A CONCEPTUAL DISCUSSION ABOUT AN INTUITIONISTIC FUZZY-SETS AND ITS APPLICATIONS.

Yogeesh N-Assistant Professor Department of Mathematics Government First Grade College, Badavanahalli, Tumkur, Karnataka, India

yogeesh.r@gmail.com

Dr.P.K. Chenniappan-Professor Head of the Department,Department of Mathematics,Sri Shakthi Institute of Engineering and Technology,Tamil Nadu, India

Abstract

The idea of an intuitionistic fuzzy-set is an extension of the concept of a fuzzy-set, the opposite is not always true. Although intuitionistic fuzzy-set theory can solve many of the issues that fuzzy-set theory can, there are certain complex problems that intuitionistic fuzzy-set theory is better suited to solve than fuzzy-set theory. Researchers are interested in intuitionistic fuzzy-sets because of its applicability in a variety of domains. Hence in this paper we have brought the concept of intuitionistic fuzzy-sets with various definitions and their applications which was given by many researchers.

Keywords: *Intuitionistic fuzzy-set, Fuzzy-sets, Intuitionistic fuzzy graphs*

1. Introduction

1.1 BASIC CONCEPTS OF INTUITIONISTIC FUZZY-SETS

The definitions of intuitionistic fuzzy-sets, as well as existing findings in the literature, are presented in this section. The non-membership grade of an element to reside in a fuzzy subset equals 1 membership grade of that element to lie in the fuzzy subset in fuzzy-set theory. For example, if a person has 0.6 membership grades in the fuzzy subset of a good man, he has 0.4 membership grades in the fuzzy subset of not a good guy, according to fuzzy-set theory. However, in real-life situations, this is no longer the case.

To address this issue, Atanassov (1986) introduced the concept of intuitionistic fuzzy-sets. The idea of fuzzy-sets is generalised in this concept.

Definition 1.1.1 (Atanassov 1986) Let*X* be a nonempty set. An intuitionistic fuzzy-set*A* of X is defined by $A = \{(\mu_A, V_A)\}$, where: $\mu_A : X \to [0,1]$and $v_A : X \to [0,1]$with the condition $0 \le \mu_A(x) + v_A(x) \le 1,\ \forall\, x \in X$. Thenumbers $\mu_A(x)$, $v_A(x) \in [0,1]$ denote the degree of membership and non-membership of *x* to lie in *A* respectively.

Definition 1.1.2 (Atanassov 1986 Assume that X is a nonempty set, and that $A = \{(\mu_A, v_A)\}$ and $B = \{(\mu_B, v_B)\}$ be two intuitionistic fuzzy-sets of *X* . Then

1. $A \subset B$ iff $\mu_A \le \mu_B$ and $V_A \ge v_B$.
2. $A = B$ iff $A \subset B$ and $B \subset A$.
3. $A \cup B = (\mu_A \vee \mu_B,\ v_A \wedge v_B) = (\max(\mu_A, \mu_B), \min(v_A, v_B))$.
4. $A \cap B = (\mu_A \wedge \mu_B,\ v_A \vee v_B) = (\min(\mu_A, \mu_B),\ \max(v_A, v_B))$.
5. $A \times B(x,y) = (\mu_{A\times B}, v_{A\times B})(x,y) = (\min\{\mu_A(x), \mu_B(y)\}, \max\{v_A(x), v_B(y)\})$
6. $A^c = (v_A, \mu_A)$.
7. $[\,]A = (\mu_A, I - \mu_A), <> A = (1 - v_A, v_A)$.

Definition 1.1.3 (Coker 1997) Let $\{A_i = (\mu_{A_i},\ v_{A_i}) \mid i \in J\}$, If X is an arbitrary family of intuitionistic fuzzy-sets, then

$(a) \cap_{ieJ} A_i = (\wedge_{ieJ}\ \mu_{A_i},\ \vee_{ieJ}\ v_{A_i})$; $(b) \cup_{ieJ} A_i = (\vee_{ieJ}\ \mu_{A_i},\ \wedge_{ieJ}\ v_{A_i})$, where $\wedge$ and $\vee$ are defined in usual.

