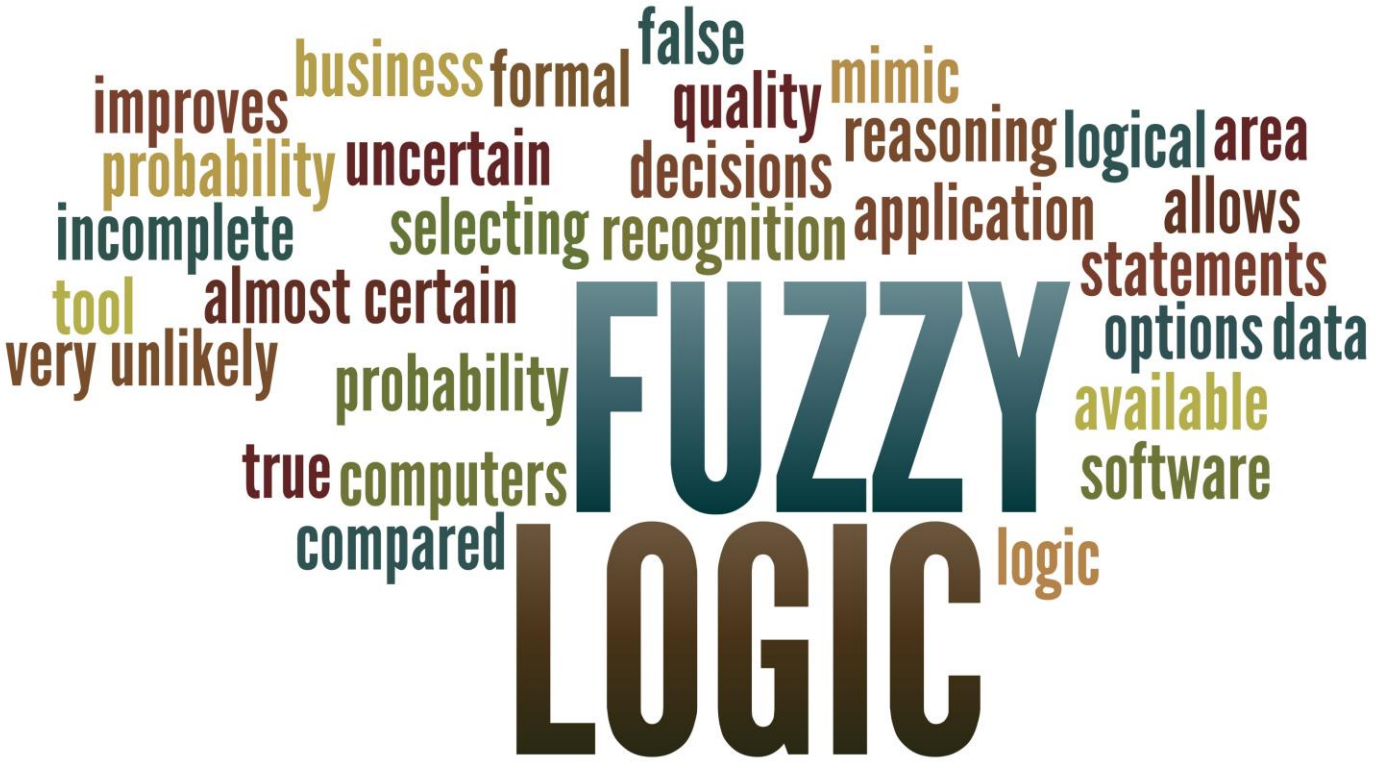
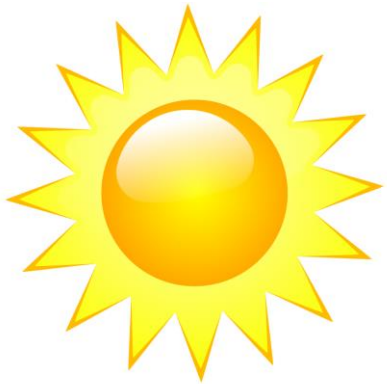
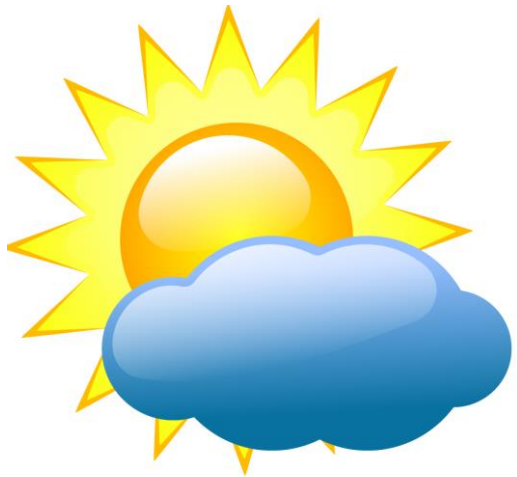
20IS603 Architecture of Intelligent Systems



