Research on the application of dynamic fuzzy logic in intelligent knowledge base system

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Abstract—With the Big data under the background of artificial intelligence --AI is increasingly popular, the core role of knowledge base system experts in the increasingly emerge, but whether the automatic driving or artificial recognition need to deal with a lot of expert knowledge data AI, and the expert knowledge not only is fuzzy, and has dynamic. This paper from a new perspective, a comprehensive interpretation of the dynamic fuzzy system theory, and the theory of dynamic fuzzy dynamic fuzzy on the knowledge base of the proposed a new characterization method based on data representation, logical representation. The knowledge base system is also studied and designed.

Keywords-expert knowledge base; data fuzziness; data dynamic; dynamic fuzzy theory

I. INTRODUCTION

In the knowledge base system, the need to deal with a lot of expert knowledge, and the expert knowledge not only is fuzzy, and is dynamic, such as when the financial decisions in the financial aspects of the knowledge base, according to various aspects of the current financial information, combined with the knowledge in the knowledge base construction, to simulate the financial plan select and determine the implementation process of the simulation, the simulation is consistent with the actual degree is fuzzy, and financial solutions in a variety of uncertain financial or economic factors, this ambiguity will reflect the dynamic change, determine again financing plan, the funds required number, capital structure and how / financing channels was reasonable with fuzziness, with the passage of time and all kinds of uncertain factors, the rationality will change, may Become more reasonable or more unreasonable, this ambiguity, dynamic to be able to grasp well, the financial decision-making will be of great benefit, otherwise it will cause greater loss of property. Therefore, in the process of the knowledge base, this paper uses the theory of dynamic fuzzy logic (Dynamic Fuzzy Logic) theory, the knowledge representation, storage, inference and update.

The knowledge base system, based on dynamic fuzzy logic (DFL) of the basic theory, firstly, this paper proposes a new method of dynamic fuzzy knowledge representation method, and the dynamic fuzzy dynamic data into a quantitative structure, the knowledge base is designed.

II. INTRODUCTION TO DYNAMIC FUZZY LOGIC (DFL) THEORY[1] [2] [3]

A. DFL propositional logic

Definition 1 A declarative sentence with dynamic fuzziness (Character of Dynamic Fuzzy) Be called DF proposition (Dynamic Fuzzy proposition)，Capital letters A, B, C..... Express, For a DF proposition (Dynamic Fuzzy proposition), Generally there is no absolute true and false, can only ask it DF true and false (Dynamic Fuzzy or false degree) how?

My daughter, Wang Ruixuan, grew up." Is a DF proposition, "long" reflects the dynamic, "big" reflects the ambiguity.

She is in a better mood." This is also a DF proposition, "turn" embodies the "dynamic", and "good" is fuzzy.

Definition 2 used to measure a DF truth degree by DF number (Dynamic Fuzzy proposition) and($\bar{a},\vec{a}$)∈[0,1] to express， The truth of the proposition, Commonly used lower case letters ($\bar{a},\vec{a}$),($\bar{b},\vec{b}$),($\bar{c},\vec{c}$)…express。among ($\bar{a},\vec{a}$) = $\bar{a}$ or $\vec{a}$ max($\bar{a},\vec{a}$) = $\vec{a}$, min($\bar{a},\vec{a}$) = $\bar{a}$ 。

Definition 3 a DF proposition can be considered as a variable on the interval [0,1]，DF propositional variable. For DF variables ($\bar{x},\vec{x}$)， ($\bar{y},\vec{y}$) ∈ [0,1] The following operations are specified:

①Deny "—"： ($\bar{x},\vec{x}$)the negation of $\overline{(\bar{x},\vec{x})}$ ， and $\overline{(\bar{x},\vec{x})}$ △= ($(1-\bar{x}),(1-\vec{x})$)

②Disjunctive “∨”： ($\bar{x},\vec{x}$) ∨ ($\bar{y},\vec{y}$) △= max (($\bar{x},\vec{x}$) , ($\bar{y},\vec{y}$))

