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Representation and reasoning in financial investment decision base on fuzzy knowledge and its different negations

Songlin Liu[1,2] , Yonghua Zhang[3], Zhengmei Fu[4]

[1]Zhongnan University of Economics and Law Wuhan College (CHINA)

[2] Economics and Management School of Wuhan University (CHINA)

[3]Shijiazhuang University Of Economics (CHINA)

[4]Wuhan Design & Research Institute of China Coal Technology & Engineering Group (CHINA)

Email: roger0007@sina.com

ABSTRACT

Based on a contradiction with negation, negation and intermediaries negate antagonism new fuzzy set FScom, study the investment decision in a financial application instance. Which, for different negative fuzzy knowledge, the introduction of fuzzy set ~+ *A* and ~-*A*, and the use of ideological distance ratio function defines the membership functions of fuzzy sets, fuzzy sets FScom given p-value as well as the definition of fuzzy production rules threshold a method to determine k discussed examples of three different fuzzy knowledge and its negative inference algorithms and implementation.

KEYWORDS

Fuzzy sets;
Fuzzy knowledge representation and reasoning,
Fuzzy production rules;
Denial of knowledge.

INTRODUCTION

Denial of knowledge in knowledge processing, especially in fuzzy knowledge processing plays a special role. For vague knowledge of the "no" distinction, which means that as well as reasoning process, in recent years, some scholars have proposed different ideas. Among them, the literature[1] proposed that in the knowledge reasoning, natural language, logic programming, semantic nets, imperative programming languages (eg Java), database query languages (such as SQL), modeling language (such as UML / OCL), production rule system (eg CLIPS and Jess) and other areas require two negative. Is a non-negated clear that the concept put forward in these calculations and information processing system to distinguish strong negative (which means explicitfalsity) and weakly negative (which means non-truth)[2]. Literature[3] in the Description Logic advocated strong distinction between classical negation and negation, and propose a strong negation and negation with a classic description of a logical extension ALC_. Literature[4] presented at LCA (1ogical concept analysis) to distinguish negative, antagonistic and possibilities. Literature[5] from the conceptual level of knowledge on the proposed deal should distinguish the contradictory relationship between knowledge and antagonistic relationship study establishes a clear knowledge and fuzzy knowledge there are five contradictory relationship with the antagonistic relationship with thus presents a contradictory negation, opposite negation and denial of new fuzzy set intermediaries FScom[6].

This article is based with contradictory negation, opposite negation and fuzzy negation intermediaries FScom, discusses the financial investment decisions in

a specific instance of fuzzy knowledge representation and reasoning and its negation.

PREPARATION AND DEFINITION

Definition 1 Let U is a universe. Mapping $\psi_A: U \to [0,1]$

Determine the fuzzy subset A in U. Mapping ψ_A is Membership function of A, $\psi_A(x)$ is Degree of membership of x to A, Denoted A (x).

Definition 2 Let A is the Fuzzy subset on U, $p \in (0,1)$.

(1) Mapping $\psi^{\perp}: \{A(x) | x \in U\} \to [0,1]$, if $\psi^{\perp}(A(x))$ =1-A(x), Mapping $\psi^{\perp}$ determined on a fuzzy subset on U, Denoted $A^{\perp}, A^{\perp}(x) = \psi^{\perp}(A(x)).A^{\perp}$ is opposite negation Set of A.

