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Modified new operations for triangular intuitionistic fuzzy numbers(TIFNS)

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Abstract

Intuitionistic fuzzy sets (IFS) are a generalization of the concept of fuzzy set. In standard intuitionistic fuzzy arithmetic operations, we have some grievances in subtraction and division operations. In this paper, modified new operations for subtraction and division on triangular intuitionistic fuzzy numbers (TIFNS) are defined. Finally an illustrative example for solving Intuitionistic fuzzy multi-objective linear programming problem (IFMOLPP) using these modified operators is provided.

Keywords: Intuitionistic fuzzy arithmetic, Triangular intuitionistic fuzzy number (TIFN), Intuitionistic fuzzy multi-objective linear programming problem (IFMOLPP).

2010 MSC: 65K05, 90C90, 90C70, 90C29.

1 Introduction

In real world, we frequently deal with vague or imprecise information. Information available is sometimes vague, sometimes inexact or sometimes insufficient. The concept of Fuzzy sets was introduced by Zadeh in 1965. The usual arithmetic operation on real numbers can be extended to the ones defined on fuzzy numbers by means of Zadeh's extension Principle [22-24].Then some of the noteworthy contributions on Fuzzy numbers and its applications have been made by Dubois and Prade [6, 7], Kaufmann [9], Kaufmann and Gupta [10], Mizumoto and Tanaka [13], Nahmias [18] and Nguyen [19]. Interval Arithmetic was first suggested by Dwyer [8] in 1951. The same was developed by Moore [14, 15].Various operations on fuzzy numbers were also available in the literature [4, 17] which includes a new operation on Triangular fuzzy number for solving linear programming problem. But these operations are not adequate explicitly. Out of several higher order fuzzy sets, intuitionistic fuzzy sets (IFS) [1,2] have been found to be highly useful to deal with vagueness. There are situations where due to insufficiency in the information available, the evaluation of membership values is not also always possible and consequently there remains a part indeterministic on which hesitation survives. Certainly fuzzy set theory is not appropriate to deal with such problems; rather intuitionistic fuzzy set (IFS) theory is more suitable. The Intuitionistic fuzzy set was introduced by Atanassov.K.T [1] in 1986. For the fuzzy multiple criteria decision making problems, the degree of satisfiability and non- satisfiability of each alternative with respect to a set of criteria is often represented by an intuitionistic fuzzy number (IFN), which is an element of IFS [11, 21].This Intuitionistic fuzzy mathematics is very little studied subject and the extension of fuzzy arithmetic operations to Intuitionistic fuzzy set is needed. Modified new arithmetic operations on intuitionistic triangular fuzzy numbers (TIFNS) are developed in this paper. According to intuitionistic fuzzy arithmetic operation using function principle [4,16], we have $\tilde{A}^I - \tilde{A}^I = \{(0,0,0);(0,0,0)\}$and

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$\frac{\tilde{A}^I}{\tilde{A}^I} \neq \tilde{1}^I = \{(1,1,1);(1,1,1)\}$. However, in optimization and many engineering applications, it can be desirable to have crisp values for $\tilde{A}^I - \tilde{A}^I$and $\frac{\tilde{A}^I}{\tilde{A}^I}$. i.e., the crisp values 0 and 1 respectively. To overcome the above, the standard intuitionistic fuzzy arithmetic operations on intuitionistic triangular fuzzy number are modified for subtraction and division operations with some necessary conditions and its application is also provided here to enhance the robustness of the new operations developed by us.
The paper is organized as follows. Section 2 deals with some preliminary definitions and the modified operations on triangular fuzzy number using function principle. In section 3 and 4, the new intuitionistic fuzzy arithmetic operations on intuitionistic triangular fuzzy number and its properties are discussed. In section 5, the definition of Intuitionistic fuzzy multi-objective linear programming problem with accuracy function is given. An application of this new operation is discussed with intuitionistic fuzzy multi-objective linear programming problem (IFMOLPP) in section 6 and some concluding remarks are given in section 7.

