Title: **Extensions of Neutrosophic Theory**

PROF. BROUMI SAID
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TWO DAYS INTERNATIONAL WEBINAR ON FUZZY & NEUTROSOPHIC SYSTEM

Organized by
Department of Mathematical Sciences, Bodoland University, Kokrajhar, India
On
August 21-22, 2020

Objectives of This Session

- Notions of neutrosophic set, neutrosophic logic with examples.
- Neutrosophic theory indexed in the most known scientific Databases.
- Geomertic representation of Neutrosophic Cube.
- Extensions of neutrosophic set.
- Applications of neutrosophic set.
- Neutrosophic tools

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Neutrosophic Sets and Systems

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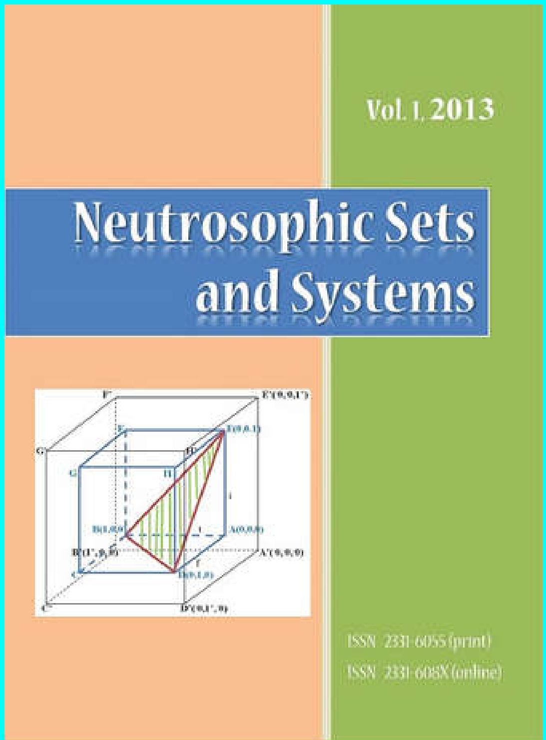

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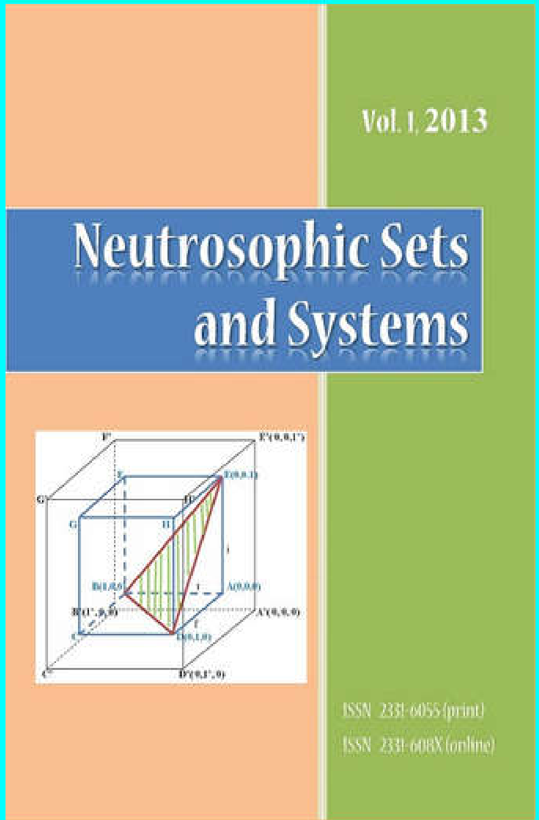

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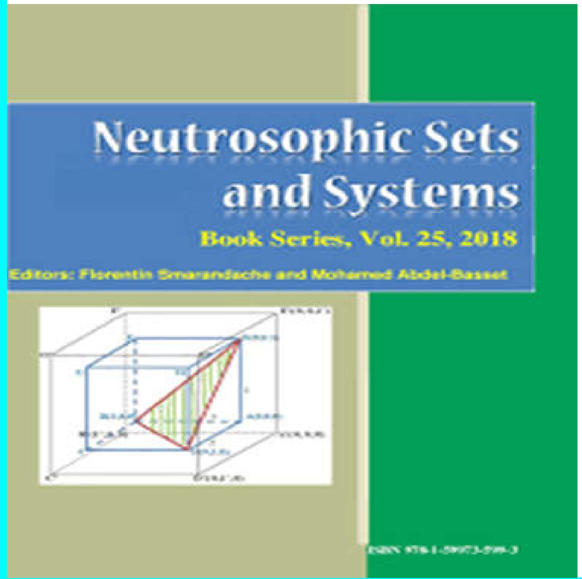

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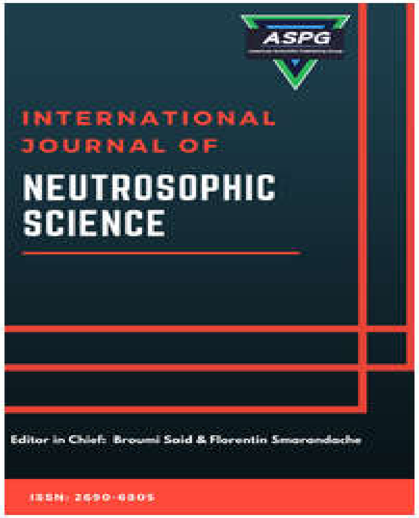

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JOURNAL/CONFERENCE

International Journal of Neutrosophic Science

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International Journal of Neutrosophic Science (IJNS) is a peer-review journal publishing high quality experimental and theoretical research in all areas of Neutrosophic and its Applications. IJNS is published quarterly. IJNS is devoted to the publication of peer-reviewed original research papers lying in the domain of neutrosophic sets and systems. Papers submitted for po

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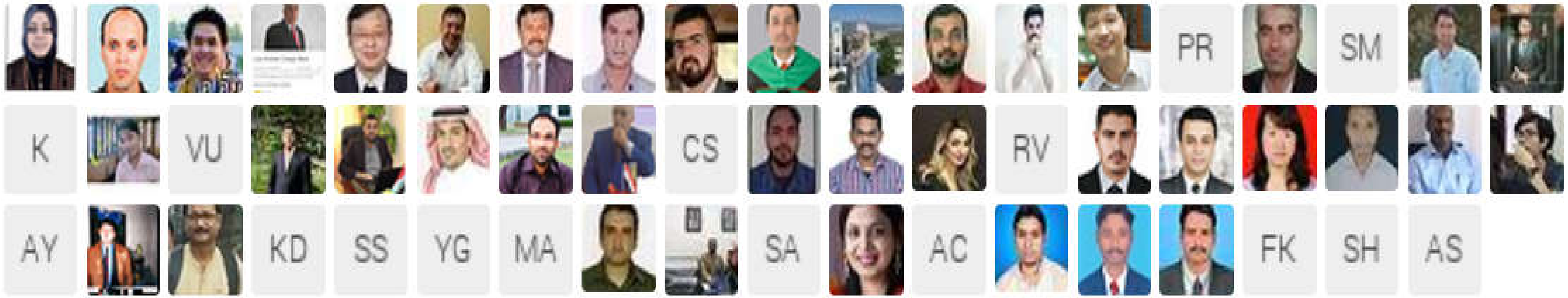

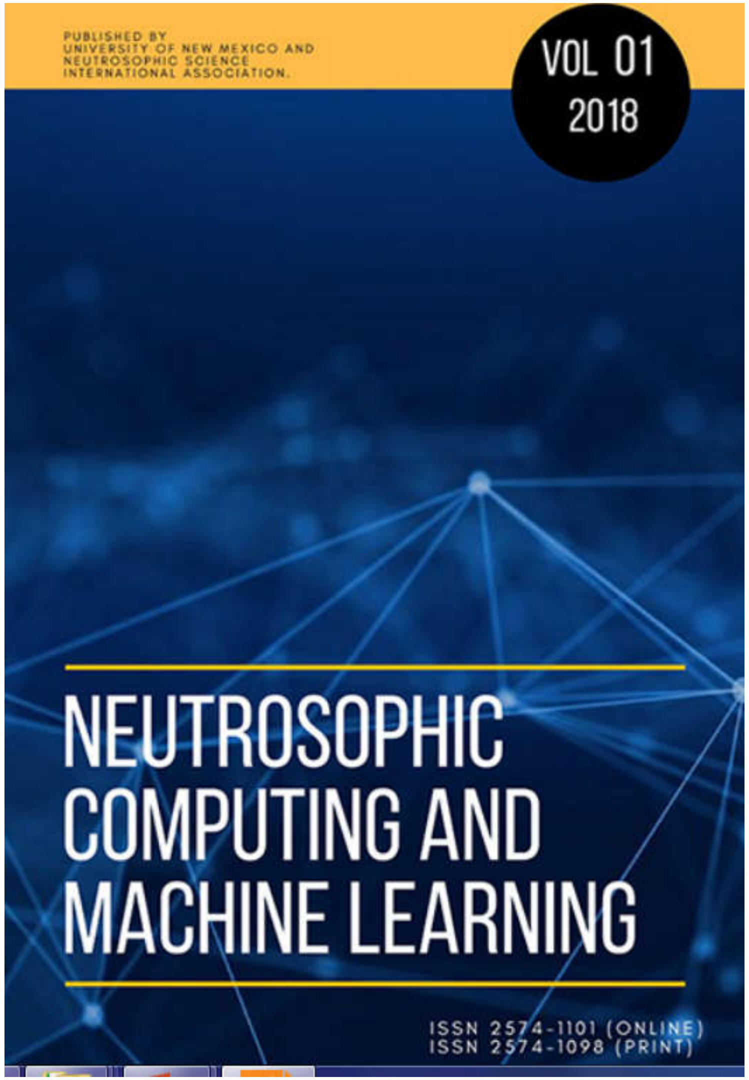

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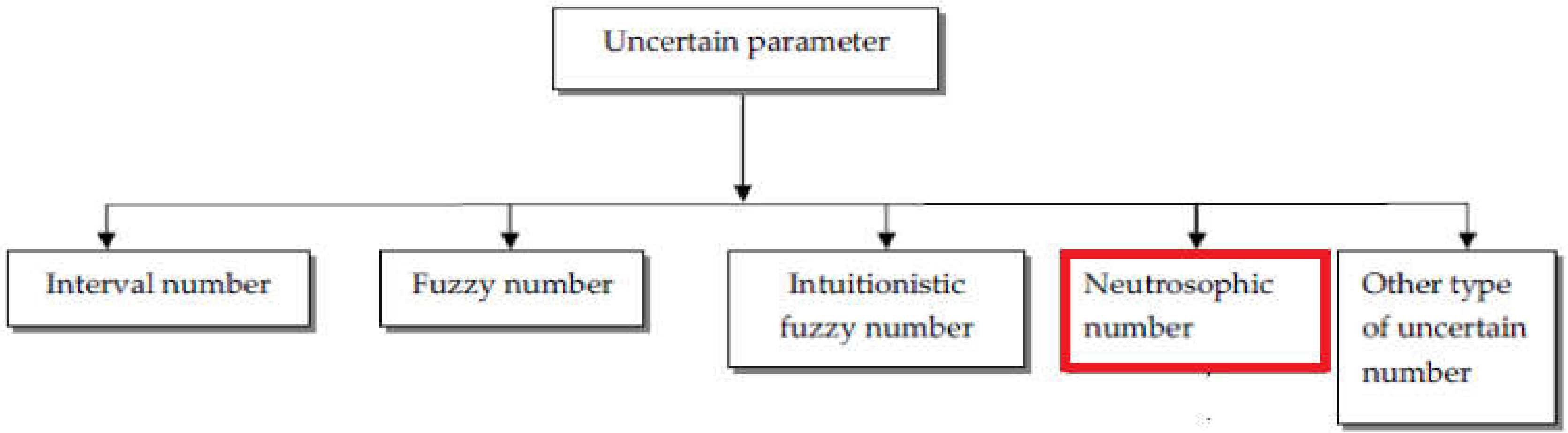


Some basic differences between some uncertain parameters:
If we take Interval number [1] then we can see,
1,The information belongs to a certain interval
2. There is no concept of membership function

If we take Fuzzy number , then we can see,

1. The concept of belongingness of the elements comes
2. The use of membership function is present

If we take Intuitionistic fuzzy number , then we can see,

1. The concept of belongingness and non-belongingness of the elementscomes
2. The use of membership and non-membership function is present

If we take Neutrosophic number , then we can see,

1. The concept of truthiness, falsity, and indeterminacy of the elements comes
2. The use of membership function for truthiness, falsity, and indeterminacy is present

Limit of the Boolean logic

to measure the proposition P = "In 2021 there will be a terrorist attack"? Because in Boolean logic he has to say either P = 0 or P = 1 [only God can say this!].

There are things that are neither black nor white, but also gray…

	Type of Logic	Founder
1	Fuzzy logic (T)	L. Zadeh (1965)
2	Intuitionistic fuzzy logic (T,F)	K.Atanassov (1983)
3	Neutrosophic logic (T,I,F)	F. Smarandache (1995)

- **In classical set theory, the membership of elements in a set is assessed in binary terms 0 and 1; according to a bivalent condition-an element either belongs or does not belong to the set.**
- **As an extension, fuzzy set theory permits the gradual assessment of the membership of elements in a set. A fuzzy set A in X is characterised by a membership function which is associated with each element in X, a real number in the interval [0,1].**
- **Lotfi A Zadeh [1] introduced a theory whose objects fuzzy sets-are sets with imprecise boundaries which allow us to represent vague concepts and contexts in natural language.**
- **Fuzzy set theory is limited to modelling a situation involving uncertainty.**
- **As an extension of fuzzy set concept, the theory of intuitionistic fuzzy sets introduced whose elements have degree of membership and non membership.**
- **Intuitionistic fuzzy sets have been introduced by Krassimir Atanassov [2] as an extension of Lotfi Zadeh's notion of fuzzy set.**
- **Let us have a fixed universe X and A is a subset of X .The intuitionistic fuzzy set can be defined as where . for membership μ and ν for non membership, which belongs to the real unit interval [0,1] and sum belongs to the same interval.**

L. Zadeh (1965)

Fuzzy logic and fuzzy sets (T)

Zadeh's FS is characterized by one part: Truth
Fuzzy logic handles the concepts of partial truth, that is, the truth with values betwen « completely true or 1 » and « completely false or 0 »

Fuzzy sets: represent the membership without expressing the corresponding degree of non membership so it provides an imperfect expression of uncertain information. The degree of nonmembership in fuzzy sets is the complement of membership for fuzzy sets, Therefore the nonmembership is not independent.

A fuzzy set cannot express the information about **rejection**.

A fuzzy set is defined as A = {(x, T(x))}, where
$0 \leq T \leq 1$; T is A function in [0, 1].

[4] L. Zadeh, "Fuzzy logic and approximate reasoning," Synthese, vol. 30, no. 3-4, 1975, pp. 407–428

K.Atanassov (1983)

Intuitionistic fuzzy logic and
Intuitionistic fuzzy sets (T,F)

Intuitionstic fuzzy sets is an extension of **fuzzy sets** which describes vaguness and impresion by a range of membership values.
intuitionistic fuzzy set give a degree of membership and a degree of non-membership of an element in a given set
Atanassov introduced the intuitionistic fuzzy set (IFS) to **bring in non-membership.**

Intuitionistic fuzzy sets, as well as vague sets, are suitable in simulating the impreciseness of human understanding in decision making by representing degree of membership and nonmembership, but it also cannot express indeterminacy degree which is the ignorance value between truth and false.

An **Intuitionistic fuzzy sets is defined as A = {(x, T(x), F(x))}, where**

$0 \leq T + F \leq 1$; T, F are functions in [0, 1].

[2] K. Atanassov, "Intuitionistic fuzzy sets: theory and applications", Physica, New York, 1999.

FOUNDER OF NEUTROSOPHIC LOGIC(SET)

- In 1995, he generalized framework for unification of many existing logics, such as fuzzy logic, paraconsistent logic, intuitionistic logic, etc. The main idea of NL is to characterize each logical statement in a 3D Neutrosophic Space, where each dimension of the space represents respectively
- **1) the truth (T)**
- **2) the falsehood (F) and**
- **3)the indeterminacy (I)**

of the statement under consideration, where T, I, F are standard or non-standard real subsets of $]^{-}0, 1^{+}[$ with not necessarily any connection between them.

Neutrosophic logic /set

As an alternative to the existing logics, Smarandache proposed the neutrosophic Logic to represent a mathematical model of

- **uncertainty vagueness,**
- **ambiguity, imprecision, undefined,**
- **unknown, incompleteness, inconsistency,**
- **redundancy, Contradiction,**

where the concept of neutrosophy is a new branch of philosophy introduced by Smarandache.

F. Smarandache. A Unifying Field in Logics: Neutrosophic Logic. Neutrosophy, Neutrosophic Set, Neutrosophic Probability", American Research Press, Rehoboth, NM, 1999.

F. Smarandache (1995)

Neutrosophic logic and neutrosophic sets(T,I,F)

Fig. 1. An example of indeterminacy. What is tossed, 1, 3 or 5?

Smarandache's NS is characterized by three parts: truth, indeterminacy, and falsity. Truth, indeterminacy and falsity membership values behave independently and deal with the problems of having uncertain, indeterminant and imprecise data

[1] F. Smarandache, "Neutrosophy. Neutrosophic Probability, Set, and Logic," ProQuest Information & Learning, Ann Arbor, Michigan, USA, 105 p., 1995

Florentine and Wang et al. [*] gave a new concept of single valued neutrosophic set (SVNS) and defined the set of theoretic operators in an instance of NS called SVNS

A single valued neutrosophic set is defined as A = {(x, T(x), I(x), F(x))}, where

$$0 \le T + I + F \le 3$$; **T, I, F are functions in [0, 1].**

[*] H. Wang, F. Smarandache, Y. Zhang and R.Sunderraman, "Single Valued Neutrosophic Sets," Multispace and Multisrtucture 4, 2010, pp.410-413.

Definition: Neutrosophic set

Let X be a non empty set, then the set A = $\{(x, \mu_A(x), \sigma_A(x), \pi_A(x)) : x \in X\}$ is called a neutrosophic set on X, where $-0 \leq \mu_A(x) + \sigma_A(x), +\pi_A(x) \leq 3+$ for all $x \in X$, $\mu_A(x), \sigma_A(x)$ *and* $\pi_A(x) \in]-0, 1+[$ are the degree of membership the degree of indeterminacy and the degree of non membership of each $x \in X$ to the set A respectively.

Definition:

The following statements are true for neutrosophic sets A and B on X:

(*i*). $\mu_A(x) \leq \mu_B(x), \sigma_A(x) \geq \sigma_B(x)$ and $\pi_A(x) \geq \pi_B(x)$ for all $x \in X$ if and only if $A \subseteq B$.

(ii) $A \subseteq B$ and $B \subseteq A$ if and only if $A = B$.

(iii) $A \cap B = \{(x, \min\{\mu_A(x), \mu_B(x)\}, \min\{\sigma_A(x), \sigma_B(x)\}, \max\{\pi_A(x), \pi_B(x)\}) : x \in X\}$.

(iv) $A \cup B = \{(x, \max\{\mu_A(x), \mu_B(x)\}, \max\{\sigma_A(x), \sigma_B(x)\}, \min\{\pi_A(x), \pi_B(x)\}) : x \in X\}$

(v) $A^C = \{(x, \pi_A(x), 1 - \sigma_A(x), \mu_A(x)) : x \in X\}$

Indeterminacy

- Indeterminacy is present everywhere in real life. If a die is tossed on a irregular surface then there is no clear face to see. Indeterminacy occurs due to defects in creation of physical space or defective making of physical items involved in the events. Indeterminacy occurs when we are not sure of any event. Neutrosophic logic will help us to consider this indeterminacy.

Fig. 1. An example of indeterminacy. What is tossed, 1, 3 or 5?

Indeterminacy

- **Indeterminacy exists almost everywhere in the whole world:**
- **if weather reports say that the probability of rain tomorrow is 70 % then it does not mean that the probability of not raining is 30% because there are some hidden weather factor like jet stream, weather fronts etc that the reporter are not aware of. So there is some ambiguity that leads to indeterminacy.**
- **Different doctors have different views on the same diagnosis of patient's disease so, indeterminacy exists there,**

Neutrosophy

- Neutrosophy is a new branch of philosophy introduced by Florentin Smarandache, which is studying the origin, nature and scope of neutralities as well as their interactions with different additional spectral (i.e. notions or ideas located between the two extremes, supporting neither nor).
- Etymologically, neutro-sophy [French neuter < Latin neuter, neutral and Greek sophia, skill/wisdom] means knowledge of neutral thought and started in 1995.

• The fundamental theory of neutrosophy is:

Every idea <A> tends to be neutralized, diminished, balanced by <nonA> ideas (not only <antiA> as Hegel asserted) -as a state of equilibrium: <nonA> = what is not <A>,

<antiA> = the opposite of <A>,

and <neutA> = what is neither <A> nor <antiA>.

Neutrosophy consider a proposition, theory, event, concept, or entity, "A" in relation to its opposite, "AntiA" and which is not "A", "Non –A", and that which is neither "A" nor "Anti-A", denoted by "Neut-A".

Neutrosophy is the basis of, neutrosophic set, neutrosophic logic, neutrosophic probability and neutrosophic statistic.

- the neutrosophic triplet (<A>, <neutA>, <antiA>) works when it makes sense in our real world, when it does exist in our everyday life -- not always.
- For example, if <A> = small, then <antiA> = big, and <neutA> = medium; it works.
- But if <A> = table, then it is not possible to say "anti-table" or "neut-table"!

- In a classical way ”A”,”neutA”, and”antiA” are disjoint two by two. Nevertheless, since in many cases the borders between notions are vague and imprecise, it is possible that ”A”, ”neutA”, and ”antiA” have common parts two by two, or even all three of them as well.

Example : In a soccer game there are three chances: to win (<A>), to have a tie game (<neutA>), or to loose (<antiA>).

The Neutrosophy's Triplet is (<A>, <neutroA>, <antiA>), where

<A> may be an item (concept, idea, proposition, theory, structure, algebra, etc.),

<antiA> the opposite of <A>,

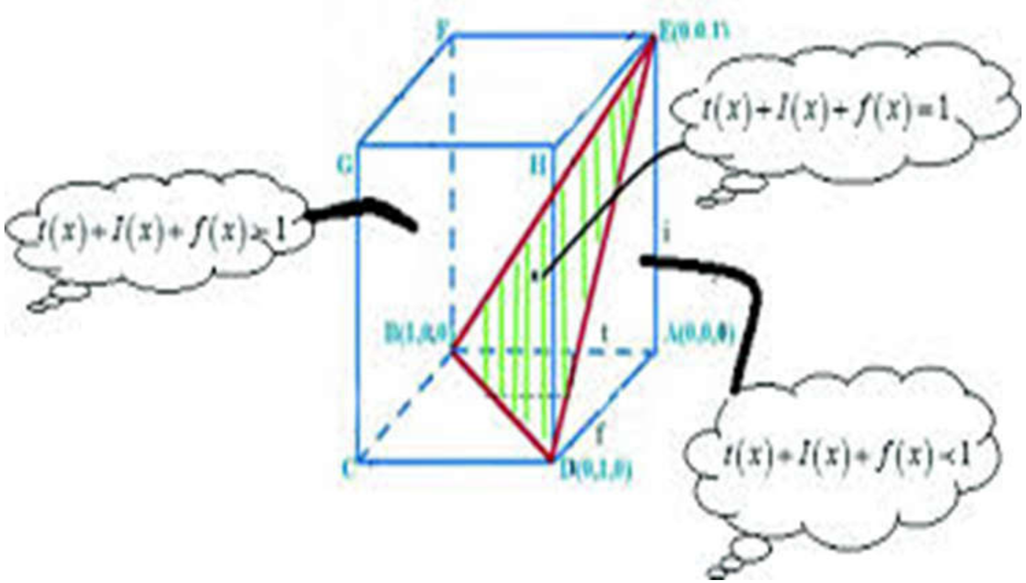
while

<neutroA> {also the notation <neutA> was employed before} the neutral between these opposites.

Based on the above triplet the following Neutrosophic Principle one has: a law of composition defined on a given set may be true (T) for some set elements, indeterminate (I) for other set's elements, and false (F) for the remainder of the set's elements.

NEUTROSOPHIC SET

- To maintain consistency with the classical and fuzzy logics and with probability, there is the special case where $t + i + f = 1$.
- But to refer to intuitionistic logic, which means incomplete information on a variable, proposition or event one has $t + i + f < 1$.
- Analogically, referring to paraconsistent logic, which means contradictory sources of information about a same logical variable, proposition, or event one has $t + i + f > 1$.