Or

?





Fuzzy Logic

- Bayesian updating and certainty theory are techniques for handling the uncertainty that arises, or is assumed to arise, from statistical variations or randomness.
- Fuzzy logic, sometimes called possibility theory, addresses a different source of uncertainty, namely, vagueness in the use of language
- Logic used to describe fuzziness
- Based on the idea that all things admit of degrees

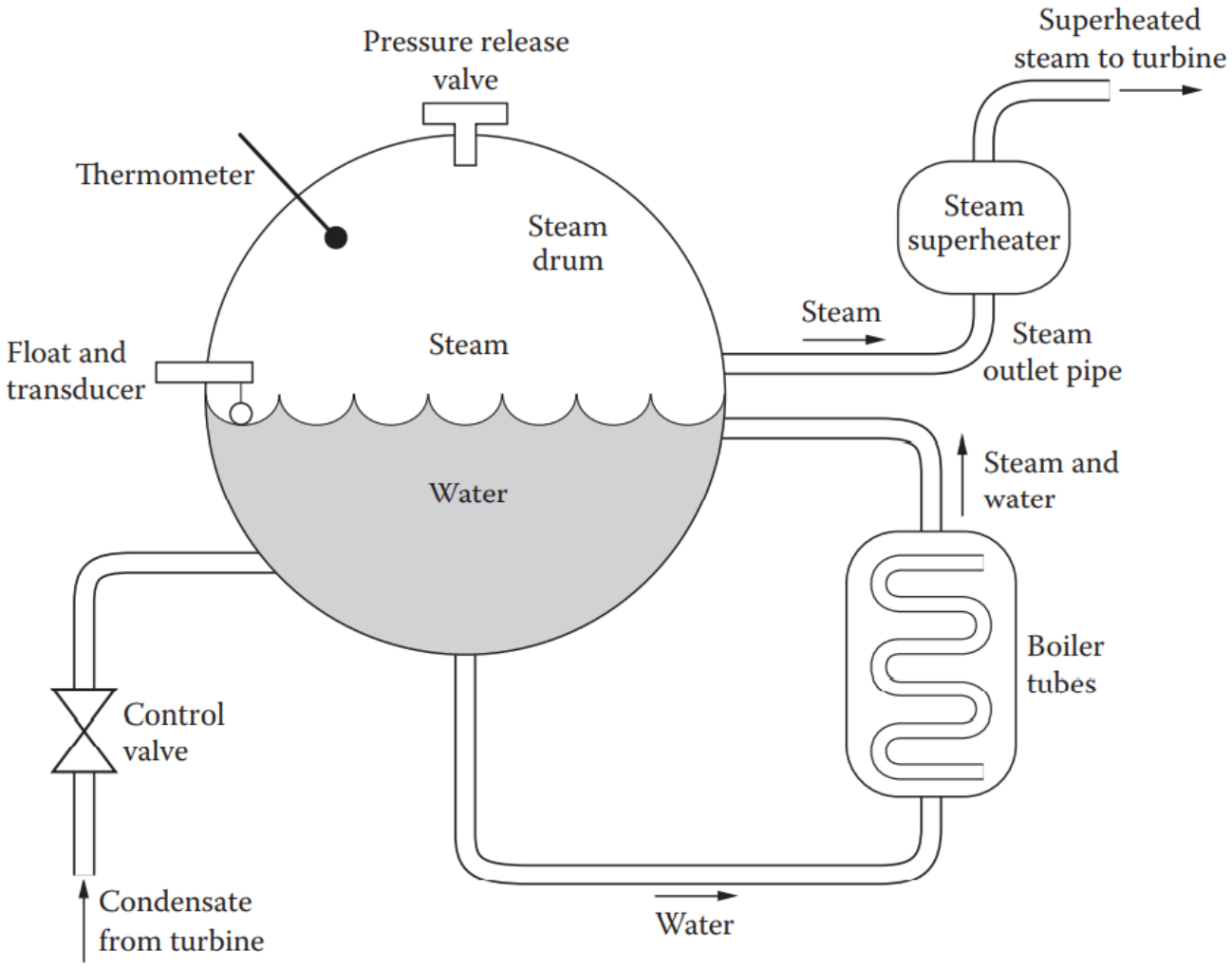
Fuzzy Logic

- Boolean or conventional logic uses sharp distinctions.

