Ranking of Fuzzy Numbers by Distance Method

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Abstract

Many ranking methods have been proposed so far. However, there is not any method which can always give a satisfactory solution for every situation. In this paper, we propose a method for ranking fuzzy numbers based on the distance method and compare the results with other ranking methods in some examples.

Keywords: Element-Free Galerkin (EFG), Moving Least Squares (MLS).

1 Introduction

In practical use, ranking fuzzy numbers is very important. For example, the concept of optimum or best choice to come true is completely based on ranking or comparison. Therefore, how to set the rank of fuzzy numbers has been one of the main problems. The concept of fuzzy sets, which was originally introduce by Zadeh [12]. The concept of fuzzy numbers is presented by Jain [7] and Dubois and Prade [6]. Ranking methods [1-4] are classified into four major classes according to Chen and Hwang’s idea [5] which are listed as follows:

(1) Preference relation
   (a) Degree of optimality       (b) Hamming distance
   (c) \( \alpha \)-cut             (d) Comparison function

(2) Fuzzy mean and spread probability distribution

(3) Fuzzy scoring
   (a) Proportion to optimal      (b) Left/right scores
   (c) Centroid index            (d) Area measurement

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In this work, at first we calculate the gravity center of all fuzzy numbers $\tilde{A}_i$, $i = 1, 2, \ldots, n$. Then, for ranking, we define a distance by using the gravity center of these fuzzy numbers.

Section 2 contains the basic notation and definitions used in the remaining parts of the article. In section 3, the distance method is introduced. In section 4, the proposed method is compared with others ranking methods in some examples.

2 Preliminaries

Fuzzy number can be defined as follows [6]:

Definition 1 A real fuzzy number $\tilde{A}$ is described as any fuzzy subset of the real line $\mathbb{R}$ with membership function $f_\tilde{A}$ which processes the following properties:

(a) $f_\tilde{A}$ is a continuous mapping from $\mathbb{R}$ to the closed interval $[0, w]$, $0 \leq w \leq 1$;
(b) $f_\tilde{A}(x) = 0$, for all $x \in (-\infty, a]$;
(c) $f_\tilde{A}$ is strictly increasing on $[a, b]$;
(d) $f_\tilde{A}(x) = w$, for all $x \in [b, c]$, where $w$ is a constant and $0 < w \leq 1$
(e) $f_\tilde{A}$ is strictly decreasing on $[c, d]$;
(f) $f_\tilde{A}(x) = 0$ for all $x \in [d, -\infty)$,

where $a, b, c$ and $d$ are real numbers. We may let $a = -\infty$, or $a = b$, or $c = d$, or $d = +\infty$

Unless elsewhere specified, it is assumed that $\tilde{A}$ is convex and bounded; i.e. $-\infty < a, d < \infty$. If $w = 1$ in (d), $\tilde{A}$ is a normal fuzzy number, and if $0 < w < 1$ in (d), $\tilde{A}$ is a non-normal fuzzy number. For convenience, the fuzzy number in definition 1 can be denoted by $\tilde{A} = (a, b, c, d; w)$. The image (opposite) of $\tilde{A} = (a, b, c, d; w)$ can be given by $-\tilde{A} = (-d, -c, -b, -a; w)$ (see [9, 12]).

The membership function $f_\tilde{A}$ of $\tilde{A}$ can be expressed as

$$f_\tilde{A}(x) = \begin{cases} 
  f_\tilde{A}^L(x), & a \leq x \leq b, \\
  w, & b \leq x \leq c, \\
  f_\tilde{A}^R(x), & c \leq x \leq d, \\
  0, & \text{otherwise}.
\end{cases}$$

where $f_\tilde{A}^L : [a, b] \to [0, w]$ and $f_\tilde{A}^R : [c, d] \to [0, w]$.