2 Preliminaries

Definition 2.1. *[1] Given a fixed set $X = \{x_1, x_2, ..., x_n\}$, an intuitionistic fuzzy set (IFS)is defined as $\tilde{A}^I = (\langle x_i, \mu_{\tilde{A}^I(x_i)}, v_{\tilde{A}^I}(x_i)\rangle x_i \in X)$ which assigns to each element x_i, a membership degree $\mu_(x_i)$ and a non-membership degree $v_A(x_i)$ under the condition $0 \leq \mu_A(x_i) + v_A(x_i) \leq 1$, for all $x_i \in X$.*

Definition 2.2. *[10] A triangular intuitionistic fuzzy number (TIFN)$\tilde{A}^I$ is an intuitionistic fuzzy set in R with the following membership function $\mu_{\tilde{A}^I}(x)$ and non-membership function $v_{\tilde{A}^I}(x)$*

$$\mu_{\tilde{A}^I}(x)=\begin{cases} \frac{x-a_1}{a_2-a_1}, a_1 \leq x \leq a_2 \\ \frac{x-a_3}{a_2-a_3}, a_2 \leq x \leq a_3 \\ 0, otherwise \end{cases} \quad and\ v_{\tilde{A}^I}(x)=\begin{cases} \frac{a_2-x}{a_2-a_1'}, a_1' \leq x \leq a_2 \\ \frac{x-a_2}{a_3'-a_2}, a_2 \leq x \leq a_3' \\ 1, otherwise \end{cases},$$

where $a_1' \leq a_1 \leq a_2 \leq a_3 \leq a_3'$ and $\mu_{\tilde{A}^I}(x) + v_{\tilde{A}^I}(x) \leq 1$ or $\mu_{\tilde{A}^I}(x) = v_{\tilde{A}^I}(x)$ for all $x \in R$
This TIFN is denoted by $\tilde{A}^I = (a_1, a_2, a_3; a_1', a_2, a_3') = \{(a_1, a_2, a_3); (a_1', a_2, a_3')\}$

2.1 Positive triangular intuitionistic fuzzy number

A positive triangular intuitionistic fuzzy number is denoted as $\{(a_1, a_2, a_3); (a_1', a_2, a_3')\}$ where all $a_i's$ and $a_i''s > 0$ for all $i = 1, 2, 3$.

2.2 Negative triangular intuitionistic fuzzy number

A negative triangular intuitionistic fuzzy number is denoted as $\{(a_1, a_2, a_3); (a_1', a_2, a_3')\}$ where all $a_i's$ and $a_i''s < 0$ for all $i = 1, 2, 3$.

2.3 Modified operations of triangular intuitionistic fuzzy numbers using function principle

The following are the modified operations that can be performed on triangular intuitionistic fuzzy numbers: Let $\tilde{A}^I = \{(a_1, a_2, a_3); (a_1', a_2, a_3')\}$ and $\tilde{B}^I = \{(b_1, b_2, b_3); (b_1', b_2, b_3')\}$

Then

1. Addition:$\tilde{A}^I + \tilde{B}^I = \{(a_1 + b_1, a_2 + b_2, a_3 + b_3); (a_1' + b_1', a_2 + b_2, a_3' + b_3')\}$.

2. Subtraction: $\tilde{A}^I - \tilde{B}^I = \{(a_1 - b_3, a_2 - b_2, a_3 - b_1); (a_1' - b_3', a_2 - b_2, a_3' - b_1')\}$.

3. Multiplication:$\tilde{A}^I \times \tilde{B}^I = \{(min(a_1b_1, a_1b_3, a_3b_1, a_3b_3), a_2b_2, max(a_1b_1, a_1b_3, a_3b_1, a_3b_3));$
$(min(a_1'b_1', a_1'b_3', a_3'b_1', a_3'b_3'), a_2b_2, max(a_1'b_1', a_1'b_3', a_3'b_1', a_3'b_3'))\}$.

4. Division: $\frac{\tilde{A}^I}{\tilde{B}^I} = \{(min(\frac{a_1}{b_1}, \frac{a_1}{b_3}, \frac{a_3}{b_1}, \frac{a_3}{b_3}), \frac{a_2}{b_2}, max(\frac{a_1}{b_1}, \frac{a_1}{b_3}, \frac{a_3}{b_1}, \frac{a_3}{b_3}))$ $(min(\frac{a_1^{'}}{b_1^{'}}, \frac{a_1^{'}}{b_3^{'}}, \frac{a_3^{'}}{b_1^{'}}, \frac{a_3^{'}}{b_3^{'}}), \frac{a_2}{b_2}, max(\frac{a_1^{'}}{b_1^{'}}, \frac{a_1^{'}}{b_3^{'}}, \frac{a_3^{'}}{b_1^{'}}, \frac{a_3^{'}}{b_3^{'}}))\}$.

