Chapter 7
A Python Toolbox for Single-Valued and Interval-Valued Fermatean Neutrosophic Matrices

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ABSTRACT

Neutrosophic sets are a type of mathematical object that can be used to model indeterminacy and inconsistent information. They are defined using three degrees of membership: truthfulness, indeterminacy, and falsity. Single-valued Fermatean neutrosophic sets (SVFNSs) and interval-valued Fermatean neutrosophic sets (IVFNSs) are two specific cases of neutrosophic sets that have been shown to be useful in a variety of applications. In this chapter, a new Python toolbox is proposed under the neutrosophic environment, which consists in some Python code for single-valued Fermatean neutrosophic matrices and interval-valued Fermatean neutrosophic matrices. Some definitions of interval-valued Fermatean neutrosophy are vague sets such as union, complement, and intersection, which are presented. Furthermore, the related examples are included.

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1. INTRODUCTION.

The idea of fuzzy sets was introduced by Zadeh, (Zadeh, 1965). He proposed that each element in a fuzzy set has a degree of membership. Based on this idea Prof. Atanassov (Atanassov,1986) introduced the concept of intuitionistic fuzzy set on a universe X as a generalization of fuzzy set. His concept is based on two degrees of belonging for each element: the degree of membership and degree of non-membership.

Later on, Prof. Smarandache (Smarandache,1998) originally gave the definition of a neutrosophic set and neutrosophic logic. The concept of neutrosophic set is based on three degrees for each element totally independent: the degree of membership, the degree of indetermination and the degree of non-membership. In (Wang et al, 2014) they proposed the concept of single-valued neutrosophic sets, which is an extensin of Neutrosophic set. In addition, the authors in (Zhang et al.,2014) developped a new extension termed as interval-valued neutrosophic set.

Several scholars have done remarkable achievements in this area (http://fs.gallup .unm.edu/NSS/). Recently, Jansi et al. introduced a new class of single-valued neutrosophic set called Pythagorean neutrosophic set (PyNS) (Jansi et al., 2019). PyNSs are characterized by the fact that the square sum of the membership value, indeterminacy value and non-membership value is equal to or less than two. This makes PyNSs more flexible than Pythagorean fuzzy sets, which can be used to represent a wider range of uncertain information. The concept of Pythagorean neutrosophic sets (PyNSs) comprises independent and dependent membership.

In addition, Antony, Crispin, Sweety, and Jansi defined a new type of neutrosophic set called Fermatean neutrosophic sets (FNSs) (Antony, Crispin, Sweety, and Jansi, 2021). The Fermatean neutrosophic sets generalises the concept of Pythagorean neutrosophic sets. Broumi et al. proposed the concept of interval-valued pythagorean neutrosophic sets as a generalisation of Pythagorean neutrosophic sets and explored the concept of interval-valued Pythagorean neutrosophic graphs (Broumi et al., 2023).

Ajay and Chellamani introduced a new type of graph called a Pythagorean neutrosophic fuzzy graph (Ajay and Chellamani, 2020). This graph is a special case of a neutrosophic graph, but it restricts the independent memberships of the vertices. In other words, it makes sure that the square sum of the membership, non-membership, and indeterminacy values of each vertex is less than or equal to 2. The same author in (Ajay et al.,2021) presented the labelling of Pythagorean neutrosophic fuzzy graphs and investigate their properties. In (Chellamani, et al.,2021) they have initiated the Pythagorean neutrosophic Dombi fuzzy graphs with an application to Multicriteria Decision Making (MCDM). In (Ajay et al.,2022) they studied regular