Since $f_\tilde{A}^L : [a, b] \to [0, w]$ is continuous and strictly increasing, the inverse function of $f_\tilde{A}^L$ exists. Similarly, since $f_\tilde{A}^R : [c, d] \to [0, w]$ is continuous and strictly decreasing, the inverse function of $f_\tilde{A}^R$ also exists. The inverse function of $f_\tilde{A}^L$ and $f_\tilde{A}^R$ can be denoted by $g_\tilde{A}^L$ and $g_\tilde{A}^R$ respectively. Since $f_\tilde{A}^L : [a, b] \to [0, w]$ is continuous and
strictly increasing, \( g^L_{\tilde{A}} : [0,w] \rightarrow [a,b] \) is also continuous and strictly increasing. Similarly, since \( f^R_{\tilde{A}} : [c,d] \rightarrow [0,w] \) is continuous and strictly decreasing, \( g^R_{\tilde{A}} : [0,w] \rightarrow [c,d] \) is also continuous and strictly decreasing, so they are integrable on \([0,w]\). That is, both \( \int_0^w g^L_{\tilde{A}} dy \) and \( \int_0^w g^R_{\tilde{A}} dy \) exist \([10]\).

### 3 Ranking Fuzzy Numbers With Distance Method of The Centroid Point

In this section, the centroid point of a fuzzy number corresponds to an \( x \) value on the horizontal axis and \( y \) value on the vertical axis. The centroid point \((\bar{x}, \bar{y})\) for a fuzzy number \( \tilde{A} \) in definition 1 is defined as \([3]\).

\[
\bar{x}_{\tilde{A}} = \frac{\int_a^b (xf^L_{\tilde{A}})dx + \int_c^d (xf^R_{\tilde{A}})dx}{\int_a^b (f^L_{\tilde{A}})dx + \int_c^d (f^R_{\tilde{A}})dx},
\]

\[
\bar{y}_{\tilde{A}} = \frac{\int_0^w (yg^L_{\tilde{A}})dy + \int_0^w (yg^R_{\tilde{A}})dy}{\int_0^w (g^L_{\tilde{A}})dy + \int_0^w (g^R_{\tilde{A}})dy},
\]

where \( f^L_{\tilde{A}} \) and \( f^R_{\tilde{A}} \) are the left and right membership functions of fuzzy number \( \tilde{A} \), respectively, \( g^L_{\tilde{A}} \) and \( g^R_{\tilde{A}} \) are the inverse functions of \( f^L_{\tilde{A}} \) and \( f^R_{\tilde{A}} \), respectively too.

Suppose \( \tilde{A}_1, \tilde{A}_2, \tilde{A}_3, \ldots, \tilde{A}_n \) are fuzzy numbers. First we calculate the gravity center all of numbers (e.g. if \( \tilde{A}_i \) is a fuzzy number, the center of its gravity will be \( (\bar{x}_{\tilde{A}_i}, \bar{y}_{\tilde{A}_i}) \)). We define \( M = (\bar{x}_M, \bar{y}_M) \) such that \( \bar{x}_M \) is maximum of \( \bar{x}_{\tilde{A}_i} \) and \( \bar{y}_M \) is maximum of \( \bar{y}_{\tilde{A}_i} \), for \( i = 1, 2, \ldots, n \). Now for ranking we calculate the distance of gravity center of all fuzzy numbers from \( M \) as follows.

\[
R(\tilde{A}, M) = \sqrt{(\bar{x}_M - \bar{x}_{\tilde{A}})^2 + (\bar{y}_M - \bar{y}_{\tilde{A}})^2}.
\]

If \( \tilde{A}_i, \tilde{A}_j \) are two fuzzy numbers then the ranking will be done as follows:

1. \( \tilde{A}_j \prec \tilde{A}_i \iff R(\tilde{A}_i, M) > R(\tilde{A}_j, M) \),
2. \( \tilde{A}_j \sim \tilde{A}_i \iff R(\tilde{A}_i, M) = R(\tilde{A}_j, M) \).
4 Comparison with Other Ranking Methods

In this section, we will compare the proposed ranking method (4) with other methods.

