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P-SETS AND ITS APPLICATION IN THE UNKNOWN INFORMATION IDENTIFICATION

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ABSTRACT

P-sets (Packet sets) is novel mathematics structure and model by introducing the dynamic characteristics into the finite Cantor set X and improving it. P-sets is a set pair composed of internal P-set $X^{\bar{F}}$ (internal packet set $X^{\bar{F}}$) and outer P-set X^{F} (outer packet set X^{F}), or $(X^{\bar{F}}, X^{F})$ is P-sets. Based on P-sets, some theorems are presented, which are internal-dynamic reasoning and information deleted theorem, outer-dynamic reasoning and information supplemented theorem, internal-outer dynamic reasoning and information deleted-supplemented theorem and so on. By using the results, the application of internal-dynamic reasoning in the unknown information identification is given. P-sets is a novel model and method with good application prospect in the intelligent information system.

Keywords: *P-Sets, Dynamic Reasoning, Information Deleted, Information Supplemented*

1. INTRODUCTION

With the development of society， all kinds of information needs to be handled immediately, efficiently and correctly. The processing speed and capacity for information are improved greatly by the computer technologies. Besides, the application of computer technologies provides fast and accurate data correction and processing for the development of information technique. While, some mathematical algorithms use provides further guarantee for the rapidity and accuracy of information identification technique [1]. The information set is denoted with X and the attribute (characteristic) set of information is denoted with α. Information set X has the following characteristics: 1. if some attrition is supplemented into the attribute set α, the elements in the information set X will be decreased. 2. if some attributes are deleted from the attribute set α, the elements in the information set X will be added. The characteristic is similar to that of P-sets (packet sets). P-sets is a novel mathematics model put forward in 2008[2, 3], which has been applied in many fields [4-10]. P-sets is obtained by introducing the dynamic characteristic into the limited Cantor set X, so P-sets has dynamic characteristic. P-sets is a set-pair consist of internal P-set $X^{\bar{F}}$ and outer P-set X^{F}, or $(X^{\bar{F}}, X^{F})$ is P-sets. P-sets achieves identification purpose by the deletion and supplementary for the attribute.

The main results: using the structure of P-sets, the internal-outer reasoning model is given. Using the theory, the application of P-reasoning in information identification is given.

In order to understand the discussion and accept the results easily in the paper, the structure of P-sets is introduced briefly as the theoretical basis and preliminary knowledge. More concepts and applications see Ref. [4-10].

2. P-sets and Its Structure

Assumption: U is a finite element universe, and V is a finite attribute universe. X is a finite general set (Cantor set) on U, and α is an attribute set on V.

In 2008, the following was proposed in Ref. [2, 3].

Given a set $X = \{x_1, x_2, \cdots, x_q\} \subset U$, and $\alpha = \{\alpha_1, \alpha_2, \cdots, \alpha_k\} \subset V$ is the attribute set of X. $X^{\bar{F}}$ is called internal P-set generated by X, which is called internal P-set for short, moreover

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$$X^{\bar{F}} = X - X^{-} \quad (1)$$

X^{-} is called $\bar{F}$ -element deleted set of X, moreover

$$X^{-} = \{x \mid x \in X, \bar{f}(x) = u \bar{\in} X, \bar{f} \in \bar{F}\} \quad (2)$$

If the attribute set α^{F} of $X^{\bar{F}}$ satisfies

$$\alpha^{F} = \alpha \bigcup \{\alpha' \mid f(\beta) = \alpha' \in \alpha, f \in F\} \quad (3)$$

Where, $\beta \in V, \beta \bar{\in} \alpha$, β is turned into $f(\beta) = \alpha' \in \alpha$ by $f \in F$. In application, $X^{\bar{F}} = \phi$. In equation (1), $X^{\bar{F}} = \{x_1, x_2, \cdots, x_p\}$, $p \le q$; $p, q \in \mathrm{N}^{+}$

Given a set $X = \{x_1, x_2, \cdots, x_q\} \subset U$, and $\alpha = \{\alpha_1, \alpha_2, \cdots, \alpha_k\} \subset V$ is the attribute set of X. X^{F} is called outer P-set generated by X, which is called outer P-set for short, moreover

$$X^{F} = X \bigcup X^{+} \quad (4)$$

X^{+} is called $\bar{F}$ -element supplemented set of X, moreover

$$X^{+} = \{u \mid u \in U, u \bar{\in} X, f(u) = x' \in X, f \in F\} \quad (5)$$

if the attribute set $\alpha^{\bar{F}}$ of X^{F} satisfies

$$\alpha^{\bar{F}} = \alpha - \{\beta_i \mid \bar{f}(\alpha_i) = \beta_i \bar{\in} \alpha, \bar{f} \in \bar{F}\} \quad (6)$$

In equation (4), $X^{F} = \{x_1, x_2, \cdots, x_r\}$, $q \le r$; $q, r \in \mathrm{N}^{+}$.

