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Development of Hybrid Model for Donations to Deserving Donees Using Multi-Polar Interval-Valued Neutrosophic Soft Set

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Abstract. Multicriteria decision-making techniques have been used widely in intelligent decision support systems for many executive decisions. Non-government organizations (NGOs), Non-Profitable Organizations (NPOs), and privileged persons employ survey methods to obtain deserving people's data for charity donations under United Nations poverty alleviation initiatives, for example, financial assistance. They collect data manually or semi-automated, then narrow down the list of deserving recipients based on specific criteria. That usually results in a list of recipients who either don't deserve it or, if they do, aren't the perfect fit. Furthermore, the final recommendations of NGOs and NPOs partially address the poverty disparity and position all of them are on same level, resulting in the less justified distribution of charity. Due to the simultaneous evaluation of several characteristics. This paper formulates the problem of distributing funds to deserving peoples as a multicriteria decision-making problem to address these concerns. A Multipolar Interval-Valued Neutrosophic Soft Set (mIVNS) is used to address the issue of selecting suitable candidates for financial aid and distribution of funds. To implement the proposed methodology, a sample of 5 distinct deserving attributes is considered according to their intensity of poverty gap for allocation of funds. By using distance-based similarity measures, the technique of mIVNS sets has been used to select candidates and distribute funds. This methodology supports the management of NPOs and NGOs, and privileged individuals to disburse financial aid in deserving families according to their needs better.

Key Words: Multi-Polar Interval-Valued Neutrosophic Soft Set, Deserving Donees, Distance Measure, TOPSIS, Hybrid Model.

1. Introduction

Decision-making identifies the problem, proposes alternatives to tackle recognized problems, assesses these options, and eventually selects the best choice to execute the offered solution [26]. Several Multicriteria Decision Making (MCDM) methods are available, including the Analytical Hierarchal Process (AHP) [7], the Analytical Network Process (ANP) [27], TOPSIS [20], Data Envelopment Analysis (DEA) [18] and Fuzzy Decision-Making [8] suggests assessing the alternatives and indicate the preferred options.

The selection of deserving donees for charitable assistance is a wide real-world dilemma that affects privileged individuals worldwide, Non-governmental organizations (NGOs) and Non-Profitable Organizations (NPOs) that seek to donate. Due to nature of the donation, which is to be given to the worthiest people, one of the most crucial areas in NGOs and NPOs initiatives is the evaluation and selection of donees. As a result, it is critical for individuals and charity organizations to take a systematic approach to assess and choose the most deserving beneficiaries of aid (s).

In reported literature, there is a lot of study on the challenges of less efficient approaches of selecting actual eligible aid recipients [16], donors' decision to donate to charity is influenced by several factors [15] and looking at the effects of class, gender and culture on people's giving habits and volunteer activities [13]. However, there is less research on the ways in which community service organizations, such as NGOs and NPOs, assess deserving donees and distribute financial aid in the literature. This research investigates whether charity giving benefits predominantly less privileged sectors in society [19]. This issue of choosing the worthiest recipients is a multicriteria decision-making problem in which several criteria must be evaluated before arriving at a final recommendation of recipients for the aid. Despite this, state-of-the-art methodologies make significant contributions; however, there are several flaws, including a lack of a standard procedure for selecting appropriate criteria, satisfaction with constraints, and ranking deserving donees according to their needs as suitable beneficiaries for the charity.

Zadeh [34] proposed fuzzy sets as an additional classical concept of set. The theory of fuzzy sets can be widely applied in domains where information is deficient or incomplete, such as in bio-informatics fuzzy set logics, the members in a set are permitted to have a moderate assessment of membership, which is explained by the membership function admired in the actual unit interim [0,1]. Molodtsov [24] introduced the soft set as a new mathematical tool for dealing with uncertainties that is free of the problems that have plagued traditional theoretical approaches to solving these problems. Molodtsov identified several potential applications for soft sets. Soft set theory research is currently advancing at a rapid pace. Maji [**?**] described how soft set theory was applied to a decision-making problem and investigated several operations based on soft set theory. Chen [9] compared and defined a new notion of soft set parametrization reduction. It is connected to the attribute reduction notion in rough set theory. Chen [10, 11] investigated the notion of a fuzzy set's similarity measure, which Molodtsov [24] found unsuccessful in trading with unpredictability in a parametric model. He identified strains and problems in mathematical representations and proposed a soft set theory to address the issues. Maji [**?**, 22] extended the soft set scheme to include fuzzy soft set theory and neutrosophic soft set theory. Feng [14] investigated decision-making fuzzy soft sets aided that. [28] AHP technique can also be used in airport evaluation problem by using fuzzy soft expert set. [32] proposes using fuzzy numbers in mobile selection in cities such as Lahore. TOPSIS MCDM technique can also be used for game prediction, and it is used in FIFA 2018 by Saeed [29]. Game prediction is a very extremely complex topic, and Saqlain predicted this game [31]. Abdel-Basset [1, 2, 3, 4] has written articles on medical disease diagnosis using a neutrosophic environment.

