Revision on FUZZY LOGIC (FL):

FL is a problem-solving methodology especially useful for system control.

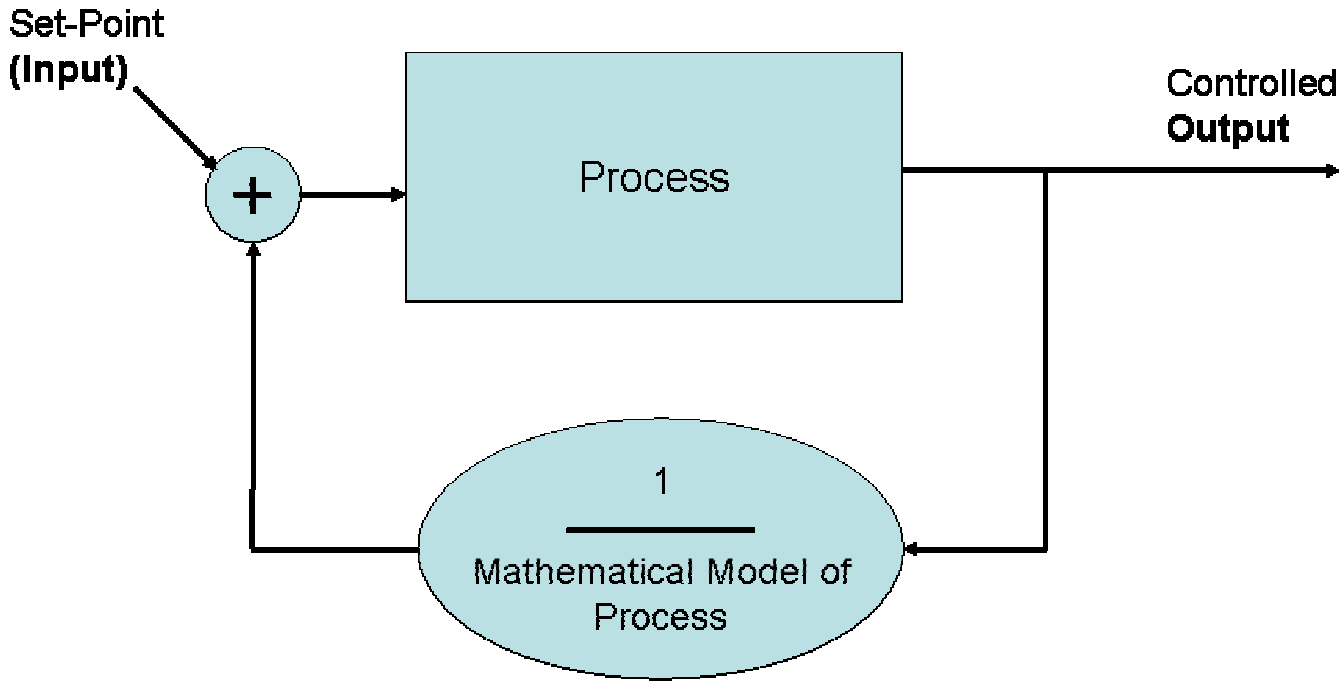
It can be implemented in hardware, software, or a combination of both.

FL provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy, or missing input information.

FL's approach to control problems mimics how a person would make decisions, only much faster.

Classic Control Theory:

Classic control is made by using a Mathematical model of the process to be controlled to create a feedback mechanism that is intended to keep the error from a set-point to a minimum (as near to cero as possible).



The main elements for a control system are:

