

Studies for Some Triple Sequences Spaces of Fuzzy Real Numbers Defined by Triple Minimal Orlicz Functions

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Abstract: In this paper, we present the studies for some triple sequences spaces of fuzzy real numbers defined by triple minimal Orlicz functions and discuss some properties like $m(\mathbb{M}, \varphi, \Delta_b^a, \rho)_{\mathbb{F}}^3$ does not solid , $m(\mathbb{M}, \varphi, \Delta_b^a, \rho)_{\mathbb{F}}^3$ does not symmetric, $m(\mathbb{M}, \varphi, \Delta_b^a, \rho)_{\mathbb{F}}^3$ does not convergence-free .

Keywords: Solidity, symmetric, convergence-free, triple sequence, fuzzy real numbers, minimal Orlicz function , triple minimal Orlicz function .

1. Introduction

Sargent ([3],[4]) was the first to use the space $m(\varphi)$. He looked at some of the properties of the space $m(\varphi)$. Later, it was studied from the perspective of sequence space, and Rath and Tipathy [2],Tripathy and Sen ([7],[8],[9]), Tripathy and Mahanta [6], and others characterized some matrix classes with one member as $m(\varphi)$.

In this paper , we introduce the triple sequences spaces $m(\mathbb{M}, \varphi, \Delta_b^a, \rho)_{\mathbb{F}}^3$ of fuzzy real numbers defined by the triple absolute Orlicz function . Definitions and preliminaries which are needed in our work have been provided in Section two. In the third section , we look at some of the properties of the space .

$\mathbb{P}(\mathbb{Q})$ denotes the set of all permutations of the element of (\mathbb{Q}_{nm}) , i.e. $\mathbb{P}(\mathbb{Q}) = \{(\mathbb{Q}_{\pi(nm)}) : \pi \text{ be a permutation on } \mathbb{N}\}$, in which \mathbb{N} be a set of natural numbers.

Assume that \mathfrak{Y}_{sre} is a class of all \mathbb{N} subsets that do not have more than elements , r,e . For all $n,m,t \in \mathbb{N}$, (φ_{nmt}) is a non-decreasing triple sequence of positive real numbers with the form $nmtj\varphi_{(n+1)(m+1)(t+1)} \leq (n+1)(m+1)(t+1)\varphi_{nmt}$.

2. Definitions and Preliminaries

If $\mathfrak{M}_1 < \mathfrak{M}_2$ implies $G(\mathfrak{M}_1) \leq G(\mathfrak{M}_2)$, $\forall \mathfrak{M}_1, \mathfrak{M}_2 \in \mathbb{R}$ then a map $G : \mathbb{R} \rightarrow \mathbb{R}$ is called non-decreasing .

If $G(\mathfrak{M}) = G(-\mathfrak{M})$, $\forall \mathfrak{M} \in \mathbb{R}$ then a map $G : \mathbb{R} \rightarrow \mathbb{R}$ is called even .

If the inequality $G\left(\frac{\mathfrak{N}_1 + \mathfrak{N}_2}{2}\right) \leq \frac{1}{2}(G(\mathfrak{N}_1) + G(\mathfrak{N}_2))$, $\forall \mathfrak{N}_1, \mathfrak{N}_2 \in \mathbb{R}$ then a map $G : \mathbb{R} \rightarrow \mathbb{R}$ is called convex .

If $\forall \varepsilon > 0, \exists \varsigma > 0 \exists |G(\mathfrak{N}) - G(a)| < \varepsilon, \forall \mathfrak{N} \in (a, a + \varsigma)$ then a map $G : \mathbb{R} \rightarrow \mathbb{R}$ is said to be a continuous from the right at .

An Orlicz function is a function $M : [0, \infty) \rightarrow [0, \infty)$, which is a continuous, non-decreasing , and convex with $M(0) = 0, M(\mathfrak{A}) > 0$ as $\mathfrak{A} > 0$ and $M(\mathfrak{A}) \rightarrow \infty$ as $\mathfrak{A} \rightarrow \infty$.

