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ORIGINAL ARTICLE

Some New Concepts of Fuzzy Soft Graphs

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Abstract In this paper, we introduce some new concepts of fuzzy soft graphs with the notions of complement and μ-complement fuzzy soft graphs introduced. Investigating some of their properties, we show that the complement of strong fuzzy soft graph is strong fuzzy soft one as well as the complement of a complete fuzzy soft graph is complete fuzzy soft one. Finally, we state and prove some results related to these concepts.

Keywords Soft set · Fuzzy graph · Fuzzy soft graph · Fuzzy soft loop · Simple fuzzy soft graph · Pseudo fuzzy soft graph · Complement fuzzy soft graph

1. Introduction

In 1999, Molodtsov [1] introduced the concept of soft set theory to solve imprecise problems in the field of engineering, social science, economics, medical science and environment. Molodtsov [1, 2] applied this theory to several directions such as smoothness of function, game theory, operation research, probability and measurement theory. In recent times, a number of research studies contributed into fuzzification of soft set theory. As a result, many researchers were more active doing research on soft set. In 2001, Maji et al. [3, 4] initiated the concept of fuzzy soft sets which is a combination of fuzzy set and soft set. In 1975, Rosenfeld [5] introduced the concept

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of fuzzy graph theory. In 1994, Moderson introduced the concept of complement of fuzzy graphs, and in 2002, Sunitha and Vijayakumar [6] gave a modified definition of complement of fuzzy graph. In 2006, Nagoorgani and Chandrasekaran [7] defined μ-complement of fuzzy graph, which slightly differs from the definition of complement of fuzzy graph discussed by Sunitha and Vijayakumar [6].

In 2015, Mohinta and Samanta [8] introduced the notions of fuzzy soft graphs, union, intersection of two fuzzy soft graphs with a few properties related to finite union and intersection of fuzzy soft graphs. Akram and Nawaz [9] introduced the notions of fuzzy soft graphs, strong fuzzy soft graph, complete fuzzy soft graph, regular fuzzy soft graph and investigated some of their properties. Akram and Nawaz [10] developed the concepts of soft graphs, vertex-induced soft graphs, edge-induced soft graphs and describe some operations on soft graphs. Akram and Zafar [11] introduced the notions of soft trees, soft cycles, soft bridges, soft cutnodes, and describe a various methods of construction of soft trees.

In 2016, Akram and Nawaz [12] presented concept of fuzzy soft graphs, certain types of irregular fuzzy soft graphs and described applications of fuzzy soft graphs in social network and road network. Akram and Zafar [13] introduced notions of fuzzy soft cycles, fuzzy soft bridge, fuzzy soft cut node, fuzzy soft trees, and investigate some of their fundamental properties. They also studied some types of arcs in fuzzy soft graphs.

In this paper, we introduce some new concepts of fuzzy soft graphs, complement fuzzy soft graphs, μ-complement fuzzy soft graphs and some properties of μ-complement fuzzy soft graphs. And then we provide some results about strong fuzzy soft graphs, complete fuzzy soft graphs and isolated fuzzy soft graphs with their complements.

2. Preliminaries

Definition 2.1 [1] *Let U be an initial universe set and E be the set of parameters. Let $P(U)$ denote the power set of U. A pair (F, E) is called a soft set over U where F is a mapping given by $F : E \longrightarrow P(U)$.*

Definition 2.2 [4] *Let U be an initial universe set and E be the set of parameters. Let $A \subset E$. A pair (F, A) is called fuzzy soft set over U where F is a mapping given by $F : A \longrightarrow I^U$, where I^U denotes the collection of all fuzzy subsets of U.*

Definition 2.3 [5] *Let V be a nonempty finite set and $\sigma : V \longrightarrow [0, 1]$. Again, let $\mu : V \times V \longrightarrow [0, 1]$ such that $\mu(x, y) \leq \sigma(x) \wedge \sigma(y)$ for all $(x, y) \in V \times V$. Then the pair $G = (\sigma, \mu)$ is called a fuzzy graph over the set V. Here σ and μ are respectively called fuzzy vertex and fuzzy edge of the fuzzy graph $G = (\sigma, \mu)$.*

Definition 2.4 [14] *Let $G = (\sigma, \mu)$ be a fuzzy graph. The order of $G = (\sigma, \mu)$ is defined as:*

$$O(G) = \sum_{u \in V} \sigma(u)$$