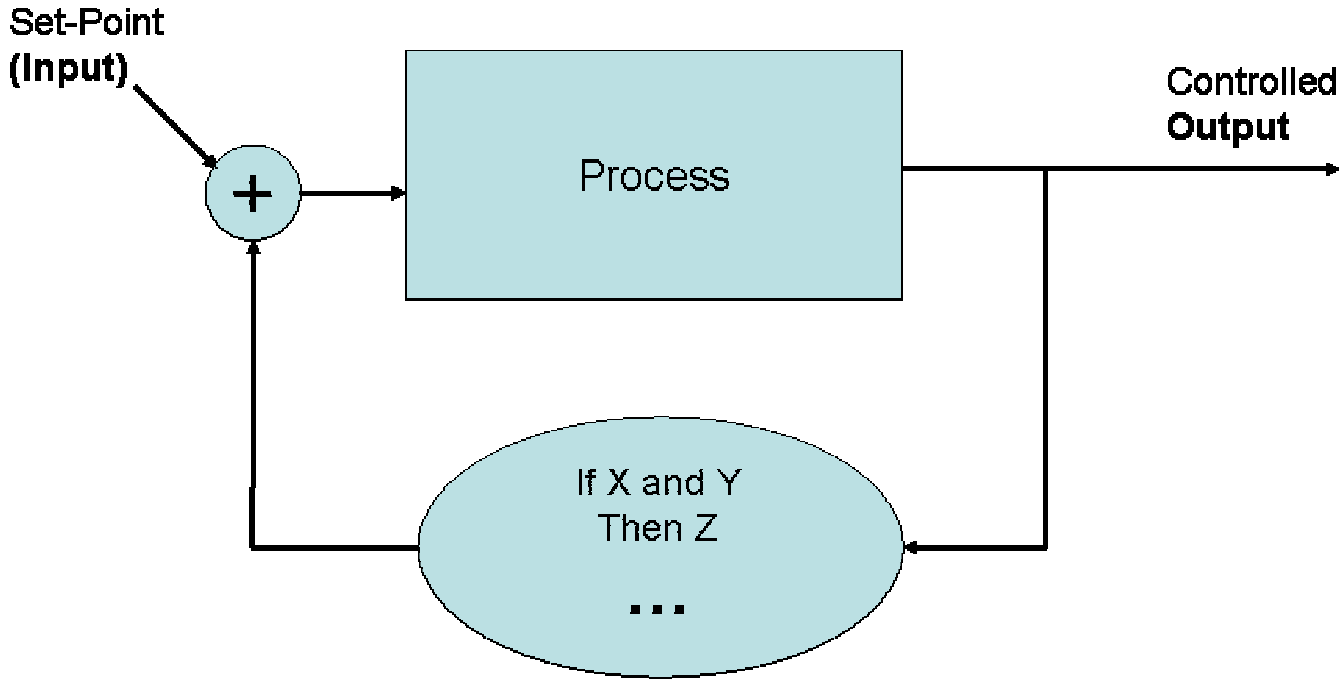
- **Variable to control** (the output to the system, is what you want to control, e.g. temperature).
- **The Set Point** (the value you what the control variable to keep, e.g. 21 degrees C)
- **Error of the variable** (the difference between that actual value the variable has to what you would like it to be. e.g. If the temperature is 15 degrees C and you want it to be 21 degrees, the error is 6 degrees)
- **The rate of change of the error of the variable** (how is the value changing, e.g. is it getting hotter o colder? Is the error increasing it decreasing?)
- **Action to achieve the control or Control Action** (how are you going to keep the variable to the value you want, e.g. turning on a heater or a fan? Turning the speed of the fan to faster or slower speed?)
- **The process** (is the whole system where your control is working, e.g. the room where you want to control the temperature, which includes things that heat it up like people and computers and things that can cool it down like open windows or thin walls, and your control action, like a fan or heater, etc…)
- **The model of the process** (a mathematical description on how all your process works)

The first five elements actually exist and are part of **ANY** control system.

Thus, to control your variable, you define a set-point, which is compared to the actual value of the variable, which defines an error, and by activating the control action, the error is minimised, ideally, eliminated.

How does FL control the process?

FL replaces the mathematical model (and **ONLY** the mathematical model) with a simple, rule-based IF X AND Y THEN Z system which represents **your experience** on how to control the process.



All the other elements of the control system remain the same (the first 5 in the list above)!

Thus, FL model is empirically-based, relying on an operator's **experience** rather than their technical understanding of the system.

How Does FL Work?

FL requires some numerical parameters in order to operate:

The main parameters are the representation of the variable to control (e.g. temperature) in the form of its significant error and significant

rate-of-change-of-error, but exact values of these numbers are usually not critical.

For example, a simple temperature control system could use a single temperature feedback sensor whose data is subtracted from the set-point to compute "error" and then time-differentiated to yield the error slope or rate-of-change-of-error, hereafter called "error-dot". These errors are then organised in ranges using Fuzzy Sets, to define no error, small errors, large errors, etc…

The standard logical operations can be performed on these sets: OR, AND, NOT. And these used then to interpret the rules (inference). The results of applying the rules are an action defined by the inference, this action is defuzzified and applied as a control action.

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