Definition 1.1.4 (Coker 1997). $\tilde{0} = \{\langle x, 0, 1\rangle : x \in X\}\ and\ \tilde{1} = \{\langle x, 1, 0\rangle : x \in X\}$.

Definition 1.1.5 (Coker 1997). Let *A*, *B*, *C*, *D* be intuitionistic fuzzy-sets in *X.* Then

[1] $A \subset B$ and $C \subset D \Rightarrow A \cup C \subset B \cup D$ and $A \cap C \subset B \cap D$.

[2] $A \subset B$ and $A \subset C \Rightarrow A \subset B \cap C$.

[3] $A \subset B$ and $B \subset C \Rightarrow A \cup B \subset C$.

[4] $A \subset B$ and $B \subset C \Rightarrow A \subset C$.

[5] $(A \cup B)^c = A^c \cap B^c$ and $(A \cup B)^c = A^c \cup B^c$

[6] $A \subset B \Rightarrow B^c \subset A^c$.

[7] $(A^c)^c = A$.

[8] $\tilde{1}^c = \tilde{0}$, $\tilde{0}^c = \tilde{1}$.

Definition 1.1.6 (Coker 1997). Let $f: X \to Y$ be any function. Let $A = (\mu_A\ ,\ v_A)$ and $B = (\mu_B\ , v_B)$ be intuitionistic fuzzy subsets of *X* and *Y* respectively. Then

i) The image $f(A) = (\mu_{f(A)}\ , v_{f(A)})$ of *A* under f is given by

$$\mu_{f(A)}(z) = \begin{cases} \sup_{x \in f^{-1}(z)} \mu_A(x) & if \quad f^{-1}(z) \neq \phi \\ 0 & otherwise \end{cases} \quad \text{and}$$

$$v_{f(A)}(z) = \begin{cases} \inf_{x \in f^{-1}(z)} v_A(x) & if \quad f^{-1}(z) \neq \phi \\ 1 & otherwise \end{cases}$$

ii) The inverse image $f^{-1}(B) = \left(\mu_{f^{-1}(B)},\ v_{f^{-1}(B)}\right)$ of *B* under *f* is given by

$$\mu_{f^{-1}(B)}(x) = \mu_B\big(f(x)\big) \ and \ v_{f^{-1}(B)}(x) = v_B\big(f(x)\big).$$

Result 1.1.1 (Coker 1997). Let $\{A = (\mu_A\ , v_A)\}$, $\{A_i = \left(\mu_{A_i}\ , v_{A_i}\right) \big| \ i \in J\ \}$ be intuitionist fuzzy-sets in *X* and let $\{B = (\mu_B\ , v_B)\}$, $\{B_i = \left(\mu_{B_i}\ , v_{B_i}\right) \big| \ i \in J\ \}$ intuitionistic fuzzy-sets in *Y* and let $f: X \to Y$ a mapping. Then

1. $A_1 \subset A_2 \Rightarrow f(A_1) \subset f(A_2)$.

2. $B_1 \subset B_2 \Rightarrow f^{-1}(B_1) \subset f^{-1}(B_2)$.

3. $A \subset f^{-1}(f(A))$. If f is injective, then $A = f^{-1}\big(f(A)\big)$.

4. $f\big(f^{-1}(B)\big) \subset B$. If f is surjective, then $f\big(f^{-1}(B)\big) = B$.

5. $f^{-1}\left(\cup B_j\right) = \cup f^{-1}(B_j)$.

6. $f^{-1}(\cap B_j) = \cap f^{-1}(B_j)$.

7. $f(\cup A_i) = \cup f(A_i)$.

8. $f(\cap A_i) \subset f(A_i)$ if f is injective, then $f(\cap A_i) = \cap f(A_i)$.

9. $f(\tilde{1}) = \tilde{1}$, if f is surjective and $f(\tilde{0}) = \tilde{0}$.

