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A New Parameters Reduction Method of Bijective Soft Set

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Abstract: Soft set theory is used to deal with uncertain problems prosed by Molodtsov in 1999. bijective soft set is a special form of soft set.This study proposed the concept of information quantity of condition parameter set,and the parameter reduction of bijective soft set based on the information quantity of every parameter.This parameters reduction algorithm adopts iterative feature selection and get the reduction of the condition parameters finally.And The results of this algorithm is compared with the results of the other reduction methods in the end of this study.

Key words: Bijective soft set, parameters reduction, information quantity

INTRODUCTION

The classical math methods is hard to deal with the uncertain date in many fields such as economics, engineering science, environmental science and social science.They have their own difficulties. One of these difficulties is their complexity parameterization tools. Soft set theory is a completely new approach for modeling vagueness (Molodtsov, 1999). The soft set theory is able to overcome this difficult effecting other existing methods. In the soft set theory, the way to set parameters is very flexible. It's parameterization tools can be words, sentences and logical expression. In recent years, soft set theory has been developed to fuzzy soft set (Ahmad and Kharal, 2009), vague soft set (Xu *et al*., 2010), interval fuzzy soft set (Yang *et al*., 2009), rough fuzzy soft set (Feng, 2009), bijective soft set (Xiao *et al*., 2010; Zou and Xia, 2008). The applications of soft set theory are also extended to incomplete information data analysis), choices making,combined forecasting and requirements analysis (Maji *et al*., 2002; Xiao *et al*., 2010; Chen *et al*., 2003).

The parameter reduction is in the premise of the classification ability unchanged, deduct the redundant parameters. Especially, when the data in the information system is a random sampling, the redundancy is more common. The parameters reduction is an important issue in the soft set theory.

Maji *et al*. (2002) first introduced the definition of soft set parameters reduction, (Chen *et al*., 2003, 2005) pointed out the errors and unreasonable of the reduction results, and proposed the new definition of soft set parameters reduction. Kon *et al*. (2008) analyzed the problem of suboptimal choices and additional parameters. Xiao *et al*. (2011) proposed the concept of bijective soft set. Bijective soft set is a special kind of soft set. The value of each parameters does not intersect (set value of non-ambiguous) and the set values of all parameters cover the entire universe (described integrity). Transforming ordinary soft set into bijective soft set can make problem simple and a reduction method based on the dependence of the parameters is also given. Miao and Wei (2012) introduced a distinct matrix parameters reduction method on the basis of previous and gave an application example as well.

In this study, the core of the parameters set is got by calculating the information quantity of parameters. The parameters whose information quantity is more than 0 is taken as the core parameter set C. After then we calculate the significance of the parameters except for the core parameter set, and add the parameters who'se significance is more than 0 to the core parameters and get a new core parameter set. We continues the cycle until and the information quantity of parameters C is equal to E and the termination condition that the significance of the parameters except for the core parameter are all 0 is satisfied, then we obtain the parameters set C is a reduction of parameters set E.

The study is organized as follows. In section 2, we review the basic definitions and a example of the bijective soft set and describe the parameterization reduction of bijective soft sets. Furthermore,the concepts of the significance of the parameters set is proposed. In Section 3, A new algorithm is presented for parameter reduction. And then, an example is given to illustrate the proposed method. the results of the new proposed method is compared with the other reduction methods, so that to prove it's validity and practicability.Finally, some conclusions are given in the end of this study.

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PRELIMINARY

Let U be a common universe and let E be a set of parameters.

Definition 1: (Soft set) A pair (F, E) is called a soft set (over U) if and only if F is a mapping of E into the set of all subset of the set U, where F is a mapping given by F: E→P (U).

In other words, the soft set is a parameterized family of subset of the set U. Every set F (ε) (ε∈E), from this family may be considered the set of ε-elements of the soft set (F, E), or as the set of ε-approximate elements of the soft set.

