Chapter 1
Fuzzy Sets, Intuitionistic Fuzzy Sets:
Separation of Generalized Interval-Valued Intuitionistic Fuzzy Sets

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ABSTRACT

In this chapter, we define four separations of generalized interval-valued intuitionistic fuzzy sets (GIVIFSs). In fact, all interval-valued Intuitionistic fuzzy sets (IVIFSs) are GIVIFSs but all GIVIFSs are not IVIFSs. Also, we studied some properties of the four separated subsets of GIVIFSs.

INTRODUCTION

It is well known that set theories play major role in various areas such as mathematics, physics, statistics, engineering, social sciences and many others. Several works on classical set theories are available in different journals even in books also. The set theories are so important that it has been placed in the school curriculum, college and university curriculum in different form and different degree of level all over world. But in all problems in daily as well as in different sectors and different subject discipline do not always involve crisp data. Recently fuzzy sets, vague set, rough set are used as the mathematical data for dealing with uncertainties. Zadeh (1965) first introduced the concept of fuzzy sets. In many real applications to handle uncertainty, fuzzy set is very much useful and in this one real value $MA(x) \in [0,1]$ is used to represent the grade of membership of a fuzzy set A defined on the universe of discourse X. After two decades the concept of interval-valued fuzzy set was introduced. Atanassov (1989) introduced several operations over interval-valued fuzzy set. It is true for some applications that it is not enough to satisfy to consider only one value to the membership-function to define the belongingness of an element in a fuzzy set. Using this conception Pal and Shyamal (2002a) introduced interval-valued fuzzy matrices

DOI: 10.4018/978-1-5225-0914-1.ch001

and have shown several properties of them. Again after two decades, Atanassov (1989 , 1994) introduced another type of fuzzy sets which is the generalization of fuzzy subset it is called intuitionistic fuzzy set which is more practical in real life situations. Intuitionistic fuzzy sets handle incomplete information i.e., the grade of membership function and non-membership function but not the indeterminate information and inconsistent information which exists obviously in belief system. Several authors present a number of results using intuitionistic fuzzy sets. By the concept of intuitionistic fuzzy sets, perhaps first time Pal (2001) introduced intuitionistic fuzzy determinant. Latter on Pal and Shyamal (2002b, 2005) introduced intuitionistic fuzzy matrices and distance between intuitionistic fuzzy matrices. Recently, Bhowmik and Pal(2008) studied some results on intuitionistic fuzzy matrices, intuitionistic circular fuzzy matrices and generalized intuitionistic fuzzy matrices. After three years of the work of Atanassov (1994) again Gargo and Atanassov (1989) introduced the interval-valued intuitionistic fuzzy sets. They have shown several properties on interval-valued intuitionistic fuzzy sets and shown applications over interval-valued intuitionistic fuzzy sets. Jana and Pal(2006) also studied some properties on interval-valued intuitionistic fuzzy sets. Bhowmik et al (2009) define generalized interval-valued intuitionistic fuzzy sets with some properties.

SOME DEFINITIONS AND PROPERTIES

We present two fundamental operators $\vee$ and $\wedge$ defined over fuzzy sets below:

On the interval [0,1] (where the fuzzy sets takes their elements) the following operations are defined for all x, y$\in$ [0,1]:

1. $x \vee y = \max(x, y)$,
2. $x \wedge y = \min(x, y)$.

We define a lattice ($L', \leq$), where $L' = \{[x_1, x_2]: (x_1, x_2) \in [0,1]^2 \text{ and } x_1 \leq x_2\}$, $[x_1, x_2] \leq [y_1, y_2] \Leftrightarrow (x_1 \leq y_1$ and $x_2 \leq y_2)$ *for all* $[x_1, x_2], [y_1, y_2] \in L'$.

Definition 1 (Fuzzy Set)

A fuzzy set A over X (universe of discourse) is an object having the form A=$\{\langle$x, $M_A(x)\rangle / x \in X\}$, where $M_A(x)$ denote the degree of membership of the element x to the set A and it can take any value from [0,1].

Some Properties of Fuzzy Set

Let A and B be two fuzzy sets of the form $A=\{\langle x, M_A(x)\rangle | x \in X\}$ and $B=\{\langle x, M_B(x)\rangle | x \in X\}$ Then

1. $A \subseteq B$ if and only if $M_A(x) \leq M_B(x)$; for all $x \in X$.
2. $\bar{A} = \left\{\left\langle x, 1 - M_A(x)\right\rangle \mid x \in X\right\}$;
3. $A \cap B = \left\{\left\langle x, M_A(x) \wedge M_B(x)\right\rangle \mid x \in X\right\}$;
4. $A \cup B = \left\{\left\langle x, M_A(x) \vee M_B(x)\right\rangle \mid x \in X\right\}$.