can be used to generate the patch. Consider a one-input-one output rule: if the input is crisp and the output is fuzzy then the patch becomes a line. And, if both are crisp sets then the patch is vanishingly small - a point.
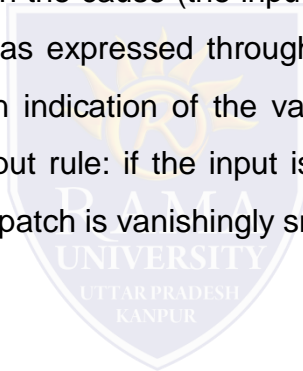
Knowledge Representation of Fuzzy system

Once we have found that the knowledge of a specialism can be expressed through linguistic variables and rules of thumb, that involve imprecise antecedents and consequents, then we have a basis of a knowledge-base. In this knowledge-base "facts" are represented through linguistic variables and the rules follow fuzzy logic. In traditional expert systems facts are stated crisply and rules follow classical propositional logic.

Fuzzification

The problem is that in the "real" world some of our knowledge of facts is derived from the use of sensors: quantity of heat measured in degrees Centigrade, length measured in meters, weight (the quantity of matter) measured in grams, etc. This quantitative, and rather precise factual information has to be mapped onto the term-set of a linguistic variable - the process of Fuzzification.

Inference

Once mapped, the rules within a knowledge base are invoked systematically to see which of the rules is fired and to what degree - the process of Inference. In traditional expert systems, only those rules fire whose antecedents are true. In fuzzy expert systems rules may fire to a certain degree: all rules may fire to a degree between zero and unity. Min and Product are two inference methods.

1. In Min inferencing the output membership function is clipped off at a height corresponding to the computed degree of truth of a rule's premise. This corresponds to the traditional interpretation of the fuzzy logic's AND operation.
2. 2. In Product inferencing the output membership function is scaled by the premise's computed degree of truth.

Composition

But, of course, we have to see what influence each rule has given the fuzzy input values. An "averaging" procedure is adopted to compute the effective contribution of each of the rules. This is the process of Composition. Max and Sum are two composition rules

1. In MAX composition, the combined fuzzy subset is constructed by taking the point wise maximum over all the fuzzy subsets assigned to the output variable by the inference rule.

2. The SUM composition, the combined output fuzzy subset is constructed by taking the point wise sum over all the fuzzy subsets assigned to output variable by their inference rule. (Note that this can result in truth values greater than 1).

Defuzzification

And, finally, we have to convert the fuzzy values outputted by the inference procedure onto a crisp number that can be used in the "real" world. This process is called Defuzzification.

Example:

Air Conditioner We'll return to the above example of an air conditioner. Suppose that we require that the air conditioner operates at 16∘C. Then our above processes are as follows:

Fuzzification: 16∘C corresponds to Cool/Pleasant.

Inference: Check the rules which contain the above linguistic variables.

Composition: Create new membership function of the alpha leveled functions for Cool and Pleasant.

Defuzzification: Examine the fuzzy sets of Slow and Medium and obtain a speed value.

1. A _____ is a decision support tool that uses a tree-like graph or model of decisions and their possible consequences, including chance event outcomes, resource costs, and utility.

a) Decision tree

b) Graphs

c) Trees

d) Neural Networks

2. Decision Tree is a display of an algorithm.

a) True

b) False
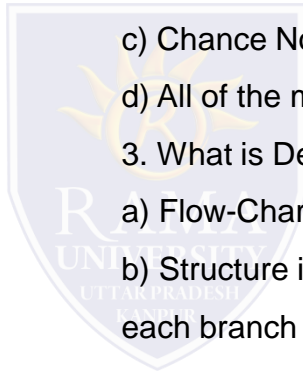
4. Decision Trees can be used for Classification Tasks.

a) True

b) False

5. Choose from the following that are Decision Tree nodes?

a) Decision Nodes

b) End Nodes

c) Chance Nodes

d) All of the mentioned

3. What is Decision Tree?

a) Flow-Chart

b) Structure in which internal node represents test on an attribute, each branch represents outcome of test and each leaf node represents class label

c) Flow-Chart & Structure in which internal node represents test on an attribute, each branch represents outcome of test and each leaf node represents class label

d) None of the mentioned

REFERENCES

❑ https://www.maths.tcd.ie/~ormondca/notes/Fuzzy%20Logic%20Notes.pdf