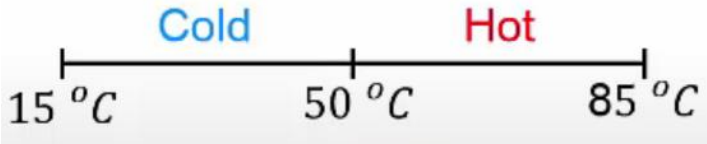
- Fuzzy or multi-valued logic - reflects how people think - leading to more human, intelligent systems

- Deals with degrees of membership and degrees of truth
- Fuzzy logic is the theory of fuzzy sets, sets that calibrate vagueness

Example



Regulate the temperature to 50^0C

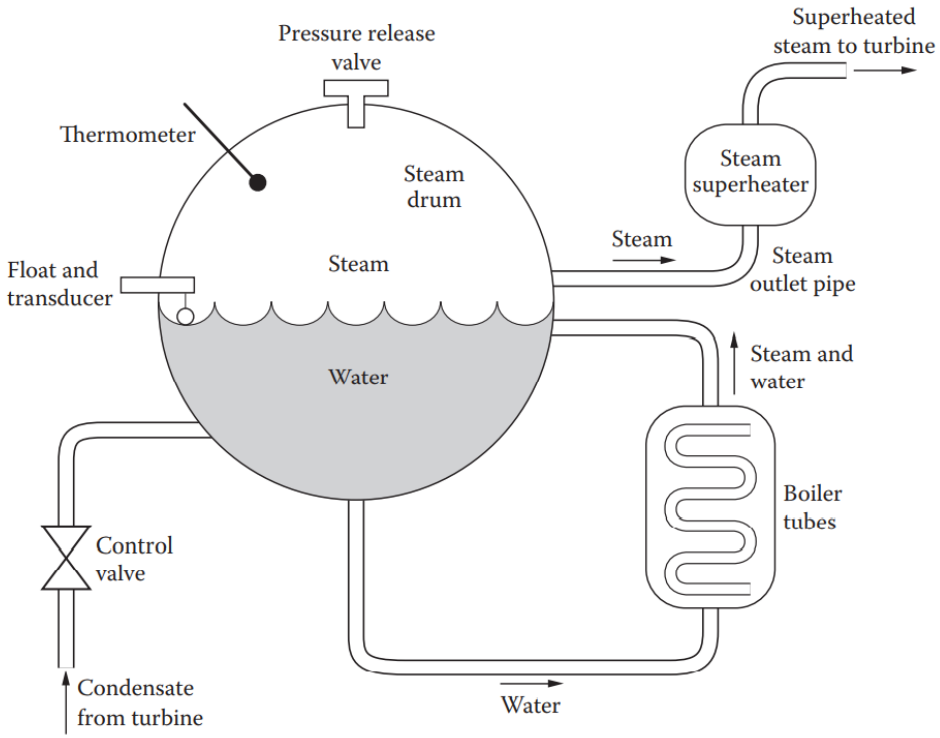


Temp	Cold	Hot
Action	Open Valve	Close Valve

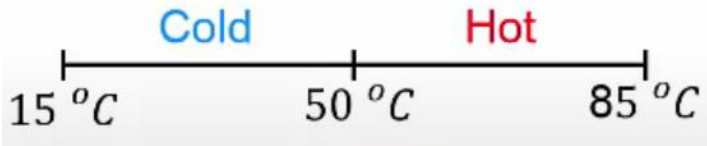
$If\ T < 50\ Then\ ValvePosition = 100\%$