Difference between Neutrosophic Set and Intuitionistic Fuzzy Set

Neutrosophic set (NS) is a generalization of Fuzzy set, especially intuitionistic fuzzy set (IFS). Hence, the differences between NS and IFS was studied deeply because one's has known their relation and differences in the first explanation. The difference between NS and IFS summarized in Table 1

TABLE 1. The difference between Neutrosophic Set and Intuitionistic Fuzzy Set.

Neutrosophic Set	Intuitionistic Fuzzy Set
1. In NS there is no restriction on T, I, F: thus NL can characterize the incomplete information (sum < 1), paraconsistent information (sum > 1).	IFS the sum of components (or their superior limits) = 1
2. NS can distinguish, between absolute membership [NS(absolute membership)=1^+] and relative membership[NS(relative membership)=1]	IFS cannot; absolute membership is membership in all possible worlds, relative membership is membership in at least one world.
3. In NS components can be nonstandard	IFS, they don't
4. NS operators can be defined with respect to T,I,F.	IFS operators are defined with respect to T and F only.
5. I can split in NS in more subcomponents (examples in Belnap's four-valued logic (1977) indeterminacy is split into uncertainty and contradiction.)	IFS cannot
6. NS, like dialetheism (some contradiction are true), can deal with paradoxes, NS (paradox element) = (1,I,1)	IFS cannot

Generalization and comment

Because the neutrosophic set is related to intuitionistic fuzzy set, paraconsistent set and fuzzy set, the generalization will focus on these type of sets. Hence, NS generalizes:

1. the *intuitionistic set*, which supports incomplete set theories (for $0 < n < 1$, $0 =< t, i, f <= 1$) and incomplete known elements belonging to a set;
2. the *fuzzy set* (for $n = 1$ and $i = 0$, and $0 =< t, i, f <= 1$);
3. the *classical set* (for $n = 1$ and $i = 0$, with t, f either 0 or 1);
4. the *paraconsistent set* (for $n > 1$, with all $t,i,f < 1^+$);
5. the *faillibilist set* ($i > 0$);
6. the *dialetheist set*, a set M has at least one of its elements also belongs to its complement C(M); thus, the intersection of some disjoint sets is not empty;
7. the *paradoxist set* ($t=f=1$);
8. the *pseudoparadoxist set* ($0 < i < 1$, $t=1$ and $f > 0$ or $t >0$ and $f =1$);
9. the *tautological set* ($i,f < 0$).

Smarandache comment's that; compared to other types of sets, in the neutrosophic set each element has three components which are subsets (not numbers as in fuzzy set) and considers a subset, similarly to intuitionistic fuzzy set, of "indeterminacy" - due to unexpected parameters hidden in some sets, and let the superior limits of the components to even boil over 1 (overloaded) and the inferior limits of the components to even freeze under 0 (underdried).

Difference between Neutrosophic Logic and Intuitionistic Fuzzy Logic

The differences between neutrosophic logic (NL) and intuitionistic fuzzy set (IFS) was summarized in Table 2 NL is attempting to unify many logics in a single field. NL is a generalization of fuzzy logic, especially IFL. Therefore, the difference between them was the importance part in studying NL.

TABLE 2. The difference between Neutrosophic Logic and Intuitionistic Fuzzy Logic.

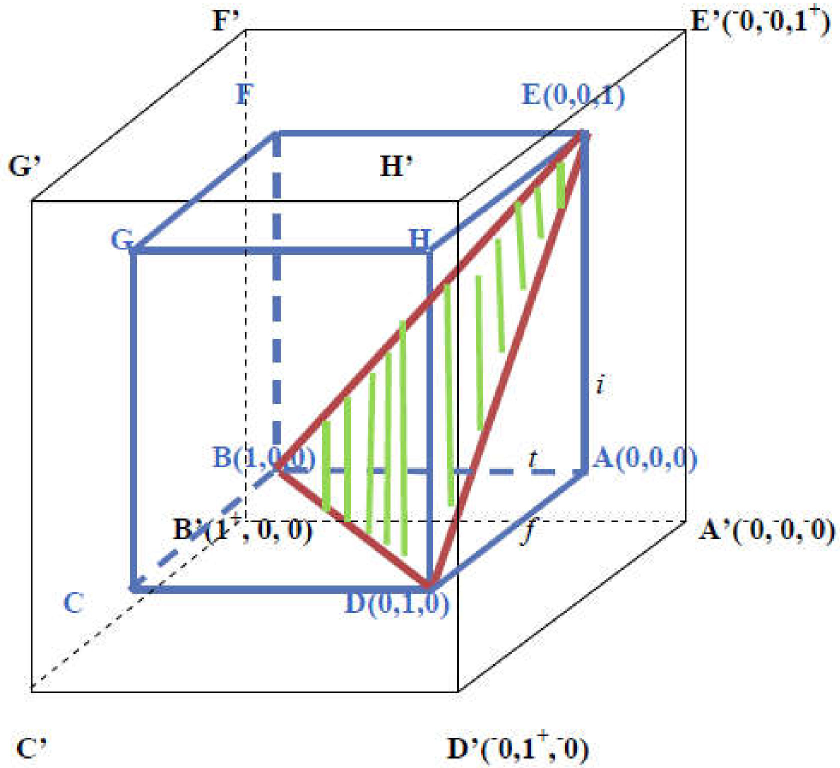
Neutrosophic Logic	Intuitionistic Fuzzy Logic
1. In NL there is no restriction on T, I, F: thus NL can characterize the incomplete information (sum < 1), paraconsistent information (sum > 1).	IFL the sum of components (or their superior limits) = 1
2. NL can distinguish, in philosophy, between absolute truth [NL(absolute truth)=1^+] and relative truth[NL(relative truth)=1]; absolute truth is truth in all possible worlds (Leibniz), relative truth is truth in at least one world	IFL cannot
3. In NL components can be nonstandard.	IFL they don't
4. NL, like dialetheism [some contradictions are true], can deal with paradoxes, NL (paradox) = (1, I, 1).	IFL cannot

Advantages of Neutrosophic Logic

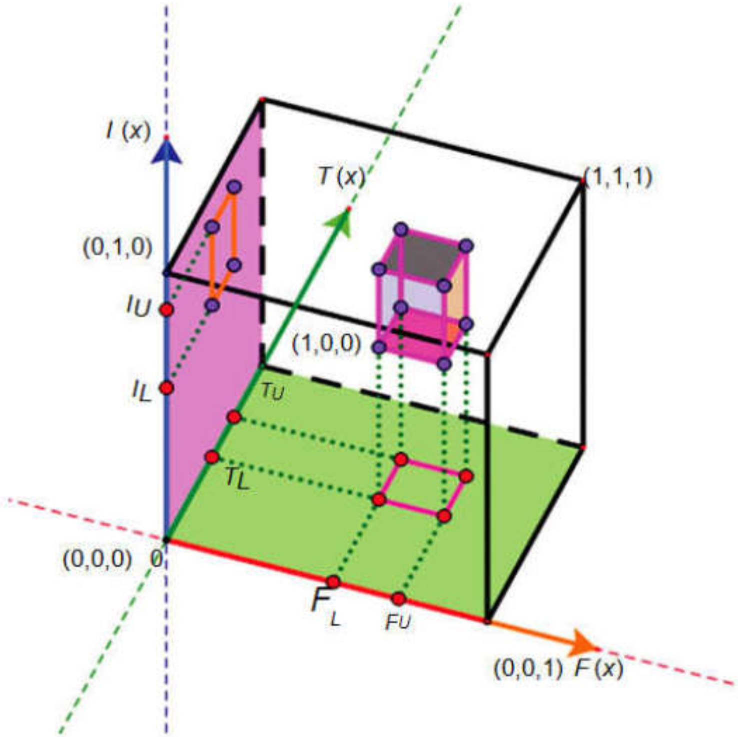
- The advantage of using neutrosophic logic is that this logic distinguishes between relative truth, that is a truth in one or a few worlds only, noted by 1, and absolute truth, that is a truth in all possible worlds, noted by 1+. And similarly, neutrosophic logic distinguishes between relative falsehood, noted by 0, and absolute falsehood, noted by –0.
- In neutrosophic logic the sum of components is not necessarily 1 as in classical and fuzzy logic, but any number between –0 and 3+, and this allows the neutrosophic logic to be able to deal with paradoxes, propositions which are true and false in the same time: thus NL(paradox)=(1, I, 1); fuzzy logic cannot do this because in fuzzy logic the sum of components should be 1.
- When the sum of components $t + i + f = 1$ (classical and fuzzy logic);
- When the sum of components is $t + i + f < 1$ (intuitionistic logic);
- When the sum of components is $t + i + f >= 1$ (paraconsistent logic).

Geomertic representation of Neutrosophic Cube

-The focal objective of neutrosophic logic is to characterize each logical statements in a 3D-neutrosophic space, where each dimension of space represents respectively the truth(T) , falsehood(F) and indeterminacies (I) of the statements under consideration
-in an easy way, every logical variable x is described by an ordered triple. x= (t, i, f)



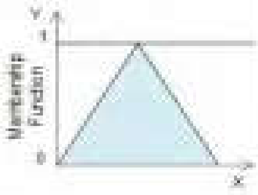
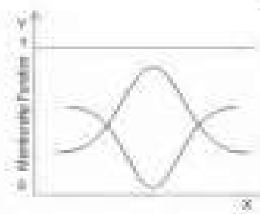
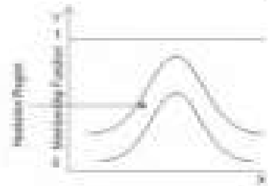
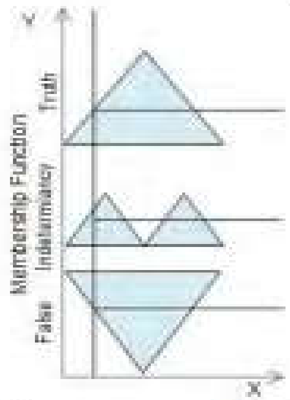
Geomertic representation of interval valued neutrosophic numbers



$[T_L, T_U] x [I_L, I_U] x [F_L, F_U]$

MULTIVALUED LOGIC

Table 1. *Multivalued Logic Membership Function*

	Fuzzy set	Intuitionistic Fuzzy	Vague	Neutrosophic
Membership Function	Degree of belonging	Degree of membership function and non-membership function	Degree of membership function and non-membership function	Degree of membership function, indeterminacy and non-membership function
	 Fig 1. Type1 fuzzy membership function [1]	 Figure 2. Intuitionistic Fuzzy Set [24]	 Figure 3. Vague Set [24]	 Figure 4. Neutrosophic Set [11]

Situations characterized by 3 states

- Now we can give some examples of situations intrinsically characterized by 3 states, some of which stem from, or are similar to, this elementary statistical vision.
- **Chemistry: acidity**
- Also related to life and the conditions it imposes, in organic chemistry we have the measurement of the pH (hydrogen potential, hydrogen ion concentration) of a solution and its representation in 3 classes, neutral, acidic and basic. Here this is due to the primordial role of water in life, and pH 0, therefore neutral, is defined as that of water.

•Chemistry: phase change

In each discipline many examples can be found, here is another in chemistry. During the phenomenon of phase change, as between solid and liquid, matter does not only have two states, the original and the final one, but also a transition state (viscous matter in fusion).

•Physics: electrical charges

Any particle in quantum physics has an electric charge or not, and this charge can be positive or negative. This produces 3 states for the electric charge characteristic of particles: positive, neutral, negative.

Similarly molecules also have a charge that is likewise either positive, neutral or negative. If they are charged then they are called ions, subdivided into positively charged cations and negatively charged anions.

Neutrosophic examples

- We may say for example (0.9, 0.05, 0.05) meaning that 90% of 5 km we are sure about, while 5% of 5 km it is indeterminate, and 5% of 5 km unsure,
- in neutrosophic triplet: proved, unprovable (indeterminate), disproved,
- **in an application Form there are three option : Yes- No/ N.A For gendre M/F/other**
- , ***Neutrosophic logic has its chance to simulate human thinking and to be utilized for real environment executions***

- Let's say there is a soccer game between India and Pakistan. If I ask you who will win, you may say, since you're subjective and patriot, that India will win, let's say with a chance of 70%; but if I ask somebody from Pakistan, he would say that Pakistan will win, let's say with 60% chance. But asking a neutral expert, he may say that there is 40% chance of tie game.
- All sources are independent, meaning they do not communicate with each other and they do not know the response of each other.
- Summing we get $0.7 + 0.6 + 0.4 > 1$.

IDETERMINACY(I)

(T, I,F)=(0,1,0)

LET'S FLIP THE COIN ON THE SURFACE OF A SEA, THEN THE COIN FALLS INTO THE SEA AND WE DO NOT KNOWN ANYTHINGS ABOUT IT, THUS INDTERMINACY =1

Other example

- An example of neutrosophic logic is as following; the argument "Tomorrow it will be sunny" does not mean a constant-valued components structure; this argument may be 60% true, 40% indeterminate and 35% false at a time, neutrosophicaly represented by (0,6, 0,4, 0,35) ; but at in a second time may change at 55% true, 40% indeterminate, and 45 % false according to new indications, provenances,neutrosophicaly represented by (0,55,0,40,0,45) , etc.

Neutrosophic example: voting process

For another example, suppose there are 10 voters during a voting process. Five vote “aye”, two vote “blackball” and three are undecided. For neutrosophic notation, it can be expressed as $x(0.5,0.3,0.2)$.

Using fuzzy it is not possible to separate the voting process in favour or against. Using Vague notation we can separate the votes in favour or votes in against but with constraint $tv + fv \leq 1$. Neutrosophic Notation has no restrictions on the boundary. In Neutrosophic Set, indeterminacy is quantified explicitly and true-membership, indeterminacy-membership and false-membership are independent. This assumption is very important in many applications

Example of NS

- For (0,1,0), which means totally indeterminate: Two points, diametrically opposed, on the margins of a marsh have to be connected by a route; it may be a total indeterminacy not knowing in what way to build the route.

- For (0,1,1), with total indeterminacy and total falsehood. The two points, diametrically opposed, on the margins of a marsh having to be connected by a route; the route construction company starts the project and builds the route on the wrong trajectory that the route sinks into the marsh.
- two nodes as the two marsh, and the line as the route.

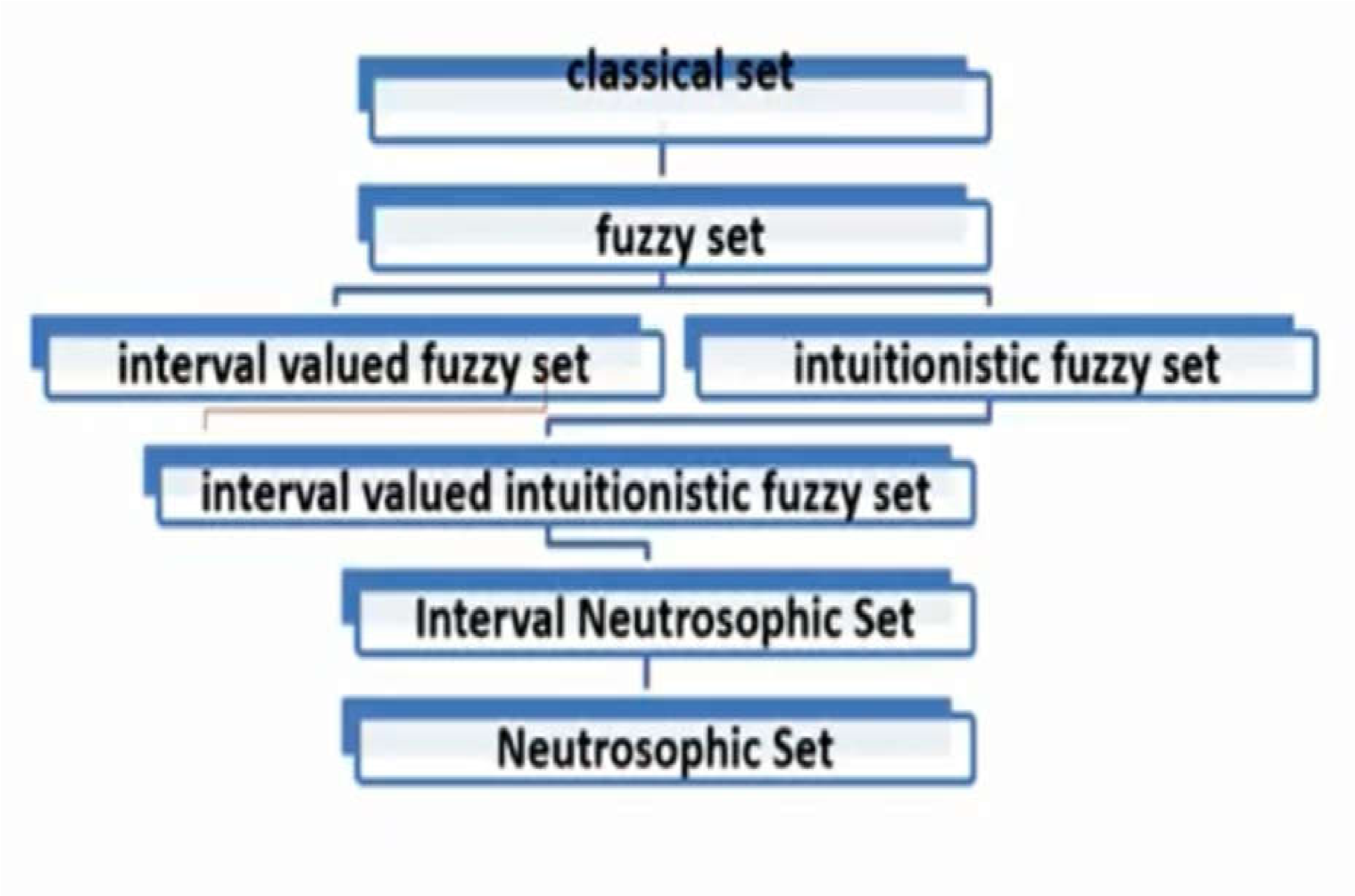
EXAMPLE TO UNDERSTAND THE INDETERMINACY AND NEUTROSOPHIC LOGIC

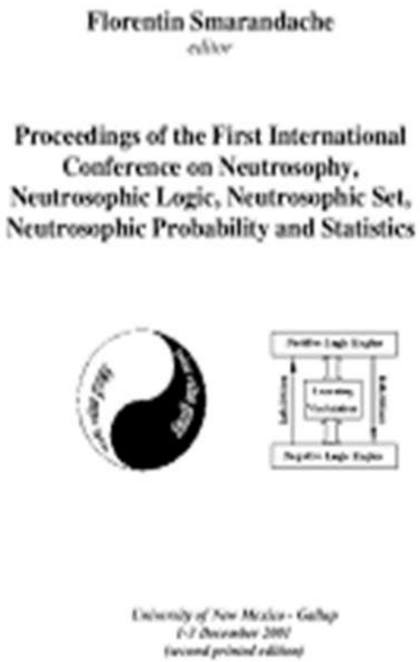
- In a given mobile phone suppose 100 calls came at end of the day.
- 1. 60 calls were received truly among them 50 numbers are saved and 10 were unsaved in mobile.
  - 60 calls will be the truth membership i.e. 0.6.
- 2. 30 calls were not-received by mobile holder. Among them 20 calls which are saved in mobile contacts were not received due to driving, meeting, or phone left in home, car or bag and 10 were not received due to uncertain numbers.
  - 30 not received will be the Indeterminacy membership i.e. 0.3.
- 3. 10 calls were those number which was rejected calls intentionally by mobile holder due to behavior of those saved numbers, not useful calls, marketing numbers or other cases for that he/she do not want to pick or may be blocked numbers
  - 10 rejected will be the false i.e. 0.1 membership value.

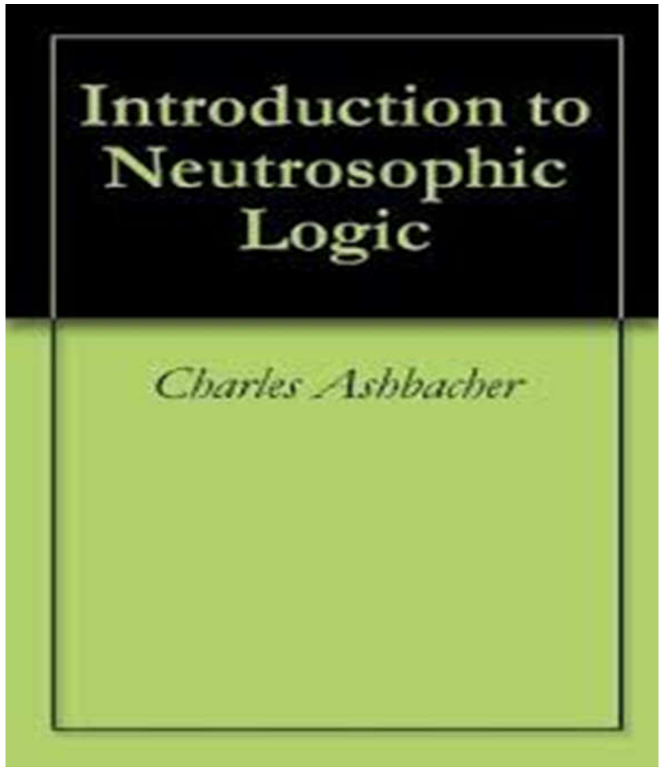
Neutrosophic examples…………

- Suppose there are few places in a city and roads connect the places. Hence the places and roads together form a network. But the problem is to find a way that a salesman can visit all the planes once with the lowest travelling cost. Now the travelling cost is directly proportional to the road distance travel by salesman. But all the roads are not in the same smooth conditions in practical. So the real travelling distance with cost may be effected the bad weather, road jam and non-pucca roads. Hence the travelling distance between the places should be taken as neutrosophic. If (T , I, F) be membership value of the road distance between two places, then T indicates distance on good, well-constructed road; I indicates distance on bad (marsh, muddied) road and F indicates distance above the water, where the bridge is not built yet…(i.e. the distance where the road does not exist yet, but it may be build under the form of a bridge to be constructed).

The relationship among neutrosophic sets and other sets







Book on neutrosphic logic with JAVA application

Chapter contents Book contents

Outline

ACADEMIC PRESS

Neutrosophic Set in Medical Image Analysis

2019, Pages 3-29

1 - Introduction to neutrosophy and neutrosophic environment

Florentin Smarandache [*], Said Broumi [†], Prem Kumar Singh [‡], Chun-fang Liu [§], V. Venkateswara Rao [¶], Hai-Long Yang [‖], Ion Patrascu [#], Azeddine Elhassouny [**]

Show more

https://doi.org/10.1016/B978-0-12-818148-5.00001-1

Abstract

Neutrosophic connectives

- Like other non-classical logic, several definitions for the logical connectives are used
- we will concentrate on the simplest case, where the neutrosophic components are real values instead of intervals or subsets of the unit interval.