The set pair composed of inters P-set $X^{\bar{F}}$ and outer P-set X^{F} is called P-sets generated by set X, and called P-sets for short, moreover

$$(X^{\bar{F}}, X^{F}) \quad (7)$$

Where, the general set X is called the ground set of $(X^{\bar{F}}, X^{F})$.

By (1)-(3) and (4-6), the following conclusions are achieved.

$$X_n^{\bar{F}} \subseteq X_{n-1}^{\bar{F}} \subseteq \cdots \subseteq X_2^{\bar{F}} \subseteq X_1^{\bar{F}} \quad (8)$$

$$X_1^{F} \subseteq X_2^{F} \subseteq \cdots \subseteq X_{n-1}^{F} \subseteq X_n^{F} \quad (9)$$

By (8) and (9), equation (10) is got.

$$\{(X_i^{\bar{F}}, X_j^{F}) \mid i \in \mathrm{I}, j \in \mathrm{J}\} \quad (10)$$

Equation (10) is the set pair family form of equation (7), or Equation (10) is the general expression of P-sets.

Theorem 1(the first relation theorem between P-sets and finite general set) P-sets $(X^{\bar{F}}, X^{F})$ and finite general set X satisfy:

$$(X^{\bar{F}}, X^{F})_{\bar{F}=F=\phi} = X \quad (11)$$

Theorem 2 (the second relation theorem between P-sets and finite general set) P-sets $\{(X_i^{\bar{F}}, X_j^{F}) \mid i \in I, j \in J\}$ and finite general set X s atisfy:

$$\{(X_i^{\bar{F}}, X_j^{F}) \mid i \in I, j \in J\}_{\bar{F}=F=\phi} = X \quad (12)$$

Using the concepts in section 2, section 3 gives:

3. THE DYNAMIC REASONING GENERATED BY P-SETS

Assumption: In the section, $X^{\bar{F}}, X, X^{F}$ are noted as $(x)^{\bar{F}}, (x), (x)^{F}$, or $(x)^{\bar{F}} = X^{\bar{F}}$, $(x) = X$, $(x)^{F} = X^{F}$.

Definition 1 $(x) = \{x_1, x_2, \cdots, x_q\}$ is Called as an information on U, if (x) has the attribute set α, and

$$\alpha = \{\alpha_1, \alpha_2, \cdots, \alpha_k\} \quad (13)$$

Definition 2 $(x)_{k+1}^{\bar{F}}$ is called the internal dynamic reasoning information generated by $(x)_k^{\bar{F}}$, which is briefly called internal dynamic reasoning information, if α_k^{F} and α_{k+1}^{F}, $(x)_k^{\bar{F}}$, $(x)_{k+1}^{\bar{F}}$ satisfy:

If $\alpha_k^{F} \Rightarrow \alpha_{k+1}^{F}$, then $(x)_{k+1}^{\bar{F}} \Rightarrow (x)_k^{\bar{F}}$ (14)

In (14), if $\alpha_k^{F} = \alpha$, then (14) will become:

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If $\alpha \Rightarrow \alpha_1^F$, then $(x)_1^{\bar{F}} \Rightarrow (x)$ (15)

$(x)_1^{\bar{F}}$ and (x) satisfy $(x)_1^{\bar{F}} = \{x_1, x_2, \cdots, x_p\} \subseteq \{x_1, x_2, \cdots, x_q\} = (x)$, $p, q \in N^+$.

Definition 3 $(x)_{k+1}^F$ is called the outer dynamic reasoning information generated by $(x)_k^F$, and is briefly called outer dynamic reasoning information, if $\alpha_k^{\bar{F}}$ and $\alpha_{k+1}^{\bar{F}}$, $(x)_k^F$, $(x)_{k+1}^F$ satisfy:

If $\alpha_{k+1}^{\bar{F}} \Rightarrow \alpha_k^{\bar{F}}$, then $(x)_k^F \Rightarrow (x)_{k+1}^F$ (16)

In (16), if $\alpha_k^{\bar{F}} = \alpha$, then (16) will become:

If $\alpha_1^{\bar{F}} \Rightarrow \alpha$, then $(x)(\Rightarrow x)_1^F$ (17)

$(x)_1^F$ and (x) satisfy $(x) = \{x_1, x_2, \cdots, x_q\} \subseteq \{x_1, x_2, \cdots, x_p\} = (x)_1^F$; $q, r \in N^+$.