Figure 1
Triangular Fuzzy numbers $\tilde{U}_1 = (0.2, 0.3, 0.5)$, $\tilde{U}_2 = (0.17, 0.32, 0.58)$ and $\tilde{U}_3 = (0.25, 0.4, 0.7)$

Example 4.1 The three triangular fuzzy numbers $\tilde{U}_1 = (0.2, 0.3, 0.5)$, $\tilde{U}_2 = (0.17, 0.32, 0.58)$ and $\tilde{U}_3 = (0.25, 0.4, 0.7)$ are shown in figure 1 ranked by Chu and Tsao [4].

\[
S(\tilde{U}_1) = \bar{x}_{\tilde{U}_1} \cdot \bar{y}_{\tilde{U}_1} = 0.333 \times 0.4872 = 0.162, \quad S(\tilde{U}_2) = \bar{x}_{\tilde{U}_2} \cdot \bar{y}_{\tilde{U}_2} = 0.357 \times 0.4868 = 0.174
\]

and \[ S(\tilde{U}_3) = \bar{x}_{\tilde{U}_3} \cdot \bar{y}_{\tilde{U}_3} = 0.450 \times 0.4857 = 0.219. \] Therefore, $\tilde{U}_1 \prec \tilde{U}_2 \prec \tilde{U}_3$ and by Cheng's method [3],

\[
R(\tilde{U}_1) = \sqrt{(\bar{x}_{\tilde{U}_1})^2 + (\bar{y}_{\tilde{U}_1})^2} = \sqrt{(0.333)^2 + (0.4872)^2} = 0.590,
\]

\[
R(\tilde{U}_2) = \sqrt{(\bar{x}_{\tilde{U}_2})^2 + (\bar{y}_{\tilde{U}_2})^2} = \sqrt{(0.357)^2 + (0.4968)^2} = 0.604,
\]

\[
R(\tilde{U}_3) = \sqrt{(\bar{x}_{\tilde{U}_3})^2 + (\bar{y}_{\tilde{U}_3})^2} = \sqrt{(0.45)^2 + (0.485)^2} = 0.662. \] Therefore, $\tilde{U}_1 \prec \tilde{U}_2 \prec \tilde{U}_3$ and by proposed method, $M = (\bar{x}_M, \bar{y}_M) = (0.45, 0.4872)$ and $R(\tilde{U}_1, M) = 0.3420,$

\[
R(\tilde{U}_2, M ) = 0.1170, \quad R(\tilde{U}_3, M ) = 0.0015, \quad \text{therefore}
\]

$R(\tilde{U}_1, M ) > R(\tilde{U}_2, M ) > R(\tilde{U}_3, M )$ and hence $\tilde{U}_1 \prec \tilde{U}_2 \prec \tilde{U}_3$.

Example 4.2 In figure 2, the fuzzy numbers $\tilde{A}_1 = (3.5, 7;1)$, $\tilde{A}_2 = (3.5, 7, 0.8)$, $\tilde{B}_1 = (5.7, 9, 10;1)$, $\tilde{B}_2 = (6.7, 9, 10;0.6)$, $\tilde{B}_3 = (7.8, 9, 10;0.4)$ are shown where, $\tilde{A}_1$ and $\tilde{A}_2$ are normal and non-normal triangular fuzzy numbers, respectively, and $\tilde{B}_1$ is a normal trapezoidal fuzzy number, $\tilde{B}_2$ and $\tilde{B}_3$ are non–normal trapezoidal fuzzy numbers. The ranking order by Cheng’s distance method is as follows:
\[ R(\tilde{A}_2) = \sqrt{(\bar{x}_{A_2}^+) + (\bar{x}_{A_2}^-)^2} = \sqrt{(5)^2 + (0.5)^2} = 5.03, \quad R(\tilde{A}_3) = \sqrt{(5)^2 + (0.4)^2} = 5.02, \]

