Single Valued Neutrosophic Soft Over / Under / Offsets

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Abstract: ***Neutrosophic set is a part of neutrosophy introduced by Smarandache[6] in 1995 as a mathematical tool for dealing problems with imprecise, indeterminacy and inconsistent data. Smarandache etal.[6] defined the concept of single valued neutrosophic set (SVNS)[2] in a specified form of neutrosophic set from a technical point of view. Smaradache[4] extended the neutrosophic set relatively to Neutrosophic overset, Neutrosophic underset and to Neutrosophic offset. Maji[3] introduced the new concept neutrosophic soft set by combining soft set and neutrosophic set. In this paper, we introduce the concept of single valued neutrosophic soft oversets/undersets/offsets (SVNSS O/U/Offsets) and define the set-theoretic operators on an SVNSS O/U/Offsets with suitable examples. Also,wepresent an application of SVNSS O/U/Offsets in a decision making problem.***

Keywords: Neutrosophic set, Neutrosophic soft set,Single valued neutrosophic overset/underset/offset, Single valued neutrosophic soft overset/underset/offset.

1. Introduction

In our real life, there are many complicated problems in various fields such as economics, engineering, environment, social science, medical science etc. including uncertainties. Uncertain data in these fields could be caused by complexities and difficulties in classical mathematical modeling. To avoid difficulties in dealing problems with uncertainty, mathematical tools such as fuzzy sets[5], rough sets[8], intuitionistic fuzzy sets [9] soft sets [10] have been developed. Fuzzy sets and intuitionistic fuzzy sets are characterized by membership functions, membership and non-membership functions respectively. Intuitionistic fuzzy sets can be used to handle only the incomplete information, not the indeterminate information.

Neutrosophic set is a part of neutrosophy which was introduced by Smarandache [6] in 1995 as a mathematical tool for dealing problems with indeterminant data. In neutrosophic set, indeterminacy is quantified explicitly whereas truth-membership, indeterminacy-membership and falsity-membership are independent. From philosophical point of view, neutrosophic set is a generalization of classical set, fuzzy set, interval valued fuzzy set, intuitionistic fuzzy set. But from technical point of view, single valued neutrosophic set (SVNS)[2] is the specified form of neutrosophic set and is also a generalization of the above mentioned sets.

Maji[3] combined the concept of soft set and neutrosophic set together by introducing a new concept neutrosophic soft set and gave an application of neutrosophic soft set in decision making problem.

Our real-world has many practical examples and applications of over/under/off-neutrosophic components. Smarandache[4] has extended the neutrosophic set respectively to neutrosophic overset, neutrosophic underset and to neutrosophic offset.

In this paper, we combine single valued neutrosophic oversets/undersets/offsets with soft sets to introduce a new concept single valued neutrosophic soft over sets/ undersets/ offsets (SVNSS O/U/Offsets). We also define the set-theoretic operators on an SVNSS O/U/Offsets. Finally, we present an application of SVNSS O/U/Offsets in a decision making problem.

2. Some Concepts in Neutrosophic Soft Set and Single Valued Neutrosophic Oversets/ Undersets/Offsets

In this section we have presented the basic definitions and results of single valued neutrosophicsets [2], neutrosophic soft sets[3] and singlevalued neutrosophic oversets/ undersets / offsets [4]. Then we gave the definitions of set-theoretic operators on an single valued neutrosophic oversets/undersets/offsets [4].

Definition 2.1 ([2]). Let X be a space of points (objects), with a generic element in X denoted by x. A single valued neutrosophicset (SVNS) A in X is characterized by truth-membership function T_A, indeterminacy-membership function I_A and falsity membership function F_A. For each point x in X, $T_A(X), I_A(x), F_A(x) \in [0,1]$.

