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Research paper

Soft Sequences in Real Analysis

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Abstract

In This work is an attempt to present new class of limit soft sequence in the real analysis it is called (limit inferior of soft sequence " and limit superior of soft sequence) respectively are introduced and given result an example with two new definitions and studied some of the properties of them are investigated.

Keywords: *limit superior, limit inferior, soft sequences, Soft set, soft real numbers*

1. Introduction

In an ongoing paper [35] S.Das, S.k. samanta, He exhibited two definitions which is soft real sets and soft real numbers along with properties and some documentation examples, Dubois and Prade [3] brought up that "Zadeh [11] utilized the word 'fuzzy' as alluding particularly to the presentation of shades or evaluations in entire/ bust ideas". As indicated by Zadeh [11], a fuzzy' set is a speculation, in the gullible sense, of a subset with limits "slow as opposed to unexpected or sharp". It is characterized by a participation work from a fundamental set to the unit interim and its cuts are sets. Diverse varieties of fuzzy sets are characterized by different researchers like Atanassov [2], Pawlak[10] etc., Anyway there is perplexity in the writing This is what is included between the word and its corresponding meaning in logic of fuzzy' Not accurate description' etc., which sort of allude to absence of adequate data, though the term 'fuzzy' expressly alludes to the possibility of steady change from 'yes' to 'no'. For example, by a fuzzy number [4], we generally mean a function f:R→[0,1], which is upper semi consistent, so that its $\propto -level\ set\ [f]_\propto$ closed interval $[a_\propto\ b_\propto]$, for each $\propto \in (0,1)$ So it may be termed as 'fuzzy interval as commented by Dubios and Prade [3])

2. Preliminaries

Definition 1.1 (Gradual element [3]).
A fuzzy (or graded) component 'e' in 'S' (where S is a given fresh set) is characterized by its task work a from L\{0} to S, where S is finished with littlest component 0 and most prominent component 1. Thus given grade λ $a_e(\lambda)=s$ is the element of S which is the representation of e at level λ. The component (element) S itself has a task work a_e characterized just for λ =1 as $a_s(\lambda)=S$

The idea of fuzzy element can be illustrated as follows:
Consider a curved (convex) fuzzy set M of real line R .

Let $m_\propto$ be the center point of the $\lambda-1$ level of 'm'. then the set of pairs $\{(\alpha, m_\alpha); \alpha \in (0,1]\}$ defines a fuzzy element of R.

Definition 1.2 (Gradual set [3]:
A continuous (gradual) subset G in 'S' is characterized by its task work from L\{0} to 2^s, A solitary fuzzy component e yields a progressive singleton E by letting $A_E(\lambda)=a_e(\lambda), \lambda \in L\setminus\{0\}$. More for the most part, the continuous set G prompted by the group of fuzzy components $e_1, e_2, \ldots, e_k$ $\in S$ with task F(x) $a_1, a_2, \ldots a_k$ have its task (assignment) function a_G characterized by $a_G(\lambda)=\{a_1(\lambda), a_2(\lambda), \ldots a_k(\lambda)\}, \forall \lambda \in \bigcup_{i=1}^{k} dom(a_i)$.

Definition 1.3 (Fuzzy set actuated by a progressive (gradual) set [3]:
The participation capacity of fuzzy set incited by the progressive set with task function a_G is $\mu_G(s)=\sup\{\lambda; s \in a_G(\lambda)\}$ with a view to introduce only fuzziness in numbers, Dubios and Prade [3] introduce the following definition of gradual numbers by redefining fuzzy real numbers.

Definition 1.4 (Gradual numbers [3]).
Definition 1.4 (Gradual numbers [3]). A continuous no of ŕ can be demonstrated by a work $A_ŕ$ from the unit interim to the real line (and not the opposite).

Task on steady (Gradual) numbers [3]
Any operation between real numbers is extended to fuzzy real numbers r_1 and r_2 with assignment functions a_α and a_β as $a_{\alpha*\beta}(\lambda)=a_\alpha(\lambda)*a_\beta(\lambda)(a_{\alpha*\beta})(\lambda)$ is the assignment function of r_1*r_2. It is to be noticed that the arrangement of every fuzzy number structures a gathering concerning expansion.