\[ R(\tilde{B}_1) = \sqrt{(\bar{x}_{B_1}^+) + (\bar{x}_{B_1}^-)^2} = \sqrt{(7.714)^2 + (0.505)^2} = 7.73, \]

\[ R(\tilde{B}_2) = \sqrt{(\bar{x}_{B_2}^+) + (\bar{x}_{B_2}^-)^2} = \sqrt{(8)^2 + (0.3)^2} = 8.01, \]

\[ R(\tilde{B}_3) = \sqrt{(\bar{x}_{B_3}^+) + (\bar{x}_{B_3}^-)^2} = \sqrt{(8.5)^2 + (0.2)^2} = 8.05. \]

Therefore, \( \tilde{A}_2 \prec \tilde{A}_1 \prec \tilde{B}_1 \prec \tilde{B}_2 \prec \tilde{B}_3 \) and by Chu and Tsao's method, \( S(\tilde{A}_1) = \bar{x}_{A_1} \times \bar{y}_{A_1} = 5 \times 0.5 = 2.5, \quad S(\tilde{A}_2) = \bar{x}_{A_2} \times \bar{y}_{A_2} = 5 \times 0.4 = 2, \)

\[ S(\tilde{B}_1) = \bar{x}_{B_1} \times \bar{y}_{B_1} = 7.714 \times 0.505 = 3.896, \quad S(\tilde{B}_2) = \bar{x}_{B_2} \times \bar{y}_{B_2} = 8 \times 0.3 = 2.4, \]

\[ S(\tilde{B}_3) = \bar{x}_{B_3} \times \bar{y}_{B_3} = 8.5 \times 0.2 = 1.7. \] Therefore, \( \tilde{B}_3 \prec \tilde{A}_2 \prec \tilde{B}_2 \prec \tilde{A}_1 \prec \tilde{B}_1 \). By the proposed method, \( (\bar{x}_{A_1}, \bar{y}_{A_1}) = (5, 0.5), \quad (\bar{x}_{A_2}, \bar{y}_{A_2}) = (5, 0.4) \), \( (\bar{x}_{B_1}, \bar{y}_{B_1}) = (7.714, 0.505), \)

\( (\bar{x}_{B_2}, \bar{y}_{B_2}) = (8, 0.3), \quad (\bar{x}_{B_3}, \bar{y}_{B_3}) = (8.5, 0.2) = 8.5, \)

\[ R(\tilde{A}_1, M) = 3.500, \quad R(\tilde{A}_2, M) = 3.501, \quad R(\tilde{B}_1, M) = 0.786, \quad R(\tilde{B}_2, M) = 0.540, \]

\[ R(\tilde{B}_3, M) = 0.302. \] Then, the result of the distance method (4) is

\[ R(\tilde{A}_2, M) > R(\tilde{A}_1, M) > R(\tilde{B}_2, M) > R(\tilde{B}_1, M) > R(\tilde{B}_3, M) \] which means \( \tilde{A}_2 \prec \tilde{A}_1 \prec \tilde{B}_1 \prec \tilde{B}_2 \prec \tilde{B}_3 \).

**Figure 2**

Five fuzzy numbers \( \tilde{A}_1, \tilde{A}_2 \) and \( \tilde{B}_1, \tilde{B}_2, \tilde{B}_3 \).

Now, in the following example, we want to compare all the results of comparisons among various ranking methods given by Abbasbandy and Asady in [1] with our proposed method.
Example 4.3 Consider the following sets of fuzzy numbers.

