STUDY ON FUZZY HARMONIOUS DECISION AND DESIGN OF INTELLECTUALIZED COMPUTER AIDED SUPPORTING SYSTEM

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ABSTRACT: This paper presents a model of Fuzzy harmonious decision for the problems of multi-factors decision, illustrates the principle of the model and the process of computation, and introduces the design of intellectualized computer aided supporting system--Multi-Use Decision Supporting System.

Key words: Fuzzy, harmonious decision, Consistent degree, Decision supporting system

1. INTRODUCTION

In modern management, when making important decision, people usually collect decision opinions of the experts reasonably. Because there is some difference in opinions of the experts for the decision in treatment of the proportion of the factors that are restricted and influenced each other, the corresponding decision is also different. In past, people usually used the method of the mean value to solve these problems, that is, to average each decision information according to the number of the experts. This method usually caused that the decision between some experts and the collected one is far apart in some way. The method not only affected the execution of the decision result, but also could not ensure that the decision getting in this way was an idea one.

The method of multi-experts harmonious decision based on the multi-factors presented in this paper builds a comprehensive decision one that collects most of the decision opinions. By using this method, idea decision can be achieved. We also design the corresponding intellectualized computer aided supporting system, which makes the scientificability and the reliability for the Fuzzy harmonious decision increase greatly.

2. FUZZY HARMONIOUS DECISION

2.1 Model of multi-level Fuzzy decision

In the process of decision, in order to standardize the information treatment of the factors that have no standard, we divide the factors set U into several groups:

$$U = \underset{i=1}{\overset{p}{u}} U_i \qquad (U_i \bigcap U_j = \phi, i \neq j),$$

Suppose $U_i = \{u_{i1}, u_{i2}, \cdots u_{ini}\}$, (When i equals 1, it means that the Fuzzy decision is level 1.) Then $U = \{u_{11}, \cdots, u_{1n1}, u_{21}, \cdots, u_{2n2}, \cdots, u_{p1}, \cdots, u_{pnp}\}$. Suppose $U^* = \{U_1, U_2, \cdots U_p\}$, then we say that U^* is the factor set layer 2, and the element u_i is the subset of the factor set layer i,

$V=\{V_1,V_2,\cdots,V_m\}$ is the judgment set. When we make single factor judgment for every factor of the $U=\{U_{i1},U_{i2},\cdots,U_{ini}\}$, We can make the follow map:

$\tilde{f}_i:U_i\to F(V),\tilde{f}_i(U_{ik})=(r_{k1}^{(i)},r_{k2}^{(i)},\cdots,r_{kn}^{(i)})\in F(V)\ i=1,2,\cdots,p$

We can also get the judgment matrixR_i. Taking (U_i,V,R_i) as the original model, giving the proportion distribution of every factor inU_i: $A=(a_{i1},a_{i2},\cdots,a_{ini})$, $\sum_{j=1}^{ni}a_{ij}=1$, then we can get the comprehensive judgment: $B_i=A_i\circ R_i\in F(V),\ (i=1,2,\cdots,p)$.Considering factor set layer 2: $U^*=\{U_1,U_2,\cdots,U_p\}$,taking B_i as the single factor judgment of factorU_i, making mapping $\tilde{f}:U^*\to F(V),U_i\to\tilde{f}(U_i)=B_i$ we can get the Fuzzy matrix of layer 2:

$R=(B_1\ B_2\ \cdots\ B_p)^T=(b_{ij})_{p\times m}$.. Taking (U^*,V,R) as the original model, giving proportion distribution of every factor inU^*: $A=(a_1,a_2,\cdots,a_p)$,$\sum_{i=1}^{p}a_i=1$, we can get comprehensive decision $B=A\circ R\in F(V)$, here the operator "$\circ$" is the multiplication of the general matrixes. The model given above is the one of level 2. We can also get the model of level 3, level 4 in the same way.

