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Shortest Path Problem Under Interval Valued Neutrosophic Setting

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***Abstract*—This paper presents a study of neutrosophic shortest path with interval valued neutrosophic number on a network. A proposed algorithm also gives the shortest path length using ranking function from source node to destination node. Here each arc length is assigned to interval valued neutrosophic number. Finally, a numerical example has been provided for illustrating the proposed approach**

Keywords*— *interval valued neutrosophic graph, score function, Shortest path problem

I. INTRODUCTION

Neutrosophy was pioneered by Smarandache in 1998. It is a branch of philosophy which studies the origin, nature, and scope of neutralities, as well as their interactions with different ideational spectra. Smarandache generalized the concepts of fuzzy sets [28] and intuitionistic fuzzy set [25] by adding an independent indeterminacy-membership. Neutrosophic set is a powerful tool to deal with incomplete, indeterminate and inconsistent information in real world, which have attracted the widespread concerns for researchers. The concept of neutrosophic set is characterized by three independent degrees namely truth-membership degree (T), indeterminacy-membership degree (I), and falsity-membership degree (F).
Later on, Smarandache extended the neutrosophic set to neutrosophic overset, underset, and offset [46]. From scientific or engineering point of view, the neutrosophic set and set-theoretic operator will be difficult to apply in the real application. Afterwards, various kinds of extended neutrosophic sets such as single valued neutrosophic sets, interval valued neutrosophic sets, simplified neutrosophic sets, bipolar neutrosophic sets and so on. The subclass of the neutrosophic sets called single-valued neutrosophic sets [14] (SVNS for short) was studied deeply by many researchers. The concept of single valued neutrosophic theory has proven to be useful in many different field such as the decision making problem, medical diagnosis and so on. Later on, the concept of interval valued neutrosophic sets [15] (IVNS for short) appear as a generalization of fuzzy sets, intuitionistic fuzzy set, interval valued fuzzy sets [20], interval valued intuitionistic fuzzy sets [26] and single valued neutrosophic sets. Interval valued neutrosophic set is a model of a

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neutrosophic set, which can be used to handle uncertainty in fields of scientific, environment and engineering. This concept is characterized by the truth-membership, the indeterminacy-membership and the falsity-membership independently, which is a powerful tool to deal with incomplete, indeterminate and inconsistent information. The concept of interval valued neutrosophic sets is more precise and flexible than single valued neutrosophic sets. Recently, the interval valued neutrosophic sets have become an interesting research topic. Additional literature on single valued neutrosophic and interval valued neutrosophic sets can be found in [1, 5, 6, 7, 8, 11, 13, 17, 18, 19, 20, 21, 22, 23, 28, 29, 30, 32, 35, 38, 42, 44]. As a generalization of single valued neutrosophic set, the concept of interval valued neutrosophic was proposed and studied. An increasing number of studies have dealt with indeterminate and inconsistent problems by applying interval neutrosophic sets. Recently, the concept of single valued neutrosophic set was combined with graph theory and new graph model was presented. This concept is called single valued neutrosophic graph [34, 37, 39]. The single valued neutrosophic graph model allows the attachment of truth-membership (t), indeterminacy–membership (i) and falsity-membership degrees (f) both to vertices and edges. The single valued neutrosophic graph is the generalization of fuzzy graph and intuitionistic fuzzy graph. In addition, the concept of interval valued neutrosophic set was combined with graph theory and new graph model was presented. This concept is called interval valued neutrosophic graph. The concept of interval valued neutrosophic graph [36, 43] generalized the concept of fuzzy graph, intuitionistic fuzzy graph, interval valued fuzzy graph and single valued neutrosophic graph. Up to the present, research on single valued neutrosophic graph and interval valued neutrosophic graph has been recently studied.