Definition 4 $\left((x)_k^{\bar{F}}, (x)_{k+1}^F\right)$ is called the internal dynamic reasoning and outer dynamic reasoning information generated by (x), briefly called internal-outer dynamic reasoning information, if $\left(\alpha_k^F, \alpha_{k+1}^{\bar{F}}\right), \left(\alpha_{k+1}^F, \alpha_k^{\bar{F}}\right)$, $(x)_k^F$ and $(x)_{k+1}^F$ satisfy:

$$\text{if } \left(\alpha_k^F, \alpha_{k+1}^{\bar{F}}\right) \Rightarrow \left(\alpha_{k+1}^F, \alpha_k^{\bar{F}}\right) \quad \text{then } \left((x)_{k+1}^{\bar{F}}, (x)_k^F\right) \Rightarrow \left((x)_k^{\bar{F}}, (x)_{k+1}^F\right) \tag{18}$$

(19) The so called internal-outer dynamic reasoning information families generated by (x), briefly called internal-outer dynamic reasoning information families, and

$$\left\{\left((x)_{k+1}^{\bar{F}}, (x)_k^F\right) \Rightarrow \left((x)_k^{\bar{F}}, (x)_{k+1}^F\right) \middle| k \in \mathrm{I}\right\} \tag{19}$$

where, $\left(\alpha_k^F, \alpha_{k+1}^{\bar{F}}\right) \Rightarrow \left(\alpha_{k+1}^F, \alpha_k^{\bar{F}}\right)$ denotes $\alpha_k^F \Rightarrow \alpha_{k+1}^F$, $\alpha_{k+1}^{\bar{F}} \Rightarrow \alpha_k^{\bar{F}}$, $k = 1, 2, \cdots, n-1$.

Theorem 3(the theorem of internal-dynamic reasoning and information deleted) If $(x)_{k+1}^{\bar{F}}$ is the internal-dynamic reasoning information generated by $(x)_k^{\bar{F}}$, there exists information $\nabla(x)_{k+1}^{\bar{F}}$ to satisfy:

$$\nabla(x)_{k+1}^{\bar{F}} \neq \phi \tag{20}$$

Where, $\nabla(x)_{k+1}^{\bar{F}}$ is the information constituted by the information elements xi, which are deleted from $(x)_k^{\bar{F}}$ in the internal-dynamic reasoning, and $\nabla(x)_{k+1}^{\bar{F}} = (x)_k^{\bar{F}} - (x)_{k+1}^{\bar{F}} = \{x_1, x_2, \cdots, x_q\} - \{x_1, x_2, \cdots, x_p\} = \{x_{p+1}, x_{p+2}, \cdots, x_q\}$.

Theorem 4 (the theorem of outer-dynamic reasoning and information supplemented) If $(x)_{k+1}^F$ is the outer-dynamic reasoning information generated by $(x)_k^F$, there exists information $\Delta(x)_{k+1}^F$ to satisfy:

$$\Delta(x)_{k+1}^F \neq \phi \tag{21}$$

Where, $\nabla(x)_{k+1}^F$ is the information constituted by the information elements xj, which are supplemented into $(x)_k^{\bar{F}}$ in the outer-dynamic reasoning, and $\Delta(x)_{k+1}^F = (x)_{k+1}^F - (x)_{k1}^F = \{x_1, x_2, \cdots, x_r\} - \{x_1, x_2, \cdots, x_q\} = \{x_{q+1}, x_{q+2}, \cdots, x_r\}$.

Theorem 5 (the theorem of inter-outer dynamic reasoning and information deleted- supplemented) If $\left((x)_{k+1}^{\bar{F}}, (x)_{k+1}^F\right)$ is the internal-outer dynamic reasoning information generated by $\left((x)_k^{\bar{F}}, (x)_k^F\right)$, then

$$\left((x)_{k+1}^{\bar{F}}, (x)_{k+1}^F\right) = \left((x)_k^{\bar{F}} - \nabla(x)_{k+1}^{\bar{F}}, (x)_k^F \bigcup \Delta(x)_{k+1}^F\right) \tag{22}$$

Here: $(x)_{k+1}^{\bar{F}} = (x)_k^{\bar{F}} - \nabla(x)_{k+1}^{\bar{F}}$, $(x)_{k+1}^F = (x)_k^F \bigcup \Delta(x)_{k+1}^F$.

