

Fuzzification

In the real world, some of our knowledge of facts are derived from the use of sensors

- *quantity* of heat measures in Centigrade
- *length* measured in metres

This quantitative and precise factual information is mapped onto the term-set of a linguistic variable.

The membership functions defined on the input variables are applied to their actual values to determine the degree of truth for each rule premise. The degree of truth for a rule's premise is sometimes referred to as its α value. If a rule's premise has a non-zero degree of truth, that is if the rule applies at all, then the rule is said to fire.

Inference

Once mapped, the rules in the knowledge base are invoked systematically to see which of the rules are fired and to what degree.

The truth-value for the premise of each rule is computed and the conclusion applied to each part of the rule. This results in one fuzzy subset assigned to each output variable for each rule.

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. In **product** inferencing the output membership function is scaled by the premise's computed degree of truth.

Composition

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 rule. This is called composition.

All the fuzzy subsets assigned to each output variable are combined together to form a single fuzzy subset for each output variable.

Two composition rules:

1. In **max** composition, the combined fuzzy subset is constructed by taking the pointwise maximum over all the fuzzy subsets assigned to the output variable by the inference rule.
2. In **sum** composition, the combined output fuzzy subset is constructed by taking the pointwise sum over all the fuzzy subsets assigned to output variable by their inference rules. (This can result in truth value greater than 1).

Defuzzification

We convert the fuzzy values outputted by the inference procedure onto a crisp number that can be used in the real world.

Two popular techniques are:

1. In **centroid** defuzzification, we can compute the "centre of gravity" (COG) or "centre of area" (coa) of the output of the rules. The COG involves the computation of the weighted sum of the speed and the corresponding membership function of the output fuzzy set and the weighted sum of the membership function. The centre of gravity approach attempts to take the rules into consideration according to their degree of applicability. If a rule dominates during a certain interval then its dominance is discounted in other intervals.
2. In **maximum** defuzzification, we use the of Mean of Maxima Method. Here again the weighted sum and weighted membership are worked out, except that the membership function is given another alpha level cut corresponding to the maximum value of the output fuzzy set.