It's a big challenge for any organization to meet the proper criteria to distribute funds for the right deserving candidate. To address these concerns, a unique hybrid technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and Multi-Polar Interval-Valued Neutrosophic Soft Set is presented to order the list of deserving donees based on the poverty gap between them. Personal profile, income profile, marital status, school-going children, Disease, physical challenge, and households are categorized characteristics. These criteria are utilized to rate the charities that have been nominated. The following are the paper's main contributions.

- Multipolar Interval-Valued Neutrosophic Soft Set ranks the deserving donees according to their needs.
- Candidates are categorized according to their deservings for financial aid; more deserving candidates will get more funds.
- Using TOPSIS and domain expert methodologies, rank and validate the list of deserving candidates.
- One proposed method is dependent and other is independent for funds distribution is implemented as an algorithm in the application.

1.1. **Literature review.** NGOs and NPOs play an essential role in supporting deserving donees by building a contract between funders and community group members. According to existing literature, NGOs' selection of deserving donees directly relates to the donor's decisions on future financial allocations [15]. Covelli [12] has focused on all NPOs or not all NPOs to solve this dilemma. The focus of Ziemek [36] has been on identifying the factors that drove donors to donate. They claim that most people donate to charity altruistic benefit, personal benefit, or exchange value advantage [36]. Apart from those mentioned above, some work has been done in the NGO's decision-making on distributing resources, such as volunteers and other materials, to tackle various community problems [23]. However, most previous research has focused on the elements that may influence donors' donations to NGOs and NPOs. This study identifies distinctive approaches that directly influence donors' decisions to donate financially and focuses on whether charitable giving serves predominantly privileged groups in society. For example, according to research, humanitarian aid benefits poor populations less than wealthy groups [33]. Similarly, Paprocki and Bothwell [25] explored that the most profitable businesses in six industries found low levels of philanthropic aid to minority populations. Malik not focused on widows and diseased deservings' donees [21]. Ali focused on widow donee on his study [5]. After the COVID-19 pandemic, the Pakistan government immediately took action and launched a financial aid support program for deserving donees known as the "Ehsaas emergency cash" program through mobile payments, which was equally distributed among deserving donees [6]. In 1992 an Independent sector of Charitable Organizations performed a national survey and found that Approximately 11% of organizations claimed that their services and programmes were aimed at the poor or economically disadvantaged [17]. According to The International News report printed on January 09, 2020, many govt officers were found among ineligible Benazir Income Support Programme (BISP) beneficiaries [38]. The dawn news breaks the news that the Federal Investigation Agency has claimed to have unearthed corruption of over Rs 3.8 billion in the (BISP) launched by the government in 2008 to provide monetary assistance to the poor [39]. According to Transparency International-Pakistan report posted on November 17, 2020, massive flaws were found in BISP, and Arrest warrants were issued for the accused [40].

The above-mentioned state-of-the-art methodologies have contributed to NGOs' decision-making for charity giving and collection, but they still have several flaws. These include identifying significant criteria for excellent donee selection, a lack of a standard procedure for selecting suitable measures, taking into account the poverty gap to faithfully select beneficiaries for various types and amounts of aid, assigning consistent relative weighting of criteria as well as a ranking of worthy donees as eligible charity recipients, so it's a significant challenge to anyone to meet the proper standards for selection of deserving for financial aid and distribution of funds according to their needs. As a result, the study focuses on creating a model hybrid approach that concludes that most deserving and eligible donees get funds according to their deservings by using Multipolar Interval-Valued Neutrosophic Soft Set to rank the deserving donees. Two proposed methods are used for the distribution of funds.

