International Journal of Applied and Advanced Scientific Research (IJAASR)
Impact Factor: 5.655, ISSN (Online): 2456 - 3080
(www.dvpublication.com) Volume 3, Issue 1, 2018

A SURVEY OF HYPO SOFT GRAPH STRUCTURES

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Cite This Article: V. Ramadoss & D. Kalpana, "A Survey of Hypo Soft Graph Structures", International Journal of Applied and Advanced Scientific Research, Volume 3, Issue 1, Page Number 159-164, 2018.

Abstract:

In this article, we have investigated the concept of hypo soft graph structures and its properties. Also we have discussed bell structures of hypo graphs with illustrative Examples.

Index Terms: Soft Set, Bi-Directional Soft Set, Normal, Soft Power Set, Path Vertex, Path Connected & Membership Functions.

1. Introduction:

Akram [2] introduced the concept of bipolar fuzzy graphs and defined different operations on it. A. Nagoorgani and K. Radha [3, 4] introduced the concept of regular fuzzy graphs in 2008 and discussed about the degree of a vertex in some fuzzy graphs. K. Radha and N. Kumaravel [5] introduced the concept of edge degree, total edge degree and discussed about the degree of an edge in some fuzzy graphs. S. Arumugam and S. Velammal [6] discussed edge domination in fuzzy graphs. Soft set theory was introduced by Molodtsov [9] for modelling vagueness and uncertainty and it has been received much attention since Maji et al [10], Sezgin and Atagun [1] introduced and studied operations of soft sets. Soft set theory has also potential applications especially in decision making as in [10]. In this article, we have investigated the concept of hypo soft graph structures and its properties. Also we have discussed bell structures of hypo graphs with illustrative Examples.

2. Preliminaries:

Definition 2.1: A graph is called finite if both V(G) and E(G) are finite. A graph that is not finite is called infinite. A simple graph H is said to be complete if every pair of distinct vertices of G are adjacent in G.

We shall in this paper deal only with graphs which are finite. N(G) and m(G) are the number of vertices and edges of the graph G, respectively. The number n(G) is called the order of G and m(G) is the size of G.

Definition 2.2: A pair (μ, A) is called a soft set over X, where μ is a mapping given by μ : $A \to P(X)$.

Definition 2.3: Let W^n denote an universe of discourse. A bi- directional fuzzy soft set $\bar{A}$ is an object having the form $\bar{A}=\left\{(x,\delta_{\bar{A}}^{\ P}(x),\delta_{\bar{A}}^{\ N}(x))/x\in W^n\right\}$ where $\delta_{\bar{A}}^{\ P}:W^n\to[0,1]$ and $\delta_{\bar{A}}^{\ N}:W^n\to[-1,0]$ satisfy $-1\le\delta_A^{\ P}+\delta_A^{\ N}\le 1$ for all $x\in W^n$, $\delta_{\bar{A}}^{\ P}$ and $\delta_{\bar{A}}^{\ N}$ is called membership element x to $\bar{A}$ respectively. Let $F(W^n)$ be the classes of normal BDFS-sets of W^n,

(ie) $\left\{x\in W^n/\delta_{\bar{A}}^{\ P}(x)/\delta_{\bar{A}}^{\ P}(x)=1 \text{ and } \delta_{\bar{A}}^{\ N}(x)=-1\right\}$ is non empty.

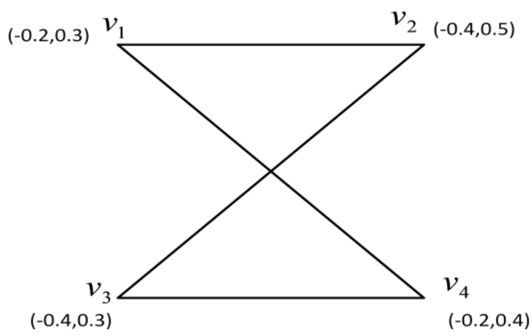
Example 2.4: Let $\bar{A}=\left\{(x,\delta_{\bar{A}}^{\ P}(x),\delta_{\bar{A}}^{\ N}(x))/x\in W\right\}$ where

$$\delta_{\bar{A}}^{\ P}(x)=\begin{cases} x2+1 & x\in[-1,0] \\ -x3+1 & x\in[0,1] \\ 0 & \text{otherwise}\end{cases} \text{ and } \delta_{\bar{A}}^{\ N}(x)=\begin{cases} -x & x\in[-1,0] \\ x\ +3 & x\in[0,1] \\ 0 & \text{otherwise}\end{cases} \text{ then } \bar{A}\in F(W).$$

