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Application of Intuitionistic Fuzzy Soft Matrices in the Analysis of the Expectations of Old Age People

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Abstract: *In our real life, we are facing the situations involving uncertainty, imprecision and vagueness. To deal with these situations the concept of Soft set was developed. To enhance the flexibility of its applications the parametrization tool of soft set theory was used. It has been said that "we start dying the day we are born". The whole life of a person is dedicated for the welfare of his family. At his old age, when his health deteriorates, he starts to expect the support from his family. When the family members are not able to support him, problems arise. This situation forces him to old age home which affects him, his family and also the society. Though all the expectations can't be satisfied by the family members, some of the vital expectations may be fulfilled. In this paper we find out the major expectation of the old age people using Intuitionistic Fuzzy Soft Matrices (IFSM).*

Keywords: *Intuitionistic fuzzy soft set, Intuitionistic fuzzy soft matrices, Old age people, Old age home.*

I. Introduction

In 1999 Molodtsov [1] introduced Soft set theory as a general mathematical tool for dealing with uncertainty. The concept of Intuitionistic fuzzy sets (IFS) was proposed by Atanassov [2, 3]. After the introduction of the concept Intuitionistic fuzzy soft sets by P.K. Maji [4] et al, Jiang et al [5] extended the methods to intuitionistic fuzzy soft theory. Intuitionistic Fuzzy Soft Matrices (IFSM) was proposed by B. Chetia et al [6] in the year 2012 and Rajarajeswari et al[7-9]. Proposed some definitions for Intuitionistic soft matrices (IFSM) and its types. In this paper the expectations of the old age people was analyzed using IFSM. This paper is organized as follows. In Section 2 the preliminaries are given. In Section 3, the problems of the old age people are elaborated based on the information which is collected from the experts using linguistic questionnaire. In Section 4, the IFSM is applied to analyze the expectations of the aged people. And in final section, conclusions are derived based on our study.

II. Preliminaries

Definition2.1.[10]A fuzzy set (class) A in X is Characterized by a membership (characteristic) function $f_A(x)$ which associates with each point in X a real number in the interval [0,1], with the value of $f_A(x)$ at x representing the "grade of membership" of x in A.

Definition 2.2. [15] Let U be a non-empty set, called initial universal set of objects and E is a set of parameters in relation to U which is often the set of attributes, characteristics or properties of objects. Let P(U) denotes the power set of U. A pair (F,E) is called a soft set over U, where F is a mapping given by $F : E \rightarrow P(U)$.

Definition 2.3.[11]. Let U be a non-empty set, called initial universal set of objects and E is a set of parameters in relation to U which is often the set of attributes, characteristics or properties of objects. Let $A \subset E$. A pair
(F, A) is called fuzzy soft set over U where F is a mapping given by $F : A \rightarrow I^U$ and I^U denotes the collection of all fuzzy subsets of U.

Definition 2.4. [12] Let $U=\{x_1, x_2, ..., x_n\}$ be the initial universe of elements and $E=\{e_1, e_2, ..., e_m\}$ be the set of parameters. The pair (U,E) will be called a soft universe. Let $F : E \rightarrow I^U$ and μ be a fuzzy subset of E, i.e., $\mu: E \rightarrow I = [0, 1]$, where I^U is the collection of all fuzzy subsets of U. Let F_μ *be a mapping* $F_\mu : E \rightarrow I^U \times I$ defined as follows:

$F_\mu(e) = (F(e), \mu(e))$, where $F(e) \in I^U$. Then F_μ is called generalized fuzzy soft set over the soft universe (U , E).

Here for each parameter e_i, $F_\mu(e_i)$ indicates not only the degree of belongingness of the elements of U in $F(e_i)$ but also the degree of possibility of such belongingness which is represented by $\mu(e_i)$.

Definition 2.5. [13] Let U be an initial universal set , E be the set of parameters. Let IF^U denotes the collection of all intuitionistic fuzzy subsets of U. Let $A \subseteq E$. A pair (F, A) is called all intuitionistic fuzzy soft set over U, where F is a mapping given by $F : A \rightarrow I\,F^U$.

