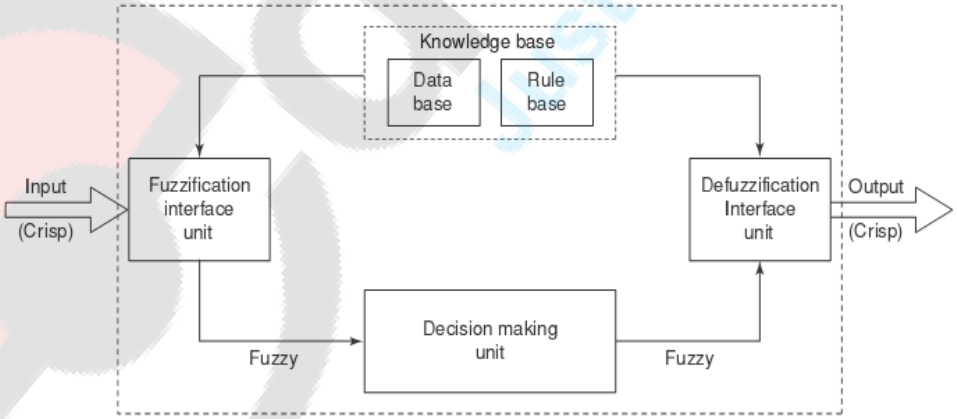
1. **What is Fuzzy Inference system (FIS)? Explain it along with its types.**

- Fuzzy rule based systems, fuzzy models, and fuzzy expert systems are also known as fuzzy inference systems.
- The key unit of a fuzzy logic system is FIS.
- The primary work of this system is decision-making.
- FIS uses "IF...THEN" rules along with connectors "OR" or "AND" for making necessary decision rules.
- The input to FIS may be fuzzy or crisp, but the output from FIS is always a fuzzy set.
- When FIS is used as a controller, it is necessary to have crisp output.
- Hence, there should be a defuzzification unit for converting fuzzy variables into crisp variables along FIS.

Mamdani FIS

1. Determine a set of fuzzy rules
2. Make the inputs fuzzy using input membership functions
3. Combine the fuzzified inputs according to the fuzzy rules for establishing a rule strength.
4. Determine the consequent of the rule by combining the rule strength and the output membership function.
5. Combine all the consequents to get an output distribution.
6. Finally, a defuzzified output distribution is obtained.



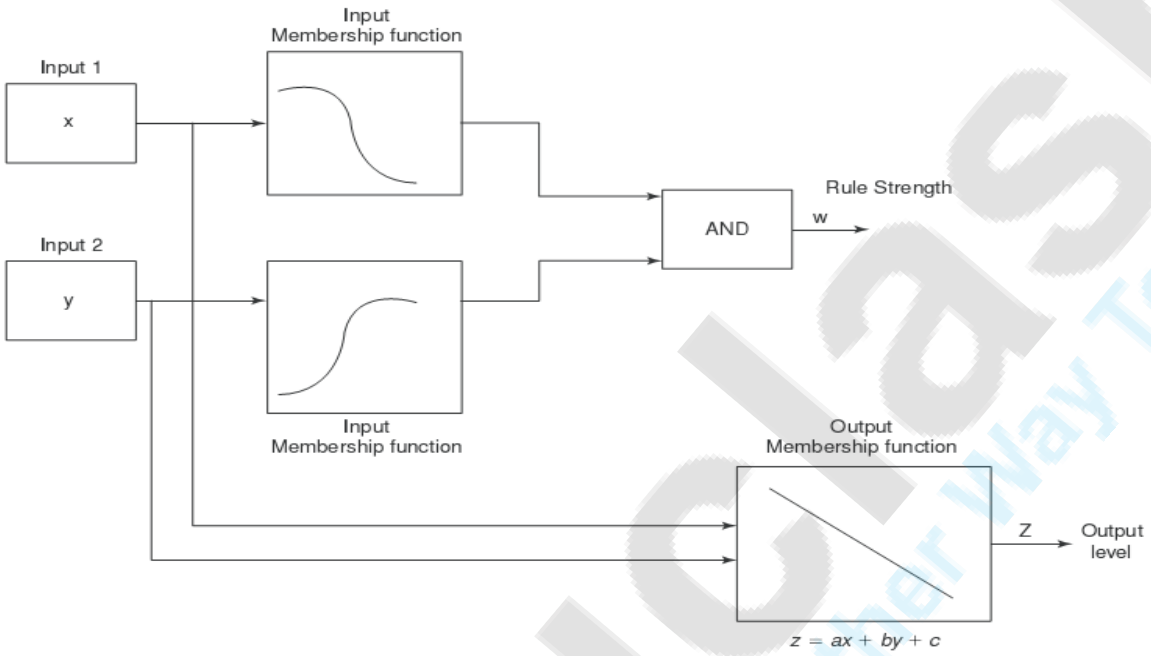
Sugeno FIS

The main steps of the fuzzy inference process namely,

1. fuzzifying the inputs and

2. applying the fuzzy operator are exactly the same as in MAMDANI FIS.