$If\ T > 50\ Then\ ValvePosition = 0\%$

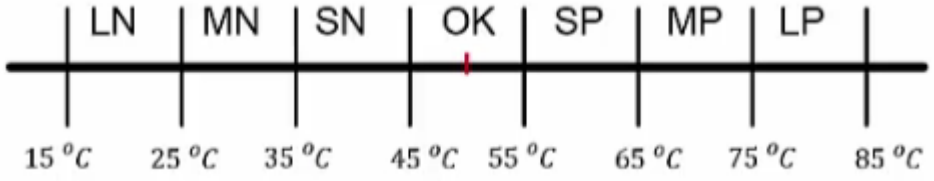
Example



Regulate the temperature to 50^0C

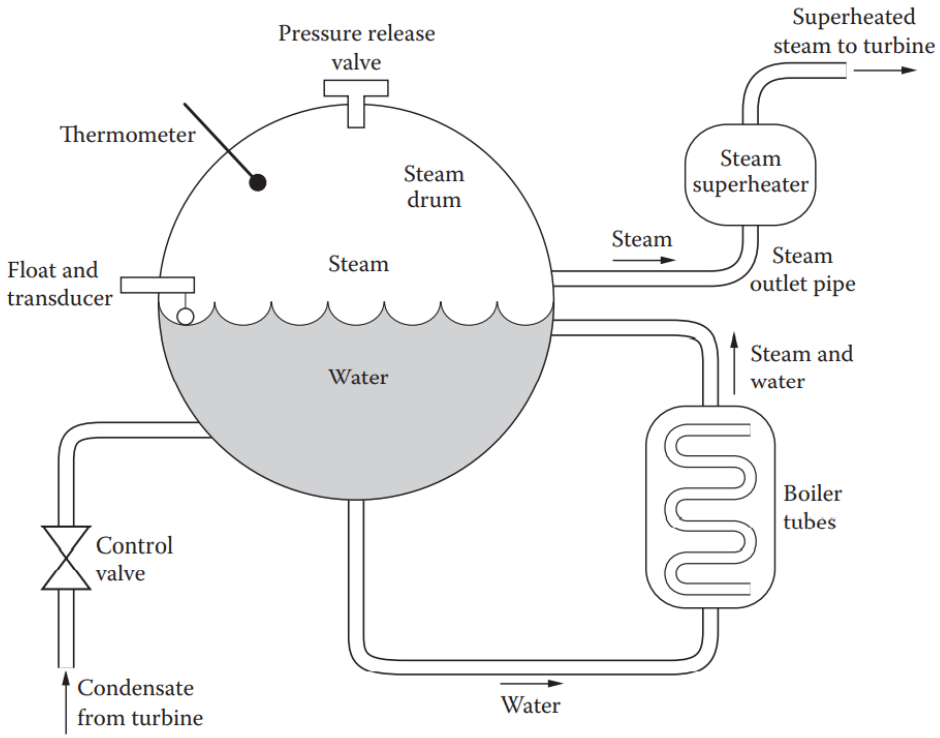


Temp	Cold	Hot
Action	Open Valve	Close Valve

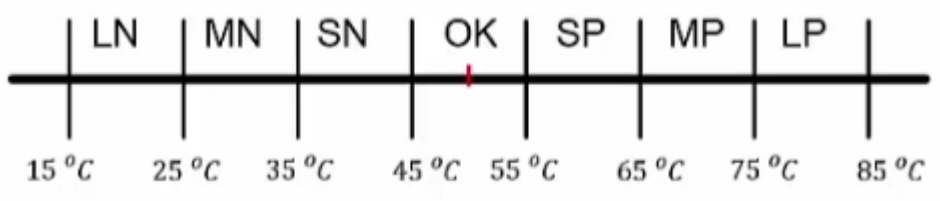


Error	LN	MN	SN	OK	SP	MP	LP
Action	+3	+2	+1	0	-1	-2	-3

Example

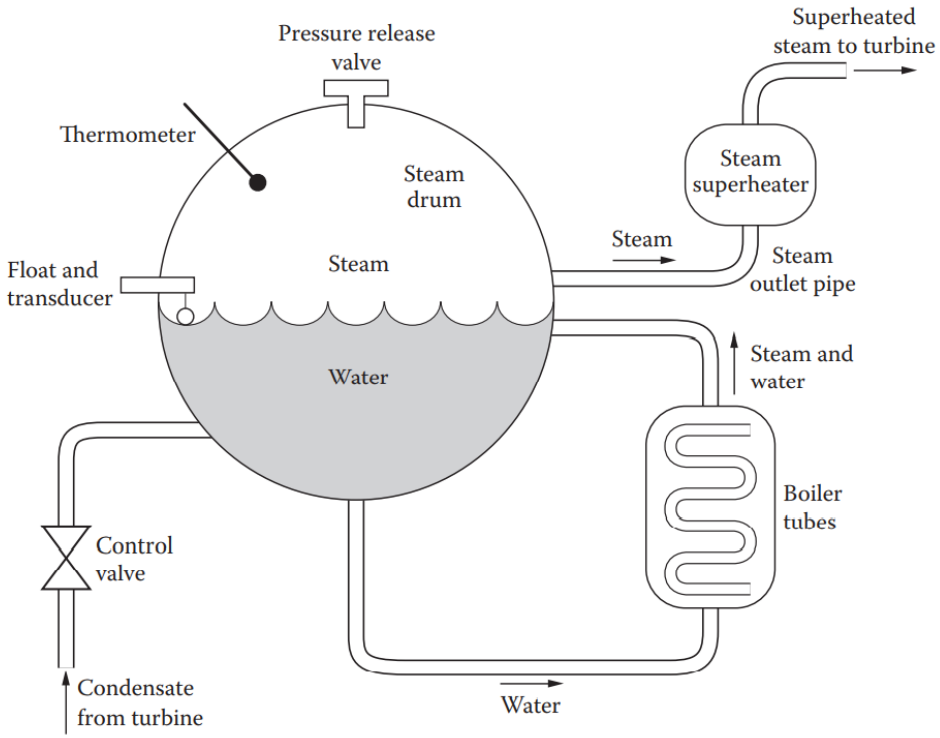


Regulate the temperature to 50^0C

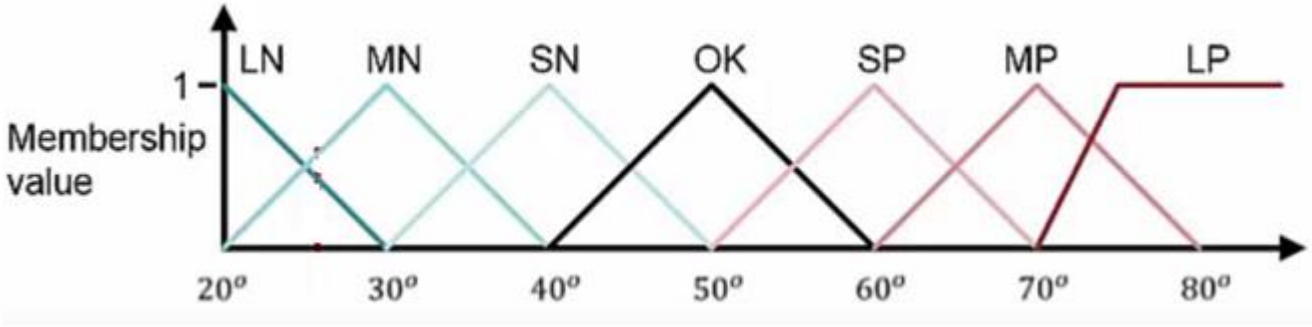


Error	LN	MN	SN	OK	SP	MP	LP
Action	+3	+2	+1	0	-1	-2	-3

Example

