**History of Neutrosophic Theory and its Applications**

Zadeh introduced the *degree of membership/truth* (t) in 1965 and defined the fuzzy set.

Atanassov introduced the *degree of nonmembership/falsehood* (f) in 1986 and defined the intuitionistic fuzzy set.

Smarandache introduced the *degree of indeterminacy/neutrality* (i) as independent component in 1995 (published in 1998) and defined the neutrosophic set on three components

(t, i, f) = (truth, indeterminacy, falsehood):

<http://fs.gallup.unm.edu/FlorentinSmarandache.htm>

**Etymology**.

The words “neutrosophy” and “neutrosophic” were coined/invented by F. Smarandache in his 1998 book.

**Neutrosophy**: A branch of philosophy, introduced by F. Smarandache in 1980, which studies the origin, nature, and scope of neutralities, as well as their interactions with different ideational spectra.

Neutrosophy considers a proposition, theory, event, concept, or entity, "A" in relation to its opposite, "Anti-A" and that 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 logic, neutrosophic probability, neutrosophic set, and

neutrosophic statistics.

{From:*The Free Online Dictionary of Computing*, edited by Denis Howe from England.

Neutrosophy is an extension of the Dialectics.}

**Neutrosophic Logic** is a general framework for unification of many existing logics, such as fuzzy logic (especially intuitionistic 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 the truth (T), the falsehood (F), and 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.

For software engineering proposals the classical unit interval [0, 1] may be used.

T, I, F are *independent components*, leaving room for incomplete information (when their superior sum < 1), paraconsistent and contradictory information (when the superior sum > 1), or complete information (sum of components = 1).

For software engineering proposals the classical unit interval [0, 1] is used.

For single valued neutrosophic logic, the sum of the components is:

0 ≤ t+i+f ≤ 3 when all three components are independent;

0 ≤ t+i+f ≤ 2 when two components are dependent, while the third one is independent from them;

0 ≤ t+i+f ≤ 1 when all three components are dependent.

When three or two of the components T, I, F are independent, one leaves room for incomplete information (sum < 1), paraconsistent and contradictory information (sum > 1), or complete information (sum = 1).

If all three components T, I, F are dependent, then similarly one leaves room for incomplete information (sum < 1), or complete information (sum = 1).

In general, the sum of two components x and y that vary in the unitary interval [0, 1] is:

0 ≤ x + y ≤ 2 - d°(x, y), where d°(x, y) is the degree of dependence between x and y, while

d°(x, y) is the degree of independence between x and y.

In 2013 Smarandache *refined the neutrosophic set to n components*:

(T1, T2, ...; I1, I2, ...; F1, F2, ...);

see [http://fs.gallup.unm.edu/n-ValuedNeutrosophicLogic-PiP.pdf](http://fs.gallup.unm.edu/n-ValuedNeutrosophicLogic.pdf) .

