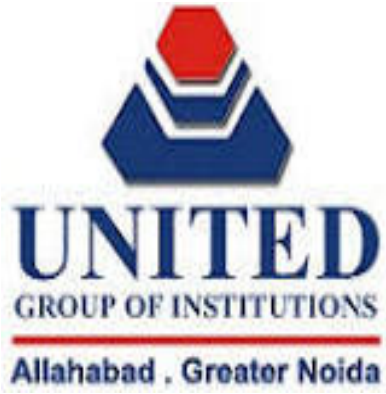
Lecture on
Interference in fuzzy logic(Unit 4 Lecture 2)



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Outline of Presentation

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- Introduction.
- Types of inference.
- Characteristics of Fuzzy Inference System.
- Functional Blocks of FIS.
- References.

Introduction

- Fuzzy inference is the process of formulating the mapping from a given input to an output using fuzzy logic. The mapping then provides a basis from which decisions can be made or patterns discerned.
- Fuzzy inference is the process of formulating the mapping from a given input to an output using fuzzy logic.
- The process of fuzzy inference involves all of the pieces described so far, i.e., membership functions, fuzzy logic operators, and if-then rules.

Types of inference

- Fuzzy Inference System (FIS) is a process to interpret the values of the input vector and, on the basis of some sets of fuzzy rules, it assigns corresponding values to the output vector. This is a method to map an input to an output using fuzzy logic. Based on this mapping process, the system takes decisions and distinguishes patterns.
- Two main types of fuzzy inference systems can be implemented: Mamdani-type (1977) and Sugeno-type (1985). These two types of inference systems vary somewhat in the way outputs are determined.

Mamdani-type inference

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- The Mamdani fuzzy inference system was proposed by Ebhasim Mamdani. This system was proposed in 1975 by Ebhasim Mamdani. Basically, it was anticipated to control a steam engine and boiler combination by synthesizing a set of fuzzy rules obtained from people working on the system. Mamdani fuzzy inference was first introduced as a method to create a control system by synthesizing a set of linguistic control rules obtained from experienced human operators.
- Mamdani-type inference expects the output membership functions to be fuzzy sets. After the aggregation process, there is a fuzzy set for each output variable, which needs defuzzification.

Mamdani inference Applications

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- The Mamdani fuzzy inference system was proposed as the first attempt to control a steam engine and boiler combination by a set of linguistic control rules obtained from experienced human operators.
- In a Mamdani system, the output of each rule is a fuzzy set.
- Mamdani systems have more intuitive and easier to understand rule bases, they are well-suited to expert system applications where the rules are created from human expert knowledge, such as medical diagnostics.

Sugeno-type inference

- This model was proposed by Takagi, Sugeno and Kang in 1985.This fuzzy inference system was proposed by Takagi, Sugeno, and Kang to develop a systematic approach for generating fuzzy rules from a given input-output dataset.
- The Sugeno method of fuzzy inference is similar to the Mamdani method in many respects. The first two parts of the fuzzy inference process, fuzzifying the inputs and applying the fuzzy operator, are exactly the same.
- The main difference between Mamdani-type and Sugeno-type fuzzy inference is that the output membership functions are only linear or constant for the Sugeno-type fuzzy inference.
- Format of this rule is given as
  IF x is A and y is B THEN Z = f(x,y)
  Here, AB are fuzzy sets in antecedents and z = f(x,y) is a crisp function in the consequent.

Sugeno-type inference-Fuzzy Inference Process

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- The fuzzy inference process under Takagi-Sugeno Fuzzy Model (TS Method) works in the following way
  Step 1: Fuzzifying the inputs : Here, the inputs of the system are made fuzzy.
  Step 2: Applying the fuzzy operator : In this step, the fuzzy operators must be applied to get the output.
  Rule Format of the Sugeno Form
  The rule format of Sugeno form is given by
  if 7 = x and 9 = y then output is z = ax+by+c.

