

SELECTION OF AGRICULTURAL AIRCRAFT USING A SVTRN-NUMBER APPROACH TO MULTI-CRITERIA DECISION MAKING

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ABSTRACT. Agricultural aircraft plays a vital role in the field of farming and agriculture in the present scenario, where the human race is highly dependent on organic foods and healthy life style. The paper targets to find the solution to the problem of proper selection aircraft used for this purpose. We consider triangular single valued Neutrosophic numbers with multiple parameters to find the solution on how to use pesticides to develop healthy farming. This paper also finds the better way for the selection of agriculture aircraft by a ranking method coupled with triangular single valued Neutrosophic numbers.

1. INTRODUCTION

Since its very inception fuzzy sets [1] have proven to be efficient in handling uncertain information and in decision making processes having ambiguous environment. The idea of fuzzy sets was refined over time and different variants were introduced to handle different forms of uncertainty. Falling in line in this process Smarandache [4] introduced neutrosophic sets which had three membership functions namely positive, indeterminate and negative. Introduction of neutrosophic sets revolutionized the application of fuzzy logic in decision making and has been applied by many researchers in the fields of [5-10]. In this paper we have used single valued neutrosophic sets in a multi-criteria decision making situation of selecting an appropriate aircraft for the purpose of agriculture. The aircraft for spraying pesticides, fertilizers and seeds are used in many countries like Brazil,

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United States, New Zealand Australia and European countries. GS Schwening and AM Abdalla [11] developed a method combining AHP and TOPSIS in fuzzy environment to find the best agricultural aircraft. Dagdeviren M. et al. [12] used TOPSIS method to find out weapon selection for efficiency of defence system. A. Rajkumar et al. [13] used Dodecagonal Fuzzy Relational Mapping (DgFRM) to propose a new method for the aircraft selection problem.

2. PRELIMINARIES

Neutrosophic sets [2] Let ε be a space of points with generic elements in ε denoted by x . Then a neutrosophic set α in ε is characterized by a truth membership function, T_α , an indeterminacy membership function I_α and a falsity membership function F_α . The function $T_\alpha : \varepsilon \rightarrow [0, 1^+]$; $I_\alpha : \varepsilon \rightarrow [0, 1^+]$; $F_\alpha : \varepsilon \rightarrow [0, 1^+]$.

It is noted that there is no restriction on the sum of $T_\alpha(x), I_\alpha(x), F_\alpha(x)$, i.e.,

$$0 \leq T_\alpha(x) + I_\alpha(x) + F_\alpha(x) \leq 3^+.$$

Single Valued Neutrosophic set [2] Let ε be a universal space of points with a generic elements of ε denoted by x . A single valued neutrosophic set S is characterized by a truth membership function $T_s(x)$, an indeterminacy membership function $I_s(x)$, a falsity membership function $F_s(x)$ with $T_s(x), I_s(x), F_s(x) \in [0, 1]$ for all x in ε . When ε is continuous a SVNS can be written as:

$$S = \int \langle T_s(x), F_s(x), I_s(x) \rangle x, \forall x \in \varepsilon.$$

When ε is discrete a SVNSs S can be written as:

$$S = \sum \langle T_s(x), F_s(x), I_s(x) \rangle x, \forall x \in \varepsilon.$$

It is noted that for a SVNS,

$$0 \leq \sup T_s(x) + \sup F_s(x) + \sup I_s(x) \leq 3, \forall x \in \varepsilon.$$

Triangular Single Valued Neutrosophic Number [3] A Triangular single Valued Neutrosophic number is defined as $\tilde{A}_{Neu} = (p_1, p_2, p_3; q_1, q_2, q_3; r_1, r_2, r_3)$ whose truth membership, indeterminacy and falsity membership is defined as follows,

$$T_{\tilde{A}_{Neu}}(x) = \begin{cases} \frac{x-p_1}{p_2-p_1} & \text{when } p_1 \leq x < p_2 \\ 1 & \text{when } x = p_2 \\ \frac{p_3-x}{p_3-p_2} & \text{when } p_2 < x \leq p_3 \\ 0 & \text{otherwise} \end{cases}$$

$$I_{\tilde{A}_{Neu}}(x) = \begin{cases} \frac{q_2-x}{q_2-q_1} & \text{when } q_1 \leq x < q_2 \\ 0 & \text{when } x = q_2 \\ \frac{x-q_2}{q_3-q_2} & \text{when } q_2 < x \leq q_3 \\ 1 & \text{otherwise} \end{cases} \quad F_{\tilde{A}_{Neu}}(x) = \begin{cases} \frac{r_2-x}{r_2-r_1} & \text{when } r_1 \leq x < r_2 \\ 0 & \text{when } x = r_2 \\ \frac{x-r_2}{r_3-r_2} & \text{when } r_2 < x \leq r_3 \\ 1 & \text{otherwise} \end{cases}$$

