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ANALYSIS OF SEMI-CIRCLE FUZZY NUMBER VIA TRIANGULAR APPROACH

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ABSTRACT

The Semi-circle fuzzy number through the triangular fuzzy number is proposed. The method of obtaining Semi-circle analysis were demonstrated with the use of membership function and introduction of the constant γ. The basic ideas underlying the conventional triangular fuzzy regression were transformed to that of the semi-circle fuzzy analysis.

1. Introduction

Fuzzy regression is used to model the functional relationship between dependent and independent variable(s) in a fuzzy environment. Fuzzy environment implies that the data is small, when the distribution assumption is not satisfied, vagueness in the relationship between input and output variable, ambiguity of event and inaccuracy, and distortion introduced by linearization [3, 12]. Thus, fuzzy techniques have been applied in various aspects of triangular and trapezium regression analysis. However, fuzzy semi-circle due to the inner and outer triangular fuzzy regression have not been studied.

The study of fuzzy regression was proposed by Tanaka et al [15] as stated below:

$$Y = A_0x_0 + A_1x_1 + \cdots + A_kx_k \quad (1)$$

Where

$x_0 = 1$, A_i, $i = 0, 1, \ldots, k$

was assumed symmetric triangular fuzzy number with center α_i and half width c_i, $c_i \geq 0$ [6, 15]. Thus, (1) was under the inference of the degree of fitting and vagueness.

The concept of triangular trapezoidal fuzzy number were proposed [4,10,11,14]

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The two main approach to fit the fuzzy regression model are, the probabilistic and the least squares model [3, 12]. Both approaches are widely useful tools in fuzzy regression. Thus, the Boschovic line to fuzzy regression that does not allow approximation of data by a model other than the regression has been proposed [13]. The effectiveness of multi-collinearity in fuzzy regression have been proposed [5, 9].
The hybrid and partition of fuzzy regression is well established [2,7,8]. The fully fuzzy linear regression with different approaches was proposed. However, some previous studies have adopted the triangular fuzzy number for resolving problems involving triangular and trapezoidal fuzzy regression, but none have been discussed with respect to the problem of how to handle semi-circle fuzzy number via the inner and outer triangular fuzzy number.
In handling the objective above, the remaining parts of this paper is organized as follows: Section two describes the evolutionary approach to half-circle fuzzy regression, Section three consists of the operation of semi—circle fuzzy number using the inner and outer fuzzy number.

2. Evolutionary Approach to Half Circle Fuzzy Regression

With respect to the fuzzy regression (1), the half-circle fuzzy number ω is define on $\mathcal{R} = (-\infty, +\infty)$ and its membership function is given by $\mu_\omega: \mathcal{R} \longrightarrow [0,1]$ i.e.

$$\mu_\omega = \begin{cases} \sqrt{1-(x-)^2}, & x\epsilon(r-1, r+1) \\ 0, & otherwise \end{cases}$$

as shown in Figure 1.

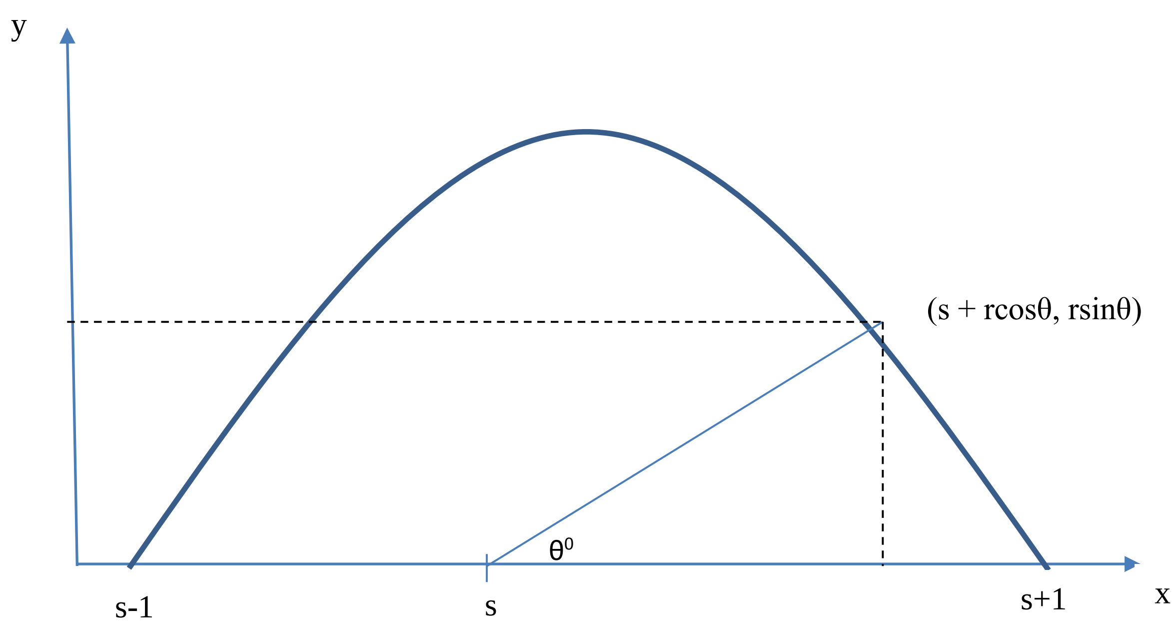

Figure 1: Showing the Membership Function of Half Circle Fuzzy Number and Its Polar Coordinates

