Study of Some Nomenclature and Membership Function Using MATLAB Program Code

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Abstract

In this article studies some properties and membership functions by using MATLAB code. Here, briefly described MATLAB program code of basic nomenclature techniques such as core, support, boundary, height, normal fuzzy set, subnormal fuzzy set, normalization, strong alpha cut, fuzzy singleton convexity, fuzzy number, fuzzy symmetry, band width, open left fuzzy set, and open right fuzzy set. Standard membership functions such as triangular, trapezoidal, gaussian, generalized bell shaped, sigmoidal, left right, open right methods, pi shaped, open left, and s-shaped membership function. These several techniques of codes using to explaining some difficulties of diverse fields such as agriculture, medical, computer, data science, machine learning and AI etc. The purpose of this paper effectively used to develop modelling, coding, predicting and graphically representation of perceptive sciences. Fuzzy logic is using various conceptions has becomes easier and this benefit to everyone. Using MATLAB programing code to represent graphically membership function. FMF can be watched as a technique for solving empirical hitches based on involvement rather than information.

Keywords: Fuzzy set, Nomenclature, Membership Function, Code.

Introduction

Fuzzy logic (FL) is qualitative computational skills which designate elusiveness or incomplete reality. FL is using numerous conceptions has becomes easier and this benefit to everyone. The common of the MF are represented graphically. FMF can be watched as a technique for solving empirical hitches based on involvement rather than information.

Membership Function: The MF precise all the information as $\underset{\sim}{Z} = \{(x_p, \mu_{\underset{\sim}{Z}}(x_p)) \mid x_p \in U, p = 1,\dots, m.\}$, Where $\mu_{\underset{\sim}{Z}}(x)$ stated as MF of $\underset{\sim}{Z}$ lies among 0 and 1. The key features of the MF described and signify a graphically by MATLAB.

MATLAB Code:

```
clc;x=(0:0.1:10); y=trapmf(x, [3, 5 ,7 , 10]) ;
plot(x, y, 'line width',7.0) ;
ylim([0 1]); ylabel('Membership Grades');
set(gca,'FontName','Times','Fontsize',25.0);
```

Core: The set t $\mu_{\underset{\sim}{Z}}(y) = 1$ is the $\underset{\sim}{Z}$, Core $(\underset{\sim}{Z}) = \{y \mid \mu_{\underset{\sim}{Z}}(y) = 1\}$

Support: The MF of $\underset{\sim}{Z}$ is definite as the part of the universe defined by a MF ($\neq 0$).

Boundary: The support of MF $\underset{\sim}{Z}$ in universe that contains nonzero elements but incomplete MF. The boundary is $1 > \mu_{\underset{\sim}{Z}}(h) > 0$. The main features of the MF graphically state

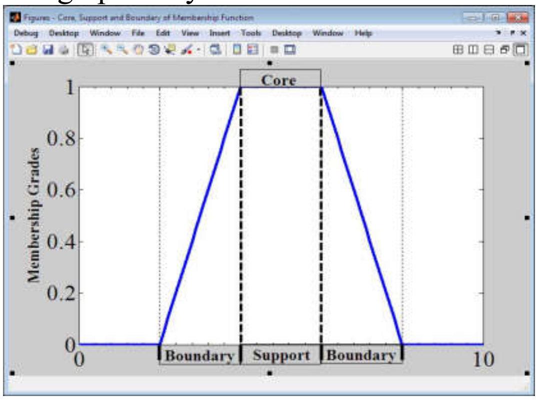

Figure 1: Core; Support; and Boundary of Membership Function

MF indicate as graph using MATLAB code.

MATLAB Program Code:

```
clc; x= (0 : 0.1 :10) ;
y=trimf(x,[2,5,8]);
plot(x,y,'line width', 7.0) ;
 ylim([0 1]) ;
ylabel('Membership Grades');
set(gca,'FontName','Times','Fontsiz',21.0
);
```

Crossover point:

The crossover points of MF of $\underset{\sim}{A}$ *is* 0.5.

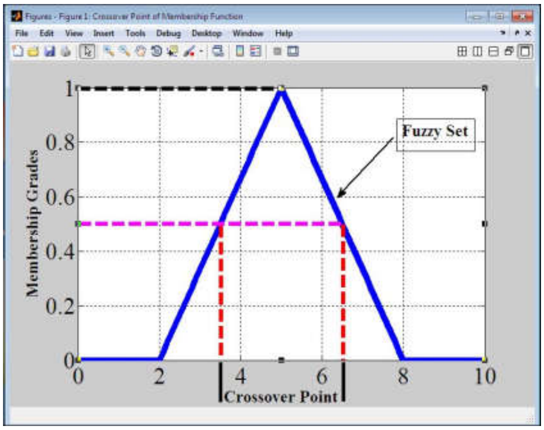

Figure 2: Crossover Point of MF

Height: The r height of $\underset{\sim}{A}$ is: hgt $(\underset{\sim}{A}) = \max\{\mu_{\underset{\sim}{A}}(x)\}$. If hgt $(\underset{\sim}{A}) < 1$ then $\underset{\sim}{A}$ known as Subnormal fuzzy set. The hgt $(\underset{\sim}{A})$ is viewed as the degree of validity or credibility of information expressed by fuzzy set $\underset{\sim}{A}$. Using MATLAB code to explained MF graphically