The shortest path problem is a fundamental algorithmic problem, in which a minimum weight path is computed between two nodes of a weighted, directed graph. This problem has been studied for a long time and has attracted researchers from various areas of interests such operation research, computer science, communication network and so on. There are many shortest path problems [2, 3, 4, 12, 31, 45] that have been studied with different types of input data, including fuzzy set, intuitionistic fuzzy sets, trapezoidal intuitionistic fuzzy sets vague set. Till now, few research papers deal with shortest path in neutrosophic environment. Broumi et al. [40] proposed an algorithm for solving neutrosophic shortest path problem based on score function. The same authors in [41] proposed a study of neutrosophic shortest path with single valued trapezoidal neutrosophic number on a network. Two key issues need to be addressed in a way to handle neutrosophic path problem. One is how to determine the sum of two edges. The other is how to compare the lengths of two different paths given that the length of each edge is represented by neutrosophic numbers. Therefore; in this study we extend the proposed method for solving neutrosophic shortest path proposed by Broumi et al. [40] for solving interval valued neutrosophic shortest path problems in which the arc lengths of a network are represented by interval valued neutrosophic numbers

The remainder of this paper is organized as follows. In Section 2, we review some basic concepts about neutrosophic sets, interval valued valued neutrosophic graph. In Section 3, an algorithm is proposed for finding the shortest path and shortest distance in interval valued neutrosophic graph. In Section 4 an illustrative example is provided to find the shortest path and shortest distance between the source node and destination node. Finally, in Section 5 we provide conclusion and proposal for further research

II. PRELIMINARIES

In this section, some basic concepts and definitions on neutrosophic sets, interval valued neutrosophic graphs are reviewed from the literature.

Definition 2.1 [9-10]. Let X be a space of points (objects) with generic elements in X denoted by x; then the neutrosophic set A (NS A) is an object having the form A = {< x: $T_A(x)$, $I_A(x)$, $F_A(x)$>, x $\in$ X}, where the functions T, I, F: X→]$^-$0,1$^+$[define respectively the truth-membership function, an indeterminacy-membership function, and a falsity-membership function of the element x $\in$ X to the set A with the condition:

$$^-0 \le T_A(x) + I_A(x) + F_A(x) \le 3^+. \qquad (1)$$

The functions $T_A(x)$, $I_A(x)$ and $F_A(x)$ are real standard or nonstandard subsets of]$^-$0,1$^+$[.

Smarandache in 1998 and later Wang et al. [15] proposed the concept of INS, which is an instance of a neutrosophic set, and introduced the definition of an INS.

Definition 2.2 [15]. Let X be a space of points (objects) with generic elements in X denoted by x. An interval valued neutrosophic set A (INS A) in X is characterized by truth-membership function $T_A(x)$, an indeterminacy-membership function $I_A(x)$, and a falsity-membership function $F_A(x)$. For each point x in X , there are $T_A(x)=\left[T_A^L, T_A^U\right] \subseteq$ [0, 1], $I_A(x)=\left[I_A^L, \mathrm{I}_A^U\right] \subseteq$ [0, 1] and $F_A(x)=\left[F_A^L, \mathrm{F}_A^U\right] \subseteq$ [0, 1], and the sum $T_A(x)$, $I_A(x)$ and $F_A(x)$ satisfies the condition $0 \le \sup T_A(x) + \sup \mathrm{I}_A(x) \sup F_A(x) \le 3$, then , an INS A can be expressed as

$$A = \{< x: T_A(x), I_A(x), F_A(x) >, x \in X\}$$
$$= \{< x: \left[T_A^L(x), T_A^U(x)\right], \left[I_A^L(x), \mathrm{I}_A^U(x)\right], \left[F_A^L(x), \mathrm{F}_A^U(x)\right] >, x \in X\} \qquad (2)$$

Definition 2.3 [15]. An interval valued neutrosophic number $\tilde{A}_1 = (T_1, I_1, F_1)$ is said to be zero interval valued neutrosophic number if and only if

$$T_1^L = 0, T_1^U = 0, I_1^L = 1, I_1^U = 1, \text{ and } F_1^L = 1, F_1^U = 1 \qquad (3)$$

Definition 2.4 [33]. Let $\tilde{A}_1 =< \left[T_1^L, T_1^U\right], \left[I_1^L, I_1^U\right], \left[F_1^L, F_1^U\right] >$ and $\tilde{A}_2 =< \left[T_2^L, T_2^U\right], \left[I_2^L, I_2^U\right], \left[F_2^L, F_2^U\right] >$ be two interval valued neutrosophic numbers and $\lambda > 0$. Then, the operations rules are defined as follows;