Operations for half-circle fuzzy number

Given ω_1 and ω_2 which represent two different half-circle fuzzy number, we have
$\omega_1 = (s_1 - 1,\ s_1,\ s_1 + 1)$ and $\omega_2 = (s_2 - 1,\ s_2,\ s_2 + 1)$

a. The addition of ω_1 and ω_2 gives
$$\omega_1 + \omega_2 = \omega_1 = (s_1 + s_2 - 2, \quad s_1 + s_2, \quad s_1 + s_2 + 2)$$
b. The subtraction of ω_1 and ω_2 gives:
$$\omega_1 - \omega_2 = \omega_1 = (s_1 - s_2 - 2, \quad s_1 - s_2, \quad s_1 - s_2 + 2)$$
c. The multiplication of ω_1 by ω_2 gives:

$$\omega_1 \times \omega_2 = ((s_1 - 1)(s_2 - 1), \quad s_1 s_2, \quad (s_1 + 1)(s_2 + 1)), s_1 s_2 \geq 1$$

d. The division of ω_1 by ω_2 gives:

$$\omega_1 \div \omega_2 = \omega_1/\omega_2((s_1 - 1)/(s_2 - 1), \quad (s_1/s_2), \quad (s_1 + 1)/(s_2 + 1)), s_1 s_2 \geq 1$$

The polar coordinate for the half circle number is given as:

$$f(r,\theta): r^2 + r^2 - 2r_0 r cos(\theta - \theta_0) = a^2, \quad a \epsilon \Re$$

where:

$(r\theta_0, \theta\theta_0)$ is the center of the circle such that the membership function is defined as:

$$\mu(r,\theta) = \begin{cases} r^2 + r^2 - 2r_0 r cos(\theta - \theta_0) - 1, & r_0 - 1 \leq r_0 \leq r_0 + 1 \\ 0, & otherwise \end{cases}$$

3. Operation of Semi-circle fuzzy using inner and outer triangular fuzzy

Among the various shape of fuzzy, we have the semi-circle fuzzy number embedded in the outer and the inner triangular fuzzy number as shown in Figure 2

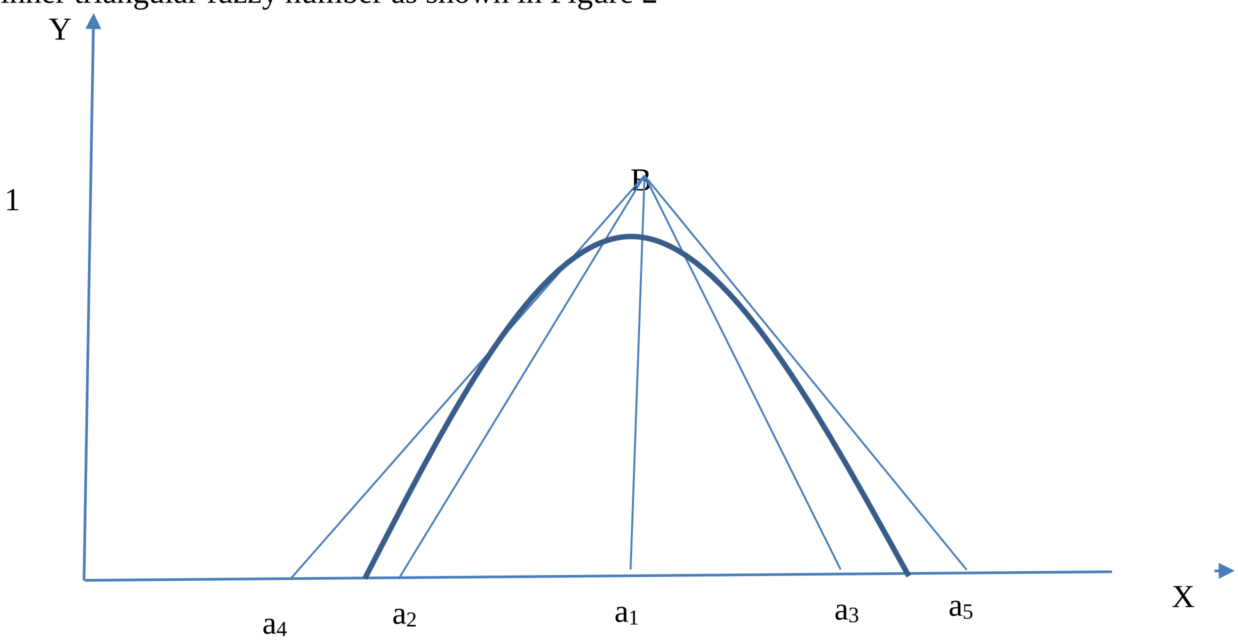

Figure 2: representation of Semi-circle fuzzy embedded in outer and inner fuzzy number

The membership function of the inner and outer fuzzy number are stated below:

Let

$\mu(x_a)$ denote membership function of the outer fuzzy number

$\mu(x_b)$ denote the membership function of inner triangular fuzzy number.

