International Journal of Advance and Applied Research
www.ijaar.co.in
ISSN – 2347-7075 Impact Factor – 7.328
Peer Reviewed Bi-Monthly
Vol.10 No.1 September – October 2022

THE USE OF FUZZY SOFT MULTI SETS IN THE ANALYSIS OF PROBLEMS INVOLVING DECISION-MAKING

Ms. Shraddha Ashok Malviya[1] & Dr. Vineeta Basotia[2]

[1]Ph.D. Research Scholar, Department of Mathematics, Shri JJTU, Rajasthan, India

[2]Professor & Research Guide, Department of Mathematics, Shri JJTU, Rajasthan, India

Corresponding Author -Ms. Shraddha Ashok Malviya

DOI - 10.5281/zenodo.7890153

Abstract:

Using the Roy-Maji Algorithm, which has a few restrictions, Alkhazaleh and Salleh provided a fuzzy soft multi set theoretic method to solving decision-making issues. We have suggested a method to address fuzzy soft multi set based decision making issues utilisingFeng's algorithm, which is more stable and more practicable than the Alkhazaleh–Salleh Algorithm. This study effort was carried out by us. An example using numerical data demonstrates that the approach that we have presented is viable for use in real-world settings.

Keywords: *Decision making, Soft set, Level soft set, Fuzzy soft set, Fuzzy soft multi set, Fuzzy soft multi set part*

Introduction:

Molodstov [12] introduced the idea of soft set theory in 1999 as a generic mathematical tool for dealing with fuzziness, uncertainty, and things that aren't precisely specified. The research that is being done on the soft set theory is making significant progress. New algebraic operations and findings on the subject of soft set theory are defined in [2, 10]. By combining fuzzy sets [15] and soft sets [12], Maji et al. [9] were able to develop fuzzy soft sets and study the fundamental features of these sets. Alkhazaleh and others [1, 4–6, 14] presented the concept of a soft multi set as an extension of the idea of a soft set. The fundamental algebraic and topological features of this new kind of set were investigated. The idea of fuzzy soft multi set theory was first proposed by Alkhazaleh and Salleh [3], who also demonstrated its application in decision making using the Roy-Maji Algorithm [13]. Maji et al. [11] first suggested the use of soft sets for the purpose of resolving difficulties associated with decision making. Subsequently, in 2007, they also provided an application on fuzzy soft sets-based decision making problems in [13]. In their study, Kong et al. [8] highlighted that the Roy-Maji method [13] included errors, and they presented a new approach as a solution. The validity of the Roy-

Majialgorithm [13] was investigated by Feng et al. [7], and they indicated that the Roy-Maji Algorithm [13] has certain restrictions. In addition, they developed an adaptable strategy for dealing with decision making issues based on fuzzy soft sets by using thresholds and choice values. In point of fact, each of these ideas may be effectively used to the resolution of a number of issues that arise in everyday life. However, it is clear that each of these models has its own set of challenges, which is why, in this article, we are going to propose an algorithm for fuzzy soft multi set based decision making problems using Feng's algorithm, which is yet another new mathematical tool for the solution of some real-world applications of decision making issues. An example using numerical data demonstrates that the approach that we have presented is viable for use in real-world settings.

Literature Review:

In their study from 2020, Ali, Adeli, and Mehdi. Neshat employed the fuzzy expert system to the detection of cardiac disease. The authors P.B. Khannale and R.P. Ambilwade (2018) described a fuzzy inference system as a means of determining whether or not a patient has hypothyroidism. Fuzzy Logic Controllers may benefit greatly from defuzzification as one of its components. Patients were classified according to relational fuzzy signs or illness matrices in Pereira JCR, Tonelli PA, Barros LC, and Ortega NRS's (2002) study, which was presented in 2002.

A fuzzy expert system that was web-based and was suggested by Mir Anamul Hasan et al., (2020), for the diagnosis of human illnesses. The majority of the work is focused on doing extensive research and developing a web-based clinical tool with the goal of improving the speed and quality of the interchange of health-related information between patients and experts working in the field of human health care. Practitioners and experts working in the field of human health may utilise this web-based model to validate a variety of diagnoses.

An expert system technique for early warning GIS prototype tool was suggested by Gavin Fleming et al. (2019). The tool's purpose was to detect favourable preconditions that might lead to outbreaks of cholera. The possibility of endemic cholera reservoirs being present is a presumption made by this model. A literature review article on the management and diagnosis of hyperglycemic hyperosmolar condition and diabetic ketoacidosis was recently published by Jean Louis Chiasson and colleagues (2019). The hyperglycemic hyperosmolar condition and diabetic ketoacidosis are the most serious disorders associated with diabetes decompensation, and they are related with an increased risk of death. Insulin insufficiency is the primary underlying issue that has to be addressed. A lack of insulin may cause a surge in hepatic glucose synthesis and a reduction in glucose absorption, both of which can lead to hyperglycemia if the levels of hormones that act as counter regulators are raised. Additionally, it has the potential to increase ketogenesis and lipolysis, both of which may ultimately result in ketoacidosis. These two conditions, hyperketonemia and hyperglycemia, will both cause osmotic diuresis, which will ultimately lead to dehydration. The majority of clinical evaluation or diagnosis is predicated on the discovery of dehydration together with increased levels of capillary glucose in the urine or plasma, with or without ketones.

