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Doubly Soft Set Model with Single Fuzzy Parameter at Second Level of Hierarchy for Making Decisions

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Abstract— We come across the challenge of uncertainty in making decisions in various real life problems. The intelligence, analytical ability, reasoning and available information is used by us to make these decisions. The imprecise nature of the available information is the main source of uncertainty which makes our task more challenging for making decisions. The available mathematical tools like fuzzy sets, rough sets, vague sets and soft sets etc. which are in use have their own limitations with regard to different types of uncertainty. Thus depending on the kinds of uncertainty involved in a decision problem, it is necessary to explore hybrid approaches to address these issues of uncertainty in making decisions in a real environment. In this paper a doubly soft set with a single fuzzy parameter at the second level of hierarchy is proposed to address the combination of two kinds of uncertainty in a decision problem. The doubly soft set takes care of the relationship of elements of the set with the two levels of parameters involved and fuzzy set takes care of relationships among the elements of the parameters at the second level of hierarchy. The proposed model is illustrated with the help of an example of a decision problem

Keywords—Fuzzy set, Soft set, Multisoftset, Decision making

I. Introduction

In our everyday life we have to deal problems which require decision making. For example buying items, career planning, choosing a movie, selecting place to visit, making friends etc. The various parameters and constraints depending on our society, culture, mindset, economic condition, etc. influence our decisions. The uncertainty is a major challenge in decision making which may arise due to imprecise or incomplete or contradictory information etc. Various research workers[1-5] have proposed mathematical tools like probability, fuzzy sets, rough sets, vague sets and soft sets , each having capability to deal with different kinds of uncertainty. However in problems with multiple kinds of uncertainty, a single tool is not sufficient to address the issues of uncertainty. Thus combinations of multiple tools are explored and employed to deal with multiple kinds of uncertainty involved in the problem of decision making. The various research workers have made attempts [6-9] to modify the existing tools and propose new mathematical tools to deal with the uncertainty.

Here a combination of multi soft set and fuzzy set is explored to propose a doubly soft set with single fuzzy parameter at second level of hierarchy to deal with the uncertainty in decision making. A suitable case has been used to demonstrate the proposed approach

II. Preliminaries

The mathematical tools like fuzzy set and soft set employed in the present study are defined in this section

Fuzzy Set:

The fuzzy set introduced by Zadeh in 1965 to deal with the uncertainty arising due to the degree of relationship among elements of a set is defined below [1]

Let X is a universal set. A fuzzy set 'S' over X is defined as a membership function $\mu(a)$ represented by the mapping $\mu(a)$: $X \rightarrow [0,1]$, here $\mu(a)$ is a membership function of a for each

A Ɛ X. Thus, fuzzy set 'S ' over X is represented as

$S = \{(a, \mu(a))| a \in X, \mu(a) \in [0,1]\}$.

Soft Set:

Let X, P(X) and E denote a universal set, power set of X, and set of all parameters respectively. Let $A \subset E$ Then, a soft set (F, A) over X is a set defined by a function F(A) representing a mapping

F_A: $A \rightarrow P(X)$ Such that [4]

$F_A(y) = \{(y, e) \mid y \in X, e \in A\}$

Here, the value $F_A(y)$ is a set called y-element of the soft set for all $y \subset X$ [4] .It is a parameterized family of subsets of X.

Two level Multi Soft Set:
Let (F,A) is a soft set and the parameters in A depend on another set of parameters α Є K. Let (A, K) forms another soft set given by
G_K (z) = {(z, α) | z ЄA, α Є K}
Then (F,A,K) forms a two level multi soft set also termed as doubly soft set and is given by

$F_{A,K}$(y) = {((y, e), α) | y Є X, e Є A and α Є K }.

Doubly Soft Set with Single Fuzzy Parameter at Second Level of Hierarchy:
Let $F_{A,K}$(y) be a doubly soft set , parameter α is fuzzy and fuzzy membership of α is given by μ(α) Є [0,1]. Then doubly soft set with single fuzzy parameter at second level of hierarchy denoted by $L_{A,K}$(y) is given by

$L_{A,K}$(y) = {((y, e), α, μ(α)) | y ЄX, e ЄA , α ЄK and μ(α) Є [0,1] }

III. DOUBLY SOFTSET APPROACH FOR DECISION MAKING

In this section the doubly soft set approach for decision making is shown with the help of following example [6]
Let A = {A1, A2, A3, A4, A5, A6, A7, A8, A9, A10} be a set of ten houses. Let X = {economical, beautiful, good location, furnished, green surroundings} be a set of parameters. Construct a soft set (F, X) which describes a good house.

Let X = { a1, a2, a3, a4, a5 }
Where: a1= economical, a2 = luxurious, a3 = ideal location, a4 = furnished, a5 = green surrounding
Here the parameter ideal location will depend upon the new set of parameters denoted by
a3 = { a31, a32, a33}
Where a31 = near the market, a32 = near railway station, a33 = near the office.
Thus the parameter a3 = ideal location will form a soft set (f, a3)

Let F(a1) = economical houses = { A1, A2, A3, A4, A5, A6, A7, A9 }, F(a2) = beautiful houses = {A1, A2, A3, A4, A5, A6, A7 , A10},
F(a4) = furnished house = {A2, A3, A6, A7, A8, A9 }
and F(a5) = green surrounding houses = {A1, A2, A3, A4, A6 A7, A9, A10}

Let us assume that following houses have location.
f(a31) = near the market = {A1, A2, A3, A4, A6, A7, A9},
f(a32) = near railway station = {A1, A2, A3, A5, A6, A7 , A10 } and
f(a33) = near the office ={A1,A2, A3, A4, A5,A7, A8, A10 }