10. $f^{-1}(\tilde{1}) = \tilde{1}$ and $f^{-1}(\tilde{0}) = \tilde{0}$.

11. $[f(A)]^c \subset f(A^c)$, if f is surjective.

12. $f^{-1}(B^c) = [f^{-1}(B)]^c$.

Gallego's concept of intuitionist fuzzy points may be extended to intuitionist fuzzy singletons as follows:

Definition 1.1.7 (Gallego 2003). Let X be a nonempty set. An intuitionistic fuzzy singleton $p_x$defined on x, or with support x, is an intuitionistic fuzzy-set(μ_{p_x}, v_{p_x})such that $\mu_{p_x}(x) > 0$ and $\mu_{p_x}(z) = 0$; $v_{p_x}(z) = 1$whenever $z \neq x$.

Definition 1.1.8 (Lakshmana and Geetha 2008 b). Let X be any set that isn't empty. An intuitionistic fuzzy-set is defined by an intuitionistic fuzzy singleton x p defined on x.

$A = (\mu_A, v_A)(p_x \in A)\ if\ \mu_{p_x} \leq \mu_Aandv_A \leq v_{p_x}$.

Note 1.1. If $p = \{(\mu_p, v_p)\}$defined on *x* is an intuitionistic fuzzy singleton, then support

$\mu_p = \{x\},\ 0 < \mu_p(x) \leq 1,\ v_p(z) = 1$, for every $z \neq x$ and$\mu_p(x) + v_p \leq 1$

2. Intuitionistic fuzzy-sets and its applications

The idea of 'intuitionistic fuzzy-set' (IFS) was established by KrassimirAtanassov (1986) as an extension of the concept of 'fuzzy-set.' The characteristics of various operations and relations over sets, as well as modal and topological operators defined over the set of IFS's, are proven. New findings on intuitionistic fuzzy-sets were presented by KrassimirAtanassov (1989). On intuitionistic fuzzy-sets, two novel operators, the modal operator and the topological operator, are defined and their fundamental characteristics are investigated. KrassimirAtanassov (1992) made another set of statements on intuitionistic fuzzy-sets, this time discussing the relationship between some intuitionistic fuzzy-set (IFS) A and the universe F, which is a universe of the IFS E, where the latter is a universe of A. Along with the current operations, KrassimirAtanassov (1994) specified four new operations $(@, \$, \#, and\ *)$. $(\cup,\ \cap,\ +\ and\ \cdot)$over the intuitionistic fuzzy-sets and some of their basic properties where discussed. Later KrassimirAtanassov (1996) proved equality between intuitionistic fuzzy-sets. It is proved that for every two intuitionistic fuzzy-sets.

$$A\ \ and\ \ B : \big((A \cap B) + (A \cup B)\big)@\big((A \cap B) \cdot (A \cup B)\big) = A@B.$$

Bustince and Burillo (1996) investigated the link and coincidence between intuitionistic fuzzy-sets defined by KrassimirAtanassov and vague sets defined by Gau and Byehrer. Intuitionistic fuzzy-sets were defined by KrassimirAtanassov and George Gargov (1998) based on the definition of several types of intuitionistic fuzzy logics. They created two versions of intuitionistic fuzzy propositional calculus (IFPC) and an intuitionistic fuzzy predicate logic version (IFPL). KrassimirAtanassov (2000) established two theorems about the relationships between some of the operators defined over intuitionistic fuzzy-sets.

Concentration, dilatation, and normalisation of intuitionistic fuzzy-sets were established by Supriya Kumar et al. (2000). These definitions will come in handy when dealing with linguistic hedges such as "extremely," "more or less," "very," "very very," and other terms that are used in situations in an intuitionistic fuzzy environment.

To compute distances between intuitionistic fuzzy-sets, EulaliaSzmidt and JanuszKacprzyk (2000) presented a geometrical model of an intuitionistic fuzzy-set. New definitions are presented, and they are compared to the fuzzy-set technique. It is shown that while computing such distances, all three factors representing intuitionistic fuzzy-sets should be taken into consideration.