Neutrosophic basic connectives: Negation

(N1) $v(\neg p) = (1 - t, 1 - i, 1 - f)$

(N2) $v(\neg p) = (f, i, t)$

(N3) $v(\neg p) = (f, 1 - i, t)$

Conjunction-disjunction-implication

- Conjunction

$$(C1)\quad v(p_1 \wedge p_2) = (t_1 \cdot t_2, i_1 \cdot i_2, f_1 \cdot f_2)$$

$$(C2)\quad v(p_1 \wedge p_2) = (min(t_1,t_2), min(i_1,i_2), max(f_1,f_2))$$

$$(C3)\quad v(p_1 \wedge p_2) = (min(t_1,t_2), max(i_1,i_2), max(f_1,f_2))$$

- Disjunction

$$(D1)\quad v(p_1 \vee p_2) = (max(t_1,t_2), max(i_1,i_2), min(f_1,f_2))$$

$$(D2)\quad v(p_1 \vee p_2) = (max(t_1,t_2), min(i_1,i_2), min(f_1,f_2))$$

- Implication

$$(I1)\quad v(p_1 \rightarrow p_2) = v(\neg p_1 \vee p_2)$$

$$(I2)\quad v(p_1 \rightarrow p_2) = (min(1, 1 - t_1 + t_2), max(0, i_2 - i_1), max(0, f_2 - f_1))$$

A bibliometric analysis of neutrosophic set: two decades review from 1998 to 2017

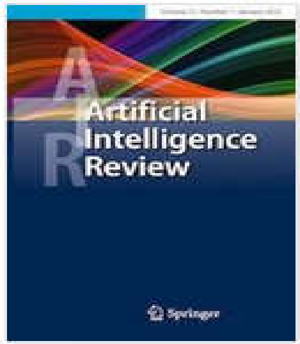
-A total of 137 neutrosophic set publication records from Web of Science are analyzed.
-57 pages
-VOSviewer software

18-08-2018 | Issue 1/2020

A bibliometric analysis of neutrosophic set: two decades review from 1998 to 2017

Journal: Artificial Intelligence Review > Issue 1/2020

Authors: Xindong Peng, Jingguo Dai



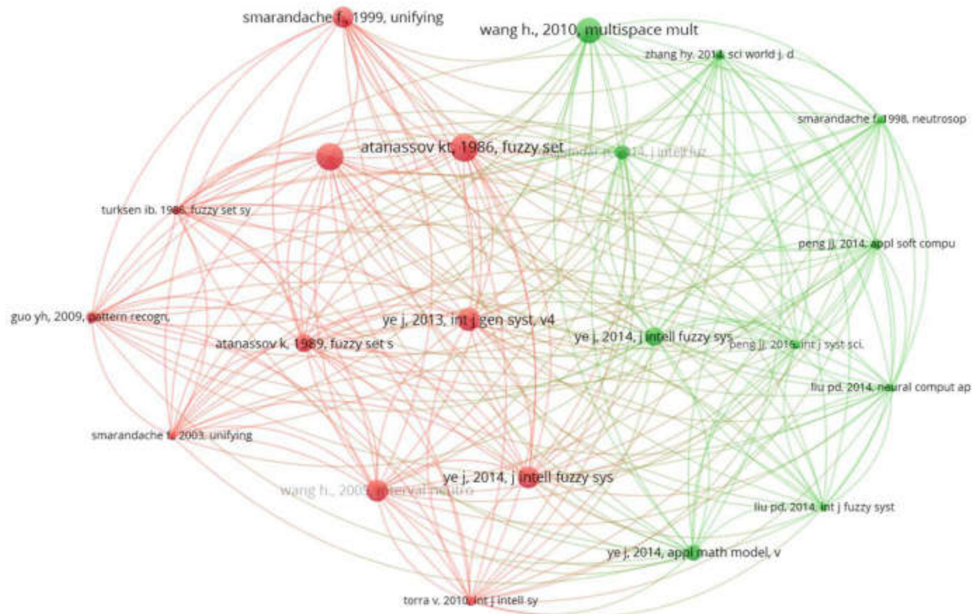


Fig. 7 The reference co-authorship network of NS-related publications

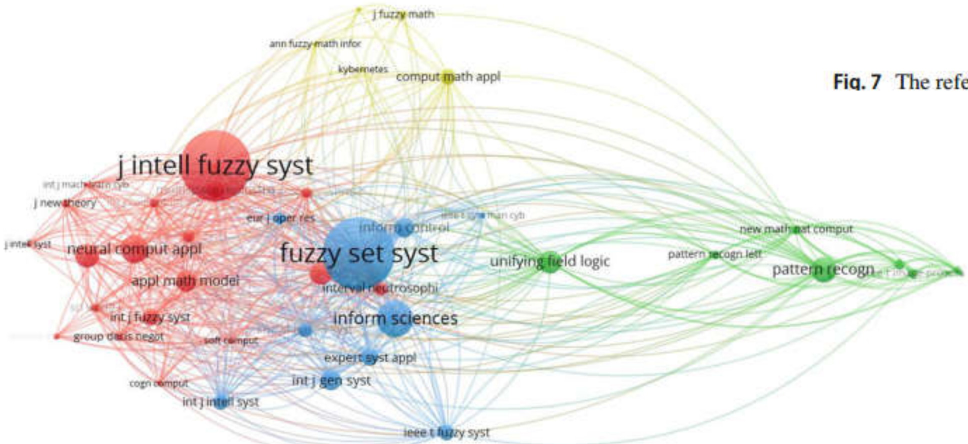


Fig. 8 The journal co-authorship network of NS-related publications

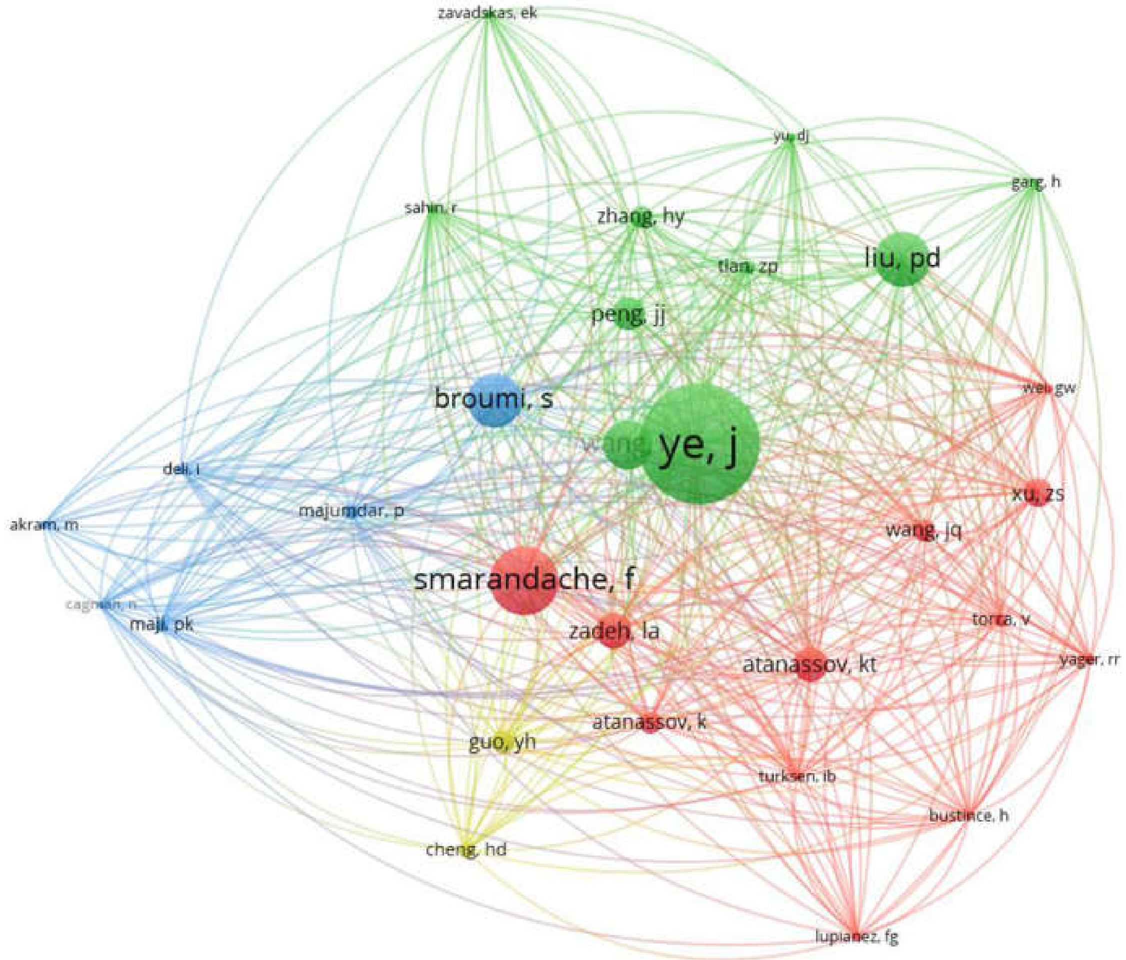


Fig. The author co-authorship network of NS-related publications https://www.researchgate.net/profile/Broumi_Said/achievement/5f38bcafaf0a827916f13fbb

Questions Jobs

Search for researchers, publications, and more

131

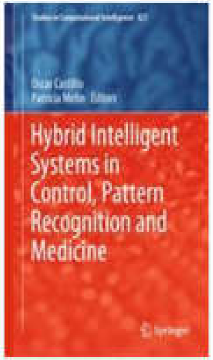
Good job, Broumi!

Your chapter reached 3,000 reads

Achieved on August 16, 2020

Chapter: Neutrosophic Sets: An Overview

Broumi, you can increase the visibility of your work



Hybrid Intelligent Systems in Control, Pattern Recognition and Medicine pp 3-18 | Cite as

Intuitionistic and Neutrosophic Fuzzy Logic: Basic Concepts and Applications

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Amita Jain, Basanti Pal Nandi

Chapter
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Review

Systematic Review of Decision Making Algorithms in Extended Neutrosophic Sets

Mohsin Khan [1], Le Hoang Son [2,*], Mumtaz Ali [3], Hoang Thi Minh Chau [4], Nguyen Thi Nhu Na [5] and Florentin Smarandache [6]

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Diffrent types of neutrosophic numbers

- Single valued neutrosophic numbers
- Interval valued neutrosophic numbers
- Bipolar neutrosophic numbers
- Trapezoidal fuzzy neutrosophic numbers
- Triangular fuzzy neutrosophic numbers
- Single valued triangular fuzzy numbers
- Single valued trapezoidal fuzzy numbers
- Hesitant Single valued neutrosophic numbers
- Refinned neutrosophic numbers. etc

Neutrosophic numbers

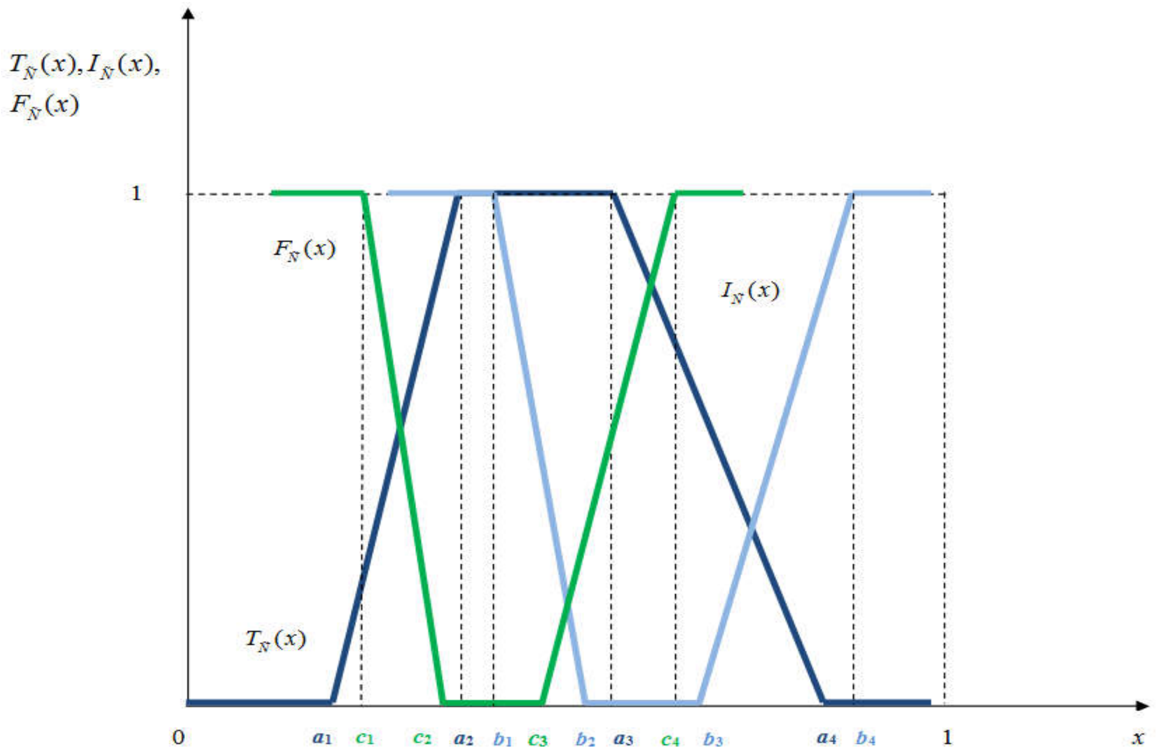
- Numerical neutrosophic components: (T, I, F)
- Literal neutroosphic componets : x=a+Ib

The formula neutrosophically works in the following way:

- x = a+bI is a neutrosophic number whose determinate part is "a" and indeterminate part is "bI", where I = indeterminacy;

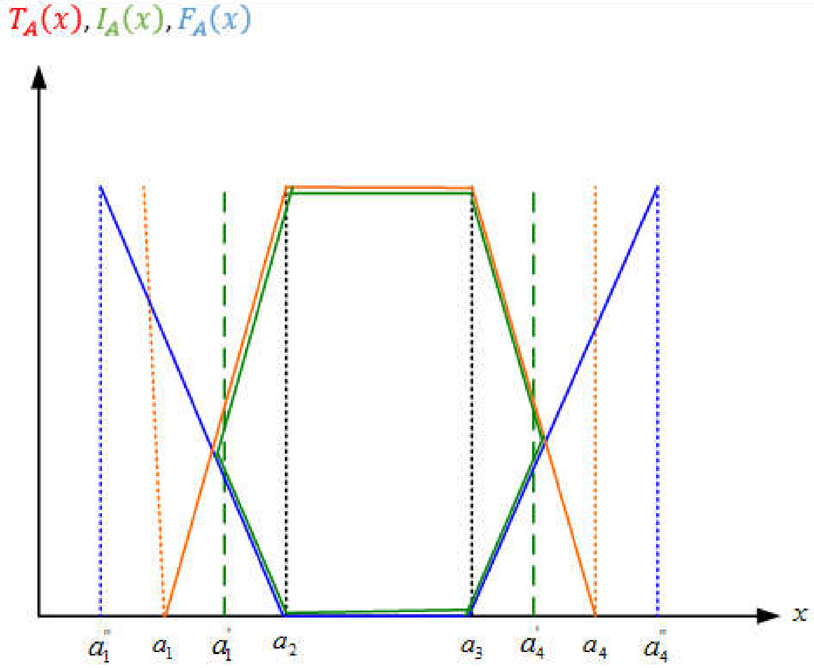
NNs can effectively describe incomplete or indeterminate information because they consist of a determinate part and indeterminate part.

Trapezoidal fuzzy neutrosophic numbers



(a) Graphical representation of TrNFN

- The following tables represents the various forms of trapezoidal fuzzy neutrosophic numbers (TrFNN) have been listed out and it shows the uniqueness of the proposed graphical representation among the existing graphical representations.

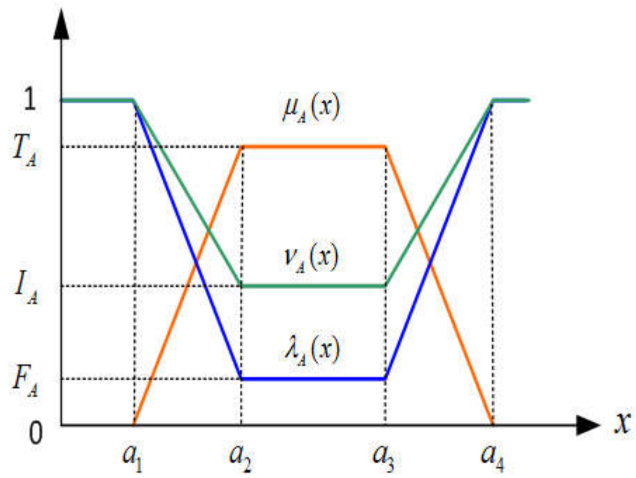
Trapezoidal fuzzy neutrosophic forms	Graphical representation
Darehmiraki [11]; A is a TrFNN, $a_1'', a_1, a_1', a_2, a_3, a_4', a_4, a_4'' \in R$ such that $a_1'' \le a_1 \le a_1' \le a_2 \le a_3 \le a_4' \le a_4 \le a_4''$ $A = \langle (a_1'', a_1, a_1', a_2, a_3, a_4', a_4, a_4''), T_A, I_A, F_A \rangle$	

Liang [21]; A is a TrFNN,

$a_1, a_2, a_3, a_4 \in [0,1]$ such that

$0 \le a_1 \le a_2 \le a_3 \le a_4 \le 1$

$A = \langle [a_1, a_2, a_3, a_4], (T_A, I_A, F_A) \rangle$



Biswas [5]; A is a TpFNN,

$(a_{41}, a_{21}, a_{31}, a_{41}), (b_{41}, b_{21}, b_{31}, b_{41}),$

$(c_{41}, c_{21}, c_{31}, c_{41}) \in R$

such that

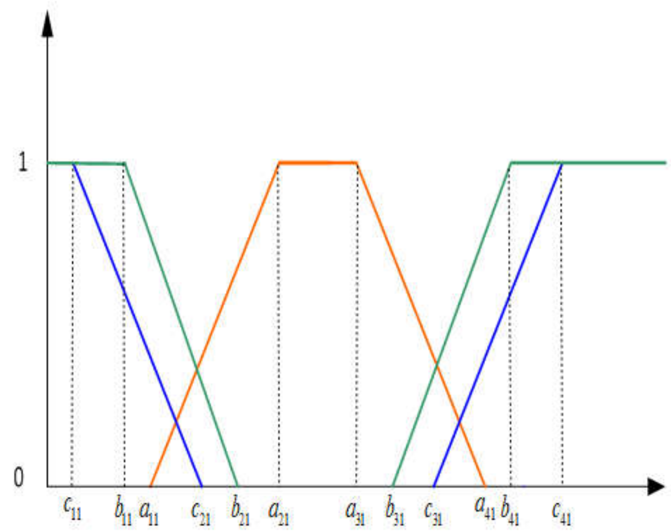
$c_{11} \le b_{11} \le a_{11} \le c_{21} \le b_{21} \le a_{21}$

$\le a_{31} \le b_{31} \le c_{31} \le a_{41} \le b_{41} \le c_{41}$

and

$A = \langle (a_{11}, a_{21}, a_{31}, a_{41}), (b_{11}, b_{21}, b_{31}, b_{41}),$

$(c_{11}, c_{21}, c_{31}, c_{41}) \rangle$



Diffrence between TFN and NN

- About neutrosophic number(T,I,F) and triangular fuzzy number (a,b,c) although have three parametres;however;the three parametres in triangular fuzzy numbers can only express the membership, and those in neutrosophic number can express the membership function,indterminacy-membership function and non-membership function,So they are completley diffrent

The score function of neutrosophic numbers

- The score function is an important index for evaluating neutrosophic numbers. For a neutrosophic R =<T, I, F > , the truth-membership T is positively correlated with the score function, and the indeterminacy-membership I and false-membership F are negatively correlated with the score function. In terms of the accuracy function, the greater the difference between the truth-membership T and false-membership F is, the more affirmative the statement is. Additionally, in regard to the certainty function, it positively depends on the truth-membership T.

Ranking of neutrosophic numbers

$$S_{1,1}(x) = \frac{2}{3} + \frac{T_x}{3} - \frac{I_x}{3} - \frac{F_x}{3}.$$

$$S_{\alpha,\beta}(x) = \frac{2}{3} + \frac{T_x}{3} - \alpha\frac{I_x}{3} - \beta\frac{F_x}{3},$$

$$K(A) = \frac{1 + a - 2b - c}{2}$$

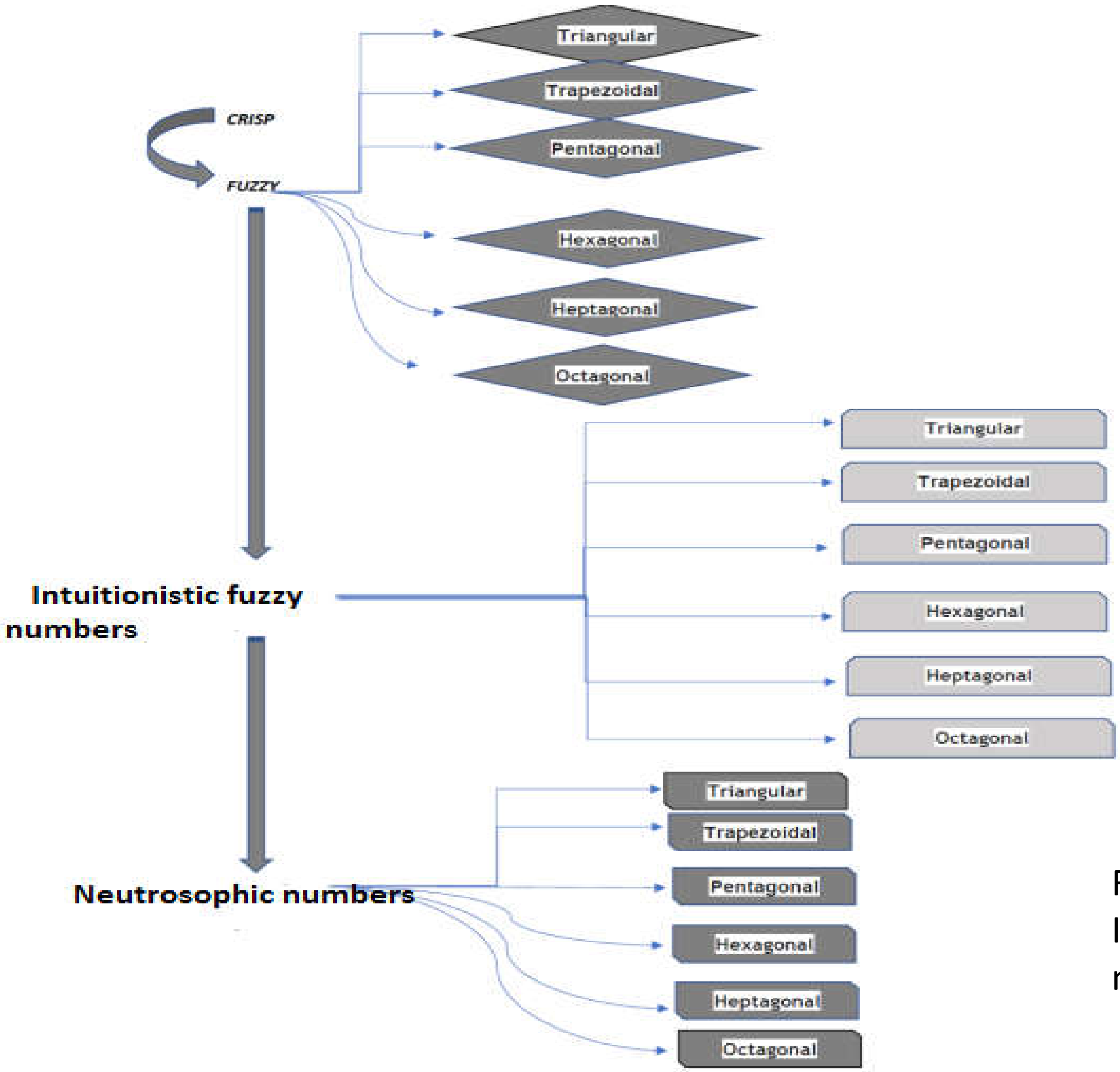
where $K(A) \in [-1,1]$.

$$sc(x) = T_1 + 1 - I_1 + 1 - F_1;$$

Extensions of neutrosophic sets

Extension of neutrosophic sets

- Fuzzy sets extensions have been often used in the modeling of problems including vagueness and impreciseness in order to better define the membership functions together with the hesitancy of decision makers.
- More than 20 different extensions of ordinary fuzzy sets have appeared in the literature after the introductions of ordinary fuzzy sets by Zadeh (1965).
- These sets involve interval-type fuzzy sets, type-2 fuzzy sets, hesitant fuzzy sets, intuitionistic fuzzy sets, Pythagorean fuzzy sets, q-rung orthopair fuzzy sets, spherical fuzzy sets, picture fuzzy sets, fermatean fuzzy sets, etc.
- Mainly, these extensions can be divided into two classes: extensions with two independent membership parameters and extensions **with three independent membership parameters.**
- Smarandache and many other researchers also discussed the various extension of neutrosophic sets in TOPSIS and MCDM



Flow chart of the three types, fuzzy, Intuitionistic fuzzy,and neutrosophic logic numbers

Edge Parameter	Uncertainty Measurement	Hesitation Measurement	Vagueness Measurement	Fluctuations
Crisp number	*	*	*	*
Fuzzy number	determinable	*	*	*
Intuitionistic Fuzzy number	determinable	determinable	*	*
Neutrosophic number	determinable	determinable	determinable	determinable

Table 1: Fuzzy numbers, their extensions and applicability

The core idea of modeling such a neutrosophic situation has been expanded together with the previous methods and tools to the following new cases:

• to handle the neutrosophic in qualitative environments in which information is linguistic form

• to manage the truth-membership, indeterminacy-membership and falsity-membership that are not exactly defined but expressed by interval-values, intuitionistic fuzzy sets, triangular fuzzy sets, cubic sets, bipolar fuzzy set, trapezoidal fuzzy sets, or hesitant

fuzzy set

• to deal with the inadequacy of the parameterized by combining soft set

• to cope with the lower and upper approximations by fusing with rough set

• These extensions are further detailed in the following table ,

Table 1 The extensions of neutrosophic set

Sets	Abbreviation	Proposed
Single valued neutrosophic set	**SVNS**	Wang et al. (2010)
Interval neutrosophic set	**INS**	Wang et al. (2005a)
Simplified neutrosophic set	**SNS**	Ye (2014h)
Neutrosophic soft set	**NSS**	Maji (2013)
Single valued neutrosophic linguistic set	**SVNLS**	Ye (2015a)
Multi-valued neutrosophic set	**MVNS**	Wang and Li (2015)
Rough neutrosophic set	**RNS**	Broumi et al. (2014a)
Simplified neutrosophic linguistic set	**SNLS**	Tian et al. (2016b)
Bipolar neutrosophic set	BNS	Deli et al. (2015)
Trapezoidal neutrosophic set	TNS	Biswas et al. (2014b)
Neutrosophic hesitant fuzzy set	NHFS	Ye (2015d)
Neutrosophic cubic set	NCS	Ali and Deli (2016) and Jun et al. (2017)
Possibility neutrosophic soft set	PNSS	Karaaslan (2017b)
Neutrosophic vague soft expert set	NVSES	Al-Quran and Hassan (2016)
Time neutrosophic soft set	TNSS	Alkhazaleh (2016)
Triangular neutrosophic set	TrNS	Deli and Şubaş (2017b)
Interval-valued neutrosophic soft set	IVNSS	Deli (2017)
Complex neutrosophic set	CNS	Ali and Smarandache (2017)
Normal neutrosophic set	NNS	Liu and Teng (2017a)
Simplified neutrosophic uncertain linguistic set	SNULS	Tian et al. (2018)

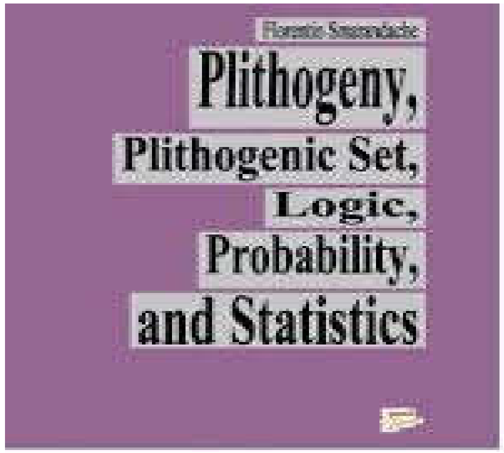
Interval neutrosophic linguistic set	INLS	Ye (2014f)
Single-valued neutrosophic refined soft set	SVNRSS	Karaaslan (2017a)
ivnpiv-Neutrosophic soft set	ivnpiv-NSS	Deli et al. (2018)
Probability multi-valued neutrosophic set	PMVNS	Peng et al. (2016b)
Probability multi-valued linguistic neutrosophic set	PMVLNS	Wang and Zhang (2017)
Interval neutrosophic hesitant fuzzy set	INHFS	Ye (2016a)
Intuitionistic neutrosophic set	InNS	Bhowmik and Pal (2009)
Generalized neutrosophic soft set	GNSS	Broumi (2013)
Intuitionistic neutrosophic soft set	INSS	Broumi and Smarandache (2013b)
Neutrosophic refined set	NRS	Smarandache (2013)
Possibility simplified neutrosophic set	PSNS	Şahin and Liu (2017c)
Linguistic neutrosophic set	LNS	Li et al. (2017)
Single valued neutrosophic trapezoid linguistic set	SVNTLS	Broumi and Smarandache (2014c)
Single-valued neutrosophic uncertain linguistic set	SVNULS	Liu and Shi (2017)
Multi-valued interval neutrosophic set	MVINS	Wang et al. (2005b)

Sets	Abbreviation	Proposed
Single valued neutrosophic rough set	SVNRS	Yang et al. (2017a)
Neutrosophic valued linguistic soft set	NVLSS	Zhao and Guan (2015)
Single valued neutrosophic multiset	SVNM	Ye and Ye (2014)
Single valued multigranulation neutrosophic rough set	SVMNRS	Zhang et al. (2016b)
n-Valued refined neutrosophic soft set	n-VRNSS	Alkhazaleh (2017)
Double-valued neutrosophic set	DVNS	Kandasamy (2018)

The bold eight NS extensions are widely used in real life

Plithogenic sets and plithogenic logic

- Plithogenic sets and plithogenic logic which is the generalisation of neutrosophic sets and logic.
- Plithogenic sets can model real-life applications in a better way as they are characterised by one or more attributes which can accommodate many values.



