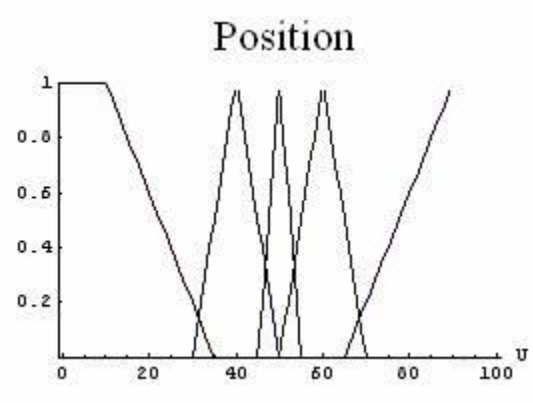
Create a fuzzy toolbox. The toolbox should support the following functionally:

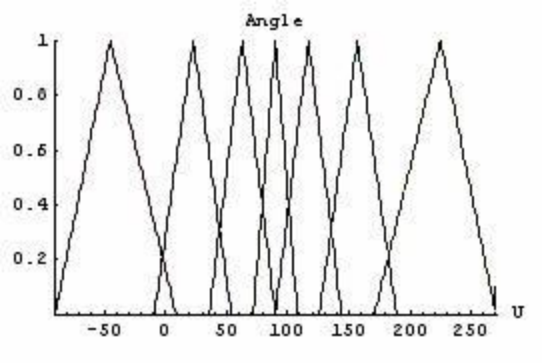
- Define a fuzzy set (membership function). (The fuzzy sets could be trapezoidal or triangular)
- Define a linguistic variable, assign membership functions to linguistic term you should also define the range of values each variable can take (E.g. Say we have Rate Variable and it could take one of 4 Linguistic 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 rule and combine output from multiple rules. 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 that 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

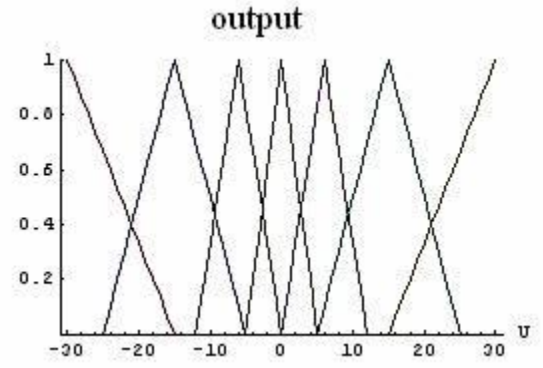
Shapes will be either 4 items for trapezoidal shape or 3 items for triangle. The height of any shape is 1 and trapezoidal shapes not necessarily are complete, Check Diagrams.



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

For **Basic assignment**, read only rule of 2 premises:

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

For **Bonus assignment**, read any number of premises:

	Var1 is …	Predict	Var2 is …	Predict	Var3 is …	output is ..
1	Go	AND	Up	AND	Circular	Fire
2	Go	OR	Down	OR	Circular	Don't_Fire

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 is number of input variables (E.g. 2)
2- Line with Variable Name and its crisp input to fuzzify it later (e.g. position 10).

3- For each variable, the data follow. First line, Number of sets (e.g. 2 for position variable)..
4- Then each set in 2 lines. First line fuzzy set name and its type (triangle or trapezoidal).
5- If Triangle then a line with 3 values come. Else 4 numbers. Check Diagrams.
6- After the input variables details, a line with number for the number of sets for output, then output variable details follow.
7- Line with output variable name then line with Number of rules follow (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 fuzzify using mathematics.
2- For Each stage in the toolbox, kindly print FULLT details in an organized way.
3- Student who handles only triangle case won't get full mark.
4- Max number of students is 3
5- How will you calculate the **centroid** of shapes to do the defuzzification step? Apply 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