Definition 2.5: A BDFS-set $\bar{A}\in F(W^n)$ is called quasi-convex if

$$\delta_{\bar{A}}^{\ P}(\lambda(x-y)+y)\ge\inf\left\{\delta_{\bar{A}}^{\ P}(x),\delta_{\bar{A}}^{\ P}(y)\right\} \text{ and } \delta_{\bar{A}}^{\ N}(\lambda(x-y)+y)\le\sup\left\{\delta_{\bar{A}}^{\ N}(x),\delta_{\bar{A}}^{\ N}(y)\right\}$$

for all $x,y\in W^n$, $\lambda\in[-1,1]$.



Definition 2.6: A BDFS- set $\bar{A} \in F(W^n)$ is called bi- directional fuzzy soft bell structure set corresponding to $y \in W^n$ if $\delta_{\bar{A}}{}^{P}(\lambda(x-y)+y) \geq \delta_{\bar{A}}{}^{P}(x)$ and $\delta_{\bar{A}}{}^{N}(\lambda(x-y)+y) \leq \delta_{\bar{A}}{}^{N}(x)$ for all $x \in W^n$, $\lambda \in [-1,1]$.

Proposition 2.7:

Let $\bar{A} \in F(W^n)$ is bi- directional fuzzy soft set corresponding to $y \in W^n$. Then $\delta_{\bar{A}}{}^{P}(x) = \sup_{x \in R^n} \{\delta_{\bar{A}}{}^{P}(x)\} = 1, \delta_{\bar{A}}{}^{N}(x) = \inf_{x \in R^n} \{\delta_{\bar{A}}{}^{N}(x)\} = -1$

Proof:

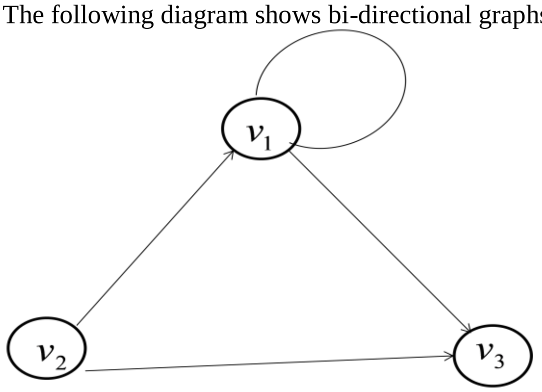
Let $\bar{A}$ is bi- directional fuzzy soft corresponding to y. Then for all $x \in R^n$
$\delta_{\bar{A}}{}^{P}(\lambda(x-y)+y) \geq \delta_{\bar{A}}{}^{P}(x)$ and $\delta_{\bar{A}}{}^{N}(\lambda(x-y)+y) \leq \delta_{\bar{A}}{}^{N}(x)$ are true for $-1 \leq \lambda \leq 1$.
Thus, only take $\lambda = 0$, it can be found that $\delta_{\bar{A}}{}^{P}(y) \geq \delta_{\bar{A}}{}^{P}(x)$ and $\delta_{\bar{A}}{}^{N}(y) \leq \delta_{\bar{A}}{}^{N}(x)$ are true for all $x \in R^n$. Hence $\delta_{\bar{A}}{}^{P}(x) = \sup_{x \in R^n} \{\delta_{\bar{A}}{}^{P}(x)\} = 1$ $\delta_{\bar{A}}{}^{N}(x) = \inf_{x \in R^n} \{\delta_{\bar{A}}{}^{N}(x)\} = -1$.

