

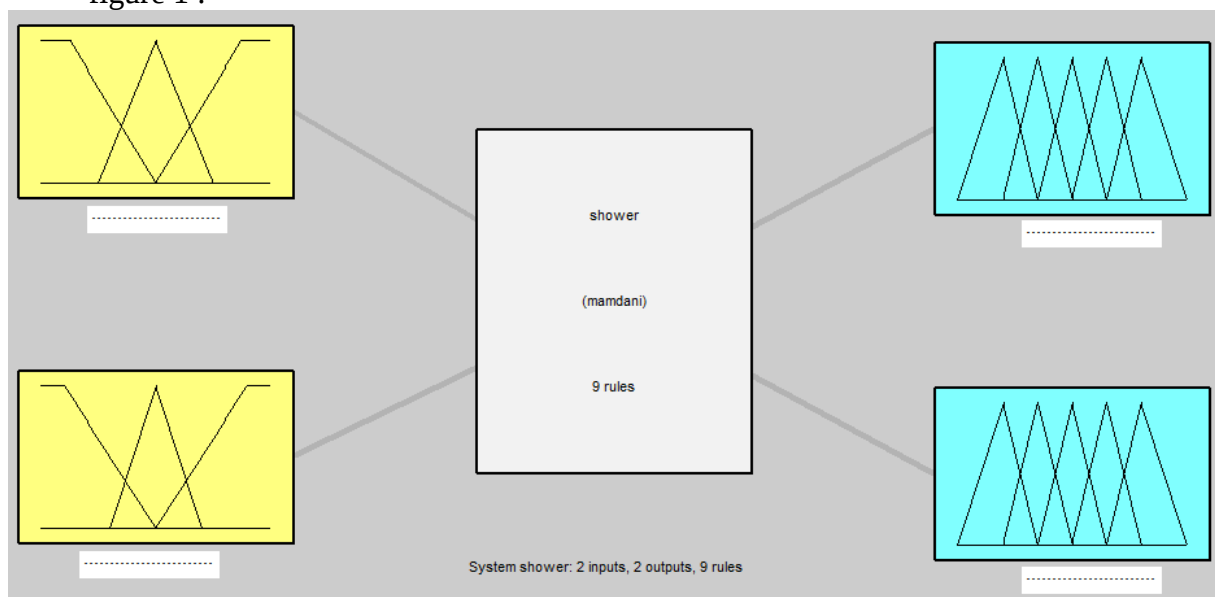
Exercise: Shower System Control

The system provides an automatic control of the temperature and water flow of a shower. The shower system consists of a **hot-water tap and a cold-water tap**, each of which supplies water **at a particular temperature and at a certain rate**. The initial settings for both cold tap and hot tap of the shower are randomly selected and the target temperature is between **-20 and +20 degrees Celsius** and the target flow rate is between **-1 and +1 litres/sec**. Upon each successive iteration, the controller receives the composite flow rate and temperature of the current combination, and must recommend adjustments to the taps in order to achieve the optimum flow and temperature in as few iterations as possible.

The shower system uses the Mandani's fuzzy inference method.

The fuzzy controller for shower system switches between the two input controllers (namely temperature and flow controllers) and produces two required outputs (cold and hot). These outputs will control correspondent valves opening.

- 1) In the case of shower system, which inference method is used ? What is its characteristics ? Is there any other inference method ?
- 2) Define the required fuzzy controller inputs and outputs. Then complete the diagram of figure 1 :



- 3) We give you in figure 2 as example the membership function of the **cold output**.