In other words, Let I^U ($I = [0, 1] \times [0, 1]$) denote the power set of all intuitionistic fuzzy soft subsets of U, A pair (F, E) is called intuitionistic fuzzy soft set over U , where $F : E \rightarrow I^U$ is a mapping from parameter set E to U, that is to say, for
$\forall e \in E, F(e) = \{< x, \mu_{F(e)}(x), \gamma_{F(e)}(x) >: x \in U\} \in I^U$, $\mu_{F(e)}(x) \in [0,1]$, $\gamma_{F(e)}(x) \in [0,1]$ denote membership and non-membership degrees of an element $x(\in U)$ regard to intuitionistic fuzzy set $F(e)$, respectively, which satisfying $\mu_{F(e)}(x) + \gamma_{F(e)}(x) \leq 1$.

Let $IFS(U)$ denote all intuitionistic fuzzy soft sets over initial universal set U . IFSs is represents according to initial universal set U is continuous or discrete.

(1)If U is continuous, we denote $(F, E) = \int_U [\mu_{F(E)}(x), \gamma_{F(E)}(x)]/x.$

(2)If U is discrete, we denote $(F, E) = \sum_{i=1}^{m} [\mu_{F(E)}(x_i), \gamma_{F(E)}(x_i)]/x_i$ where $|U| = m$.

Definition 2.6[14](Inclusion relation). Suppose (F, E) and $(G, E) \in IFS(U)$, we say that (F, E) is a intuitionistic fuzzy soft subset of (G, E), If for $e \in E$, we have $F(e) \subset G(e)$, that is to say , for $\forall e \in E, \forall x \in U$, we have $\mu_{F(e)}(x) \leq \mu_{G(e)}(x)$ *and* $\gamma_{F(e)}(x) \geq \gamma_{G(e)}(x)$ denoted by $(F, E) \tilde{\subseteq} (G, E)$.

Definition 2.7(Equation relation). Suppose (F, E) and $(G, E) \in IFS(U)$, we say they are intuitionistic fuzzy soft equal if and only if $(F, E) \tilde{\subseteq} (G, E)$ and $(F, E) \tilde{\supseteq} (G, E)$, namely for $\forall e \in E, \forall x \in U$, $\mu_{F(e)}(x) = \mu_{G(e)}(x)$ *and* $\gamma_{F(e)}(x) = \gamma_{G(e)}(x)$ denoted by $(F, E) \cong (G, E)$.

Definition 2.8(Complement operation) Suppose $(F, E) \in IFS(U)$, $(F, E)^c \cong (F^c, E)$ is defined as intuitionistic fuzzy soft complementary set of (F, E),where $F^c : E \rightarrow I^U$, for
$\forall e \in E,\ F^c(e) = \{< x, \mu_{F(e)}(x), \gamma_{F(e)}(x) >: x \in U\}$. Obviously (F^c, E) is also an IFSs over the same initial universal set U.

Definition 2.9 (Union and Intersection operation). Suppose (F, E) and $(G, E) \in IFS(U)$,

(i) The Intuitionistic fuzzy soft union of these two IFSss can be defined as $(F, E) \tilde{\bigcup} (G, E) \cong$ (M, E) where for $\forall e \in E$, we have

$$M(e) = F(e) \bigcup G(e) = \{< x, \mu_{M(e)}(x) = \mu_{F(e)}(x) \vee \mu_{G(e)}(x), \gamma_{M(e)}(x) = \gamma_{F(e)}(x) \wedge \gamma_{G(e)}(x) >: x \in U\}$$

(ii) The Intuitionistic fuzzy soft intersection of these two IFSss can be defined as $(F, E) \tilde{\bigcap} (G, E) \cong$ (H, E) where for $\forall e \in E$, we have

$$H(e) = F(e) \bigcap G(e) = \{< x, \mu_{H(e)}(x) = \mu_{F(e)}(x) \wedge \mu_{G(e)}(x), \gamma_{H(e)}(x) = \gamma_{F(e)}(x) \vee \gamma_{G(e)}(x) >: x \in U\}$$