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4. THE APPLICATION OF P-SETS IN THE UNKNOWN INFORMATION IDENTIFICATION

For the simplicity and generality, the example only gives the application of internal-dynamic reasoning in the unknown information identification. $x_1 \sim x_{10}$ are the undergraduates of college of information science and engineering, university of Jinan, which are shown as table 1.

Table 1. $x_1 \sim x_{10}$ and its attribute set $\alpha = \{\alpha_1, \alpha_2, \alpha_3\}$

x	x1	x2	x3	x4	x5	x6	x7
x8	x9	x10					
α			α_1	α_2		α_3	

In the table 1, $\alpha_1 =$female, $\alpha_2 =$thin, $\alpha_3 =$ twenty years;

The characteristic values of $x_1 \sim x_{10}$ (the height of $x_1 \sim x_{10}$) is shown as table 2.

Table 2. The characteristic values of $x_1 \sim x_{10}$

x	x1	x2	x3	x4	x5	x6
x7	x8	x9	x10			
y	1.66	1.68	1.70	1.53	1.63	1.58
1.72	1.60	1.69	1.76			

The information in table 1 and 2 are denoted with sets (x) and y, respectively.

$$(x) = \{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}\} \quad (23)$$

$$(y) = \{y_1, y_2, y_3, y_4, y_5, y_6, y_7, y_8, y_9, y_{10}\} = \{1.66,1.68,1.70,1.53,1.63,1.58, 1.72,1.60,1.69,1.76\} \quad (24)$$

(x) It has the attribute set α, and

$$\alpha = \{\alpha_1, \alpha_2, \alpha_3\} \quad (25)$$

It is easy to get:

$$\text{if } \alpha \Leftrightarrow \alpha \text{, then } (x) \Leftrightarrow (x) \quad (26)$$

If attribute $\beta_1 =$ "Shandong province" is supplemented into α, α becomes $\alpha_1^{\bar{F}}$, moreover:

$$\alpha_1^{\bar{F}} = \alpha \bigcup \{f(\beta_1)\} = \{\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_1'\} \quad (27)$$

It is obtained:

$$\text{if } \alpha \Rightarrow \alpha_1^F \text{, then } (x)_1^{\bar{F}} \Rightarrow (x) \quad (28)$$

Where, $(x)_1^{\bar{F}} = \{x_3, x_9\}$, $(x)_1^{\bar{F}}$ is an internal-reasoning information of (x), $(x)_1^{\bar{F}} \subset (x)$.

If attribute $\beta_2 =$ "Jinan city" is supplemented into α, α becomes $\alpha_2^{\bar{F}}$, moreover:

$$\begin{aligned} \alpha_2^{\bar{F}} &= \alpha_1^{\bar{F}} \bigcup \{f(\beta_2)\} \\ &= \alpha \bigcup \{f(\beta_1), f(\beta_2)\} \\ &= \{\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_1', \alpha_2'\} \end{aligned} \quad (29)$$

it is obtained:

$$\text{if } \alpha \Rightarrow \alpha_2^F \text{, then } (x)_2^{\bar{F}} \Rightarrow (x) \quad (30)$$

Where, $(x)_2^{\bar{F}} = \{x_9\}$, $(x)_2^{\bar{F}}$ is an internal-reasoning information of (x). $(x)_2^{\bar{F}} \subset (x)$.

By the internal-dynamic reasoning, it is known that the students x_3, x_9 of Shandong province are found in (x), and the student x_9 of Jinan city, Shandong province are found in (x), or , using the internal-dynamic reasoning, the internal information $(x)_1^{\bar{F}}, (x)_2^{\bar{F}}$ are found in (x), which are the information unforeknown by people.

5. CONCLUSION

P-sets are a novel mathematics model and has dynamic characteristic. The dynamic characteristic comes from the change of attribute set α (some attributes are supplemented into α , or some attributes are deleted from α). Under the dynamic condition, set X is changed into a set pair. The characteristic describes that the original feature of the dynamic information. The confirmation process of crime suspects also has this characteristic, through the unceasing supplement evidence; the criminal offenders are caused to float the water surface gradually. Namely suspect's confirmation process is dynamic. P-sets are a novel mathematics theory and method that study unknown information identification.

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