Example 2.1. *Let* $\tilde{A}^I = \{(2,4,6);(1,4,7)\}$ *and* $\tilde{B}^I = \{(1,2,3);(0.5,2,3.5)\}$
Then

1. $\tilde{A}^I + \tilde{B}^I = \{(3,6,9);(1.5,6,10.5)\}$
2. $\tilde{A}^I - \tilde{B}^I = \{(-1,2,5);(-2.5,2,6.5)\}$
3. $\tilde{A}^I \times \tilde{B}^I = \{(2,8,18);(0.5,8,24.5)\}$
4. $\frac{\tilde{A}^I}{\tilde{B}^I} = \{(0.6,2,6);(0.286,2,14)\}$
5. $\frac{\tilde{A}^I}{\tilde{A}^I} = \{(0.333,1,3);(0.143,1,7)\}$

Remark 2.1. *As mentioned earlier that* $\tilde{A}^I - \tilde{A}^I \neq \tilde{0}^I = \{(0,0,0);(0,0,0)\}$;
$\frac{\tilde{A}^I}{\tilde{A}^I} \neq \tilde{1}^I = \{(1,1,1);(1,1,1)\}$.
It follows that $\tilde{C}^I$ *is the solution of the intuitionistic fuzzy linear equation* $\tilde{A}^I + \tilde{B}^I = \tilde{C}^I$. *Then we would expect* $\tilde{B}^I = \tilde{C}^I - \tilde{A}^I$.
For example, $\tilde{A}^I + \tilde{B}^I = \{(2,4,6);(1,4,7)\} + \{(1,2,3);(0.5,2,3.5)\} = \{(3,6,9);(1.5,6,10.5)\}$.
But$\{(1,2,3);(0.5,2,3.5)\} = \{(1,2,3);(0.5,2,3.5)\} - \{(2,4,6);(1,4,7)\}$
$\{(1,2,3);(0.5,2,3.5)\} = \{(-3,2,7);(-5.5,2,9.5)\} \neq \tilde{B}^I$.
The same thing appears when solving the intuitionistic fuzzy equation $\tilde{A}^I \times \tilde{B}^I = \tilde{C}^I$ *whose solution is not given by* $\tilde{B}^I = \frac{\tilde{C}^I}{\tilde{A}^I} = \frac{\{(2,8,18);(0.5,8,24.5)\}}{\{(2,4,6);(1,4,7)\}}$
$\tilde{B}^I = \{(\frac{2}{6}, \frac{8}{4}, \frac{18}{2});(\frac{0.5}{7}, \frac{8}{4}, \frac{24.5}{1})\} = \{(0.333,2,9);(0.071,2,24.5)\} \neq \tilde{B}^I$
Therefore, the addition and subtraction (respectively multiplication and division) of intuitionistic triangular fuzzy numbers are not reciprocal operations. According to this statement, it is not possible to solve inverse problems exactly using the standard fuzzy arithmetic operators. To overcome this in function principle operation of triangular intuitionistic fuzzy numbers, a new operation is proposed that allows exact inversion.

3 A New Operation for Subtraction on intuitionistic Triangular fuzzy Number:

In this section our objective is to develop a new subtraction operator on triangular intuitionistic fuzzy number, which is the exact inverse of the addition $'+'$.

3.1 Condition on Subtraction Operator

Let $\tilde{A}^I = \{(a_1,a_2,a_3);(a_1^{'},a_2,a_3^{'})\}$ and $\tilde{B}^I = \{(b_1,b_2,b_3);(b_1^{'},b_2,b_3^{'})\}$
Then $\tilde{A}^I - \tilde{B}^I = \{(a_1-b_1,a_2-b_2,a_3-b_3);(a_1^{'}-b_1^{'},a_2-b_2,a_3^{'}-b_3^{'})\}$.
The new subtraction operation exists only if the following conditions are satisfied $D(\tilde{A}^I) \geq D(\tilde{B}^I)$ and $D(\tilde{A}^{I'}) \geq D(\tilde{B}^{I'})$, where $D(\tilde{A}^I) = \frac{a_3-a_1}{2}, D(\tilde{B}^I) = \frac{b_3-b_1}{2}, D(\tilde{A}^{I'}) = \frac{a_3^{'}}{2}$ and $D(\tilde{B}^I) = \frac{b_3^{'}-b_2^{'}}{2}$. Here D denotes difference point of a intuitionistic triangular fuzzy number.