Characteristics of Fuzzy Inference System

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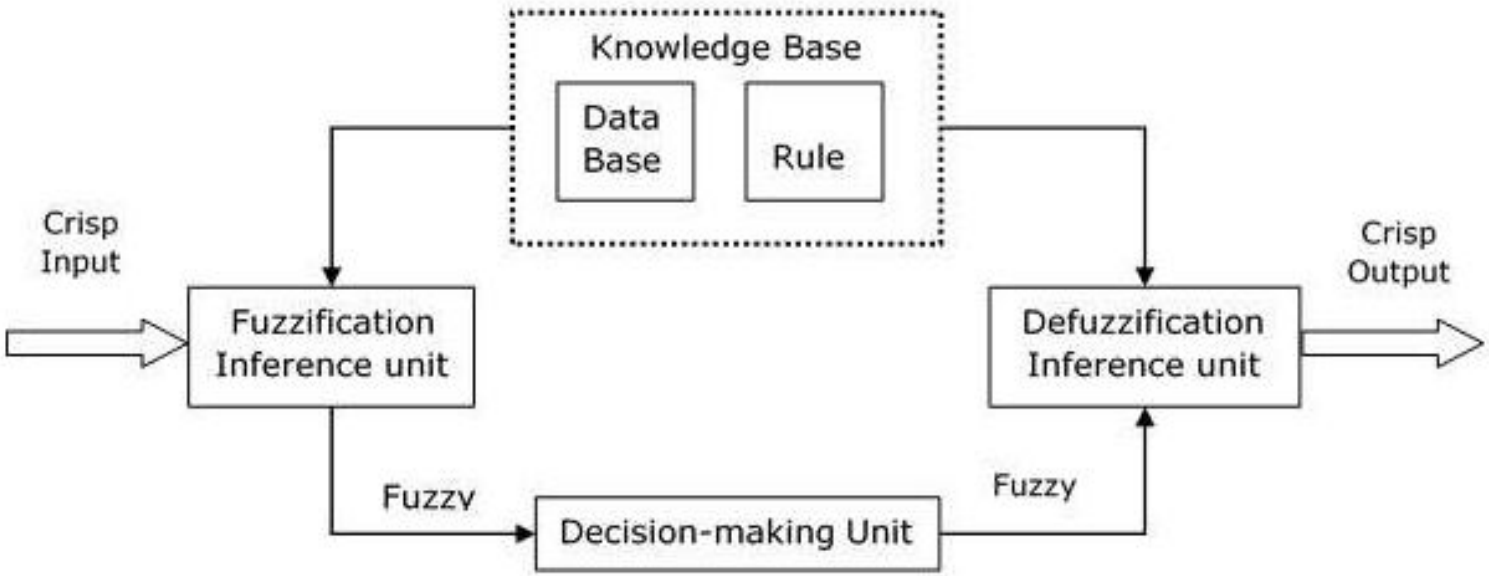
- Following are some characteristics of FIS:
  1. The output from FIS is always a fuzzy set irrespective of its input which can be fuzzy or crisp.
  2. It is necessary to have fuzzy output when it is used as a controller.
  3. A defuzzification unit would be there with FIS to convert fuzzy variables into crisp variables.

Functional Blocks of FIS

- The following five functional blocks will help you understand the construction of FIS
  1. Rule Base: It contains fuzzy IF-THEN rules.
  2. Database: It defines the membership functions of fuzzy sets used in fuzzy rules.
  3. Decision making Unit: It performs operation on rules.
  4. Fuzzification Interface Unit: It converts the crisp quantities into fuzzy quantities.
  5. Defuzzification Interface Unit: It converts the fuzzy quantities into crisp quantities. Following is a block diagram of fuzzy interference system.