Program Code:

```
x=(0:0.1:10);
mf1=trimf(x,[2,4,6]);
mf2=trimf(x,[4,6,8]);
mf3=trapmf(x,[6,7,8,9]);
y=max(max(0.5*mf1,0.9*mf2),0.6*mf3
);
plot(x,y,'linewidth',3.5);
ylim([0 1]);ylabel('Membership
Grades');xlabel('Generic Variable') ;
'set(gca,'FontName','Times','Fontsize',24
.0)' ;
```

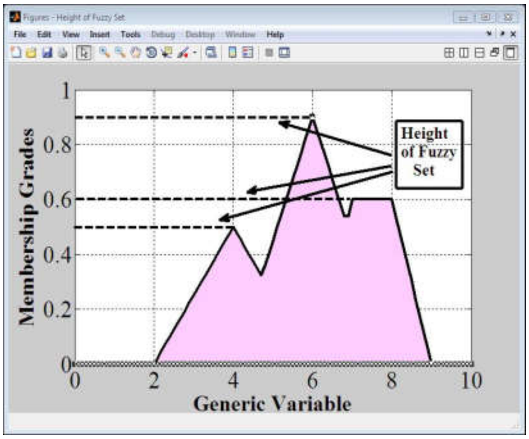

Figure 3: Height of FS

Normal Fuzzy Set:

$\underset{\sim}{A}$ is normal if its core is non empty, or A point u in U such that $\mu_{\underset{\sim}{A}}(u) = 1$.

The MF represents using MATLAB.

MATLAB Code:

```
x=(0:0.1:10);mf1=trimf(x,[2,4,6]);
y=1*mf1;
plot(x,y,'linewidth',3.5);
ylim([0 1]);ylabel('Membership Grades');xlabel('Generic Variable') ;
set(gca,'FontName','Times','Fontsize',22.0) ;
```

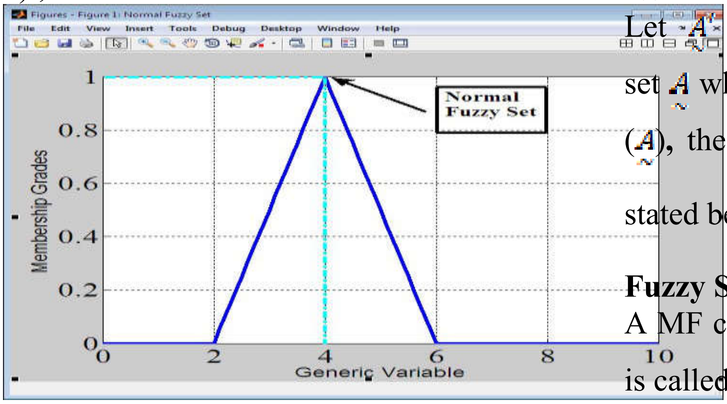

Figure 4: Normal Fuzzy Set

Subnormal Fuzzy Set:

A $\underset{\sim}{A}$ is subnormal if its core is empty. In otherworld's A point x in universe discourse of X such that $\mu_{\underset{\sim}{A}}(x) \neq 1$.The MF described and represent a graphically using MATLAB as below:

MATLAB Program Code:

```
x=(0:0.1:10);mf1=trimf(x,[2,4,6]);y=0.5*mf1;
plot(x,y,'linewidth',3.5);
ylim([0 1])';xlabel('Generic Variable');
ylabel('Membership Grades');
set(gca,'FontName','Times','Fontsize',25.0);
```

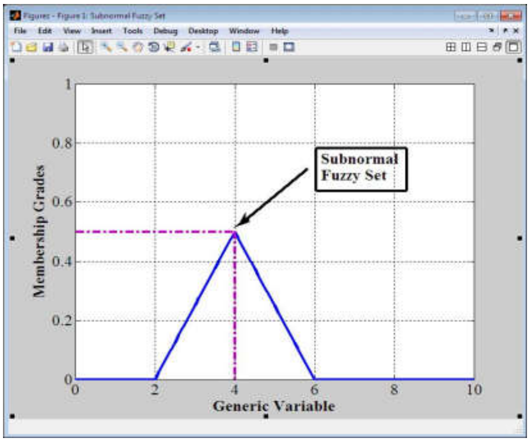

Figure 5: Subnormal Fuzzy Set

Normalization of a FS:

Let $\underset{\sim}{A}'$ is normalized version of a fuzzy set $\underset{\sim}{A}$ which is represented by $\underset{\sim}{A}'$= Norm ($\underset{\sim}{A}$), the normalization is carried out as stated below $\underset{\sim}{A}'$=Norm ($\underset{\sim}{A}$)=$\sum \frac{\mu_{\underset{\sim}{A}}(x) / \text{hgt}(\underset{\sim}{A})}{x}$

Fuzzy Singleton:

A MF can be representing as $\mu_{\underset{\sim}{A}}(x) = 1$ is called fuzzy-singleton.