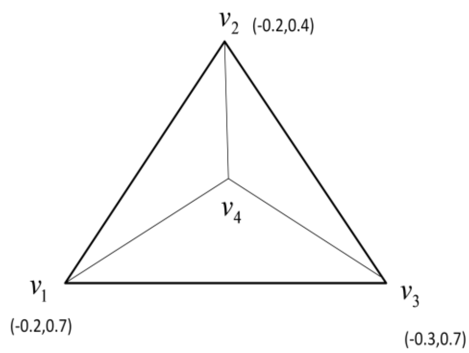
Example 2.8:

A bi- directional fuzzy soft set $\bar{A} \in F(R^n)$ with $\delta_{\bar{A}}{}^{P}(x) = \begin{cases} e^{x} 2x & x \in (-\infty, 0] \\ e^{-x} 1/2x & x \in (0, \infty) \end{cases}$,

$\delta_{\bar{A}}{}^{N}(x) = \begin{cases} 1 - e^{x2} & x \in (-\infty, 0] \\ 1 - e^{-x5} & x \in (0, \infty) \end{cases}$ is bi-directional fuzzy soft set corresponding to $y = 0$.

The following diagram shows bi-directional graphs





Proposition 2.9:

A bi- directional fuzzy soft set $\bar{A} \in F(W^n)$ is corresponding to $y \in R^n$ if and only if its level sets are bell structure corresponding to y.

Proof:

Suppose $\delta_{\bar{A}}{}^{[\alpha,\beta]}$ is bell structure relative to $y \in R^n$ for all $\alpha, \beta \in [-1,1]$.

For $x \in R^n$, let $\alpha = \delta_{\bar{A}}{}^{P}(x)$, $\beta = \delta_{\bar{A}}{}^{N}(x)$ then $\overline{xy} \in \delta_{\bar{A}}{}^{[\alpha,\beta]}$ that is for any $\lambda \in [-1,1]$

$\delta_{\bar{A}}{}^{P}(\lambda(x-y)+y) \geq \alpha = \delta_{\bar{A}}{}^{P}(x)$ and $\delta_{\bar{A}}{}^{N}(\lambda(x-y)+y) \leq \beta = \delta_{\bar{A}}{}^{N}(x)$

Conversely, if for all $x \in R^n$, $\lambda \in [-1,1]$. $\delta_{\bar{A}}{}^{P}(\lambda(x-y)+y) \geq \delta_{\bar{A}}{}^{P}(x)$ and

$\delta_{\bar{A}}{}^{N}(\lambda(x-y)+y) \leq \delta_{\bar{A}}{}^{N}(x)$ hold.

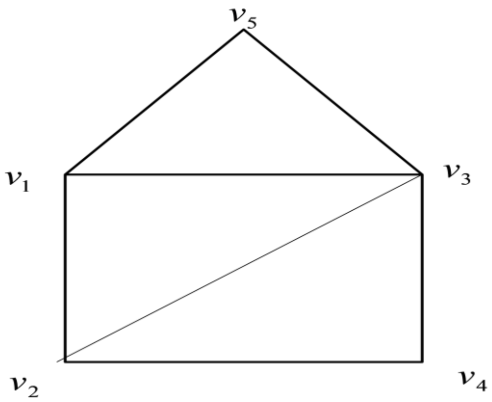
Since $\delta_{\bar{A}}{}^{[\alpha,\beta]} \neq \phi$, there exists $x \in \delta_{\bar{A}}{}^{[\alpha,\beta]}$, which means $\delta_{\bar{A}}{}^{P}(x) \geq \alpha$ and $\delta_{\bar{A}}{}^{N}(x) \leq \beta$.

Hence $\delta_{\bar{A}}{}^{P}(\lambda(x-y)+y) \geq \delta_{\bar{A}}{}^{P}(x) \geq \alpha$ and $\delta_{\bar{A}}{}^{N}(\lambda(x-y)+y) \leq \delta_{\bar{A}}{}^{N}(x) \leq \beta$ for any $\lambda \in [-1,1]$.

So $\overline{xy} \in \delta_{\bar{A}}{}^{[\alpha,\beta]}$. Then $\delta_{\bar{A}}{}^{[\alpha,\beta]}$ is bell structure relative to y.