3.2 Properties of Subtraction Operator

1. Inverse operator of $+$: $\tilde{B}^I + (\tilde{A}^I - \tilde{B}^I) = (\tilde{A}^I - \tilde{B}^I) + \tilde{B}^I$
2. Multiplication by a scalar: $\lambda(\tilde{A}^I - \tilde{B}^I) = \lambda\tilde{A}^I - \lambda\tilde{B}^I$
3. Neutral element: $\tilde{A}^I - \tilde{0}^I = \tilde{A}^I$
4. Associativity: $\tilde{A}^I - (\tilde{B}^I - \tilde{C}^I) = (\tilde{A}^I - \tilde{B}^I) - \tilde{C}^I$

5. Inverse element: Any intuitionistic triangular fuzzy number is its own inverse under the modified subtraction i.e., $\tilde{A}^I - \tilde{A}^I = \tilde{0}^I$

6. Regularity:$\tilde{A}^I - \tilde{B}^I = \tilde{A}^I - \tilde{C}^I \Rightarrow \tilde{B}^I = \tilde{C}^I$

7. Pseudo - distributivity with respect to + : $(\tilde{A}^I + \tilde{B}^I) - (\tilde{C}^I + \tilde{D}^I) = (\tilde{A}^I - \tilde{C}^I) + (\tilde{B}^I - \tilde{D}^I)$

3.3 Mid point of a intuitionistic triangular fuzzy number

Let $\tilde{A}^I = \{(a_1, a_2, a_3); (a_1^{'}, a_2, a_3^{'})\}$ and $\tilde{B}^I = \{(b_1, b_2, b_3); (b_1^{'}, b_2, b_3^{'})\}$
Then $M(\tilde{A}^I) = \frac{a_3+a_1}{2}$,$M(\tilde{B}^I) = \frac{b_3+b_1}{2}$,$M(\tilde{A}^{I^{'}}) = \frac{a_3^{'}+a_1^{'}}{2}$, $M(\tilde{B}^{I^{'}}) = \frac{b_3^{'}+b_1^{'}}{2}$.Here M denotes midpoint of a intuitionistic triangular fuzzy number.

3.4 Necessary Existence Condition for Subtraction

Proposition 3.1. *The new subtraction operations exists only if the following conditions are satisfied* $D(\tilde{A}^I) \geq D(\tilde{B}^I)$ *and* $D(\tilde{A}^{I^{'}}) \geq D(\tilde{B}^{I^{'}})$.

Proof 1. *We have derived the necessary existence condition for*$\tilde{A}^I - \tilde{B}^I$ *which is equal to* $\{(C_1, C_2, C_3); (C_1^{'}, C_2, C_3^{'})\}$.
Let as take $C_1 \leq C_2 \leq C_3 \Rightarrow C_1 \leq C_3 \Rightarrow a_1 - b_1 \leq a_3 - b_3$
$\Rightarrow [M(\tilde{A}^I) - D(\tilde{A}^I)] - [M(\tilde{B}^I) - D(\tilde{B}^I)] \leq [M(\tilde{A}^I) + D(\tilde{A}^I)] - [M(\tilde{B}^I) + D(\tilde{B}^I)]$
$\Rightarrow [M(\tilde{B}^I) + D(\tilde{B}^I)] - [M(\tilde{B}^I) - D(\tilde{B}^I)] \leq [M(\tilde{A}^I) + D(\tilde{A}^I)] - [M(\tilde{A}^I) - D(\tilde{A}^I)]$
$\Rightarrow 2D(\tilde{B}^I) \leq 2D(\tilde{A}^I)$
$\Rightarrow D(\tilde{B}^I) \leq D(\tilde{A}^I)$
$\Rightarrow D(\tilde{A}^I) \geq D(\tilde{B}^I)$
Similarly we can prove $D(\tilde{A}^{I^{'}}) \geq D(\tilde{B}^{I^{'}})$.
These are the necessary conditions for new subtraction operator.

4 Condition on Division Operator:

Let $\tilde{A}^I = \{(a_1, a_2, a_3); (a_1^{'}, a_2, a_3^{'})\}$ and $\tilde{B}^I = \{(b_1, b_2, b_3); (b_1^{'}, b_2, b_3^{'})\}$
Then $\frac{\tilde{A}^I}{\tilde{B}^I} = \{(\frac{a_1}{b_1}, \frac{a_2}{b_2}, \frac{a_3}{b_3}); (\frac{a_1^{'}}{b_1^{'}}, \frac{a_2}{b_2}, \frac{a_3^{'}}{b_3^{'}})\}$.