Preliminary Notes:

In this current piece, we will review some fundamental concepts about soft sets, fuzzy soft multi sets, and level soft sets in a concise manner.

Definition 2.1 [12] Suppose that, U be an initial universe and $\hat{E}$ be a set of parameters. Also, let $\tilde{P}(U)$ denotes the power set of the universe U and $\hat{A} \subseteq \hat{E}$. A pair $(\tilde{F}, \hat{A})$ is said to be a soft set over the universe U, where $\tilde{F}$ is a mapping given by $\tilde{F} : \hat{A} \rightarrow \tilde{P}(U)$.

Definition 2.2 [3] Suppose $\{U_i : i \in \Lambda\}$ be a set of universes, such that $\cap_{i\in\Lambda} U_i = \phi$ and let for each $i \in \Lambda$, E_i be a sets of decision parameters. Also, let $\tilde{U} = \prod_{i\in\Lambda} FS(U_i)$ where $FS(U_i)$ is the set of all fuzzy subsets of U_i, $\hat{E} = \prod_{i\in\Lambda} E_{U_i}$ and $\hat{A} \subseteq \hat{E}$. A pair $(\tilde{F}, \hat{A})$ is said to be a fuzzy soft multi set over the universe $\tilde{U}$, where $\tilde{F}$ is a function given by $\tilde{F} : \hat{A} \rightarrow \tilde{U}$.

Definition 2.3 [3] For any fuzzy soft multi set $(\tilde{F}, \hat{A})$, where $\hat{A} \subseteq \hat{E}$ and $\hat{E}$ is a set of parameters. A pair $\left(e_{U_i,j}, \tilde{F}_{e_{U_i,j}}\right)$ is said to be a U_i—fuzzy soft multi set part of $(\tilde{F}, \hat{A})$ over U, $\forall e_{U_i,j} \in a_k$ and $\tilde{F}_{e_{U_i,j}} \subseteq \tilde{F}(\hat{A})$ is an approximate value set, for $a_k \in \hat{A}$, $k \in \{1, 2, 3, .., m\}$, $i \in \{1, 2, 3, .., n\}$ and $j \in \{1, 2, 3, .., r\}$.

Definition 2.4 [7] Let $\varpi = (\tilde{F}, \hat{A})$ is a fuzzy soft set over the universe U, where $\hat{A} \subseteq \hat{E}$ and $\hat{E}$ is a set of parameters. For $t \in [0, 1]$, the t-level soft set of ϖ is a crisp soft set $L(\varpi; t) = (\tilde{F}_t, \hat{A})$ defined by $\tilde{F}_t(e) = \left\{u \in U : \mu_{\tilde{F}(e)}(u) \geq t\right\}$, $\forall e \in \hat{A}$.

Definition 2.5 [7] Suppose $\varpi = (\tilde{F}, \hat{A})$ be a fuzzy soft set over U, where $\hat{A} \subseteq \hat{E}$ and $\hat{E}$ is the parameter set. Let $\lambda : \hat{A} \rightarrow [0,1]$ be a fuzzy set in $\hat{A}$, which is called a threshold fuzzy set. The level soft set of the fuzzy soft set ϖ with respect to the fuzzy set λ is a crisp soft set $L(\varpi; \lambda) = (\tilde{F}_\lambda, \hat{A})$ defined by $\tilde{F}_\lambda(e) = \left\{ u \in U : \mu_{\tilde{F}(e)}(u) \geq \lambda(e) \right\}$, $\forall e \in A$.

Definition 2.6 [7] Let $\varpi = (\tilde{F}, \hat{A})$ is a fuzzy soft set over a finite universe U, where $\hat{A} \subseteq \hat{E}$ and $\hat{E}$ is the set of parameters. The mid-threshold of the fuzzy soft set ϖ define a fuzzy set $mid_\varpi : \hat{A} \rightarrow [0,1]$ by $\forall e \in \hat{A}$, $mid_\varpi(e) = \frac{1}{|U|} \sum_{u \in U} \mu_{\tilde{F}(e)}(u)$ and the level soft set of ϖ with respect to the mid-threshold fuzzy set mid_ϖ, namely $L(\varpi; mid_\varpi)$ is said to be mid-level soft set of ϖ.