***α* - Cut:** The α-cut or α-level set of $\underset{\sim}{A}$ is a crisp set defined as

$\underset{\sim}{A}_{\alpha}$= $\{x | \mu_{\underset{\sim}{A}}(x) \geq \alpha\}$

MATLAB Program Code:

```
x=(0:0.1:10);y=trimf(x,[2,5,8]);
plot(x,y,'line width',7.0);
```

```
ylim([0,1]);
ylabel('membership grades');
xlabel('Generic Variable');
set(gca,'FontName','Times','Fontsize',23.0);
```

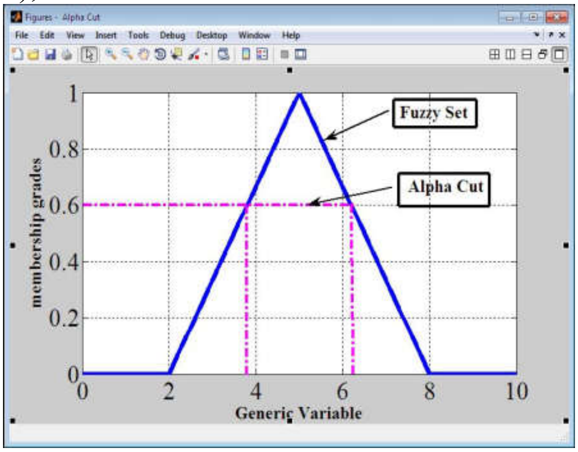

Figure 6: Alpha cut

Strong α- cut: The strong α-cut of FS stated as below $\underset{\sim}{A}'_{\alpha} = \{x \mid \mu_{\underset{\sim}{A}}(x) > \alpha\}$

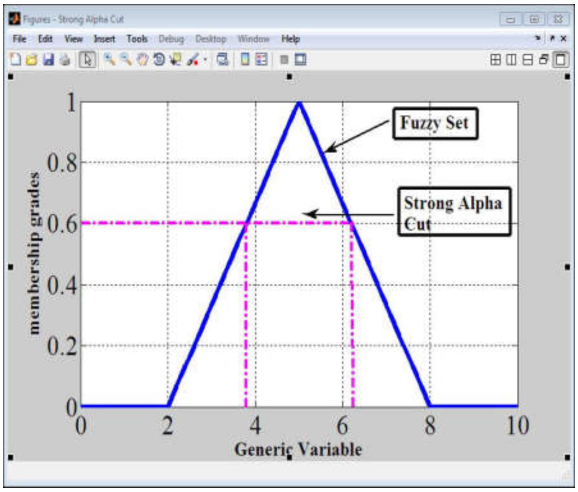

Figure 7: Strong-alpha cut

Convexity: A FS$\underset{\sim}{A}$ is convex $\Leftrightarrow \forall\, x_1$, $x_2 \in X$, and $\lambda \in [0\ \ 1]$, the following condition satisfies

$\mu_{\underset{\sim}{A}}(\lambda x_1 + (1-\lambda)x_2) \geq \min\ [\mu_{\underset{\sim}{A}}(x_1), \mu_{\underset{\sim}{A}}(x_2)]$.

MATLAB Program Code:

```
x=(0:0.1:10);
y=gbellmf(x,[2,1,5]);
plot(x,y,'linewidth',7.0);
ylim([0 1]);ylabel('Membership Grades');
xlabel('Generic Variable');
set(gca,'FontName','Times','Fontsiz',26.0);
```

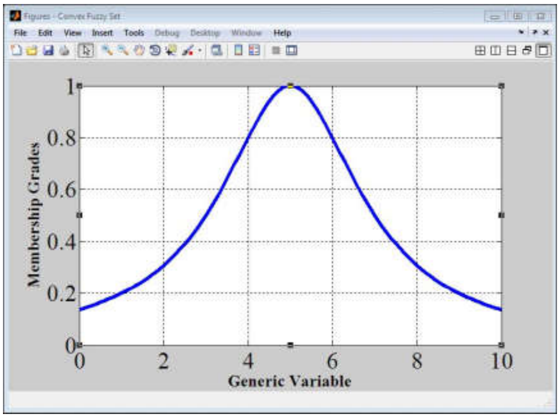

Figure 8: Convex Fuzzy Set

Fuzzy Number: Fuzzy number 'A' is satisfying the stipulation for normality and convexity