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Example 1: Let universe U = $\{h_1, h_2, h_3, h_4\}$ be a set of houses, a set of parameters E = $\{c_1, c_2, c_3, c_4\}$ be a set of status of houses which stand for the parameters "beautiful", "cheap", "in green surroundings" and "in good location", respectively. Consider the mapping F be a mapping of E into the set of all subsets of the set U. Now consider a soft set (F, E) that describes the "attractiveness of houses for purchase". According to the data collected, the soft set (F, E) is given by

$$(F, E) = \{(c1, \{h1, h3, h4\}),\ (c_2, \{h_1, h_2\}), (c_3, \{h_1, h_3\}), (c_4, \{h_2, h_3, h_4\})\}$$

where, F (c_1) = $\{h_1, h_3, h_4\}$, F (c_2) = $\{h_1, h_2\}$, F (c_3) = $\{h_1, h_3\}$ and F (c_4) = $\{h_2, h_3, h_4\}$. In order to store a soft set in computer, a two-dimensional table is used to represent the soft set (F, E) is the tabular form of the soft set (F, E). If $h_i \in F_{(cij)}$, then h_{ij} = 1, otherwise h_{ij} = 0, where h_{ij} are the entrie (Table 1).

Definition 2: A soft set (F, A) over U is said to be a NULL soft set denoted byΦ, if ϵ ∈A, F (ϵ) = ∅.

Definition 3 (And operation on Two Soft Set). If (F, A) and (G, B) are two soft set then "(F, A) and (G, B)" denoted by (F, A)∧(G, B) is defined by (F, A)∧(G,B) = (H, A×B), where H (α, β) = F(α)∩G (β), ∀(α, β)∈A×B.

Definition 4: (bijective soft set) let (F, B) be a soft set over a common universe U, where F is a mapping F: B→P (U) and B is nonempty parameter set. We say that (F, B) is a bijective soft set, if (F, B) such that:

Table 1: Tabular representation of (F, E)

U	e_1	e_2	e_3	e_4
h_1	1	1	1	0
h_2	0	1	0	1
h_3	1	0	1	1
h_4	1	0	0	1

(i) $\underset{e\in B}{U} F(e)=U$

(ii) For any two parameters e_i, $e_j \in B$, $e_i \neq e_j$, F $(e_i) \cap F (e_j) = \varnothing$.

Theorem 1: Suppose that (F, E) and (G, B) are two bijective soft set over common universe U. (H, C) = (F, E)∧(G, B) is a bijective soft set.

Definition 5: (Bijective soft decision system) suppose that (F_i, E_i) (i = 1,2,3,…,n) are n bijective soft set over a common universe U, where any $E_i \cap E_j = \varnothing$ (i = 1, 2, 3, …, n; j = 1, 2, 3, …,n; i≠j), (G, B) is a bijective soft set over a common universe U, $B \cap E_i = \varnothing$ (I = 1, 2, 3,.., n) and we call it the decision soft set. Suppose:

$$\gamma_{(C)}(E_3) = 1 - \frac{|(F, C \cup E_3)|}{|(F, C)|} = 1 - 1 = 0$$

The triple ((F, E), (G, B), U) is called soft decision system over a common universe U.

Definition 6: (Information quantity of condition parameter set) Suppose that:

$$(\cup_{i=1}^{n}(F_i, E_i), (G,B), U)$$

is a soft decision system. where condition parameter set:

$$A = \cup_{i=1}^{m} E_i, (1 \le m < n), A \subseteq E$$

F (A) = $\{X_1, X_2,.., X_n\}$, the information quantity of condition parameter set A is denoted by:

$$I(A) = \sum_{i=1}^{n} \frac{|X_i|}{|U|}(1 - \frac{|X_i|}{|U|}) = 1 - \frac{1}{|U|^2}(\sum_{i=1}^{n} |X_i|^2)$$

where, $|X_i|$ is t the cardinal number of the X_i.

Definition 7: Suppose that $(\cup_{i=1}^{n}(F_i, E_i), (G,B), U)$ is a soft decision system. where condition parameter set $A = \cup_{i=1}^{m} E_i, (1 \le m < n), A \subseteq E$ the significance of parameter set $E_j \subseteq (E\text{-}A)$ to parameters set A is denoted by:

$$\gamma_A(E_j) == I[\wedge_{i=1}^{m}(F_i, E_i) \wedge (F, E_j)] - I[\wedge_{i=1}^{m}(F_i, E_i)]$$

The concept of significance of two condition parameter set is to describe the increased degree of the resolution that caused by adding another parameter set on the basis of the original parameter set.The easier the objects over the common universe U to be distinguished after one parameter set AND operated another, the significance of the new parameter set is larger.

