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Optimize of a Development Project Based on the VMD Method

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Abstract: The VMD method is a method of vague pattern recognition. The detailed steps of this method are that: (1). Establish a scheme set. Need establish reserve scheme sets. Draw an optimal scheme set theoretically (2). Turn the original data turn into the vague data. Need that turn a monodrama data into a vague data and turn a language value data into a vague data and (3). Vague multiattribute decision. Fix the weight of the every index. Calculate weighing similarity measures between vague sets of the reserve scheme and vague set of an optimal scheme in theory. Vague multiattribute decision: By a maximal value of the weighing similarity measures a correspondence scheme is optimal scheme. Given a transforming formula from the monodromy value data to vague data. Presented a weighing similarity measure formula between vague sets. The application example of this method shows that this method and these formulas are useful.

Key words: Vague sets, transforming data, weighing similarity measures, the VMD method, application example

INTRODUCTION

Gau and Buehrer (1993) present vague set theory and it is one of popularizes of fuzzy set theory (Zadeh, 1965). Owing to the fact that can clearly express affirm member degree and oppose member degree and not fix degree when using vague set theory describe fuzzy information, therefore vague set than fuzzy set have more advantages. In reference Yun *et al*. (2010) the Fuzzy-AHP-TOPSIS method and by use this method solve decision question of the optimization of multiattribute decision plan, and get a better application effect. Hope applies vague set theory and discusses an identical question in the essay.

MEASURE SIMILARITY BETWEEN VAGUE SETS (VALUE)

Definition 1: Hua-Wen and Hengyang (2004): One of the data mining of a vague value is: Let vague value as $h = [t_h, 1\text{-}f_h]$ and:

$$t_h^{(0)} = t_h, f_h^{(0)} = f_h, \pi_h^{(0)} = \pi_h = 1 - t_h - f_h;$$
$$t_h^{(m)} = t_h \cdot (1 + \pi_h + \pi_h^2 + \cdots + \pi_h^m),$$
$$f_h^{(m)} = f_h \cdot (1 + \pi_h + \pi_h^2 + \cdots + \pi_h^m)$$

$$\pi_h^{(m)} = \pi_h^{m+1};\ p^{(m)}(h) = t_h^{(m)} - f_h^{(m)},\ (m = 0,1,2,\cdots).$$

Definition 2: Wang (2010a): Suppose vague values as $h = [t_h\text{-}1\text{-}f_h]$, $e = [t_e\text{-}1\text{-}f_e]$, definition.

- Trivial axiom T (h, e)∈[0, 1]
- Symmetric axiom T (h, e) = T (e, h)
- Maximum axiom M (h, h) = 1;
- Minimum axiom If the when h = [1, 1], e = [0, 0] or h = [1, 1], there is M (p, e) = 0, or ever.

Then formula T (h, e) known as similarity measures between vague values h and e, if the T (h, e) content at the least mentioned axioms.

Theorem 1: Let vague values as $h = [t_h, 1\text{-}f_h]$, $e = [t_e, 1\text{-}f_e]$, (m = 0, 1, 2, ...). Then:

$$T_m(h,e) = \left[1 - \left|t_h^{(m)} - t_e^{(m)}\right|\right] \cdot \left[1 - \frac{1}{2}\left|p^{(m)}(h) - p^{(m)}(e)\right|\right]$$

is the similarity measure between vague values h and e.

Copy definition 2 can be given to the definition of similarity measures between vague sets and to the definition of the weighted similarity measure between sets, no give a minute description. Theorem 2 will be described below with reference to the results.

Theorem 2: Suppose a universe of discourse is $Z = \{z_1, z_2, ..., z_n\}$, on Z there is vague sets:

$$H = \sum_{i=1}^{n} \left[t_H(z_i), 1 - f_H(z_i)\right] / z_i$$

and

$$E=\sum_{i=1}^{n}\left[t_E(z_i),1-f_E(z_i)\right]/z_i$$

note simple as:

$$H=\sum_{i=1}^{n}\left[t_{h_i},1-f_{h_i}\right]/z_i, E=\sum_{i=1}^{n}\left[t_{e_i},f_{e_i}\right]/z_i$$

Then:

$$T_m(H,E)=\frac{1}{n}\sum_{i=1}^{n}\left[1-\left|t_{h_i}^{(m)}-t_{e_i}^{(m)}\right|\right]\cdot\left[1-\frac{1}{2}\left|p_{h_i}^{(m)}-p_{e_i}^{(m)}\right|\right](m=1, 2, ...) \quad (1)$$

is the similarity measure between vague sets H and E.