Definition 2.7 [7] Let $\varpi = (\tilde{F}, \hat{A})$ be a fuzzy soft set over a finite universe U, where $\hat{A} \subseteq \hat{E}$ and $\hat{E}$ is the parameter set. The max-threshold of the fuzzy soft set ϖ define a fuzzy set $\max_\varpi : \hat{A} \rightarrow [0,1]$ by $\forall e \in \hat{A}$, $\max_\varpi(e) = \max_{u \in U} \mu_{\tilde{F}(e)}(u)$ and the level soft set of ϖ with respect to the max-threshold fuzzy set $\max_\varpi$, namely $L(\varpi; \max_\varpi)$ is said to be top-level soft set of ϖ.

Application Of Fuzzy Soft Multi Sets In Decision-Making Problems:

In this part, we will present an algorithm (Algorithm 2) for fuzzy soft multi sets based decision making issues. This algorithm will use Feng's Algorithm [7], which was mentioned in the previous section. In the following, we are going to demonstrate our method, which is called Algorithm 2:

Algorithm 2

(1) Input the (resultant) fuzzy soft multi set $(\tilde{F}, \hat{A})$

(2) Apply the Algorithm 1 (Feng's Algorithm) to the first fuzzy soft multi set part in $(\tilde{F}, \hat{A})$, to obtain the decision S_{k_1}.

(3) Modify the fuzzy soft multi set $(\tilde{F}, \hat{A})$, by taking all values in each row, where the choice value of S_{k_1} is maximum and changing the values in the other rows by 0 (zero), to get $(\tilde{F}, \hat{A})_1$.

(4) Apply the Algorithm 1 (Feng's Algorithm) to the second fuzzy soft multi set part in $(\tilde{F}, \hat{A})_1$, to obtain the decision S_{k_2}

(5) Modify the fuzzy soft multi set $(\tilde{F}, \hat{A})_1$, by taking the first two parts fixed and apply the method as in step (3) to the next part, to get $(\tilde{F}, \hat{A})_2$

(6) Apply the Algorithm 1 (Feng's Algorithm) to the third fuzzy soft multi set part in $(\tilde{F}, \hat{A})_2$, to obtain the decision S_{k_3}.

(7) Finally, we have the optimal decision for decision maker is $(S_{k_1}, S_{k_2}, S_{k_3})$.

Application In Decision-Making Problems:

Let us consider three universes $U_1 = \{h_1, h_2, h_3, h_4\}$, $U_2 = \{c_1, c_2, c_3\}$ and $U_2 = \{v_1, v_2, v_3\}$ are sets of houses, cars and hotels respectively and let $E_{U_1} = \{e_{U_1,1}, e_{U_1,2}, e_{U_1,3}\}$, $E_{U_2} = \{e_{U_2,1}, e_{U_2,2}, e_{U_2,3}\}$, $E_{U_3} = \{e_{U_3,1}, e_{U_3,2}, e_{U_3,3}\}$ be the sets of respective decision parameters related to the above three universes.

Let $\tilde{U} = \prod_{i=1}^{3} FS(U_i)$, $\tilde{E} = \prod_{i=1}^{3} E_{U_i}$ and $\hat{A} \subseteq \hat{E}$, such that

$$\hat{A} = \{a_1 = (e_{U_1,1}, e_{U_2,1}, e_{U_3,1}), a_2 = (e_{U_1,1}, e_{U_2,2}, e_{U_3,1}), a_3 = (e_{U_1,2}, e_{U_2,3}, e_{U_3,1}), a_4 = (e_{U_1,3}, e_{U_2,3}, e_{U_3,1}),$$
$$a_5 = (e_{U_1,1}, e_{U_2,1}, e_{U_3,2}), a_6 = (e_{U_1,1}, e_{U_2,2}, e_{U_3,2}), a_7 = (e_{U_1,2}, e_{U_2,3}, e_{U_3,3}), a_8 = (e_{U_1,3}, e_{U_2,3}, e_{U_3,3})\}.$$

Assume that Mr. X is interested in purchasing a home, leasing a vehicle, and staying in a hotel with regard to the three different sets of choice factors described in the previous paragraph. Imagine that the generated fuzzy soft multi set is "F; A" and that this table contains it.

As can be seen from the above image, our technique, which we will refer to as Algorithm 2, is too straightforward and requires less calculations than the Alkhazaleh–Salleh Algorithm [3]. Because, in place of computing comparison tables and calculating scores as in the Alkhazaleh–Salleh Algorithm [3,] we need to consider only the choice values of objects form the level soft sets of fuzzy soft multi set parts in the fuzzy soft multi set. This is because the Alkhazaleh–SallehAlgorithm [3] requires us to do those things.