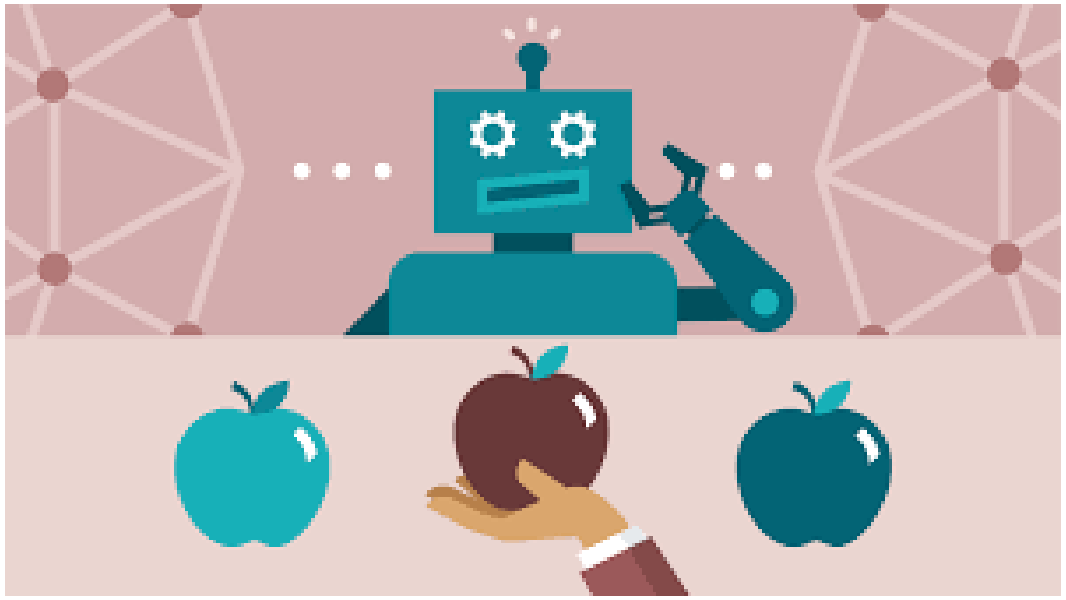


Regulate the temperature to 50^0C



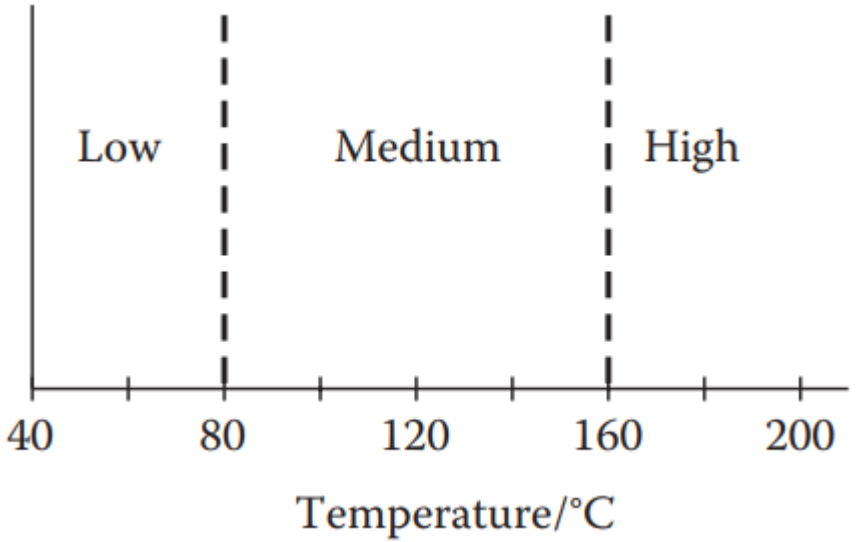
Fuzzy Logic

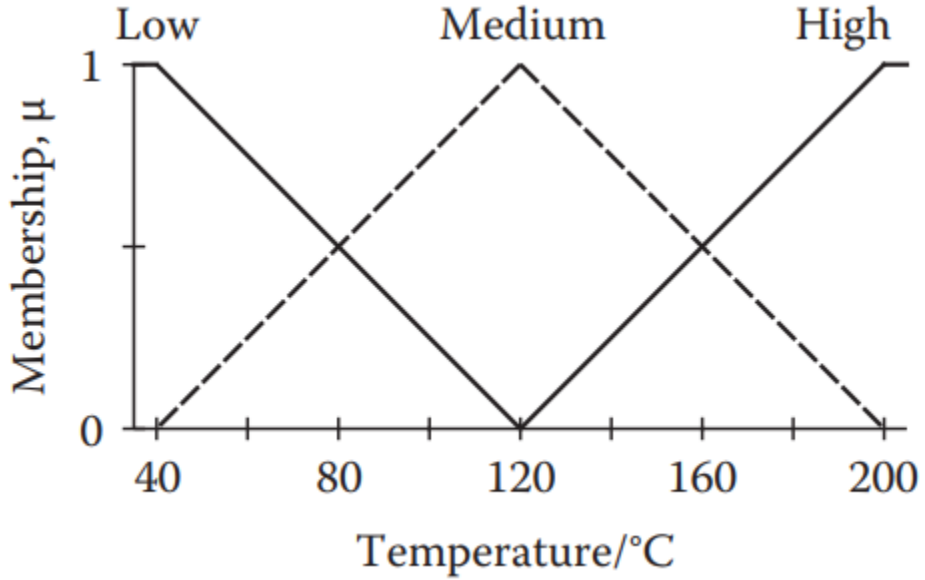
- Unlike two-valued Boolean logic, fuzzy logic is multi-valued.
- It deals with degrees of membership and degrees of truth
- Fuzzy logic uses the continuum of logical values between 0 (completely false) and 1 (completely true).
- Instead of just black and white, it employs the spectrum of colours, accepting that things can be partly true and partly false at the same time.