The new division operator exists only if the following conditions are satisfied $\mid \frac{D(\tilde{A}^I)}{M(\tilde{A}^I)} \mid \geq \mid \frac{D(\tilde{B}^I)}{M(\tilde{B}^I)} \mid ; \mid \frac{D(\tilde{A}^{I^{'}})}{M(\tilde{A}^{I^{'}})} \mid \geq \mid \frac{D(\tilde{B}^{I^{'}})}{M(\tilde{B}^{I^{'}})} \mid$ and the negative triangular intuitionistic fuzzy number should be changed into negative multiplication of positive triangular intuitionistic fuzzy number.

4.1 Properties of Division Operator

1. Inverse operator of X:$\tilde{B}^I \times (\frac{\tilde{A}^I}{\tilde{B}^I}) = (\frac{\tilde{A}^I}{\tilde{B}^I}) \times \tilde{B}^I$

2. Neutral element: The singleton $\tilde{1}^I = \{(1,1,1); (1,1,1)\}$ defined by constant profile equal to $\tilde{1}^I$ is a right neutral element of division $\frac{\tilde{A}^I}{\tilde{1}^I} = \{(\frac{a_1}{1}, \frac{a_2}{1}, \frac{a_3}{1}); (\frac{a_1^{'}}{1}, \frac{a_2}{1}, \frac{a_3^{'}}{1})\} = \{(a_1, a_2, a_3); (a_1^{'}, a_2, a_3^{'})\} = \tilde{A}^I$

3. Inverse element: Any triangular intuitionistic fuzzy number is its own inverse under modified division operator$\frac{\tilde{A}^I}{\tilde{A}^I} = \{(\frac{a_1}{a_1}, \frac{a_2}{a_2}, \frac{a_3}{a_3}); (\frac{a_1^{'}}{a_1^{'}}, \frac{a_2}{a_2}, \frac{a_3^{'}}{a_3^{'}})\} = \{(1,1,1); (1,1,1)\} = \tilde{1}^I$

4. Regularity: $\frac{\tilde{A}^I}{\tilde{B}^I} = \frac{\tilde{A}^I}{\tilde{C}^I} \Rightarrow \tilde{B}^I = \tilde{C}^I$

5. Distributivity with regard to +:$\frac{\tilde{A}^I + \tilde{B}^I}{\tilde{C}^I} = \frac{\tilde{A}^I}{\tilde{C}^I} + \frac{\tilde{B}^I}{\tilde{C}^I}$

4.2 Necessary Existence Condition for Division

Proposition:
We have derived the necessary existence condition for $\frac{\tilde{A}^I}{\tilde{B}^I}$ which is equal to $\{(C_1, C_2, C_3); (C_1^{'}, C_2, C_3^{'})\}$.
Let as take $C_1 \leq C_2 \leq C_3 \Rightarrow C_1 \leq C_3 \Rightarrow \frac{a_1}{b_1} \leq \frac{a_3}{b_3}$
$\Rightarrow \frac{[M(\tilde{A}^I)-D(\tilde{A}^I)]}{[M(\tilde{B}^I)-D(\tilde{B}^I)]} \leq \frac{[M(\tilde{A}^I)+D(\tilde{A}^I)]}{[M(\tilde{B}^I)+D(\tilde{B}^I)]}$
$\Rightarrow \{M(\tilde{A}^I)M(\tilde{B}^I) + M(\tilde{A}^I)D(\tilde{B}^I) - D(\tilde{A}^I)M(\tilde{B}^I) - D(\tilde{A}^I)D(\tilde{B}^I)\} \leq \{M(\tilde{A}^I)M(\tilde{B}^I) - M(\tilde{A}^I)D(\tilde{B}^I) + D(\tilde{A}^I)M(\tilde{B}^I) - D(\tilde{A}^I)D(\tilde{B}^I)\}$
$\Rightarrow 2M(\tilde{A}^I)D(\tilde{B}^I) \leq 2D(\tilde{A}^I)M(\tilde{B}^I)$
$\Rightarrow \frac{D(\tilde{B}^I)}{M(\tilde{B}^I)} \leq \frac{D(\tilde{A}^I)}{M(\tilde{A}^I)}$
In this $\tilde{B}^I$ may be positive or negative. So we take the condition as $\mid \frac{D(\tilde{A}^I)}{M(\tilde{A}^I)} \mid \geq \mid \frac{D(\tilde{B}^I)}{M(\tilde{B}^I)} \mid$. Similarly we can prove $\mid \frac{D(\tilde{A}^{I'})}{M(\tilde{A}^{I'})} \mid \geq \mid \frac{D(\tilde{B}^{I'})}{M(\tilde{B}^{I'})} \mid$.
These are the necessary conditions for new subtraction operator.