When X is continuous, a SVNS A can be written as

$$A=\int_X \langle T(x),I(x),F(x)\rangle/x, x\in X$$

When X is discrete, a SVNS A can be written as

$$A=\sum_{i=1}^{n} \langle T(x_i),I(x_i),F(x_i)\rangle/ x_i,\ x_i\in X$$

Example 2.2 ([2]). Assume that $X=\{x_1,x_2,x_3\}$ where x_1 is capability, x_2 is trustworthiness and x_3 is price. The values of x_1,x_2 and x_3 are in[0,1]. They are obtained from the questionnaire of some domain experts, their option could be a degree of “good service”, a degree of “indeterminacy” and a degree of “poor service”. A is a single valued neutrosophic set of X defined by

$A=\langle 0.3,0.4,0.5\rangle/x_1 + \langle 0.5,0.2,0.3\rangle/x_2 + \langle 0.7,0.2,0.2\rangle/x_3$

B is a single valued neutrosophic set of X defined by

$B=\langle 0.6,0.1,0.2\rangle/x_1 + \langle 0.3,0.2,0.6\rangle/x_2 + \langle 0.4,0.1,0.5\rangle/x_3$

Definition 2.3 ([2]). The complement of a single valued neutrosophic set A is denoted by $C(A)$ and is defined by

$T_{C(A)}(x) = F_A(x)$
$I_{C(A)}(x) = 1 - I_A(x)$
$F_{C(A)}(x) = T_A(x)$
for all x in X.

Definition 2.4 ([2]). Let A be the single valued neutrosophic set defined in Example 2.2.Then $C(A)$=<0.5,0.6,0.3>/x_1+<0.3,0.8,0.5>/x_2+<0.2,0.8,0.7>/x_3.

Definition 2.5([2]). A single valued neutrosophic set A is contained in the other single valued neutrosophic set B, $A \subseteq B$, if and only if

$T_A(x) \le T_B(x)$
$I_A(x) \le I_B(x)$
$F_A(x) \ge F_B(x)$
for all x in X.

For example, let A and B be the single valued neutrosophic sets defined in Example 2.2. Then A is not contained in B and B is not contained in A.

Definition 2.6 ([2]). Two single valued neutrosophic sets A and B are equal, written as A=B, if and only if $A \subset B$ and $B \subset A$.

Theorem 2.7([2]). $A \subset B \leftrightarrow C(B) \subset C(A)$.

Definition 2.8 ([2]). The union of two single valued neutrosophic set A and B is a single valued neutrosophic set C, written as $C = A \cup B$, where truth membership, indeterminacy-membership and falsity membership functions are related to those of A and B by

$T_C(x)=\max(T_A(x),T_B(x))$
$I_C(x)=\max(I_A(x),I_B(x))$
$F_C(x)=\min(F_A(x),F_B(x))$
for all x in X.

Example 2.9 ([2]). Let A and B be the single valued neutrosophic sets defined in Example 2.2. Then,$A \cup B$ = <0.6,0.4,0.2>/x_1+<0.5,0.2,0.3>/x_2+<0.7,0.2,0.2>/x_3

Theorem 2.10 ([2]). $A \cup B$ is the smallest single valued, neutrosophic set containig both A and B.

Definition 2.11 ([2]). The intersection of two single valued neutrosophic sets A and B, is a single valued neutrosophic set C, written as $C = A \cap B$, whose truth-membership, indeterminacy-membership, and falsity-membership functions are related to those of A and B by

$T_C(x)=\min(T_A(x),T_B(x))$
$I_C(x)=\min(I_A(x),I_B(x))$
$F_C(x)=\max(F_A(x),F_B(x))$
for all x in X.

Example 2.12 ([2]). Let A and B be the single valued neutrosphic sets defined in Example 2.2. Then $A \cap B$=<0.3,0.1,0.5>/x_1+<0.3,0.2,0.6>/x_2+<0.4,0.1,0.5>/x_3.

Theorem 2.13 ([2]). $A \cap B$ is the largest single valued neutrosophic set contained in both A and B.

Definition 2.14 ([3]). Let U be an initial universe set and E be a set pf parameters. Consider $A \subset E$. Let P(U) denotes the set of all neutrosophic sets of U. The collection (F,A) is termed to be the soft neutrosophic set over U, where F is a mapping given by $F: A \rightarrow P(U)$.