MATLAB Program Code:

```
x=(0:0.4:10);y=gbellmf(x,[1,5,2]);
plot(x,y,'linewidth',7.0);
ylim([0 1]);ylabel('Membership Grades');xlabel('Generic Variable');
set(gca,'FontName','Times','Fontsiz',27.0);
```

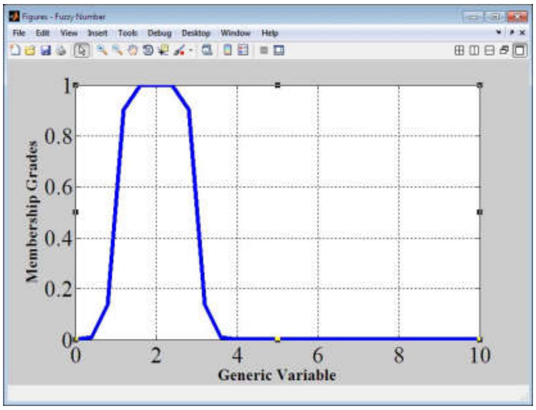

Figure 9: Fuzzy Number

Band Width: For, bandwidth of normal and convex fuzzy set $\underset{\sim}{A}$ stated the distance between the two unique crossover points.

width $(\underset{\sim}{A}) = | x_1 - x_2 |$, Here, $\mu_{\underset{\sim}{A}}(x_1) = \mu_{\underset{\sim}{A}}(x_2) = 0.5$

MATLAB Program Code:

```
x=(0:0.1:10);
y=gbellmf(x,[1.5,1,1.9,0.9]);
plot(x,y,'linewidth',7.0);
ylim([0 1]);
xlabel('Generic Variable');
ylabel('Membership Grades');
set(gca,'FontName','Times','Fontsiz',19.0);
```

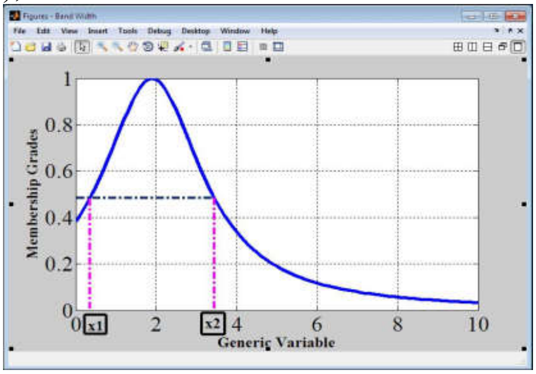

Figure 10: Band Width

Fuzzy Symmetry:

Let $\underset{\sim}{A}$ symmetric if it satisfies point c given below $\mu_A(c + x) = \mu_A(c - x), \quad \forall x \in X$

MATLAB Program Code:

```
x=(0:0.1:10);
mf1=trimf(x,[1 3 5]);mf2=trapmf(x,[5,6,8,9]);
y=max(mf1,mf2);
plot(x,y,'linewidth',3.5);
ylim([0 1]); ylabel('Membership Grades');xlabel('Generic Variable') ;
set(gca,'FontName','Times','Fontsize',24.0) ;
```

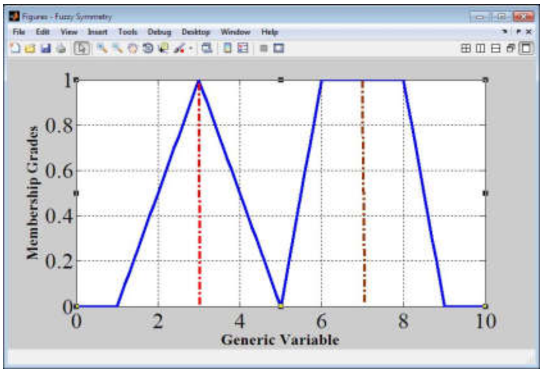

Figure 11: Fuzzy Symmetry

Open Left FS: A fuzzy set $\underset{\sim}{A}$ is open left, if

$\lim_{n \to -\infty} \mu_{\underset{\sim}{A}}(x) = 1$, and

$\lim_{n \to +\infty} \mu_{\underset{\sim}{A}}(x) = 0$

MATLAB Program Code:

```
x=(0:0.1:10);
mf1=trapmf(x,[0 0 4 4]);mf2=trimf(x,[4,4,7]);
y=max(1*mf1,1*mf2);
plot(x,y,'linewidth',3.5);
ylim([0 1]);
ylabel('Membership Grades');xlabel('Generic Variable') ;
set(gca,'FontName','Times','Fontsize',28.0) ;
```