2.2 Consistentability of the decision

Definition 1: Suppose $\tilde{B}$ is a set that consists of all of the decision making by the decision makers, if function $f:\tilde{B}\times\tilde{B}\to[0,1]$ meets:

1) When $\forall B_i\tilde{B},f(B_i,B_i)=0$,

2) when $\forall B_1,B_2\in\tilde{B},f(B_2,B_1)=f(B_1,B_2)$

then we say that the f is the consistent degree function of the two decisions.

If $f(B_1,B_2)=0$, we say that B_1 is consistent with B_2 completely. If $f(B_1,B_2)$ =1, we say B_1 is not consistent with B_2 at all. B_1 is consistent with B_2 means that the two decision vectors are equal, that means that the decision is an identity one.

Suppose $B_1,B_2\in\tilde{B}$,if their vectors are represented by$B_i=(b_1^i,b_2^i,\cdots,b_k^i)$, (i=1,2), define that the distance between B_1 and B_2 is: $g(B_1,B_2)=\sqrt{\frac{1}{2}\sum_{j=1}^{k}(b_j^1-b_j^2)^2}$, then we can proof easily that $g(B_1,B_2)$ satisfies the condition of the consistent degree, and when$g(B_1,B_2)=0,B_1$ is consistent with B_2 completely.

Definition 2: Suppose $B=\{B_1,B_2,\cdots,B_s\}\subseteq\tilde{B}$, then we say the matrix:

$$F=\begin{bmatrix} f(B_1,B_1) & f(B_1,B_2) & \cdots & f(B_1,B_s) \\ f(B_2,B_1) & f(B_2,B_2) & \cdots & f(B_2,B_s) \\ \cdots & \cdots & \cdots & \cdots \\ f(B_s,B_1) & f(B_s,B_2) & \cdots & f(B_s,B_s) \end{bmatrix}$$

is the consistent degree matrix of B. It is a symmetric matrix in which the element in the main diagonal lines is zero.

Definition 3: Suppose $B \subseteq \widetilde{B}, F:\overline{P}(\widetilde{B}) \to [0,1], F(B) = \max\{f(B_i,B_j) / B_i, B_j \in \widetilde{B}\}$

Then we say that the set B is the consistent function. F(B) is the consistent degree of set B.

Definition 4: Suppose $\alpha \in [0,1]$, for $B \subseteq \widetilde{B}$, if

1) $F(B) \le \alpha$

2) When $\forall B' \in \widetilde{B} - B$, $F(B \cup \{B'\}) > \alpha$

Then we say that B is the set of consistent degree that has precision α.

We can find the consistent set B that has the precision α easily from the consistent matrix. The process is:

1) Take $\forall B_j \in B$ as the nodes, link up all the nodes B_i, B_j which satisfy $f(B_i,B_j) \le \alpha$.

2) Find the maximal complete polygon. The set making by the nodes of the maximal polygon is the consistent degree set B_α that has precision α.

2.3 Realization of the consistentability

In reality, because there is difference between the decision makers and the factors, there is also some difference in decision information made by people. In order to find the comprehensive decision that collects most of the decision opinions, the process of decision should include two consistentabilities, one is the proportion distribution of the factors, another is the single factor judgment.

1) Proportion distribution

Before making any decision, the leader of the decision makers should organize experts to study and discuss the details of the decision, and based on which, allocate the weight value to the factor of the U^*. First, he should find the weight factor A of the most decision makers under some precision. Then he should consult with the decision makers who is not in the range of the consistent set determining by this precision, suggest the makers to adjust the value assignment, and find new A again and make the α meet the need of the precision. If the decision makers persist in their own opinions after consultation, the decision of theirs should be removed. Of course, only few of the makers are gotten rid of. After doing this, we can find respectively the vector $A_1, A_2, \cdots, A_p$ that meets the need of the precision in same way.