1.2. **Structure of Paper.** In section 2, basic mathematical definitions related to the proposed study are revised. Section 3 deals with a case study problem corresponding to the desired situation. In the last section, the article's conclusion and future work are depicted.

2. Preliminaries

This section studies some basic definitions related to this article,

2.1. **Soft Set.** [**?**] Let universal set Z and the set of attributes of elements E be in Z. The subset X of E defined a function F as

$$F : X \to P(Z),$$

Then a pair (F, X) is stated as a soft set over Z i.e.,

$$(F, X) = \{[e, F(e)] : e \in X, F(e) \in P(Z)\}$$

2.2. **Interval-valued Neutrosophic Set.** [35] Let Z be a universal set. A neutrosophic set X can be defined as:

$$X = \{z, ({}^{I}T_X(z), {}^{I}I_X(z), {}^{I}F_X(z)) : z \in Z\},$$

where

$$\begin{gathered} {}^{I}T_X(z), {}^{I}I_X(x), {}^{I}F_X(z) \subseteq [0, 1] \\ 0 \leq sup\ {}^{I}T_X(z) + sup\ {}^{I}I_X(z) + sup\ {}^{I}F_X(z) \leq 3 \\ \text{for all } z \in Z \end{gathered}$$

2.3. **Interval-valued Multi-Polar Neutrosophic Set.** [30] An mIVN set on a universal set Z is a mapping

$$\begin{gathered} X = (({}^{I}T^1_X(z), {}^{I}T^2_X(z), \cdots, {}^{I}T^m_X(z)), ({}^{I}I^1_X(z), {}^{I}I^2_X(z), \cdots, {}^{I}I^m_X(z)), \\ ({}^{I}F^1_X(z), {}^{I}F^2_X(z), \cdots, {}^{I}F^m_X(z))) : Z \to ([0, 1]^m, [0, 1]^m, [0, 1]^m) \end{gathered}$$

Where the $i-th$ mapping is described as follows:

$$^{I}T_X^i : [0,1]^m \to [0,1]$$
$$^{I}I_X^i : [0,1]^m \to [0,1]$$
$$^{I}F_X^i : [0,1]^m \to [0,1]$$

and

$$0 \le sup\ ^{I}T_X(z) + sup\ ^{I}I_X(z) + sup\ ^{I}F_X(z) \le 3$$
for all $i = 1, 2, \cdots, m$ and $z \in Z$

2.4. **Interval-valued Neutrosophic Soft Sets.** [30] A Neutrosophic Soft set (ω, X) over a universal set Z is a mapping from X to $P(Z)$ and defined as

$$(\omega, X) = \Omega_X = \{(e, (z, ^{I}T_X(e)(z), ^{I}I_X(e)(z), ^{I}F_X(e)(z)) : z \in Z, e \in E)\}$$

where $P(Z)$ shows collection of all neutrosophic subsets of Z. Each of $^{I}T_X(e), ^{I}I_X(e)$ and $^{I}F_X(e)$ is a mapping from Z to interval $[0, 1]$ and

$$0 \le sup\ ^{I}T_X(z) + sup\ ^{I}I_X(z) + sup\ ^{I}F_X(z) \le 3$$
for all $e \in E$ and $z \in Z$

2.5. **Multi-Polar Interval-valued Neurotrophic Soft set.** [37] Let a universal set Z, set of attributes E and $X \subseteq E$.
Define $\omega : X \to m\text{IVN}^Z$ where $m\text{IVN}^Z$ is the assemblage of all mIVN subsets of set Z. Then mIVNS set (ω, X) over Z is defined as follows

$$\Omega_X = (\omega, X) = \{e, \omega_X(e) : e \in E, \omega_X(e) \in mN^Z\}$$

and $\omega_X(e)$ is an mIVN set denoted by,

$$\omega_X(e) = \{z, ^{I}T_x^i(e)(z, ^{I}I_x^i(e)(z), ^{I}F_x^i(e)(z) : z \in Z\}$$

where

$$^{I}T_x^i(e)(z) = [^{I}T_x^{i-}(e)(z), ^{I}T_x^{i+}(e)(z)]$$
$$^{I}I_x^i(e)(z) = [^{I}I_x^{i-}(e)(z), ^{I}I_x^{i+}(e)(z)]$$
$$^{I}F_x^i(e)(z) = [^{I}F_x^{i-}(e)(z), ^{I}F_x^{i+}(e)(z)]$$
$$0 \le sup\ ^{I}T_X(z) + sup\ ^{I}I_X(z) + sup\ ^{I}F_X(z) \le 3$$
for all $i = 1, 2, \cdots, m$; $e \in E$ and $z \in Z$