A minimal Orlicz function is a function $H : [0, \infty) \rightarrow [0, \infty) \exists H(\mathfrak{A}) = \mathfrak{A}M(\mathfrak{A})$ and M is Orlicz function , which is a continuous , non-decreasing and convex with $H(0) = 0, H(\mathfrak{A}) > 0$ as $\mathfrak{A} > 0$ and $H(\mathfrak{A}) \rightarrow \infty$ as $\mathfrak{A} \rightarrow \infty$.

A triple minimal Orlicz function is a function $\mathbb{M} : [0, \infty) \times [0, \infty) \times [0, \infty) \rightarrow [0, \infty) \times [0, \infty) \times [0, \infty) \exists \mathbb{M}(\mathfrak{A}, \mathfrak{S}, \mathfrak{R}) = (\mathbb{M}_1(\mathfrak{A}), \mathbb{M}_2(\mathfrak{S}), \mathbb{M}_3(\mathfrak{R}))$, where $\mathbb{M}_1 : [0, \infty) \rightarrow [0, \infty) \exists \mathbb{M}_1(\mathfrak{A}) = \mathfrak{A}M_1(\mathfrak{A})$ and $\mathbb{M}_2 : [0, \infty) \rightarrow [0, \infty) \exists \mathbb{M}_2(\mathfrak{S}) = \mathfrak{S}M_2(\mathfrak{S})$ and $\mathbb{M}_3 : [0, \infty) \rightarrow [0, \infty) \exists \mathbb{M}_3(\mathfrak{R}) = \mathfrak{R}M_3(\mathfrak{R})$.These functions are non-decreasing, continuous, even, convex , that hold the following conditions :

- i) $\mathbb{M}_1(0) = 0, \mathbb{M}_2(0) = 0, \mathbb{M}_3(0) = 0 \Rightarrow \mathbb{M}(0, 0, 0) = (\mathbb{M}_1(0), \mathbb{M}_2(0), \mathbb{M}_3(0)) = (0, 0, 0)$.
- ii) $\mathbb{M}_1(\mathfrak{A}) > 0, \mathbb{M}_2(\mathfrak{S}) > 0, \mathbb{M}_3(\mathfrak{R}) > 0 \Rightarrow \mathbb{M}(\mathfrak{A}, \mathfrak{S}, \mathfrak{R}) = (\mathbb{M}_1(\mathfrak{A}), \mathbb{M}_2(\mathfrak{S}), \mathbb{M}_3(\mathfrak{R})) > (0, 0, 0)$, for $\mathfrak{A} > 0, \mathfrak{S} > 0, \mathfrak{R} > 0$,by which we say $(\mathfrak{A}, \mathfrak{S}, \mathfrak{R}) > (0, 0, 0)$ that $\mathbb{M}_1(\mathfrak{A}) > 0, \mathbb{M}_2(\mathfrak{S}) > 0, \mathbb{M}_3(\mathfrak{R}) > 0$.

iii) $M_1(\mathfrak{A}) \rightarrow \infty, M_2(\mathfrak{S}) \rightarrow \infty, M_3(\mathfrak{R}) \rightarrow \infty$ as $\mathfrak{A} \rightarrow \infty, \mathfrak{S} \rightarrow \infty, \mathfrak{R} \rightarrow \infty \Rightarrow M(\mathfrak{A}, \mathfrak{S}, \mathfrak{R}) = (M_1(\mathfrak{A}), M_2(\mathfrak{S}), M_3(\mathfrak{R})) \rightarrow (\infty, \infty, \infty)$ as $(\mathfrak{A}, \mathfrak{S}, \mathfrak{R}) \rightarrow (\infty, \infty, \infty)$ by which we say $M(\mathfrak{A}, \mathfrak{S}, \mathfrak{R}) \rightarrow (\infty, \infty, \infty)$ as $M_1(\mathfrak{A}) \rightarrow \infty, M_2(\mathfrak{S}) \rightarrow \infty, M_3(\mathfrak{R}) \rightarrow \infty$.

If $(\alpha_{\ell k j} \mathfrak{A}_{\ell k j}) \in \mathbb{E}^3$ whenever $(\mathfrak{A}_{\ell k j}) \in \mathbb{E}^3$ for every quadruple sequence $(\alpha_{\ell k j})$ of scalars with $|\alpha_{\ell k j}| \leq 1, \forall \ell, k, j \in \mathbb{N}$ then the quadruple sequence spaces \mathbb{E}^3 is a solid .