(2) Mapping $\psi^{-}: \{A(x) | x \in U\} \to [0,1]$, if:

$$\psi^{-}(A(x)) = \begin{cases} \frac{2p-1}{1-p}(A(x)-p)+1-p, & p \in \left[\frac{1}{2},1\right) \ A(x) \in (p,1] \\ \frac{2p-1}{1-p}A(x)+1-p, & p \in \left[\frac{1}{2},1\right) \ A(x) \in [0,1-p) \\ \frac{1-2p}{p}A(x)+p, & p \in \left(0,\frac{1}{2}\right] \ A(x) \in [0,p) \\ \frac{1-2p}{p}(A(x)+p-1)+p, & p \in \left(0,\frac{1}{2}\right] \ A(x) \in (1-p,1] \\ \frac{1}{2}, & A(x)=\frac{1}{2} \end{cases}$$

Mapping ψ^{-} determined on a fuzzy subset on U, Denoted $A^{-}, A^{-}(x) = \psi^{-}(A(x)).\ A^{-}$ is Intermediary negative Set of A.

(3) Mapping $\psi^{\dashv}: \{A(x) | x \in U\} \to [0,1]$, if $\psi^{\dashv}(A(x)) = \mathrm{Max}(A^{\perp}(x), A^{-}(x))$, $\psi^{\dashv}$ determined on a fuzzy subset on U, Denoted $A^{\dashv}, A^{\dashv}(x) = \psi^{\dashv}(A(x)).A^{\dashv}$ is Contradictory negation Set of A.

Fuzzy Sets which be determinedby definition 1 and definition 2 on universe U, called " Fuzzy Sets for differentiate Contradictory negation, Opposite negation alld Medium negation ", abbreviated as FScom.

Fuzzy knowledge representation and reasoning based on fuzzy sets FScom

Based on fuzzy sets FScom, the symbolic ~+ and ~- is introduced, which definition as :

Definition 3 Let A is a fuzzy sets FScom. ~+A is fuzzy sets of A- approaching to A which is intermediary negative of A, ~-A is fuzzy sets of A- approaching to opposition denied $\dashv A$, Following:

$$0, \quad p \geq \frac{1}{2} \ A(x) \geq \frac{1}{2} \quad 1-p \leq A(x) < \frac{1}{2} \oplus 1, \quad p \geq \frac{1}{2} \ A(x) \geq \frac{1}{2} \quad \frac{1}{2} < A(x) \leq p \oplus 1, \quad p \geq \frac{1}{2},$$

which, ~-A( )=1-~+ A(x), particularly, if A(x)=1/2, ~+A(x)=1/2.

Epitaxial relationship between the transition of fuzzy sets ~+A and ~-A in universal set, show as figure 1 and figure 2.

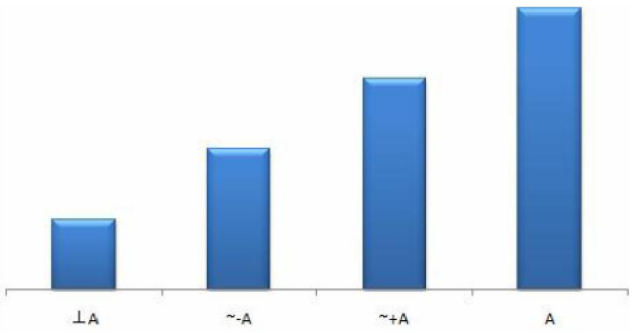

Figure 1 : When A(x)≥1/2 , Epitaxial relationship between ~+A, ~-A and A with ⊥A

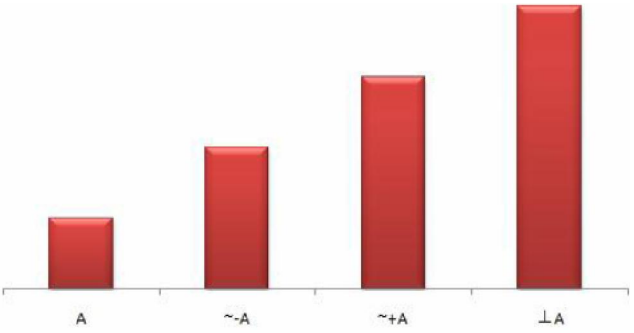

Figure 2 : When A(x)≤ 1/2 , Epitaxial relationship between ~+A, ~-A and A with ⊥A

Financial investment decision support

Personal finance and investment, mainly based on the personal income of the current economic situation and the bank deposits, investment environment and investment combined with the risk of a comprehensive consideration of the operation and management of personal funds. Generally refer to the following principles:

(1) or more and more investors to deposit revenue is high, consider investing in stocks and a small majority of bonds.