The link between several extensions of fuzzy-set theory was shown by Glad Deschrijver and Etienne Kerre (2003). There is a summary of the connections that exist between fuzzy-sets and various mathematical models. Intuitionistic fuzzy and interval-valued fuzzy-set theory: creation, classification, and application were studied by Chris Cornelis et al. (2004). In addition, intuitionistic principles are reinterpreted, resulting in both methods being used as models of imprecision in a practical setting. The mathematical link between intuitionistic fuzzy-sets and various models of imprecision was studied by Glad Deschrijver and Etienne Kerre (2007).

Intuitionistic fuzzy-sets have been used in a variety of scenarios involving uncertainty, including decision-making, artificial intelligence, and so on. The following are a few articles that discuss the use of intuitionistic fuzzy-sets.

PlamenAngelov (1997) provided a novel approach to the optimization issue in the presence of uncertainty. It's a fuzzy optimization extension in which the degrees of objective(s) and constraint rejection are considered with the degrees of satisfaction. The intuitionistic fuzzy (IF) set notion is used to optimization issues in this method. A method for solving such issues is provided, and a simple numerical example is used to demonstrate it. It takes the presented intuitionistic fuzzy optimization (IFO) issue and turns it into a crisp (non-fuzzy) problem. The benefit of IFO problems is twofold: they provide the most comprehensive equipment for the formulation of optimization issues, and their solutions may meet the objective(s) to a greater extent than the similar fuzzy and crisp optimization problems.

Supriya Kumar et al. (2001) investigated Sanchez's technique for medical diagnostics and expanded on it using the idea of intuitionistic fuzzy-set theory, an extension of fuzzy-set theory.

Deng-Feng Li (2005) investigates multi-attribute decision making using intuitionistic fuzzy-sets, in which various criteria are explicitly evaluated, numerous linear programming models are created to provide optimum weights for attributes, and decision-making procedures are also presented. A numerical example is used to demonstrate the feasibility and efficacy of the suggested strategy. Intuitionistic fuzzy interpretations of multi-person and multi-measurement instrument multi-criteria decision making were examined by KrassimirAtanassov et al. (2005).

For fault-tree analysis on printed circuit board assembly, Ming-Hung Shu et al. (2006) employed intuitionistic fuzzy-sets. Based on certain fundamental concepts, this work proposes an algorithm for intuitionistic fuzzy fault-tree analysis to compute fault intervals of system components and to discover the most crucial system component for management decision-making. The suggested approach is used to solve the issue of failure analysis in printed circuit board assembly. Deng-Feng Li (2008) presented a paper on the use of intuitionistic fuzzy-sets for fault tree analysis in printed circuit board assembly.

New strategies for tackling multi-criteria decision-making problems in an intuitionistic fuzzy environment were presented by Hua-Wen Liu and Guo-Jun Wang (2007). It is presented and explained the notion of intuitionistic fuzzy point operators. The degree of uncertainty of the elements in a universe corresponding to an intuitionistic fuzzy-set is lowered by utilising intuitionistic fuzzy point operators. Furthermore, a set of novel score functions based on intuitionistic fuzzy point operators and the evaluation function are created for multi-criteria decision-making problems, and their usefulness and advantages are shown using examples.

The notions of intuitionistic preference relation, consistent intuitionistic preference relation, incomplete intuitionistic preference relation, and acceptable intuitionistic preference relation were developed and investigated by Zeshui Xu (2007). The intuitionistic fuzzy arithmetic averaging operator and the intuitionistic fuzzy weighted arithmetic averaging operator are used to aggregate intuitionistic preference information, and the score function and accuracy function are used to the ranking and selection processes, respectively. Finally, to demonstrate the established methodologies, a practical example is offered.

The dynamic multi-attribute decision making issues using intuitionistic fuzzy information were explored by Zeshui Xu and Ronald Yager (2007). The terms intuitionistic fuzzy variable and uncertain intuitionistic fuzzy variable are introduced, as well as two novel aggregation operators: dynamic intuitionistic fuzzy weighted averaging operator and uncertain dynamic intuitionistic fuzzy weighted averaging operator.