Definition 2.10: BDFS-set $\bar{A} \in F(R^n)$ is said to be bi- directional fuzzy soft quasi set (BDFSQS) corresponding to $x \in R^n$, if for all $x \in R^n$, $\lambda \in [-1,1]$, the following hold

$\delta_{\bar{A}}{}^{P}(\lambda(x-y)+y) \geq \inf\left\{\delta_{\bar{A}}{}^{P}(x), \delta_{\bar{A}}{}^{P}(y)\right\}$, $\delta_{\bar{A}}{}^{N}(\lambda(x-y)+y) \leq \sup\left\{\delta_{\bar{A}}{}^{N}(x), \delta_{\bar{A}}{}^{N}(y)\right\}$.



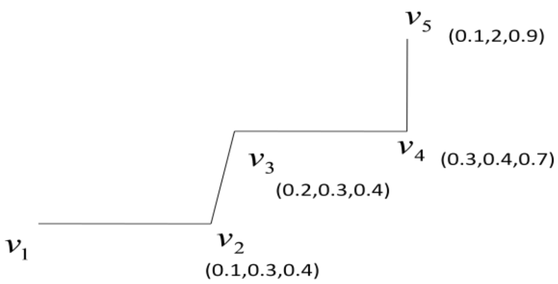
Definition 2.11: A BDFS-set $\bar{A} \in F(R^n)$ is said to be bipolar fuzzy soft power set (BDFSPS) relative to $x \in R^n, \lambda \in [-1,1]$, the following are true

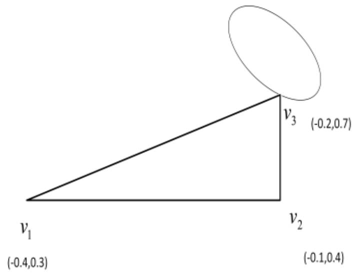
$$\delta_{\bar{A}}{}^{P}(\lambda(x-y)+y) \geq \lambda\delta_{\bar{A}}{}^{P}(x)+(1-\lambda)\delta_{\bar{A}}{}^{P}(y),\ \delta_{\bar{A}}{}^{N}(\lambda(x-y)+y) \leq \lambda\delta_{\bar{A}}{}^{N}(x)+(1-\lambda)\delta_{\bar{A}}{}^{N}(y)$$

Definition 2.12: A bi- directional fuzzy soft hypo graph of $\bar{A}$ denoted by for hypo ($\bar{A}$), is defined as

$f.hypo(\bar{A}) = f.hypo(\delta_{\bar{A}}{}^{P}) \cup f.hypo(\delta_{\bar{A}}{}^{N})$ Where $f.hypo(\delta_{\bar{A}}{}^{P}) = \left\{(x,t)/x \in R, t \in [-1, \delta_{\bar{A}}{}^{P}(x)]\right\}$

$f.hypo(\delta_{\bar{A}}{}^{N}) = \left\{(x,s)/x \in R, s \in [\delta_{\bar{A}}{}^{N}(x), 1]\right\}$.





3. Properties of Bi-Directional Hypo Graphs:

In this section, we analyzed some various theorems on hypo graph structures.

Theorem 3.1:

Let $\bar{A} \in F(R^n)$ is BDFSP-set corresponding to $y \in R^n$. Then it is BDFSP-set relative to y.

Proof:

Since for all $x \in R^n, \lambda \in [-1,1]$, the following hold,

$$\delta_{\bar{A}}{}^{P}(\lambda(x-y)+y) \geq \lambda\delta_{\bar{A}}{}^{P}(x)+(1-\lambda)\delta_{\bar{A}}{}^{P}(y) \geq \inf\left\{\delta_{\bar{A}}{}^{P}(x), \delta_{\bar{A}}{}^{P}(y)\right\}$$

$\delta_{\bar{A}}{}^{N}(\lambda(x-y)+y) \leq \lambda\delta_{\bar{A}}{}^{N}(x)+(1-\lambda)\delta_{\bar{A}}{}^{N}(y) \leq \sup\left\{\delta_{\bar{A}}{}^{N}(x), \delta_{\bar{A}}{}^{N}(y)\right\}$ .Thus $\bar{A}$ is BDFSQ-set relative to y.