2.6. **Multi-Polar Interval-valued Neutrosophic Soft Subset.** [37] Let Z be a universal set, X and Y are subsets of a set of attributes E. A set Ω_X is an mIVNS subset of Ψ_Y denoted by $\Omega_X \breve{\subseteq} \Psi_Y$ if

(i) $X \subseteq Y$
(ii) $\omega_X(e) \subseteq \psi_Y(e)$ i.e.

$$^{I}T_X^i(e)(z) \subseteq {}^{I}T_Y^i(e)(z),\ ^{I}I_X^i(e)(z) \subseteq {}^{I}I_Y^i(e)(z) \text{ and } ^{I}F_X^i(e)(z) \supseteq {}^{I}F_Y^i(e)(z)$$
for all $i = 1, 2, \cdots, m$; $e \in X$ and $z \in Z$

Example 3.1 Let $Z = \{z_1, z_2\}$ be a universal set and $E = \{e_1, e_2, e_3, \}$ be a set of attributes.

$X = \{e_1, e_2\}, Y = \{e_1, e_2\} \subseteq E$. Let Ω_X and Ψ_Y be two $3-$NS set defined as:

$$\Omega_X = \{e_1, \{z_1, ([0.7, 0.8], [0.4, 0.5], [0.4, 0.5]), ([0.2.0, 3], [0.2.0.3], [0.3, 0.4]), ([0.2, 0.3], [0.4, 0.5], [0.2, 0.3]\}$$

$$\{z_2, ([0.2, 0.3], [0.4, 0.5], [0.3, 0.4]), ([0.2, 0.3], [0.2, 0.3), [0.3, 0.4]), ([0.2, 0.3], [0.4, 0.5], [0.3, 0.4])\}$$

$$e_2, \{z_1, ([0.3, 0.4], [0.4, 0.5], [0.5, 0.6]), ([0.4, 0.5], [0.4, 0.5], [0.2, 0.3]), ([0.6, 0.7], [0.4, 0.5], [0.2, 0.3])$$

$$(z_2, ([0.6, 0.7], [0.2, 0.3], [0.6, 0.7]), ([0.2, 0.3], [0.3, 0.4], [0.3, 0.4]), ([0.5, 0.6].[0.6, 0.7], [0.3, 0.4]))\}$$

$$\Omega_Y = \{e_1, \{z_1, ([0.6, 0.9], [0.3, 0.6], [0.3, 0.6]), ([0.3.0, 4], [0.3.0.4], [0.2, 0.5]), ([0.1, 0.4], [0.5, 0.6], [0.1, 0.4]\}$$

$$\{z_2, ([0.1, 0.4], [0.3, 0.6], [0.2, 0.5]), ([0.1, 0.4], [0.1, 0.4), [0.2, 0.5]), ([0.1, 0.4], [0.3, 0.2], [0.2, 0.5])\}$$

$$e_2, \{z_1, ([0.2, 0.5], [0.3, 0.6], [0.4, 0.7]), ([0.3, 0.6], [0.5, 0.6], [0.1, 0.4]), ([0.5, 0.8], [0.3, 0.6], [0.3, 0.4])$$

$$(z_2, ([0.5, 0.8], [0.1, 0.4], [0.5, 0.8]), ([0.1, 0.4], [0.2, 0.5], [0.2, 0.5]), ([0.6, 0.7].[0.5, 0.8], [0.2, 0.5]))\}$$

$$\text{this implies } \Omega_X \breve{\subseteq} \Psi_Y$$

2.7. **Distances.** Let $Z = \{z_1, z_2, ..., z_n\}$ be a universal set, $E = \{e_1, e_2, ..., e_q\}$ be a set of attributes and $X, Y \in E$. Let Ω_X, Ψ_Y are two mIVNS sets over Z with their mIVN approximate mapping