③Conjunctive “∧”： ($\bar{x},\vec{x}$) ∧ ($\bar{y},\vec{y}$) △= min (($\bar{x},\vec{x}$) , ($\bar{y},\vec{y}$))

④ condition “→”： ($\bar{x},\vec{x}$)→($\bar{y},\vec{y}$) ⇔ $\overline{(\bar{x},\vec{x})}$ ∨ ($\bar{y},\vec{y}$) △= max ($\overline{(\bar{x},\vec{x})}$, ($\bar{y},\vec{y}$))

⑤Double condition "$\leftrightarrow$" : $(\vec{x},\vec{x})\leftrightarrow(\vec{y},\vec{y})\triangle=\min(\max(\overline{(\vec{x},\vec{x})},(\vec{y},\vec{y})),\ \max((\vec{x},\vec{x}),\overline{(\vec{y},\vec{y})}))$

The definition of propositional formula of 4 DF can be defined as:

①A single DF propositional variable itself is a unified formula;

②if($\vec{x},\vec{x}$)PA is unified formula，that $\overline{(\vec{x},\vec{x})P}$ Is also a formula;

③if ($\vec{x},\vec{x}$)P and ($\vec{y},\vec{y}$)Q closed formula，that ($\vec{x},\vec{x}$)P $\vee$ ($\vec{y},\vec{y}$)Q，($\vec{x},\vec{x}$)P $\wedge$ ($\vec{y},\vec{y}$)Q，($\vec{x},\vec{x}$)P$\rightarrow$($\vec{y},\vec{y}$)Q, ($\vec{x},\vec{x}$)P$\leftrightarrow$($\vec{y},\vec{y}$)Q All are formulas.

B. Predicate calculus of DFL [4][5]

Define recursive definition of 5 DFL predicate formula:

①The atom (first order predicate symbol) is a formula.

②If G, H is a formula, T is the true value of the assigned value of DF, ($\vec{x},\vec{x}$) is free variables in DFL，that $\overline{G}$，G$\vee$H，G$\wedge$H，G$\rightarrow$H，G$\leftrightarrow$H，($\vec{x},\vec{x}$)G，（$\forall$($\vec{x},\vec{x}$)G），（$\exists$($\vec{x},\vec{x}$)G）is formula.

③All the formulas in DFL are used ①、② for finite times.

Define 6 an interpretation of the formula G in DFL 6 by I and the following rules are composed of U

①Specify a DF element in U for each variable symbol in G;

②Specifying the mapping for each n function symbol in G U T→ D

③Specify the mapping for each n predicate symbol in G DT→ B

Where B is the DF atomic weight, based on these definitions, some properties of the DFL predicate system are listed below

Property 1

$$\overline{(\vec{T},\vec{T})\forall(\vec{x},\vec{x})G}=(\vec{1}-\vec{T},\vec{1}-\vec{T})\overline{\forall(\vec{x},\vec{x})G}=(\vec{T},\vec{T})\exists(\vec{x},\vec{x})G$$

Property 2 $\overline{(\vec{T},\vec{T})G}=(1-\vec{T},1-\vec{T})G$

Property 3 $(\vec{T},\vec{T})\forall(\vec{x},\vec{x})G=(\vec{T},\vec{T})(\forall(\vec{x},\vec{x})G)$

$$((\vec{T},\vec{T})\exists(\vec{x},\vec{x}))G=(\vec{T},\vec{T})(\exists(\vec{x},\vec{x})G)$$

III. DYNAMIC FUZZY LOGIC REPRESENTATION OF KNOWLEDGE IN KNOWLEDGE BASE SYSTEM [5] [6]

Constructing knowledge base system is an important and difficult problem. Hundreds of rules and a lot of facts are obtained by visiting experts in the field, and at the same time, the knowledge will be generated during the operation of the model library. The expert knowledge representation into facts and rules is tedious and time-consuming process, the main difficulties are: expert with the way he understands declarative knowledge, these knowledge includes the background, concepts, relations and problems, it is difficult to use a computer program to describe the existence; subjective, uncertain and dynamic problems such as expert knowledge no, the consistency of knowledge including knowledge redundancy, implication, contradictions, omissions and other aspects, this is a problem not to be ignored for the knowledge base system.