5 Intuitionistic Fuzzy Multi-Objective Linear Programming Problem (IF-MOLPP):

Multi objective linear Programming with Triangular Intuitionistic Fuzzy Variables is defined as Minimize: $[\tilde{C}_1^I \tilde{x}^I, \tilde{C}_2^I \tilde{x}^I, ..., \tilde{C}_n^I \tilde{x}^I]$
Subject to $\sum_{j=1}^{n} \tilde{a}_{ij}^I \tilde{x}_j^I \leq \tilde{b}_i^I$, $\tilde{x}_j^I \geq 0$
where $i = 1, 2, ..., m; j = 1, 2, ..., n$ where $\tilde{A}^I = (\tilde{a_{ij}^I}), \tilde{C}^I, \tilde{b}^I, \tilde{x}^I$ are $(m \times n), (1 \times n), (m \times 1), (n \times 1)$ intuitionistic fuzzy matrices consisting of triangular intuitionistic fuzzy numbers (TIFN).

5.1 Accuracy function [16]:

Let $\tilde{A}^I = \{(a_1, a_2, a_3); (a_1^{'}, a_2, a_3^{'})\}$ be a TIFN.
Then we define $(\tilde{A}^I) = \frac{\{(a_1+2a_2+a_3)+(a_1^{'}+2a_2+a_3^{'})\}}{8}$, an accuracy function of $\tilde{A}^I$, to defuzzify the given number.

Example 5.2. *Here we are going to solve fully intuitionistic fuzzy multi-objective linear programming problem using simplex algorithm and using new operators.*
Maximize $\{\tilde{Z}_1^I = \tilde{4}^I \tilde{x}_1^I + \tilde{10}^I \tilde{x}_2^I, \tilde{Z}_2^I = \tilde{2}^I \tilde{x}_1^I + \tilde{5}^I \tilde{x}_2^I\}$
Subject to the constraints

$$\tilde{2}^I \tilde{x}_1^I + \tilde{1}^I \tilde{x}_2^I = \tilde{5}^I$$
$$\tilde{2}^I \tilde{x}_1^I + \tilde{5}^I \tilde{x}_2^I = \tilde{10}^I$$
$$\tilde{2}^I \tilde{x}_1^I + \tilde{3}^I \tilde{x}_2^I = \tilde{9}^I$$

We consider the first objective with the given constraints and it can be written as
Maximize $\{\tilde{Z}_1^I = \tilde{4}^I \tilde{x}_1^I + \tilde{10}^I \tilde{x}_2^I + \tilde{0}^I \tilde{s}_1^I + \tilde{0}^I \tilde{s}_2^I + \tilde{0}^I \tilde{s}_3^I\}$
Subject to the constraints

$$\tilde{2}^I \tilde{x}_1^I + \tilde{1}^I \tilde{x}_2^I + \tilde{1}^I \tilde{s}_1^I = \tilde{5}^I$$
$$\tilde{2}^I \tilde{x}_1^I + \tilde{5}^I \tilde{x}_2^I + \tilde{1}^I \tilde{s}_2^I = \tilde{10}^I$$
$$\tilde{2}^I \tilde{x}_1^I + \tilde{3}^I \tilde{x}_2^I + \tilde{1}^I \tilde{s}_3^I = \tilde{9}^I$$

Using Simplex Algorithm (by5.1),the current solution is
$\tilde{x}_1^I = \{(0, 0, 0); (0, 0, 0)\}$ *and* $\tilde{x}_2^I = \{(1.5, 2, 2.75); (1.385, 2, 2.875)\}$
Hence, Maximize $\tilde{Z}_1^I = \{(13.5, 20, 30.250); (12.465, 20, 33.063)\} = \tilde{20}^I$

Using Simplex Algorithm (by5.1, then the current solution is
Here, $\tilde{x}_1^I = \{(0, 0, 0); (0, 0, 0)\}$ *and* $\tilde{x}_2^I = \{(1.5, 2, 2.75); (1.385, 2, 2.875)\}$

Hence, Maximize $\tilde{Z}_2^I = \{(6, 10, 16.5); (5.540, 10, 18.688)\} = \tilde{10}^I$

6 Conclusion

The main aim of this paper is to introduce a new operation for subtraction and division on intuitionistic triangular fuzzy number which will be the inverse operations of addition and multiplication. These operations may help us to reduce the computational complexities exist in solving many optimization problems.