(i)

$$\tilde{A}_1 \oplus \tilde{A}_2 = \left[T_1^L + T_2^L - T_1^L T_2^L, T_1^U + T_2^U - T_1^U T_2^U\right], \left[I_1^L I_2^L, I_1^U I_2^U\right], \left[F_1^L F_2^L, F_1^U F_2^U\right] \qquad (4)$$

(ii)

$$\tilde{A}_1 \otimes \tilde{A}_2 =< \left[T_1^L T_2^L, T_1^U T_2^U\right], \left[I_1^L + I_2^L - I_1^L I_2^L, I_1^U + I_2^U - I_1^U I_2^U\right], \left[F_1^L + F_2^L - F_1^L F_2^L, F_1^U + F_2^U - F_1^U F_2^U\right] > \qquad (5)$$

(iii)

$$\lambda \tilde{A} =< \left[1-(1-T_1^L)^\lambda, 1-(1-T_1^U)^\lambda)\right], \left[(I_1^L)^\lambda, (I_1^U)^\lambda\right], \left[(F_1^L)^\lambda, (F_1^U)^\lambda\right] > \qquad (6)$$

(iv)

$$\tilde{A}_1^\lambda =< \left[(T_1^L)^\lambda, (T_1^U)^\lambda)\right], \left[1-(1-I_1^L)^\lambda, 1-(1-I_1^U)^\lambda)\right], \left[1-(1-F_1^L)^\lambda, 1-(1-F_1^U)^\lambda)\right] >$$

where $\lambda > 0$ (7)

Definition 2.5 [33]. In order to make a comparisons between two IVNN, Ridvan [33], introduced a concept of score function in 2014. The score function is applied to compare the grades of IVNS. This function shows that greater is the value, the greater is the interval-valued neutrosophic sets and by using this concept paths can be ranked. Let $\tilde{A}_1 = (T_1, I_1, F_1)$ be an interval valued neutrosophic number, then, the score function $s(\tilde{A}_1)$, accuracy function $a(\tilde{A}_1)$ and certainty function $c(\tilde{A}_1)$ of an IVNN are defined as follows:

(i) $$s(\tilde{A}_1) = \left(\frac{1}{4}\right) \times \left[2 + T_1^L + T_1^U - 2I_1^L - 2I_1^U - F_1^L - F_1^U\right] \qquad (8)$$

(ii)

Comparison of interval valued neutrosophic numbers

Let $\tilde{A}_1 = (T_1, I_1, F_1)$ and $\tilde{A}_2 = (T_2, I_2, F_2)$ be two interval valued neutrosophic numbers then

(i) $\tilde{A}_1 \prec \tilde{A}_2$ if $s(\tilde{A}_1) \prec s(\tilde{A}_2)$

(ii) $\tilde{A}_1 \succ \tilde{A}_2$ if $s(\tilde{A}_1) \succ s(\tilde{A}_2)$

(iii) $\tilde{A}_1 = \tilde{A}_2$ if $s(\tilde{A}_1) = s(\tilde{A}_2)$

Definition 2.6[36]. By an interval-valued neutrosophic graph of a graph = (V, E) we mean a pair G = (A, B), where A =< $\left[T_A^L, T_A^U\right]$, $\left[I_A^L, I_A^U\right]$, $\left[F_A^L, F_A^U\right]$ > is an interval-valued neutrosophic set on V, and B =< $\left[T_B^L, T_B^U\right]$, $\left[I_B^L, I_B^U\right]$, $\left[F_B^L, F_B^U\right]$> is an interval-valued neutrosophic relation on E satisfying the following condition:

1.V= { v_1, v_2 ,…, v_n } such that T_A^L :V $\rightarrow$ [0, 1], T_A^U :V $\rightarrow$ [0, 1], I_A^L :V $\rightarrow$ [0, 1], I_A^U :V $\rightarrow$ [0, 1], and F_A^L :V $\rightarrow$ [0, 1], F_A^U :V $\rightarrow$ [0, 1] denote the degree of truth-membership, the degree of indeterminacy-membership and falsity-membership of the element $v_i \in$ V, respectively, and

$0 \leq T_A(v_i) + I_A(v_i) + F_A(v_i) \leq 3$ for all $v_i \in$ V (i=1, 2, …, n). (9)