A large number of dynamic fuzzy knowledge in knowledge base can be expressed by the method of dynamic fuzzy logic.

A. Dynamic fuzzy logic system[7]

Because the traditional logic system is not easy to deal with dynamic fuzzy problems, here we use dynamic fuzzy logic system, which is composed of a dynamic fuzzy (global) database, dynamic fuzzy logic rules and dynamic fuzzy logic rule interpreter composition.

The dynamic fuzzy database is used to store the initial information provided by the user, the intermediate information obtained in the process of reasoning, and the final conclusion.

The dynamic fuzzy logic rule base is composed of a set of dynamic fuzzy logic rules. A dynamic fuzzy logic rule can be abstractly described as a three tuple::

Prerequisite P, action or conclusion Q, rule of confidence ($\overrightarrow{CF},\overleftarrow{CF}$)) where the preconditions P and conclusion Q can also be dynamic fuzzy

Dynamic fuzzy logic rule interpreter: responsible for part of the rules of the fuzzy and dynamic conditions of the contents of the database according to the rules of credibility ($\overrightarrow{CF},\overleftarrow{CF}$), if the matching success, dynamic fuzzy rule interpreter according to the description of the information content of the action part to modify the dynamic fuzzy database, repeated indefinitely until the issue is resolved.

Dynamic fuzzy logic rules are the traditional DF rules, can be carried out from the following aspects:

① The precondition of DF is to introduce the DF predicate and the DF state quantifier to express the DF relation and the DF state in the rule precondition, and define a DF matching principle.

② Conclusion: the DF action or action or the conclusion of rules has a DF or DF conclusion itself is a predicate or a DF state or action itself is a kind of action to operate with DF DF data in DF database.

③Set rule activation threshold. When the matching degree of the present condition is greater than or equal to the rule, the rule is activated.

④Set rules for reliability ($\overrightarrow{CF},\overleftarrow{CF}$). To determine the credibility of the DFL rules to reflect the degree of credibility, it will somehow affect the credibility of the conclusions or actions.

B. *DFL rule and DF data represen tation method[9] [10] [11]*

First of all, the representation of several DF propositions is given

P=[P'=(A(x) is D), $(\vec{t},\vec{t})$]

Here P is a DF proposition, X is the object name, A is the X attribute name, D is a deterministic state expression, P'=(A(x) is D) is P the corresponding deterministic proposition, $(\vec{t},\vec{t})$ is to use P'to express the degree DFof P

② P=[A $(\vec{x},\vec{x})$ is $\pi(\vec{t},\vec{t})$]

Here $\pi(\vec{t},\vec{t})$ is the membership function of A. $(\vec{x},\vec{x})$

③ P=[P'=(A $(\vec{x},\vec{x})$ is $\pi(\vec{x},\vec{x})$), $(\vec{t},\vec{t})$]

$(\vec{t},\vec{t})$ is to use P'to express the degree DFof P

According to the representation of DF proposition, a dynamic fuzzy logic rule

IF(P1,P2,……Pm) THEN (Q1,Q2,……) WITH $\overrightarrow{CF},\overleftarrow{CF}$ Can be expressed as:

IF $[(P_1', f_1,(\vec{t}_1,\vec{t}_1))AND(P_2', f_2,(\vec{t}_2,\vec{t}_2))AND\cdots AND(P_m', f_m,(\vec{t}_m,\vec{t}_m))]$ THEN

$[(Q_1', g_1,(\vec{S}_1,\vec{S}_1)),(Q_2', g_2,(\vec{S}_2,\vec{S}_2)),\cdots]$ WITH $(\overrightarrow{CF},\overleftarrow{CF})$

Here, P1, P2,..... Pm represents the dynamic fuzzy preconditions of rules , Q1, Q2,..... Dynamic fuzzy conclusions and actions in rules, $(\overrightarrow{CF},\overleftarrow{CF})$ express rule strength, P_1', P_2' , … , P_m' is P1,P2,……Pm Corresponding deterministic expression. $Q_1', Q_2', \cdots$ is $Q_1, Q_2, \cdots$ Corresponding deterministic expression, $f_1, f_2, \cdots, f_m$ is used P_1', P_2' , … , P_m' expression of P1, P2,..... State probability distribution of Pm. $(\vec{t}_1,\vec{t}_1),(\vec{t}_2,\vec{t}_2),\cdots,(\vec{t}_m,\vec{t}_m)$ is used $(P_1', f_1),(P_2', f_2),\cdots,(P_m', f_m)$ expression of P1,P2,…… Pm' DF degree.