If $(\mathfrak{A}_{\pi(\ell)\pi(k)\pi(j)}) \in \mathbb{E}^3$ whenever $(\mathfrak{A}_{\ell k j}) \in \mathbb{E}^3$, then a triple sequence spaces \mathbb{E}^3 is a symmetric .

If $(\mathfrak{S}_{\ell k j}) \in \mathbb{E}^3$ whenever $(\mathfrak{A}_{\ell k j}) \in \mathbb{E}^3$ and $\mathfrak{A}_{\ell k j} = 0$ implies $\mathfrak{S}_{\ell k j} = 0$, then a quadruple sequence spaces \mathbb{E}^4 is a convergent-free .

A fuzzy real number \mathbb{F} is a fuzzy subset of the real line \mathbb{R} , i.e. a mapping $\mathbb{F} : \mathbb{R} \rightarrow [0,1]$ associating each real number r with its grade of membership $\mathbb{F}(r)$, satisfies the following conditions :

1. \mathbb{F} is a convex if for each $\mathbb{F}(r_2) \geq \mathbb{F}(r_1) \wedge \mathbb{F}(r_3) = \min\{\mathbb{F}(r_1), \mathbb{F}(r_3)\}, \forall r_1 < r_2 < r_3, \forall r_1, r_2, r_3 \in \mathbb{R}$.
2. \mathbb{F} is normal if there is a $r_0 \in \mathbb{R}$ and $\mathbb{F}(r_0) = 1$.
3. \mathbb{F} is upper-semi-continuous $\forall a \in \mathbb{I}, \forall \varepsilon > 0$ and $\mathbb{F}^{-1}([0, a + \varepsilon])$ is open in the usual topology of \mathbb{R}
4. \mathbb{F} is a non-negative fuzzy number $\forall r < 0$ implies $\mathbb{F}(r) = 0$.

The set of all non-negative fuzzy numbers of $\mathbb{R}(\mathbb{I})$ denoted by $\mathbb{R}^*(\mathbb{I})$. Let $\mathbb{R}(\mathbb{I})$ denote the set of all fuzzy numbers which are upper-semi continuous , normal and have compact support, i.e. if $H \in \mathbb{R}(\mathbb{I})$ then H^∞ is compact, for any $\alpha \in [0,1]$, where

$$H^\alpha = \{r \in \mathbb{R} : H(r) \geq \alpha, \text{if } \alpha \in [0,1]\}.$$

$$H^0 = \text{closure of } (\{r \in \mathbb{R} : H(r) > 0, \text{if } \alpha = 0\}).$$

We define and offer the triple sequences space $m(M, \varphi, \Delta_b^a, p)_{\mathbb{F}}^3$ as follows :

$$m(M, \varphi, \Delta_b^a, p)_{\mathbb{F}}^3 = \left\{ Q_{nmt} = ((Q_1)_{nmt}, (Q_2)_{nmt}, (Q_3)_{nmt}) : \sup_{s,r,e \geq 1, o \in \mathcal{Y}_{sre}} \frac{1}{\varphi_{sre}} \sum_{n \in o} \sum_{m \in o} \sum_{t \in o} \left[\left(M_1 \left(\frac{\bar{d}(\Delta_b^a(Q_1)_{nmt}, \bar{0})}{\rho} \right) \vee M_2 \left(\frac{\bar{d}(\Delta_b^a(Q_2)_{nmt}, \bar{0})}{\rho} \right) \vee M_3 \left(\frac{\bar{d}(\Delta_b^a(Q_3)_{nmt}, \bar{0})}{\rho} \right) \right]^p \right] < (\infty, \infty, \infty), \text{for some } \rho > 0 \right\}, \forall 0 < p < \infty \text{ where } M = (M_1, M_2, M_3).$$

3. Main results

Theorem 3.1 :

$\forall 0 < p < \infty, m(M, \varphi, \Delta_b^a, p)_{\mathbb{F}}^3$ does not solid .