Definition 1.5
Soft set **[9].** Let X be a non-empty crisp set and A be a set which is called index set. A pair (f, L) where $f: A \to$ 2^x it is a map, is said to be a soft set on X.

Example of a Soft set 1.6 [9].
Assume the accompanying: M is the arrangement of the houses Under thought and $M = \{S_1, S_2, S_3, S_4, S_5, S_6\}$. A is the set of parameter and $A = \{e_1, e_2, e_3, e_4, e_5,\}$ ={Beautiful, wooden, shoddy, in the green environment, in great repair}.
Assume that,
$F(e_1) = \{S_{2,}S_4\}, F(e_2) = \{S_1, S_3\}, F(e_3) = \{S_3 S_{4,} S_5\}, F(e_4) = \{S_1, S_3, S_5\}, F(e) = \{S_1\}$, then the soft (F,A) can be looked as a gathering of approximations as underneath:
(F, A)={beautiful house= $\{S_{2,}S_4\}$wooden house= $\{S_1, S_3\}$, shoddy houses= $\{S_3 S_{4,} S_5\}$, in the green surroundings houses = $\{S_1, S_3, S_5\}$ *and* in decent shape houses=$\{S_1\}$

1.7 Soft Real Sets and Soft Real Numbers

Definition 1.8 [35]:
(Soft element or component). Let Y be a non-vacant set and X be a non-vacant parameter set. At that point a function $\varepsilon: X \to Y$ is said to be a soft component of Y. A soft component of Y is said to have a place with a soft set A of Y, meant by $\varepsilon \in A$, if $\varepsilon(e) \in A(e), \forall e \in X$, Thus a soft set A of Y concerning the index set X can be communicated as $A(e) = \{\varepsilon(e), \varepsilon \in A\}, e \in X$
Note 1.9. [35]: It is to be noticed that each singleton soft set (a soft set (F, A) for which $F(e)$ is a singleton set,$\forall \lambda \in A$) can be related to a soft component by basically distinguishing the singleton set with the component that it contains { $\forall \lambda \in A$} .

Definition 1.10. [35]:
Let R be the set of real numbers, $\wp(R)$ be the accumulation of all non vacant bounded subsets of R and A be a set of parameters. At that point a mapping $F: A \to \wp(R)$ is known as a soft real set. It is meant by (F, A), in particular is a singleton soft set, at that point relating (F, A),, to the comparing soft component, it will be known as *a soft real number.*
It can be easily checked that a fuzzy real number [4] is a special case of soft real set
when the parameter set is {0,1}and the $\lambda -$ approximation sets are closed interval for every $\lambda \in A$ It can also be checked that the gradual (fuzzy) real numbers defined by Dubois and Prade [3] are soft real numbers with parameter set {0,1}

Example of soft real set.**1.11**.
[35]: Here we give two different examples of soft real sets.

Example 1.12. [35]
Let R be the set of real numbers and A be a set of parameters given By $A = \{e_1, e_2, e_3, e_4\}$. By assume that

$$F(e_1) = \{3,2,1\}, F(e_2) = \{7,5,4,3\}, F(e_3) = \{1,3\}$$

$$F(e_4) = \{12,41,35,6,0\},$$

then the softreal set (F,A) can be looked as a gathering of approximations as underneath :
(F, A) =
$(e_1, \{1,2,3\}), (e_2, \{4,5,6,7\}), (e_3, \{3,7\}), (e_4, \{12,41,35,6,0\})$.

Example 1.13.
[35] Let R be the set of real numbers and A be a set of parameters given
By $A = \{[1,10],[11,20],[21,30],[31,40],[41,50]\} = \{e_1, e_2, e_3, e_4, e_5\}$
If $F: A \to P(R)$ describes the numbers within the interval" then
$F(e_1) = \{2,3,5,7\}, F(e_2) = \{11,13,17,19\}, F(e_3) = \{23,29\}, F(e_4) = \{31,37\}, F(e_5) = \{41,43,47\}$
then (F,A) can be considered as a soft real set such that (F,A)=

$$e_1\{2,3,5,7\}), (e_2\{11,13,17,19\})$$

$$(e_3, \{23,29\}), (e_4, \{31,37\}), (e_5, \{41,43,47\})\}.$$

Example of soft real number.**1.14**.
[35] We present two different examples of soft real Numbers.