2. The functions T_B^L :V x V $\rightarrow$ [0, 1], T_B^U :V x V $\rightarrow$ [0, 1], I_B^L :V x V $\rightarrow$ [0, 1], I_B^U :V x V $\rightarrow$ [0, 1] and F_B^L :V x V $\rightarrow$ [0,1], F_B^U :V x V $\rightarrow$ [0, 1] are such that:

$T_B^L(v_i, v_j) \leq$ min [$T_A^L(v_i)$, $T_A^L(v_j)$], $T_B^U(v_i, v_j) \leq$ min [$T_A^U(v_i)$, $T_A^U(v_i)$] ,

$I_B^U(v_i, v_j) \geq$ max [$I_A^L(v_i)$, $I_A^L(v_i)$], $I_B^U(v_i, v_j) \geq$ max[$I_A^U(v_i)$, $I_A^U(v_i)$] and

$F_B^L(v_i, v_j) \geq$ max [$F_A^L(v_i)$, $F_A^L(v_i)$], $F_B^U(v_i, v_j) \geq$ max[$F_A^U(v_i)$, $F_A^U(v_i)$] (10)

denoting the degree of truth-membership, indeterminacy-membership and falsity-membership of the edge $(v_i, v_j) \in$ E respectively, where:

$0 \leq T_B(v_i, v_j) + I_B(v_i, v_j) + F_B(v_i, v_j) \leq 3$, for all $(v_i, v_j) \in$ E (i, j = 1, 2,…, n). (11)

They called A the interval valued neutrosophic vertex set of V, and B the interval valued neutrosophic edge set of E, respectively; note that B is a symmetric interval valued neutrosophic relation on A.

III. ALGORITHM OF INTERVAL VALUED NEUTROSOPHIC PATH PROBLEM

This algorithm illustrates the steps involved in finding the arc length in a network. This network considers the length of each arc as a neutrosophic number in intervals.

The algorithm for the shortest path is as follows.

Step 1: Identify the first node length of the arc $\tilde{d}_1$ = <[0, 0], [1, 1], [1, 1]> and label the source node (say node1) as [$\tilde{d}_1$ = <[0, 0], [1, 1], [1, 1]>,-].

Step 2: Find the minimum of the length of node 1 with its neighbor node as $\tilde{d}_j$ = min{ $\tilde{d}_i \oplus \tilde{d}_{ij}$ }; j = 2,3,…,n.

Step 3: If the minimum occurs in the node corresponding to unique value of i (i.e.,i = r), then label node j as [$\tilde{d}_j$, r].

Step 4: If the minimum occurs in the node corresponding to more than one values of i then it shows that there are more than one interval valued neutrosophic path between source node i and node j but interval valued neutrosophic distance along path is $\tilde{d}_j$,choose any value of i.

Step 5: Let the destination node (say node n) be labeled as [$\tilde{d}_n$, l]. Then the interval valued neutrosophic shortest distance between source node is $\tilde{d}_n$.

Step 6: With respect to [$\tilde{d}_n$, l] find the interval valued neutrosophic shortest path between source node and destination node and check the label of node l. Let it be [$\tilde{d}_l$, p]. Check the label of node p and so on. Repeat the same procedure until node 1 is obtained.

Step 7: The interval valued neutrosophic shortest path can be obtained by combining all the nodes obtained by repeating the process in step 4.

Remark 5.1 Let $\tilde{A}_i$; i =1, 2,…, n be a set of interval valued neutrosophic numbers, if S($\tilde{A}_i$) < S($\tilde{A}_k$), for all i, the interval valued neutrosophic number is the minimum of $\tilde{A}_k$

IV.ILLUSTRATIVE EXAMPLE

This example illustrates the procedure of finding the shortest distance and shortest path between source node and destination node on the network of a interval valued neutrosophic graph.

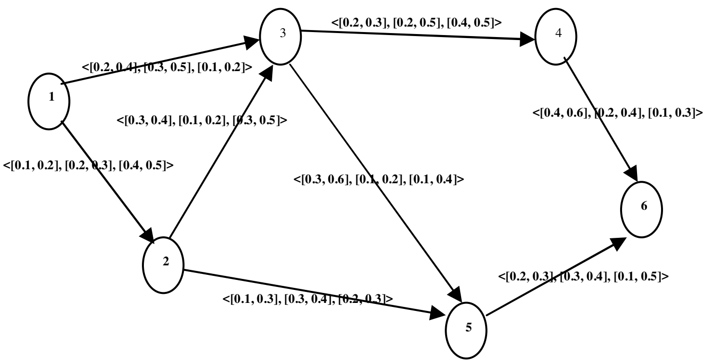

Fig.1.