Example 2.15 ([3]). Let U be the set of houses under consideration and E is the set of parameters. Each parameter is a neutrosophic word or sentence involving neutrosophic words. Consider E = {beautiful, wooden, costly, moderate, in the green surroundings, cheap, expensive}. In this case to define a neutrosophic soft set means to point out beautiful, houses, wooden houses, costly houses and so on.There are five housesin the Universe U given by, U={h_1,h_2,h_3,h_4,h_5}and the set of parameters A={e_1,e_2,e_3,e_4}, where e_1 stands for the parameter 'beautiful',e_2 stands for the parameter 'wooden',e_3 stands for the parameter 'costly' and the parameter e_4 stands for 'moderate'. Suppose that,
F(beautiful)={<h_1,0.5,0.6,0.3>,<h_2,0.4,0.7,0.6>,<h_3,0.6,0.2,0.3>,<h_4,0.7,0.3,0.2>,<h_5,0.8,0.2,0.3>},
F(wooden)={<h_1,0.6,0.3,0.5>,<h_2,0.7,0.4,0.3>,<h_3,0.8,0.1,0.2>,<h_4,0.7,0.1,0.3>,<h_5,0.8,0.3,0.6>}
F(costly)={<h_1,0.7,0.4,0.3>,<h_2,0.6,0.7,0.2>,<h_3,0.7,0.2,0.5>,<h_4,0.5,0.2,0.6>,<h_5,0.7,0.3,0.4>}
F(moderate)={<h_1,0.8,0.6,0.4>,<h_2,0.7,0.9,0.6>,<h_3,0.7,0.6,0.4>,<h_4,0.7,08,0.6>,<h_5,0.9,0.5,0.7>}.

The neutrosophic soft set (NSS) (F,E) is a parametrized family.{F(e_i),i=1,.....10} of all neutrosophic sets of U and describes a collection of approximation of an object. The mapping F here is 'houses(.)' where dot(.) is to be filled upby a parameter e $\in$ E.Therefore, F(e_1) means 'houses (beautiful)' whose functional-value is the neutrosophic set {<h_1,0.5,0.6,0.3>, <h_2,0.4,0.7,0.6>, <h_3,0.6,0.2,0.3>, <h_4,0.7,0.3,0.2>, <h_5,0.8,0.2,0.3>}. Thus we can view the neutrosophic soft set (NSS) (F,A) as a collection of approximation as below:(F,A)={beautifulhouses= {<h_1,0.5,0.6,0.3>, <h_2, 0.4,0.7,0.6>, <h_3,0.6,0.2,0.3>, <h_4,0.7,0.3,0.2>, <h_5,0.8,0.2,0.3>}, wooden houses= {<h_1,0.6,0.3,0.5>,<h_2,0.7,0.4,0.3>,<h_3,0.8,0.1,0.2>,<h_4,0.7,0.1,0.3>,<h_5,0.8,0.3,0.6>}, costly houses = {<h_1,0.7,0.4,0.3>,<h_2,0.6,0.7,0.3>,<h_3,0.7,0.2,0.5>,<h_4,0.5,0.2,0.6>,<h_5,0.7,0.3,0.4>}, moderate houses = {<h_1,0.8,0.6,0.4>, <h_2,0.7,0.9,0.6>, <h_3,0.7,0.6,0.4>, <h_4,0.7,0.8,0.6>, <h_5,0.9,0.5,0.7>}}

Definition 2.16 ([3]). Comparison Matrix. It is a matrix whose rows are labelled by the object names $h_1,h_2,...h_n$ and the columns are labelled by the parameters $e_1,e_2,...e_m$. The entries c_{ij} are calculated by $c_{ij}=a+b-c$, where 'a' is the integer calculated as 'how many times T_{h_i} (e_j) exceeds or equal to T_{h_k} (e_j)', for $h_i \neq h_k$, $\forall h_k \in U$,'b' is the integer calculated as 'how many times I_{h_i} (e_j)exceeds or equal to I_{h_k} (e_j)', for $h_i \neq h_k$, $\forall h_k \in U$ and 'c' is the integer 'how many times $F_{hi}(e_j)$ exceeds or equal to F_{h_k} (e_j)', for $h_i \neq h_k$, $\forall h_k \in U$.