3. ALGORITHM

Step 1: Problem field selection: Consider a multi-attribute decision making problem with m alternatives and n attributes Triangular single valued Neutrosophic set decision matrix:

$$D = \langle d_{ij} \rangle_{m \times n} \left\{ \begin{array}{cccc} \langle d_{11} \rangle & \langle d_{12} \rangle & \cdots & \langle d_{1n} \rangle \\ \langle d_{21} \rangle & \langle d_{22} \rangle & \cdots & \langle d_{2n} \rangle \\ \vdots & \vdots & & \vdots \end{array} \right\}.$$

Here, $d_{ij} (i = 1, 2, \dots, m \text{ and } j = 1, 2, \dots, n)$ are all single valued Neutrosophic number.

Step 2: Input the Triangular single valued Neutrosophic Fuzzy number as edge weight.

Step 3: Take the coefficient of Triangular single valued. Neutrosophic Fuzzy number as pascal’s triangle number taken along the three sides of pascal’s triangle.

Step 4: Add and divide by the total of pascal’s triangle number and call it as pascal’s triangle for Triangular single valued Neutrosophic Fuzzy number. The Pascal’s triangle for Triangular Neutrosophic Fuzzy number is given by

$$P_p = \frac{1}{4} [a_1 + 2(a_2) + a_3].$$

Step 5: Convert Triangular Neutrosophic single valued Fuzzy number into a Single Valued Neutrosophic Fuzzy number using the below formula

$$SVNFN(A_i) = \frac{1}{m} \sum_{n=1}^m \left[\frac{2 + T_{rj} - I_{rj} - F_{rj}}{3} \right].$$

Step 6: Selection zone.

Single valued neutrosophic fuzzy value are classified into three zones. These are described as follows.

Highly acceptable zone: $0.50 \leq SVNFN(A_i) \leq 1.$

Tolerable acceptable zone: $0.25 \leq \text{SVNFN}(A_i) \leq 0.50$.

Unacceptable acceptable zone: $0.00 \leq \text{SVNFN}(A_i) \leq 0.25$.

Step 7: Ranking of Alternatives

According to the Single Valued Neutrosophic number, we can set up a panel of all alternatives in descending order and we can choose larger number of alternatives into the decision making process considering highly acceptable zone and tolerable acceptable zone.

Step 8: End

Numerical example (case study):

Selection of Agricultural Aircraft using Triangular Single valued Neutrosophic Multi-criteria Decision making problem.

Step 1:

ALTERNATIVES:

R_1 : Air Tractor AT402B

R_2 : Fletcher FU24

R_3 : Embrer EMB202 IPANEMA

R_4 : PZL M18 Dromader

R_5 : Antonov AN2

ATTRIBUTES:

H_1 : Hopper Capacity

H_2 : Take Off Distance

H_3 : Fuel Capacity

H_4 : Thrust Produced

H_5 : Aspect Ratio

H_6 : Rate of Climb

H_7 : Range

H_8 : Empty Weight

H_9 : Maximum Speed

Step 2:

The membership function for the linguistic variable is defined as:

Truth membership function: $0.8 \leq x \leq 0.5$.

Indeterminacy membership function: $0.7 \leq x \leq 0.0$.

Falsity membership function: $0.7 \leq x \leq 0.0$.

Step 3: The Pascal's triangle for Triangular single valued Neutrosophic Fuzzy number is given by

$$P_p = \frac{1}{4}[a_1 + 2(a_2) + a_3]$$

$$P_{11} = \frac{0.5+2(0.2)+0.3}{4} = 0.3; \frac{0.5+2(0.3)+0.3}{4} = 0.35; \frac{0.5+2(0.3)+0.2}{4} = 0.325$$

$$P_{12} = \frac{0.6+2(0.4)+0.1}{4} = 0.275; \frac{0.6+2(0.1)+0.2}{4} = 0.25; \frac{0.6+2(0.3)+0.1}{4} = 0.325$$

$$P_{13} = \frac{0.8+2(0.4)+0.3}{4} = 0.475; \frac{0.8+2(0.3)+0.3}{4} = 0.425; \frac{0.8+2(0.2)+0.1}{4} = 0.325$$

$$P_{14} = \frac{0.7+2(0.3)+0.2}{4} = 0.375; \frac{0.7+2(0.4)+0.3}{4} = 0.45; \frac{0.7+2(0.3)+0.1}{4} = 0.35$$

$$P_{15} = \frac{0.8+2(0.5)+0.3}{4} = 0.525; \frac{0.8+2(0.3)+0.2}{4} = 0.4; \frac{0.8+2(0.2)+0.1}{4} = 0.325$$