Definition 2.10.(IFSM) Suppose (*F*, *E*) ∈ *IFS(U)*, denote |U| = m, |E| = n, Intuitionistic fuzzy soft matrix is defined by $\tilde{F}=(f_{ij})_{m\times n}$,where $f_{ij}=(\mu_{F(e_j)}(x_i),\gamma_{F(e_j)}(x_i)), i=1,2,\ldots,m,\ j=1,2,\ldots,n.$ The concrete form of IFSM is as follows:

$$\tilde{F}=\begin{pmatrix} & e_1 & e_2 & \cdots & e_n \\ x_1 & (\mu_{F(e_1)}(x_1),\gamma_{F(e_1)}(x_1)) & (\mu_{F(e_2)}(x_1),\gamma_{F(e_2)}(x_1)) & \cdots & (\mu_{F(e_n)}(x_1),\gamma_{F(e_n)}(x_1)) \\ x_2 & (\mu_{F(e_1)}(x_2),\gamma_{F(e_1)}(x_2)) & (\mu_{F(e_2)}(x_2),\gamma_{F(e_2)}(x_2)) & \cdots & (\mu_{F(e_n)}(x_2),\gamma_{F(e_n)}(x_2)) \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ x_n & (\mu_{F(e_1)}(x_m),\gamma_{F(e_1)}(x_m)) & (\mu_{F(e_2)}(x_m),\gamma_{F(e_2)}(x_m)) & \cdots & (\mu_{F(e_n)}(x_m),\gamma_{F(e_n)}(x_m)) \end{pmatrix}$$

IFSM over initial universe could be denoted by *IFSM(U).*

Definition 2.11. Suppose $\tilde{G},\tilde{F}\in IFSM(U),\lambda>0,$ then some operations about IFSM could be defined as follows:

(1) $\tilde{F}\oplus\tilde{G}=(\mu_{F(e_j)}(x_i)+\mu_{G(e_j)}(x_i)-\mu_{F(e_j)}(x_i)\times\mu_{G(e_j)}(x_i),\ \gamma_{F(e_j)}(x_i)\times\gamma_{G(e_j)}(x_i))_{m\times n};$

(2) $\tilde{F}\otimes\tilde{G}=\left(\mu_{F(e_j)}(x_i)\times\mu_{G(e_j)}(x_i)\ ,\ \gamma_{F(e_j)}(x_i)+\gamma_{G(e_j)}(x_i)-\ \gamma_{F(e_j)}(x_i)\times\gamma_{G(e_j)}(x_i)\right)_{m\times n};$

(3) $\lambda\tilde{F}=\lambda\left(\mu_{F(e_j)}(x_i),\gamma_{F(e_j)}(x_i)\right)_{m\times n}=\left(1-\left(1-\mu_{F(e_j)}(x_i)^{\lambda},\gamma_{F(e_j)}(x_i)\right)^{\lambda}\right)_{m\times n};$

(4) $\tilde{F}=\left(\mu_{F(e_j)}(x_i),\gamma_{F(e_j)}(x_i)\right)^{\lambda}_{m\times n}=\left(\left(\mu_{F(e_j)}(x_i)\right)^{\lambda},\left(1-\left(1-\gamma_{F(e_j)}(x_i)\right)^{\lambda}\right)\right)_{m\times n}.$

Proposition 2.1. Suppose $\tilde{G},\tilde{F}\in IFSM(U),\ and\ \lambda,\lambda_1,\lambda_2>0,$ we have

(1) $\tilde{F}\oplus\tilde{G}=\tilde{G}\oplus\tilde{F};$

(2) $\tilde{F}\otimes\tilde{G}=\tilde{G}\otimes\tilde{F};$

(3) $\lambda\left(\tilde{F}\oplus\tilde{G}\right)=\lambda\tilde{G}\oplus\lambda\tilde{F};$

(4) $\left(\tilde{F}\otimes\tilde{G}\right)^{\lambda}=\tilde{F}^{\lambda}\otimes\tilde{G}^{\lambda};$

(5) $\lambda_1\tilde{F}\oplus\lambda_2\tilde{F}=(\lambda_1+\lambda_2)\tilde{F};$

(6) $\tilde{F}^{\lambda_1}\otimes\tilde{F}^{\lambda_2}=\tilde{F}^{(\lambda_1+\lambda_2)}.$

Definition 2.12. Let U be a finite universe, $\tilde{F}_k\in IFSM(U),(k=1,2,\ldots K),$ and $w=(w_1,w_2,\ldots,w_k),\sum_{k=1}^{K}w_k=1$ is a weight vector, then the weighted arithmetic average operator is defined as follows:

The weighted arithmetic average operator $f_w=IFSM(U)\rightarrow IFSM(U),$ namely

$$f_w(\tilde{F}_1,\tilde{F}_2,\ldots,\tilde{F}_k)=\bigoplus_{k=1}^{K}w_k\tilde{F}_k \qquad (1)$$

Algorithm for multi expert group decision making problems:

Step 1: Input the IFSM (given by the experts) over a finite universe U and a finite parameter set E.