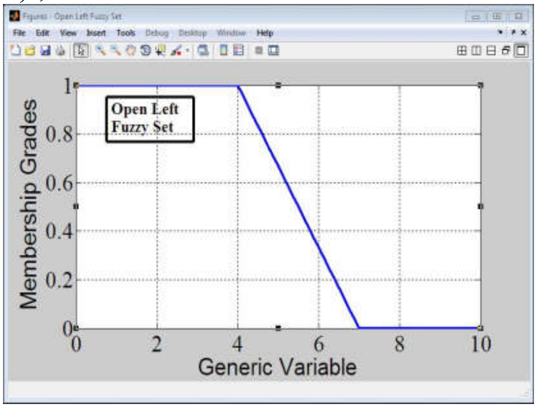

Figure 12: Open Left Fuzzy Set

Open Right Fuzzy Set:

A fuzzy set $\underset{\sim}{B}$ is open right, if $\lim_{n\to-\infty}\mu_{\underset{\sim}{B}}(x) = 0$ and $\lim_{n\to+\infty}\mu_{\underset{\sim}{B}}(x) = 1$

MATLAB Program Code:

```
x=(0:0.1:10);mf1=trapmf(x,[0 0 4 4]);mf2=trimf(x,[4,4,7]);
y=max(1*mf1,1*mf2);
plot(x,y,'linewidth',3.5);
ylim([0 1]);ylabel('Membership Grades')';xlabel('Generic Variable')
set(gca,'FontName','Times','Fontsize',17.0);
```

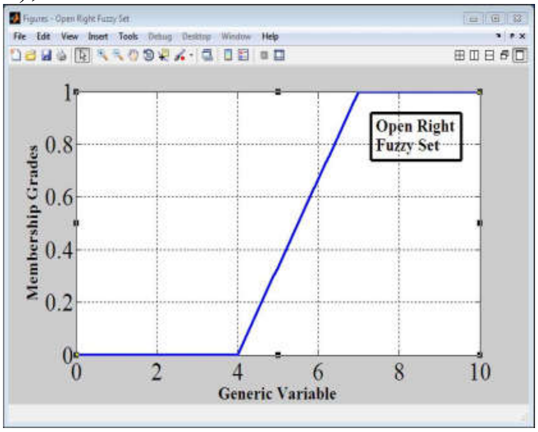

Figure 13: Open Right Fuzzy Set

Standard Membership Function

Triangular membership function

Using three variables [σ, τ, ω] defined by a triangular MF with (σ< τ<ω), and represent MF as below

triangle (u ; σ, τ, ω)

↑

Vertices

$$= \begin{cases} 0 & , \quad u \le \sigma \\ \frac{u-\sigma}{\tau-\sigma} & , \sigma \le u \le \tau \\ \frac{\omega-u}{\omega-\tau} & , \tau \le u \le \omega \\ 0 & , \quad \omega \le u \end{cases}$$

The equation denoted as triangle (u ; σ, τ, ω) = max {min $[\frac{u-\sigma}{\tau-\sigma}, \frac{\omega-u}{\omega-\tau}]$, 0}

MATLAB Program Code:

```
'clc';x=(0:0.1:10);y=trimf(x,[3,7,9]);
plot(x,y,'linewidth',7.0);
ylim([0 1])'; xlabel('Generic Variable');ylabel('Membership Grades');
set(gca,'FontName','Times','Fontsiz',21.0);
```

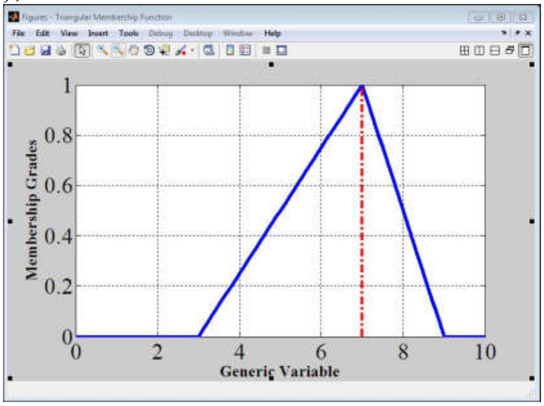

Figure 14: MF of Triangular

Trapezoidal Membership Function

A trapezoidal MF, specified by parameter [e, f, g, h], with e ≤ f ≤ g ≤ h as follows

trapezoid(v;e, f, g, h)

↑

Vertices

$$= \begin{cases} 0 & , \quad v \le e \\ \frac{v-e}{f-e} & , e \le v \le f \\ 1 & , f \le v \le g \\ \frac{g-v}{g-h} & , g \le x \le h \\ 0 & , \quad h \le v \end{cases}$$

Other expression for TMF denoted as trapezoid (v ; e, f, g, h) = max {min $[\frac{v-e}{f-e}, 1, \frac{g-v}{g-h}]$, 0}

MATLAB Program Code:

'clc';x=(0:0.1:10);y=trapmf(x,[3,5, 8,10]);
plot(x,y,'linewidth',7.0);
ylim([0 1]);ylabel('Membership Grades');xlabel('Generic Variable');
set(gca,'FontName','Times','Fontsize',26.0);