$\mu(x_{ab})$ denote the membership function of the space in between the outer and inner triangular fuzzy number

$$\mu(x_a) = \begin{cases} 0, & x < a_4 \\ \dfrac{x - a_4}{a_1 - a_4}, & a_4 \leq x \leq a_1 \\ \dfrac{a_5 - x}{a_5 - a_1}, & a_1 \leq x \leq a_5 \\ 0, & x > a_5 \end{cases}$$

$$\mu(x_b) = \begin{cases} 0, & x < a_2 \\ \dfrac{x - a_2}{a_1 - a_2}, & a_2 \leq x \leq a_1 \\ \dfrac{a_3 - x}{a_3 - a_1}, & a_1 \leq x \leq a_3 \\ 0, & x > a_3 \end{cases}$$

Therefore, $\mu(x_{ab})$, the membership function difference is given as:

$\mu(x_{ab}) = \mu(x_a) - \mu(x_b)$. Hence, we have

$$\mu(x_{ab}) = \begin{cases} 0, & x < a_4 \\ \frac{1}{2}\left[\frac{x - a_4}{a_1 - a_4} - \frac{x - a_2}{a_1 - a_2}\right] + \mu(x_b), & a_4 \le x \le a_2 \\ \frac{1}{2}\left[\frac{a_5 - x}{a_5 - a_1} - \frac{a_2 - x}{a_3 - a_1}\right] + \mu(x_b), & a_3 \le x \le a_5 \\ 0, & x > a_5 \end{cases}$$

Let outer and inner fuzzy number $\tilde{\tau}_1$ and $\tilde{\tau}_2$ be defined as:

$\tilde{\tau}_1 = [a_2, a_1, a_3]$; $\tilde{\tau}_2 = [\bar{a}_2, \bar{a}_1, \bar{a}_3]$

We have the following condition, that the result of the operator in semi-circle fuzzy number can be obtained using the outer and the inner triangular fuzzy number.

We define

$$\gamma_1 = \frac{1}{2}\left[\frac{x- a_4}{a_1- a_4} - \frac{x- a_2}{a_1- a_2}\right] + \mu(x_b)$$

$$\gamma_2 = \frac{1}{2}\left[\frac{a_5-x}{a_5-a_1} - \frac{a_2-x}{a_3-a_1}\right] + \mu(x_b)$$

If the triangular fuzzy is symmetrical, then $\gamma = \gamma_1 = \gamma_2$

Addition:

$\tilde{\tau}_1(+)\tilde{\tau}_2 = 2\gamma a_2 + R\gamma\bar{a}, 2\gamma a_1 + 2\gamma\bar{a}_1, 2\gamma a_3 + 2\gamma\bar{a}_3$

$= 2\gamma[a_2 + \bar{a}, a_1 + \bar{a}_1, a_3 + \bar{a}_3]$

Subtraction:

$\tilde{\tau}_1(-)\tilde{\tau}_2 = 2\gamma[a_2 - \bar{a}, a_1 - \bar{a}_1, a_3 - \bar{a}_3]$

$-\tilde{\tau}_2 = 2\gamma[\bar{a}_2, \quad \bar{a}_1, \quad \bar{a}_3]$

Multiplication:

$\tilde{\tau}_1 \times \tilde{\tau}_2 = 2\gamma[a_2\bar{a}_2, a_1\bar{a}_1, a_3\bar{a}_3]$

Division:

$\tilde{\tau}_1 / \tilde{\tau}_2 = 2\gamma[a_2/\bar{a}_2, a_1/\bar{a}_1, a_3/\bar{a}_3]$

γ can be computed in the conventional triangular fuzzy method except that, it is multiplied by γ. Also, the conventional circle application is by the use of the equilibrium point of a closed-loop fuzzy system.

$x(t) = \sum\sum h(t)h(t)\{(A - BK)x(t)$.

If there exists a common positive definite matrix P such that

$(A- BK)^{TPT} + P (A - BK) < 0$

where

$P = P^T$ and I, l = 1, 2, …, r [10]

This paper uses γ and the convention outer and inner triangular fuzzy number to evaluate Semi-circle fuzzy number and its analysis.

4. Conclusion

In this paper, we applied triangular fuzzy technique in solving Semi-circle fuzzy. The main aim of using triangular fuzzy number and analysis to evaluate the Semi-circle of fuzzy counterpart is that it makes computation and analysis simple and easy to handle.

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