$$\omega_X(e_j) = \{({}^IT_X^i(e_j)(z_k), {}^II_X^i(e_j)(z_k), {}^IF_X^i(e_j)(z_k))\}$$
$$\psi_Y(e_j) = \{({}^IT_Y^i(e_j)(z_k), {}^II_Y^i(e_j)(z_k), {}^IF_Y^i(e_j)(z_k))\} \text{ for all } i = 1, 2, \cdots, m; j = 1, 2, \cdots, q \text{ and } k = 1, 2, \cdots, n$$

respectively, then the distance measure between Ω_X and Ψ_Y is defined as

(1) Hamming distance

$$d_H(\Omega_X, \Psi_Y) = \frac{1}{6mq}\{\sum_{i=1}^{m}\sum_{j=1}^{q}\sum_{k=1}^{n}({}^IT_X^{i-}(e_j)(z_k) - {}^IT_Y^{i-}(e_j)(z_k)|$$

$$+|{}^II_X^{i-}(e_j)(z_k) - {}^II_Y^{i-}(e_j)(z_k)| + |{}^IF_X^{i-}(e_j)(z_k) - {}^IF_Y^{i-}(e_j)(z_k)|)$$

$$+{}^IT_X^{i+}(e_j)(z_k) - {}^IT_Y^{i+}(e_j)(z_k)| + |{}^II_X^{i+}(e_j)(z_k) - {}^II_Y^{i+}(e_j)(z_k)| +$$

$$|{}^IF_X^{i+}(e_j)(z_k) - {}^IF_Y^{i+}(e_j)(z_k)|)\}$$

(2) Normalized Hamming distance

$$d_{NH}(\Omega_X, \Psi_Y) = \frac{1}{6mqn}\{\sum_{i=1}^{m}\sum_{j=1}^{q}\sum_{k=1}^{n}(|^{I}T_X^{i-}(e_j)(z_k) - {}^{I}T_Y^{i-}(e_j)(z_k)|$$

$$+|^{I}I_X^{i-}(e_j)(z_k) - {}^{I}I_Y^{i-}(e_j)(z_k)| + |^{I}F_X^{i-}(e_j)(z_k) - {}^{I}F_Y^{i-}(e_j)(z_k)|)$$

$$+(|^{I}T_X^{i+}(e_j)(z_k) - {}^{I}T_Y^{i+}(e_j)(z_k)| + |^{I}I_X^{i+}(e_j)(z_k) - {}^{I}I_Y^{i+}(e_j)(z_k)|$$

$$+|^{I}F_X^{i+}(e_j)(z_k) - {}^{I}F_Y^{i+}(e_j)(z_k)|)\}$$

(3) Euclidean distance

$$d_E(\Omega_X, \Psi_Y) = \{\frac{1}{6mq}\sum_{i=1}^{m}\sum_{j=1}^{q}\sum_{k=1}^{n}((^{I}T_X^{i-}(e_j)(z_k) - {}^{I}T_Y^{i-}(e_j)(z_k))^2$$

$$+(^{I}I_X^{i-}(e_j)(z_k) - {}^{I}I_Y^{i-}(e_j)(z_k))^2 + (^{I}F_X^{i-}(e_j)(z_k) - {}^{I}F_Y^{i-}(e_j)(z_k))^2)$$

$$+(^{I}T_X^{i+}(e_j)(z_k) - {}^{I}T_Y^{i+}(e_j)(z_k))^2 + (^{I}I_X^{i+}(e_j)(z_k) - {}^{I}I_Y^{i+}(e_j)(z_k))^2$$

$$+(^{I}F_X^{i+}(e_j)(z_k) - {}^{I}F_Y^{i+}(e_j)(z_k))^2)\}^{\frac{1}{2}}$$

(4) Normalized Euclidean distance

$$d_{NE}(\Omega_X, \Psi_Y) = \{\frac{1}{6mqn}\sum_{i=1}^{m}\sum_{j=1}^{q}\sum_{k=1}^{n}((^{I}T_X^{i-}(e_j)(z_k) - {}^{I}T_Y^{i-}(e_j)(z_k))^2$$

$$+(^{I}I_X^{i-}(e_j)(z_k) - {}^{I}I_Y^{i-}(e_j)(z_k))^2 + (^{I}F_X^{i-}(e_j)(z_k) - {}^{I}F_Y^{i-}(e_j)(z_k))^2)$$