The Plithogenic set is a generalization of crisp, fuzzy, intuitionistic fuzzy, and Neutrosophic sets, it is a set whose elements are characterized by many attributes' values.
The authors have defined, described and developed Plithogenic graphs and given some applications of them to real world problems.

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PLITHOGENIC GRAPHS

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PLITHOGENIC GRAPHS

W.B.VASANTHA KANDASAMY
K. ILANTHENRAL
FLORENTIN SMARANDACHE

CONTENTS

Complex neutrosophic set (CNS)

- Complex neutrosophic set (CNS) is a modified version of the complex fuzzy set, to cope with complicated and inconsistent information in the environment of fuzzy set theory.
- The CNS is characterised by three functions expressing the degree of complex-valued membership, complex-valued abstinence and degree of complex-valued non-membership.
- The CNS is characterized by complex-valued MS, complex-valued abstinence and complex-valued NMS grades with a condition that the sum of real-valued MS (Imaginary-valued MS), real-valued abstinence (Imaginary-valued abstinence) and real-valued NMS (Imaginary-valued NMS) grades is less than or equal to 3+

Definition Complex neutrosophic set.

A complex neutrosophic set S defined on a universe of discourse X, which is characterized by a truth membership function $T_S(x)$, an indeterminacy membership function $I_S(x)$, and a falsity membership function $F_S(x)$ that assigns a complex-valued grade of $T_S(x)$, $I_S(x)$, and $F_S(x)$ in S for any $x \in X$. The values $T_S(x)$, $I_S(x)$, $F_S(x)$ and their sum may all within the unit circle in the complex plane and so is of the following form,

$$T_S(x) = p_S(x).e^{j\mu_S(x)}, \quad I_S(x) = q_S(x).e^{j\nu_S(x)} \text{ and } F_S(x) = r_S(x).e^{j\omega_S(x)}$$

where $p_S(x)$, $q_S(x)$, $r_S(x)$ and $\mu_S(x)$, $\nu_S(x)$, $\omega_S(x)$ are, respectively, real valued and $p_S(x), q_S(x), r_S(x) \in [0, 1]$ such that $^-0 \leq p_S(x) + q_S(x) + r_S(x) \leq 3^+$.

The complex neutrosophic set S can be represented in set form as

$$S = \{(x, T_S(x) = a_T, I_S(x) = a_I, F_S(x) = a_F) : x \in X\},$$

where $T_S{:}X \to \{a_T{:}a_T \in C, |a_T| \leq 1\}$, $I_S{:}X \to \{a_I{:}a_I \in C, |a_I| \leq 1\}$ and $F_S{:}X \to \{a_F{:}a_F \in C, |a_F| \leq 1\}$ and $|T_S(x) + I_S(x) + F_S(x)| \leq 3$.

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ORIGINAL ARTICLE

Complex neutrosophic set

Mumtaz Ali[1] · Florentin Smarandache[2]

Received: 6 July 2015 / Accepted: 21 December 2015

Interval complex neutrosophic set

- As an extension of neutrosophic set, interval complex neutrosophic set is a new research topic in the field of neutrosophic set theory, which can handle the uncertain, inconsistent and incomplete information in periodic data.

Interval complex neutrosohic set

$\boxed{\text{Interval complex neutrosohic set}}$

Definition *Let X be a space of points(objects) with generic elements in X denoted by x. An ICNS S in X is characterized by a truth-membership function $T_S(x)$, an indeterminacy-membership function $I_S(x)$, and a falsity-membership function $F_S(x)$, which are satisfied the following conditions:*

$$T_S(x) : X \to \Gamma^{[0,1]} \times R, T_S(x) = t_S(x) \cdot e^{j\omega_S(x)}$$

$$I_S(x) : X \to \Gamma^{[0,1]} \times R, I_S(x) = i_S(x) \cdot e^{j\psi_S(x)}$$

$$F_S(x) : X \to \Gamma^{[0,1]} \times R, F_S(x) = f_S(x) \cdot e^{j\phi_S(x)}$$

where $\Gamma^{[0,1]}$ is the collection of interval neutrosophic sets and R is the set of real numbers, $t_S(x)$ is the interval truth membership function, $i_S(x)$ is the interval indeterminate membership function and $f_S(x)$

is the interval falsehood membership function, while $e^{j\omega_S(x)}$, $e^{j\psi_S(x)}$ *and* $e^{j\phi_S(x)}$ *are the corresponding interval-valued phase terms, respectively, with* $j = \sqrt{-1}$. *In set theoretic form, an interval complex neutrosophic set can be written as:*

$$S = \left\{ \left\langle \frac{t_S(x) \cdot e^{j\omega_S(x)}, i_S(x) \cdot e^{j\psi_S(x)}, f_S(x) \cdot e^{j\phi_S(x)}}{x} \right\rangle : x \in X \right\} \tag{2.1}$$

In (2.1), the amplitude interval-valued terms $T_S(x)$, $I_S(x)$, $F_S(x)$ *can be further split as* $t_S(x) = \left[t_S^L(x), t_S^U(x)\right]$, $i_S(x) = \left[i_S^L(x), i_S^U(x)\right]$ *and* $f_S(x) = \left[f_S^L(x), f_S^U(x)\right]$. *Similarly, for the phase terms:* $\omega_S(x) = \left[\omega_S^L(x), \omega_S^U(x)\right]$, $\psi_S(x) = \left[\psi_S^L(x), \psi_S^U(x)\right]$ *and* $\phi_S(x) = \left[\phi_S^L(x), \phi_S^U(x)\right]$.

Definition 2.5. *[18] The complement of an ICNS S is denoted by* S^c *and is defined as*

$$S^c = \left\{ \left\langle \frac{t_{S^c}(x) \cdot e^{j\omega_{S^c}(x)}, i_{S^c}(x) \cdot e^{j\psi_{S^c}(x)}, f_{S^c}(x) \cdot e^{j\phi_{S^c}(x)}}{x} \right\rangle : x \in X \right\} \tag{2.2}$$

where $t_{S^c}(x) = f_S(x), \omega_{S^c}(x) = 2\pi - \omega_S(x), i_{S^c}(x) = \left[1 - i_S^U(x), 1 - i_S^L(x)\right], \psi_{S^c}(x) = 2\pi - \psi_S(x)$, $f_{S^c}(x) = t_S(x), \phi_{S^c}(x) = 2\pi - \phi_S(x)$.

Definition . *Let A be an ICNN, then the score function S (A) of A is defined as:*

$$S(A) = \frac{1}{12}\left(\left(2 + t_A^L - i_A^L - f_A^L\right) + \left(2 + t_A^U - i_A^U - f_A^U\right) + \frac{1}{2\pi}\left(\left(4\pi + \omega_A^L - \psi_A^L - \phi_A^L\right) + \left(4\pi + \omega_A^U - \psi_A^U - \phi_A^U\right)\right)\right)$$

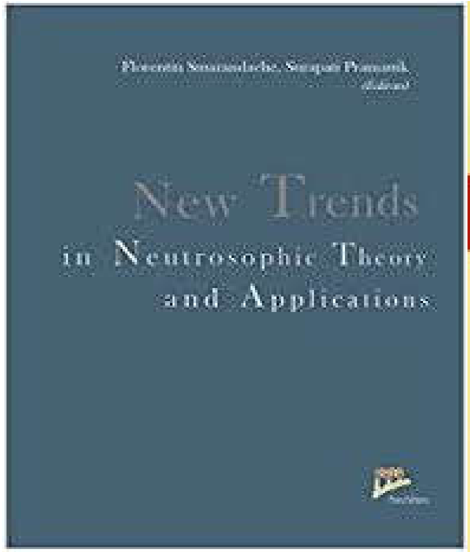
Definition . *Let A be an ICNN, then the accuracy function H (A) of A is defined as:*

$$H(A) = \frac{1}{3}\left(\frac{t_A^L - f_A^L + t_A^U - f_A^U}{2} + \frac{\omega_A^L - \phi_A^L + \omega_A^U - \phi_A^U}{2\pi}\right)$$

Definition *Let A_1 and A_2 be two ICNNs, and S be the score functions, H be the accuracy functions. If $S(A_1) < S(A_2)$ then $A_1 < A_2$, if $S(A_1) = S(A_2)$ then*

(1) If $H(A_1) < H(A_2)$, then $A_1 < A_2$;

(2) If $H(A_1) = H(A_2)$, then $A_1 = A_2$.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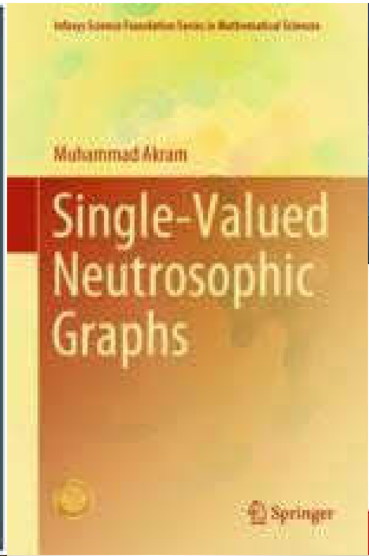
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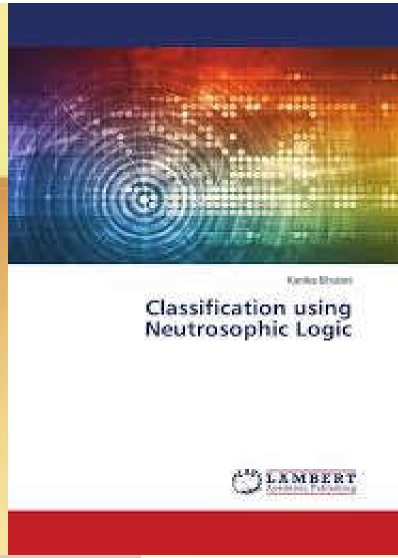
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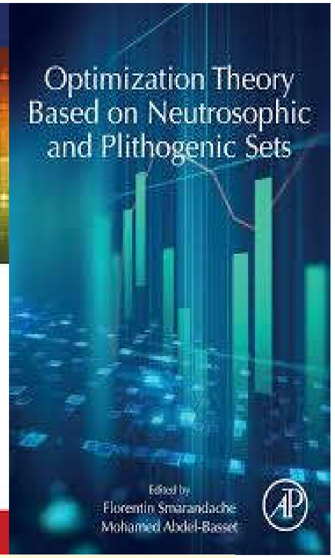
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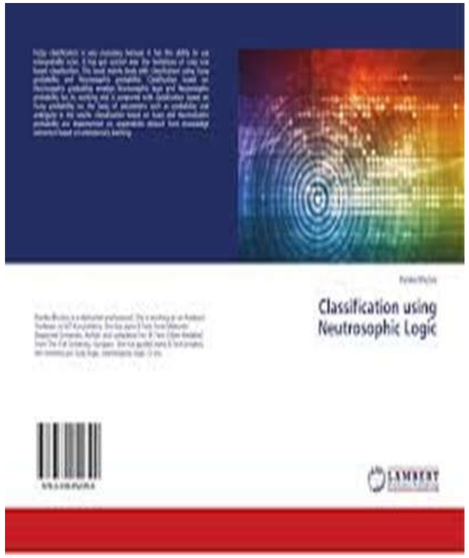
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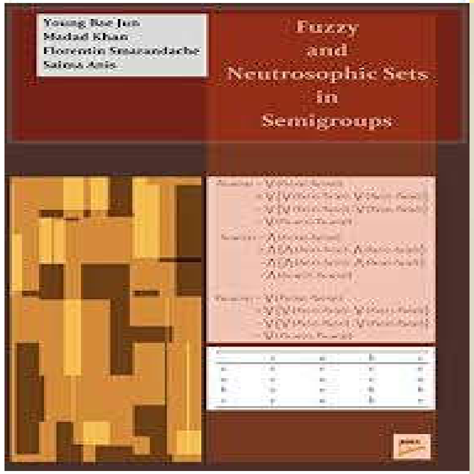
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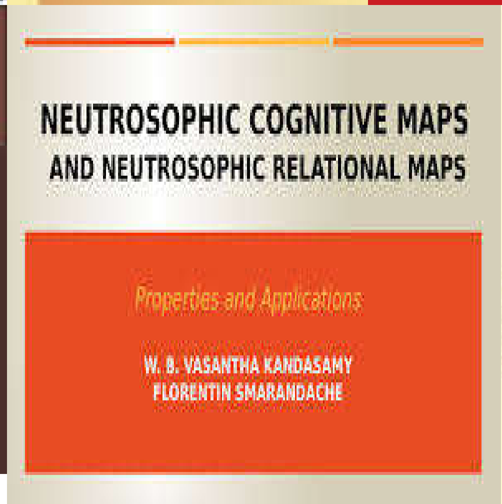
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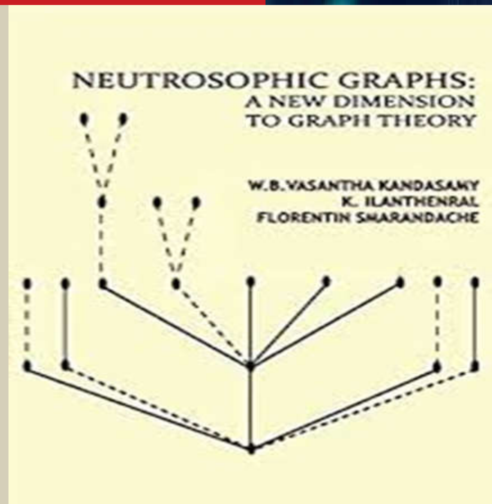
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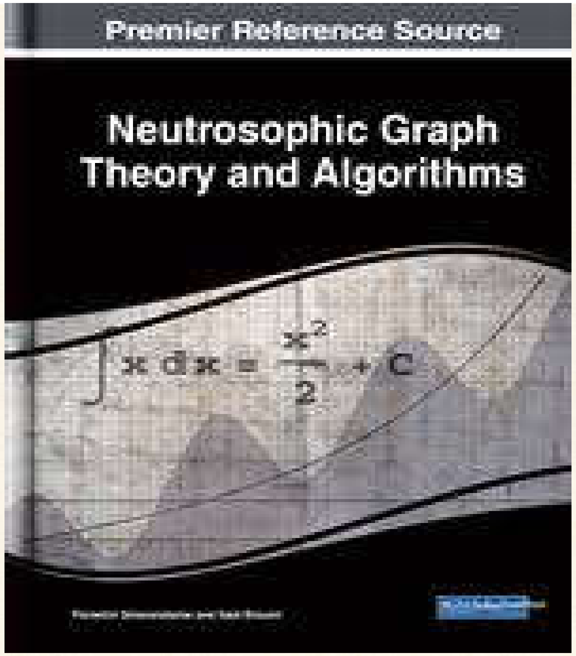
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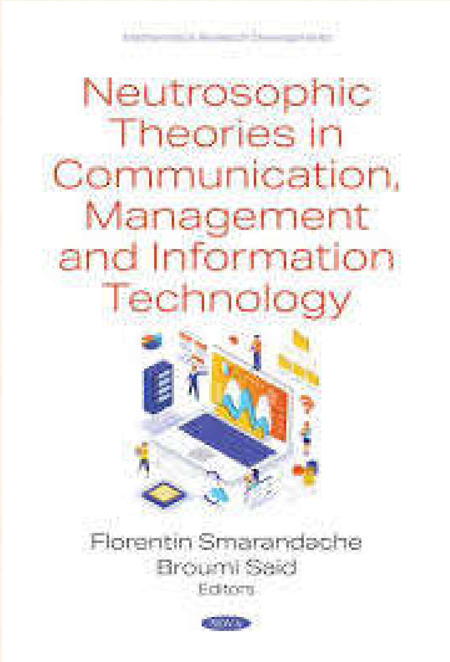
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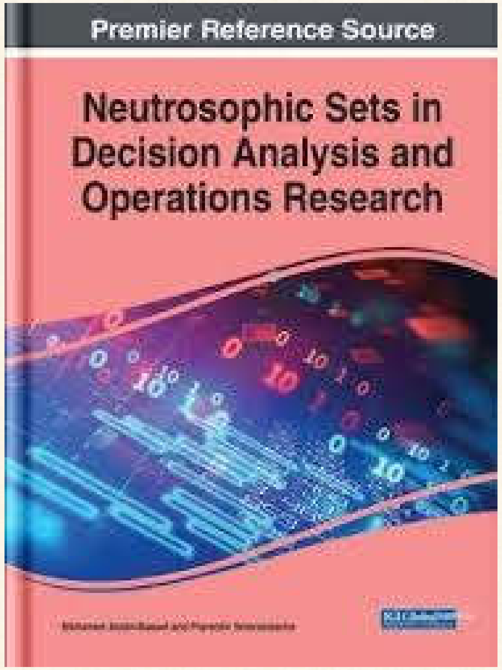
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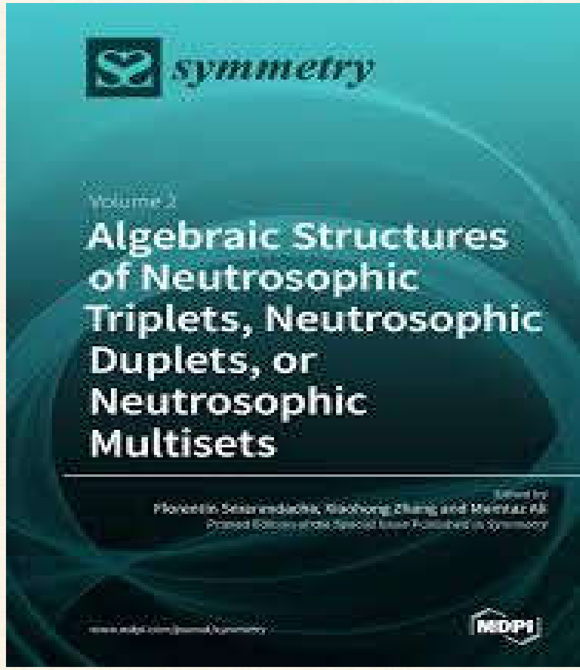
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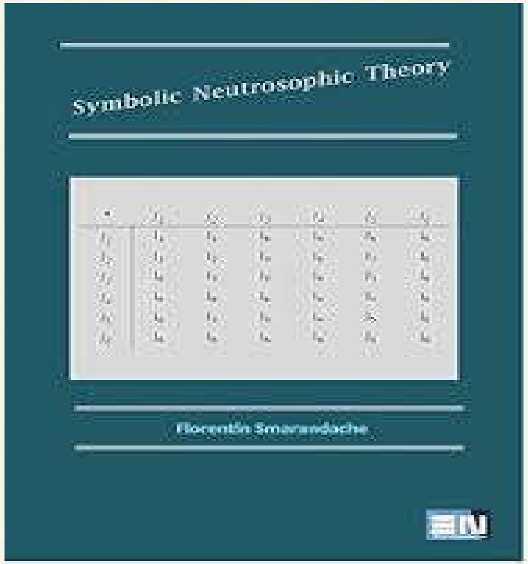
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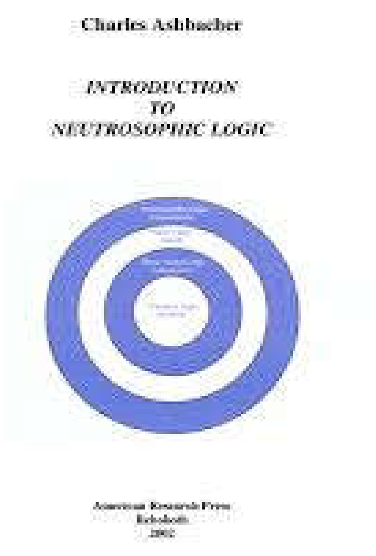
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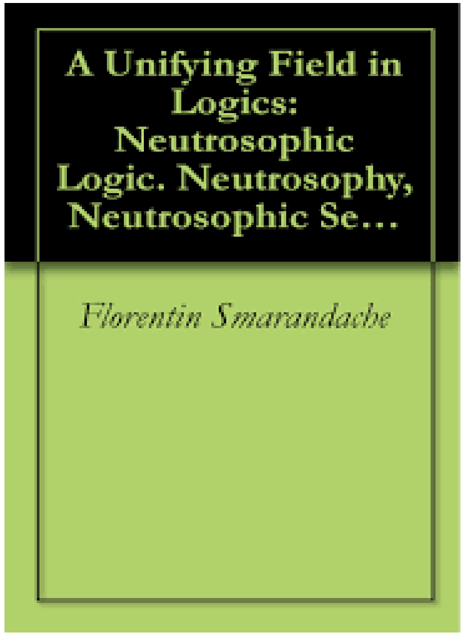
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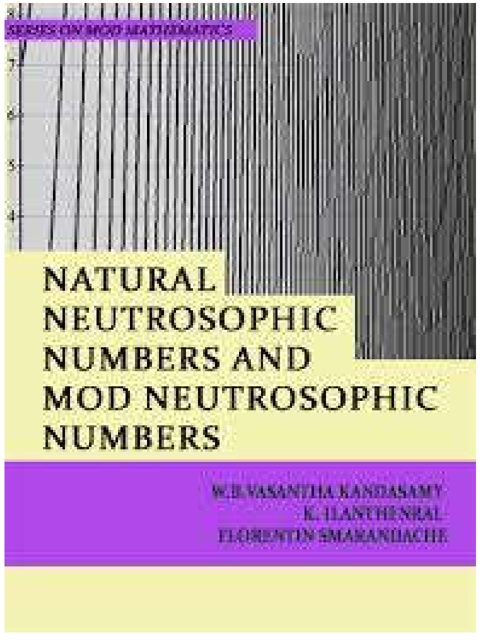
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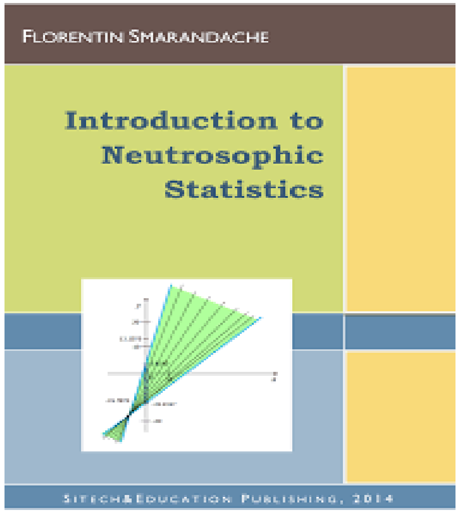
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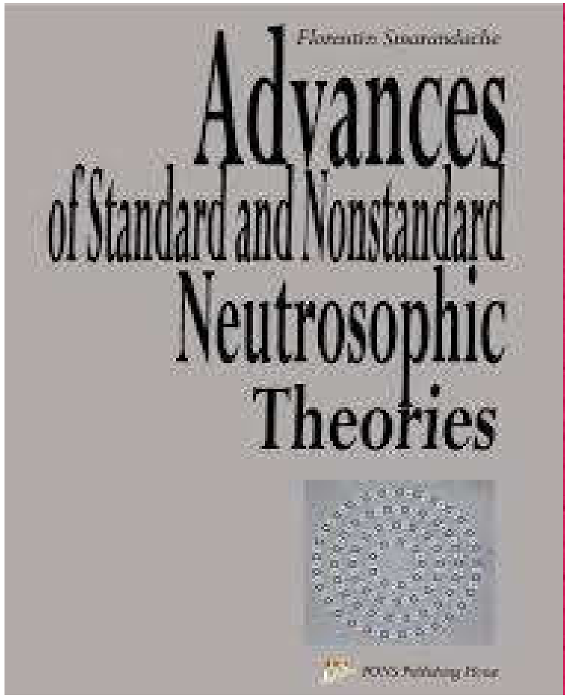