Set 1: $\tilde{A} = (0.5, 0.1, 0.5)$, $\tilde{B} = (0.7, 0.3, 0.3)$, $\tilde{C} = (0.9, 0.5, 0.1)$ (figure 3.1),
Set 2: $\tilde{A} = (0.4, 0.7, 0.1, 0.2)$, $\tilde{B} = (0.7, 0.4, 0.2)$, $\tilde{C} = (0.7, 0.2, 0.2)$ (figure 3.2),
Set 3: $\tilde{A} = (0.5, 0.2, 0.2)$, $\tilde{B} = (0.5, 0.8, 0.2, 0.1)$, $\tilde{C} = (0.5, 0.2, 0.4)$ (figure 3.3),
Set 4: $\tilde{A} = (0.4, 0.7, 0.4, 0.1)$, $\tilde{B} = (0.5, 0.3, 0.4)$, $\tilde{C} = (0.6, 0.5, 0.2)$ (figure 3.4).
In table 1, the results of different ranking methods of these sets of fuzzy numbers are demonstrated and in table 2, the result of the distance method is shown.

### Table 1
Comparative results of Example 4.4

<table>
<thead>
<tr>
<th>Authors</th>
<th>Fuzzy Number</th>
<th>Set 1</th>
<th>Set 2</th>
<th>Set 3</th>
<th>Set 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choobineh and Li</td>
<td>( \tilde{A} )</td>
<td>0.3333</td>
<td>0.458</td>
<td>0.333</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>( \tilde{B} )</td>
<td>0.50</td>
<td>0.583</td>
<td>0.4167</td>
<td>0.5833</td>
</tr>
<tr>
<td></td>
<td>( \tilde{C} )</td>
<td>0.667</td>
<td>0.667</td>
<td>0.5417</td>
<td>0.6111</td>
</tr>
<tr>
<td>Results</td>
<td></td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
</tr>
<tr>
<td>Yager</td>
<td>( \tilde{A} )</td>
<td>0.60</td>
<td>0.575</td>
<td>0.5</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>( \tilde{B} )</td>
<td>0.70</td>
<td>0.65</td>
<td>0.55</td>
<td>0.525</td>
</tr>
<tr>
<td></td>
<td>( \tilde{C} )</td>
<td>0.80</td>
<td>0.7</td>
<td>0.625</td>
<td>0.55</td>
</tr>
<tr>
<td>Results</td>
<td></td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
</tr>
<tr>
<td>Chen</td>
<td>( \tilde{A} )</td>
<td>0.3375</td>
<td>0.4315</td>
<td>0.375</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td>( \tilde{B} )</td>
<td>0.50</td>
<td>0.5625</td>
<td>0.425</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>( \tilde{C} )</td>
<td>0.667</td>
<td>0.625</td>
<td>0.55</td>
<td>0.625</td>
</tr>
<tr>
<td>Results</td>
<td></td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
</tr>
<tr>
<td>Baldwin and Guild</td>
<td>( \tilde{A} )</td>
<td>0.30</td>
<td>0.27</td>
<td>0.27</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>( \tilde{B} )</td>
<td>0.33</td>
<td>0.27</td>
<td>0.37</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td>( \tilde{C} )</td>
<td>0.44</td>
<td>0.37</td>
<td>0.45</td>
<td>0.42</td>
</tr>
<tr>
<td>Results</td>
<td></td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
</tr>
<tr>
<td>Chu and Tsao</td>
<td>( \tilde{A} )</td>
<td>0.299</td>
<td>0.2847</td>
<td>0.25</td>
<td>0.24402</td>
</tr>
<tr>
<td></td>
<td>( \tilde{B} )</td>
<td>0.350</td>
<td>0.3247</td>
<td>0.31526</td>
<td>0.26243</td>
</tr>
<tr>
<td></td>
<td>( \tilde{C} )</td>
<td>0.3993</td>
<td>0.350</td>
<td>0.27475</td>
<td>0.2619</td>
</tr>
<tr>
<td>Results</td>
<td></td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
</tr>
<tr>
<td>Yao and Wu</td>
<td>( \tilde{A} )</td>
<td>0.6</td>
<td>0.575</td>
<td>0.50</td>
<td>0.475</td>
</tr>
<tr>
<td></td>
<td>( \tilde{B} )</td>
<td>0.7</td>
<td>0.65</td>
<td>0.625</td>
<td>0.525</td>
</tr>
<tr>
<td></td>
<td>( \tilde{C} )</td>
<td>0.8</td>
<td>0.7</td>
<td>0.55</td>
<td>0.525</td>
</tr>
<tr>
<td>Results</td>
<td></td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
</tr>
<tr>
<td>Sign distance method ( \rho = 1 )</td>
<td>( \tilde{A} )</td>
<td>1.2</td>
<td>1.15</td>
<td>1</td>
<td>0.95</td>
</tr>
<tr>
<td></td>
<td>( \tilde{B} )</td>
<td>1.4</td>
<td>1.3</td>
<td>1.25</td>
<td>1.05</td>
</tr>
<tr>
<td></td>
<td>( \tilde{C} )</td>
<td>1.6</td>
<td>1.4</td>
<td>1.1</td>
<td>1.05</td>
</tr>
<tr>
<td>Results</td>
<td></td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
<td>( \tilde{A} \prec \tilde{B} \prec \tilde{C} )</td>
</tr>
</tbody>
</table>
For example in set 1, we should intuitively obtain that $\tilde{A} \prec \tilde{B} \prec \tilde{C}$. The methods of Cheng CV uniform distribution and Cheng CV proportional distribution gives us $\tilde{B} \prec \tilde{C} \prec \tilde{A}$. In set 2, it seems natural to obtain $\tilde{A} \prec \tilde{B} \prec \tilde{C}$, but by method of Baldwin and Guild, $\tilde{A} \sim \tilde{B} \prec \tilde{C}$, and by method of Cheng CV uniform distribution and Cheng CV proportional distribution $\tilde{C} \prec \tilde{B} \prec \tilde{A}$.