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| **The Most Important Books and Papers in the Advancement of Neutrosophics** |  |  |  |
| 1995-1998 – *Smarandache generalizes the dialectics to neutrosophy;*  *introduces the neutrosophic set/logic/probability/statistics;*  *introduces the single-valued neutrosophic set (pp. 7-8);*  [*http://fs.gallup.unm.edu/ebook-neutrosophics6.pdf*](http://fs.gallup.unm.edu/ebook-neutrosophics6.pdf) *(last edition)*    2002 – introduces special types of sets / probabilities / statistics / logics, such as:   * intuitionistic set, paraconsistent set, faillibilist set, paradoxist set, pseudo-paradoxist set, tautological set, nihilist set, dialetheist set, trivialist set; * intuitionistic probability and statistics, paraconsistent probability and statistics, faillibilist   probability and statistics, paradoxist probability and statistics, pseudo-paradoxist probability and statistics, tautological probability and statistics, nihilist probability and statistics, dialetheist probability and statistics, trivialist probability and statistics;   * paradoxist logic (or paradoxism), pseudo-paradoxist logic (or pseudo-paradoxism), tautological logic (or tautologism);   <http://fs.gallup.unm.edu/DefinitionsDerivedFromNeutrosophics.pdf>  2003 – *introduction of neutrosophic numbers (a+bI, where I = indeterminacy)*  2003 – *introduction of I-neutrosophic algebraic structures*  2003 – *introduction to neutrosophic cognitive maps*  <http://fs.gallup.unm.edu/NCMs.pdf>    2005 - *introduction of interval neutrosophic set/logic*  [http://fs.gallup.unm.edu/INSL.pdf](http://fs.gallup.unm.edu/INSL.pdf%20%0d)    *2006 – introduction of degree of dependence and degree of independence*  *between the neutrosophic components T, I, F*  [*http://fs.gallup.unm.edu/ebook-neutrosophics6.pdf*](http://fs.gallup.unm.edu/ebook-neutrosophics6.pdf) *(p. 92)*  <http://fs.gallup.unm.edu/NSS/DegreeOfDependenceAndIndependence.pdf>  2007 – The Neutrosophic Set was extended [Smarandache, 2007] to Neutrosophic Overset (when some neutrosophic component is > 1), since he observed that, for example, an employee working overtime deserves a degree of membership > 1, with respect to an employee that only works regular full-time and whose degree of membership = 1;  and to Neutrosophic Underset (when some neutrosophic component is < 0), since, for example, an employee making more damage than benefit to his company deserves a degree of membership < 0, with respect to an employee that produces benefit to the company and has the degree of membership > 0;  and to and to Neutrosophic Offset (when some neutrosophic components are off the interval [0, 1], i.e. some neutrosophic component > 1 and some neutrosophic component < 0).  Then, similarly, the Neutrosophic Logic/Measure/Probability/Statistics etc. were extended to respectively Neutrosophic Over-/Under-/Off- Logic, Measure, Probability, Statistics etc.  <http://fs.gallup.unm.edu/SVNeutrosophicOverset-JMI.pdf>  <http://fs.gallup.unm.edu/IV-Neutrosophic-Overset-Underset-Offset.pdf>  <https://arxiv.org/ftp/arxiv/papers/1607/1607.00234.pdf>  2007 – Smarandache *introduced the Neutrosophic Tripolar Set* and *Neutrosophic Multipolar Set*  and consequently  – *the Neutrosophic Tripolar Graph* and *Neutrosophic Multipolar Graph*  [*http://fs.gallup.unm.edu/ebook-neutrosophics6.pdf*](http://fs.gallup.unm.edu/ebook-neutrosophics6.pdf) *(p. 93)*  <http://fs.gallup.unm.edu/IFS-generalized.pdf>  2009 – *introduction of N-norm and N-conorm*  <http://fs.gallup.unm.edu/N-normN-conorm.pdf>    2013 - *development of neutrosophic probability            (chance that an event occurs, indeterminate chance of occurrence,*  *chance that the event does not occur)*  <http://fs.gallup.unm.edu/NeutrosophicMeasureIntegralProbability.pdf>    2013 - *refinement of components (T1, T2, ...; I1, I2, ...; F1, F2, ...)*  <http://fs.gallup.unm.edu/n-ValuedNeutrosophicLogic.pdf>    2014 *– introduction of the law of included multiple middle*  *(<A>; <neut1A>, <neut2A>, …; <antiA>)*  <http://fs.gallup.unm.edu/LawIncludedMultiple-Middle.pdf>    2014 - *development of neutrosophic statistics (indeterminacy is introduced into classical statistics with respect to the sample/population, or with respect to the individuals that only partially  belong to a sample/population)*  <http://fs.gallup.unm.edu/NeutrosophicStatistics.pdf>    2015 - *introduction of neutrosophic precalculus and neutrosophic calculus*  [http://fs.gallup.unm.edu/NeutrosophicPrecalculusCalculus.pdf](http://fs.gallup.unm.edu/NeutrosophicPrecalculusCalculus.pdf%0d)    2015 – *refined neutrosophic numbers (a+ b1I1 + b2I2 + … + bnIn), where I1, I2, …, In are subindeterminacies of indeterminacy I;*  2015 – *(t,i,f)-neutrosophic graphs;*  2015 - *Thesis-Antithesis-Neutrothesis, and Neutrosynthesis, Neutrosophic Axiomatic System, neutrosophic dynamic systems, symbolic neutrosophic logic, (t, i, f)-Neutrosophic Structures, I-Neutrosophic Structures,  Refined Literal Indeterminacy, Multiplication Law of Subindeterminacies*:  <http://fs.gallup.unm.edu/SymbolicNeutrosophicTheory.pdf>  2015 – *Introduction of the subindeterminacies of the form , for k ∈ {0, 1, 2, …, n-1}, into the ring of modulo integers Zn -* called *natural neutrosophic indeterminacies* [Vasantha-Smarandache]  <http://fs.gallup.unm.edu/MODNeutrosophicNumbers.pdf> | | | | |
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2015 – Introduction of *neutrosophic triplet structures* and *m-valued refined neutrosophic triplet structures* [Smarandache - Ali]