(2) or more and more investors to deposit revenue in the middle or on the side, consider the amount equal opportunities to invest in stocks and bonds.

(3) or more, but many investors to deposit income is not high (below the middle income), consider in-

vesting in more bonds and fewer stocks.

(4) investor deposits middle and not low income (ie, above average income), consider investing in stocks.

(5) investor deposits middle and middle-income or below the middle, then consider investing in bonds.

(6) If an investor deposits less or less, regardless of the income situation is good or bad, have preferred the money deposited in the lowest-risk banking.

Example

According to the National Bureau of Statistics 2012 national provincial economic statistics, several representatives were selected domestic provinces and cities as reference (see TABLE 1), the reference 2012 these provinces and rural households per capita annual income of urban and rural residents Closing balance per capita savings status, made to fit the year of investment planning.

TABLE 1 : 2012 statistical indicators of the national economy

Provinces	Closing balance of urban and rural residents in storage (million yuan)	fuzzy set of population units (Million)	Closing balance of urban and rural residents per capita storage (yuan)	urban and rural residents per capita disposable annual household income (yuan)
Hubei	19032	5779	32933	18374
Guangdong	46265	10594	43671	26897
Shanghai	21512	2380	90387	36230
Beijing	21644	2069	104611	32903
Jiangsu	30057	7919	37956	26341
Zhejiang	26902	5477	49118	30971
Tianjin	7135	1413	50495	26921
Fujian	10974	3748	29280	24907
Shandong	26494	9684	27359	22792

In this paper, which means that per capita income, select 3I, I / 3 were high, the low-income threshold (the level of the urban income gap is about 9 times), in order to facilitate the calculation of the deposit division also uses this approach, so, get the following data (TABLE 2) (as a statistical survey and calculation error, so for each type of data to determine an elastic range, respectively, in the corresponding data is indicated in parentheses after the name.)

(1) Instance-based knowledge representation

In the investment principles and examples of ambiguity exists, "high income", "large deposit", "deposit moderate", "low deposit", "low income", which are different fuzzy sets and the "high income" and "low income" ("deposit and more" and "less deposit") is a pair of vertical negated set, "middle-income" ("deposit medium") is a "high-income" and "low income" ("deposit many" and "deposits less ") intermediary negative set which 'income, savings, stocks, bonds, insurance," is to determine the individual investment options of five factors.

TABLE 2 : 2012 Income and deposits around the table

Provinces	High income (concepts) (yuan per yeas) (±5000)	Low income (concepts) (yuan per yeas) (±2000)	Much deposits (concepts) (yuan) (±20000)	Less deposits (concepts) (yuan) (±5000)
Hubei	55122	6125	98799	10978
Guangdong	80691	8966	131013	14557
Shanghai	108690	12077	271161	30129
Beijing	98709	10968	313833	34870
Jiangsu	79023	8780	113868	12652
Zhejiang	92913	10324	147354	16373
Tianjin	80763	8974	151485	16832
Fujian	74721	8302	87840	9760
Shandong	68376	7597	82077	9120

Let population groups domain of U, X is the U of individuals, the introduction:

Collection of *savings (X)*: X is represents deposits;

Collection of *income (X)*: X is represents income;

Collection *mfsavings (X)*: X is used to deposit money represents;

Collection *mfstocks (X)*: X is used to invest in stocks represents money;

Collection *mfbonds (X)*: X is used to invest in bonds represent money;

Collection *mfinsurance (X)*: X is used to represent investment insurance money.

