USSING MAPLE FOR DETERMINATION THE SHORTEST INTUITIONISTIC FUZZY HYPERPATH

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ABSTRACT : In this article I will present a program algorithm for determining the shortest intuitionistic fuzzy hyperpath. The procedure is done for the algorithm introduced by [11]. It has been found that when expert systems varies with different degrees of precision Intuitionistic fuzzy graph theory reduce the differences between classical methods used in engineering and the symbolic models used in expert systems.

KEY WORDS: Intuitionistic Fuzzy hypergraph, Decision making, Intuitionistic fuzzy shortest hyperpath, Score, Accuracy, Euclidean distance.

1. INTRODUCTION

The concept of Intuitionistic fuzzy hypergraph It was introduced by S. Thilagavathi, R. Parvathi, M.G. Karunambigai in [12].
In [11] the authors shows an algorithm for searching the shortest hyperpath of an intuitionistic fuzzy hyperpath.
For this algorithms I thought that you can write a procedure in Maple. The procedure can be improved in that they can be automatically determinate and all roads connecting the input with the output of the network. A second procedure may be modified easily also for relative Euclidian distance, normalized Euclidean distance, Hamming distance, relative Hamming distance and normalized Hamming distance.

2. PRELIMINARIES

To define concepts of intuitionistic fuzzy number (IFN), intuitionistic fuzzy set (IFS) I will use the notations of Atanassov in [3]-[5]. Let X be a non-empty set and let A:

$$A=\{(x,\mu_A(x),\nu_A(x))|x\in X\} \quad (1)$$

where besides the degree of membership $\mu_A : X \to [0,1]$ of each element $x \in X$ to a set A there was considered a degree of non-membership $\nu_A : X \to [0,1]$, but such that

$$0 \le \mu_A(x)+\nu_A(x) \le 1, \forall x \in X \quad (2)$$

Consider therefore $V=\{v_1,\dots,v_n\}$ a finite set of vertices and $E=\{E_1,\dots,E_m\}$ a family of intuitionistic fuzzy subsets of V. The sets V and E are crisp sets.

Definition 2.1. [11] By intuitionistic fuzzy hypergraph (IFHG) we understand an ordered pair H = (V, E) where

1. $E_j = \{(v_i, \mu_j(v_i), \nu_j(v_i)) | v_i \in V\}$, $0 \le \mu_j(v_i) + \nu_j(v_i) \le 1$, *j=1,2,…,m*, $\mu_j(v_i), \nu_j(v_i) \ge 0$
2. $E_j \ne \emptyset$, *j=1,2,…,m*,
3. $\bigcup_j \text{supp}(E_j) = V$, *j=1,2,…,m*.

Where $\mu_j(v_i)$ and $\nu_j(v_i)$ besides the degree of membership and respectively degree of non-membership of each vetex v_i to edge E_j .

Definition 2.2. [12] An intuitionistic fuzzy hyperarc e $\in$E is defined as a pair (T (e),h(e)), where T (e) $\subset$ N, with T (e) = $\emptyset$, is its tail, and h(e) $\in N - T$ (e) is its head.

Definition 2.3. [12] A node s is said to be a source node in H if h(e) = s, for every e $\in$ E. A node d is said to be a destination node in H if d = T (e), for every e $\in$E.

Definition 2.4. [12] By the direct intuitionistic fuzzy hypergraph (IFDHG) we understand an ordered pair DH = (N , E) where where N is a non-empty set of nodes and E is a set of intuitionistic fuzzy hyperarcs.

Definition 2.5. [11] We consider A an IFS given the relationship (1) then the pair $(\mu_A(x), \nu_A(x))$ is called as an intuitionistic fuzzy number, denoted by $((a,b,c),(e, f, g))$, where $(a,b,c) \in F(I)$, $(e, f, g) \in F(I)$, I = [0, 1], $0 \le c + g \le 1$.

Definition 2.6. [12] A triangular intuitionistic fuzzy number (TriIFN) A is denoted by $A = \{(\mu_A(x), \nu_A(x)) \mid x \in X\}$, where $\mu_A(x)$ and $\nu_A(x)$ are triangular fuzzy numbers with $\nu_A(x) \le \mu_A^c(x)$.

Therefore, by a TriIFN A we understand pair $((a,b,c),(e, f, g))$ with $(e, f, g) \le (a,b,c)^c$. Hence $e \ge b$ and $f \ge c$ or $f \le a$ and $g \le b$ are membership and non-membership fuzzy numbers of A.