Blocks of FIS



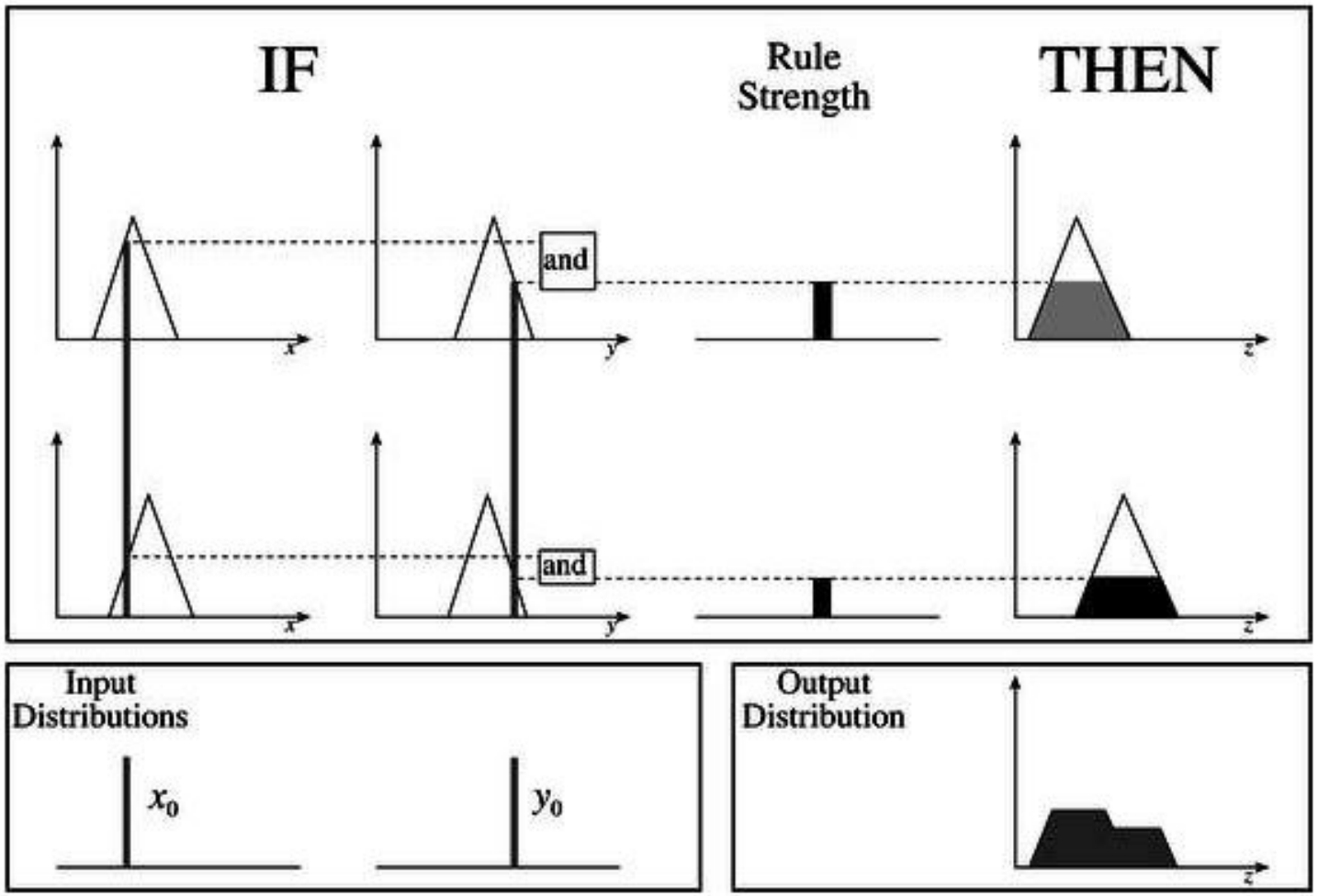
Working of FIS

- The working of the FIS consists of the following steps
  1. A fuzzification unit supports the application of numerous fuzzification methods, and converts the crisp input into fuzzy input.
  2. A knowledge base - collection of rule base and database is formed upon the conversion of crisp input into fuzzy input.
  3. The defuzzification unit fuzzy input is finally converted into crisp output.

Steps for Computing the Output

- Following steps need to be followed to compute the output from this FIS
  Step 1 Set of fuzzy rules need to be determined in this step.
  Step 2 In this step, by using input membership function, the input would be made fuzzy.
  Step 3 Now establish the rule strength by combining the fuzzified inputs according to fuzzy rules.
  Step 4 In this step, determine the consequent of rule by combining the rule strength and the output membership function.
  Step 5 For getting output distribution combine all the consequents.
  Step 6 Finally, a defuzzified output distribution is obtained.

Following is a block diagram of Mamdani Fuzzy Interface System.



Difference between both types of inference

Fuzzy Inference System	Advantages
Mamdani	• Intuitive • Well-suited to human input • More interpretable rule base • Have widespread acceptance
Sugeno	• Computationally efficient • Work well with linear techniques, such as PID control • Work well with optimization and adaptive techniques • Guarantee output surface continuity • Well-suited to mathematical analysis

Difference between both types of inference

MAMDANI FIS	SUGENO FIS
Output membership function is present	No output membership function is present
The output of surface is discontinuous	The output of surface is continuous
Distribution of output	Non distribution of output, only Mathematical combination of the output and the rules strength
Through defuzzification of rules consequent of crisp result is obtained	No defuzzification here. Using weighted average of the rules of consequent crisp result is obtained
Expressive power and interpretable rule consequent	Here is loss of interpretability
Mamdani FIS possess less flexibility in the system design	Sugeno FIS possess more flexibility in the system design
It has more accuracy in security evaluation block cipher algorithm	It has less accuracy in security evaluation block cipher algorithm
It is using in MISO (Multiple Input and Single Output) and MIMO (Multiple Input and Multiple Output) systems	It is using only in MISO (Multiple Input and Single Output) systems
Mamdani inference system is well suited to human input	Sugeno inference system is well suited to mathematically analysis
Application: Medical Diagnosis System	Application: To keep track of the change in aircraft performance with altitude

Refrences

- Mamdani, E.H. and S. Assilian, "An experiment in linguistic synthesis with a fuzzy logic controller," International Journal of Man-Machine Studies, Vol. 7, No. 1, pp. 1-13, 1975.
- Leszek Rutkowski., Flexible Neuro-Fuzzy Systems: Structures, Learning and Performance Evaluation, Technical University of Czestochowa, Poland, Kluwer Academic Publishers New York.
- Bilgic, Taner and Turksen, Burhan. 1999. Measurement of Membership Function: Theoretical and Experimental Work. In D. Dubois and H. Prade (editors) Handbook of Fuzzy Systems, Vol. 1.
- W. Barada and H. Singh, Generating Optimal Adaptive Fuzzy-Neural Models of Dynamical Systems with Applications to Control, IEEE Transactions on Systems, Man, and Cybernetics, Part C 28 (1998) 371-391. 2001.

Queries

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Thanking You