Example 3.2:

A bi- directional fuzzy soft set with the (+) membership function $\delta_{\bar{A}}{}^{P}(x) = \begin{cases} 2+x & x \in [-2,-1] \\ x^2 & x \in [-1,1] \\ 2-x & x \in [1,2] \\ 0 & \text{otherwise} \end{cases}$ and the (-) membership function $\delta_{\bar{A}}{}^{N}(x) = \begin{cases} -x-1 & x \in [-2,-1] \\ 1-x^2 & x \in [-1,1] \\ x-1 & x \in [1,2] \\ 1 & \text{otherwise} \end{cases}$ is BDFSQ-set corresponding to $y=0$. But it is not BDFSP-set corresponding to $y=0$.

Theorem 3.3:

Let $\overline{A} \in F(R^n)$ is BDFSQ-set corresponding to $y \in R^n$, then $\delta_{\overline{A}}^{P}(y) = \sup_{x \in R^n}\{\delta_{\overline{A}}^{P}(x)\} = 1$, $\delta_{\overline{A}}^{N}(y) = \inf_{x \in R^n}\{\delta_{\overline{A}}^{N}(x)\} = -1$ if and only if $\overline{A} \in F(R^n)$ is BDFS-set corresponding to y.

Proof:

Since $\overline{A} \in F(R^n)$ is BDFSQ-set corresponding to $y \in R^n$,

$\delta_{\overline{A}}^{P}(y) = \sup_{x \in R^n}\{\delta_{\overline{A}}^{P}(x)\} = 1$ and $\delta_{\overline{A}}^{N}(y) = \inf_{x \in R^n}\{\delta_{\overline{A}}^{N}(x)\} = -1$,then for all $x \in R^n$, $\lambda \in [-1,1]$.

We have $\delta_{\overline{A}}^{P}(\lambda(x-y)+y) \geq \inf\{\delta_{\overline{A}}^{P}(x), \delta_{\overline{A}}^{P}(y)\} = \delta_{\overline{A}}^{P}(x)$

$\delta_{\overline{A}}^{N}(\lambda(x-y)+y) \leq \sup\{\delta_{\overline{A}}^{N}(x), \delta_{\overline{A}}^{N}(y)\} = \delta_{\overline{A}}^{N}(x)$ .Hence $\overline{A}$ is BDFS-set corresponding to y.

Also Since $\overline{A}$ is BDFS-set corresponding to y, which means for all $x \in R^n$, $\lambda \in [-1,1]$,

$\delta_{\overline{A}}^{P}(\lambda(x-y)+y) \geq \delta_{\overline{A}}^{P}(x)$ and $\delta_{\overline{A}}^{N}(\lambda(x-y)+y) \leq \delta_{\overline{A}}^{N}(x)$

Take $\lambda = 0$, we get $\delta_{\overline{A}}^{P}(y) \geq \delta_{\overline{A}}^{P}(x)$ and $\delta_{\overline{A}}^{N}(y) \leq \delta_{\overline{A}}^{N}(x)$ for all $x \in R^n$.

Thus $\delta_{\overline{A}}^{P}(\lambda(x-y)+y) \geq \delta_{\overline{A}}^{P}(x) \geq \inf\{\delta_{\overline{A}}^{P}(x), \delta_{\overline{A}}^{P}(y)\}$

$\delta_{\overline{A}}^{N}(\lambda(x-y)+y) \leq \delta_{\overline{A}}^{N}(x) \leq \sup\{\delta_{\overline{A}}^{N}(x), \delta_{\overline{A}}^{N}(y)\}$ .Hence $\overline{A}$ is BDFSQ-set corresponding to y. $\delta_{\overline{A}}^{P}(y) = \sup_{x \in R^n}\{\delta_{\overline{A}}^{P}(x)\} = 1, \delta_{\overline{A}}^{N}(y) = \inf_{x \in R^n}\{\delta_{\overline{A}}^{N}(x)\} = -1$

