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Answer Note "A novel method for solving the fully neutrosophic linear programming problems: Suggested modifications"

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Abstract. Singh et al. [1], for solving the fully neutrosophic linear programming problems stated that the method of Abdel-Basset et al. [2] is scientifically incorrect and suggested a modified version for it. They have constructed their modifications based on different model assumptions which have been discussed in detail in the answer note. The purpose of this answer note is to inform that the justifications and clarifications given by Singh et al. [1] are not appropriate. We show that the outcome obtained by Abdel-Basset et al. [2] is correct and the method holds all conditions of the problem under neutrosophic environment. This answer note has also discussed some additional narrative which was not discussed in Abdel-Basset et al. [3] comment paper. Finally, we aim to bring back the faith in readers on the proposed method by Abdel-Basset et al. [2].

Keywords: Linear Programming Problem; Neutrosophic Linear Programming Problem; Note; reply

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1. **Introduction**

Fuzzy or neutrosophic or uncertain information are generally processed by transforming into an accurate number. This transformation can happen at the beginning of the decision process, or in the middle or final stage. Very recently, two articles [1,2] considered the solution of fully neutrosophic linear programming problems. However, the research by Singh et al. [1], and the research by Abdel-Basset et al. [2] are different due to the transformation of uncertain information into accurate numbers at different stages. Therefore, both the proposed methods hold good in their respective model and this implies that the modification suggested by Singh et al. [1] are not required being the conditions and provisions of these two models are itself different.

In this paper, the models considered by Abdel-Basset et al. [2] (Model 1, in Definition 1.1) and Singh et al. [1] (Model 2, in Definition 1.2) have been discussed in detail to understand the difference between the two proposed methods and therefore to justify our objective.

1.1. *Discussion on different models to handle LPP under neutrosophic environment*

Definition 1.1. (Section 3.1, Step 1, pp. 886-887) [1]: Abdel-Basset et al. [2] proposed Model 1 is as follows:
Maximize/Minimize $\left[\sum_{j=1}^{n} R\left(\tilde{C}_j\right) x_j\right]$
Subject to (P2)

Definition 1.2. (Section 4.1, Step 1, pp. 887): Singh et al. [1] consider the different model such as:
Maximize/Minimize $\left[R\left(\sum_{j=1}^{n} \tilde{C}_j x_j\right)\right]$
Subject to constraints.
where,

$\tilde{C}_j$= Neutrospohic cost value, and
x_{ij}= the neutrosophic variable.
R: rank function.

1.2. *Comparison of any two random neutrosophic numbers*

Definition 1.3. [2, 3]: Where $\hat{r}^N = \langle[\hat{r}_T, \hat{r}_I, \hat{r}_M, \hat{r}_E], (T_{\hat{r}}, I_{\hat{r}}, F_{\hat{r}})\rangle$ and $\hat{s}^N = \langle[\hat{s}_T, \hat{s}_I, \hat{s}_M, \hat{s}_E], (T_{\hat{s}}, I_{\hat{s}}, F_{\hat{s}})\rangle$ are two Trapezoidal neutrosophic numbers:

(a) $\hat{r}^N > \hat{s}^N$ iff $R\left(\hat{r}^N\right) > R\left(\hat{s}^N\right)$
(b) $\hat{r}^N < \hat{s}^N$ iff $R\left(\hat{r}^N\right) < R\left(\hat{s}^N\right)$
(c) $\hat{r}^N = \hat{s}^N$ iff $R\left(\hat{r}^N\right) = R\left(\hat{s}^N\right)$

Where $R\left(\hat{r}^N\right)$ is ranking function for $\hat{r}^N$ neutrosophic number.

1.3. *Discussion on arithmetic operation to handle LPP under neutrosophic environment*

To solve Model 1, Abdel-Baset et al. [2] use the following Definition 1.4.

Definition 1.4. [2]: Neutrosophic multiplication property with β ; where β is constant parameter;

$$\beta\tilde{\underline{m}} = \left\langle \left[\beta\tilde{m}^a, \beta\tilde{m}^s, \beta\tilde{m}^h, \beta\tilde{m}^o\right], \left(T_{\tilde{m}}, I_{\tilde{m}}, F_{\tilde{m}}\right)\right\rangle \text{ if } (\beta > 0)$$

Whereas, Singh et al. [1] use the below Definition 1.5 to solve Model 2.