Example 1.15.
[35] Suppose a Nursery school has six classes namely Nursery, KG,Class I, Class II,Class III and Class IV. There is various numbers of students in different classes. If we consider a parameter set A={ KG,Class I, Class II,Class III and Class IV} and defind $F: A \to P(R) by F(e) =$the number of student in class e, if F (Nursery) ={54} ,F(KG)={51} ,F(class I)={44} , F(Class II)={42} ,F(Class III)={62} ,F(Class IV)={49} then identifying (F,A) with the corresponding soft element we get a soft real number (F,A) such tht (F,A)={ Nursery of student =54; KG student =51; Class I students=44, Class II students=42,Class III students=62, Class IV students=49}

Example 1.16.
[35] Consider the example of soft set in If a mapping $G: E \to P(R)$
be define by G(e) the number Of houses a vailable under the category e .
Then we have from 2.6,
$G(e_1) = \{2\}, G(e_2) = \{2\}, G(e_3) = \{3\}, G(e_4) = \{3\}, G(e_5) = \{1\},$
Then (G,E) identifying , with the corresponding soft element, it can be taken as a soft real
number such that G,E)={beautiful houses=2; wooden houses=2; cheap houses=3;in the green surroundings houses=3; in good repair houses=1} . Let us denote the set of all soft real sets by R(A) and the set of all soft real numbers By □ (A).

3. Main Result

Limit superior and limit inferior of soft sequences in Real analysis In this paper we will define limit superior and limit inferior of soft sequences. So will present some properties for them and for (finite,infinite) with two examples and given Result.

Definition: 2.1.
let $\{\tilde{x}_n\}$ be a sequence(rename (seq) of soft Real numbers ,and λ be a fixed real number the limit superior $\overline{\text{lim}} < \tilde{x}_n(\tilde{\lambda}) >$ of soft seq $\{\tilde{x}_n\}$
is defined by:

$$\overline{\text{lim}} < \tilde{x}_n(\tilde{\lambda}) > = \tilde{\inf}_n \tilde{\sup}_{k \geq n} \tilde{x}_k(\tilde{\lambda}).$$

And,
The limit inferior $\underline{\text{lim}} < \tilde{x}_n(\tilde{\lambda}) >$ of soft seq $\{\tilde{x}_n\}$
is defined by:

$$\underline{\text{lim}} < \tilde{x}_n(\tilde{\lambda}) > = \tilde{\sup}_n \tilde{\inf}_{k \geq n} \tilde{x}_k(\tilde{\lambda}).$$

We have $\overline{\lim} < -\tilde{x}_n(\tilde{\lambda}) > = -\underline{\lim} < \tilde{x}_n(\tilde{\lambda}) >$ and,

$$\underline{\lim}[< \tilde{x}_n(\tilde{\lambda}) >] \leq \overline{\lim}[< \tilde{x}_n(\tilde{\lambda}) >].$$

Thus seq $< \tilde{x}_n(\tilde{\lambda}) >$ is converges to an extended soft real numbers ι if and only if

$\iota = \underline{\lim} < \tilde{x}_n(\tilde{\lambda}) > = \overline{\lim} < \tilde{x}_n(\tilde{\lambda}) >$.

Definition:2.2 .

let $\{\tilde{x}_n\}$ be a seq of soft Real sets. Then the seq $\{\tilde{x}_n\}$ is said to be soft converge to a soft real set ' X ' if :

$$\lim_{n\to\infty} \tilde{\sup} < \tilde{x}_n(\tilde{\lambda}) > = \tilde{\sup}\, x(\tilde{\lambda})$$

and, $\lim_{n\to\infty} \tilde{\inf} < \tilde{x}_n(\tilde{\lambda}) > = \tilde{\inf}\, \tilde{x}(\tilde{\lambda}),\ \forall \lambda \in A.$

$\{\tilde{x}_n\}$ is then said to be a soft convergent seq converging to the soft limit x and $x_n \sim$ x .