In order to distinguish instances fuzzy sets, the introduction of symbols *MUCH*, *MORE*, *BALANCE* and *INVESTMENT*, knowledge representation based on instance:

MUCH(savings): represents more deposits ;MUCH(income): represents high income.

~MUCH(savings): represents medium deposits;~+MUCH(savings): represents medium more deposits. ~-MUCH(savings): represents medium less

deposits; ⊥MUCH(savings) represents seldom deposits.

~MUCH(income): represents medium income;~+MUCH(income): represents medium high income. ~-MUCH(income): represents medium low income;⊥MUCH(income): represents seldom income..

INVESTMENT (X, stocks): represents the X invest in stocks.

INVESTMENT (X, savings): represents the X Investment bank deposits.

INVESTMENT (X, bonds): represents the X invest in bonds.

INVESTMENT (X, insurance): represents the X investment insurance.

MORE (mfbonds, mfstocks): represents the X bond investment money in equities.

BALANCE (mfbonds, mfstocks): represents the X money investing in bonds and stocks money balance; otherwise similar expressions.

Using these fuzzy sets and reasoning statement, investment principles different expressions using logical reasoning as follows:

Rule 1

(MUCH(savings) $\vee$ ~+MUCH(savings) $\wedge$ (MUCH(income) →INVESTMENT(More(mfstocks,mfbonds))

Rule 2

(MUCH(savings) $\vee$ ~+ MUCH(savings)) $\wedge$ (~MUCH(income) $\vee$ ~+ MUCH (income) (INVESTMENT(BALANCE(mfbonds, mfstocks))

Rule 3

(MUCH(savings) $\vee$ ~+ MUCH(savings)) $\wedge$ (~MUCH(income) $\vee$ ⊥MUCH(income) → (INVESTMENT(More(mfbonds, mfstorcks))

Rule 4

~ M U C H (s a v i n g s) $\wedge$ (MUCH(income) $\vee$ ~+MUCH(income) →(INVESTMENT(X,mfstocks)

Rule 5

~MUCH(savings) $\wedge$ (~MUCH(income) $\vee$ ~+MUCH(income) ⊥MUCH(income) → (INVESTMENT (X,bonds)

Rule 6

(~-MUCH(savings) $\vee$ ⊥MUCH(savings) → (INVESTMENT(X,savings)

(2) Collection of examples to explore the membership function

Comprehensive data from TABLE 2 knowledge, the concept of a minimum of high-income 55122 yuan / year or more, up to 108,690 yuan / year, corresponding to the data in the elastic region, respectively [50122, 60122], [103690, 113690] (Unit: yuan).

Concept of minimum income 7122 yuan / year, up to 9661 yuan / year in the following, the corresponding data were elastic region [4125,8125], [10077,14077] (Unit: yuan).

Deposit more than the concept of a minimum of 82,077 yuan, more than a maximum of 3,138,330,000 yuan, respectively, the corresponding data elastic region [62077,102077], [293833,333833] (unit: million).

Deposits with the concept of a minimum of 9,120 yuan or less, a maximum of 34,870 yuan or less, respectively, the corresponding data elastic region [4120,14120], [29870,39870] (unit: million).

Shanghai high-income regions also belong to other regions in high-income, low-income areas in Hubei region also belong to other income for deposits, deposits

FULL PAPER

up to the Beijing area is the highest for the other regions, the lowest in the Shandong region is the lowest for the other regions the.