Definition 1.5. [2]: Neutrosophic multiplication property with two neutrosophic numbers $\hat{r}^N$ and $\hat{s}^N$

$$\hat{r}^N \otimes \hat{s}^N = \begin{cases} \langle [\hat{r}_T \cdot \hat{s}_T, \hat{r}_I \cdot \hat{s}_I, \hat{r}_M \cdot \hat{s}_M, \hat{r}_E \cdot \hat{s}_E], (T_{\hat{r}} \wedge T_{\hat{s}}, I_{\hat{r}} \vee I_{\hat{s}}, F_{\hat{r}} \vee F_{\hat{s}}) \rangle \text{ if } (\hat{r}_E > 0, \hat{s}_E > 0) \\ \langle [\hat{r}_T \cdot \hat{s}_E, \hat{r}_I \cdot \hat{s}_E, \hat{r}_M \cdot \hat{s}_I, \hat{r}_E \cdot \hat{s}_T], (T_{\hat{r}} \wedge T_{\hat{s}}, I_{\hat{r}} \vee I_{\hat{s}}, F_{\hat{r}} \vee F_{\hat{s}}) \rangle \text{ if } (\hat{r}_E < 0, \hat{s}_E > 0) \\ \langle [\hat{r}_E \cdot \hat{s}_E, \hat{r}_M \cdot \hat{s}_M, \hat{r}_I \cdot \hat{s}_I, \hat{r}_T \cdot \hat{s}_T], (T_{\hat{r}} \wedge T_{\hat{s}}, I_{\hat{r}} \vee I_{\hat{s}}, F_{\hat{r}} \vee F_{\hat{s}}) \rangle \text{ if } (\hat{r}_E < 0, \hat{s}_E < 0) \end{cases}$$

Where $\hat{r}^N = \langle [\hat{r}_T, \hat{r}_I, \hat{r}_M, \hat{r}_E], (T_{\hat{r}}, I_{\hat{r}}, F_{\hat{r}}) \rangle$ and $\hat{s}^N = \langle [\hat{s}_T, \hat{s}_I, \hat{s}_M, \hat{s}_E], (T_{\hat{s}}, I_{\hat{s}}, F_{\hat{s}}) \rangle$ are two Trapezoidal neutrosophic numbers.

2. Reply to suggested modification in the existing solution in Singh et al. [1]

When we consider the Model 1 (Definition 1.1) as suggested by the Abdel-Basset et al. [2], we need to follow the arithmetic property as mentioned in Definition 1.4. and when we consider the model 2 (Definition 1.2) as suggested by Singh et al. [1] we need to follow the Definition 1.5.

In this answer note, it is clear that Singh et al. [1], have suggested the modifications in Abdel-Basset et al. [2] which are not required. The authors have considered a different model (model 2) to modify the technique of Abdel-Basset et al. [2]. The conditions and provisions of these two methods are entirely different as the transformation of uncertainty information has taken place at different stages. So, based on above justification, we can say that Abdel-Basset et al. [2] method still holds all the required conditions necessary to solve all types of LPP problem under neutrosophic environment and do not needs any further modification.

2.1. *Second Irrelevant Condition of linearity of Singh et al. [1]*

Singh et al. [1] claims that the Abdel-Basset et.al. [2] proposed technique doesn't hold the linear property which is shown in Section 5, point i-ii, pp.888

We observe that Abdel-Basset et al. [2] already considered the above-mentioned demerit while drafting the manuscript. To justify our claim, we share a short observation below:

Observation: Abdel-Basset et al. [2] first found the score of each neutrosophic cost as shown in Definition 1.1, and then multiplied with neutrosophic number using the Definition 1.4. This helped in avoiding the above-discussed demerit of scoring property of neutrosophic set. Additionally, Singh et al. [1] has considered a different model (Definition 1.2) to justify their claim. The used model is wrong and nowhere used in the method proposed by Abdel-Basset et al. [2]. Hence, the model proposed by Singh et al. [1] doesn't prove any limitation of the technique proposed by Abdel-Basset et al. [2].

Conclusion

The method proposed by Abdel-Basset et al. [2] satisfy all the fundamental requirements for solving the problem under neutrosophic environment. Singh et al. [1] suggested some unnecessary changes ($P1 - P29$) with a different model for solving LPs where the transformation of uncertain information has taken place at different stage. So, the results mentioned in Abdel-Basset et al. [2] are still logical and legitimate. Hence, the model proposed by Singh et al. [1] doesn't prove any limitation of the technique proposed by Abdel-Basset et al. [2]. To motivate the readers, few relevant research articles [4–17] have been suggested to provide more insight on neutrosophic environment.

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