Definition 2.17([4]). Let U be a universe of discourse and the neutrosophic set $A \subset U$. Let T(x),I(x),F(x) be the

functions that describe the degrees of membership, indeterminate membership and non membership respectively of a generic element x ϵ U with respect to the neutrosophic set A. A single-valued neutrosophic overset A on the universe of discourseU is defined as
$A=\{(x,<T(x),I(x),F(x)>),x\epsilon U$ and $T(x),I(x),F(x) \epsilon [0,\Omega]\}$
where $T(x),I(x),F(x) : U \rightarrow [0,\Omega], 0<1<\Omega$ and Ω is called over limit.Then there exists atleast one element in A such that it has atleast one neutrosophic component > 1, and no element has neutrosophic components < 0.

Example2.18([4]).$A=\{(x_1,<1.3,0.5,0.1>),(x_2,<0.2,1.1,0.2>)\}$. Since$T(x_1)=1.3>1$, $I(x_2)=1.1>1$ and no neutrosophic component<0.

Definition 2.19 ([4]). Let U be a universe of discourse and the neutrosophic set A⊂U. Let T(x),I(x),F(x) be the functions that describe the degrees of membership, indeterminate membership and non membership respectively of a generic element x ϵ U with respect to the neutrosophic set A. A single-valued neutrosophic underset A on the universe of discourse U is defined as
$A=\{(x,<T(x),I(x),f(x)>), x\epsilon U$ and $T(x),I(x),F(x) \epsilon [\Psi,1]\}$ where $T(x),I(x),F(x) :U \rightarrow [\Psi,1], \Psi<0<1$ and Ψ is called lower limit.Then there exits atleast one element in A such it that has atleast one neutrosophic component < 0, and no element has neutrosophic components > 1.

Example 2.20 ([4]). $A=\{(x_1,<-0.4,0.5,0.3>),(x_2,<0.2,0.5,-0.2>)\}$, since $T(x_1)=-0.4<0, F(x_2)=-0.2<0$ and no neutrosophic components > 1.

Definition 2.21 ([4]). Let U be a universe of discourse and the neutrosophic set A⊂U. Let T(x),I(x),F(x) be the functions that describe the degrees of membership, indeterminate membership and non membership respectively of a generic element x ϵ U with respect to the neutrosophic set A. A single valued neutrosophic offset A on the universe of discourse U is defined as $A=\{(x,<T(x),I(x),F(x)>), x\epsilon U$ and $T(x),I(x),F(x) \epsilon [\Psi,\Omega]\}$ where $T(x), I(x), F(x):U\rightarrow[\Psi,1]$, $\Psi<0<1<\Omega$ and Ψ is called underlimit while Ω is called overlimit.Then there existssome elements in A such that atleast one neutrosophic component > 1, and atleast another neutrosophic component <0.

Example 2.22 ([4]).$A=\{(x_1,<1.2,0.4,0.1>),(x_2,<0.2,0.3,-0.7>)\}$,since $T(x_1)=1.2>1, F(x_2)=-0.7<0$. Also $B_3=\{(a,<0.3,-0.1,1.1>)\}$, since $I(a) = -0.1<0$ and $F(a)=1.1>1$.

2.1 SingleValuedNeutrosophicOversets/Undersets/Offsets Operators

Let U be the Universe of discourse and $A=\{(x,<T_A(x),I_A(x),F_A(x)>),x \epsilon U\}$ and $B=\{(x,<T_B(x),I_B(x),F_B(x)>), x \epsilon U\}$ be two single valued neutrosophic oversets/undersets/offsets. $T_A(x),I_A(x),F_A(x),T_B(x),I_B(x),F_B(x) : U \rightarrow [\Psi,\Omega]$ where $\Psi\leq0<1\leq\Omega$, and Ψ is called underlimit while Ω is called overlimit. $T_A(x),I_A(x),F_A(x),T_B(x),I_B(x),F_B(x)\epsilon [\Psi,\Omega]$ we take the inequality sign ≤ instead of < on both extremes above, in order to comprise all three cases:
overset {when $\Psi=0$, and $1<\Omega$},
underset {when $\Psi<0$, and $1=\Omega$}, and
offset {when $\Psi<0$, and $1<\Omega$}.