Setp 2: Calculate collective IFSM $\tilde{F}^*$ using the weighted arithmetic average operator by formula (1)

Step 3:Compute the threshold vectors based on median $\lambda_{med}(E)$ by using the formula,

$\lambda_{med}(E)=\{\lambda_{med}(e_j)1\le j\le n\}=\{(\mu_{med}(e_j),\gamma_{med}(e_j))1\le j\le n\},$ where for $\forall e_j\in E,\mu_{med}(e_j)$ is the median by ranking membership degree of all alternatives according to order from large to small (or from small to large), namely

$$\mu_{med}(e_j)=\begin{cases}\mu_{e_j}\left(x_{\left(\frac{m+1}{2}\right)}\right) & \text{, if } m \text{ is an odd number,}\\ \left(\mu_{e_j}\left(x_{\left(\frac{m}{2}\right)}\right)+\mu_{e_j}\left(x_{\left(\frac{m}{2}+1\right)}\right)\right)\Big/2 & \text{, if } m \text{ is an even number,}\end{cases}$$

and $\gamma_{med}(e_j)$ is also median by ranking membership degree of all alternatives according to order from large to small (or from small to large), namely

$$\gamma_{med}(e_j)=\begin{cases}\gamma_{e_j}\left(x_{\left(\frac{m+1}{2}\right)}\right) & \text{, if } m \text{ is an odd number,}\\ \left(\gamma_{e_j}\left(x_{\left(\frac{m}{2}\right)}\right)+\gamma_{e_j}\left(x_{\left(\frac{m}{2}+1\right)}\right)\right)\Big/2 & \text{, if } m \text{ is an even number,}\end{cases}$$

Step 4. Calculate choice value(c_i) of all alternatives.
Step 5. Rank all alternatives according to choice value and select the optimal decision by $c_k \max_{1\le i\le m} c_i$.

III. Old Age People

We have conducted a survey in various old age homes in Chennai during May to June 2014. We framed a linguistic questionnaire and administered the same to 100 old aged persons living under different difficult circumstances. Based on our study , Here we listed some of the problems of the old age people, and the solutions to overcome these problems.

Table 1.

Problems of the old age people	**Needs**
Isolation	Inclusion
Boredom	Be usefully occupied
Neglect	Care
Abuse	Protection
Fear	Reassurance
Economical Insecurity	Economical security
Failing Health	Doing exercise ,healthy food
Lack of respect	Respect and love
Lack of self esteem	Self confidence
Lake of preparedness for old age	Preparedness of old age

Five important attributes are given by the three experts which is obtained based on the data given above.
The attributes given by experts are as follows
x_1 - Economic security
x_2 - Inclusion
x_3 - Care
x_4 - Respect and Love
x_5 - Be usefully occupied

Family status
e_1 - Poor
e_2 - Middle Class
e_3 - Rich

Economic security

Retirement is not “golden” for all older adults. Post retirement period is the dependence period on their children. These older adults struggle each day with rising housing and health care bills, inadequate nutrition, lack of access to transportation, diminished savings, and job loss. So they need some regular income and be prepared financially . The children should give them money without hesitation. They should realize that it is their duty to spend money for their parents.

Inclusion

It is important that the older adults must feel included in the happenings around them, both in the family as well as in the society. So the children should try their best to make them comfortable and get them involved in family and society related activities so that they can spend the rest of their life happily.

Care

For a plant to grow, atleast in starting stage somebody should take care of it. Without any care, even a pet will not stay with us. Parents are the epitome for their children’s life, they spend their whole life for their children, so children should take care of them.

Respect and Love

"We make them cry,
who care for us.
We cry for those,
who never care for us."
This is the truth of life. Its STRANGE but TRUE!"