Definition 8: (Core parameter set)suppose that $(\breve{\cup}_{i=1}^{n}(F_i,E_i),(G,B),U)$ is a soft decision system. where condition parameter set $E_j \subseteq E$,, $1 \leq j \leq m$, E_j, is called core parameter set, if $\gamma_{(E-E_j)}(E_j)>0$.

Definition 9: (Liao and Long, 2007) Suppose that $(\breve{\cup}_{i=1}^{n}(F_i,E_i),(G,B),U)$ is a soft decision system. where condition parameter set $A \subseteq E, A = \cup_{i=1}^{m} E_i, 1 \leq i < n$. parameter set A is called a reduction of parameter set A,if A such that:

(i) I [(F, A)] = I [(F, E)]
(ii) $\forall E_i \subseteq A$, $E_j \subseteq E-A$, $\gamma_{(A-E_i)}(E_j)>0$, $\gamma_{(A)}(E_j) = 0$

PARAMETER REDUCTION ALGORITHM BASED ON THE INFORMATION QUANTITY

Algorithm analysis

Input: Bijective soft decision system:

$$(\breve{\cup}_{i=1}^{n}(F_i,E_i),(G,B),U)$$

Output: Rreduction result of parameters set E:

- **Step 1:** According to Definition 6, Calculate the information quantity of condition parameter set E
- **Step 2:** According to Definition 8, Determine the core parameter set by calculating their significance. It's possible that the core parameter set is $\varnothing$
- **Step 3:** Suppose $C = \cup_{j=1}^{m} E_j (1 \leq m < n)$ is a set of all the core parameters is.Calculate the significance of parameter set $E_i \subseteq (E-C)$ (i =1, 2, n-m) to parameters set C. If $\gamma_{(C)}(E_i) >0$, then $C = C \cup E_i$
- **Step 4:** Calculate like this until $I(E_j) = I(E)$. then we obtain the parameters set C is a reduction of parameters set E

Example analysis: Let universe U = (x_1, x_2, x_3, x_4, x_5, x_6) be a set of stores, (F, E) be a soft set describes the situations of the stores cover the universe U. Parameters set $E = E_1 \cup E_2 \cup E_3 \cup E_4$ be a set of status of the stores which stand for the parameters "Personal spending power""Degree of prosperity","Traffic conditions","profitability of the store".where E_1 = {high, med, low}, E_2 = {good, avg.}

Table 2: Tabular form of (F, E)

	E_1	E_2	E_3	D					
	High	Med.	Low	Good	Avg.	No	Yes	Profit	:oss
x_1	1			1		1		1	
x_2		1		1		1			1
x_3		1		1		1		1	
x_4			1		1	1			1
x_5		1			1		1		1
x_6	1				1		1	1	

E_3 = {no, yes}, E_4 = {profit, loss}.

The soft set (F, E) is given by F_1 (high) = {x_1, x_6}, F_1 (med) ={x_2, x_3, x_5}, F_1 (low) = {x_4}, F_2 (good) = {x_1, x_2, x_3}, F_2 (avg) = {x_4, x_5, x_6}, F_3 (no) = {x_1, x_2, x_3, x_4}, F_3 (yes) = {x_5, x_6}, F_4 (profit) = {x_1, x_3, x_6}, F_4 (loss) = {x_2, x_4, x_5}