Let $A = ((a_1,b_1,c_1),(e_1, f_1, g_1))$ and B $= ((a_2,b_2,c_2),(e_2, f_2, g_2))$ be two TriIFNs.

Definition 2.7. [11] The addition of two TriIFN, denoted by A + B, is defined as A + B=

$$((a_1+a_2, b_1+b_2, c_1+c_2),(e_1+e_2, f_1+f_2, g_1+g_2))$$

Definition 2.8. [11] The score of A is an IFS whose membership and non-membership values are given respectively as

$$S(A^\mu) = \frac{a+2b+c}{4}$$

$$S(A^\upsilon) = \frac{e+2f+g}{4}.$$

Definition 2.9. [11] The accuracy of a TriIFN A is defined as:

$$Acc(A) = \frac{S(A^\mu) + S(A^\upsilon)}{2}$$

3. MAPLE PROCEDURES FOR ALGORITHM TO SEARCHING THE SHORTEST HYPERPATH

In this section I will present two procedures for determining the minimum length of a network is a TriIFN. In the article "Ussing maple for determination minimum arc length of an intuitionistic fuzzy hyperpath" I presented procedure "arc1" for determination minimum arc length of an intuitionistic fuzzy hyperpath. I will use it here without it has resumed. We will announce the algorithm given below [11]. The author propose a new method based on scores of IFNs, or simply score-based method.

3.1 Score-based method

In the [11] authors propose find the intuitionistic fuzzy shortest hyperpath in the easiest way namely, score-based method:

Algorithm.
Step 1. Consider all possible paths from source node to destination node.
Step 2. Find the scores of the paths.
Step 3. Find their accuracy.
Step 4. Obtain the shortest hyperpath with the lowest accuracy.

In Maple procedure proposed by me for this algorithm is:

```
arc2 := proc(l)
local n, i, a, b, c, e, f, g, ScoreAccuracy;
n := nops(l);
ScoreAccuracy := [seq([[0, 0], 0], i = 1 ..n)];
for i from 1 to n do
ScoreAccuracy[i][1][1]
    := (l[i][1][1] + 2·l[i][1][2] + l[i][1][3]) / 4;
ScoreAccuracy[i][1][2]
    := (l[i][2][1] + 2·l[i][2][2] + l[i][2][3]) / 4;
ScoreAccuracy[i][2]
    := (ScoreAccuracy[i][1][1] + ScoreAccuracy[i][1][2]) / 2;
end do;
RETURN(ScoreAccuracy)
end proc;
```

Example 3.1. Consider a network with a triangular intuitionistic fuzzy arc length presented in the article "Ussing maple for determination minimum arc length of an intuitionistic fuzzy hyperpath"
For the network given in Fig. 1, the algorithm is executed as follows:
Step 1.
Path (1) 1→2→6→9, L_1=(10,15,18), (13,21,25);
Path (2) 1→3→6→9, L_2=(13,23,34), (18,28,41);
Path (3) 1→3→9, L_3=(5,9,14), (9,15,19);
Path (4) 1→3→7→9, L_4=(6,12,18), (13,21,25);
Path (5) 1→4→7→9, L_5=(3,7,14), (7,14,19);
Path (6) 1→4→8→9, L_6=(7,12,19), (11,17,23);
Path (7) 1→5→8→9, L_7=(8,14,21), (13,21,26);

```
> ltest := [[[10, 15, 18], [13, 21, 25]], [[13, 23, 34], [18, 28, 41]], [[5,
    9, 14], [9, 15, 19]], [[6, 12, 118], [13, 21, 25]], [[3, 7, 14], [7, 14,
    19]], [[7, 12, 19], [11, 17, 23]], [[8, 14, 21], [13, 21, 26]] ];

  ltest := [[[10, 15, 18], [13, 21, 25]], [[13, 23, 34], [18, 28, 41]], [[5,
    9, 14], [9, 15, 19]], [[6, 12, 118], [13, 21, 25]], [[3, 7, 14], [7, 14,
    19]], [[7, 12, 19], [11, 17, 23]], [[8, 14, 21], [13, 21, 26]]]

> map(evalf, arc2(ltest));
  [[[14.50000000, 20.], 17.25000000], [[18., 26.], 22.], [[23.50000000,
    30.], 26.75000000], [[9., 18.50000000], 13.75000000],
    [[9.750000000, 20.75000000], 15.25000000], [[13.75000000,
    20.25000000], 17.]]
```

The path P4 : 1→3→7→9 with least accuracy 13.75 has been identified as intuitionistic fuzzy shortest hyperpath.