Definition 2.1.1 ([4]). The Union of two single valued neutrosophic overset/underset/offset A and B is a single valued neutrosophic overset/underset/offsetÇ, and is denoted by C=A∪B, and is defined by $C=A\cup B=\{(x,<\max\{T_A(x),T_B(x)\},\min\{I_A(x),I_B(x)\}, \min\{F_A(x),F_B(x)\}>),x\epsilon U\}$.

Definition 2.1.2 ([4]). The intersection of two single valued neutrosophic overset/underset/offset A and B is a single valued neutrosophic overset/underset/offset Cand is denoted by C=A∩B and is defined by
$C=A\cap B=\{(x,<\min\{T_A(x),T_B(x)\},\max\{I_A(x),I_B(x)\}, \max\{F_A(x),F_B(x)\}>),x\epsilon U\}$

Definition 2.1.3 ([4]). The complement of a single valued neutrosophic overset/underset/offset A is denoted by *C*(A) and is defined by
$C(A)=\{(x,<F_A(x),\Psi+\Omega-I_A(x),T_A(x)>),x\epsilon U\}$
Using the concept of single valued neutrosophic overset/underset /offset, now we introduce the concept of single valued neutrosophic soft overset/underset/offset (SVNSS O/U/Offset).

3. Single Valued Neutrosophic Soft Oversets/Undersets/Offsets

In this section, we introduce the concept of neutrosophic soft oversets, neutrosophic soft undersets and neutrosophic soft offsets and also we discuss the set-theoretic operations on SVNSSO/U/Offsetswith an example.

Definition 3.1. Let U be an initial Universe set and E be a set of parameters. Consider A⊂E. The collection (F,A) is termed to be the single valued neutrosophic soft overset/underset/offset over U where F is a mapping given by F : A → P(U).

Example 3.2. Let U be the set of cars under consideration and E is the set of parameters. Each parameter is a neutrosophic word or sentence involving neutrosophic words. Consider E={displacement$_{(cc)}$,power$_{(bhp)}$,mileage, airbags, torque, power steering, cost, aircondition, climate control, central locking, alloy wheel, body colour}.In this case, to define a SVNSS O/U/Offset means to point out displacement$_{(cc)}$ of the car, power$_{(bhp)}$ of the car, mileage of the car and the car with airbags and so on. Suppose that, there are five cars in the universe U given by $U=\{c_1,c_2,c_3,c_4,c_5\}$ and the set of parameters $A=\{e_1,e_2,e_3,e_4\}$ where e_1 stands for the parameter 'displacement$_{(cc)}$', e_2 stands for the parameter 'power$_{(bhp)}$', e_3 stands for the parameter 'mileage' and the parameter e_4 stands for 'air bags'. Suppose that
F(displacement$_{(cc)}$)
$=\{(c_1,<1.1,0.6,0.7>),(c_2,<1.2,0.9,0.8>),(c_3,<0.9,1.1,0.8>), (c_4,<0.5,0.7,1.1>),(c_5,<1.2,0.5,0.6>)\}$

$F(power_{(bhp)})$
$=\{(c_1,<0.6,1.2,0.8>),(c_2,<1.1,0.8,0.7>),(c_3,<0.8,0.7,1.1>),(c_4,<0.7,1.1,0.5>),(c_5,<1.2,0.3,0.9>)\}$
$F(mileage)=\{(c_1,<-0.1,1.1,0.7>),(c_2,<1.1,0.8,-0.2>),(c_3,<0.9,0.7,-0.1>),(c_4,<0.4,1.1,-0.2>),(c_5,<0.9,0.7,-0.1>)\}$
$F(airbags)=\{(c_1,<0.7,-0.1,0.8>),(c_2,<0.8,0.7,-0.2>),(c_3,<0.9,0.5,-0.1>),(c_4,<0.4,0.7,-0.1>),(c_5,<0.9,0.3,-0.2>)\}$.