In this way, the knowledge in the knowledge base system can be represented by the dynamic fuzzy logic.

IV. A NEW METHOD FOR CHARACTERIZING DYNAMIC AMBIGUITY

In theory, the knowledge of dynamic fuzzy degree can be represented by a DF number, but can be found through the analysis, a number of DF actually contains two aspects of fuzzy and dynamic information, is the subject of ambiguity, and put forward the dynamic change trend.

However, in practical applications, the solution of dynamic fuzzy problems is not satisfied with the fuzzy and dynamic changes, but also requires the size of dynamic changes, that is, the degree of dynamic change. In this paper, a new method of dynamic variation is introduced.

Definition: the so-called moment t dynamic change degree D (T), refers to the change in the rate of membership at the time of T, that is, the $f(t)$ derivative of the membership function at the moment

d(t)= $f(t)$

When d (t) >0, the direction of the increase of the value of the degree of membership changes, the greater the value, the faster the speed: when d (T) <0, the direction of the change in the degree of membership value, the smaller the value, the faster the speed.

In practice, it is difficult to obtain the membership function directly, but only a few discrete data:

(1) Difference quotient:

$$d(t) \approx \frac{f(t) - f(t')}{t - t'}$$

Here the moment is usually desirable <t t a moment, that is, the difference between the back of commercial law, of course, can also choose forward difference commercial law, depending on the specific circumstances

(2) Curve fitting method

According to the discrete values of membership degree F, as shown in Table 3.1, the curve fitting, the fitting curve of the membership function y = $f(t)$ And then the fitting curve function in the T derivative is d (t) = $f(t)'$

TABLE I. DISCRETE DATA OF MEMBERSHIP

T_i	t_1	t_2 ……	t_m
F_i	f_1	f_2 ……	f_m

Curve fitting method is usually applied to the case of a large amount of data.

(3) Expert investigation

For a number of financial management experts, using the questionnaire method to obtain the basic dynamic measurement data, and then get the average dynamic measurement.

This design adopts the backward difference method to get the dynamic fuzzy data dynamic degree.

V. DESIGN OF KNOWLEDGE BASE SYSTEM BASED ON DFL

A. *Functional structure of DFL rule knowledge base subsystem*

The main function of the knowledge base system based on DFL is to provide the knowledge of the whole process. Its main functions are knowledge representation (in this paper, the use of dynamic fuzzy representation), knowledge reasoning (based on dynamic fuzzy logic inference method) and knowledge learning three functions, as shown in Figure 1.

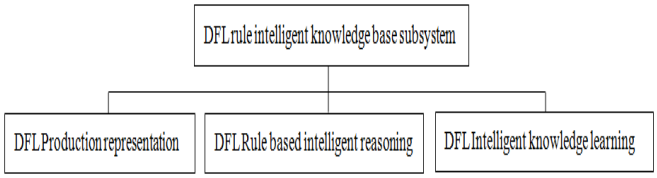

Figure 1. Function structure of DFL rule knowledge base subsystem

With regard to the method of knowledge learning, FDSS adopts the method of mechanical learning and inductive learning. The mechanical learning method is realized by the maintenance of the knowledge base. The inductive learning method is implemented by running the model in the model base.

VI. SUMMARY

This paper is mainly the theory of fuzzy function and logic design of knowledge base system based on dynamic, which can well solve the representation and reasoning of the dynamic in the objective world and fuzzy problems, so as to deepen and improve the level of intelligent knowledge base system.

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