This feature combined with the data in the discussion of data X to the degree of membership of the fuzzy sets, the use of one dimensional Euclidean distance measure, denoted as *d (x, y)*, namely d (x, y) =. If data X the fuzzy set *UCH (savings)* the higher the degree of membership, then from ⊥ MUCH (savings) the farther the data area, thereby obtaining the following definition:

Definition 4 Let be a fuzzy set in TABLE 2 for the most true MUCH survey data, is the elastic amplitude of the data. is the truest Survey data of the fuzzy sets ⊥ MUCH, is the elastic amplitude,any survey data X,from definition 1,

$$MUCH(X)=\begin{cases}0 & X\le \alpha_F-\varepsilon_F\\ \dfrac{d(X,\alpha_F-\varepsilon_F)}{d(\alpha_F-\varepsilon_F,\alpha_T+\varepsilon_T)} & \alpha_F-\varepsilon_F<X<\alpha_T+\varepsilon_T\\ 0 & X\ge \alpha_T+\varepsilon_T\end{cases}$$

from definition 2, ⊥MUCH(X)=1- MUCH(X).

For income from table 2: α_T =108690,α_F =7122,ε_T =5000,ε_F =2000, Analogously, for deposits: =313833, =9120,=20000,= 5000.

(3) Establishment of parameter p

In Shanghai, for example, the concept was 108,690 more than high-income, low-income concept is 12,077 or less. Defined by four, then there (retained three decimal places):

MUCH(108690)=d(108690, 5122)/d(5122, 113690)=0.954

⊥MUCH(108690)=1-0.954=0.046

MUCH(12077)=0.073,⊥MUCH(9661)=1-0.073=0.927

High-income and low-income pair is established on the concept of regional income to reflect the status of two important indicators, therefore, study the income situation of a region should consider them. Using the weighted average of the ideological factor attributes, according to the literature, so p=(0.954+0.927)/2=0.941,if MUCH(income(X)) > p = 0.941,X is high income in Shanghai area; if ⊥MUCH(income(X))>p =0.941,X is low income in Shanghai area

Similarly, to get around the income and deposits p Index in TABLE 3.

Determine the value of p can be assessed on income and deposits numerically according to region and if a specific survey data X from Hubei, Hubei will refer to the corresponding p values to assess if the data from Guangdong, Guangdong, they refer to the corresponding the p index.

TABLE 3 : Income concepts and ideas deposits p index

Provinces	Income concepts	deposits concepts
Hubei	0.726	0.633
Guangdong	0.830	0.677
Shanghai	0.945	0.866
Beijing	0.904	0.923
Jiangsu	0.823	0.653
Zhejiang	0.880	0.699
Tianjin	0.831	0.704
Fujian	0.806	0.618
Shandong	0.780	0.611

Based on fuzzy set FScom fuzzy production rules

Determine p values and data X for the corresponding fuzzy set membership degrees, according to the investment rules prerequisites and the degree of matching data X to make the appropriate decisions to facilitate the process, consider using fuzzy production rules.

A fuzzy production rules The general form is:
Q←P,CF,k or *IF P THEN Q, (CF,k)*

P represents a set of assumptions or conditions, Q represents a number of conclusions or action, Premise P and conclusion Q can be ambiguous. CF(0≤ CF≤1) called the confidence of the rule,k(0≤k≤1) is a threshold. The meaning of this rule is "If the premise P is satisfied in a way you can launch a certain fidelity conclusion Q (or action Q), the credibility of the rules for the CF".

In discussing the true value of logical reasoning formula when k parameters according fuzzy sets FSeom calculate the actual meaning and if a rule premise *MUCH (income)* and X belongs to the Shanghai area,from table 3,p=0.51,and only if *MUCH(income(X))>0.51*, In order to explain X in the Shanghai area belong to high-income people. So, characteristics of parameter p to some extent with the threshold k has some similarities. When the rule confidence values greater than p p This article will as a rule logic threshold formulas, that is k=p.

If there are multiple sets in rules prerequisite,for example:

Q←P1,P2,…,Pn,CF,k, which k related to the collection { P_1, P_2,..., P_n },so threshold k=max{ P_1, P_2,..., P_n },and pi is parameter index for the area of the discussion object of Pi,so if P is the income of Shanghai,from table 4,pi =0.749.

When the data X can meet the conditions of a rule P_1, P_2,..., P_n, then the action part of the rule is executed Q, reasoning ends.