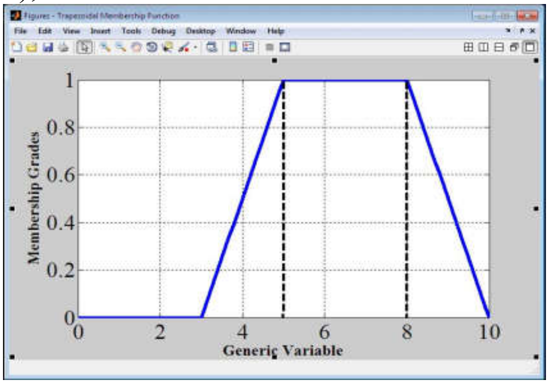

Figure 15: Trapezoidal Membership Function

Gaussian membership function

The definite factors $[k, \rho]$, GMF defined as gaussian $(y\ ;\ k, \rho) = e^{-\frac{1}{2}\left(\frac{y-k}{\rho}\right)^2}$

Where k denotes the Membership functions centre and ρ determines width of MF.

MATLAB Program Code:

'clc';x=(0:0.1:10); y=gaussmf(x,[0.5,2]);
plot(x,y,'linewidth',3.0);
ylim([0 1]);xlabel('Generic Variable');ylabel('Membership Grades');
set(gca,'FontName','Times','Fontsize',27.0);

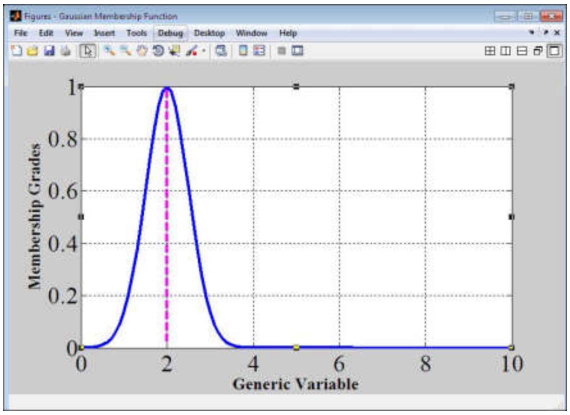

Figure 16: Membership Function of Gaussian

Generalized Bell-Shaped MF

BMF is stated by variables [p, q, r] defined bell $(z\ ;\ p, q, r) = \frac{1}{1+\left|\frac{z-r}{p}\right|^{2q}}$

MATLAB Program Code:

'clc'; x=(0:0.1:10);y=gbellmf(x,[1,4,6]);
plot(x,y,'linewidth',3.0);
ylim([0 1]);xlabel('Generic Variable');
ylabel('Membership Grades');
set(gca,'FontName','Times','Fontsize',25.0);

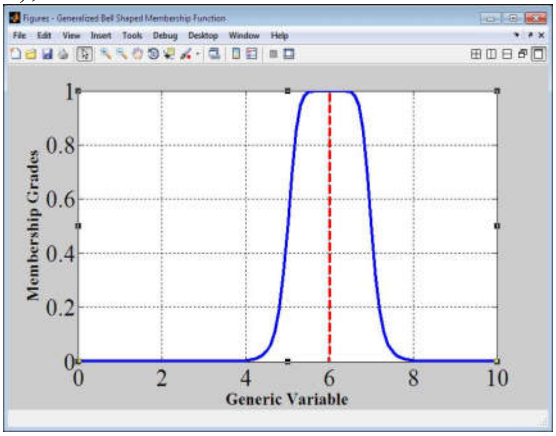

Figure 17: Generalized Bell-Shaped MF

Membership Function of Sigmoidal

The sigmoidal MF is given by

sig$(w\ ;\ r, t) = \frac{1}{1+e^{-r(w-t)}}$

MATLAB Program Code:

'clc';x=(0:0.1:10);y=sigmf(x,[4, 5]);

```
plot(x,y,'linewidth',4.0);
ylim([0 1]);xlabel('Generic Variable');
ylabel('Membership Grades');
set(gca,'FontName','Times','Fontsize',18.0);
```

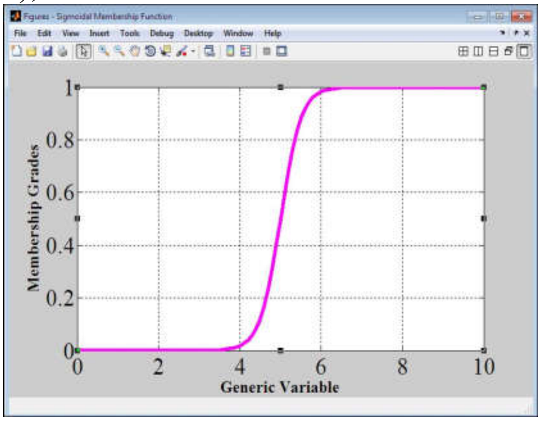

Figure 18: Sigmoidal Membership Function

Left-Right Membership function

A left-right membership function specified by three parameters [α, β, δ] as

$$LR\,(s;\ \delta,\ \alpha,\ \beta\,) = \begin{cases} F_L\left(\frac{\delta-s}{\alpha}\right), & s\ \le\ \delta \\ F_R\left(\frac{s-\delta}{\beta}\right), & s \ge \delta \end{cases}$$

Where ‘δ’ denotes the MFV is 1, ‘α’ and ‘β’ controls the width of the both region.