Example 3.4:

A bi- directional fuzzy soft set $\overline{A} \in F(R^n)$ with $\delta_{\overline{A}}^{P}(x) = \begin{cases} e^{x} & x \in (-\infty, 0] \\ e^{-x} & x \in (0, \infty) \end{cases}$

$\delta_{\overline{A}}^{N}(x) = \begin{cases} 1-e^{x} & x \in (-\infty, 0] \\ 1-e^{-x} & x \in (0, \infty) \end{cases}$ is bi- directional fuzzy soft set corresponding to $y = 0$. But it is not BDFSP-set corresponding to $y = 0$.

Theorem 3.5:

A bi- directional fuzzy soft set (BFSS-set) $\overline{A} \in F(R^n)$ is bi- directional fuzzy soft bell structure corresponding to $y \in R^n$ iff for all $x \in R^n$, $\lambda \in [-1,1]$, the following hold,

$\delta_{\overline{A}}^{P}(\lambda x+y) \geq \delta_{\overline{A}}^{P}(x+y)$ and $\delta_{\overline{A}}^{N}(\lambda x+y) \leq \delta_{\overline{A}}^{N}(x+y)$.

Proof:

Suppose $\overline{A}$ is bi- directional fuzzy soft bell structure corresponding to y , that is for all $x \in R^n$, $\lambda \in [-1,1]$

$$\left.\begin{array}{l} \delta_{\overline{A}}^{P}(\lambda(x-y)+y) \geq \delta_{\overline{A}}^{P}(x) \text{ and} \\ \delta_{\overline{A}}^{N}(\lambda(x-y)+y) \leq \delta_{\overline{A}}^{N}(x) \end{array}\right\} \quad \ldots\ldots\ldots\ldots\ldots(1)$$

Replacing x by $x+y$ in the above equation (1), we can get

$\delta_{\overline{A}}^{P}(\lambda(x+y-y)+y) \geq \delta_{\overline{A}}^{P}(x+y) \Rightarrow \delta_{\overline{A}}^{P}(\lambda x+y) \geq \delta_{\overline{A}}^{P}(x+y)$ is proved and

$\delta_{\overline{A}}^{N}(\lambda(x+y-y)+y) \leq \delta_{\overline{A}}^{N}(x+y) \Rightarrow \delta_{\overline{A}}^{N}(\lambda x+y) \leq \delta_{\overline{A}}^{N}(x+y)$ is proved. Similarly, we can get the converse part.

Theorem 3.6:

A bi- directional fuzzy soft set $\overline{A} \in F(R^n)$ is BDFSQ-set corresponding to $y \in R^n$ iff $\delta_{\overline{A}}^{[\alpha,\beta]}$ is bell structure set corresponding to y for $\alpha \in [-1, \delta_{\overline{A}}^{P}(y)]$, $\beta \in [\delta_{\overline{A}}^{N}(y), 1]$.

Proof:

Suppose $\overline{A}$ is BDFSQ-set relative to y, that is for all $x \in R^n$, $\lambda \in [-1,1]$,

$\delta_{\bar{A}}{}^{P}(\lambda(x-y)+y) \geq \inf\{\delta_{\bar{A}}{}^{P}(x), \delta_{\bar{A}}{}^{P}(y)\}, \delta_{\bar{A}}{}^{N}(\lambda(x-y)+y) \leq \sup\{\delta_{\bar{A}}{}^{N}(x), \delta_{\bar{A}}{}^{N}(y)\}$

For any $\alpha \in [-1, \delta_{\bar{A}}{}^{P}(y)], \beta \in [\delta_{\bar{A}}{}^{N}(y), 1]$, if $x \in \delta_{\bar{A}}{}^{[\alpha,\beta]}$, then we have that $x, y \in \delta_{\bar{A}}{}^{[\alpha,\beta]}$.

From the above inequality, We get that $\delta_{\bar{A}}{}^{P}(\lambda(x-y)+y) \geq \alpha$ and $\delta_{\bar{A}}{}^{N}(\lambda(x-y)+y) \leq \beta$. So $\overline{xy} \in \delta_{\bar{A}}{}^{[\alpha,\beta]}$.