Crisp Sets and Fuzzy Sets

- Fuzzy sets are a means of smoothing out the boundaries
- Membership functions that can assume values between 0 and 1 corresponding to degrees of membership from “not a member” through to “a full member”
- Degree of membership is sometimes called the possibility - process of deriving these possibility values is called fuzzification





Crisp Set Theory

- Let X be a classical (crisp) set and x an element.
- The element x either belongs to X, $x \in X$
  or does not belong to X, $x \notin X$
- Classical set theory imposes a sharp boundary on this set and gives each member of the set the value of 1, and all members that are not within the set a value of 0.
- Logic uses one of only two values: true or false
- Crisp set A of X is defined as function $f_A(x)$ called the characteristic function of A

$$f_A(x) : X \rightarrow \{0, 1\}$$

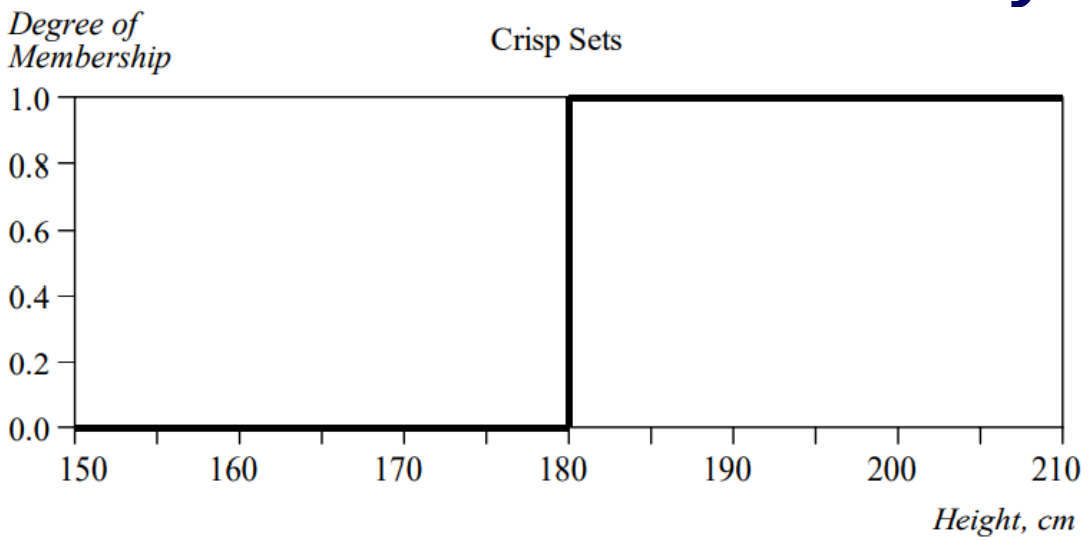
$$\text{where } f_A(x) = \begin{cases} 1, & \text{if } x \in A \\ 0, & \text{if } x \notin A \end{cases}$$