Also, in set 3, the distance method (4) shows $\tilde{A} \prec \tilde{C} \prec \tilde{B}$, but Choobineh and Li, Yager, Chen, Baldwin and Guild distribution give $\tilde{A} \prec \tilde{B} \prec \tilde{C}$. In set 4, the proposed method shows $\tilde{A} \sim \tilde{B} \prec \tilde{C}$, The method of Baldwin and Guild, Yao and Wu and Sign distance method $\rho = 1$ give $\tilde{A} \prec \tilde{B} \prec \tilde{C}$ and the method of Chu and Tsao, Cheng's distance gives $\tilde{A} \prec \tilde{C} \prec \tilde{B}$ while the method of Cheng CV uniform distribution and Cheng CV proportional distribution give $\tilde{B} \prec \tilde{C} \prec \tilde{A}$ and the new approach for ranking mentioned in [2] gives $\tilde{B} \prec \tilde{A} \prec \tilde{C}$.

Table 2
The comparative results of example 4.4 by proposed method

<table>
<thead>
<tr>
<th>Fuzzy Number</th>
<th>Set 1</th>
<th>Set 2</th>
<th>Set 3</th>
<th>Set 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>The proposed method</td>
<td>$\tilde{A}$</td>
<td>0.823</td>
<td>0.121</td>
<td>0.122</td>
</tr>
<tr>
<td></td>
<td>$\tilde{B}$</td>
<td>0.069</td>
<td>0.067</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>$\tilde{C}$</td>
<td>0.0</td>
<td>0.012</td>
<td>0.060</td>
</tr>
<tr>
<td>Results</td>
<td>$\tilde{A} \prec \tilde{B} \prec \tilde{C}$</td>
<td>$\tilde{A} \prec \tilde{B} \prec \tilde{C}$</td>
<td>$\tilde{A} \prec \tilde{B} \prec \tilde{C}$</td>
<td>$\tilde{A} \prec \tilde{B} \prec \tilde{C}$</td>
</tr>
</tbody>
</table>
5 Conclusions

In this paper, we have presented a simple ranking method by using the distance method. Shortcomings are found in Cheng’s cv index for ranking fuzzy numbers. In the proposed ranking method one can compare normal and non normal fuzzy triangular and trapezoidal numbers easily and in many cases can find a satisfactory solution for ranking them.

References