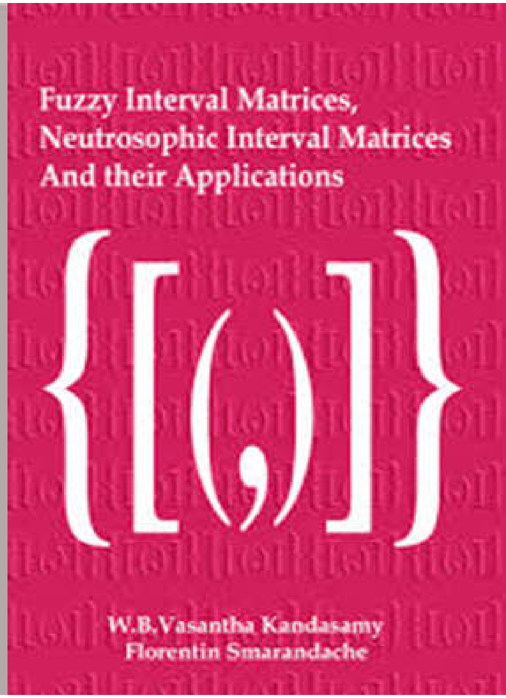

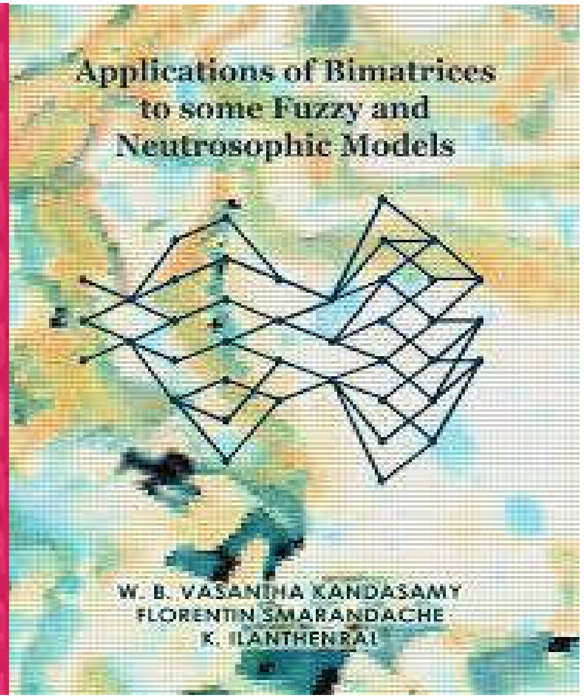

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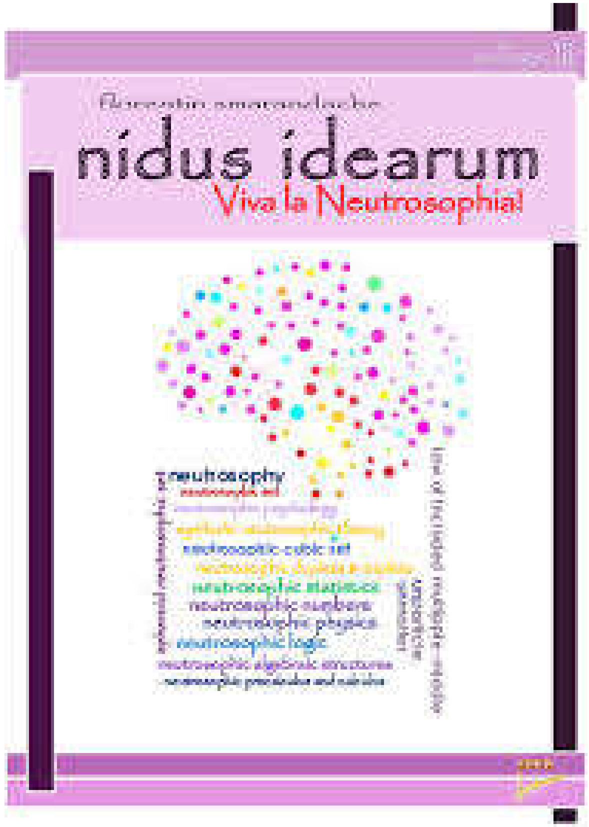

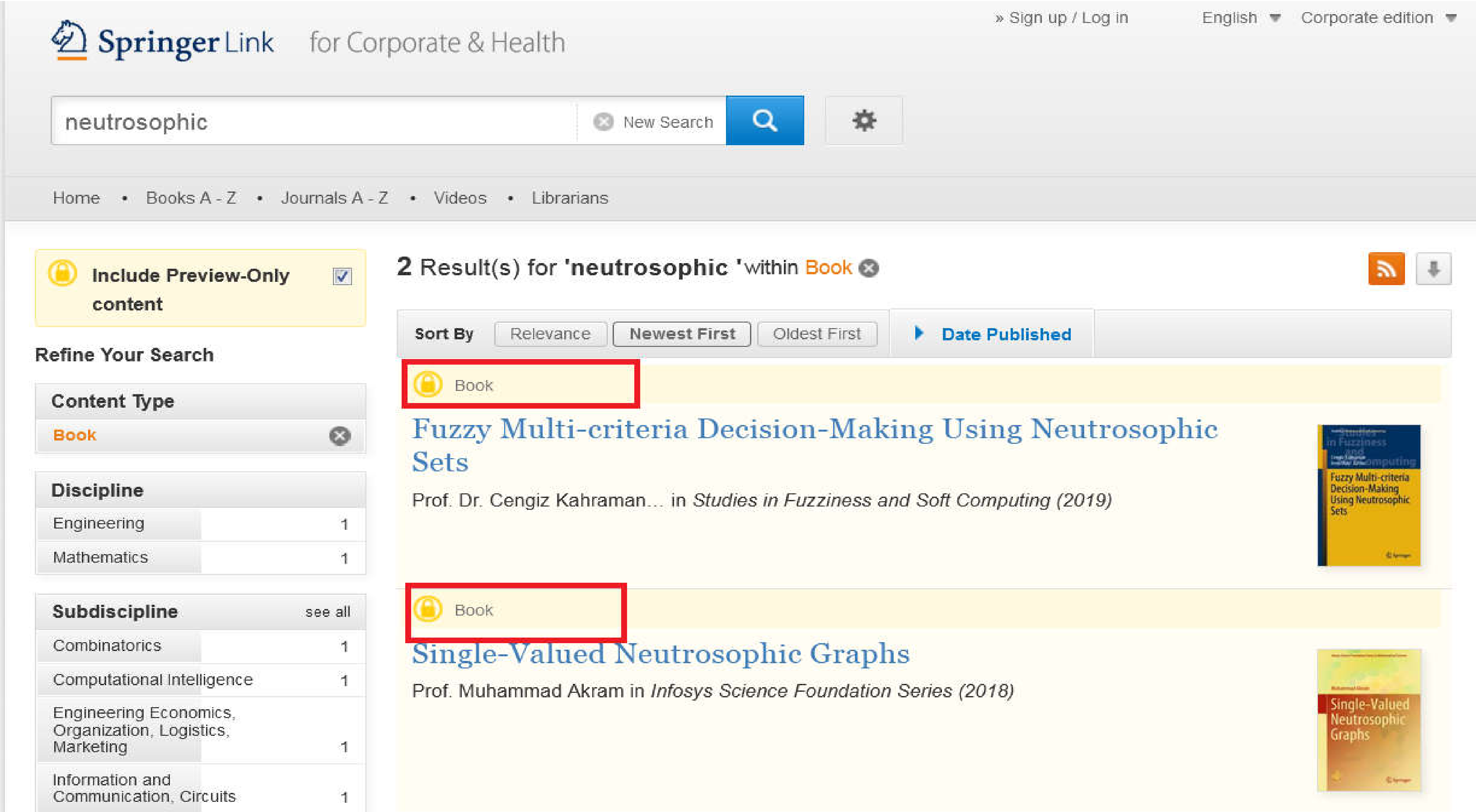
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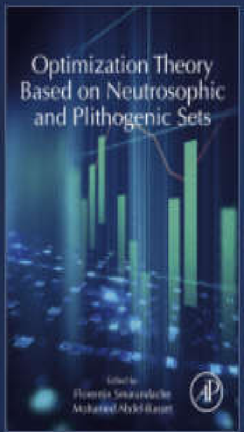

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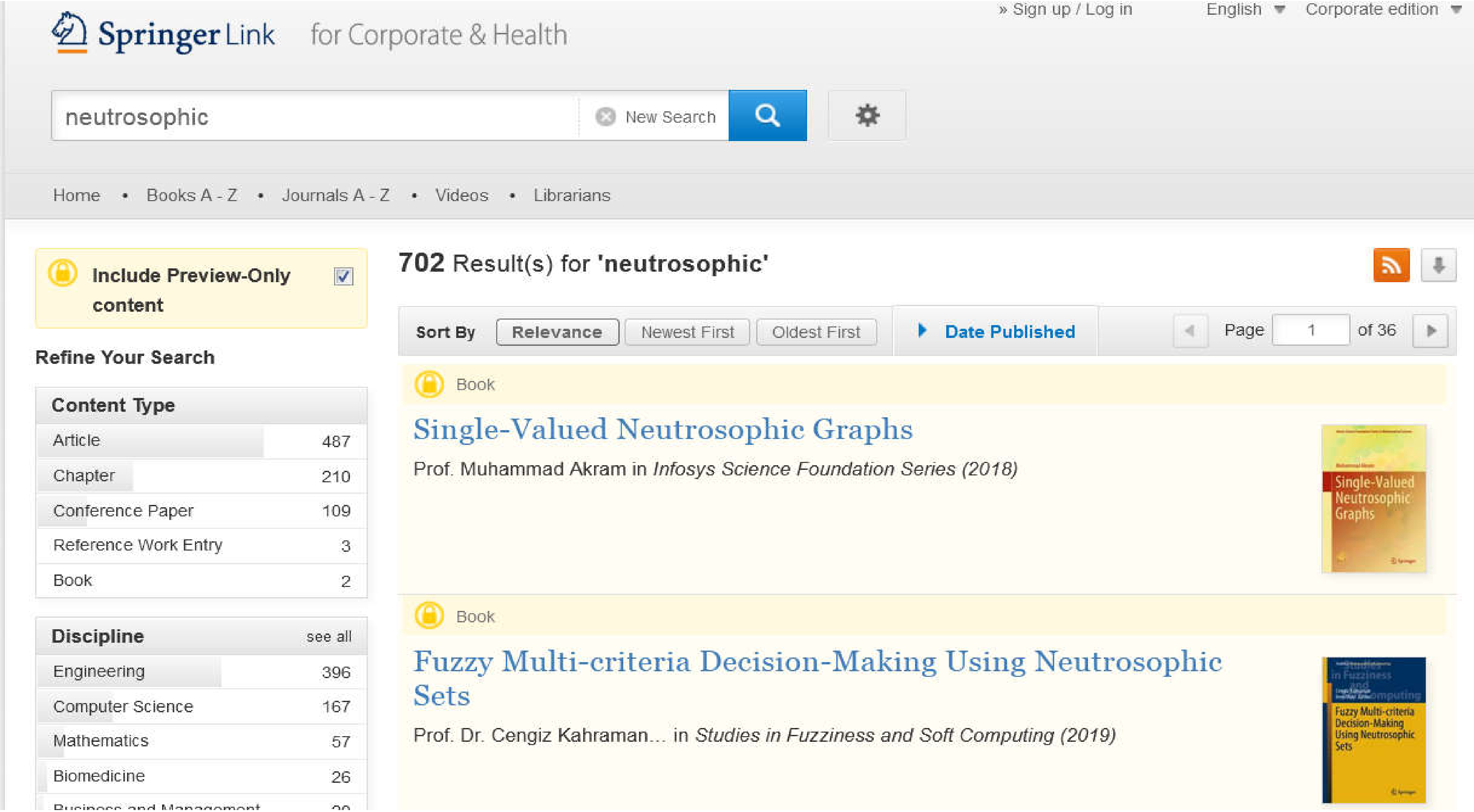
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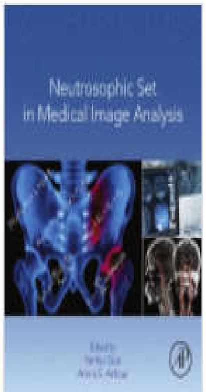

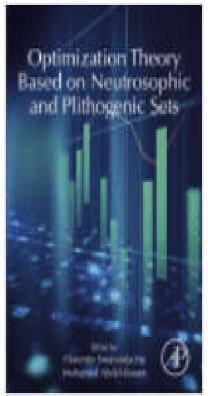

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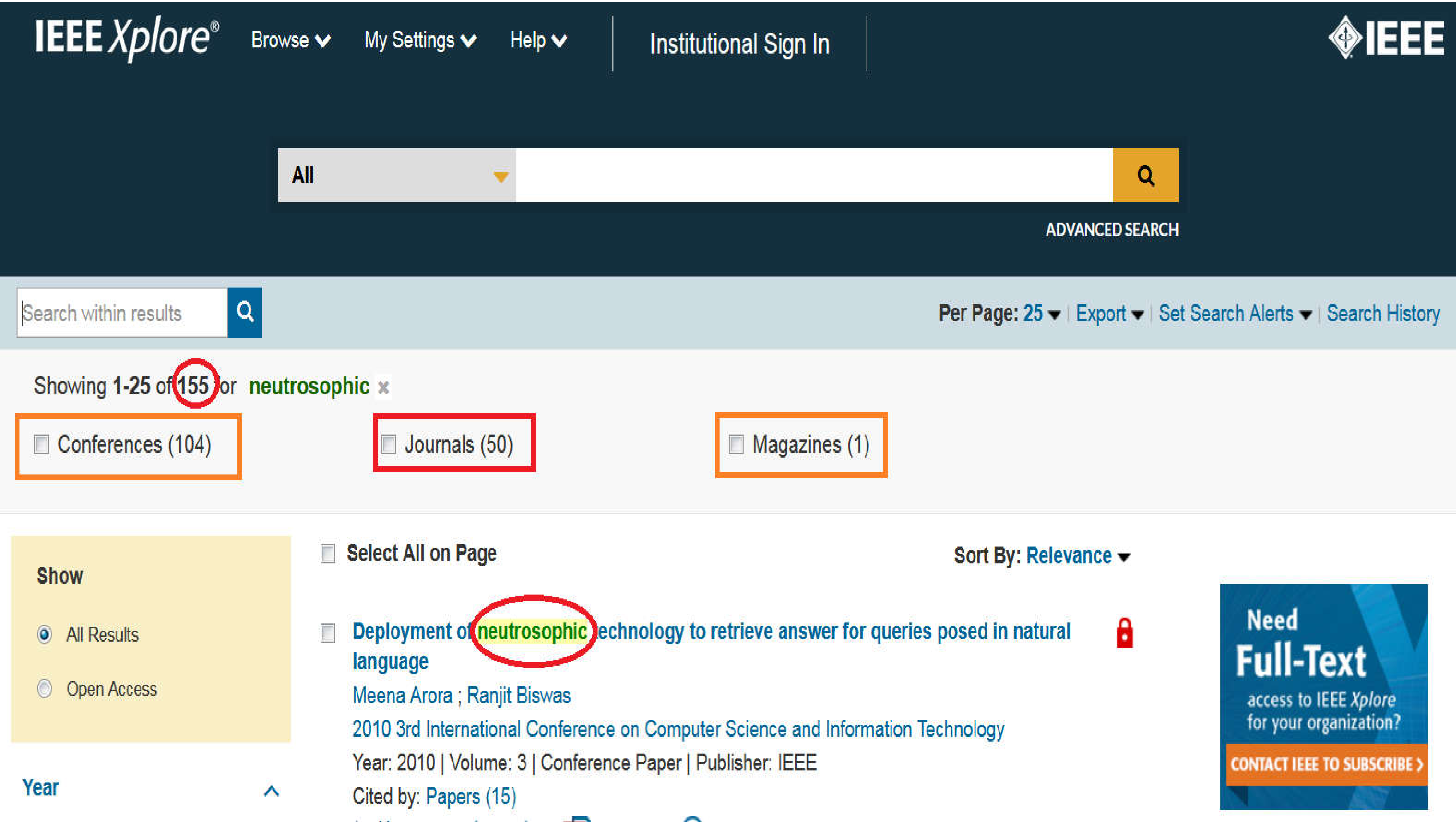
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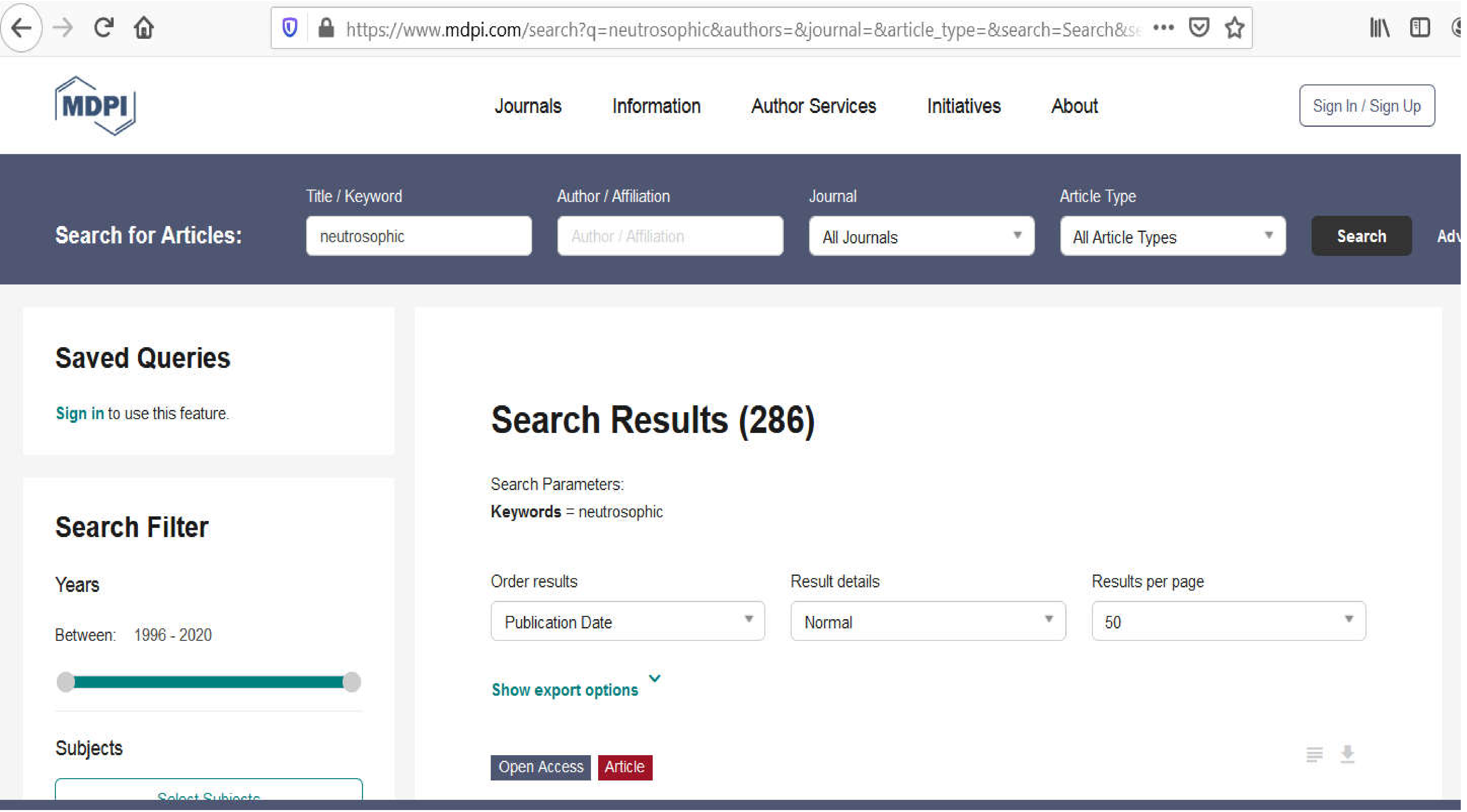
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Symmetry **2020**, *12*(6), 1012; https://doi.org/10.3390/sym12061012 - 16 Jun 2020

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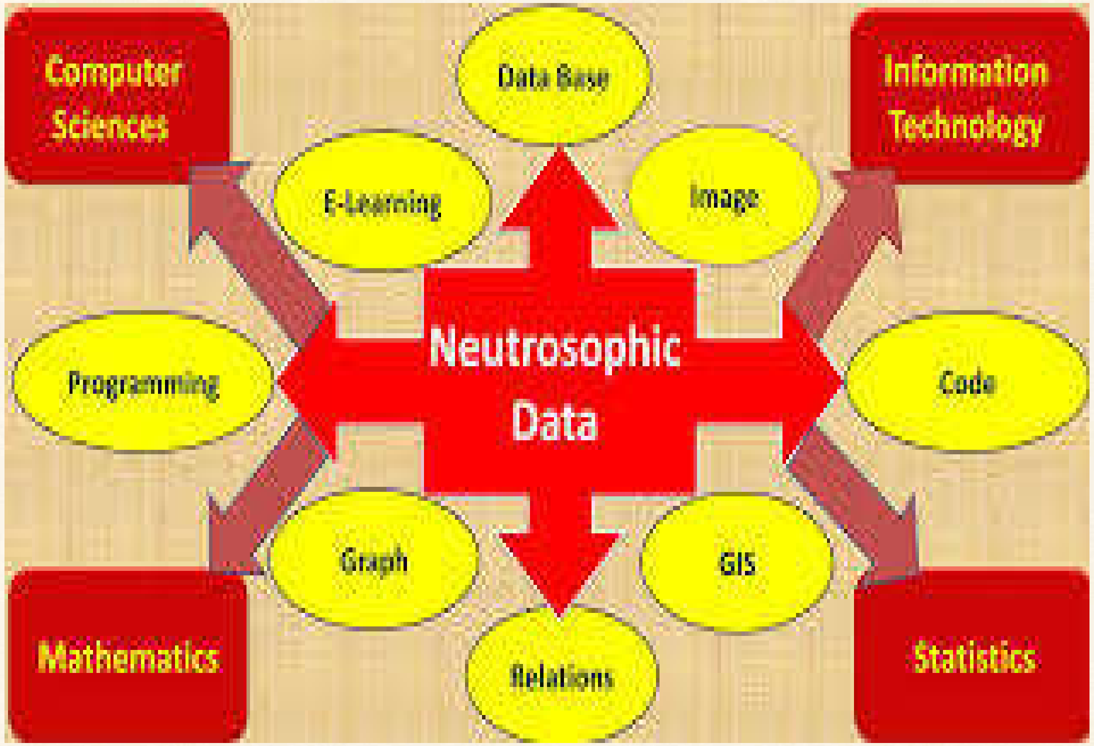

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Neutrosophic set in medical imaging

- Generally, the neutrosophic set (NS) approaches were applied successfully into image processing including image de-noising based on neutrosophic median filtering

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- Noise is one kind of indeterminant information on images. de-noising research domain Hence, NS can be successfully applied into image.
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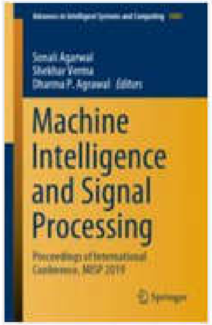

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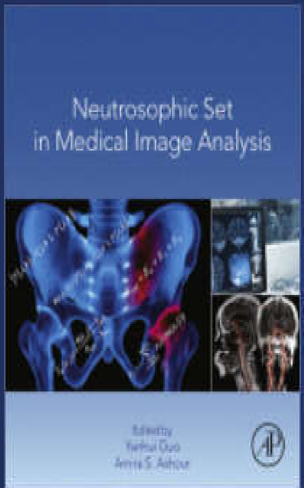

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Muhammad Aslam,[1] Osama H. Arif,[1] and Rehan Ahmad Khan Sherwani[2]

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Outline

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Future Generation Computer Systems

Volume 98, September 2019, Pages 144-153

A novel and powerful framework based on neutrosophic sets to aid patients with cancer

Mohamed Abdel-Basset, Mai Mohamed

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Neutrosophic Based Nakagami Total Variation Method for Speckle Suppression in Thyroid Ultrasound Images - 04/02/18

Doi : 10.1016/j.irbm.2017.11.003

D. Koundal [a, b, *], S. Gupta [b], S. Singh [b]

[a] Department of Computer Science & Engineering, Chitkara University Institute of Engineering & Technology, Chitkara University, Baddi, Himachal Pradesh, India

[b] Department of Computer Science & Engineering, University Institute of Engineering & Technology, Panjab University, Chandigarh, Punjab, India

*Corresponding author.