Theorem 3: Let the elements of z_i the weight as the $a_i \in [0, 1]$:

$$\sum_{i=1}^{n}a_i=1$$

in such as under the assumption of theorem 2. Then:

$$WT_m(H,E)=\sum_{i=1}^{n}a_i\cdot\left[1-\left|t_{h_i}^{(m)}-t_{e_i}^{(m)}\right|\right]\cdot\left[1-\frac{1}{2}\left|p_{h_i}^{(m)}-p_{e_i}^{(m)}\right|\right](m=0,1,2,...) \quad (2)$$

is a weighted similarity measures between vague sets H and E.

FROM THE ORIGINAL DATA TRANSFORM TO VAGUE DATA

In the study, an application example need a transforming formula from a monodromy data into the vague data. Such the transforming formulas are given by Wang (2010b). Below we get a so transforming formula.

Definition 3: Wang (2010c): Suppose a universe of discourse is Z = $\{z_1, z_2, ..., z_n\}$, the data of index z_j (j = 1, 2, ..., n)of sets Hi (i = 1, ..., m) on Z are the monodromy data z_{ij} (≥ 0). If a monodromy data z_{ij} (≥ 0) transform to a vague data.

H_i (z_j) = [t_{ij}, 1-f_{ij}] satisfies vagueaxiom and returns axiom, then refer to this formula as returns type transforming formula. If satisfies vague axiom and consume axiom, then refer to this formula as consume type transforming formula. Here:

- Vague axiom: $0\leq t_{ij}\leq 1\text{-}f_{ij}\leq 1$
- Returns axiom: If the $z_{xj}>z_{yj}\geq 0$, z_{xj}, z_{yj}, respectively, into the vague data as:

$$H_x(z_j)=z_{xj}=[t_{xj},1-f_{xj}], H_y(z_j)=z_{yj}=[t_{yj},1-f_{yj}]$$

- Content: $t_{xj}\geq t_{yj}$, $1\text{-}f_{xj}\geq 1\text{-}f_{yj}$.
- Consume axiom: If the $z_{xj}>z_{yj}\geq 0$, z_{xj}, z_{yj}, respectively, into the vague data as:

$$H_x(z_j)=z_{xj}=[t_{xj},1-f_{xj}], H_y(z_j)=z_{yj}=[t_{yj},1-f_{yj}]$$

- Content $t_{xj}\leq t_{yj}$, $1\text{-}f_{xj}\leq 1\text{-}f_{yj}$.

Note: When the index value takes the more bigger, the better, the appropriate make use of returns type transformation formula and when the index value takes "the more smaller, the more better, the appropriate make use of consume type transforming formula.

Theorem 4: Suppose: z_{jmax} = max $\{z_{1j}, z_{2j}, ..., z_{mj}\}$, z_{jmin} = min $\{z_{1j}, z_{2j}, ..., z_{mj}\}$ (j = 1, 2, ..., n). Then that:

$$H_i(z_j)=z_{ij}=\left[\left(\frac{z_{ij}-z_{jmin}}{z_{jmax}-z_{jmin}}\right)^3,\left(\frac{z_{ij}-z_{jmin}}{z_{jmax}-z_{jmin}}\right)^{\frac{3}{2}}\right] \quad (3)$$

is a returns type transforming formula.

$$H_i(z_j)=z_{ij}=\left[1-\left(\frac{z_{ij}-z_{jmin}}{z_{jmax}-z_{jmin}}\right)^{\frac{3}{2}},1-\left(\frac{z_{ij}-z_{jmin}}{z_{jmax}-z_{jmin}}\right)^3\right] \quad (4)$$

is a consume type transforming formula.

THE VMD METHOD

Popularize Vague sets integrated decision-making rules that document (Yun *et al.*, 2010) gives, get the VMD (Vague multiattribute decision) method. The detailed steps of this method are that: (1). Establish a scheme set. Need establish reserve scheme sets. Draw an optimal scheme set theoretically: (2). Turn the original data turn into the vague data. Need that turn a monodromy data into a vague data and turn a language value data into a vague data. C. Vague multiattribute decision. Fix the weight of the every index and (3) calculate weighing similarity measures between vague sets of the reserve scheme and vague set of an optimal scheme theoretically. Vague multiattribute decision: By a maximal value of the weighing similarity measures a correspondence scheme is an optimal scheme.