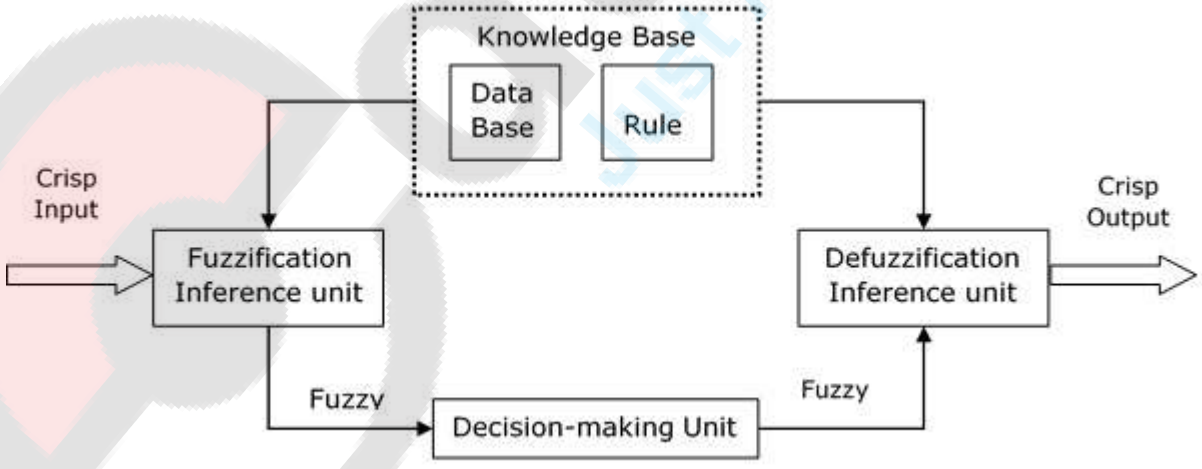
The main difference between Mamdani's and Sugeno's methods is that Sugeno output membership functions are either linear or constant



2. What is Fuzzy Inference system? With suitable block diagram, explain the working principles of an FIS. OR Write a note on FIS.

- Fuzzy rule based systems, fuzzy models, and fuzzy expert systems are also known as fuzzy inference systems.
- The key unit of a fuzzy logic system is FIS.
- Fuzzy inference is the actual process of mapping from a given input to an output using fuzzy logic
- The process involves all the pieces as: **membership functions, fuzzy logic operators, and if-then rules**
- The primary work of this system is decision-making.
- FIS uses "IF...THEN" rules along with connectors "OR" or "AND" for making necessary decision rules.
- The input to FIS may be fuzzy or crisp, but the output from FIS is always a fuzzy set.
- When FIS is used as a controller, it is necessary to have crisp output.
- Hence, there should be a defuzzification unit for converting fuzzy variables into crisp variables along FIS.

- Fuzzy inference systems have been successfully applied in fields such as automatic control, data classification, decision analysis, expert systems, and computer vision
- Functional blocks of FIS:
    - Rule base
    - Database
    - Decision making unit
    - Fuzzification interface unit
    - Defuzzification interface unit
- **Knowledge base**: The **rule base** and the **database** are jointly referred to as the **knowledge base**
    - A rule base contains a number of fuzzy IF–THEN rules
    - A database defines the membership functions of the fuzzy sets used in the fuzzy rules
- **Fuzzification interface unit :**Converts the crisp input to a fuzzy input using the membership functions stored in the fuzzy knowledge base
- **Decision making unit/Inference Engine** :Using If-Then type fuzzy rules converts the fuzzy input to the fuzzy output
- **Defuzzification interface unit:** Converts the fuzzy output of the inference engine to crisp using membership functions analogous to the ones used by the fuzzifier



- The working methodology of FIS is as follows.

Initially, in the fuzzification unit, the crisp input is converted into a fuzzy input.

Various fuzzification methods are employed for this.

After this process, rule base is formed with the help of experts.

Finally, defuzzification process carried out to produce crisp output.

Mainly, the fuzzy rules are formed in the rule base and suitable decisions are made in the decision making unit.

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