$$+(^{I}T_X^{i+}(e_j)(z_k) - {}^{I}T_Y^{i+}(e_j)(z_k))^2 + (^{I}I_X^{i+}(e_j)(z_k) - {}^{I}I_Y^{i+}(e_j)(z_k))^2$$

$$+(^{I}F_X^{i+}(e_j)(z_k) - {}^{I}F_Y^{i+}(e_j)(z_k))^2)\}^{\frac{1}{2}}$$

3. Problem Formulation and Assumptions

The proposed algorithm can be utilized to distribute funding; here, we are giving one numerical example of a solution for such a funding problem in the light of mathematics. The algorithm can be used for any funding to the needy peoples of the nation. The needy can be elaborated in many categories like Widow, Disease, low income, educational expense, physical challenges, house rent, the dowry of daughters, etc. The said people are well deserving of funding. We applied similarity measures on the $mIVNS$ structure for such a type of solution to get insured and accurate results.

3.1. Problem of Distribution of Funds Among Deserving Donees: Multi-Polar Interval-Valued Neutrosophic Soft Set. The poverty gap in our society is different for different people due to a lack of fundamental requirements of existence. The selection of the most deserving candidate from many people may be swayed by single feature analysis of the less fortunate community members. There are many attributes in which people are a deserving of financial aid like widow, disease, low income, physical challenges, house rent, dowry, and many more. Consider the case of a candidate donee who is a widow and mother of three school-going kids. This Widow could be qualified for a charitable donation or not. For example, if the Widow is a government employee or owns a successful career, she is ineligible for support. However, if her profile differs from the one depicted above, she is a qualified donee. Also, consider the case of a candidate donee who is suffering from some disease and parent of school going kids. This candidate could be qualified for a charitable donation or not. For example, if the candidate is a government employee or owns a successful business, the candidate is ineligible for support. Suppose their profile differs from the one depicted above. In that case, however, they are a qualified donee, as shown in table 1, data of 30 applicants.

	$\breve{Marital Status}$	$\breve{Kids}$	$\breve{School Going Kids}$	$\breve{Disease}$	$\breve{Handicap}$	$\breve{Income}$	$\breve{Status}$
A_1	Widow	3	3	Mild	Nil	1200	Ineligible
A_2	Widow	3	2	Mild	Level1	850	eligible
A_3	Married	3	3	Nil	Nil	1800	Ineligible
…	...	...	...	...	...	...	...
A_{30}	Married	4	3	Life Threaten	Nil	300	eligible

Table 1: Selection of deserving candidate as a multi-criteria decision making problem

As a result, selecting deserving applicants becomes a multi-criteria decision-making process.

3.2. Deserving donee Identification and Ranking Framework. A unique deserving applicants identification and ranking framework are suggested to analyze and rank an extensive list of deserving applicants using several crucial qualities of the candidates, called criteria. The suggested framework is designed to accurately pick and rank deserving candidates according to their needs to assist the study's objectives and, as a result, donors' efforts to find suitable donees. Influential traits, known as criteria, are determined first using a survey strategy based on domain experts. Then, in the second stage, a survey is conducted to obtain genuine data for the requirements that have been specified.

[scale=0.2,transform shape] 1Criteria Selection; (p1.south)+(0.0,-1.5) 2Survey Based Data Collection; (p2.south)+(0.0,-1.0) 3Online Submission of Application; (p3.south)+(0.0,-1.5) 4Ranking Applicants According to Their Needs; (p4.south)+(0.0,-1.0) 5Apply Methodology; (p5.south)+(-3.0,-2.0) 6Method1: Dependent; (p5.south)+(3.0,-2.0) 7Method2: Independent; [below=of p5] (p6-7) ; (p6.south)+(0.0,-2.0) 8Distribution of Funds; (p7.south)+(0.0,-2.0) 9Distribution of Funds; [below=of p6-7] (p8-9) ; [line] (p1.south) – node [above] (p2); [line] (p3.south) – node [above] (p4); [line] (p4.south) – node [above] (p5); p2p2p3p3bk1 p4p4p5p5bk2 p6p6p7p7bk3 [line] (p5.south) – node [above] (bk3-n); [line] (bk3-s) – node [above] (p8); [line] (bk3-s) – node [above] (p9); (bk1-w)+(+6.0,0) node (ur1)[ur] ; (bk2-w)+(+6.0,0) node (ur2)[ur] ; bk1-wApplicants Dataur1; bk2-wEligible Candidatesur2;