Example 2.3.

let $\{\tilde{x}_n\}$ be a seq of Real sets. Where $< \tilde{x}_n(\tilde{\lambda}) > = [\tilde{a}_\lambda + (1/\tilde{n})],\ < \tilde{x}_n(\tilde{\lambda}) > = [\tilde{b}_\lambda - (1/\tilde{n})]$, $\forall \lambda \in A, n = 1,2,3$. a_λ, b_λ are fixed real Numbers for each λ . Then for every $\lambda \in A$.

$\underline{\lim} < \tilde{x}_n(\tilde{\lambda}) > = \tilde{b}_\lambda$ and $\overline{\lim} < \tilde{x}_n(\tilde{\lambda}) > = \tilde{a}_\lambda$.

Let $a_\lambda = \zeta$ and , $b_\lambda = \mu$ so $x(\lambda) = (\zeta, \mu)$ and,

Let $y(\lambda) = (\zeta_1, \mu_1), then\ x, y \in R(A)$ and $x \neq y$

but we know that by definition of soft convergence $x_n \sim x$ and $x_n \sim y$.

2.4 Properties of Limit Superior and Limit Inferior of Soft Sequences

Let $< \tilde{x}_n(\tilde{\lambda}) >,\ n \in N^+$ be a bounded seq then

$\alpha = \overline{\lim} < \tilde{x}_n(\tilde{\lambda}) > = \tilde{\inf}_n \tilde{\sup}_{k\geq n} < \tilde{x}_k(\tilde{\lambda}) >$ if and only if $\in > 0$,

1- the seq $\{n \in N^+ :< \tilde{x}_n(\tilde{\lambda}) > \quad > \alpha + \in\}$ is finite

2- the sequence $\{n \in N^+ :< \tilde{x}_n(\tilde{\lambda}) > > \quad \alpha - \in\}$ is infinite

And,

$\beta = \underline{\lim} < \tilde{x}_n(\tilde{\lambda}) > = \tilde{\sup}_n \tilde{\inf}_{k\geq n} < \tilde{x}_k(\tilde{\lambda}) >$ if and only if $\in > 0$

1. The seq $\{n \in N^+ :< \tilde{x}_n(\tilde{\lambda}) > \quad > \beta + \in\}$ is finite
2. The seq $\{n \in N^+ :< \tilde{x}_n(\tilde{\lambda}) > > \quad \beta - \in\}$ is infinite.

Result 2.5

if $< \tilde{x}_n(\tilde{\lambda}) >$ and $< \tilde{y}_n(\tilde{\lambda}) >$ are two sequence then we have

$\underline{\lim} < \tilde{x}_n(\tilde{\lambda}) > + \underline{\lim} < \tilde{y}_n(\tilde{\lambda}) > \leq$

$\underline{\lim} < \tilde{x}_n + \tilde{y}_n > (\tilde{\lambda})$

$\leq \overline{\lim} < \tilde{x}_n(\tilde{\lambda}) > + \underline{\lim} < \tilde{y}_n(\tilde{\lambda}) >$

$\leq \overline{\lim} < \tilde{x}_n + \tilde{y}_n > (\tilde{\lambda})$

$\leq \overline{\lim} < \tilde{x}_n(\tilde{\lambda}) > + \overline{\lim} < \tilde{y}_n(\lambda) >$.

Proposition 2.6:

Let $\{\tilde{x}_n\}$ be a soft convergent seq of negative or positive soft real sets converging to soft real set x , then $\frac{1}{\tilde{x}_n}, \frac{1}{\tilde{x}}$ $provided\ zero$ doesn't $x(\tilde{\lambda})$ for any $\lambda \in A$.