In this network each edge have been assigned to interval valued neutrosophic number as follows:

Edges	Interval valued Neutrosophic distance
1-2	<[0.1, 0.2], [0.2, 0.3], [0.4, 0.5]>
1-3	<[0.2, 0.4], [0.3, 0.5], [0.1, 0.2]>
2-3	<[0.3, 0.4], [0.1, 0.2], [0.3, 0.5]>
2-5	<[0.1, 0.3], [0.3, 0.4], [0.2, 0.3]>
3-4	<[0.2, 0.3], [0.2, 0.5], [0.4, 0.5]>
3-5	<[0.3, 0.6], [0.1, 0.2], [0.1, 0.4]>
4-6	<[0.4, 0.6], [0.2, 0.4], [0.1, 0.3]>
5-6	<[0.2, 0.3], [0.3, 0.4], [0.1, 0.5]>

Table 1. weights of the interval valued neutrosophic graphs

The computation of the shortest path based on the algorithm of interval valued neutrosophic path problem is shown below. Since node 6 is the destination node, so n= 6.

assume $\tilde{d}_1$ = <[0, 0], [1, 1], [1, 1]> and label the source node (say node 1) as [<[0, 0], [1, 1], [1, 1]>,-], the value of $\tilde{d}_j$; j= 2, 3, 4, 5 ,6 can be obtained as follows:

Iteration 1 Since only node 1 is the predecessor node of node 2, so putting i = 1 and j = 2 in step 2 of the proposed algorithm, the value of $\tilde{d}_2$ is

$\tilde{d}_2$ = minimum{ $\tilde{d}_1 \oplus \tilde{d}_{12}$ } = minimum{<<[0, 0], [1, 1], [1, 1]> ⊕ <[0.1, 0.2], [0.2, 0.3], [0.4, 0.5]> = <[0.1, 0.2], [0.2, 0.3], [0.4, 0.5]>

Since minimum occurs corresponding to i = 1, so label node 2 as [<[0.1, 0.2], [0.2, 0.3], [0.4, 0.5]>, 1]

Iteration 2 The predecessor node of node 3 are node 1 and node 2, so putting i = 1, 2 and j = 3 in step 2 of the proposed algorithm, the value of $\tilde{d}_3$ is $\tilde{d}_3$ = minimum{ $\tilde{d}_1 \oplus \tilde{d}_{13}, \tilde{d}_2 \oplus \tilde{d}_{23}$ }= minimum{<[0, 0], [1, 1], [1, 1]> ⊕ <[0.2, 0.4], [0.3, 0.5], [0.1, 0.2]>, <[0.1, 0.2], [0.2, 0.3], [0.4, 0.5]> ⊕ <[0.3, 0.4], [0.1, 0.2], [0.3, 0.5]>} = minimum{<[0.2, 0.4], [0.3, 0.5], [0.1, 0.2]> , <[0.37, 0.52], [0.02, 0.06], [0.12, 0.25]>}

S (<[0.2, 0.4], [0.3, 0.5], [0.1, 0.2]>)

$= s(\tilde{A}_1) = \left(\frac{1}{4}\right) \times \left[2 + T_1^L + T_1^U - 2I_1^L - 2I_1^U - F_1^L - F_1^U\right]$ =0.175

= S (<[0.37, 0.52], [0.02, 0.06], [0.12, 0.25]>) = 0.59

Since S (<[0.2, 0.4], [0.3, 0.5], [0.1, 0.2]>) < S (<[0.37, 0.52], [0.02, 0.06], [0.12, 0.25]>)

So, minimum{<[0.2, 0.4], [0.3, 0.5], [0.1, 0.2]> , <[0.37, 0.52], [0.02, 0.06], [0.12, 0.25]>} = <[0.2, 0.4], [0.3, 0.5], [0.1, 0.2]>

