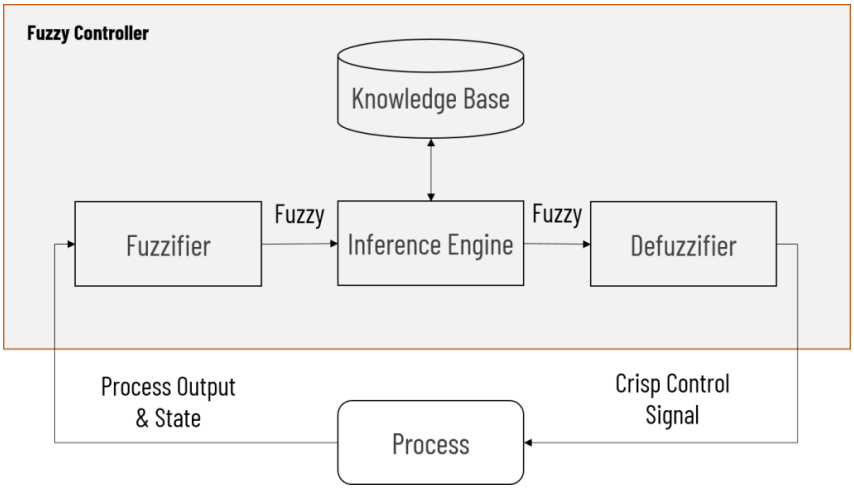
Fuzzy Inference System (FIS)

- It is a key component of any fuzzy controller. FIS consists of various functional blocks.
- The fundamental task of any FIS is to apply the if-then rules on fuzzy input and produce the corresponding fuzzy output. The whole process is based on the computer paradigm including fuzzy set theory, if-then rules and the fuzzy reasoning process.
- Fuzzy inference (reasoning) is the actual process of ***mapping from a given input to an output using fuzzy logic***.
- FIS has been successfully applied in fields such as automatic control, data classification, decision analysis, expert systems and many more

And because of its multi-disciplinary nature, the fuzzy inference system is also known as

- Fuzzy-rule-based system
- Fuzzy expert system
- Fuzzy model
- Fuzzy associative memory
- Fuzzy logic controller
- Fuzzy system

The functional block diagram of the fuzzy Inference system is depicted in the following diagram:



Fuzzy inference system

As shown in Figure, a fuzzy controller operates by repeating a cycle of the following four steps :

1. Compare the input variables with the membership functions on the **antecedent** part to obtain the membership values of each linguistic label. (this step is often called *fuzzification.)*
2. Combine (*usually multiplication or* min) the membership values on the **premise** part to get the *firing strength* (*decree of fulfilment) of each rule.*
3. Generate the **qualified consequents** (either fuzzy or crisp) or each rule depending on the firing strength.
4. **Aggregate the qualified consequents** to produce a crisp output. (This step is called *defuzzification.)*

Components of FIS:

Knowledge Base = Data Base + Rule Base

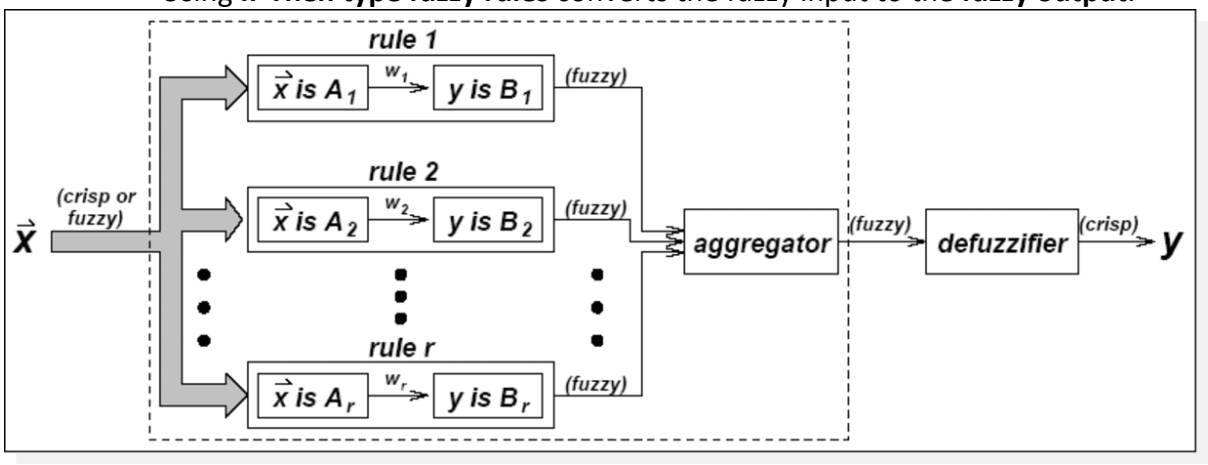
- A database which defines the membership functions of the fuzzy sets used in the fuzzy rules
- A rule base containing a number of fuzzy IF-THEN rules

Fuzzifier:

- Converts the **crisp input** to a **linguistic variable** using the membership functions stored in the fuzzy knowledge base.

Inference Engine:

- Using **If-Then type fuzzy rules** converts the fuzzy input to the **fuzzy output**.



Fuzzy inference process

Defuzzifier:

- Converts the **fuzzy output** of the inference engine to **crisp value** using membership functions analogous to the ones used by the fuzzifier.
- Some commonly used defuzzifying methods:
    - Maxima Methods
    - Weighted Average Method
    - Center of Gravity (CoG) Method
    - Center of Sums (CoS) Method
    - Centroid of area (COA) Method