Vol 39 - N° 1

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A novel segmentation method for breast ultrasound **images** based on **neutrosophic** l-means clustering.

Shan J, Cheng HD, Wang Y

Med Phys, 39(9):5669-5682, 01 Sep 2012

authors propose a novel clustering approach called **neutrosophic** l-means (NLM) to detect the lesion boundary.... feature to improve the image quality, and a novel **neutrosophic**

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Original Research | Published: 28 January 2020

Neutrosophic Set-Based Caries Lesion Detection Method to Avoid Perception Error

Soma Datta, Nabendu Chaki & Biswajit Modak

SN Computer Science 1, Article number: 63 (2020) | Cite this article

Abstract; Dental caries is an infectious oral disease. The monitoring of caries region boundary, in regular intervals, is important for treatment purpose. To detect dental caries lesion, most of the time dentists use X-ray images. Due to human brain perception, sometimes it is difficult to detect the caries lesion accurately by observing the X-ray image manually. In this work, a framework has been proposed to detect caries lesion automatically within the optimum time. Almost all caries detection methods from the radiographic images apply iterative methods upon the entire image to separate initially suspected regions. Then, further processing is performed on the separated regions. This method reduced huge computation efforts by avoiding applying iterative methods upon the entire input image. This method transforms the input X-ray image into its equivalent neutrosophic domain to obtain initially suspected region. We have used a custom feature named 'weight' for neutrosophication. This feature is calculated by fusing other features differently. Once the initial region is detected, it is examined further to test whether there exists any iso-center rings like the catchment basin. This is the most important property of caries lesions. After the suspected region is confirmed as caries lesion, then the caries boundary is detected using active contour technique. The advantage of this system is that it avoids repetitive iterations at the time of suspected region selection using neutrosophication. Repetitive iterations upon the entire picture dimension are a time-consuming job. The performance of the proposed research work is satisfactory; the average accuracy is above 92%.

Dental x-ray Image Segmentation using Maker Based Watershed Technique in Neutrosophic Domain

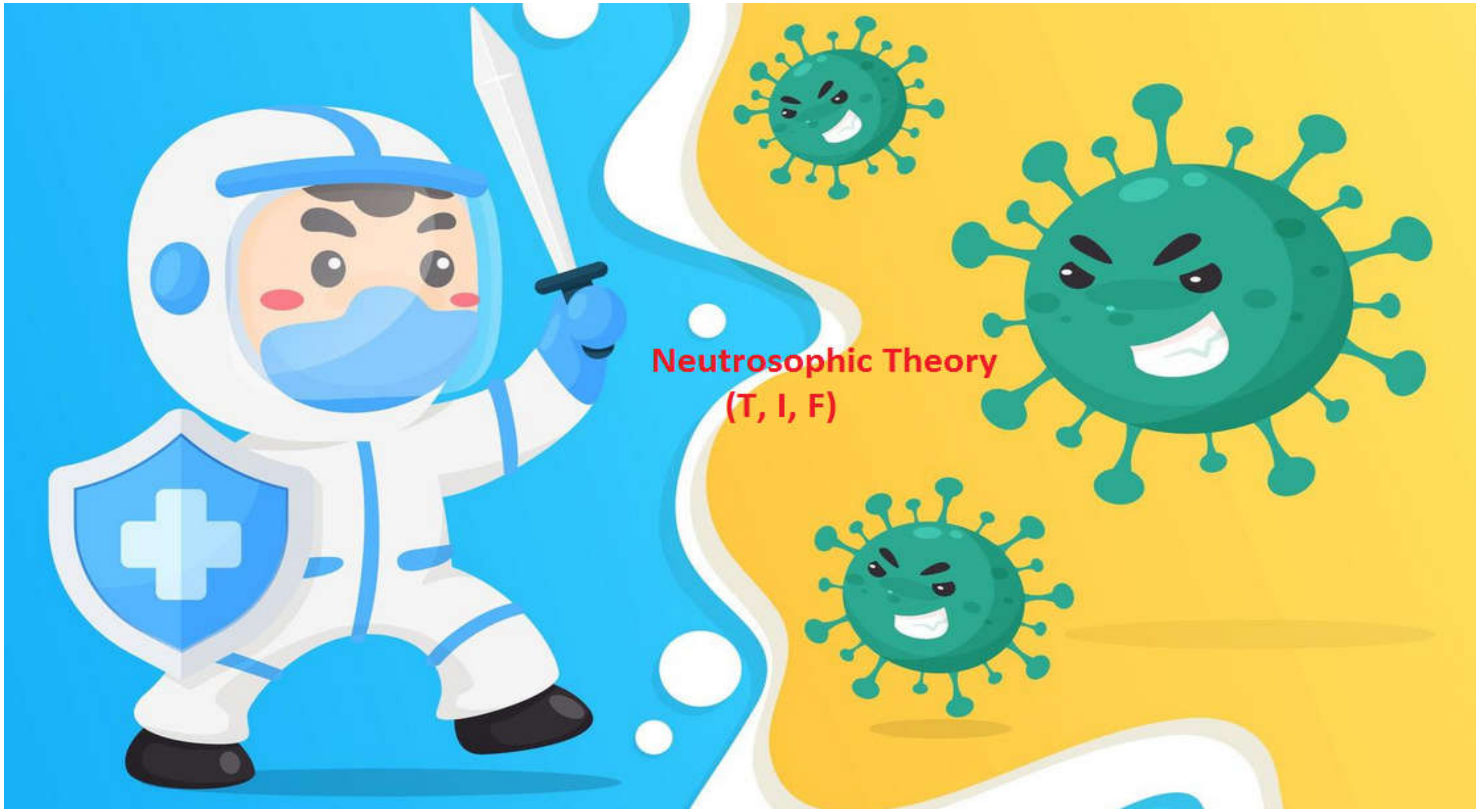
Soma Datta ; Nabendu Chaki

2020 International Conference on Computer Science, Engineering and Applications (ICCSEA)

Year: 2020 | Conference Paper | Publisher: IEEE

Abstract (html) (2057 Kb)

New recent Neutrosophic papers in the battle against COVID -19 Pandemic



International Journal of Neutrosophic Science (IJNS) Vol. 9, No. 1, PP. 54-59, 2020

A Suggested Diagnostic System of Corona Virus based on the Neutrosophic Systems and Deep Learning

A.A. Salama[1], Mohamed Fazaa[2], Mohamed Yahya[3], M. Kazim[4]

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[2, 3] Member of the Egyptian inventors Syndicate, and the Arab Invention Development Authority, Egypt.
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moh.kazim@metmans.edu.eg

Neutrosophic Sets and Systems, Vol. 35, 2020
University of New Mexico

COVID-X: Novel Health-Fog Framework Based on Neutrosophic Classifier for Confrontation Covid-19

Ibrahim Yasser [1,*], Abeer Twakol [2], A. A. Abd El-Khalek [3], Ahmed Samrah [4] and A. A. Salama [5]

[1] Communications and Electronics Engineering Department, Nile Higher Institute for Engineering and Technology Mansoura, Egypt; ibrahimyasser14@gmail.com.
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[3] Communications and Electronics Engineering Department, Nile Higher Institute for Engineering and Technology Mansoura, Egypt; ayayakot94@gmail.com.
[4] Electronics and Communications Engineering Department, Faculty of Engineering, Mansoura University, Egypt; shmed@mans.edu.eg.
[5] Department of Mathematics and Computer Science, Faculty of Sciences, Port Said University, Egypt; drsalama44@gmail.com.

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COVID-19 Chest X-Ray Images Diagnosis: A Neutrosophic and Deep Transfer Learning Approach

M. Khalifa NE, Smarandache F, Loey M

Preprints.org, 21 Apr 2020

grayscale spatial domain to the **neutrosophic** domain. The **neutrosophic** domain consists of three types of... True (T) **neutrosophic** images only. The second one is training on Indeterminacy (I) **neutrosophic** images,

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COVID-19 Chest X-Ray Images Diagnosis: A Neutrosophic and Deep Transfer Learning Approach

M. Khalifa NE, Smarandache F, Loey M

Working Paper Article Version 1 This version is not peer-reviewed

A Study of the Neutrosophic Set Significance on Deep Transfer Learning Models: An Experimental Case on a Limited COVID-19 Chest X-Ray Dataset

Nour Eldeen M. Khalifa *, Florentin Smarandache, Mohamed Loey

Version 1 : Received: 27 April 2020 / Approved: 28 April 2020 / Online: 28 April 2020 (09:57:20 CEST)

How to cite: M. Khalifa, N.E.; Smarandache, F.; Loey, M. A Study of the Neutrosophic Set Significance on Deep Transfer Learning Models: An Experimental Case on a Limited COVID-19 Chest X-Ray Dataset. *Preprints* **2020**, 2020040494 Copy

Machine Learning in Neutrosophic environment

List of major contributions on machine learning algorithms in Neutrosophic environment.

Authors	Title	Publisher
Salama, A. A., Eisa, M., ELhafeez, S. A., Lotfy, M. M. (2015)	Review of recommender systems algorithms utilized in social networks based e-Learning systems neutrosophic system	Neutrosophic Sets and Systems 8 : 32-40
Ansari, A. Q., Biswas, R., Aggarwal, S. (2013)	Neutrosophic classifier: An extension of fuzzy classifer	Applied Soft Computing, 13(1), 563-573
Zhang, M., Zhang, L., Cheng, H. D. (2010)	A neutrosophic approach to image segmentation based on watershed method	Signal Processing, 90(5), 1510-1517
Zhang, X., Bo, C., Smarandache, F., Dai, J. (2018)	New inclusion relation of neutrosophic sets with applications and related lattice structure	International Journal of Machine Learning and Cybernetics, 9, 1753-1763
Mondal, K. A. L. Y. A. N., Pramanik, S. U. R. A. P. A. T. I., Giri, B. C. (2016)	Role of neutrosophic logic in data mining. New Trends in Neutrosophic Theory and Application	Pons Editions, Brussels, 15-23.
Sengur, A., Guo, Y. (2011)	Color texture image segmentation based on neutrosophic set and wavelet transformation	Computer Vision and Image Understanding,115(8), 1134-1144
Akbulut, Y., engr, A., Guo, Y., Smarandache, F. (2017)	A novel neutrosophic weighted extreme learning machine for imbalanced data set	Symmetry, 9(8), 142
Kraipeerapun, P., Fung, C. C., Wong, K. W. (2007 August)	Ensemble neural networks using interval neutrosophic sets and bagging	In Third International Conference on Natural Computation (ICNC 2007) (Vol. 1, pp. 386-390). IEEE
Kavitha, B., Karthikeyan, S., Maybell, P. S(2012)	An ensemble design of intrusion detection system for handling uncertainty using Neutrosophic Logic Classifier	Knowledge-Based Systems, 28, 88-96

Ye, J. (2014).	Single-valued neutrosophic minimum spanning tree and its clustering method	Journal of intelligent Systems, 23(3), 311-324
Thanh, N. D., Ali, M. (2017, July)	Neutrosophic recommender system for medical diagnosis based on algebraic similarity measure and clustering	In 2017 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE) (pp. 1-6). IEEE
Akbulut, Y., engr, A., Guo, Y., Polat, K. (2017)	KNCM: Kernel neutrosophic c-means clustering	Applied Soft Computing, 52, 714-724
Kraipeerapun, P., Fung, C. C., Wong, K. W. (2006)	Multiclass classification using neural networks and interval neutrosophic sets	World Scientific and Engineering Academy and Society (WSEAS)
Ali, M., Khan, M., Tung, N. T. (2018)	Segmentation of dental X-ray images in medical imaging using neutrosophic orthogonal matrices	Expert Systems with Applications, 91, 434-441
Long, H. V., Ali, M., Khan, M., Tu, D. N. (2019)	A novel approach for fuzzy clustering based on neutrosophic association matrix	Computers and Industrial Engineering, 127, 687-697
Kraipeerapun, P., Fung, C. C. (2008, February)	Comparing performance of interval neutrosophic sets and neural networks with support vector machines for binary classification problems	In 2008 2nd IEEE International Conference on Digital Ecosystems and Technologies (pp. 34-37). IEEE
Thanh, N. D., Ali, M. (2017)	A novel clustering algorithm in a neutrosophic recommender system for medical diagnosis	Cognitive Computation, 9(4), 526-544

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Applications of neutrosophic logic to robotics: An introduction

Publisher: IEEE Cite This PDF

2 Author(s) Florentin Smarandache ; Luige Vlădăreanu **All Authors**

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DOI: 10.7763/IJMO.2020.V10.751

Neutrosophic Theory Applied in the Multi Objectives Optimization of the Robot's Joints Accelerations with the Virtual LabVIEW Instrumentation

A. Olaru, S. Olaru, N. Mihai, and N. Smidova

Applications of neutrosophic logic to robotics: An introduction

Publisher: IEEE

2 Author(s) Florentin Smarandache ; Luige Vlădăreanu All Authors

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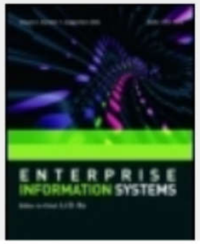

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Mohamed Abdel-Basset, Nada A. Nabeeh, Haitham A El-Ghareeb & Ahmed Aboelfetouh

Received 04 Jan 2019, Accepted 16 Jun 2019, Published online: 27 Jun 2019

Download citation https://doi.org/10.1080/17517575.2019.1633690

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Neutrosophic approach in Business intelligence and Big Data

Neutrosophic approach in data warehouse concepts

International Journal of Neutrosophic Science (IJNS) *Vol. 8, No. 2, PP. 87-109, 2020*

Online Analytical Processing Operations via Neutrosophic Systems

A. A. Salama[1], M.S.Bondok Henawy[2], Rafif Alhabib[3]

[1,2]Department of Mathematics and Computer Science, Faculty of Sciences, Port Said University Egypt.
drsalama44@gmail.com
[3]Department of Mathematical Statistics, Faculty of Science, Albaath University, Homs, Syria;
rafif.alhabib85@gmail.com

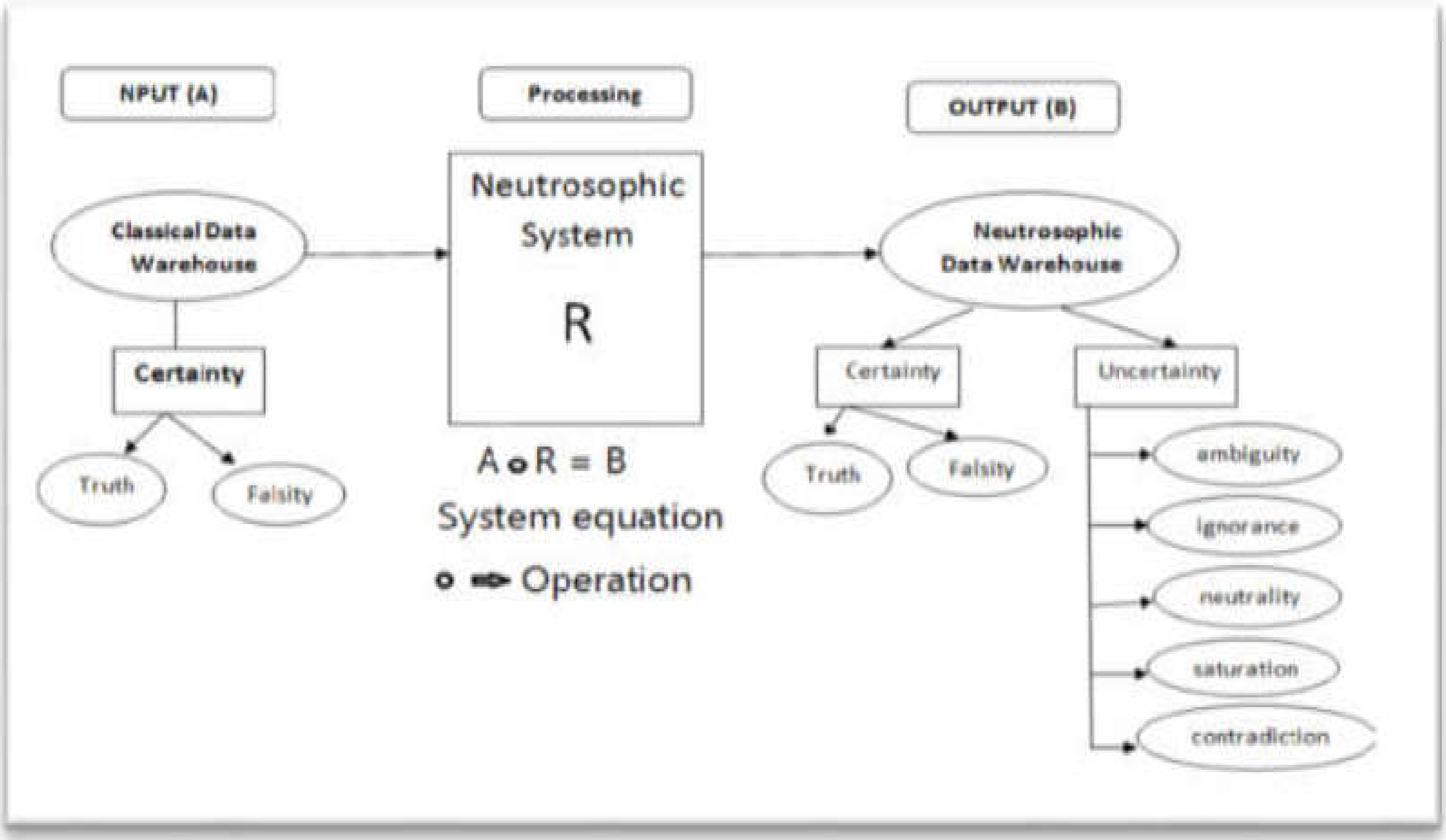

Figure 1: convert classical data warehouse into Neutrosophic Fuzzy Data warehouse

Journals / Symmetry / Volume 10 / Issue 4 / 10.3390/sym10040106

Open Access Feature Paper Article

Neutrosophic Association Rule Mining Algorithm for Big Data Analysis

by Mohamed Abdel-Basset [1,*], Mai Mohamed [1], Florentin Smarandache [2,*] and Victor Chang [3]

MANET, WIRLESS Network and telephony

Research Article | Open Access
Volume 2018 | Article ID 5828517 | 10 pages | https://doi.org/10.1155/2018/5828517

A Novel Approach for Classifying MANETs Attacks with a Neutrosophic Intelligent System based on Genetic Algorithm

Haitham Elwahsh,[1] Mona Gamal,[2] A. A. Salama,[3] and I. M. El-Henawy[4]
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Achievable Single-Valued Neutrosophic Graphs in Wireless Sensor Networks

Author

Listed:

- Mohammad Hamidi
  (Department of Mathematics, Faculty of Mathematics, Payame Noor University, Tehran, Iran)
- Arsham Borumand Saeid
  (arsham@uk.ac.ir) (Department of Pure Mathematics, Faculty of Mathematics and Computer, Shahid Bahonar University of Kerman, Kerman, Iran)

Global Journal of Computer Science and Technology: E
Network, Web & Security
Volume 18 Issue 2 Version 1.0 Year 2018
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Novel System and Method for Telephone Network Planing based on Neutrosophic Graph

By Said Broumi, Kifayat Ullah, Assia Bakali, Mohamed Talea, Prem Kumar Singh, Tahir Mahmood, Florentin Smarandache, Ayoub Bahnasse, Santanu Kumar Patro & Angelo de Oliveira

University Hassan II

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Article

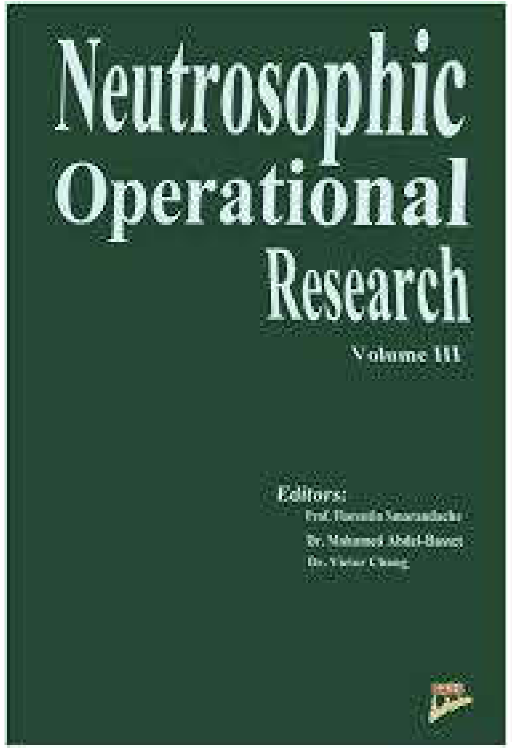
Single-Valued Neutrosophic Set Correlation Coefficient and Its Application in Fault Diagnosis

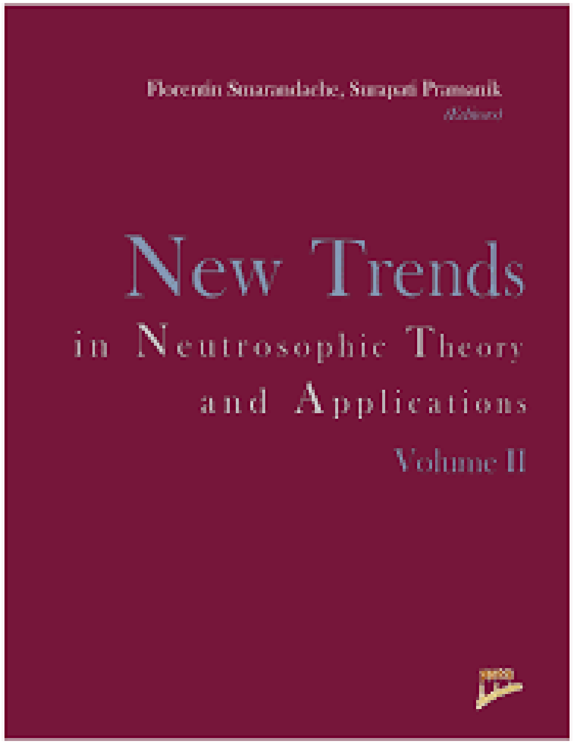
Shchur Iryna [1], Yu Zhong [1], Wen Jiang [1,2,*], Xinyang Deng [1] and Jie Geng [1]

1 School of Electronics and Information, Northwestern Polytechnical University, Xi'an 710072, China; irynashchur93@mail.nwpu.edu.cn (S.I.); yuzhong@mail.nwpu.edu.cn (Y.Z.); xinyang.deng@nwpu.edu.cn (X.D.); gengjie@nwpu.edu.cn (J.G.)
2 Peng Cheng Laboratory, Shenzhen 518055, China
* Correspondence: jiangwen@nwpu.edu.cn; Tel.: +86-29-8843-1267

Received: 3 July 2020; Accepted: 11 August 2020; Published: 17 August 2020

Neutrosophic operational Research





Published: 07 March 2019

Neutrosophic approach for enhancing quality of signals

Sudan Jha, Raghvendra Kumar, Le Hoang Son, Francisco Chiclana, Vikram Puri & Ishaani Priyadarshini

Multimedia Tools and Applications **79**, 16883–16914(2020) | Cite this article

Abstract : Information in a signal is often followed by undesirable disturbance which is termed as noise. Preventing noise in the signal leads to signal integrity, which also leads to better signal quality. The previous related works have the major issues while reducing noise in signals regarding assumptions, frequency and time domain, etc. This paper proposes a new Neutrosophic approach to reduce noises and errors in signal transmission. In the proposed method, confidence function is used as the truth membership function, which is associated with sampled time intervals. Then, we define a Dependency function at each time interval for the frequency of transmitted signal. Finally, a Falsehood function, which indicates the loss in information due to amplitude distortion, is defined. This function shows how much information has been lost. Our objective is to minimize the falsehood function using several neutrosophic systems. Experimental results show 1% decrease in loss compared to the original signal without PAM. It is shown the decrease of 0.1% if the frequency is shifted to a higher range.