Since minimum occurs corresponding to i = 1, so label node 3 as [<[0.2, 0.4], [0.3, 0.5], [0.1, 0.2]>, 1]

Iteration 3. The predecessor node of node 4 is node 3, so putting i = 3 and j = 4 in step 2 of the proposed algorithm, the value of $\tilde{d}_4$ is $\tilde{d}_4$ = minimum{ $\tilde{d}_3 \oplus \tilde{d}_{34}$ }= minimum{<[0.2, 0.4], [0.3, 0.5], [0.1, 0.2]> ⊕ <[0.2, 0.3], [0.2, 0.5], [0.4, 0.5]>} = <[0.36, 0.58], [0.06, 0.25], [0.04, 0.1]>

So minimum{<[0.2, 0.4], [0.3, 0.5], [0.1, 0.2]> ⊕ <[0.2, 0.3], [0.2, 0.5], [0.4, 0.5]>}= <[0.36, 0.58], [0.06, 0.25], [0.04, 0.1]>

Since minimum occurs corresponding to i = 3, so label node 4 as [<[0.36, 0.58], [0.06, 0.25], [0.04, 0.1]>,3]

Iteration 4 The predecessor node of node 5 are node 2 and node 3, so putting i= 2, 3and j= 5 in step 2 of the proposed algorithm, the value of $\tilde{d}_5$ is $\tilde{d}_5 =$

minimum{ $\tilde{d}_2 \oplus \tilde{d}_{25}, \tilde{d}_3 \oplus \tilde{d}_{35}$ } = minimum{<[0.1, 0.2], [0.2, 0.3], [0.4, 0.5]> $\oplus$ <[0.1, 0.3], [0.3, 0.4], [0.2, 0.3]>, <[0.2, 0.4], [0.3, 0.5], [0.1, 0.2]> $\oplus$ <[0.3, 0.6], [0.1, 0.2], [0.1, 0.4]>} =
Minimum{<[0.19, 0.44], [0.06, 0.12], [0.08, 0.15]>, , <[0.44, 0.76], [0.03, 0.1], [0.01, 0.08]>}
S (<[0.19, 0.44], [0.06, 0.12], [0.08, 0.15]>) = 0.51
S (<[0.44, 0.76], [0.03, 0.1], [0.01, 0.08]>) = 0.71
Since S (<[0.19, 0.44], [0.06, 0.12], [0.08, 0.15 < S (<[0.44, 0.76], [0.03, 0.1], [0.01, 0.08]>)
Minimum{<[0.19, 0.44], [0.06, 0.12], [0.08, 0.15]>, <[0.44, 0.76], [0.03, 0.1], [0.01, 0.08]>}
= <[0.19, 0.44], [0.06, 0.12], [0.08, 0.15]>,
$\tilde{d}_5$ = <[0.19, 0.44], [0.06, 0.12], [0.08, 0.15]>
Since minimum occurs corresponding to i=2, so label node 5 as [<[0.19, 0.44], [0.06, 0.12], [0.08, 0.15]>, 2]

Iteration 5. The predecessor node of node 6 are node 4 and node 5, so putting i = 4, 5and j = 6 in step 2 of the proposed algorithm, the value of $\tilde{d}_6$ is $\tilde{d}_6 =$