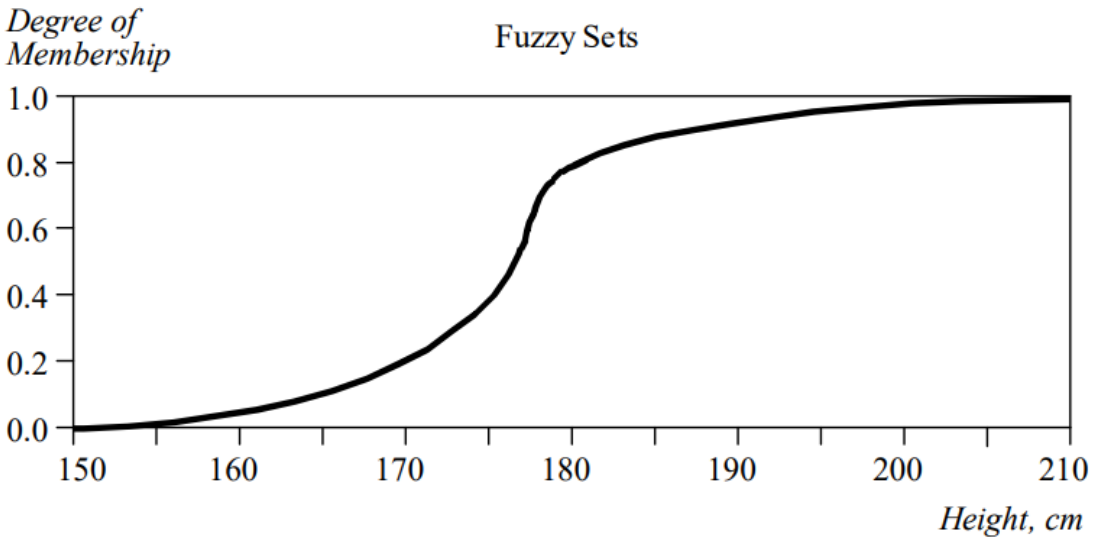
Fuzzy Set Theory

- Classical example in the fuzzy set theory is *tall men*.
- The elements of the fuzzy set '*tall men*' are all men, but their degrees of membership depend on their height.
- Crisp set asks the question, 'Is the man *tall*?'
- Fuzzy set asks, 'How *tall* is the man?'
- The variable here is the human height.

Name	Height, cm	Degree of Membership	
		Crisp	*Fuzzy*
Chris	208		
Mark	205		
John	198		
Tom	181		
David	179		
Mike	172		
Bob	167		
Steven	158		
Bill	155		
Peter	152		

Fuzzy Set Theory





Name	Height, cm	Degree of Membership	
		Crisp	*Fuzzy*
Chris	208	1	1.00
Mark	205	1	1.00
John	198	1	0.98
Tom	181	1	0.82
David	179	0	0.78
Mike	172	0	0.24
Bob	167	0	0.15
Steven	158	0	0.06
Bill	155	0	0.01
Peter	152	0	0.00

- The x-axis represents the universe of discourse – the range of all possible values applicable to a chosen variable.
- The y-axis represents the membership value of the fuzzy set.
- Here, the fuzzy set of ‘tall men’ maps height values into corresponding membership values