3.3. Algorithm. Step 1: Construct a set of attributes of selection purpose as $E = \{e_1, e_2, \cdots, e_q\}$
Step 2: Construct an mIVNS set Ω_X as the requirements of a firm concluded by decision-making team.
Step 3: Construct t mIVNS sets Ψ_Y^h by the help of evaluation of different alternatives given by decision-making team, where $h = 1, 2, \cdots, t$
Step 4: Compute the distance between Ω_X and Ψ_Y^h by using the distance formula

$$d_E(\Omega_X, \Psi_Y) = \{\frac{1}{6mq}\sum_{i=1}^{m}\sum_{j=1}^{q}\sum_{k=1}^{n}((^{I}T_X^{i-}(e_j)(z_k) - {}^{I}T_Y^{i-}(e_j)(z_k))^2 + (^{I}I_X^{i-}(e_j)(z_k) - {}^{I}I_Y^{i-}(e_j)(z_k))^2 + (^{I}F_X^{i-}(e_j)(z_k) - {}^{I}F_Y^{i-}(e_j)(z_k))^2) + (^{I}T_X^{i+}(e_j)(z_k) - {}^{I}T_Y^{i+}(e_j)(z_k))^2 + (^{I}I_X^{i+}(e_j)(z_k) - {}^{I}I_Y^{i+}(e_j)(z_k))^2 + (^{I}F_X^{i+}(e_j)(z_k) - {}^{I}F_Y^{i+}(e_j)(z_k))^2)\}^{\frac{1}{2}} \quad (3.\ 1)$$

Step 5: Calculate the distance and analyze the result to find which alternative is more deserving for funding.

3.4. **Application of Algorithm.** A survey conducts of a group of people who wants to register themselves for financial aid.
Consider a universal set $Z = \{f_1 =$ NGOs, $f_2 =$ NPOs $\}$ and set of attributes for the selection purpose as E=$\{e_1 =$ Widow, $e_2 =$ Disease, $e_3 =$ Education, $e_4 =$ Income, $e_5 =$ Handicapped$\}$. Let $X = Y \subseteq E$, then we construct a $3-$IVMNS set Ω_X as requirements for funding. Furthermore, attributes are categorized into three intervals. For example, consider a candidate donee with widow status if she has three kids, then she is more deserving of financial aid than widow with two kids and widow with one kid. Parent of three school-going kids needs more financial aid to meet their children's educational expense; a person with a level 3 handicap means they are a serious kind of physically or mentally disabled. They are more deserving of financial aid; a person suffering from life-threatening diseases like cancer or brain tumors needs more financial assistance to meet their medical expenses than high-risk diseases of mild diseases. If the candidate has an average income, they are less deserving than those with no income or less income.

W_X	F
w_1	Widow with one child
w_2	Widow with two children
w_3	Widow with three children

Table 2: Ranking of widows

Edu_X	F
edu_1	School going one child
edu_2	School going two children
edu_3	School going three children

Table 3: Ranking of school going children's parents donees

I_X	F
i_1	Average income
i_2	Low income
i_3	No income

Table 4: Ranking of below than 1000 income donees

H_X	F
h_1	Level 1-Handicapped
h_2	Level 2-Handicapped
h_3	Level 3-Handicapped

Table 5: Ranking of handicapped donees

D_X	F
d_1	Mild Disease
d_2	High Risk Disease
d_3	Life threatened Disease

Table 6: Ranking of diseased donees

If an applicant income greater then 1000 he/she found ineligible for financial aid.

$$\delta_i = \begin{cases} 1, \text{ when I} \leq 1000, \\ 0, \text{ when I} > 1000. \end{cases}$$

Priorities Intervals: According to the wish of donors, priories intervals will be selected; for example, a donor wants to distribute more funds to widow, then a large interval will be set. $[0, 0.2], [0, 0.4], [0, 0.6], [0, 0.8], [0, 1]$

Priorities of donor: This is a customized method for individuals wish who want to charity among deservings for financial aid, but he wants to distribute more funds to widows than disease, handicap, education, and limited income.