Table 1

	R ₁	R ₂	R ₃	R ₄	R ₅
H ₁	<0.5,0.2,0.3; 0.5,0.3,0.3; 0.5,0.3,0.2 >	<0.6,0.2,0.1; 0.6,0.1,0.2; 0.6,0.3,0.1 >	<0.8,0.4,0.3; 0.8,0.3,0.3; 0.8,0.2,0.1 >	<0.7,0.3,0.2; 0.7,0.4,0.3; 0.7,0.3,0.1 >	<0.8,0.5,0.3; 0.8,0.3,0.2; 0.8,0.2,0.1 >
H ₂	<0.5,0.1,0.2; 0.5,0.2,0.1; 0.5,0.3,0.2 >	<0.6,0.3,0.2; 0.6,0.2,0.1; 0.6,0.2,0.0 >	<0.8,0.4,0.1; 0.8,0.3,0.2; 0.8,0.4,0.3 >	<0.7,0.3,0.0; 0.7,0.4,0.1; 0.7,0.4,0.2 >	<0.8,0.6,0.5; 0.8,0.4,0.4; 0.8,0.3,0.1 >
H ₃	<0.5,0.3,0.2; 0.5,0.4,0.3; 0.5,0.2,0.1 >	<0.6,0.2,0.1; 0.6,0.3,0.5; 0.6,0.4,0.1 >	<0.8,0.3,0.2; 0.8,0.4,0.3; 0.8,0.3,0.4 >	<0.4,0.3,0.3; 0.7,0.4,0.3; 0.7,0.5,0.3 >	<0.8,0.6,0.1; 0.8,0.4,0.2; 0.8,0.5,0.0 >
H ₄	<0.5,0.3,0.4; 0.5,0.2,0.1; 0.5,0.4,0.3 >	<0.6,0.3,0.1; 0.6,0.3,0.2; 0.6,0.4,0.3 >	<0.8,0.3,0.4; 0.8,0.4,0.4; 0.8,0.5,0.2 >	<0.7,0.4,0.3; 0.7,0.5,0.2; 0.7,0.1,0.3 >	<0.8,0.7,0.6; 0.8,0.6,0.3; 0.8,0.4,0.3 >
H ₅	<0.5,0.4,0.3; 0.5,0.3,0.2; 0.5,0.3,0.1 >	<0.6,0.2,0.1; 0.6,0.3,0.2; 0.6,0.4,0.3 >	<0.8,0.3,0.4; 0.8,0.4,0.2; 0.8,0.3,0.1 >	<0.7,0.3,0.3; 0.7,0.5,0.3; 0.7,0.3,0.5 >	<0.8,0.7,0.3; 0.8,0.5,0.2; 0.8,0.4,0.3 >
H ₆	<0.5,0.2,0.1; 0.5,0.1,0.1; 0.5,0.3,0.2 >	<0.6,0.3,0.2; 0.6,0.4,0.3; 0.6,0.5,0.4 >	<0.8,0.5,0.3; 0.8,0.6,0.4; 0.8,0.7,0.5 >	<0.7,0.2,0.1; 0.7,0.4,0.5; 0.7,0.3,0.2 >	<0.8,0.5,0.6; 0.8,0.6,0.4; 0.8,0.4,0.2 >
H ₇	<0.5,0.3,0.2; 0.5,0.3,0.1; 0.5,0.2,0.1 >	<0.6,0.4,0.3; 0.6,0.3,0.2; 0.6,0.2,0.0 >	<0.8,0.4,0.3; 0.8,0.5,0.3 0.8,0.2,0.3 >	<0.7,0.3,0.4; 0.7,0.4,0.3; 0.7,0.3,0.1 >	<0.8,0.6,0.2; 0.8,0.5,0.7; 0.8,0.7,0.4 >
H ₈	<0.5,0.2,0.3; 0.5,0.1,0.3; 0.5,0.3,0.3 >	<0.6,0.3,0.4; 0.6,0.2,0.2; 0.6,0.5,0.4 >	<0.8,0.3,0.4 0.8,0.5,0.3 0.8,0.5,0.4 >	<0.7,0.4,0.5; 0.7,0.4,0.4; 0.7,0.3,0.2 >	<0.8,0.6,0.5; 0.8,0.5,0.7; 0.8,0.4,0.8 >
H ₉	<0.5,0.3,0.1; 0.5,0.2,0.1; 0.5,0.1,0.1 >	<0.6,0.4,0.3; 0.6,0.4,0.2; 0.6,0.3,0.3 >	<0.8,0.3,0.4; 0.8,0.3,0.0; 0.8,0.2,0.1 >	<0.7,0.2,0.4; 0.7,0.3,0.4; 0.7,0.3,0.2 >	<0.8,0.7,0.4; 0.8,0.6,0.2; 0.8,0.5,0.3 >

Step 4:

Similarly we have to convert all the Triangular Neutrosophic Fuzzy number into Neutrosophic Fuzzy number. The table below shows the Neutrosophic number.

