Chapter 31
Application of Soft Set in Game Theory

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ABSTRACT

In recent years, most of the applications in game theory have been developed based on the theory of fuzzy sets. But the inadequacy of the parameterization tool in fuzzy set theory leads to difficulties for decision making in the game theory. Soft sets were introduced by Molodtsov to overcome this problem in fuzzy sets and it was illustrated by him. Choice functions play an important role in game theory. Soft set theory gives an opportunity to construct new mathematical tool which keeps all good sides of choice function and eliminates its drawbacks. Also, decision making is an integral part of games and many researchers have applied soft set theory in decision making. In this chapter, the authors describe all these and propose some important improvements leading to better deals in game environments.

INTRODUCTION

Soft set theory is a new mathematical approach to handle uncertainty based problems. It was introduced in (Molodtsov, 1999). Later on, fuzzy soft sets is defined in (Maji et al. 2001) and provided an application of soft set theory in decision-making problems (Maji et al., 2002). There are several theories which deal with vagueness and ambiguity. Some of these are: probability theory, interval mathematics and fuzzy set theory. All these models have their own drawbacks; such as fuzzy sets (Zadeh, 1965) are completely dependent on membership functions. There is no unique formula to define membership functions. Molodtsov observed that the main reason of these drawbacks is perhaps due to the inadequacy of parameterization tools. That led him to introduce soft set theory, which is a parameterized collection of subsets.

DOI: 10.4018/978-1-5225-7368-5.ch031

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Game theory is defined as the mathematical model of interaction between rational, intelligent decision makers. In this chapter, we mention how game theory and soft sets are related. When we handle real life situations, we can observe that most of the information available is ambiguous or uncertain. Now a days, in most of the games we need to create human models or human behaviour. There exist a lot of approaches to describe human behavior in game theory. Some of them are pay function, choice functions etc. Molodtsov has introduced s-function (soft function) which keeps all good sides of choice function and eliminates the drawbacks of pay function and choice functions (Molodtsov, 1999). Deli and Cagman has studied further to associate soft set theory in game theory (Deli et al., 2013).

This chapter is further organized into ten sections. The next section contains definitions and notions of soft set theory. In the section three we have given some descriptions about the game theory. In the section four we have provided classification of games. Section five illustrates the representation of games in some subsections subsequently. In section six the definitions and notions related to both game theory and soft set theory are discussed. Section seven provides the definitions and notions about soft sets in decision making. In the section eight we provided the soft sets in decision making based on game theory which further describes about two-person soft game and n-person soft game under the subsections subsequently. Section nine provides future scope of this research work. Finally provide conclusions drawn from our research work. The chapter ends with a bibliography of sources referred for the compilation of our work.

BACKGROUND

Soft set is a parameterized family of subsets defined over a universe associated with a set of parameters.

The definition of soft set is given below.

Definition 1(Molodtsov, 1999): A pair *(F, E)* is called a soft set over *U* iff *F* is a mapping of *E* into the set of all subsets of the universal set *U; i.e.*

$$F: E \rightarrow P(U) \tag{1}$$

where U is the universal set, E is the parameter set and *P(U)* is the power set *U*.

In other words, a soft set over *U* is a parameterised family of subsets of the universe *U*. For $e \in E$, *F(e)* can be called as the set of e-approximate elements of the soft set *(F, E).* So, a soft set can be represented as a collection of approximations. The parameter part of the approximation is called as predicate and for each parameter in *E* and the set containing all the elements of F*(e)* is called the value set of *e* in *(F, E).*

The pair *(U, E)* is often regarded as a soft universe. A parameter can be anything adverbial for the elements, such as a number, word, phrase or a sentence which can describe the value set more appropriately.

The way of describing an object in soft set theory differs principally from the way an object is described in classical mathematics. Normally, in classical mathematics a mathematical model of an object is constructed to define the notion of the exact solution of that model. Sometimes the mathematical model becomes too complicated to find the exact solution. So, we need the notion of approximate solution to get rid of these types of problems. However, in soft set theory, we are getting the solution to the problems by the opposite approach. The description of the object will have an approximate nature initially and so that we do not need to use the notion of exact solution.

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