Proof :

Suppose $a = 2, b = 3, p = 2$. Let $(Q_{nmt}) = ((Q_1)_{nmt}, (Q_2)_{nmt}, (Q_3)_{nmt}) = (\overline{nmt}, \overline{nmt}, \overline{nmt}), \forall n, m, t \in \mathbb{N}$ and $\varphi_{sre} = sre, \forall s, r, e \in \mathbb{N}$. Assume that $(x_1, x_2, x_3) = (|x_1|, |x_2|, |x_3|), \forall x_1, x_2, x_3 \in [0, \infty)$. Then $\bar{d}(\Delta_3^2 Q_{nmt}, \bar{0}) = 0, \forall n, m, t \in \mathbb{N}$. Then we have

$$\sup_{s,r,e \geq 1, o \in \mathcal{Y}_{sre}} \frac{1}{sre} \sum_{n \in o} \sum_{m \in o} \sum_{t \in o} \left[\left(M_1 \left(\frac{\bar{d}(\Delta_3^2(Q_1)_{nmt}, \bar{0})}{\rho} \right) \vee M_2 \left(\frac{\bar{d}(\Delta_3^2(Q_2)_{nmt}, \bar{0})}{\rho} \right) \vee M_3 \left(\frac{\bar{d}(\Delta_3^2(Q_3)_{nmt}, \bar{0})}{\rho} \right) \right)^2 \right] < (\infty, \infty, \infty), \text{for some } \rho > 0.$$

This tends to ,

$$(Q_{nmt}) = (Q_1)_{nmt}, (Q_2)_{nmt}, (Q_3)_{nmt} \in m(M, sre, \Delta_3^2, 2)_{\mathbb{F}}^3.$$

Take the triple sequence for example $(\alpha_{nmt}) = ((\alpha_1)_{nmt}, (\alpha_2)_{nmt}, (\alpha_3)_{nmt})$ a collection of scalars specified by,

$$\alpha_{nmt} = \begin{cases} (1,1,1), & \forall n, m, t \text{ is even} \\ (0,0,0), & \text{otherwise} \end{cases}$$

$$\text{Now, } \alpha_{nmt} Q_{nmt} = \begin{cases} \overline{nmt}, & \forall n, m, t \text{ is even} \\ (0,0,0), & \text{otherwise} \end{cases}.$$

This implies that,

$$\sup_{s,r,e \geq 1, o \in \mathfrak{Y}_{sre}} \frac{1}{sre} \sum_{n \in o} \sum_{m \in o} \sum_{t \in o} \left[\left(M_1 \left(\frac{\bar{d}(\Delta_3^2(\alpha_1)_{nmt}, \bar{0})}{\rho} \right) \vee M_2 \left(\frac{\bar{d}(\Delta_3^2(\alpha_2)_{nmt}, \bar{0})}{\rho} \right) \vee M_3 \left(\frac{\bar{d}(\Delta_3^2(\alpha_3)_{nmt}, \bar{0})}{\rho} \right) \right) \right]^2 = (\infty, \infty, \infty), \text{ for fixed } \rho > 0.$$

Therefore $\alpha_{nmt} \notin m(M, sre, \Delta_3^2, 2)_{\mathbb{F}}^3$.

Thus,

$m(M, \varphi, \Delta_b^a, p)_{\mathbb{F}}^3$ does not solid, for $0 < p < \infty$.

Proposition 3.2 :

$\forall 0 < p < \infty, m(M, \varphi, \Delta_b^a, p)_{\mathbb{F}}^3$ does not symmetric.

Proof :

Assume $a = 1, b = 1, p = \frac{1}{2}$. Let $M(x_1, x_2, x_3) = (x_1^2, x_2^2, x_3^2), \forall x_1, x_2, x_3 \in [0, \infty)$. Suppose $\varphi_{sre} = sre, \forall s, r, e, c \in \mathbb{N}$.

Let $(Q_{nmt}) = ((Q_1)_{nmt}, (Q_2)_{nmt}, (Q_3)_{nmt}) = (\overline{nmt}, \overline{nmt}, \overline{nmt}), \forall n, m, t \in \mathbb{N}$. Then $\bar{d}(\Delta Q_{nmt}, \bar{0}) = 1, \forall n, m, t \in \mathbb{N}$.

