Higher Institute for Applied Sciences and Technology
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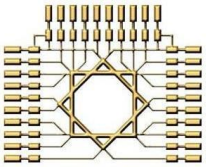

Fuzzy Logic

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Smart Washing Machine

When we use a washing machine, we generally set wash time based on the amount of clothes and the type and degree of dirt cloths have. We want to automate this process using sensors to detect these parameters. The wash time is then determined from this data. Unfortunately, there is no easy way to formulate a precise mathematical relationship between volume of clothes and dirt and wash time required. So, we want to design a simple fuzzy logic controller that helps determine wash time according to data received by sensors.
To Simplify the problem, we will work with few parameters:

1. **Type of Dirt (saturation)**
   Type of dirt is determined by the time of saturation; the amount of time water takes to saturate with the dirt.
   The Saturation time is defined in the range of 0 to 10 minutes and can be divided into three subsets:

type	range
Small	0 - 5
Medium	0 - 10
Large	5 -10

2. **Degree of Dirt (dirtiness)**
   The type of stain or type of dirtiness of cloth. The dirtiness is defined in the range from 0 to 30, can be divided into three subsets:

degree	range
Low	0 - 15

Medium	0 - 30
High	15 -30

3. Wash Time (time)

The wash-time required to clean the dirt. The wash time is defined in the range from 0 to 15 minutes and can be divided into:

subset	range
Very Low	0 – 4
Low	0 – 8
Medium	4 - 11
High	7 – 15
Very High	11 - 15

The Rules

The washing machine follows these rules (joined by AND):

		Dirtiness		
		LOW	MEDIUM	HIGH
Time / Saturation	SMALL	VERY_LOW	LOW	MEDIUM
	MEDIUM	LOW	MEDIUM	HIGH
	LARGE	MEDIUM	HIGH	VERY_HIGH

Lab Work:

Part1

Now we will build a fuzzy Inference System to automatically set washing time.

1. Define the (input/output) Fuzzy Variables and their fuzzy sets, using the Matlab fuzzy logic editor.

2. Add the rules to your fuzzy system.

3. Test your fuzzy system for ***Saturation*** = 5 and ***Dirtiness*** = 4

   a. What is the washing time?

   4.980559529929043 which belongs to sets [low = (0,8)] and [medium = (4,11)].

   b. Which rules gave an output?

   If Saturation is medium and Dirtiness is medium then time is medium.
   If Saturation is medium and Dirtiness is low then time is low.
   If Saturation is small and Dirtiness is medium then time is low.
   If Saturation is large and Dirtiness is low then time is medium.

   c. Why these rules gave output?

   If Saturation is medium and Dirtiness is medium then time is medium.
   Saturation = 5 which belongs to medium and Dirtiness = 4 belongs to medium

   (Saturation = medium & Dirtiness = medium) => time is medium.

   If Saturation is medium and Dirtiness is low then time is low.
   Saturation = 5 which belongs to medium and Dirtiness = 4 belongs to low

   (Saturation = medium & Dirtiness = medium) => time is low.

   If Saturation is small and Dirtiness is medium then time is low.
   Saturation = 5 which belongs to small and Dirtiness = 4 belongs to medium

   (Saturation = small & Dirtiness = medium) => time is low.

   If Saturation is large and Dirtiness is low then time is medium.
   Saturation = 5 which belongs to large and Dirtiness = 4 belongs to low

   (Saturation = large & Dirtiness = medium) => time is medium.

d. Change input values to include the following rules:
If dirtiness is low and saturation is small then time is very low
If dirtiness is medium and saturation is small then time is low
Your chosen input values:

Dirtiness = 9
Saturation = 4

e. Explain your choice.

Dirtiness = 9 that means it belongs to low range [0-15] and to the medium range [0-30].
Saturation = 4 that means it belongs to the small range [0-5].

4. Fix input values and compare defuzzification methods results
For **Dirtiness = 10** & **Saturation = 6**

Defuzzification	**Washing Time**
Centroid	7.274815507743478
Bisector	7.098958333333334
SOM	6.0
MOM	7.0
LOM	8.0