MATLAB Program Code:

```
'clc';
alpha=40;
beta=10;
c=70;
'x=(0:0.1:100)';
'for i=1:size(x,1)'
'if(x(i,1)>=c)'
'x1=(x(i,1)-c)/beta';
'y(i,1)=exp(-abs((x1)^3))';
'elseif(x(i,1)<=c)'
'x2=(c-x(i,1))/alpha';
'y(i,1)=exp(-abs((x2)^3))';
end
end
'plot(x,y,'linewidth',4.0)';
'ylim([0 1])';'xlabel('Generic Variable')';'ylabel('Membership Grades')';
'set(gca,'FontName','Times New Roman','Fontsize',19.0)';
```

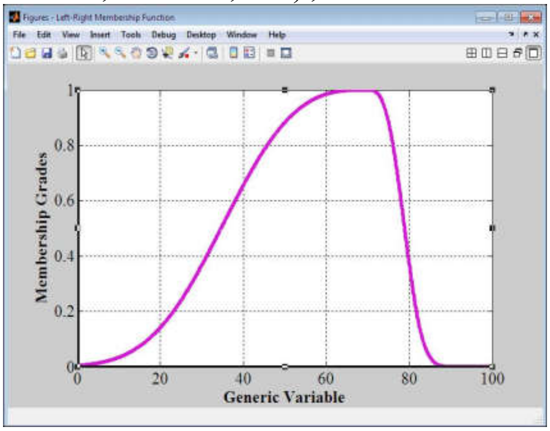

Figure 19: Left-Right Membership Function

Pi Shaped (π) Membership Function

The first MF described as

$\pi_1\ (x\ ;\ a,\ b) = \frac{1}{1+(\frac{x-a}{b})^2}$ and other MF defined as the following

$\pi_2\ (e;\ lw,\ lp,\ rp,\ rw)$

$$= \begin{cases} \frac{lw}{lp+lw-e} & , \quad e < lp \\ 1 & , \quad lp \le e \le rp \\ \frac{rw}{e-rp+rw} & , \quad e > rp \end{cases}$$

Parameters ‘lw’ and ‘rw’ classify the feet of the membership function, and parameters ‘lp’ and ‘rp’ definite its shoulders respectively.

MATLAB Program Code:

```
'clc'; 'x=(0:0.1:10)';
'y=pimf(x,[2,5,8,10])';
'plot(x,y,'linewidth',4.0)';
'ylim([0 1])';
'xlabel('Generic Variable')';
'ylabel('Membership Grades')';
'set(gca,'FontName','Times New Roman','Fontsize',15.0)';
```

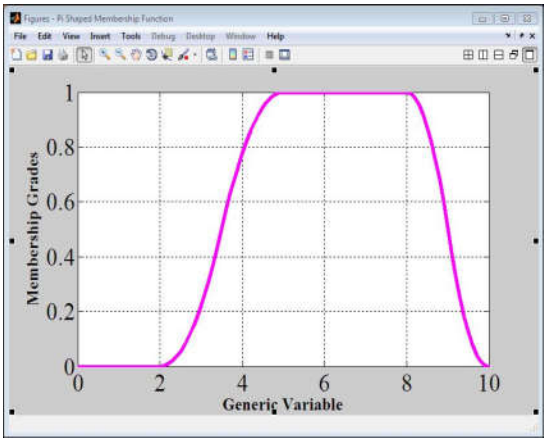

Figure 20: Pi Shaped Membership Function

Open Left Membership Function

The open left membership is defined by two parameter [α, β] as follow

'openL $(l \quad ; \quad \alpha, \quad \beta \quad)$'

$$= \begin{cases} 1 & , \quad l < \alpha \\ \frac{\beta - l}{\beta - \alpha} & , \alpha \leq l \leq \beta \\ 0 & , \quad l > \beta \end{cases}$$

MATLAB Program Code:

```
'clc';
'x=(0:0.1:10)';
'alpha=3; beta=6';
'OpenL=zeros(size(x))';
'for i=1:size(x,1)'
'if x(i,1)<alpha'
'OpenL(i,1) = 1';
'elseif x(i,1)>beta'
'OpenL(i,1) = 0';
'else'
'OpenL(i,1)=(beta-x(i-1))./(beta-alpha)';
'end'
'end'
'plot(x,OpenL,'linewidth',4.0)';
'ylim([0 1])';
'xlabel('Generic Variable')';
'ylabel('Membership Grades')';
'set(gca,'FontName','Times New
Roman','Fontsize',17.0)';
```

