



Some new product operations of T-spherical fuzzy graphs and an application of T-spherical fuzzy graphs in MCGDM

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Abstract

A T-spherical fuzzy (T-SF) graph (T-SFG) structure is a generalization of the spherical fuzzy graphs (SFGs) and other extensions of the fuzzy graphs (FGs). In this paper, we define the strong product, cross product, lexicographic product, modular product, and homomorphic product operations between two T-SFGs and investigate some of their properties. We give examples to make the defined operations more understandable. We also propose a multi-criteria group decision-making (MCGDM) method under the T-SF-environment. Besides, a numerical example is given to show the progress of the proposed method.

Keywords T-spherical fuzzy set · T-spherical fuzzy graph · Minimum spanning tree · Product operations · Decision-making

1 Introduction

In real life, many problems in engineering, medical, social science etc. involve uncertain data. Zadeh (1965) introduced the concept of fuzzy sets (FSs) to eliminate uncertainty in these problems. In 1986, Atanassov (1986) widened the concept of the FSs and proposed the notion of intuitionistic fuzzy sets (IFSs). An IFS is identified by two functions called membership μ and non-membership ν functions such that the sum of the membership degree (MD) and non-membership degree (NMD) of an element is less than or equal to 1. If the sum of MD and NMD is greater than 1, the problem cannot be modeled using IFSs. Therefore, Yager (2013) introduced the notion of the Pythagorean fuzzy set (PyFS), which eliminates the constraints of IFS. In a PyFS, the sum of MD and NMD may be greater than 1, but the sum of their square of them must be less than or equal to 1. If the sum of their square of them is greater than 1, then it is needed another extension of IFS and PyFS. This extension, called q-rung orthopair fuzzy set (q-ROFS),

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