Assignment #4

MODEL SOLUTION

ECE449, Intelligent Systems Engineering — Fall 2019

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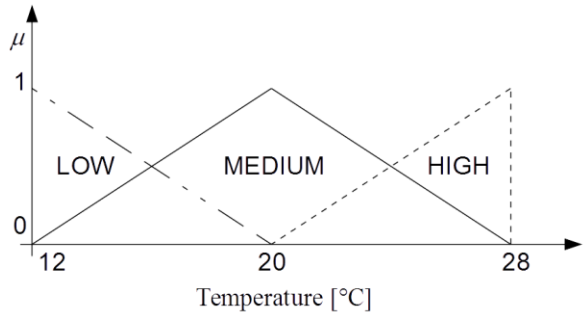
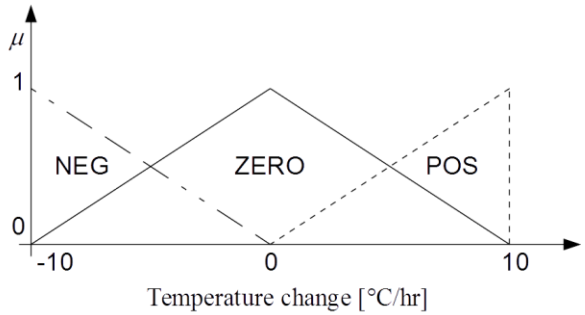
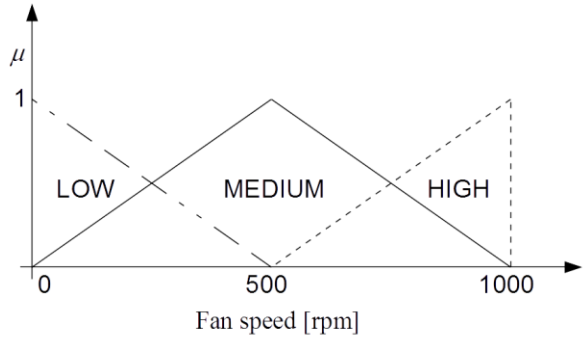
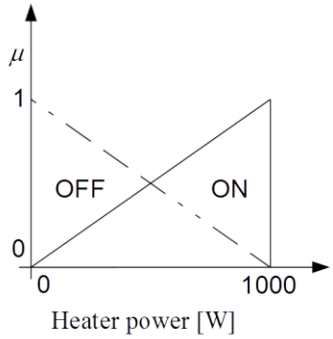
1. [10 marks] A fuzzy system is used to control the temperature in a room. The inputs to the controller are the 'Temperature' and 'Temperature change'. The outputs are the 'Fan Speed' and 'Heater power'. The membership functions are shown in the following figures









and the rule base is described by the following table

	LOW	**MEDIUM**	**HIGH**
NEG	ON/LOW	ON/LOW	ON/MEDIUM
ZERO	ON/LOW	OFF/LOW	OFF/MEDIUM
POS	OFF/LOW	OFF/MEDIUM	OFF/HIGH

If the temperature is 22°C and the change of temperature is 4°C/hr, answer the following questions:

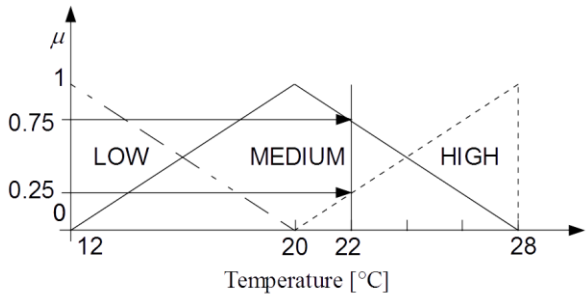
a) What is the result of fuzzification of those inputs?

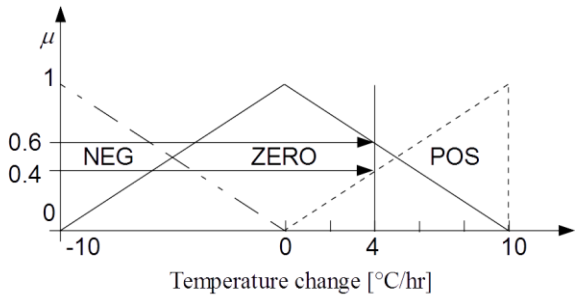
b) Use the rules and Mamdani inference to specify the fuzzy membership values of the outputs.

c) Calculate the 'Heater power' and 'Fan speed' using your choice of defuzzification method.

a) What is the result of fuzzification of those inputs?

Fuzzification can be derived directly from the graphs of the input membership functions





b) Use the rules and Mamdani inference to specify the fuzzy membership values of the outputs.

The memberships are derived above; each rule has DOF (λ) corresponding to the minimum (AND) of the two values at corresponding row/column

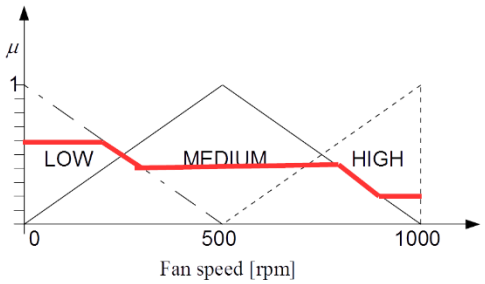
	LOW [0]	**MEDIUM [0.75]**	**HIGH [0.25]**
NEG [0]	ON/LOW [0]	ON/LOW [0]	ON/MEDIUM [0]
ZERO [0.6]	ON/LOW [0]	OFF/LOW [0.6]	OFF/MEDIUM [0.25]
POS [0.4]	OFF/LOW [0]	OFF/MEDIUM [0.4]	OFF/HIGH [0.25]

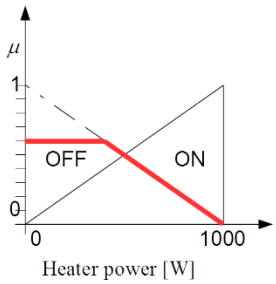
i.e. the following rules will apply (they have nonzero DOF):

IF	T is **MEDIUM**	AND	TC is **ZERO**	THEN	HP is **OFF**	λ=0.6
IF	T is **MEDIUM**	AND	TC is **POS**	THEN	HP is **OFF**	λ=0.4
IF	T is **HIGH**	AND	TC is **ZERO**	THEN	HP is **OFF**	λ=0.25
IF	T is **HIGH**	AND	TC is **POS**	THEN	HP is **OFF**	λ=0.25
IF	T is **MEDIUM**	AND	TC is **ZERO**	THEN	FS is **LOW**	λ=0.6
IF	T is **MEDIUM**	AND	TC is **POS**	THEN	FS is **MEDIUM**	λ=0.4
IF	T is **HIGH**	AND	TC is **ZERO**	THEN	FS is **MEDIUM**	λ=0.25
IF	T is **HIGH**	AND	TC is **POS**	THEN	FS is **HIGH**	λ=0.25

Therefore, using Mamdani implication (min), the following output fuzzy sets will be clipped at the levels indicated in the parenthesis (when more than one output fuzzy set is considered, maximum of corresponding DOF values is used to model the ELSE connective):

HP is **OFF** (0.6)
FS is **LOW** (0.6)
FS is **MEDIUM** (0.4)
FS is **HIGH** (0.25)





Graphical representation of the distribution of the membership values of the outputs is shown on the right.

c) Calculate the 'Heater power' and 'Fan speed' using your choice of defuzzification method.

Results may vary, depending on the defuzzification method used.