Let us construct a tabular representation of soft set named location. Here if Ai ∊ f(a3) then Aij = 1 else Aij = 0

Table 1 : Soft set based scores for location of house

A	a31	a32	a33	Score(a3)
A1	1	1	1	3/3=1
A2	1	1	1	3/3=1
A3	1	1	1	3/3=1
A4	1	0	1	2/3
A5	0	1	1	2/3
A6	1	0	0	1/3
A7	1	1	1	3/3=1
A8	0	0	1	1/3
A9	1	0	0	1/3
A10	0	1	1	2/3

Adding entries in each row and dividing the sum by number of entries in that row gives the score for a location of the house.
The soft set(F,X) in a tabular form for a good house is given by

Table 2: Soft set based scores for a good house

A/X	a1	a2	a3	a4	a5	score
A1	1	1	1	0	1	4/5
A2	1	1	1	1	1	5/5=1
A3	1	1	1	1	1	5/5=1
A4	1	1	2/3	0	1	11/15
A5	1	1	2/3	0	0	8/15
A6	1	0	1/3	1	1	10/15=2/3
A7	1	1	1	1	1	5/5=1
A8	0	0	1/3	0	0	1/15
A9	1	0	1/3	1	1	10/15=2/3
A10	0	1	2/3	0	1	8/15

Here soft set based score of a3 is taken from Table 1. Adding the entries of each row and dividing the sum by the number of entries in that row gives the score for a good house.
In Table 2, the houses A2, A3 and A7 have the highest scores and thus are the best houses.
The two soft sets i.e. a good house and good location are combined to form a two level soft set Here the soft set for good location is evaluated first to input the value to soft set for good house.

IV. Doubly Soft Set with Single Fuzzy Parameter at Second Level for Decision Making

Let the distances of market, railway station and office from the house are given as shown in Table 3

Table 3: Distance of market, railway station and office from the house

A	Distance (in km) from house		
	a31: market	a32: railway station	a33: office
A1	1.0	2.0	3.0
A2	0.5	1.5	2.5
A3	0.75	1.75	3.25
A4	0.6	0.75	1.25
A5	0.8	0.5	0.9
A6	0.9	2.0	2.5
A7	1.0	1.0	1.25
A8	0.5	2.0	1.0
A9	1.5	1.0	2.0
A10	1.80	1.20	0.5

Here in Table 3 the minimum distance of the house from the facility/destination is 0.5 km and maximum distance of the house from the facility/destination is 3.25 km.
We construct a function NEAR as a fuzzy function assuming the membership of distance = 0.5 km from house as 1 and membership of distance ≥ 5 km from house as 0. Thus the membership function for nearness of house from the facility/destination is given by

NEAR: $\mu(x) = (5- x)/4.5$ for $0.5 \le x \le 5$

and $\mu(x) = 0$ for $x \ge 5$

Thus fuzzy memberships for nearness of house from the market, railway station and office is obtained using above membership function $\mu(x)$ and is given in Table 4

Table 4: Membership values for nearness of house to the facility/destination

A	Membership μ(x) of Distance from the house			Score for a3
	a31: market	a32: railway station	a33: office	
A1	0.89	0.67	0.44	2/3=0.67
A2	1.0	0.78	0.56	2.34/3= 0.78
A3	0.94	0.72	0.39	2.05/3=0.68
A4	0.98	0.94	0.83	2.75/3=0.92
A5	0.93	1.0	0.91	2.84/3=0.95
A6	0.91	0.67	0.56	2.14/3=0.71
A7	0.89	0.89	0.83	2.61/3=0.87
A8	1.0	0.67	0.89	2.56/3=0.85
A9	0.78	0.89	0.67	2.34/3= 0.78
A10	0.71	0.84	1.0	2.55/3= 0.85

Now we can obtain doubly soft set with parameter NEAR as fuzzy at second level of hierarchy Good location and the same is shown in Table 5.

Table 5: Doubly soft set with fuzzy parameter at second level of hierarchy

A	a1	a2	a3	a4	a5	score
A1	1	1	0.67	0	1	3.67/5= 0.734
A2	1	1	0.78	1	1	4.78/5=0.956
A3	1	1	0.68	1	1	4.68/5=0.936
A4	1	1	0.92	0	1	3.92/5 = 0.784
A5	1	1	0.95	0	0	2.95/5= 0.59
A6	1	0	0.71	1	1	3.71/5=0.742
A7	1	1	0.87	1	1	4.87/5= 0.974
A8	0	0	0.85	0	0	0.85/5= 0.17
A9	1	0	0.78	1	1	3.78/5= 0.756
A10	0	1	0.85	0	1	2.85/5= 0.57

According to Table 5, house A7 is the best choice as it has the highest score.
The combination of soft set for a good house and fuzzy soft set for good location forms a two level soft set in which the fuzzy soft set for good location is evaluated to input the value to soft set for good house.

V. Conclusion

A two level multisoft set namely doubly soft set with a fuzzy parameter at second level is proposed and successfully employed for making the decision regarding the purchase of a good house. The granular nature of human thinking is effectively modelled by the proposed doubly soft set with a fuzzy parameter at second level for decision making. More parameters based on the purchase specifications can be modelled as fuzzy to extend this two level multisoft set for better decision making. Moreover, this multilevel soft set can be further extended to ‘n’ levels based on the dependence of some parameters at the ‘n’ hierarchical levels of the parameters, arising due to practical conditions of the problem. In all, it is a new contribution to mathematical sciences as well as in the area of decision making.

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