Research on the Shortest Path Solution Method of Interval Valued Neutrosophic Graphs Based on the Ant Colony Algorithm

Publisher: IEEE

Cite This | PDF

3 Author(s) Lehua Yang ; Dongmei Li ; Ruipu Tan All Authors

Open Access Comment(s)

Abstract:
The shortest path problem (SPP) is considerably important in several fields. After typhoons, the resulting damage leads to uncertainty regarding the path weight that can be expressed accurately. A neutrosophic set is a collection of the truth membership, indeterminacy membership, and falsity membership degrees of the elements. In an uncertain environment, neutrosophic numbers can express the edge distance more effectively. Based on the theories of interval valued neutrosophy and neutrosophic graphs, this paper proposes a shortest path solution method of interval valued neutrosophic graphs using the ant colony algorithm. Further, an analysis comparing the proposed algorithm with the Dijkstra algorithm was used to probe the potential shortcomings and advantages of the proposed method. In addition, this approach confirmed the effectiveness of the proposed algorithm. Furthermore, we investigated the convergence processes of the ant colony algorithm with different parameter settings, analyzed their results, and used different score functions to solve the SPP and analyze the results.

Topic: Intelligent Information Services

Published in: IEEE Access (Volume: 8)

Page(s): 88717 - 88728

INSPEC Accession Number: 19658998

Date of Publication: 28 April 2020

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Operations Research Perspectives

Volume 6, 2019, 100099

A new perspective on traffic control management using triangular interval type-2 fuzzy sets and interval neutrosophic sets

D. Nagarajan [a], M. Lathamaheswari [a], Said Broumi [b], J. Kavikumar [c]

Outline

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Volume 52, December 2018, Pages 1056-1065

Neutrosophic state feedback design method for SISO neutrosophic linear systems

Jun Ye, Wenhua Cui

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Methods and Applications

Editors: **Smarandache**, Florentin, **Abdel-Basset**, Mohamed (Eds.)

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Presents state-of-the-art research on neutrosophic theory and its application in operations research

Guest Editorial: Neutrosophic decision making and applications in knowledge management

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1 Author(s) Harish Garg All Authors

Abstract

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Published in: CAAI Transactions on Intelligence Technology (Volume: 5 , Issue: 2 , 6 2020)

Page(s): 67 - 67

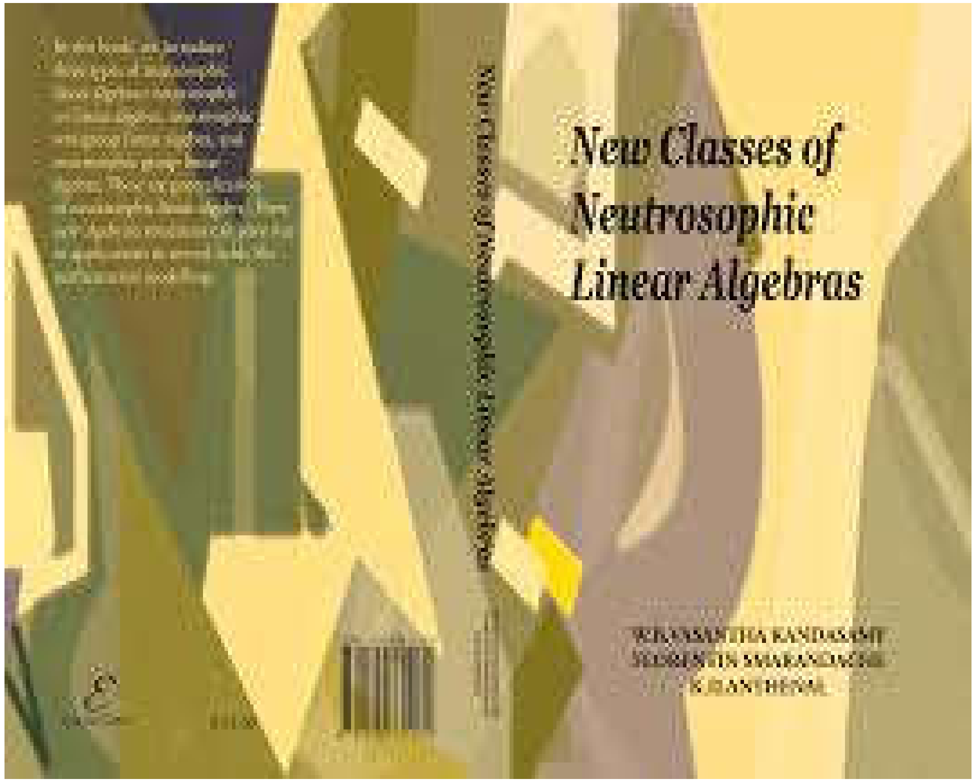
DOI: 10.1049/trit.2020.0096

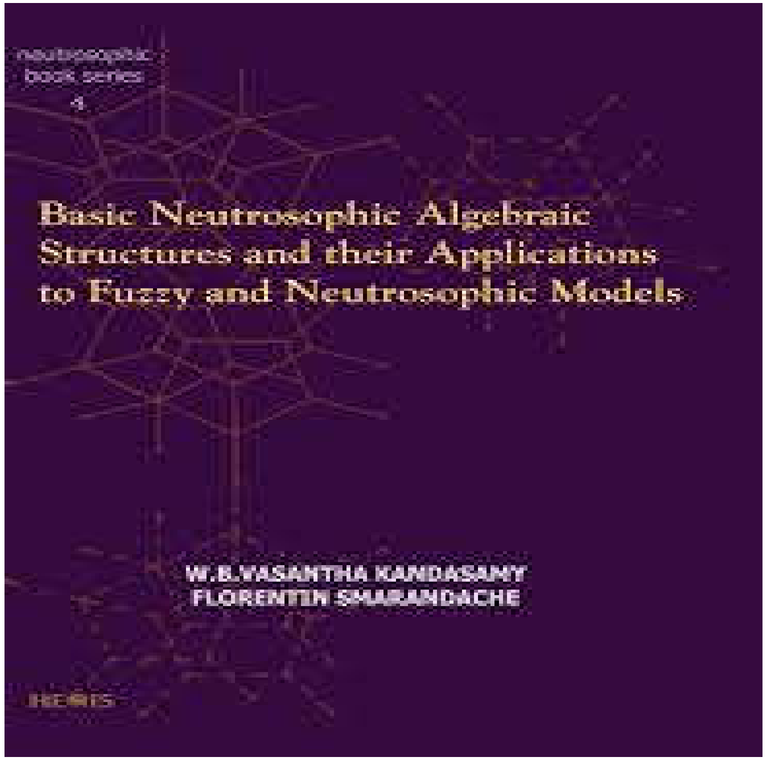
Date of Publication: 01 July 2020

Publisher: IET

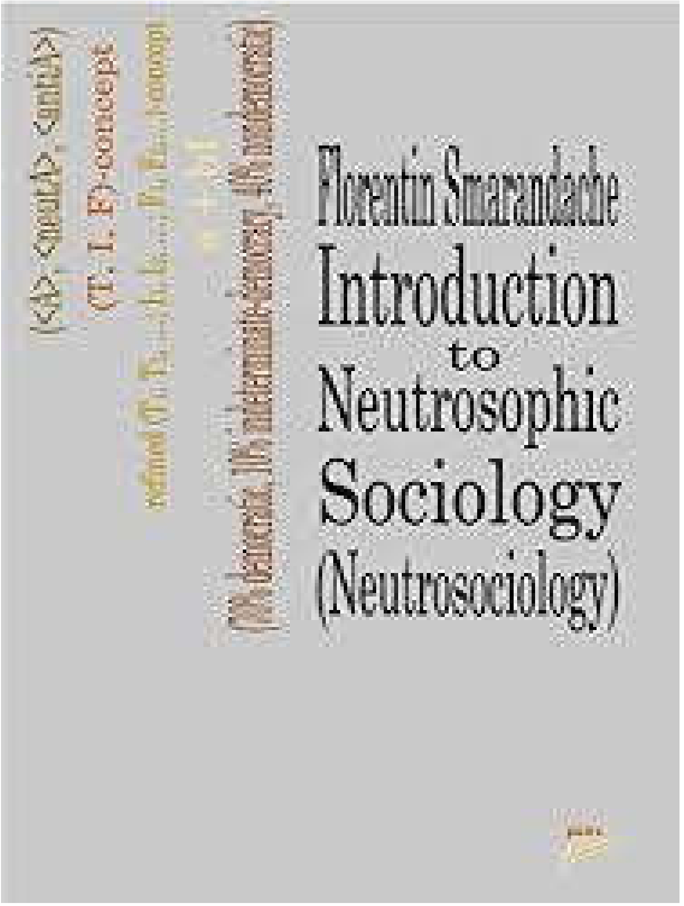
Electronic ISSN: 2468-2322

Neutrosophic Linear Algebra





Neutrosophic Sociology



The physical world as seen through human eyes at the most immediate level is organized into three categories: average, above average, and below average. This basic perception can be applied to any observation. Typically in sociology, one of the basic criteria of (socio-professional) classification is to consider 3 levels of wealth: the middle, upper and lower classes.

Neutrosophic Quantum Computer

Intern. J. Fuzzy Mathematical Archive
Vol. 10, No. 2, 2016, 139-145
ISSN: 2320 –3242 (P), 2320 –3250 (online)
Published on 12 May 2016
www.researchmathsci.org

International Journal of
Fuzzy Mathematical Archive

Neutrosophic Quantum Computer

Florentin Smarandache

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Article

Neutrosophic Logic Based Quantum Computing

Ahmet Çevik [1], Selçuk Topal [2,*] and Florentin Smarandache [3]

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2 Department of Mathematics, Faculty of Science and Arts, Bitlis Eren University, Bitlis 13000, Turkey
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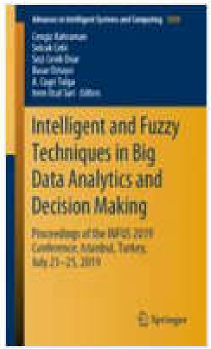
* Correspondence: s.topal@beu.edu.tr; Tel.: +90-532-709-0239

Received: 18 October 2018; Accepted: 16 November 2018; Published: 20 November 2018

Introduction to the Neutrosophic Quantum Theory

Smarandache, Florentin

Neutrosophic Quantum Theory (NQT) is the study of the principle that certain physical



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Neutrosophic TOPSIS Method for Technology Evaluation of Unmanned Aerial Vehicles (UAVs)

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Ali Karaşan, İhsan Kaya

Conference paper

First Online: 06 July 2019

Part of the Advances in Intelligent Systems and Computing book series (AISC, volume 1029)

Sustainable Development

RESEARCH ARTICLE

A multi-criteria sustainable supplier selection framework based on neutrosophic fuzzy data and entropy weighting

Shouzhen Zeng, Yingjie Hu, Tomas Balezentis, Dalia Streimikiene

First published: 22 June 2020 | https://doi.org/10.1002/sd.2096

Funding information: China Postdoctoral Science Foundation, Grant/Award Number: 2019M651403; Major Humanities and Social Sciences Research Projects in Zhejiang Universities, Grant/Award Number: 2018QN058; Ningbo Province Natural Science Foundation, Grant/Award Number: 2019A610037; Zhejiang Province Natural Science Foundation, Grant/Award Number: LY18G010007; Fundamental Research Funds for the Provincial Universities of Zhejiang, Grant/Award Number: SJWZ2020002

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Fuzzy and neutrosophic modeling for link prediction in social networks

Tran Manh Tuan, Pham Minh Chuan, Mumtaz Ali, Tran Thi Ngan, Mamta Mittal & Le Hoang Son

Evolving Systems **10**, 629–634(2019) | Cite this article

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Generalized neutrosophic planar graphs and its application

Rupkumar Mahapatra, Sovan Samanta & Madhumangal Pal

Journal of Applied Mathematics and Computing (2020) | Cite this article

In the existing definition of a neutrosophic planar graph, there is a limitation. In that definition, the value of falsity in degree of planarity is 1, even then the crisp underline graph is planar. This limitation is removed in the proposed definition. In this study, an advanced concept of the neutrosophic planar graphs is given and investigated the generalized neutrosophic planar graphs (GNPG). The score of planarity is calculated based on the true, falsity and indeterminacy values of degree of planarity to measure the overall planarity of a GNPG. And a few related properties are investigated. A real-life application is presented and solved by this concept of a GNPG.

Published: 21 December 2019

On hesitant neutrosophic rough set over two universes and its application

Hu Zhao & Hong-Ying Zhang

Artificial Intelligence Review **53**, 4387–4406(2020) | Cite this article

A new method to classify malicious domain name using neutrosophic sets in DGA botnet detection

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Authors: Van Can, Nguyen | Tu, Doan Ngoc | Tuan, Tong Anh | Long, Hoang Viet | Son, Le Hoang | Son, Nguyen Thi Kim

Article Type: Research Article

Abstract: In Botnet Detection, Domain generation algorithms are the most effective method to intercept and analyze captured package. In this article, we propose a new method to classify harmful domain names using ***Neutrosophic*** Sets. Data of domain name, after being selected featured and fuzzed into ***Neutrosophic*** Sets will be used to classify benign domain names, malicious domain names and indeterminacy domain names, minimizing false detection of benign domain names. The proposed model is going to be tested and evaluated with other malicious domain detection models in the aspects of accuracy points, Accuracy, Revocation, and F1, all of which show ... Show more

Keywords: DGA domain detection, ***neutrosophic*** clustering, classifying

DOI: 10.3233/JIFS-190681

Citation: Journal of Intelligent & Fuzzy Systems, vol. 38, no. 4, pp. 4223-4236, 2020

Journal of Economics, Finance and Accounting – (JEFA), ISSN: 2148-6697, http://www.pressacademia.org/journals/jefa

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Journal of Economics, Finance and Accounting

Year: 2017 Volume: 4 Issue: 4

ANALYZING MOBILE BANKING QUALITY FACTORS UNDER NEUTROSOPHIC SET PERSPECTIVE: A CASE STUDY OF TURKEY

DOI: 10.17261/Pressacademia.2017.746

JEFA- V.4-ISS.4-2017(1)-p.354-367

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Article

Shortest Path Solution of Trapezoidal Fuzzy Neutrosophic Graph Based on Circle-Breaking Algorithm

Lehua Yang [1], Dongmei Li [2,*] and Ruipu Tan [1]

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Definition : X *is a domain, and a trapezoidal fuzzy NS* $\tilde{N}$ *can be expressed as follows:*

$$\tilde{N} = \{\langle x, T_{\tilde{N}}(x), I_{\tilde{N}}(x), F_{\tilde{N}}(x)\rangle | x \in X\}, \quad (1)$$

where $T_{\tilde{N}}(x) \subset [0,1]$, $I_{\tilde{N}}(x) \subset [0,1]$, *and* $F_{\tilde{N}}(x) \subset [0,1]$ *are trapezoidal fuzzy numbers, expressed as* $T_{\tilde{N}}(x) = \left(t_{\tilde{N}}^{1}(x), t_{\tilde{N}}^{2}(x), t_{\tilde{N}}^{3}(x), t_{\tilde{N}}^{4}(x)\right) : X \to [0,1]$, $I_{\tilde{N}}(x) = \left(i_{\tilde{N}}^{1}(x), i_{\tilde{N}}^{2}(x), i_{\tilde{N}}^{3}(x), i_{\tilde{N}}^{4}(x)\right) : X \to [0,1]$, *and* $F_{\tilde{N}}(x) = \left(f_{\tilde{N}}^{1}(x), f_{\tilde{N}}^{2}(x), f_{\tilde{N}}^{3}(x), f_{\tilde{N}}^{4}(x)\right) : X \to [0,1]$, *respectively, which meet the condition* $0 \le t_{\tilde{N}}^{4}(x) + i_{\tilde{N}}^{4}(x) + f_{\tilde{N}}^{4}(x) \le 3, x \in X$.

Definition : *A TrFNN in domain X can be expressed as*

$\tilde{n} = \langle (a_1, a_2, a_3, a_4), (b_1, b_2, b_3, b_4), (c_1, c_2, c_3, c_4) \rangle$. *The parameters can satisfy the following relationships:* $a_1 \le a_2 \le a_3 \le a_4$, $b_1 \le b_2 \le b_3 \le b_4$, *and* $c_1 \le c_2 \le c_3 \le c_4$. *The truth membership function of a trapezoidal fuzzy NS can be expressed as*

$$T_{\tilde{N}}(x) = \left\langle \begin{array}{cc} \dfrac{x - a_1}{a_2 - a_1} & a_1 \le x \le a_2 \\ 1 & a_2 \le x \le a_3 \\ \dfrac{a_4 - x}{a_4 - a_3} & a_3 \le x \le a_4 \\ 0 & otherwise \end{array} \right\rangle . \tag{2}$$

The indeterminacy membership function of a trapezoidal fuzzy NS can be expressed as

$$I_{\tilde{N}}(x) = \left\langle \begin{array}{cc} \dfrac{b_2 - x}{b_2 - b_1} & b_1 \le x \le b_2 \\ 0 & b_2 \le x \le b_3 \\ \dfrac{x - b_3}{b_4 - b_3} & b_3 \le x \le b_4 \\ 1 & otherwise \end{array} \right\rangle. \qquad (3)$$

The falsity membership function of a trapezoidal fuzzy NS can be expressed as

$$F_{\tilde{N}}(x) = \left\langle \begin{array}{cc} \dfrac{c_2 - x}{c_2 - c_1} & c_1 \le x < c_2 \\ 0 & c_2 \le x \le c_3 \\ \dfrac{x - c_3}{c_4 - c_3} & c_3 < x \le c_4 \\ 1 & otherwise \end{array} \right\rangle. \qquad (4)$$

. *Ranking Function*

Definition 5. *[10]:* $\tilde{n} = \langle (a_1, a_2, a_3, a_4), (b_1, b_2, b_3, b_4), (c_1, c_2, c_3, c_4) \rangle$ *is a TrFNN and its score function can be expressed as*

$$S(\tilde{n}) = \frac{1}{3}\left(2 + \frac{a_1 + a_2 + a_3 + a_4}{4} - \frac{b_1 + b_2 + b_3 + b_4}{4} - \frac{c_1 + c_2 + c_3 + c_4}{4}\right), S(\tilde{n}) \in [0, \quad (9)$$

A larger value of $S(\tilde{n})$ *results in a larger TrFNN* $\tilde{n}$.

Definition 6. *[11]:* $\tilde{n} = \langle (a_1, a_2, a_3, a_4), (b_1, b_2, b_3, b_4), (c_1, c_2, c_3, c_4) \rangle$ *is a TrFNN, and its exact function can be expressed as*

$$H(\tilde{n}) = \frac{a_1 + a_2 + a_3 + a_4}{4} - \frac{c_1 + c_2 + c_3 + c_4}{4}, H(\tilde{n}) \in [-1, 1]. \quad (10)$$

As the value of $H(\tilde{n})$ *increases, the value of the TrFNN of* $\tilde{n}$ *also increases. The ordering relationship of the two TrFNN can be achieved based on the score function,* $S(\tilde{n})$*, and exact function,* $H(\tilde{n})$.

Definition 7. *[10]:* $\tilde{n}_1 = \langle (a_1, a_2, a_3, a_4), (b_1, b_2, b_3, b_4), (c_1, c_2, c_3, c_4) \rangle$ *and*

$\tilde{n}_2 = \langle (e_1, e_2, e_3, e_4), (f_1, f_2, f_3, f_4), (g_1, g_2, g_3, g_4) \rangle$ *are two TrFNN,* $S(\tilde{n}_1)$ *and* $S(\tilde{n}_2)$ *are the score functions of* $\tilde{n}_1$ *and* $\tilde{n}_2$*, respectively, and* $H(\tilde{n}_1)$ *and* $H(\tilde{n}_2)$ *are the exact functions of* $\tilde{n}_1$ *and* $\tilde{n}_2$*, respectively. The ordering relationship of the TrFNN is as follows:*

if $S(\tilde{n}_1) > S(\tilde{n}_2)$*, then* $\tilde{n}_1 > \tilde{n}_2$

if $S(\tilde{n}_1) < S(\tilde{n}_2)$*, then* $\tilde{n}_1 < \tilde{n}_2$

if $S(\tilde{n}_1) = S(\tilde{n}_2)$*, then*

① *if* $H(\tilde{n}_1) > H(\tilde{n}_2)$*, then* $\tilde{n}_1 > \tilde{n}_2$

② *if* $H(\tilde{n}_1) < H(\tilde{n}_2)$*, then* $\tilde{n}_1 < \tilde{n}_2$

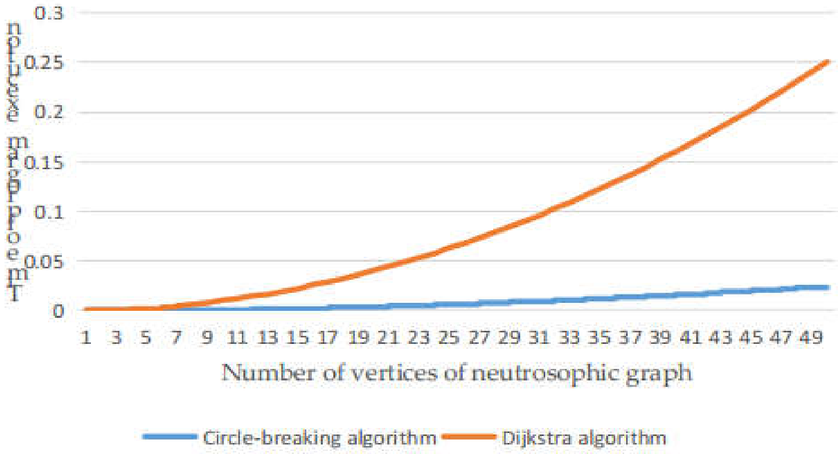

Figure 4. Comparison of the execution times of the circle-breaking and Dijkstra algorithms.

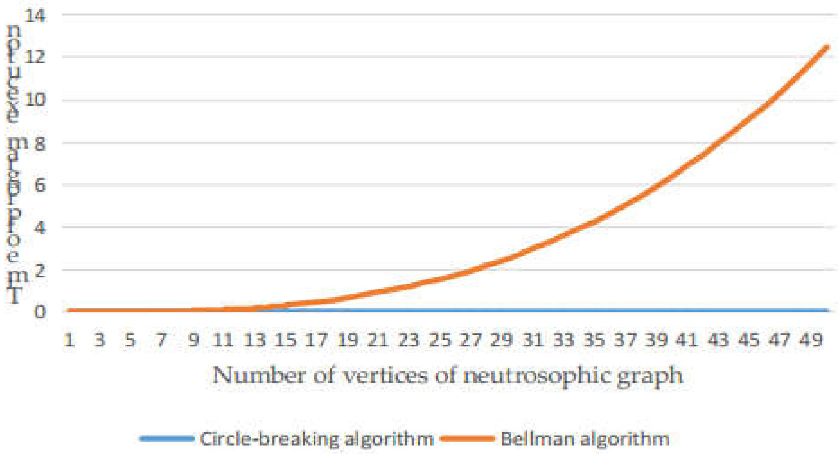

Figure 5. Comparison of the execution times of the circle-breaking and Bellman algorithms.

In these figures, the abscissa represents the number of vertices of the neutrosophic graph, and the ordinate represents the running time of the algorithm. As shown in Figures 4 and 5, in the case of the same number of vertices in the neutrosophic graph, the running time of the circle-breaking algorithm is lesser than those of the Dijkstra and Bellman algorithms. Hence, the circle-breaking algorithm is feasible and reasonable.