Consequently $(Q_{nmt}) \in m(M, sre, \Delta, \frac{1}{2})_{\mathbb{F}}^4$.

Assume $(S_{nmt}) = ((S_1)_{nmt}, (S_2)_{nmt}, (S_3)_{nmt})$ be a reorganization of $(Q_{nmt}) \ni (S_{nmt}) = (Q_{111}, Q_{222}, Q_{444}, Q_{333}, Q_{999}, Q_{555}, Q_{161616}, Q_{666}, Q_{252525}, \dots)$

Then, $\bar{d}(\Delta S_{nmt}, \bar{0}) = ((nmt-1)^2 + (2nmt-1), (nmt-1)^2 + (2nmt-1), (nmt-1)^2 + (2nmt-1)) = ((nmt)^2, (nmt)^2, (nmt)^2), \forall n, m, t \in \mathbb{N}$.

This demonstrates that,

$$\sup_{s,r,e \geq 1, o \in \mathfrak{Y}_{sre}} \frac{1}{sre} \sum_{n \in o} \sum_{m \in o} \sum_{t \in o} \left[\left(M_1 \left(\frac{\bar{d}(\Delta(S_1)_{nmt}, \bar{0})}{\rho} \right) \vee M_2 \left(\frac{\bar{d}(\Delta(S_2)_{nmt}, \bar{0})}{\rho} \right) \vee M_3 \left(\frac{\bar{d}(\Delta(S_3)_{nmt}, \bar{0})}{\rho} \right) \right) \right]^{\frac{1}{2}} = (\infty, \infty, \infty), \text{ for some } \rho > 0.$$

Therefore $(S_{nmt}) \notin m(M, sre, \Delta, \frac{1}{2})_{\mathbb{F}}^3$.

Thus ,

$m(M, \varphi, \Delta_b^a, p)_{\mathbb{F}}^3$ does not symmetric.

Proposition 3.3 :

$\forall 0 < p < \infty, m(M, \varphi, \Delta_b^a, p)_{\mathbb{F}}^3$ does not convergence-free .

Proof :

Assume $a = 1, b = 4, p = \frac{1}{2}$, Let $M(x_1, x_2, x_3) = (x_1^4, x_2^4, x_3^4), \forall x_1, x_2, x_3 \in [0, \infty)$. Let take $\varphi_{sre} = sre, \forall s, r, e \in \mathbb{N}$.

Consider the triple sequence $(Q_{nmt}) = ((Q_1)_{nmt}, (Q_2)_{nmt}, (Q_3)_{nmt})$, which is described as:

$$Q_{nmt}(x) = \begin{cases} (1 + nmtx, 1 + nmtx, 1 + nmtx), & \forall x \in \left[\frac{-1}{nmt}, 0 \right], \\ (1 - nmtx, 1 - nmtx, 1 - nmtx), & \forall x \in \left[0, \frac{1}{nmt} \right], \\ (0, 0, 0) & \text{otherwise} \end{cases}$$

$$\text{Then, } \Delta_4 Q_{nmt}(x) = \begin{cases} \left(1 + \frac{nmt(nmt+4)}{2nmt+4} x, 1 + \frac{nmtj(nmt+4)}{2nmt+4} x, 1 + \frac{nmtj(nmt+4)}{2nmt+4} x \right), & \forall x \in \left[\frac{-2nmt+4}{nmt(nmt+4)}, 0 \right], \\ \left(1 - \frac{nmt(nmt+4)}{2nmt+4} x, 1 - \frac{nmtj(nmt+4)}{2nmt+4} x, 1 - \frac{nmtj(nmt+4)}{2nmt+4} x \right), & \forall x \in \left[0, \frac{2nmt+4}{nmt(nmt+4)} \right], \\ (0, 0, 0) & \text{otherwise} \end{cases}$$

As,

$$\bar{d}(\Delta_4 \mathfrak{Q}_{nmt}, \bar{0}) = \left(\frac{2nmt+4}{nmt(nmt+4)}, \frac{2nmt+4}{nmt(nmt+4)}, \frac{2nmt+4}{nmt(nmt+4)} \right) = \left(\frac{1}{nmt} + \frac{1}{nmt+4}, \frac{1}{nmt} + \frac{1}{nmt+4}, \frac{1}{nmt} + \frac{1}{nmt+4} \right).$$