Proof:

Since $\tilde{x}_n \to x$, and '0' is not a member of $x(\lambda)$ for any $\lambda \in A$, x is also either -ve or +ve soft real set . we have for every $\lambda \in A$,

$\overline{\lim} < \tilde{x}_n(\tilde{\lambda}) > = \tilde{\inf}_n \tilde{\sup}_{k\geq n} \tilde{x}_k(\tilde{\lambda})$,and

$\underline{\lim} < x_n(\lambda) > = \tilde{\sup}_n \tilde{\inf}_{k\geq n} \tilde{x}_k(\tilde{\lambda}), \lambda \in A$,

We have for every $\lambda \in A$ and $n \in N$,

$\tilde{\sup}\{1/(\tilde{x}_n(\tilde{\lambda})\} = 1/\tilde{\inf}\{x_n(\tilde{\lambda})\}$ and $\tilde{\inf}\{1/(\tilde{x}_n(\tilde{\lambda})\} = 1/\tilde{\sup}\{\tilde{x}_n(\tilde{\lambda})\},$

Taking limit superior and limit inferior,

$\overline{\lim}\tilde{\sup}\{1/\tilde{x}_n(\tilde{\lambda})\} = \underline{\lim}\tilde{\inf}(1/\tilde{\inf}\{\tilde{x}_n(\tilde{\lambda})\}$

$1/\underline{\lim}\tilde{\inf}\{\tilde{x}_n(\tilde{\lambda})\} = 1/\tilde{\inf}\{\tilde{x}(\tilde{\lambda})\}$

$= \tilde{\sup}(1/\tilde{x})(\tilde{\lambda}),$

Also,

$\underline{\lim}\tilde{\inf}\{(1/\tilde{x}_n(\tilde{\lambda})\} = \overline{\lim}(1/\tilde{\sup}\{\tilde{x}_n(\tilde{\lambda})\}$

$= 1/(\overline{\lim}\tilde{\sup}\{\tilde{x}_n(\tilde{\lambda})\}$

$= 1/\tilde{\sup}\{\tilde{x}(\tilde{\lambda})\} = \tilde{\inf}(1/\tilde{x})(\tilde{\lambda}), \forall \lambda \in A$

$\therefore 1/x_n \square 1/x.$

Example:2.7

suppose seq $\{\tilde{x}_n\}$ of a soft real sets ∋ $\tilde{x}_n \square \tilde{x}$ then the soft seq $1/\tilde{x}_n$ need not converge to the soft real set $1/\tilde{x}$.

Solution:

Taking a seq $\{\tilde{x}_n\}$ of a soft real Numbers we have

$< \tilde{x}_n(\tilde{\lambda}) > = \{-6,-4,-3,1,2,3\}$ for every $\lambda \in A$ for every $n \in N$ And

$< \tilde{x}(\tilde{\lambda}) > = \{-6, 3\},$ for every $\lambda \in A$

$\overline{\lim} < \tilde{x}_n(\tilde{\lambda}) > = \tilde{\inf}_n \tilde{\sup}_{k\geq n} \tilde{x}_k(\tilde{\lambda}) = \tilde{\inf}_n 3 = \sup \tilde{x}(\tilde{\lambda})$, $\forall \lambda \in A,$

$$\underline{\lim} < \tilde{x}_n(\tilde{\lambda}) > \quad = \tilde{\sup}_n \tilde{\inf}_{k \geq n} \tilde{x}_k(\tilde{\lambda}) \quad .=$$

$$-6 = \tilde{\inf}\, \tilde{x}(\tilde{\lambda}), \forall \tilde{\lambda} \in A$$

$so, x_n \square x, But\{1/(\tilde{x}_n(\tilde{\lambda})\} = \{-1/6, -1/4, -1/3, 1, 1/2, 1/3\}, and$

$\{1/(\tilde{x}(\tilde{\lambda}))\} = \{-1/6, 1/3\}$

$$Now, \overline{\lim} < 1/\tilde{x}_n(\tilde{\lambda}) > = \tilde{\inf}_n \tilde{\sup}_{k \geq n} 1/\tilde{x}_k(\tilde{\lambda}) = 1$$

$$\underline{\lim} < 1/\tilde{x}_n(\tilde{\lambda}) > = \tilde{\sup}_n \tilde{\inf}_{k \geq n} 1/\tilde{x}_k(\tilde{\lambda}) = 1/3$$

$\therefore 1/\tilde{x}_n, not\ \ soft\ \ converge$, does not soft converge to the $1/\tilde{x}$.

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