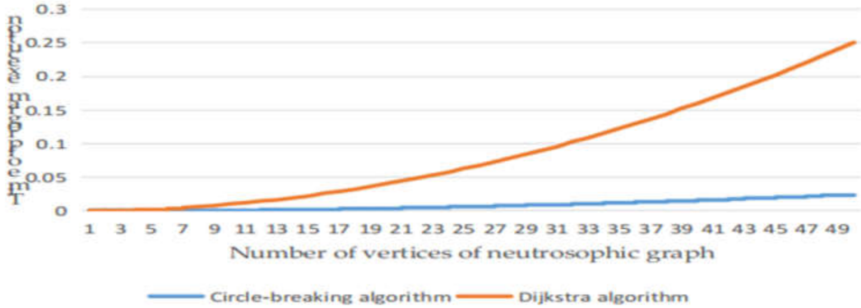

Figure 4. Comparison of the execution times of the circle-breaking and Dijkstra algorithms.

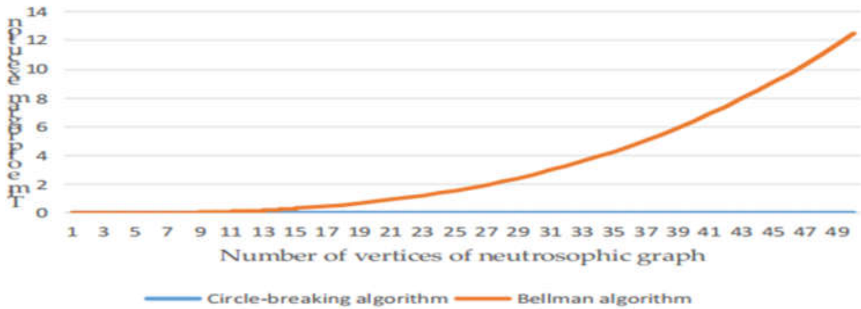

Figure 5. Comparison of the execution times of the circle-breaking and Bellman algorithms.

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Research on the Shortest Path Solution Method of Interval Valued Neutrosophic Graphs Based on the Ant Colony Algorithm

Publisher: IEEE

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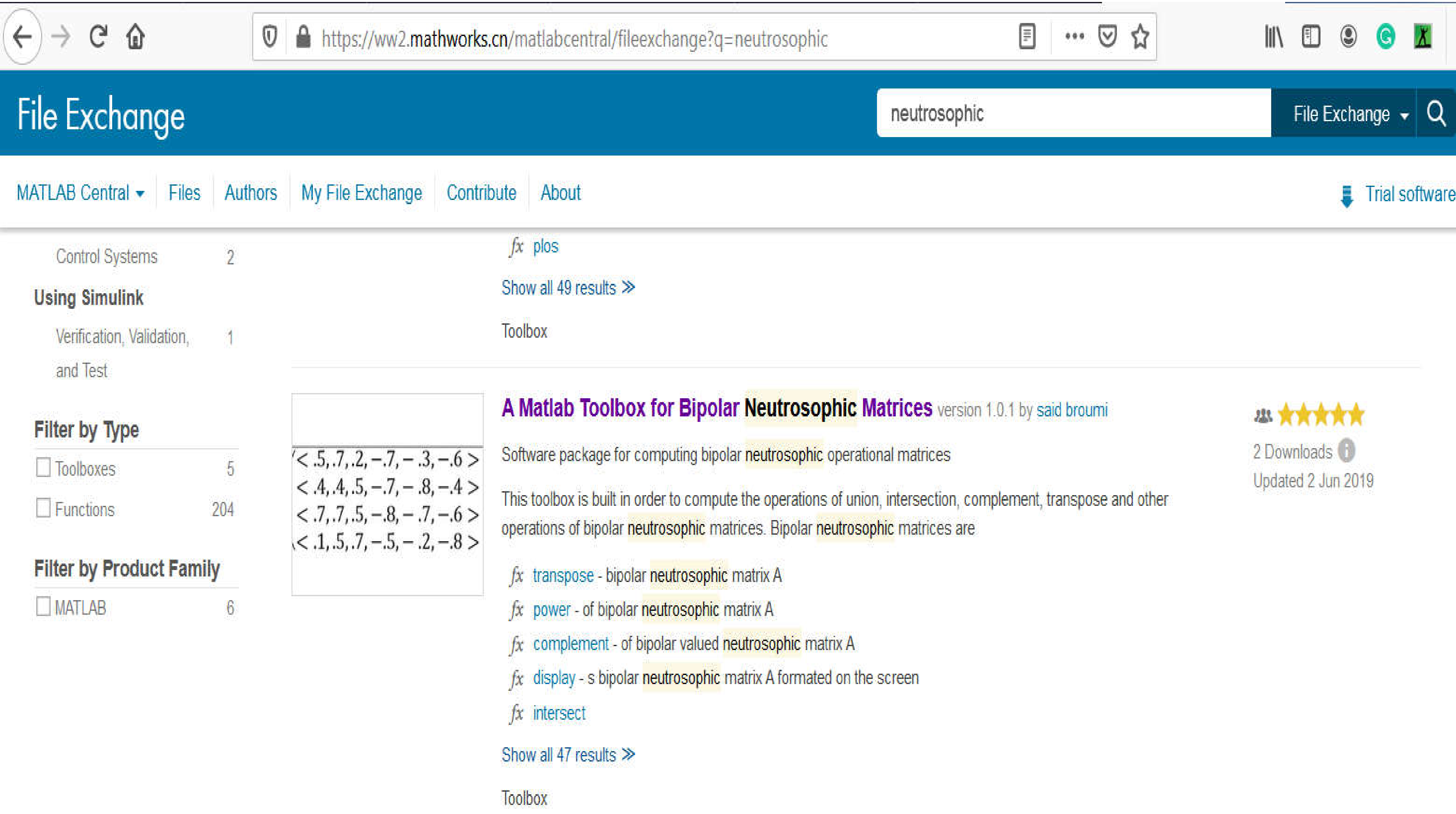
3 Author(s) Lehua Yang ; Dongmei Li ; Ruipu Tan All Authors

Neutrosophic Tools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Toolboxes 5
Functions 204
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Show all 49 results
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< .5,.7,.2,−.7,−.3,−.6 >
< .4,.4,.5,−.7,−.8,−.4 >
< .7,.7,.5,−.8,−.7,−.6 >
< .1,.5,.7,−.5,−.2,−.8 >
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Software package for computing bipolar neutrosophic operational matrices
This toolbox is built in order to compute the operations of union, intersection, complement, transpose and other operations of bipolar neutrosophic matrices. Bipolar neutrosophic matrices are
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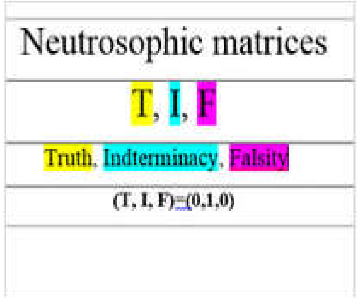
power - of bipolar neutrosophic matrix A
complement - of bipolar valued neutrosophic matrix A
display - s bipolar neutrosophic matrix A formated on the screen
intersect
Show all 47 results
Toolbox



toolbox for the interval valued bipolar neutrosophic matrice version 1.0.0 by said broumi

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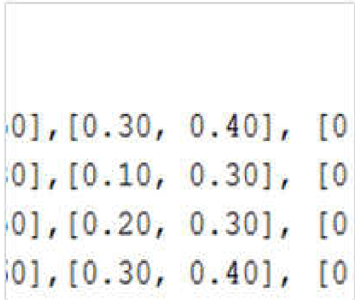
software package for computing operations on interval valued bipolar neutrosophic matrices

This package is used to calculate the operations on interval valued bipolar neutrosophic matrices This package is descriped with examples in a submited articlethis pakage is under construction and

- *fx* transpose - interval valued bipolar neutrosophic matrix A
- *fx* minmaxmax - of two interval valued bipolar neutrosophic matrix A and B
- *fx* ivbnm
- *fx* isempty
- *fx* complement

Show all 41 results »

Toolbox



A Matlab Toolbox for Interval Valued Neutrosophic Matrices version 1.0.0 by said broumi

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Software package for computing a variety of operations on interval valued neutrosophic matrices

A Matlab Toolbox for Interval Valued Neutrosophic Matrices for Computer ApplicationsThis pakage aims to provide an new tools to be utilized in Neutrosophic community. This pakages was developped in

- *fx* transpose - interval valued neutrosophic matrix A
- *fx* power - of interval valued neutrosophic matrix A
- *fx* complement - of an interval valued neutrosophic matrix A
- *fx* scalar - of interval valued neutrosophic matrix A
- *fx* Spec - trum of an interval valued neutrosophic matrix A

Implementation of Neutrosophic Function Memberships Using MATLAB Program

Definition:A trapezoidal neutrosophic number $a = \langle (a,b,c,d); w_a, u_a, y_a \rangle$ is a special neutrosophic set on the real number set R, whose truth-membership, indeterminacy– membership and falsity-membership functions are defined as follows:

$$\mu_a(x) = \begin{cases} \frac{(x-a)}{(b-a)} w_a & , \quad a \le x \le b \\ w_a & , \quad b \le x \le c \\ \frac{(d-x)}{(d-c)} w_a & , \quad c \le x \le d \\ 0 & , \quad otherwise \end{cases}$$

$$v_a(x) = \begin{cases} \frac{(b-x)+u_a(x-a)}{(b-a)} & , \quad a \le x \le b \\ u_a & , \quad b \le x \le c \\ \frac{(x-c)+u_a(d-x)}{(d-c)} & , \quad c \le x \le d \\ 1 & , \quad otherwise \end{cases}$$

$$\lambda_a(x) = \begin{cases} \frac{(b-x)+y_a(x-a)}{(b-a)} & , \quad a \le x \le b \\ y_a & , \quad b \le x \le c \\ \frac{(x-c)+y_a(d-x)}{(d-c)} & , \quad c \le x \le d \\ 1 & , \quad otherwise \end{cases}$$

https://www.mathworks.com/matlabcentral/fileexchange?q=neutrosophic

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fx Spec - trum of an interval valued neutrosophic matrix A

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Matlab code to find Trapezoidal Neutrosophic Function version 1.0.1 by said broumi

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A novel Matlab code for trapezoidal neutrosophic function

the matlab code of trapezoidal neutrosophic function is generalisation of trapezoidal fuzzy function and trapezoidal intuitionistic fuzzy function.

Function

A Neutrosophic Recommender System for Medical Diagnosis Based on Algebraic Neutrosophic Measures version 1.0 by pham viet

1 Download

Updated 4 Feb 2016

Implementation of Neutrosophic Recommender System

Implementation of Neutrosophic Recommender System

Toolbox

Trapezoidal neutrosophic Function (trin)
%x=45:70;
%[y,z]=trin(x,50,55,60,65, 0.6, 0.4,0.6)%

U truth membership
V indterminacy membership
W :falsemembership

```
function [y,z,t]=trin(x,a,b,c,d,u,v,w)
y=zeros(1,length(x));
z=zeros(1,length(x));
t=zeros(1,length(x));
for j=1:length(x)
if(x(j)<=a)
    y(j)=0;
    z(j)=1;
    t(j)=1;
elseif(x(j)>=a)&&(x(j)<=b)
y(j)=u*(((x(j)-a)/(b-a)));
z(j)=(((b-x(j))+v*(x(j)-a))/(b-a));
t(j)=(((b-x(j))+w*(x(j)-a))/(b-a));
elseif(x(j)>=b)&&(x(j)<=c)
y(j)=u;
    z(j)=v;
    t(j)=w;
```

4.1 Example

The figure 1 portrayed the pictorical representation of the trapezoidal neutrosophic function $a = \langle (0.3, 0.5, 0.6, 0.7); 0.4, 0.2, 0.3 \rangle$

The line command to show this function in Matlab is written below:

```
x=0:0.01:1;
[y,z,t]=trin(x,0.3,0.5,0.6,0.7, 0.4, 0.2,0.3)
```

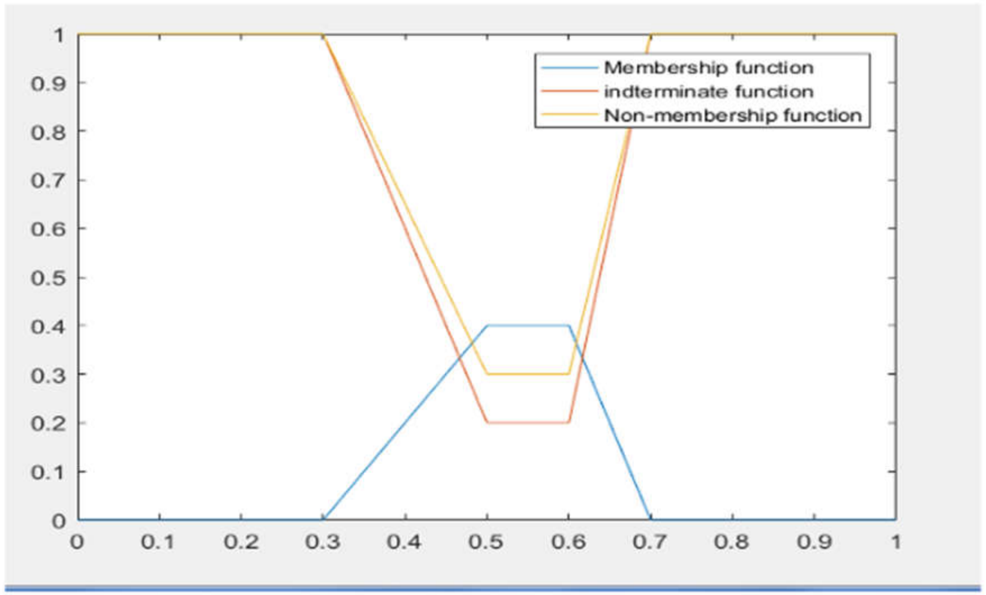
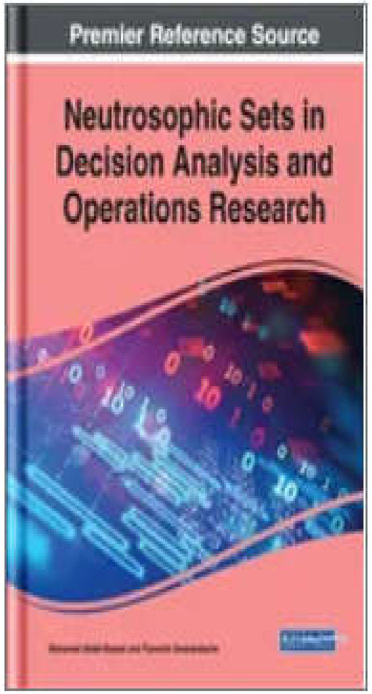


Figure 1: Trapezoidal neutrosophic function for example 4.1



A Novel Python Toolbox for Single and Interval-Valued Neutrosophic Matrices

Said Broumi (Laboratory of Information Processing, Faculty of Science Ben M'Sik, University Hassan II, Morocco), Selçuk Topal (Faculty of Science and Arts, Bitlis Eren University, Turkey), Assia Bakali (Ecole Royale Navale, Casablanca, Morocco), Mohamed Talea (Laboratory of Information Processing, Faculty of Science Ben M'Sik, University Hassan II, Morocco) and Florentin Smarandache (Department of Mathematics, University of New Mexico, USA)

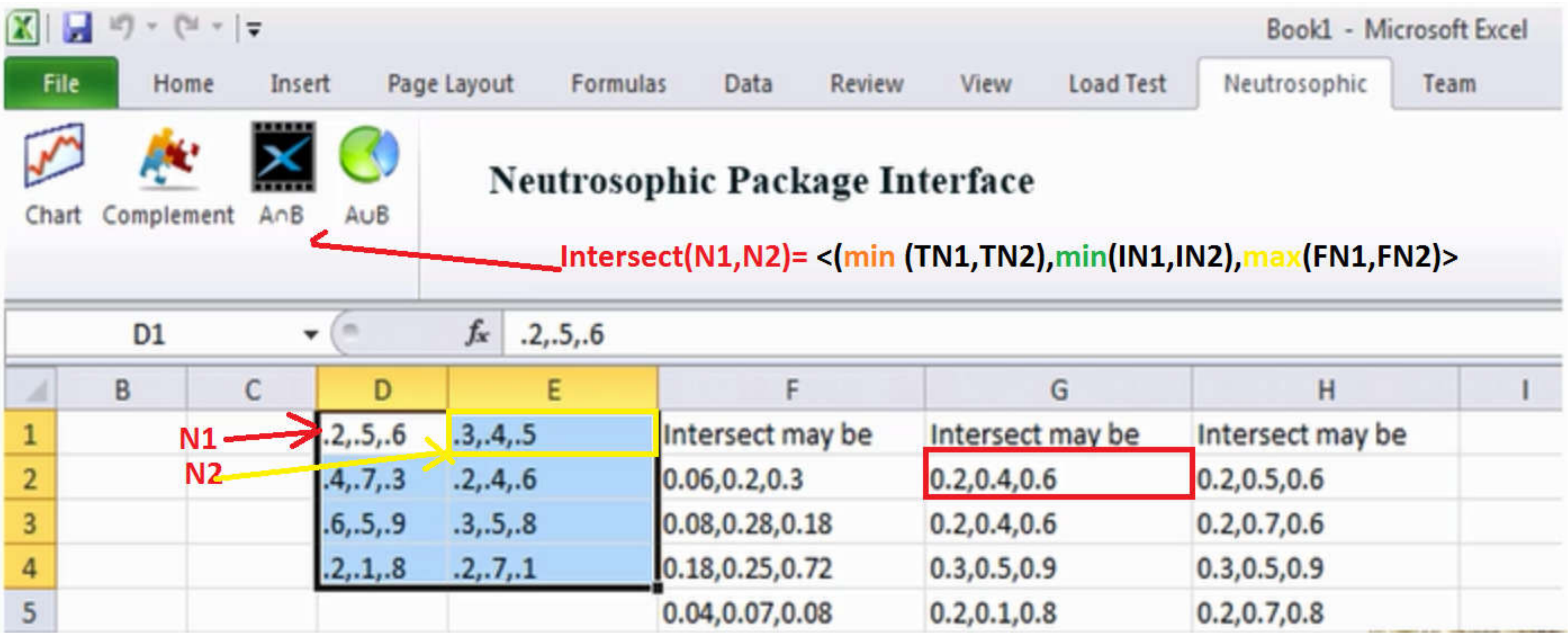
Source Title: Neutrosophic Sets in Decision Analysis and Operations Research

 | Pages: 50

DOI: 10.4018/978-1-7998-2555-5.ch013

Neutrosophic Excel package

- utilized for calculating neutrosophic data and analyze them.



Finally.

- Neutrosophic theory studies objects whose values vary in the sets of elements and are not true or false, but in between, that can be called by neutral, indeterminate, unclear, vague, ambiguous, incomplete or contradictory quantities,
- Neutrosophy is a modeling based on three states and not just two as in classical logic

More on neutrosophic theory

- http://fs.unm.edu/neutrosophy.htm
- **BOOKS ON NEUTROSOPHICS**
- **Neutrosophic PATENTS**
- **PostDoctorals, PhD DISSERTATIONS and MSc. THESES ON NEUTROSOPHICS AND THEIR APPLICATIONS**
- **INTERNATIONAL WEBINARS ON NEUTROSOPHICS**
- **Encyclopedia of Neutrosophic Researchers (Vol. 1, Vol. 2, Vol. 3 new)**

Neutrosophic PATENTS

METHODS AND SYSTEMS FOR PERFORMING SEGMENTATION AND REGISTRATION OF IMAGES USING NEUTROSOPHIC SIMILARITY SCORES, by Yanhui Guo, Segundo Gonzalez, United States Patent Application 20200226414, Kind Code: A1, 2020, http://www.freepatentsonline.com/y2020/0226414.html

Methods and systems for performing segmentation and registration of images using neutrosophic similarity scores, by Guo, Yanhui & Gonzalez, Segundo Jaime, United States Patent 10152796, 2018, http://www.freepatentsonline.com/10152796.html

Apparatus and method for lesions segmentation [*performing neutrosophic image segmentation*], by Alsmadi, Mutasem K., United States Patent 10115197, 2018, http://www.freepatentsonline.com/10115197.html

Title: METHODS AND SYSTEMS FOR PERFORMING SEGMENTATION AND REGISTRATION OF IMAGES USING NEUTROSOPHIC SIMILARITY SCORES

Document Type and Number: United States Patent Application 20200226414

Kind Code: A1

Abstract: An example method for segmenting an object contained in an image includes receiving an image including a plurality of pixels, transforming a plurality of characteristics of a pixel into respective neutrosophic set domains, calculating a neutrosophic similarity score for the pixel based on the respective neutrosophic set domains for the characteristics of the pixel, segmenting an object from background of the image using a region growing algorithm based on the neutrosophic similarity score for the pixel, and receiving a margin adjustment related to the object segmented from the background of the image.

PostDoctorals, PhD DISSERTATIONS and MSc. THESES ON NEUTROSOPHICS AND THEIR APPLICATIONS

- Postdoctoral of Science in Scientific Research, Neutrosophy and Complexity, Campus Miami-Dade, Florida, USA, 2020.
- Sistema experto probabilistico neutrosofico para seleccion de estrategia en la gestion del riesgo en la cadena de suministro, Maestria en Ingenieria Industrial, por Rafael Hernan Rojas Gualdron, Director Carlos Eduardo Diaz Bohorquez, Codirector Florentin Smarandache, Universidad Industrial de Santander, Bucaramanga, Colombia, 06 Agosto 2020.
- Some Decision Making Models Based on Neutrosophic Strategy, PhD Thesis, by Kalyan Mondal under the supervision of Dr. Surapati Pramanik, Nandalal Ghosh B.T. College, Papur, Dr. B.C. Giri, Department of Mathematics, Jadavpur University, Jadavpur, West Bengal, India, May 2, 2020.
- Some Studies on Neutrosophic Decision Making, Ph. D. Thesis, by Shyamal Dalpati under the supervision of Dr. Surapati Pramanik, Nandalal Ghosh B.T. College, Papur, Dr. Shariful Alam, Department of Mathematics, Indian Institute of Engineering Science and Technology, Shibpur, West Bengal, India , April 2, 2020.

INTERNATIONAL WEBINARS ON NEUTROSOPHICS

- Neutrosophic Theory: Notions and Applications, by Dr. Said Broumi, International FDP on "ASTUTE-EFFLUX TRENDS IN MATHEMATICS", Department of Mathematics, SNS College of Engineering, Coimbatore, India, 2-7 JUNE 2020.
- **Neutrosophic Mathematics and Computer Science, by Prof. Dr. Ahmed Salama, International Faculty Development Programme on Avant-garde Trends in Mathematics, at Bannari Amman Institute of Technology, Sathyamangalam-638401, Erode, Tamil Nadu, India, 17 June-23 June 2020**
- Neutrosophic Algebraic Structures and Hyperstructures, by Prof. Dr. Agboola Adesina AA, International Faculty Development Programme on Avant-garde Trends in Mathematics, at Bannari Amman Institute of Technology, Sathyamangalam-638401, Erode, Tamil Nadu, India, 17 June-23 June 2020.

- International Webinar on Neutrosophic Sets, Introducion to Neutrosophic Automata by Dr. Jacob Kavikumar, Universiti Tun Hossein Onn, Batu Pahat, Malaysia, August 3rd 2020 https://youtu.be/PMvVGZhc-ec,
- and by The Recent Advances in Neutrosophic Theories by Dr. Said Broumi, Faculty of Science Ben M'Sik, University of Hassan II, Casablanca, Morocco, August 4th 2020 https://youtu.be/R6hOWjlid-s

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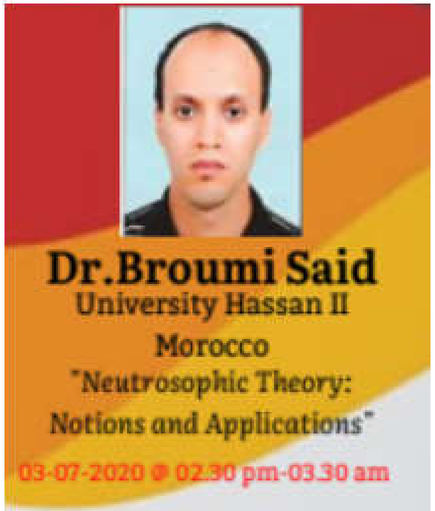
Neutrosophic Theory: Notions and applications



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Department of Mathematics

Organizes

International Webinar on

"Neutrosophic Sets"

Day 2:

Title: The recent advances of Neutrosophic theory

(4th August 2020, Tuesday, 1:30 p.m. to 2.30 p.m. IST)

Prof. Said Broumi

Laboratory of Information Processing,
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University Hassan II, Casablanca, Morocco

Thank you