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Short communication

Comments on "Normal parameter reduction in soft set based on particle swarm optimization algorithm"

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ABSTRACT

This paper aims to bring in some notes and improvements for the paper (Kong et al., 2015). Firstly, we give some notes and suggestions on its assumption for numbers of dispensable parameter subsets in soft sets. This helps make the theories in Kong et al. (2015) much more logical clear and consistent. Then we propose a linear programming mathematical representation for normal parameter reduction problems of soft sets. This allows us to solve normal parameter reduction problems of soft sets with Lingo or MATLAB software. By the way, we point out that the answer of Example 6.1 in Kong et al. (2015) is not correct and figure out the right answer with our linear programming method.

1. Introduction

In this paper we deal with the normal parameter reduction problems [2] in soft set theory. Soft set was initiated as a new mathematical tool for dealing with uncertainties and vagueness by Molodtsov [3] in 1999. The theory of soft sets has potential applications in various fields like game theory, operations research, decision making and so on [4–20].

Many researchers have investigated parameter reduction theory of soft sets. Maji [16] proposed the concept of reduct-soft-set. The definition of the reduct there is actually the same with traditional information systems or rough sets. Chen et al. [21] pointed out that problems tackled by attributes reduction in rough set theory and parameters reduction in soft set theory are different, and then presented a new notion of parameter reduction in soft sets. This notion was compared with the concepts of attribute reduction in rough set theory. After this kind of parameter reduction, only the set of optimal choices remains the same. So this concept has the problem of suboptimal choice (i.e., the set of suboptimal choices may change after parameter reduction). In order to overcome this problem the concept of normal parameter reduction was introduced in [2]. An algorithm for normal parameter reduction was also developed in [2]. But the algorithm involves a great amount of computation. Ma et al. [22] pointed out an important property of normal parameter reduction of soft sets. Then this property was used for reducing the workload for finding candidate parameter sets. Another method of reduction of parameters was proposed by Ali [23]. This method is very much similar to reduction of attributes in case of rough sets. Instead Ali proposed to delete parameters only one at each time in order to avoid the heavy searching work. Gong et al. [24] developed parameters reduction concepts in bijective soft set decision system under fuzzy environments. Han and Li [25] proposed a method for embedding all the normal parameter reductions of a soft set into a proposition formula.

Kong et al.[1] also dealt with normal parameter reduction problems in soft sets. The main contributions of this paper consist of the following aspects: (1) It has tried to propose some characterizations for dispensable sets and normal parameter

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Table 1
Tabular representation of a soft set $S = (F, A)$ and its choice value function σ.

	e_1	e_2	e_3	e_4	e_5	e_6	e_7	σ
u_1	0	0	1	1	1	1	1	5
u_2	1	0	1	1	1	0	0	4
u_3	0	1	1	1	0	1	0	4
u_4	0	0	0	0	0	1	1	2
u_5	1	0	1	0	0	0	0	2
u_6	1	0	1	0	0	0	0	2

reductions. (2) A mathematical representation of normal parameter reduction problems has been invented. (3) Based on Particle Swarm Optimization Algorithm was brought in to solve the normal parameter reductions in soft sets.

However, there remain some problems in [1] need to be improved. (1') The assumption about the number of dispensable parameter subsets is not clearly given, which may cause logical confusion to some extent. (2') The mathematical representation of normal parameter reduction problems invented there is not explicit so that we can't see the inner nature of normal parameter reduction problems. (3') The Particle Swarm Optimization Algorithm failed in giving a right answer in the Example 6.1 of [1].

The remainder of this paper is organized as follows. Section 2 makes an introduction to normal parameter reduction concepts in soft set theory. Section 3 develops some notes and suggestions for understanding the Section 3 of [1]. In Section 4, we propose a linear programming representation for normal parameter reduction problems of soft sets. An error in the Example 6.1 of [1] is pointed out and corrected with our linear programming model. Finally, we come to a conclusion of this article and outlook for potential future work.

2. Preliminaries

In this paper, suppose $U = \{u_1, u_2, \ldots, u_n\}$ is a finite set of objects, E is a set of parameters. $\wp(U)$ means the powerset of U, $|A|$ means the cardinality of set A. By Molodtsov [3] and Feng et al. [26] we have basic concepts about soft sets shown in Definition 2.1 and 2.2.

Definition 2.1 (Soft set)**.** A soft set on U is a pair $S = (F, A)$, where

(i) A is a subset of E;
(ii) F: $A \to \wp(U)$, $\forall e \in A$, $F(e)$ means the subset of U corresponding with parameter e. We also use $\mathbf{F(e)}(u) = 1$ ($\mathbf{F(e)}(u) = 0$) to mean than u is (not) an element of $F(e)$, where **F(e)** should be understood as the characteristic function of subset $F(e)$.

Definition 2.2 (Choice value function)**.** Let $S = (F, A)$ be a soft set over U. The function $\sigma_S : U \to \mathbb{N}$ defined by $\sigma_S(u) = |\{e \in A | u \in F(e)\}|$ is called the choice value function of S.

When the underlying soft set $S = (F, A)$ is explicit, $A_1 \subseteq A$, we also write $\sigma_{A_1}(u)$ to mean $|\{e \in A_1 | u \in F(e)\}|$.

Example 2.1. Table 1 represents a soft set $S = (F, A)$ over $U = \{u_1, u_2, \ldots, u_6\}$, where $A = \{e_1, e_2, \ldots, e_7\}$. The function F is characterized by the columns indexed by e_j, $j = 1, 2, \ldots, 7$, $\mathbf{F(e}_j\mathbf{)}(u_i) = 1$ if and only if the value in the u_i row and e_j column is equal to 1.

Remark 2.1. In [1] the entries of tabular representation of soft set over objects domain U and parameters domain E are denoted by h_{ij}, $1 \le i \le |U|$, $1 \le j \le |E|$, i.e., $h_{ij} = 1$ if and only if $\mathbf{F(e}_j\mathbf{)}(u_i) = 1$.

According to [2] we give the concept of normal parameter reduction problem of soft set.

Definition 2.3 (Dispensable subset of parameters)**.** For soft set (F, E), $E = \{e_1, e_2, \ldots, e_m\}$, B is a nonempty subset of E, If the constraint $\sum_{e \in B} \mathbf{F(e)}(u_1) = \cdots = \sum_{e \in B} \mathbf{F(e)}(u_n)$ is satisfied, then B is called dispensable; otherwise, A is indispensable.

Definition 2.4 (Normal parameter reduction)**.** For soft set $S = (F, A)$ over U, $B \subseteq A$, if $A - B$ is a maximal dispensable subset of parameters, then B is called a normal parameter reduction of S.

3. Notes on *Section 3* of [1]

Note 3.1 When we are reading the sentence "In the following section, we consider only two dispensable sets in soft set" which lies in the 5th line and the 6th line in page 4811, we should delete or omit this sentence.

Reasons for Note 3.1 According to the proofs of *Theorem 3.2* and *Theorem 3.5* in [1], there exist two meanings when we are reading the sentence:

(1) there are only two dispensable subsets of parameters for any soft set discussed in the Section 3 of paper [1];

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