Also, our method, which we will refer to as Algorithm 2, is an adjustable algorithm. This is due to the fact that the level soft set (decision rule) that decision makers employ may be altered. For instance, if we take the top-level decision criterion in the second step of our algorithm (Algorithm 2), then we have the choice value of each object in the top-level soft set of fuzzy soft multi set parts in the fuzzy soft multi set. On the other hand, if we take another decision rule such as the mid-level decision criterion, then we have choice values from the mid-level soft set of fuzzy soft multi set parts in the fuzzy soft multi set.

Tables and Figures:

Table 1 The tabular representation of the fuzzy soft multi-set ðF~; A^Þ

U_i		a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8
U_1	h_1	0.3	0.8	1	0.8	0.4	0.9	1	0.8
	h_2	0.4	0.9	0.8	0.6	0.6	0.6	0.9	0.7
	h_3	0.9	0.3	0.7	0.1	0.8	0.7	0.8	1
	h_4	0.7	0.8	0	0.5	0.7	0.5	0.4	0.9
U_2	c_1	0.8	0.8	0.8	0.5	1	0.8	0.8	0.8
	c_2	0.6	0.8	0.6	0.3	0.9	0.8	0.8	0.8
	c_3	0.6	0.5	0.3	0.1	0.9	0.5	0.5	0.5
U_3	v_1	0.9	0.7	0.5	0.5	0.8	0.8	0.5	0.8
	v_2	0.7	0.6	0.5	0.3	0.5	0.8	0.6	0.9
	v_3	0.9	0.5	0.7	0.4	0.4	1	0.8	0.9

Conclusion:

Alkhazaleh and Salleh [3] presented an application of fuzzy soft multi set based decision-making problems using Roy-Maji Algorithm [13], so Alkhazaleh–Salleh Algorithm [3] is not sufficient to solve fuzzy soft multi set based decision making problems. In [8], Kong et al. mentioned that the Roy-Maji Algorithm [13] was incorrect. Feng et al. [7] mentioned that the Roy-Maji Using Feng's method [7], which is more stable and more practicable than the Alkhazaleh–Salleh Algorithm [3] for addressing decision-making issues based on fuzzy soft multi sets, we have suggested an algorithm for fuzzy soft multi set based decision making problems in this research.

Acknowledgement:

We would want to extend our gratitude to those of them who contributed valuable insights and areas of expertise to the research.

References:

[1]. Alhazaymeh, K., Hassan, N.: Vague soft multiset theory. Int. J. Pure Appl. Math. 93, 511–523 (2014)

[2]. Ali, M.I., Feng, F., Liu, X., Min, W.K., Shabir, M.: On some new operations in soft set theory. Comput. Math Appl. 57, 1547–1553 (2009)

[3]. Alkhazaleh, S., Salleh, A.R.: Fuzzy soft multi sets theory. abstract and applied analysis, vol. 2012, Article ID 350603, 20 p,

HindawiPublishing Corporation (2012). doi:10.1155/2012/ 350603

[4]. Alkhazaleh, S., Salleh, A.R., Hassan, N.: Soft multi sets theory. Appl. Math. Sci. 5, 3561– 3573 (2011)

[5]. Babitha, K.V., John, S.J.: On soft multi sets. Ann. Fuzzy Math. Inf. 5, 35–44 (2013)

[6]. Balami, H.M., Ibrahim, A.M.: Soft multiset and its application in information system. Int. J. Scientific Res. Manag. 1, 471–482 (2013)

[7]. Feng, F., Jun, Y.B., Liu, X., Li, L.: An adjustable approach to fuzzy soft set based decision making. J. Comput. Appl. Math. 234, 10–20 (2010)

[8]. Kong, Z., Gao, L.Q., Wang, L.F.: Comment on A fuzzy soft set theoretic approach to decision making problems. J. Comput. Appl. Math. 223, 540–542 (2009)

[9]. Maji, P.K., Biswas, R., Roy, A.R.: Fuzzy soft sets. J. Fuzzy Math. 9, 589–602 (2001)

[10]. Maji, P.K., Biswas, R., Roy, A.R.: Soft set theory. Comput. Math Appl. 45, 555–562 (2003)

[11]. Maji, P.K., Roy, A.R., Biswas, R.: An application of soft sets in a decision making problem. Comput. Math Appl. 44, 1077–1083 (2002)

[12]. Molodtsov, D.: Soft set theory-first results. Comput. Math Appl. 37, 19–31 (1999)

[13]. Roy, A.R., Maji, P.K.: A fuzzy soft set theoretic approach to decision making problems. J. Comput. Appl. Math. 203, 412–418 (2007)

[14]. Tokat, D., Osmanoglu, I.: Soft multi set and soft multi topology. Nevsehir Universitesi Fen Bilimleri Enstitusu Dergisi Cilt. 2 (2011) 109–118

[15]. Zadeh, L.A.: Fuzzy sets. Inf. Control 8, 338–353 (1965)