The SVNSS O/U/Offset (F,E) is a parametrized family{F(e_i); i=1,2....12} of all single valued neutrosophic oversets/undersets/offsets of U, and describes a collection of approximation of an object. Thus we can view the SVNSS/O/U/Offset (F,A) as a collection of approximation as below:
$(F,A)=\{displacement_{(cc)}$ of the car $=\{(c_1,<1.1,0.6,0.7>),(c_2,<1.2,0.9,0.8>),(c_3,<0.9,1.1,0.8>),(c_4,<0.5,0.7,1.1>),(c_5,<1.2,0.5,0.6>)\}$, $power_{(cc)}$ of the car $=\{(c_1,<0.6,1.2,0.8>),(c_2,<1.1,0.8,0.7>),(c_3,<0.8,0.7,1.1>),(c_4,<0.7,1.1,0.5>),(c_5,<1.2,0.3,0.9>)\}$, mileage of the car $=\{(c_1,<-0.1,1.1,0.7>),(c_2,<1.1,0.8,-0.2>),(c_3,<0.9,0.7,-0.1>),(c_4,<0.4,1.1,-0.2>),(c_5,<0.9,0.7,-0.1>)\}$, car with air bags $=\{(c_1,<0.7,-0.1,0.8>),(c_2,<0.8,0.7,-0.2>),(c_3,<0.9,0.5,-0.1>),(c_4,<0.4,0.7,-0.1>),(c_5,<0.9,0.3,-0.2>)\}\}$

Definition 3.3. Union of two single valued neutrosophic soft oversets/undersets/offsets. Let (F,A) and (G,B) be two SVNSS O/U/Offsetsover the same universe U then the union of (F,A) ad (G,B) is denoted by '(F,A) ∪ (G,B)' and is defined by
(F,A) ∪ (G,B) = (H,C) , where C=A∪B

(ie). $\{(x,<T_{H(e)}(x),I_{H(e)}(x),F_{H(e)}(x)>) \not\forall e \in C, x \in U\}$
$=\{(x,<\max\{T_{F(e)}(x),T_{G(e)}(x)\}, \min\{I_{F(e)}(x),I_{G(e)}(x)\}, \min\{(F_{F(e)}(x),F_{G(e)}(x)\}>), \not\forall e\epsilon C, x\epsilon U\}$

Example 3.4. Let (F,A) and (G,B) be two SVNSS O/U/Offsets over the common universe U. Consider the tabular representation of the SVNSS O/U/Offset(F,A) is as follows:

Table 1: Tabular form of SVNSS O/U/Offset (F,A)

U	displacement (cc)	power(bhp)	mileage	airbags
c_1	<1.1,0.6,0.7>	<0.6,1.2,0.8>	<-0.1,1.1,0.7>	<0.7,-0.1,0.8>
c_2	<1.2,0.9,0.8>	<1.1,0.8,0.7>	<1.1,0.8,-0.2>	<0.8,0.7,-0.2>
c_3	<0.9,1.1,0.8>	<0.8,0.7,1.1>	<0.9,0.7,-0.1>	<0.9,0.5,-0.1>
c_4	<0.5,0.7,1.1>	<0.7,1.1,0.5>	<0.4,1.1,-0.2>	<0.4,0.7,-0.1>
c_5	<1.2,0.5,0.6>	<1.2,0.3,0.9>	<0.9,0.7,-0.1>	<0.9,0.3,-0.2>

The tabular representation of the SVNSS O/U/Offset (G,B) is as follows:

Table 2: Tablular form of the SVNSS O/U/Offset (G,B)

U	Displacement	torque (kgm)
c_1	<1.2,0.8,0.7>	<0.5,-0.2,0.6>
c_2	<0.7,0.9,1.1>	<0.8,0.5,-0.1>
c_3	<0.8,1.2,0.7>	<-0.2,0.7,0.6>
c_4	<1.1,0.6,0.5>	<0.9,0.4,-0.2>
c_5	<0.4,1.1,0.6>	<-0.2,0.9,0.6>

Then the union of (F,A) and (G,B) is (H,C) whose tablular representation is as :

Table 3: Tabular form of SVNSS O/U/Offset (H,C)