2) factor evaluation

By using the consultant method given above, we can choose the consistentability of the original evaluation find the consistent decision. In the same way, we can also find $B_i (i = 1,2,\cdots,p)$, which meets the need of precision, to get the decision that includes the opinions of the most decision makers.

In practice, we can also accord the actual circumstances to find the consistent decision that meets the need of the precision on the bases of the comprehensive decision making by all of the experts.

3. DESIGN OF THE INTELLECTUALIZED COMPUTER AIDED SUPPORTING SYSTEM

In order to easy the application of the Fuzzy harmonious decision, we design a corresponding intellectualized computer aided supporting system--Multi-Use Decision Supporting System (MUDSS). The system has three functions. 1) It can be a tool by which the department responsible for the auxiliary decision management can select and optimize the actual decision model. 2) It can be the simulating experimental system for testing new conception, new algorithm using by the auxiliary researchers. 3) The information combination, harmonious decision, and information output etc., can be achieved automatically.

3.1 Total structure of the MUDSS

The MUDSS system is an integrated one that is composed of five subsystems running independently. The total structure of MUDSS is shown in Fig.1. The major functions of the subsystems are given below.

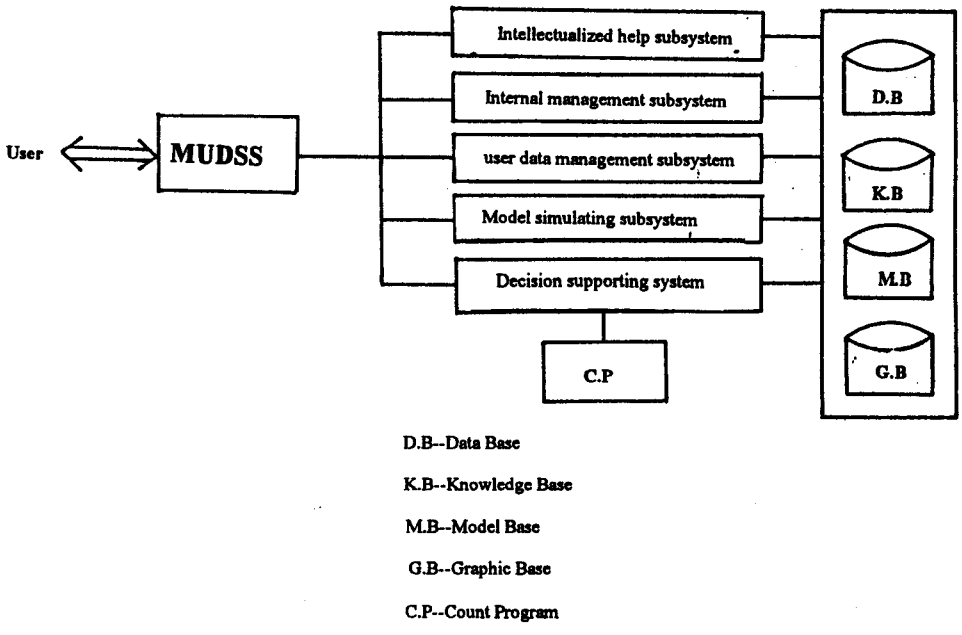

Fig.1 Total structure of the MUDSS

Intellectualized help subsystem: This subsystem supplies the professional knowledge of how to use the knowledge in the field of knowledge and the management decision of MUDSS.

Internal management subsystem: This system is used to maintain and manage the internal information of the system. The subsystem includes windows distribution, menu structure and its content, basic data files of the system, unit knowledge base. The subsystem supplies a tool that has the function of adjustment, expansion and redefinition by itself. In order to prevent the subsystem from damaging occasionally, only assigned user can use the subsystem.

