# Genetic Algorithms
Assignment 3

## Create a fuzzy toolbox. The toolbox should support the following functionally:

* Define a fuzzy set (membership function). (Fuzzy sets could be trapezoidal or triangular)

* Define a linguistic variable, assign a membership functions to each linguistic term. You should also define each variable's the range of values (E.g. If we have "Rate" variable and it could take one of 4 linguistic terms {few ,very few, many, a lot} and have range [0,30]).

* Fuzzify a crisp input (E.g. the crisp input of "Rate"=10).

* Process given rules and combine their outputs. A rule may contain up to 10 fuzzy premises and one consequent. (After taking the rules from the user and fuzzifying the crisp inputs you should be able to process all the rules the same way you took in the lecture .for example if the rule was "if rate is very few and line is few Time is Big" and from the fuzzifying step you got that rate is 0.3 few and 0.1 very few. The rule contains an "And" so to process the if then rule you will get the minimum between 0.3 and 0.1 min(0.3,0.1)=0.1 then this rule indicates that the Time will be 0.1Big).

* Defuzzify the output similar to what you took in the lecture
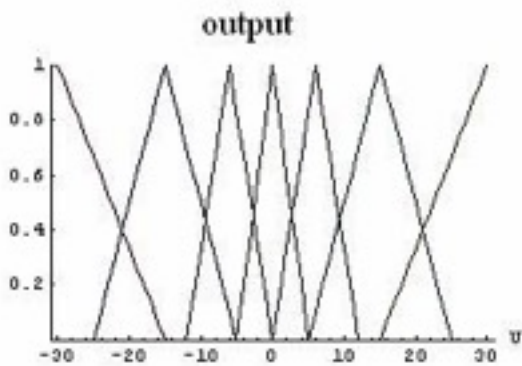
Shapes Example

Shapes will be described by 4 numbers if trapezoidal or 3 numbers if triangular. The height of any shape is 1. Trapezoidal shapes are not necessarily complete. Check Diagrams.
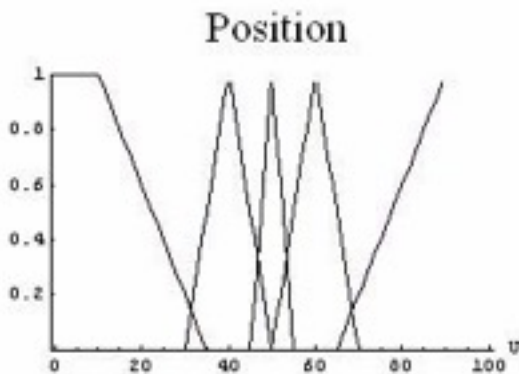
Position: Left (0,0,10,35), LeftCenter (30,40,50), Center (45,50,55), RightCenter (50,60,70), Right (65,90,100,100)
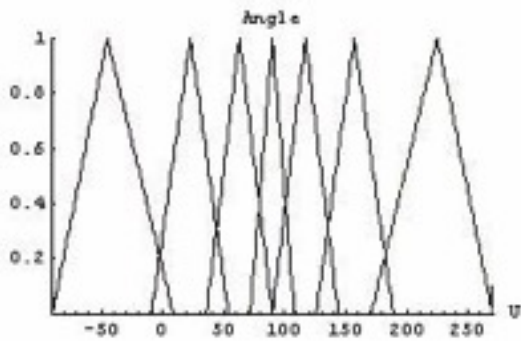
Angle: RBelow (-90,-45,9), RUpper (-9,23,54), RVertical (36,63,90), Vertical (72,90,108), LVertical (90,117,144), LUpper (126,157,189), LBelow (171,225,270)

Output: NegBig (-30,-15), NegMed (-25,-15,-5), NegSm (-12,-6,0), Zero (-5,0,5), PosSm (0,6,12), PosMed (5,15,25), PosBig (15,30)

Rules Example

	position is …	Predict	angle is …	output is ..
1	Left	AND	RBelow	PosSm
2	LeftCenter	OR	RBelow	PosMed
3	Center	AND	RBelow	PosMed

Input File Example

2

position 10

2

Left trapezoidal

0 0 10 35

LeftCenter triangle

30 40 50

angel -45

2

RBelow triangle

-90 -45 9

RUpper triangle

-9 23 54

firePosition

3

NegBig triangle

-30 -30 -15

NegMed triangle

-25 -15 -5

NegSm triangle

-12 -6 0

4

2 position = Left AND angel = RBelow then firePosition = PosSm

2 ANGEL = RBelow OR position = LeftCenter then firePosition = PosMed

2 position = Center AND angel = RBelow   then firePosition = NegSm

2 position = Center OR angel = LBelow then firePosition = NegMed

In the above file:

1- First line represents number of input variables (E.g. 2).

2- Second line gives a Variable Name and its crisp input to fuzzify it later (e.g. position 10).

3- Lines after each variable represents: first line, number of sets (e.g. 2 for position variable).

4- Then each set is described in 2 lines. First line fuzzy set name and its type (triangle or trapezoidal).

5- If triangular then a line with 3 values come. Else 4 numbers. Check Diagrams.

6- After listing the details of the input variables, a line with output variable name, then a line with a number representing number of output sets, then output variable details follow.

7- Line with number of rules follows. (E.g. 4).

8- Each rule start with number of premises, then statement the rule follows.

Output:

1- Fuzzifying the inputs

2- Inference of rules

3- Defuzzification output

Notes:

1- It is your task to handle the shapes well and to fuzzily the inputs (numbers) using mathematics.

2- For each stage in the toolbox, kindly print all the details in an organized way.

3- Student who handles only the triangular case won't get full mark.

4- Number of team members: 3 - 4

5- How will you calculate the **centroid** of shapes to do the defuzzification step? Calculate centroid of polygon [1] to work over triangle or trapezoid.

The centroid of a non-self-intersecting closed polygon defined by n vertices (x_0,y_0), (x_1,y_1), ..., (x_{n-1},y_{n-1}) is the point (C_x, C_y), where

$$C_x = \frac{1}{6A} \sum_{i=0}^{n-1} (x_i + x_{i+1})(x_i\, y_{i+1} - x_{i+1}\, y_i)$$

$$C_y = \frac{1}{6A} \sum_{i=0}^{n-1} (y_i + y_{i+1})(x_i\, y_{i+1} - x_{i+1}\, y_i)$$

and where A is the polygon's signed area,

$$A = \frac{1}{2} \sum_{i=0}^{n-1} (x_i\, y_{i+1} - x_{i+1}\, y_i)$$

[1]http://en.wikipedia.org/wiki/Centroid