3.2. Euclidean distance method

The Euclidian distance between A and B is defined as follows:

$$e(A, B) = \sqrt{\sum_{i=1}^{n}(\mu_A(x_i)-\mu_B(x_i))^2+(\nu_A(x_i)-\nu_B(x_i))^2+(\pi_A(x_i)-\pi_B(x_i))^2}$$

In the [11] authors consider Euclidean distance method to compare it to score-based method:

Step 1. Find out all possible hyperpaths from source node to destination node d and compute the arc lengths of corresponding hyperpath L_i , i = 1, 2, 3, . . . ,n.
Step 2. Compute L_{min} by using an intuitionistic fuzzy shortest hyperpath procedure.
Step 3. Find the Euclidean distance d_i for i = 1, 2, 3, . . . ,n between all possible hyperpaths and L_{min}.
Step 4. Decide the shortest hyperpath with the lowest Euclidean distance.

Example 3.2. Consider a network with a triangular intuitionistic fuzzy arc length shown in Fig1.

Step 1 is the previous example.
Step 2 Compute L_{min} by using an intuitionistic fuzzy shortest hyperpath procedure "arc1" we have:

```
> map(evalf, arc1(ltest));
  [[5., 7.045454545, 9.], [12., 15.39899624, 19.]]
```

Step 3,4. Find the Euclidean distance d_i for i = 1, 2, 3, . . . ,n between all possible hyperpaths and L_{min} using the procedure below:

```
arc3 := proc(l)
local n, i, a, b, c, e, f, g, lmin, deuc, dmin, k;
n := nops(l); lmin := arc1(l);
dmin := [0, 0]; deuc := [0, 0]; k = 1;
dmin[1]
     := ((l[1][1][1] − lmin[1][1])^2 + (l[1][1][2] − lmin[1][2])^2 -
     − lmin[1][3])^2)^(1/2);
dmin[2]
     := ((l[1][2][1] − lmin[2][1])^2 + (l[1][2][2] − lmin[2][2])^2 -
     − lmin[2][3])^2)^(1/2);
print(1, map(evalf, dmin));
 for i from 2 to n do
deuc[1]
     := ((l[i][1][1] − lmin[1][1])^2 + (l[i][1][2] − lmin[1][2])^2 +
     − lmin[1][3])^2)^(1/2);
deuc[2]
     := ((l[i][2][1] − lmin[2][1])^2 + (l[i][2][2] − lmin[2][2])^2 +
     − lmin[2][3])^2)^(1/2);
print(i, map(evalf, deuc));
if evalf(dmin[1]) > evalf(deuc[1]) then dmin := deuc; k := i end
    if;
 end do;
print("Path ", k, " the minimum Euclidian distance ", map(evalf, dmin))
end proc;
```

```
> map(evalf, arc3(ltest));
1, [13.01056468, 8.268690534]
2, [19.49364168, 18.42778577]
3, [32.32227311, 25.14739188]
4, [4.451993703, 6.161755279]
5, [5.072409568, 9.453636505]
6, [11.72031154, 8.553901778]
"Path ", 4, " the minimum Euclidian distance ", [4.451993703, 6.161755279]
```

Hence it is concluded that Path (4): 1→3→7→9 has the least Euclidean distance.

4. CONCLUSION

The score-based method chosen by the authors [11] was compared with the Euclidean distance method to identify the shortest hyperpath between intuitionistic fuzzy arc length and intuitionistic fuzzy shortest hyperpath it can be completed and possibly other methods based on relative Euclidian distance, normalized Euclidean distance, Hamming distance

$$h(A, B) = \sum_{i=1}^{n} |\mu_A(x) - \mu_A(x)| + |\nu_A(x) - \nu_A(x)| + |\pi_A(x) - \pi_A(x)|$$

, relative Hamming distance and normalized Hamming distance. Certainly for these distances can be held easily algorithms and corresponding procedures in Maple. A natural extension of this research work is application of intuitionistic fuzzy digraphs in the area of soft computing, including neural networks, decision-making, and geographical information systems.

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