U	displacement (cc)	power(bhp)	mileage	Airbags	torque(kgm)
c_1	<1.2,0.6,0.7>	<0.6,1.2,0.8>	<-0.1,1.1,0.7>	<0.7,-0.1,0.8>	<0.5,-0.2,,0.6>
c_2	<1.2,0.9,0.8>	<1.1,0.8,0.7>	<1.1,0.8,-0.2>	<0.8,0.7,-0.2>	<0.8,0.5,-0.1>
c_3	<0.9,1.1,0.7>	<0.8,0.7,1.1>	<0.9,0.7,-0.1>	<0.9,0.5,-0.1>	<-0.2,0.7,0.6>
c_4	<1.1,0.6,0.5>	<0.7,1.1,0.5>	<0.4,1.1,-0.2>	<0.4,0.7,-0.1>	<0.9,0.4,-0.2>
c_5	<1.2,0.5,0.6>	<1.2,0.3,0.9>	<0.9,0.7,-0.1>	<0.9,0.3,-0.2>	<-0.2,0.9,0.6>

Definition 3.5. Intersection of two single valued neutrosophic soft overset/underset/offsets. Let (F,A) and (G,B) be two SVNSS O/U/Off sets over the same universe U. Then the intersection of (F,A) and (G,B) is denoted by '(F,A)∩(G,B)' and is defined by (F,A)∩(G,B)=(H,C) where C=A∩B
(ie). $\{(x,<T_{H(e)}(x),I_{H(e)}(x),F_{H(e)}(x)>), \not\forall e\epsilon C, x\epsilon U\}$
$=\{(x,<\min\{T_{F(e)}(x),T_{G(e)}(x)\},\max\{I_{F(e)}(x),I_{G(e)}(x)\}, \max\{(F_{F(e)}(x),F_{G(e)}(x)\}>), \not\forall e\epsilon C, x\epsilon U\}$

Example 3.6. Consider the above example 3.4. Then that tabular representation of (F,A)∩(G,B) is as follows:

Table 4: Tabular form of SVNSS O/U/Offset (H,C)

U	displacement(cc)
c_1	<1.1,0.8,0.7>
c_2	<0.7,0.9,1.1>
c_3	<0.8,1.2,0.8>
c_4	<0.5,0.7,1.1>
c_5	<0.4,1.1,0.6>

Definition 3.7. Complement of a singlevalued neutrosophic soft overset/underset/offset. The complentent of a SVNSS O/U/Offset(F,A) is denoted by $(F,A)^c$ and is defined by $(F,A)^c=(F^c,\neg A)$where
$F^c:\neg A\rightarrow P(U)$ is a mapping given by $(F^c,\neg A)=$
$\{(x,<T_{F^c_{(x)}}, I_{F^c_{(x)}}, F_{F^c_{(x)}}>), x\epsilon U\}$. $F^c(\alpha) = \{(x,<F_{F(x)},\Psi+\Omega-I_{F(x)},T_{F(x)}>), x\epsilon U\}$ is the single valued neutrosophic soft complement.

Example 3.8. Consider the example 3.4.Then $(F,A)^c$ describes the 'not attractiveness of the cars'. we haveF(not airbags) $= \{(c_1,<0.8,\Psi+\Omega+0.1,0.7>\},(c_2,<-0.2,\Psi+\Omega-0.7,0.8>),(c_3,<-0.1,\Psi+\Omega-0.5,0.9>),(c_4,<-0.1,\Psi+\Omega-0.7,0.4>),(c_5,<-0.2,\Psi+\Omega-0.3,0.9>)\}$and so on.

4. An Application of SVNSS O/U/Offsets in a Decision Making Problem

Now, we present an application of SVNSS O/U/Offsets in a decision making problem.

Suppose that $U=\{c_1,c_2,c_3,c_4,c_5\}$ is a set of cars and $A=\{e_1,e_2,e_3,e_4\}$={displacement$_{(cc)}$,power$_{(bhp)}$,mileage, airbags} is a set of parameters which are attractiveness of cars. Suppose Mr.X wants to buy one of the most suitable car for regular daily travel taking into consideration four of the parameters only. Here the selection is dependent on the choice of the parameters of the buyer Mr.X.