Ω_X	f_i
$Widow$	0.400
$Disease$	0.200
$Education$	0.100
$Income$	0.100
$Handicapped$	0.200

Table 7: Customized wish of donor

We have four applicants who were found eligible for financial aid. There details are as below.

(1) Applicant-1 Miss Julie said her husband died in an accident in 2019. She has two kids, getting school education in two different classes. She further explained that she has a low income and suffers from level 1 disability and mild Disease.
(2) Applicant-2 Miss Vanila said she has a very low income, and her husband died due to corona in 2021. One child is school-going. She is level 1 handicapped.
(3) Applicant-3 Miss Sophia is a widow and has two school-going children; one is at the primary level, and the other one is at the elementary level and suffering from high-risk disease and level 2 handicapped. She has no source of income.
(4) Applicant-4 Mr. John is a life-threatening Disease and meager income. He has three schools going, children. The Elder one is in high school. Mr. John has not any kind of disability

Ω_X	$Widow$	$Disease$	$Education$	$Income$	$Handicapped$
A_1	0.666	0.266	0.166	0.166	0.266
A_2	0.533	0.200	0.133	0.166	0.266
A_3	0.666	0.333	0.166	0.200	0.200
A_4	0.400	0.200	0.200	0.166	0.200

Table 8: Ranking of applicants according to their needs

$$A_i = \sqrt{(w_o - w_i)^2 + (d_o - d_i)^2 + (e_o - e_i)^2 + (i_o - i_i)^2 + (h_o - h_i)^2} \times \delta_i$$

$$A_1 = \sqrt{(0.400 - 0.666)^2 + (0.200 - 0.266)^2 + (0.100 - 0.166)^2 + (0.100 - 0.166)^2 + (0.200 - 0.266)^2} \times 1$$

$$A_1 = 0.297 \tag{3. 2}$$

similarly,

$$A_2 = 0.165 \tag{3. 3}$$

$$A_3 = 0.320 \tag{3. 4}$$

$$A_4 = 0.119 \tag{3. 5}$$

Method:1 In this method, each donee depends on other donee scores and number of donees because we have fixed financial aid which we have to distributes among applicants according to their needs. As in above cases applicant 4 is more deserving and his score is high as compared to others so he will get more financial aid, by using above Eqs (3.2), (3.3), (3.4) and (3.5) we have,

$$A = 0.297 + 0.165 + 0.320 + 0.119$$
$$= 0.901$$

$$A_1 = \frac{A_1}{A} \times 1000 = \frac{0.297}{0.901} \times 1000 = 329.63.$$

similarly,

$$A_2 = 183.13,\ A_3 = 355.16,\ A_4 = 132.07.$$

The above results show that applicant 1 will get the financial aid of amount 329.63, applicant 2 will get amount 183.13, applicant three will get amount 355.16 and applicant four will get financial aid of amount 132.07 We distributed amount of 1000 to four applicants according to their problems and needs.

Method:2 This method is independent of each other donee scores and number of donees because we do not have any limitations of financial assistance which we have to distribute aid among applicants according to their needs by using above Eqs (3.2), (3.3), (3.4) and (3.5) we have,

$$A_1 = 0.297 \times 1000 = 297.$$

similarly,

$$A_2 = 165, A_3 = 320, A_4 = 119.$$

The above results show that applicant 1 will get the financial aid of amount 297, applicant 2 will get amount 165, applicant 3 will get amount 320, and applicant 4 will get financial assistance of amount 219. Therefore, we distributed an amount of 901 to four applicants according to their problems and needs.

4. Conclusion and Future Work

The study looked at how wealthy individuals and charity organizations, such as NGOs and NPOs, choose and rank beneficiaries according to their needs for philanthropic donations. A new deserving donees identification and ranking framework are created, with five significant attributes are chosen. The Multipolar Interval-Valued Neutrosophic Soft Set approach is applied. We have used distance-based similarity measures in decision-making for the distribution of funds by two methods to the deserving applicants according to their needs. Moreover, we defined some basic operations and their properties on mIVN soft sets. The research can help charitable organizations improve their effectiveness in distributing aid to the most deserving recipients.

One can broaden the study in the terms of selection criteria in the future and identify correlations among the criteria that have been established.

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