Concrete realization

Continue the discussion of fuzzy production rules for Rule 6:

(~-MUCH(savings) $\bigvee$ ⊥MUCH(savings) →

(INVESTMENT(X,savings)

Obviously, *INVESTMENT* is a binary predicate clear, but it is true extent dependent on the ¥" *MUCH (savings (X))* and ~-*MUCH (savings (X))*. This logic formulas as production rules, rules credibility can also be obtained through the random survey, in which we may assume that this rule credibility CF = 0.96> p. If the inspection object is located in Shanghai, the threshold k p = 0.951 desirable values.

Therefore, this rule can be expressed as:

INVESTMENT(X,savings)←(~-

MUCH(savings) $\bigvee$ ⊥MUCH(savings)),0.96,0.951

Similarly, the remaining rules can also be transformed into an object under investigation fuzzy production rules may assume Rule l ~ Rule 6 Rule credibility are 0.96.

Example: Lucas lives in Hangzhou, annual salary of 60,000 yuan / year, personal bank deposits 300,000 yuan, with reference to the investment strategy in 2007 how he should choose to invest in solutions.

First, Lucas living in Hangzhou, determining income take p1 = 0.832, when determining deposit taking p2 = 0.638. Clearly, p1, p2 is less than CF = 0.96.

From definition 4, savings and revenue as following:

MUCH(savings(300 thousand))=d(30,0.78)/d(0.78,37.94)= 0.786,

⊥MUCH(savings(300 thousand))=0.214,~MUCH(savings(300 thousand))=(2×0.638-1) ×(0.786-0.638)/(1-0.638)+1-0.638=0.399,

~+MUCH(savings(300 thousand))=l,~-MUCH(savings(300 thousand))=0.

MUCH(income(60 thousand))=d(60000,6122)/d(6122,91949)=0.628, ⊥MUCH(income(60 thousand))=0.372,

Because 0.372<MUCH(income(60 thousand))=0.628<0.832,

~MUCH(income(60 thousand))=1,

~+MUCH(income(60 thousand))=l,~-MUCH(income(60 thousand))=0.

Secondly, in the investment cycle rule base to find, when Lucas's data to meet the conditions of a certain part of investment rules, then executes the rule's action part of the rule 1:

mfbonds))←(MUCH(savings) $\bigvee$ ~+MUCH(savings) $\bigwedge$

(MUCH(income),0.96,0.832;

Prerequisite matching degree: set t1=min{0.786,0.96}=0.786>0.638, description Lucas belong to more deposits, but t2 =min{0.628,0.96}=0.628<0.832, description Lucas not belong to high income, the rules cannot be executed.

From rule 2:

INVESTMENT(BALANCE(mfbonds, mfstocks))

←(MUCH(savings) $\bigvee$ ~+MUCH(savings) $\bigwedge$

(~MUCH(income) $\bigvee$

~+MUCH(income)),0.96,0.832;

Similarly, t1=min{0.786,0.96}=0.786 >0.638,description Lucas belong to more deposits, and t2=min{1,0.96}=0.96>0.832, ~+MUCH(income(60 thousand))=1, description Lucas belong to medium high income, Prerequisites are met, then the implementation of the rules two actions. Summary, this person may take Rule 2 for financial management.

Until the fuzzy inference is a type of cycle, execution when a rule precondition is satisfied. The action

FULL PAPER

part of the rule to calculate this end.

SUMMARY

Based on fuzzy sets FScom, discusses the financial investment decision and its various negative fuzzy knowledge representation and reasoning which, expanded definition of fuzzy set ~ + A and ~-A; with a real financial investment decisions, for example, gives the definition of fuzzy set FScom parameters p and fuzzy production rules in a determined threshold value k method, and on this basis, automated reasoning and implementation; indicate fuzzy sets FScom in fuzzy knowledge of the "no" case, which means that as well as reasoning is validity.

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