Also, for $x \in R^n$, $\lambda \in [-1,1]$, if $\delta_{\bar{A}}{}^{P}(x) \geq \delta_{\bar{A}}{}^{P}(y)$, then let $\alpha = \delta_{\bar{A}}{}^{P}(y)$. Accordingly we have $\overline{xy} \in \delta_{\bar{A}}{}^{[\alpha,\beta]}$, that is $\delta_{\bar{A}}{}^{P}(\lambda(x-y)+y) \geq \inf\{\delta_{\bar{A}}{}^{P}(x), \delta_{\bar{A}}{}^{P}(y)\}$.

If $\delta_{\bar{A}}{}^{P}(x) \leq \delta_{\bar{A}}{}^{P}(y)$, then let $\alpha = \delta_{\bar{A}}{}^{P}(x)$. Accordingly we have $\overline{xy} \in \delta_{\bar{A}}{}^{[\alpha,\beta]}$, that is $\delta_{\bar{A}}{}^{P}(\lambda(x-y)+y) \geq \inf\{\delta_{\bar{A}}{}^{P}(x), \delta_{\bar{A}}{}^{P}(y)\}$.

If $\delta_{\bar{A}}{}^{N}(x) \leq \delta_{\bar{A}}{}^{N}(y)$, then let $\beta = \delta_{\bar{A}}{}^{N}(y)$. Accordingly we have $\overline{xy} \in \delta_{\bar{A}}{}^{[\alpha,\beta]}$, that is $\delta_{\bar{A}}{}^{N}(\lambda(x-y)+y) \leq \sup\{\delta_{\bar{A}}{}^{N}(x), \delta_{\bar{A}}{}^{N}(y)\}$.

If $\delta_{\bar{A}}{}^{N}(x) \geq \delta_{\bar{A}}{}^{N}(y)$, then let $\beta = \delta_{\bar{A}}{}^{N}(x)$. Accordingly we have $\overline{xy} \in \delta_{\bar{A}}{}^{[\alpha,\beta]}$, that is $\delta_{\bar{A}}{}^{N}(\lambda(x-y)+y) \leq \sup\{\delta_{\bar{A}}{}^{N}(x), \delta_{\bar{A}}{}^{N}(y)\}$.Thus $\bar{A}$ is BDFSQ-set corresponding to $y \in R^n$.

Theorem 3.7:

A bi- directional fuzzy soft set $\bar{A} \in F(R^n)$ is BDFSP-set corresponding to y iff $f.hypo(\delta_{\bar{A}}{}^{P})$ is bell structure relative to $(y, \delta_{\bar{A}}{}^{P}(y))$ and $f.hypo(\delta_{\bar{A}}{}^{N})$ is bell structure corresponding to $(y, \delta_{\bar{A}}{}^{N}(x))$.

Proof:

If $\bar{A}$ is BDFSP-set corresponding to y, $(x,t) \in f.hypo(\delta_{\bar{A}}{}^{P})$ and $(x,s) \in f.hypo(\delta_{\bar{A}}{}^{N})$.

Since $\bar{A}$ is BDFSP-set corresponding to y.

For any $\lambda \in [-1,1]$, we have $\delta_{\bar{A}}{}^{P}(\lambda(x-y)+y) \geq \lambda\delta_{\bar{A}}{}^{P}(x) + (1-\lambda)\delta_{\bar{A}}{}^{P}(y) \geq \lambda t + (1-\lambda)\delta_{\bar{A}}{}^{P}(y)$

$\delta_{\bar{A}}{}^{N}(\lambda(x-y)+y) \leq \lambda\delta_{\bar{A}}{}^{N}(x) + (1-\lambda)\delta_{\bar{A}}{}^{N}(y) \leq \lambda s + (1-\lambda)\delta_{\bar{A}}{}^{N}(y)$

Thus, we have

$\lambda(x,t) + (1-\lambda)(y, \delta_{\bar{A}}{}^{P}(y)) \in f.hypo(\delta_{\bar{A}}{}^{P}), \lambda(x,s) + (1-\lambda)(y, \delta_{\bar{A}}{}^{N}(y)) \in f.hypo(\delta_{\bar{A}}{}^{N})$

Hence $f.hypo(\delta_{\bar{A}}{}^{P})$ is bell structure corresponding to $(y, \delta_{\bar{A}}{}^{P}(y))$ and $f.hypo(\delta_{\bar{A}}{}^{N})$ is bell structure corresponding to $(y, \delta_{\bar{A}}{}^{N}(y))$.