User information management subsystem: This subsystem manages and decides various information related to the system, such as original weight value of the decision system, corresponding evaluation of

the factors, information about the consistent degree, precisionα, harmonious condition, condition of forming comprehensive decision . The subsystem is an object-oriented information inquiring subsystem.
Model simulating subsystem: This system can make simulation according to the given model and the given condition. The subsystem has two effects: 1) It can supply idea simulating running data for analyses and researches. 2) It can verify the reasonability of the selection of the real model, predict running status of the decision process.
Decision supporting subsystem: This system helps users to accomplish all of the decision according to the input and output samples given to the system and the information related to other system knowledge.

3.2 Design of the main function of the system

3.2.1 In-line help

Since MUDSS is an intellectualized multi-technological system that involves many-sided knowledge, the function of the in-line help is very necessary to users. The in-line help function of the MUDSS runs through all of the process of the running system. The function is accomplished together with the status tracking apparatus, working controller, dynamic index table and in-line dictionary module. The system status tracking apparatus records automatically the position of current interactive interface of the control path tree of the system. While system runs, it has two working statutes: one is execution status, another is help status. In execution status, every selective item in the interface has a corresponding program. In help status, the system will determine the current interfaces according to the records of the status tracking apparatus, form dynamically an information index table corresponding the selective items in interface, and pick up related knowledge in-line dictionary from the knowledge base. The selected items will be taken as the key words to index in-line dictionary.
When user needs help for some problems from current interactive interface of the system, what he only to do is to use mice to select the help function and to determine what item he wants to know. The help system will pick up related interpretation or suggestion automatically from the in-line dictionary and displays them in the information window setting by the system.

3.2.2 Selection of interactive model

In order to make scientific decision, it is a very crucial and difficult task to select model and information correctly. To do this, the system has to depend on the professional knowledge and experience of the decision makers. A module that can supply a tool for optimizing model is designed. By using this tool, a user interaction method can be used to help users determine the decision model and the information composed algorithm.
The models which can be selected by MUDSS are: 1) model of Fuzzy decision of level 1,2 and 3. 2) Model of Fuzzy opinion decision. 3) Model of Fuzzy intention decision. 4) Model of Fuzzy priority relative arrangement decision. 5) model of Fuzzy classifying decision.
In models given above, the information composed algorithm can be selected from one of the equations below according to the actual condition:

1) "$\wedge$","$\vee$": $a_i \vee b_j = \max(a_i, b_j), a_i \wedge b_j = \min(a_i, b_j)$

2) $M(.,\vee)$: $b_j = \bigvee_{k=1}^{n} (a_k . r_{kj})$

3) "$\cdot$","$\hat{+}$": $a \cdot b = ab, a \hat{+} b = a + b - ab$

4) "⊗","⊗": $a \otimes b = \max(0, a+b-1), a \otimes b = \min(1, a+b)$

5) "ε","ε": $a \varepsilon b = \frac{ab}{1+(1-a)(1-b)}, a \overset{+}{\varepsilon} b = \frac{a+b}{1+ab}$

6) $M(.,+)$

According to the practical system knowledge and experience mastered, users put forward a probing selection for the model and algorithm. The supporting subsystem makes a simulating decision to the model according to the samples that have similar decision problems, and displays the decision information on the contrasting analysis window for users to select. If users are not satisfied with the results, he can do it again, until a better decision model and algorithm are selected. If necessary, users can also modify the model and algorithm in some way.

3.2.3 knowledge based precision selection

In MUDSS, a knowledge based inference method is used. The precision α is determined according to the actual data of consistent degree matrix and the classification of the harmonious decision. The harmonious process is accomplished by means of service menu that can guide user to do what he should to do.

4. CONCLUSION

In actual production and management, the theory and the method of the Fuzzy decision provide an efficient tool for the scientificalness of making decision .

The main program of MUDSS is developed with Microsoft c++ 7.0 and should be used under the environment of Windows 3.1. The hardware of the system should be IBM 486 compatible computer.

MUDSS can be used to support decision in a distributed environment that is made up of several computers. A terminal can be taken as the decision harmonist. Every decision maker accomplishes his decision on his terminal, and consults with the harmonist, until the consistent decision that meets the need of the precision is reached.

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