We get, $\sup_{s,r,e \geq 1, \sigma \in \mathfrak{Y}_{sre}} \frac{1}{sre} \sum_{n \in \sigma} \sum_{m \in \sigma} \sum_{t \in \sigma} \left[\left(\mathbb{M}_1 \left(\frac{\bar{d}(\Delta_4(\mathfrak{Q}_1)_{nmt}, \bar{0})}{\rho} \right) \vee \mathbb{M}_2 \left(\frac{\bar{d}(\Delta_4(\mathfrak{Q}_2)_{nmt}, \bar{0})}{\rho} \right) \vee \mathbb{M}_3 \left(\frac{\bar{d}(\Delta_4(\mathfrak{Q}_3)_{nmt}, \bar{0})}{\rho} \right) \right) \right]^{\frac{1}{2}}$ for fixed $\rho > 0$.

Therefore $(\mathfrak{Q}_{nmt}) \in m(\mathbb{M}, sre, \Delta_4, \frac{1}{2})_{\mathbb{F}}^3$.

Consider the triple sequence $(\mathfrak{S}_{nmt}) = ((\mathfrak{S}_1)_{nmt}, (\mathfrak{S}_2)_{nmt}, (\mathfrak{S}_3)_{nmt}) \ni$

$$\mathfrak{S}_{nmt}(x) = \begin{cases} \left(1 + \frac{x}{(nmt)^2}, 1 + \frac{x}{(nmt)^2}, 1 + \frac{x}{(nmt)^2} \right), & \forall x \in [-(nmt)^2, 0], \\ \left(1 - \frac{x}{(nmt)^2}, 1 - \frac{x}{(nmt)^2}, 1 - \frac{x}{(nmt)^2} \right), & \forall x \in [0, (nmt)^2], \\ (0,0,0) & \text{otherwise} \end{cases}$$

So that,

$$\Delta_4 \mathfrak{S}_{nmt}(x) = \begin{cases} \left(1 + \frac{x}{2(nmt)^2 + 8nmt + 16}, 1 + \frac{x}{2(nmt)^2 + 8nmt + 16}, 1 + \frac{x}{2(nmt)^2 + 8nmt + 16} \right), & \forall x \in [-(2(nmt)^2 + 8nmt + 16), 0], \\ \left(1 - \frac{x}{2(nmt)^2 + 8nmt + 16}, 1 - \frac{x}{2(nmt)^2 + 8nmt + 16}, 1 - \frac{x}{2(nmt)^2 + 8nmt + 16} \right), & \forall x \in [0, (2(nmt)^2 + 8nmt + 16)], \\ (0,0,0) & \text{otherwise} \end{cases}$$

Hence,

$$\bar{d}(\Delta_4 \mathfrak{S}_{nmt}, \bar{0}) = (2(nmt)^2 + 8nmt + 16), \forall n, m, t \in \mathbb{N}. \text{ Hence } \sup_{s,r,e \geq 1, \sigma \in \mathfrak{Y}_{sre}} \frac{1}{sre} \sum_{n \in \sigma} \sum_{m \in \sigma} \sum_{t \in \sigma} \left[\left(\mathbb{M}_1 \left(\frac{\bar{d}(\Delta_4(\mathfrak{S}_1)_{nmt}, \bar{0})}{\rho} \right) \vee \right. \right. \\ \left. \left. \mathbb{M}_2 \left(\frac{\bar{d}(\Delta_4(\mathfrak{S}_2)_{nmt}, \bar{0})}{\rho} \right) \vee \mathbb{M}_3 \left(\frac{\bar{d}(\Delta_4(\mathfrak{S}_3)_{nmt}, \bar{0})}{\rho} \right) \right) \right]^{\frac{1}{2}} = (\infty, \infty, \infty).$$

Therefore $(\mathfrak{S}_{nmt}) \notin m(\mathbb{M}, sre, \Delta_4, \frac{1}{2})_{\mathbb{F}}^3$.

Thus,

$m(\mathbb{M}, \varphi, \Delta_b^a, \mathcal{P})_{\mathbb{F}}^3$ does not convergence-free.

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