Table 2

	R ₁	R ₂	R ₃	R ₄	R ₅
H ₁	<0.3,0.35,0.325>	<0.275,0.25,0.325>	<0.475,0.425,0.325>	<0.375,0.45,0.35>	<0.375,0.35,0.225>
H ₂	<0.225,0.25,0.325>	<0.35,0.275,0.25>	<0.425,0.4,0.475>	<0.325,0.4,0.425>	<0.3,0.325,0.2>
H ₃	<0.325,0.4,0.25>	<0.275,0.425,0.375>	<0.4,0.475,0.45>	<0.4,0.45,0.5>	<0.35,0.225,0.25>
H ₄	<0.375,0.25,0.4>	<0.325,0.35,0.425>	<0.4,0.5,0.5>	<0.45,0.475,0.3>	<0.3,0.225,0.2>
H ₅	<0.4,0.325,0.3>	<0.275,0.35,0.425>	<0.45,0.45,0.375>	<0.4,0.5,0.45>	<0.325,0.3,0.15>
H ₆	<0.25,0.2,0.325>	<0.35,0.425,0.5>	<0.525,0.6,0.675>	<0.3,0.5,0.375>	<0.3,0.325,0.35>
H ₇	<0.325,0.3,0.25>	<0.425,0.35,0.25>	<0.475,0.525,0.375>	<0.425,0.45,0.35>	<0.3,0.225,0.15>
H ₈	<0.3,0.25,0.35>	<0.4,0.3,0.5>	<0.45,0.525,0.55>	<0.625,0.475,0.375>	<0.275,0.275,0.15>
H ₉	<0.3,0.25,0.2>	<0.425,0.4,0.375>	<0.45,0.35,0.325>	<0.375,0.425,0.375>	<0.275,0.275,0.15>

Step 5:

To Convert Triangular Neutrosophic Fuzzy number into a Single Valued Neutrosophic Fuzzy number (SVNFN):

$$\begin{aligned} \text{SVNFN}(R_i) &= \frac{1}{m} \sum_{n=1}^m \left[\frac{2 + T_{rj} - I_{rj} - F_{rj}}{3} \right] \\ \text{SVNFN}(R_1) &= \frac{1}{9} \left[\frac{2 + 0.3 - 0.35 - 0.325}{3} + \frac{2 + 0.225 - 0.25 - 0.325}{3} \right. \\ &\quad + \frac{2 + 0.325 - 0.4 - 0.25}{3} + \frac{2 + 0.375 - 0.25 - 0.4}{3} \\ &\quad + \frac{2 + 0.4 - 0.325 - 0.3}{3} + \frac{2 + 0.25 - 0.2 - 0.325}{3} \\ &\quad + \frac{2 + 0.3 - 0.25 - 0.355}{3} + \frac{2 + 0.325 - 0.3 - 0.25}{3} \\ &\quad \left. + \frac{2 + 0.3 - 2}{3} + \frac{2 + 0.3 - 0.25 - 0.2}{3} \right] \\ &= \frac{1}{9} [0.5417 + 0.55 + 0.5583 + 0.575 + 0.5917 + 0.575 + 0.5917 \\ &\quad + 0.5667 + 0.6167] = \frac{1}{9} [5.1668] \\ &= 0.5741 \end{aligned}$$

Similarly

$$\text{SVNFN}(R_2) = 0.5389$$

$$\text{SVNFN}(R_3) = 0.5093$$

$$\text{SVNFN}(R_4) = 0.4667$$

$$\text{SVNFN}(R_5) = 0.6074$$

Step 6:

0.6074, 0.5741, 0.5389, 0.5093 are highly acceptable zone

0.4667 are Tolerable acceptable zone

Step 7:

Ranking of the alternatives

$$0.6074 \gg 0.5741 \gg 0.5389 \gg 0.5093 \gg 0.4667$$

$$R_5 \gg R_1 \gg R_2 \gg R_3 \gg R_4 \quad R_5 \text{ is best Aircraft}$$

R5: Antonov AN2 Aircraft is the best for Agriculture

Step 8: END

4. CONCLUSION

The Best Aircraft was analysed by Single Valued Neutrosophic Fuzzy set, Triangular Single Valued Neutrosophic, the Pascal's Triangle for Triangular Neutrosophic fuzzy number, from the above results we conclude that an Antonov AN2 Aircraft is the best aircraft for pesticides, fertilizer and seeds.

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