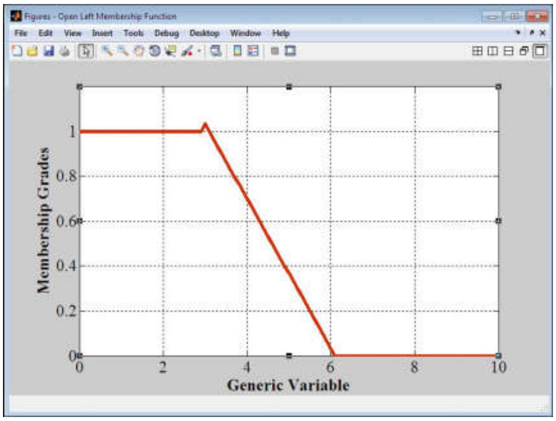

Figure 21: Open Left Membership Function

Open Right Membership function

The open right membership is defined by two variables [α, β], represent as

openR $(x \quad ; \quad \alpha, \quad \beta \quad)$

$$= \begin{cases} 0 & , \quad x < \alpha \\ \frac{x - \alpha}{\beta - \alpha} & , \alpha \leq x \leq \beta \\ 1 & , \quad x > \beta \end{cases}$$

MATLAB Program Code:

```
clc;x=(0:0.1:10);
alpha=3;beta=6;
'OpenR=zeros(size(x))';
'for i=1:size(x,1)'
'if x(i,1)<alpha'
'OpenR(i,1)=0';
'elseif x(i,1)>beta'
'OpenR(i,1)=1';
else
'OpenR(i,1)=(x(i-1)-alpha)/(beta-alpha)';
end
end
'plot(x,OpenR,'linewidth',4.0)';
'ylim([0 1])';
xlabel('Generic Variable');
ylabel('Membership Grades');
'set(gca,'FontName','Times New
Roman','Fontsize',20.0)';
```

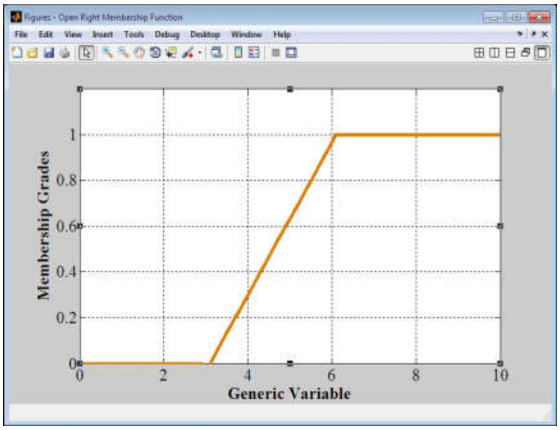

Figure 22: Open Right MF

S Shaped Membership function

The S-shaped MF definite in closed interval a and b, it described as follows

f(x; a, b)

$$= \begin{cases} 0 & , \quad x \leq a \\ 2\left(\frac{x-a}{b-a}\right)^2 & , \quad a \leq x \leq \frac{a+b}{2} \\ 1 - 2\left(\frac{x-b}{b-a}\right)^2 & , \quad \frac{a+b}{2} \leq x \leq b \\ 1 & , \quad x \geq b \end{cases}$$

In S-SMF parameter 'a' defines as the feet of MF and parameter 'b' state as its shoulder.

MATLAB Program Code:

```
'clc';
'x=(0:0.1:10)';
'y=smf(x,[4 8])';
'plot(x,y,'linewidth',4.0)';
'ylim([0 1])';
'xlabel('Generic Variable')';
'ylabel('Membership Grades')';
'set(gca,'Font Name', 'Times New Roman','Fontsize',21.0)';
```

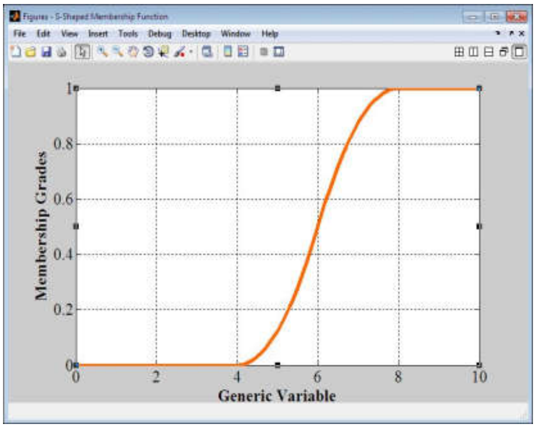

Figure 23: S - Shaped M

.

Conclusion

This article should be focus on MATLAB codes of some nomenclature and standard membership function. Using these codes of techniques to solving many problems of various areas. The target of this task to help of student, research scholars and scientists to developing predicting, modelling and coding in future of different fields.

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