References

[1] Atanassov.K.T., More on intuitionistic fuzzy sets, *Fuzzy Sets and Systems*, 33(1986), 37-46.

[2] Atanassov.K.T., Intuitionistic fuzzy sets, *Fuzzy Sets and Systems*, 20(1986), 87-96.

[3] Alefeld, G., and Herzberger, J., *Introduction to Interval Computation*, Academic Press, New York, 1983.

[4] Chen, S.H ., Operations on fuzzy numbers with function principle, *Tamkang Journal of Management*, 6(1)(1985), 13 - 26.

[5] Compas.L and Verdegay.J.L ., Linear Programming Problems and ranking of fuzzy numbers, *Fuzzy Sets and Systems*, 32(1989), 1- 11.

[6] Dubois,D.,and Prade,H., perations of Fuzzy Number's, *Internat.J. Systems Sci.,* 9(6)(1978), 613-626.

[7] Dubois, D., and Prade, H., *Fuzzy Sets and Systems, Theory and Applications* Academic Press, New York, 1980.

[8] Dwyer,P.S., *Linear Computation*, New York, 1951.

[9] Kaufmann,A., *Introduction to theory of Fuzzy Subsets*, Academic Press, New York, 1975.

[10] Kaufmann,A.,andGupta,M.M., *Introduction to Fuzzy Arithmetic*, Van Nostrand Reinhold, New York, 1985.

[11] Liu H.W. Synthetic decision based on intuitionistic fuzzy relations, *Journal of Shandong University of Technology*, 33(5)(2003), 579-581.

[12] G.S.Mahapatra and T.K.Roy, *Reliability Evaluation using Triangular Intuitionistic Fuzzy numbers Arithmetic operations*., World Academy of science, Engineering and Technology 50(2009), 574-581.

[13] Mizumoto,M.,andTanaka,K.,*The four Operations of Arithmetic on Fuzzy Numbers*., Systems Comput. Controls 7(5) (1977)73-81.

[14] Moore,R.E., *Interval Analysis*.,Printice Hall,Inc. Englewood & Cliffs, N.J., 1966.

[15] Moore,R.E., *Methods andApplications of Interval Analysis*., SIAM, Philadelphia, 1979.

[16] A.Nagoorgani and K.Ponnalagu , *Solving Linear Programming Problem in an Intuitionistic Environment*., Proceedings of the Heber international conference on Applications of Mathematics and Statistics, HICAMS 5-7(2012).

[17] A. Nagoorgani and S.N. Mohamed Assarudeen, A new operation on Triangular fuzzy number for solving linear programming problem, *Applied Mathematical Sciences*,6(11)(2012), 525- 532.

[18] Nahmias, S., *Fuzzy variables, Fuzzy sets and systems*', 1(2) (1977)97-110.

[19] Neumaier, A., *Interval Methods for Systems of Equations*., Cambridge University Press, Cambridge, (1990).

[20] Nguyen,H.T., A Note on extension principle for fuzzysets, *J. Math. Anal. Appl.*, 64(1978), 369-380.

[21] Rardin, R.L.,*Optimization in Operations Research*, Pearson Education, New Delhi, 2003.

[22] Xu Z.S., Intuitionistic preference relations and their application in group decision making, *Information Sciences*, (177)(2007), 2363-2379.

[23] Zadeh,L.A., The concept of a Linguistic variable and its applications to approximate Reasoning-parts I, II and III"., *Information Sciences*, 8(1975), 199-249; 8, 1975301-357; 9(1976) 43-80.

[24] Zadeh, L.A., Fuzzy sets, *Information and Control*, 8(1965), 339-353.

[25] Zadeh,L.A., Fuzzy sets as a basis for a theory of possibility, *Fuzzy Sets and Systems*, 1(1978), 3-28.

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