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Spanning Tree Problem with Neutrosophic Edge Weights

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Abstract

Neutrosophic set and neutrosophic logic theory are renowned theories to deal with complex, not clearly explained and uncertain real life problems, in which classical fuzzy sets/models may fail to model properly. This paper introduces an algorithm for finding minimum spanning tree (MST) of an undirected neutrosophic weighted connected graph (abbr. UNWCG) where the arc/edge lengths are represented by a single valued neutrosophic numbers. To build the MST of UNWCG, a new algorithm based on matrix approach has been introduced. The proposed algorithm is compared to other existing methods and finally a numerical example is provided

Keywords: Single valued neutrosophic sets; neutrosophic matrix; score function; minimum spanning tree problem

1. Introduction

Smarandache [5] has proposed the idea of "Neutrosophic set" (abbr. NS) which can capture the natural phenomenon of the imprecision and uncertainty that exists in the real life scenarios. The idea of NS is direct extensions of the idea

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of the conventional set, type 1 fuzzy set and intuitionistic fuzzy set. The NSs are described by a truth membership function (t), an indeterminate membership function (i) and a false membership function (f) independently. The values of t, i and f are within the nonstandard unit interval $]^{-}0, 1^{+}[$. Moreover, for the sake of applying NSs in real-world problems efficiently, Smarandache [5] introduced the idea of single valued neutrosophic set (abbr. SVNS). Then, Wang et al.[6] described some properties of SVNSs. The NS model is an useful method for dealing with real world problems because it can capture the uncertainty (i.e., incomplete, inconsistent and indeterminate information) of the real world problem. The NSs is applied in various fields [24]. To make distinction between two single valued neutrosophic numbers, a series of score functions are presented by some scholars (see table 1). Many algorithms are available to find minimum spanning tree which has a large applications in divers fields of computers science and engineering. In classical graph theory, there are many algorithms for finding the MST [4], two most well know algorithms are Prim's algorithm and Kruskal algorithm. In the literature, several types of spanning tree problems have been developed by many researchers when the weights of the edges are not precise and there is an uncertainty [1, 2, 3, 10, 28]. Recently using the idea of single valued neutrosophic sets on graph theory, a new theory is introduced and it is defined as single valued neutrosophic graph theory (abbr. SVNGT). The concept of SVNGT and their extensions finds its applications in diverse fields [12- 24]. However, to the best of our knowledge, there are only few studies in the literature to deal with the minimum spanning tree problem in neutrosophic environment. Ye [8] presented a method to design the MST of a graph where nodes (samples) are represented in the form of SVNS and distance between two nodes which represents the dissimilarity between the corresponding samples has been derived. Mullai et al. [27] studied the shortest path problem by minimal spanning tree algorithm using bipolar neutrosophic numbers. Kandasamy [7] proposed a double-valued neutrosophic Minimum Spanning Tree (abbr. DVN-MST) clustering algorithm, to cluster the data represented by double-valued neutrosophic information. Mandal and Basu [9] proposed a solution approach of the optimum spanning tree problems considering the inconsistency, incompleteness and indeterminacy of the information. The authors consider a network problem with multiple criteria which are represented by weight of each edge in neutrosophic sets. The approach proposed by the authors is based on similarity measure. It should be noted that the triangular fuzzy numbers and SVNSs are similar in the mathematical notation, but totally different.

Table 1. Different types of score functions of SVNS

Refrences	Score function
27	$S_{RIDVAN}(A) = \frac{(1+T-2I-F)}{2}$
11	$S_{NANCY}(A) = \frac{1+(1+T-2I-F)(2-T-F)}{2}$
25	$S_{ZHANG}(A) = \frac{(2+T-I-F)}{3}$

The main contribution of this manuscript is to extend the matrix approach for finding the cost minimum spanning tree of an undirected neutrosophic graph. Neutrosophic graphs give more precision, and compatibility to model the MST problem in neutrosophic environment when compared to the fuzzy MST.

The manuscript is organized as follows. We briefly introduce the ideas of NSs, SVNS, and the score function of single valued neutrosophic number in Section 2. Section 3 present the formulation problem. Section 4 describes an algorithm for finding the minimum spanning tree of neutrosophic undirected graph. In Section 5, an example is presented to described the proposed method. In Section 6, A comparative study with others existing methods is presented. We present the conclusion of the paper in Section 7.

2. Preliminaries

Some of the important background knowledge for the materials that are presented in this paper is presented in this section. These results can be found in [5, 6, 25].