Also, Assume that $(x, \delta_{\bar{A}}{}^{P}(x)) \in f.hypo(\delta_{\bar{A}}{}^{P})$ and $(x, \delta_{\bar{A}}{}^{N}(x)) \in f.hypo(\delta_{\bar{A}}{}^{N})$. By the bell structure of $f.hypo(\delta_{\bar{A}}{}^{P})$ and $f.hypo(\delta_{\bar{A}}{}^{N})$, we can have

$\lambda x + (1-\lambda)y$, $\lambda\delta_{\bar{A}}{}^{P}(x) + (1-\lambda)\delta_{\bar{A}}{}^{P}(y) \in f.hypo(\delta_{\bar{A}}{}^{P})$

$\lambda x + (1-\lambda)y$, $\lambda\delta_{\bar{A}}{}^{N}(x) + (1-\lambda)\delta_{\bar{A}}{}^{N}(y) \in f.hypo(\delta_{\bar{A}}{}^{N})$ For any $\lambda \in [-1,1]$. Thus $\bar{A}$ is BDFSP-set corresponding to y.

Definition 3.8: A path in a set S in R^n is a continuous mapping $f:[-1,1] \to S$. A set S is said to be path connected, if there exist a path f such that $f(-1) = x$ and $f(1) = y$ for all $x, y \in S$.

- ✓ A set BDFS-set $\bar{A}$ is said to be path connected if its level sets are path connected.
- ✓ Since a bell structure crisp set is path connected.

Proposition 3.9:

If $\bar{A} \in F(R^n)$ is bi- directional fuzzy soft quasi convex set, then it is BFSGS. Furthermore, if $\bar{A} \in F(R^n)$ is BDFSGS, then $\bar{A}$ is a BDFSQC-set.

Proof:

If $\bar{A}$ is a BDFSQC-set, that for all $x, y \in R^n$, $\lambda \in [-1,1]$, we have

$\delta_{\bar{A}}{}^{P}(\lambda(x-y)+y) \geq \inf\{\delta_{\bar{A}}{}^{P}(x), \delta_{\bar{A}}{}^{P}(y)\}$, $\delta_{\bar{A}}{}^{N}(\lambda(x-y)+y) \leq \sup\{\delta_{\bar{A}}{}^{N}(x), \delta_{\bar{A}}{}^{N}(y)\}$

then for all $x, y \in R^n$, the following hold,

$$\delta_{\bar{A}}{}^{P}(\lambda(x-y)+y) \geq \inf\{\delta_{\bar{A}}{}^{P}(x), \delta_{\bar{A}}{}^{P}(y)\} \geq \inf\{\alpha, \alpha\} \geq \alpha$$

$$\delta_{\bar{A}}{}^{N}(\lambda(x-y)+y) \leq \sup\{\delta_{\bar{A}}{}^{N}(x), \delta_{\bar{A}}{}^{N}(y)\} \leq \sup\{\beta, \beta\} \leq \beta \ .$$

So $\overline{xy} \in \delta_{\bar{A}}{}^{[\alpha,\beta]}$. In other words $\bar{A}$ is a BDFSGS-set. Additionally if $\bar{A} \in F(R^n)$ is BDFSGS-set, then $\delta_{\bar{A}}{}^{[\alpha,\beta]}$ is bell structure. Thus they are path convex. So we have that $\bar{A}$ is BDFS-set relative to y and is a BDFSQC-set.

Conclusion:

Hypo graphs is a powerful tool for network analysis and communication theory. Path vertex is played in various transport analysis.

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