CASE

By application vague multiattribute decision method restudy the example in reference (Yun *et al*., 2010).

Establish a scheme set: Take up the indexes that z_1 as: The recoverable reserves added value (10^8m^4), z_2 as: The unit a steel mean (Mpa/km), z_3 as: Total power required to the compressor (kw), z_4 as: The scheme investment, z_5: Financial internal rate of return (%), z_6: Financial net present value rate (%), z_7: Technological risks, z_8: Management risk. They constitute an index set. Take up the schemes that H_1 as: Scheme 1, H_2 as: Scheme 2, H_3: as: Scheme 3, H_4: as: Scheme They constitute a scheme set.

Because the indexes z_1, z_5 and z_6 are and the more and bigger, the better. And the other indexes are and the more and smaller, the better. Therefore, get a must optimize scheme on the theory E (Table 1).

From the primary data change to vague data: In the Table 1 indexes z_7 and z_8 are the primary data expressed by the nature language of the people, by the expert may direct give corresponding vague data as: very low [0.00, 0.15], low [0.15, 0.29], lower [0.29, 0.43], general [0.43, 0.57], higher [0.57, 0.71], high [0.71, 0.85], very high [85,100].

Indexes z_1 and z_5 and z_6, are the and the more and bigger, the better. Application formula (3) calculate indexes z_1 and z_5 and z_6. And other indexes are and the more and smaller, the better. Application formula (4) calculate other indexes Table 2.

By Table 2, already get that the vague sets of the schemes H_1, H_2 H_3 H_4 and a vague set of an most optimize scheme on the theory E.

Vague multiattribute decision: Note the weighs of the elements of reference (Yun *et al*., 2010) for the $a_1 = 0.3313$, $a_2 = 0.1059$, $a_3 = 0.0327$, $a_4 = 0.1572$, $a_5 = 0.2307$, $a_6 = 0.0709$, $a_7 = 0.0477$, $a_8 = 0.0236$. And take m = 2, Application formula (2) calculate the weighted similarity measures between vague sets H_i (m = 0,1,2, ...) and E. The results are follows:

$$WT_2(H_1,E) = 0.53, WT_2(H_2,E) = 0.36,$$
$$WT_2(H_3,E) = 0.50, WT_2(H_4,E) = 0.49$$

According as the big or small of the weighted similarity measure values can be getting following order of the schemes: scheme H_1, scheme H_3, scheme H_4, scheme H_2. An optimal scheme is scheme H_1.

Table 1: Indexes data of scheme influence factors (original)

Sch.	H_1	H_2	H_3	H_4	E
z_1	0.61	0.61	0.91	0.91	0.91
z_2	0.044	0.035	0.039	0.036	0.035
z_3	439	313	580	512	313
z_4	1430	1718	2238	2317	1430
z_5	25.7	20.1	23.4	22.4	25.7
z_6	57.1	33.3	47.4	42.8	57.1

Table 2: Indexes data of scheme influence factors (vague)

Sch.	H1	H2	H3	H4	E
z_1	[0.00,0.00]	[0.00,0.00]	[1.00,1.00]	[1.00,1.00]	[1.00,1.00]
z_2	[1.00,1.00]	[0.00,0.00]	[0.09,0.30]	[0.00,0.00]	[1.00,1.00]
z_3	[0.10,0.32]	[0.00,0.00]	[1.00,1.00]	[0.42,0.65]	[1.00,1.00]
z_4	[0.00,0.00]	[0.03,0.17]	[0.75,0.87]	[1.00,1.00]	[1.00,1.00]
z_5	[1.00,1.00]	[0.00,0.00]	[0.21,0.46]	[0.07,0.26]	[1.00,1.00]
z_6	[1.00,1.00]	[0.00,0.00]	[0.21,0.46]	[0.06,0.24]	[1.00,1.00]
z_7	[0.15,0.29]	[0.00,0.15]	[0.57,0.71]	[0.43,0.57]	[0.00,0.15]
z_8	[0.29,0.43]	[0.15,0.29]	[0.71,0.85]	[0.71,0.85]	[0.15,0.29]

CONCLUSION

Yun *et al*. (2010) applied Fuzzy-AHP-TOPSIS method studied the problem; need to used fuzzy matrix calculation, this method approaches can theoretically guarantee the optimum, but it costs long time and request large EMS memory. The VMD method is one of the vague patted recognition methods. A tool of the patted recognition is a similarity measure formula and a weighing similarity measure formula between vague sets. The application example shows that this method is convenient and simple. The result is eff.

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