APPENDIX 1

MEMBERSHIP FUNCTIONS

Membership Function

The membership function of a fuzzy set $A$ on the universe of discourse $X$ is determined by $\mu_A: X \rightarrow [0,1]$, where every element of the $X$ is mapped the value between 0 and 1. This value is called the degree of membership, which quantifies the score for the membership element $X$ to the fuzzy set $A$.

Membership functions of the fuzzy set are represented graphically. The $x$-axis denotes the universe of discourse, and $y$-axis denotes the membership degree in the [0,1] interval.

Triangular Membership Function

The proposed research work has adopted the triangular membership function. The triangular membership function is the simplest membership functions which are shaped using straight lines. The triangular membership function used the collection of three points in order to form the triangle.
Figure A1.1 Triangular Membership Function

\[
\mu(x) = \begin{cases} 
0 & x \leq a_1 \\
\frac{x-a_1}{b_1-a_1} & a_1 \leq x \leq b_1 \\
\frac{c_1-x}{c_1-b_1} & b_1 \leq x \leq c_1 \\
0 & c_1 \leq x 
\end{cases}
\] (A1.1)

Or, the alternate expression for preceding equation

\[
\mu_A(x) = \max(\min\left(\frac{x-a_1}{b_1-a_1}, \frac{c_1-x}{c_1-b_1}\right), 0)
\] (A1.2)

where, the point \((a_1, c_1)\) locates the lower of the triangle and the point \((b_1)\) locates upper limit.

**Trapezoid Membership Function**

The trapezoidal membership function has the flat top and actually is a truncated triangle curve. The straight line of these membership functions has the benefit of simplicity.
Figure A1.2 Trapezoidal Membership Function

\[
\mu(x) = \begin{cases} 
0 & x \leq a_1 \\
\frac{x-a_1}{b_1-a_1} & a_1 \leq x \leq b_1 \\
1 & b_1 \leq x < c_1 \\
\frac{c_1-x}{c_1-b_1} & c_1 \leq x \leq d_1 \\
0 & d_1 \leq x 
\end{cases} \tag{A1.3}
\]

Or, the alternate expression for preceding equation

\[
\mu(x) = \max\left(\min\left(\frac{x-a_1}{b_1-a_1}, 1, \frac{d_1-x}{d_1-c_1}\right) 0\right) \tag{A1.4}
\]

where, the points \((a_1 \text{ and } d_1)\) signifies the bottom of the trapezoid and the points \((b_1 \text{ and } c_1)\) signifies the top of the trapezoid.
REFERENCES