LudmilaDymova and Pavel Sevastjanov (2010) offered an evidence theory-based explanation of intuitionistic fuzzy-sets: the decision-making component. This interpretation allows all mathematical operations on intuitionistic fuzzy values to be represented as interval operations. The created method's utility is shown using a well-known example of a multiple-criteria decision-making issue.

The intuitionistic fuzzy multiple attribute decision-making issues were examined by Zeshui Xu and Hui Hu (2010), where the attribute values are stated as intuitionistic fuzzy numbers or interval-valued intuitionistic fuzzy numbers. A variety of concepts are presented, including intuitionistic fuzzy ideal point, interval-valued intuitionistic fuzzy ideal point, modules of intuitionistic fuzzy numbers, and interval-valued intuitionistic fuzzy numbers.

Wei Yang and Zhiping Chen (2012) proposed a novel multi-criteria decision-making approach based on intuitionistic fuzzy data. Ejegwa et al. (2012) explored the notion of intuitionistic fuzzy-sets and advocated utilising the normalised Euclidean distance approach to measure the distance between each student and career. The answer is found by calculating the shortest distance between each student and each profession.

Cen Zuo , Anita Pal and ArindamDey (2008)The photograph fuzzy-set is an effective mathematical version to address uncertain actual life troubles, in which a intuitionistic fuzzy-set may additionally fail to show nice effects. Picture fuzzy-set is an extension of the classical fuzzy-set and intuitionistic fuzzy-set. It can work very efficiently in uncertain scenarios which contain extra answers to those kind: sure, no, abstain and refusal. In this paper, we introduce the idea of the image fuzzy graph primarily based at the picture fuzzy relation. Some types of image fuzzy graph such as a normal photo fuzzy graph, strong picture fuzzy graph, whole photograph fuzzy graph, and supplement photo fuzzy graph are added and some properties also are defined. The concept of an isomorphic photograph fuzzy graph is likewise introduced on this paper. We also outline six operations along with Cartesian product, composition, join, direct product, lexicographic and robust product on photograph fuzzy graph. Finally, we describe the software of the photo fuzzy graph and its application in a social network.

3. OBJECTIVES OF THE PAPER

The objective of this research work is

1. To learn more about intuitionistic fuzzy-sets.
2. Discussion about the various concepts of intuitionisticfuzzy-sets.
3. To use intuitionistic fuzzy-sets knowledge in real-world applications.

4. REVIEW OF LITERATURE

One of fuzzy-set theory's most appealing aspects is that it offers a mathematical framework for the integration of subjective categories represented by membership functions. Intuitionistic fuzzy-sets are a kind of fuzzy-set that includes not only a membership degree but also a non-membership degree that is more or less independent. Given the increased interest in intuitionistic fuzzy-sets, it is important to identify the applications of intuitionistic fuzzy-set theory in many domains such as decision making, quantitative analysis, and information processing, among others. The necessity for knowledge-handling systems capable of dealing with and discriminating between distinct facts of imprecision necessitates a clear and formal characterisation of the mathematical models that perform such analyses, which is done using fuzzy graphs and intuitionistic fuzzy graphs also.

5. Conclusion

We came to know that The idea of 'intuitionistic fuzzy-set' (IFS) was established by KrassimirAtanassov (1986) after that many researchers found various concepts and finding of intuitionistic fuzzy-set based on new concept of fuzzy-set. After the various studies carried out on the concept of intuitionistic fuzzy-sets many applications were brought into real word as discussed in this paper. Based on these, Shannon and KrassimirAtanassov (2006) proposed a novel extension of intuitionistic fuzzy graphs that relied on the notions of intuitionistic fuzzy-sets, intuitionistic fuzzy relations, and index matrices as a foundation. Like this many researchers and scientists discover the concepts based on fuzzy numbers, fuzzy-sets and intuitionistic fuzzy-sets. Further based on these findings many concepts like intuitionistic fuzzy graphs and hyper graphs were evolved and produces many applications in the real word.

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