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Short Communication

Information Fusion Using Plithogenic Set and Logic

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While the crisp, fuzzy, intuitionistic fuzzy, and neutrosophic sets are sets whose elements x are characterized by a single attribute, called "appurtenance", whose attribute values are: "membership" (for crisp sets and fuzzy sets), or "membership" and "nonmembership" (for intuitionistic fuzzy set), or "membership" and "nonmembership" and "indeterminacy" (for neutrosophic set), a plithogemic set is a set whose elements x are characterized by many attributes, and each attribute may have many attribute values [1-6].

Neutrosophic set was extended *to* plithogenic set by Smarandache in 2017.

A simple example

Let's consider a set M = {x1, x2, x3}, such that each element is characterized by two attributes:

C = color, and S = size. Suppose the attribute values of C = {white (w), blue (b), green (g)} and of size are S = {small (s), medium (m)}.

Thus, each x element of M is characterized by the all five attribute values: white, blue, green, small, tall, i.e. M = {x1(w, b, g; s, m), x2(w, b, g; s, m), x3(w, b, g; s, m)}.

Therefore, each element x belongs to the set M with a degree of white d(w), a degree of blue d(b), a degree of green d(g), a degree of small d(s), and a degree of medium d(m).

Thus, M = { x1(d1(w), d1(b), d1(g); d1(s), d1(m)), x2(d2(w), d2(b), d2(g); d2(s), d2(m)), x3(d3(w), d3(b), d3(g); d3(s), d3(m)) }

Where d1(.), d2(.), and d3(.) are the degrees of appurtenance of x1, x2, and x3 respectively to the set M with respect to each of the five attribute values.

But the degree of appurtenance may be: classical degree { whose values are 0 or 1 }, fuzzy degree { whose values are in [0, 1] }, intuitionistic fuzzy degree { whose values are in [0, 1]^2 }, or neutrosophic degree { whose values are in [0, 1]^3 }.

Therefore, we may get:

A plithogenic classical set:

M = { x1(0, 1, 0; 0, 1), x2(1, 0, 0; 0, 0), x3(1, 0, 0; 1, 0) }, which means that:

x1 is not white, x1 is blue, x1 is not green, x1 is not small, x1 is medium; similarly for x2 and x3.

A plithogenic fuzzy set:

M = { x1(0.2, 0.7, 0.5; 0.8, 0.3), x2(0.5, 0.1, 0.0; 0.9, 0.2), x3(0.5, 1, 0.6; 0.4, 0.3) },

which means that:

x1 has the fuzzy degree of white equals to 0.2, x1 has the fuzzy degree of blue equals to 0.7,

x1 has the fuzzy degree of green equals to 0.1, x1 has the fuzzy degree of small size equals to 0.8,

and x1 has the fuzzy degree of medium size equals to 0.3;

similarly for x2 and x3.

A plithogenic intuitionistic fuzzy set:

M = { x1((0.4,0.1), (0.2,0.7), (0.0,0.3); (0.8,0.5), (0.2,0.3)), x2((0.7,0.2), (0.2,0.6), (1.0,0.0); (0.6,0.4), (0.1,0.5)), x3((0.4,0.4), (0.5,0.6, (0.5,0.1); (0.5,0.6), (0.3,0.3));

which means that:

x1 has the truth-degree of white equals to 0.4 and the false-degree of white equals to 0.1;

x1 has the truth-degree of blue equals to 0.2 and the false-degree of blue equals to 0.7;

x1 has the truth-degree of green equals to 0.0 and the false-degree of green equals to 0.3;

x1 has the truth-degree of small size equals to 0.8 and the false-degree of small size equals to 0.5;

x1 has the truth-degree of medium size equals to 0.2 and the false-degree of white equals to 0.3;

similarly for x2 and x3.

A plithogenic neutrosophic set:

M = { x1((0.2,0.4,0.3), (0.5,0.2,0.7), (0.6,0.4,0.3); (0.9,0.6,0.5), (0.1,0.2,0.3)), x2((0.1,0.7,0.2), (0.3,0.2,0.7), (0.0,0.2,1.0); (0.6,0.6,0.1), (0.0,0.1,0.6)), x3((0.7,0.4,0.4), (0.5,0.6, (0.3,0.5,0.1); (0.0,0.5,0.6), (0.8,0.3,0.2));

which means that:

x1 has the truth-degree of white equals to 0.2, the indeterminacy-degree of white equals to 0.4, and the false-degree of white equals to 0.3;

x1 has the truth-degree of blue equals to 0.5, the indeterminacy-degree of blue equals to 0.2, and the false-degree of blue equals to 0.7;

x1 has the truth-degree of green equals to 0.6, the indeterminacy-degree of green equals to 0.4, and the false-degree of green equals to 0.3;

x1 has the truth-degree of small size equals to 0.9, the indeterminacy-degree of small size equals to 0.6, and the false-degree of small size equals to 0.5;

x1 has the truth-degree of medium size equals to 0.1, the indeterminacy-degree of minimum size equals to 0.2, and the false-degree of minimum size equals to 0.3;

similarly for x2 and x3.

Of course, we have considered the Single-Valued Plithogenic Set, i.e. when all degrees are single-valued (crip) numbers from [0, 1].

But similarly we may define:

Interval-Valued Plithogenic Set (when the degrees are intervals included into [0, 1]),

or Hesitant Plithogenic Set (when the degrees are discrete finite subsets included into [0, 1]),

or in the most general case Subset Plithogenic Set (when the degrees are any subsets included into [0, 1]).

Using generic notations one has

Plithogenic fuzzy set

$x(v_1(t_1), v_2(t_2), ..., v_n(t_n))$

Plithogenic intuitionistic fuzzy set

$x(v_1(t_1, f_1), v_2(t_2, f_2), ..., v_n(t_n, f_n))$, with $0 \le t_j + f_j \le 1$, for all $j \in \{1, 2, ..., n\}$.

Plithogenic neutrosophic set

$x(v_1(t_1, i_1, f_1), v_2(t_2, i_2, f_2), ..., v_n(t_n, i_n, f_n))$, with $0 \le t_j + i_j + f_j \le 3$, for all $j \in \{1, 2, ..., n\}$.

where t_j, i_j, $f_j \in [0, 1]$ are degrees of membership, indeterminacy, and nonmembership respectively. Plithogenic Set is much used in Multi-Criteria Decision Making.