minimum{ $\tilde{d}_4 \oplus \tilde{d}_{46}, \tilde{d}_5 \oplus \tilde{d}_{56}$ }= minimum{<[0.36, 0.58], [0.06, 0.25], [0.04, 0.1]> $\oplus$ <[0.4, 0.6], [0.2, 0.4], [0.1, 0.3]>, <[0.19, 0.44], [0.06, 0.12], [0.08, 0.15]> $\oplus$ <[0.2, 0.3], [0.3, 0.4], [0.1, 0.5]> } = minimum{<[061, 0.83], [0.01, 0.1], [0.004, 0.03]>, <[0.35, 0.60], [0.01, 0.04], [0.008, 0.075]> }
S (<[061, 0.83], [0.01, 0.1], [0.004, 0.03]>) = 0.79
S (<[0.35, 0.60], [0.01, 0.04], [0.008, 0.075]>) = 0.68
Since S (<[0.35, 0.60], [0.01, 0.04], [0.008, 0.075]>) < S (<[061, 0.83], [0.01, 0.1], [0.004, 0.03]>)
So minimum{<[061, 0.83], [0.01, 0.1], [0.004, 0.03]>, <[0.35, 0.60], [0.01, 0.04], [0.008, 0.075]> }= <[0.35, 0.60], [0.01, 0.04], [0.008, 0.075]
$\tilde{d}_6$ = <[0.35, 0.60], [0.01, 0.04], [0.008, 0.075]
Since minimum occurs corresponding to i = 5, so label node 6 as [<[0.35, 0.60], [0.01, 0.04], [0.008, 0.075]>, 5]
Since node 6 is the destination node of the given network, so the interval valued neutrosophic shortest distance between node 1 and node 6 is <[0.35, 0.60], [0.01, 0.04], [0.008, 0.075]>
Now the interval valued neutrosophic shortest path between node 1 and node 6 can be obtained by using the following procedure:
Since node 6 is labeled by [<[0.35, 0.60], [0.01, 0.04], [0.008, 0.075]> , 5], which represents that we are coming from node 5. Node 5 is labeled by [<[0.19, 0.44], [0.06, 0.12], [0.08, 0.15]>, 2] , which represents that we are coming from node 2. Node 2 is labeled by [<[0.1, 0.2], [0.2, 0.3], [0.4, 0.5]>, 1] which represents that we are coming from node 1. Now the interval valued neutrosophic shortest path between node 1 and node 6 is obtaining by joining all the obtained nodes. Hence the interval valued neutrosophic shortest path is $1 \rightarrow 2 \rightarrow 5 \rightarrow 6$
The interval valued neutrosophic shortest distance and the neutrosophic shortest path of all nodes from node 1 is shown in the table 2 and the labeling of each node is shown in figure 2

Node No.(j)	$\tilde{d}_i$	Interval valued Neutrosophic shortest path between jth and 1st node
2	**<[0.1, 0.2], [0.2, 0.3], [0.4, 0.5]>**	$1 \rightarrow 2$
3	**<[0.2, 0.4], [0.3, 0.5], [0.1, 0.2]>**	$1 \rightarrow 3$
4	**<[0.36, 0.58], [0.06, 0.25], [0.04, 0.1]>**	$1 \rightarrow 3 \rightarrow 4$
5	**<[0.19, 0.44], [0.06, 0.12], [0.08, 0.15]>**	$1 \rightarrow 2 \rightarrow 5$
6	**<[0.35, 0.60], [0.01, 0.04], [0., 0.075]>**	$1 \rightarrow 2 \rightarrow 5 \rightarrow 6$

Table2. Tabular representation of different interval valued neutrosophic shortest path

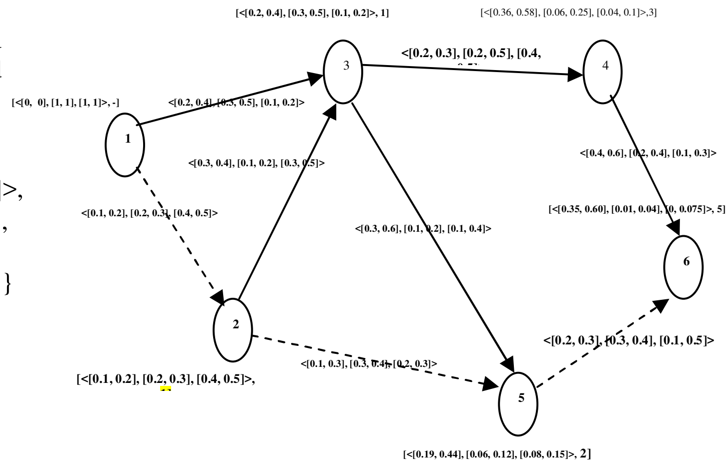

Fig.2.Network with interval valued neutrosophic shortest distance of each node from node 1

V. Conclusion

In this paper we developed an algorithm for solving shortest path problem on a network with interval valued neutrosophic arc lengths. The process of ranking the path is very useful to make decisions in choosing the best of all possible path alternatives. We have explained the method by an example with the help of a hypothetical data. Further, we plan to extend the following algorithm of interval neutrosophic shortest path problem in an interval valued bipolar neutrosophic environment.

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