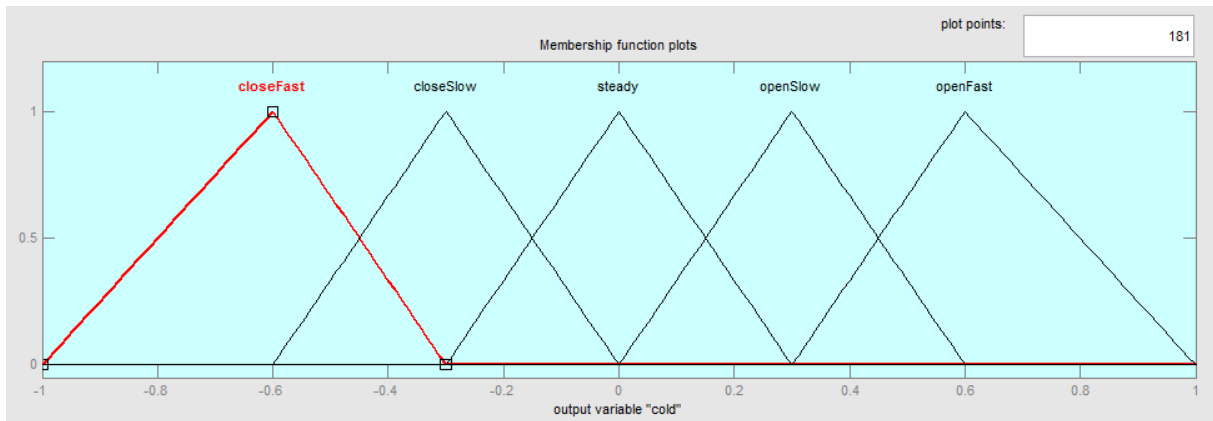


Figure 2: Membership function of cold output

Draw the membership functions of the other inputs and output

Input 1 range: [-20 20]

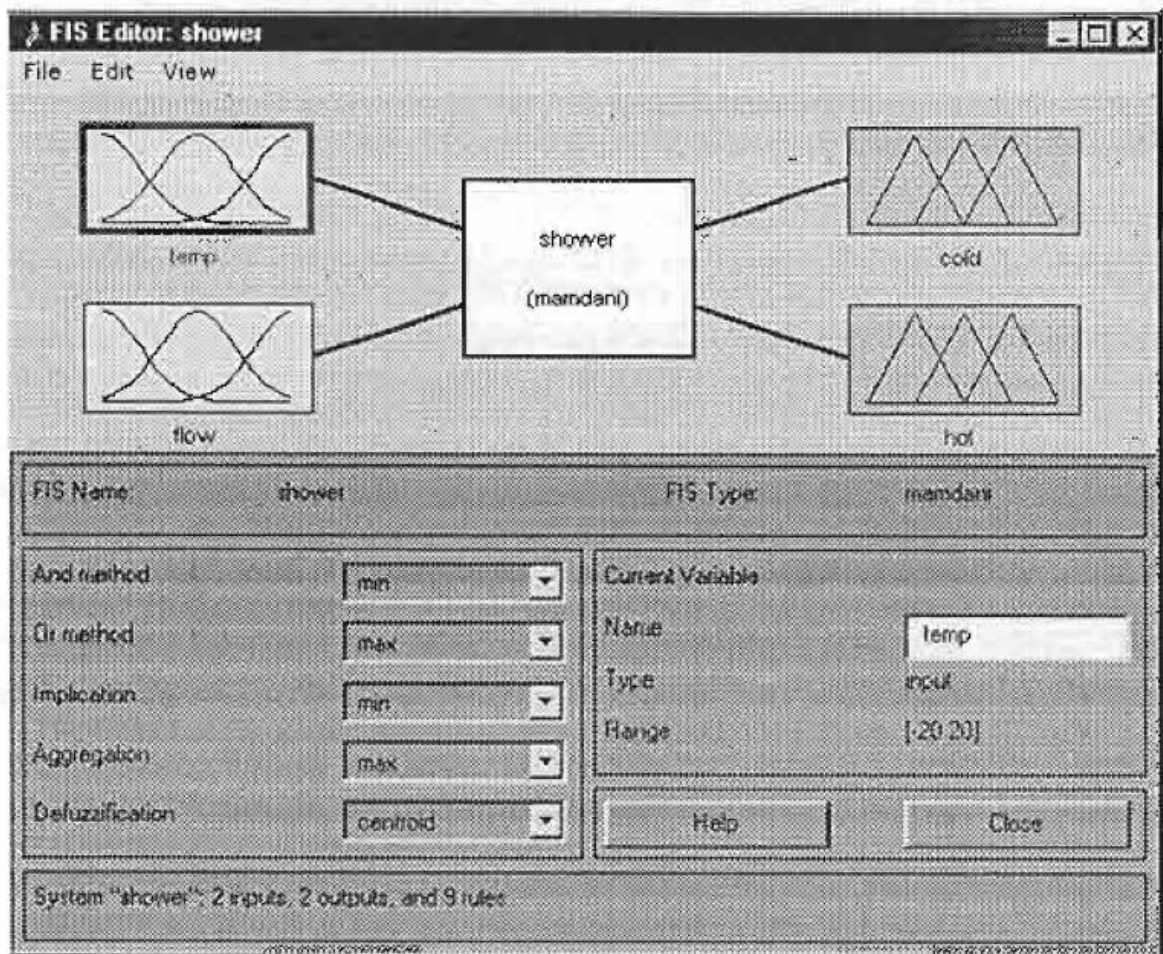
Input 2 range: [- 1 1]