The bijective soft set soft decision system in tabular form as follows:

$$(F,E) = \wedge_{i=1}^{3}(F_i,E_i) = \{x_1,x_2,x_3,x_4,x_5,x_6\}$$
$$(F,E-E_1) = (F_2,E_2) \wedge (F_3,E_3)$$
$$= \{(x_1,x_3),x_2,x_4,x_5,x_6\}$$

$$(F,E-E_2) = (F_1,E_1) \wedge (F_3,E_3)$$
$$= \{x_1,x_3,x_2,x_4,x_5,x_6\}$$

$$(F,E-E_3) = (F_1,E_1) \wedge (F_2,E_2)$$
$$= \{(x_1,x_2,x_3,x_4,x_5,x_6\}$$

- **Step 1:** According to Definition 6, Calculate the information quantity of condition parameter set E:

$$I(E) = 1 - \frac{1^2+2^2+1^2+1^2+1^2}{6^2} = \frac{7}{9}$$

- **Step 2:** According to Definition 8, Determine the core parameter set by calculating their significance:

$$I(E-E_1) = 1 - \frac{1^2+2^2+3^2}{6^2} = \frac{11}{18}$$
$$I(E-E_2) = 1 - \frac{1^2+2^2+1^2+1^2+1^2}{6^2} = \frac{7}{9}$$
$$I(E-E_3) = 1 - \frac{1^2+2^2+1^2+1^2+1^2}{6^2} = \frac{7}{9}$$

According to Definition 7, Calculate the significance of parameter set E_i parameters set $E-E_i$:

$$\gamma_{E-E_1}(E_1) = I(E) - I(E-E_1)$$
$$= \frac{28}{36} - \frac{22}{36} = \frac{1}{6}$$
$$\gamma_{E-E_2}(E_2) = I(E) - I(E-E_2)$$
$$= \frac{28}{36} - \frac{28}{36} = 0$$
$$\gamma_{E-E_3}(E_3) = I(E) - I(E-E_3)$$
$$= \frac{28}{36} - \frac{28}{36} = 0$$

According to Definition 8,the core parameter set is E_1, then $c = \{E_1\}$.

In the next step,we calculate the information quantity of $C \cup E_j E_j \in E\text{-}C$:

$$(F,C) = (F_1,E_1) = \{(x_1,x_6),(x_2,x_3,x_5),x_4\}$$
$$(F,C \cup E_2) = (F_1,E_1) \wedge (F_2,E_2)$$
$$= \{x_1,(x_2,x_3),x_4,x_5,x_6\}$$
$$(F,C \cup E_3) = (F_1,E_1) \wedge (F_3,E_3)$$
$$= \{x_1,(x_2,x_3),x_4,x_5,x_6\}$$
$$I(C \cup E_2) = I(E_1 \cup E_2)$$
$$= 1 - \frac{1^2+2^2+1^2+1^2+1^2}{6^2} = 1 - \frac{8}{36} = \frac{7}{9}$$
$$I(C \cup E_3) = I(E_1 \cup E_3)$$
$$= 1 - \frac{1^2+2^2+1^2+1^2+1^2}{6^2} = 1 - \frac{8}{36} = \frac{7}{9}$$

According to Definition8 , $C = \{E_1, E_2\}$ or $\{E_1, E_3\}$, Now suppose $C = \{E_1, E_2\}$:

$$(F,C) = (F_1,E_1) \wedge (F_2,E_2)$$
$$= \{x_1,(x_2,x_3),x_4,x_5,x_6\}$$
$$(F,C \cup E_3) = (F_1,E_1) \wedge (F_2,E_2) \wedge (F_3,E_3)$$
$$= \{x_1,(x_2,x_3),x_4,x_5,x_6\}$$
$$\gamma_{(C)}(E_3) = 1 - \frac{|(F,C \cup E_3)|}{|(F,C)|} = 1 - 1 = 0$$

And then the significance of parameter set $E_I \subseteq$ (E-C) to parameters set C is 0.so the parameters set C is a reduction of parameters set E.

The parameters set $C = \{E_1, E_3\}$ is a reduction of parameters set E by the same method. This example is from the literature, the results if the reduction results are consistent with it.

CONCLUSION

Parameter reduction is an important issue of knowledge mining in soft set theory, this study prosed a new method nn the basis of previous study. bijective soft set is a special form soft set. Research on this field is relatively is very scarce.We calculated the information quantity of the condition parameter set to get the core parameter set, After then we adopt iterative feature selection to get the reduction of the condition parameters finally. And the result of the method is compared with the others to prove it's feasibility and effectiveness finally. This study only considers the reduction of conditions parameters of the bijective soft set, In future research,the decision parameters can be considered, so that to the get reduction results relevant to the decision parameters,and will be more accurate.

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