USSING MAPLE FOR DETERMINATION MINIMUM ARC LENGTH OF AN INTUITIONISTIC FUZZY HYPERPATH

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ABSTRACT : In this article I will present a program algorithm for determining the minimum arc length of an intuitionistic fuzzy hyperpath. The procedure is done for the algorithm introduced by [16] and based on [17]. 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.

1. INTRODUCTION

The concept of intuitionistic fuzzy (IF) relations and intuitionistic fuzzy graphs (IFGs) it was introduced by Atanassov in [5]. Developing relationships and defining its components is done by Parvathi, R. and Karunambigai in [15]. Starting from the usual structures that generate graphics that are found as the hypergraph, it passed to notion of directed hypergraphs. The main problem in achieving the networks is to determine the shortest path between input and output. In practice determining a minimum road network it is not so simple because if we choose as our objective function only time could, for example, that the cost will be very high. It is necessary therefore a choice that takes into account multiple objective functions. To eliminate this was switched to using IFN for modeling the problem and finding intuitionistic fuzzy shortest hyperpath in a network. The concept of Intuitionistic fuzzy hypergraph It was introduced by S. Thilagavathi, R. Parvathi, M.G. Karunambigai in [17]. In [16] the same authors, relying on [19] shows an algorithm for determining minimum arc length of an intuitionistic fuzzy hyperpath.
For this algorithm 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.

2. PRELIMINARIES

In this section, I will give the necessary definitions using notations from [16]. We will also consider known the notions of intuitionistic fuzzy number (IFN), intuitionistic fuzzy set (IFS) introduced by the Atanassov in [4], [5].
The intuitionistic fuzzy set (IFS) on a universe X was introduced by K. Atanassov in 1983 as a generalization of FS,

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

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

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

We call degrees of indeterminacy of x to A, for each A in X the numbers [19]:

$$\pi_A(x) = 1 - \mu_A(x) - \nu_A(x) \ , \ \forall x \in X \quad (3)$$

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

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

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

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 .
We note with
$M = \{(a_{ij}, \mu_j(v_i), \nu_j(v_i))\}$ matrix of IFHG.

Definition 2.2. [16] 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. [16] 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. 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. [16] 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. [16] 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.

3. MINIMUM ARC LENGTH OF AN INTUITIONISTIC FUZZY HYPERPATH

In this section we consider the arc length of a network is a TriIFN. We will announce the algorithm given below [16].

Algorithm.
Let L_i denotes arc length of the ith hyperpath.
Step 1. Compute the lengths of all possible hyperpaths L_i for i = 1, 2, 3, . . . ,n, where $L_i = ((a_i', b_i', c_i'), (e_i', f_i', g_i'))$;
Step 2. Initialize $L_{min} = ((a,b,c),(e,f,g)) = L_1 = ((a_1', b_1', c_1'), (e_1', f_1', g_1'))$;

Step 3. Set $i = 2$.
Step 4. Determine the amounts $(a,b,c),(e,f,g)$ using relationships:

$$a = \min\left(a, a_i^{'}\right),$$

$$b = \begin{cases} b & \text{if } b \le a_i^{'} \\ \dfrac{bb_i^{'} - aa_i^{'}}{\left(b + b_i^{'}\right) - \left(a + a_i^{'}\right)} & \text{if } b > a_i^{'} \end{cases}$$

$$c = \min\left(c, b_i^{'}\right)$$

for the membership values, and

$$e = \min\left(e, e_i^{'}\right)$$

$$f = \begin{cases} f & \text{if } f \le e_i^{'} \\ \dfrac{ff_i^{'} - ee_i^{'}}{\left(f + f_i^{'}\right) - \left(e + e_i^{'}\right)} & \text{if } f > e_i^{'} \end{cases}$$

$$g = \min\left(g, f_i^{'}\right)$$

for the non- membership values.
Step 5. Set $L_{min} = \left((a,b,c),(e,f,g)\right)$ as calculated in step 4.
Step 6. $i = i + 1$.
Step 7. If $i < n + 1$, go to step 3, otherwise stop the procedure.

For this algorithm of [16] we created in Maple following procedure:

```
arc1 := proc(l)
local n, i, a, b, c, e, f, g, lmin;
n := nops(l);
lmin := l[1];
for i from 2 to n do
lmin[1][1] := min(l[i][1][1], lmin[1][1]);
if lmin[1][2] > l[i][1][1] then
lmin[1][2]
    := (lmin[1][2]·l[i][1][2] − lmin[1][1]·l[i][1][1]) / ((lmin[1][2] + l[i][1][2]) − (lmin[1][1] + l[i][1][1]))
end if;
lmin[1][3] := min(lmin[1][3], l[i][1][2]);
lmin[2][1] := min(l[i][2][1], lmin[2][1]);
if lmin[2][2] > l[i][2][1] then
lmin[2][2]
    := (lmin[2][2]·l[i][2][2] − lmin[2][1]·l[i][2][1]) / ((lmin[2][2] + l[i][2][2]) − (lmin[2][1] + l[i][2][1]))
end if;
lmin[2][3] := min(lmin[2][3], l[i][2][2]);

end do;
RETURN(lmin)
end proc;
```

Example 3.1. Consider a network with a triangular intuitionistic fuzzy arc length shown in Fig. 1

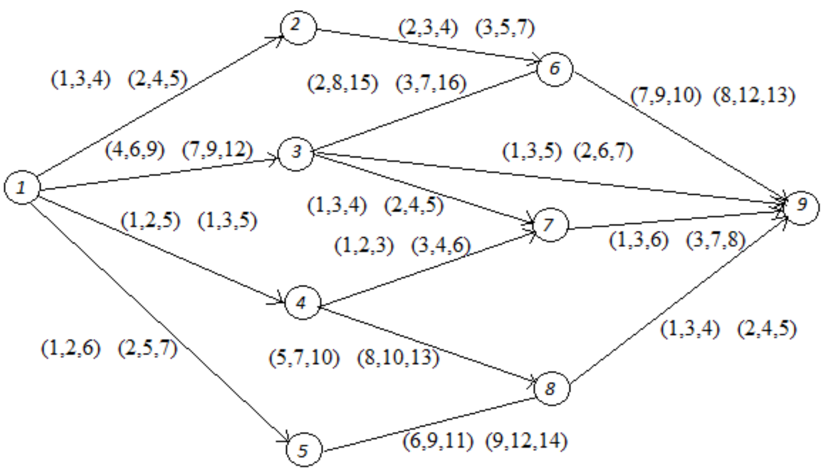

Figure 1. Intuitionistic fuzzy hypernetwork

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);

Step 2. Initialize L_{min} = $\left((a,b,c),(e,f,g)\right)$ = L_1 = $\left((a_1',b_1',c_1'),(e_1',f_1',g_1')\right)$==((10,15,18), (13,21,25));

Applying procedure "arc1" we get:

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

Finally, we get the minimum of arc lengths of intuitionistic fuzzy hyperpath as

L_{min} = ((5, 7.04, 9), (12, 15.39, 19))

4. CONCLUSION

For such problems there are several methods for determining the minimum length arc using the intuitionistic fuzzy shortest hyperpath. As I said, the procedure can be improved with automatic determination of possible roads network.

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