Output range: [-1 1].

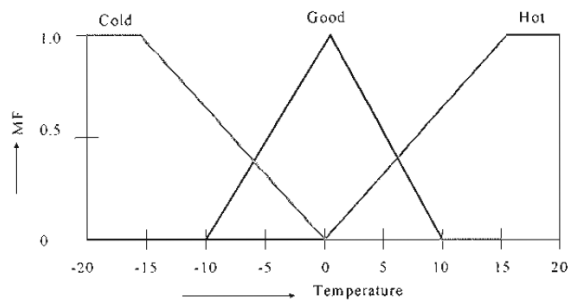
4) Enunciate the 9 “if-then” rules necessary for shower system control.

Correction

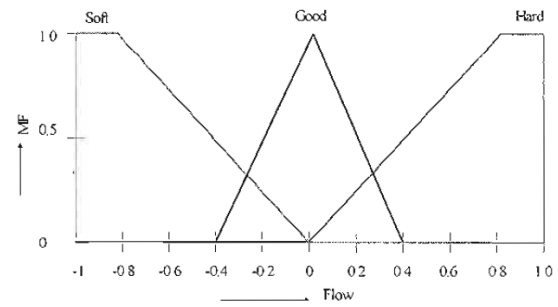
- 1) The shower system uses the Mandani's fuzzy inference method. Mandani-type inference expects the output membership functions to be fuzzy sets. After aggregation process, there is a fuzzy set for each output variable that needs defuzzification.
- 2)



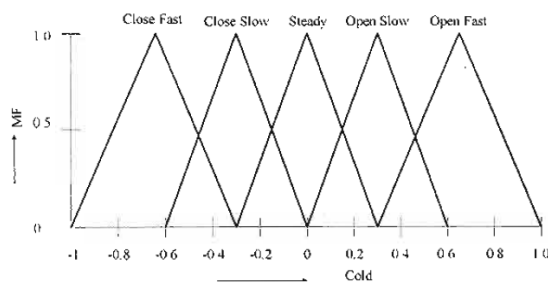
3)



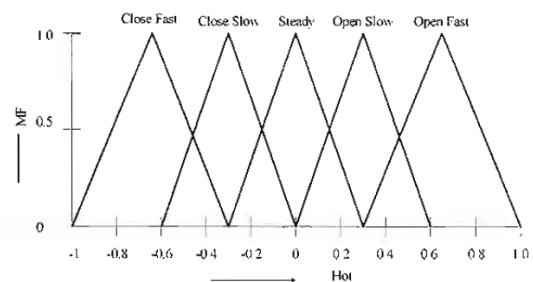
(a) MF of the Temperature Controller



(b) MF of the Flow Controller



(c) MF of the Cold Controller



(d) MF of the Hot Controller

4)

- Rule-1** IF temp is cold and flow is soft THEN cold is openSlow, hot is openFast.
- Rule-2** IF temp is cold and flow is good THEN cold is closeSlow, hot is openSlow
- Rule-3** IF temp is cold and flow is hard THEN cold is closeFast, hot is closeSlow
- Rule-4** IF temp is good and flow is soft THEN cold is openSlow, hot is openSlow
- Rule-5** IF temp is good and flow is good THEN cold is steady, hot is steady
- Rule-6** IF temp is good and flow is hard THEN cold is closeSlow, hot is closeSlow
- Rule-7** IF temp is hot and flow is soft THEN cold is openFast, hot is openSlow
- Rule-8** IF temp is hot and flow is good THEN cold is openSlow, hot is closeSlow
- Rule-9** IF temp is hot and flow is hard THEN cold is closeSlow, hot is closeFast