Parents play an important role in our lives. They brought up their children despite of having so many socio-economic difficulties. They fulfill our every demand & never complain for anything. In return its our duty to give respect, love & care to them.

Be usefully occupied.

A person who is not usefully occupied tends to physically and mentally decline and this in turn has a negative emotional impact. Most people who have reached the age of 60 years or more have previously led productive lives and would have gained several skills during their life-time. Identifying these skills would be a relatively easy task. Motivating them and enabling them to use these skills is a far more challenging process that requires determination and consistent effort by dedicated people working in the same environment as the affected elders.

IV. Application Of IFSM

$U=\{x_1,x_2,x_3,x_4,x_5\}$ is the set of attributes, $E=\{e_1,e_2,e_3\}$ is the set of family status , $\tilde{F}_k\,(1\le k\le 3)$ is the IFSM given by three experts, where the experts weights are $w=\{0.5,0.3,0.2\}$

Table 2. The evaluation value of $\tilde{F}_1$

	e_1	e_2	e_2
x_1	(0.8,0.1)	(0.6,0.3)	(0.2,0.1)
x_2	(0.6,0.3)	(0.4,0.3)	(0.4,0.3)
x_3	(0.5,0.3)	(0.5,0.4)	(0.5,0.2)
x_4	(0.7,0.2)	(0.7,0.2)	(0.7,0.1)
x_5	(0.7,0.1)	(0.3,0.2)	(0.2,0.2)

Table 3. The evaluation value of $\widetilde{F}_2$

	e_1	e_2	e_3
x_1	(0.7,0.1)	(0.4,0.5)	(0.3,0.5)
x_2	(0.5,0.2)	(0.3,0.2)	(0.5,0.3)
x_3	(0.5,0.3)	(0.4,0.5)	(0.6,0.3)
x_4	(0.8,0.1)	(0.7,0.3)	(0.9,0.2)
x_5	(0.3,0.4)	(0.6,0.2)	(0.3,0.2)

Table 4. The evaluation value of $\widetilde{F}_3$

	e_1	e_2	e_3
x_1	(0.6,0.2)	(0.7,0.2)	(0.6,0.2)
x_2	(0.4,0.1)	(0.3,0.3)	(0.7,0.1)
x_3	(0.5,0.2)	(0.3,0.5)	(0.3,0.1)
x_4	(0.8,0.1)	(0.6,0.1)	(0.5,0.1)
x_5	(0.3,0.5)	(0.3,0.4)	(0.4,0.2)

Table 5.Collective IFSM $\widetilde{F}^*$ and the threshold vector $\lambda_{med}(E)$.

	e_1	e_1	e_1
x_1	(0.7405,0.1149)	(0.5735,0.3224)	(0.3309,0.1862)
x_1	(0.5362,0.2132)	(0.3519,0.2656)	(0.5055,0.2408)
x_1	(0.5000,0.2766)	(0.4351,0.4472)	(0.4998,0.1966)
x_1	(0.7551,0.1414)	(0.6822,0.1966)	(0.7610,0.1231)
x_1	(0.5417,0.2091)	(0.4082,0.2297)	(0.2744,0.2000)
$\lambda_{med}(E)$	(0.5417,0.2091)	(0.4351,0.2656)	(0.4998,0.1966)

Table 6 .T he choice value of all alternatives

	e_1	e_2	e_3	c_i
x_1	1	0	0	1
x_2	0	0	0	0
x_3	0	0	1	1
x_4	1	1	1	3
x_5	1	0	0	1

Rank all alternatives x_i (i = 1,2,…,5) in accordance with choice value $x_4 > x_1$,x_3, $x_5 > x_2$. This shows that the very important need of the old age people is respect and love.

V. Conclusion

We found that the most important need of the aged persons is respect and love. Even though they were in different family status, they are expecting the love and respect from their children and grandchildren. Why do some of us leave them in Old-age Homes? Why they had to struggle all alone there? God has given human beings the quality to take care of their old ones. Hence, we should not ignore Almighty's reward. To eradicate this problem parents should set an example before their children by serving their parents & grand parents. Once the children get this precious quality in their genes we wouldn't have such inhumanity in our society.

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