Now, we present an algorithm to select the most suitable car for Mr.X.

Algorithm 4.1.

1) Input the SVNSS O/U/Offset (F,E)
2) Input A, the choice parameters of Mr.X which is a subset of E.
3) Consider the SVNSS O/U/Offset(F,A) and write it in tabular form.
4) Compute the comparison matrix(c_{ij})of SVNSS O/U/Offset (F,A)
5) Assign weights w_j for the parameter set A by pairwise comparison method using the steps given below:
   a) Arrange the parameter in a square matrix
   b) Across rows - compare parameter according to pairs
   c) Create the ranking
   d) Assign weights
6) Find Score $C^* = \max_i \sum_{j=1}^{4} c_{ij} w_j$; i=1,2,3,4,5 for the decision matrix D where C^* is the score of the best object c_{ij} the actual value of the i^{th} object in terms of the j^{th} parameter and w_j is the weight of importance of the j^{th} parameter.
7) Find the order of perference of an object as per ranking.

Let us use the algorithm to solve the problem. Suppose A={displacement$_{(cc)}$, power$_{(bhp)}$, mileage,airbags}.

Consider the tabular representation of the SVNSS O/U/Offset (F,A) as below:

Table 5: Tabular form of SVNSS O/U/Offset (F,A)

U	displacement (cc)	power (bhp)	mileage	airbags
c_1	<1.1,0.6,0.7>	<0.6,1.2,0.8>	<-0.1,1.1,0.7>	<0.7,-0.1,0.8>
c_2	<1.2,0.9,0.8>	<1.1,0.8,0.7>	<1.1,0.8,-0.2>	<0.8,0.7,-0.2>
c_3	<0.9,1.1,0.8>	<0.8,0.7,1.1>	<0.9,0.7,-0.1>	<0.9,0.5,-0.1>
c_4	<0.5,0.7,1.1>	<0.7,1.1,0.5>	<0.4,1.1,-0.2>	<0.4,0.7,-0.1>
c_5	<1.2,0.5,0.6>	<1.2,0.3,0.9>	<0.9,0.7,-0.1>	<0.9,0.3,-0.2>

The comparison matrix of the above SVNSS O/U/Offset (F,A) is as below:

Table 6: Comparison matrix of the SVNSS O/U/Offset (F,A)

U	displacement (cc)	power (bhp)	mileage	airbags
c_1	2	2	0	-3
c_2	4	4	5	5
c_3	2	-1	1	3
c_4	-2	4	4	1
c_5	4	1	1	4

Next we assign weight of the parameter $w(e_1) = 16$; $w(e_2) = 33$; $w(e_3) = 50$; $w(e_4) = 1$ by pairwise comparison method.

Table 7: Decision matrix D

	e_1	e_2	e_3	e_4
$w(e_j)$	16	33	50	1
c_1	2	2	0	-3
c_2	4	4	5	5
c_3	2	-1	1	3
c_4	-2	4	4	1
c_5	4	1	1	4

Now we compute the score C^* for each car C_i is as follows

C_1= 2 x 16 +2x33 +0 x 50 -3x1=95
C_2=4x 16 +4x33+5x50+5x 1= 451
C_3=2x 16 -1x33+1x50 +3x1= 52
C_4=-2x 16 +4x33+4x 50 +1x 1= 301
C_5=4 x 16 +1x33+1x 50 +4x 1=151
Here, Max $C^* = C_2 = 451$
Hence we conclude that C_2 is the best suitable car for Mr.X for regular daily travel.

As per the ranking, the order of preference of the cars is given by $c_2>c_4>c_5>c_1>c_3$.

5. Conclusions

In this paper, we have introduced the concept of single valued neutrosophic soft overset/underset/offsets. The set theoretic operators have been defined on the SVNSS O/U/Offsets with suitable examples. We also presented an application of SVNSS O/U/Offsets in a decision making problemby determining the order of preference of an object by assigning weights to the parameters.There is scope of studying about these SVNSS O/U/Offsets to apply the theory in practical applications of our daily life involvingsingle valued over/under/off neutrosophic components.

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