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Risk analysis model based on the three-way decisions' boundary domain

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ABSTRACT

The three-way decisions theory is formulated based on the notions of acceptance, rejection and noncommitment. The theory, which is an extension of the commonly used binary-decision model with an added third option, has been widely used in many fields and disciplines. Considering the costs of noncommitment are often the same with misjudgment in the positive region or negative region. That the basis of noncommitment decision converting to acceptance or rejection and the invert costs function are given as an aid in the scheme of decision making, further improved the three-way decisions.

Key words: three-way decisions; noncommitment decision; costs function; misjudgment

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INTRODUCTION

The Three –way decisions is a new theory proposed by Y.Y.Yao et al who based on decision-theoretic rough sets [1]. Professor Y.Y.Yao gave congress academic report and systematically introduced the background, the framework and the application of three-way decisions theory at the Rough Set and Soft Computing Conference in China on October,2012. The Theory and Application of Three-way decisions[2] marked the three-way decisions has gradually developed from the semantic interpretation of rough set in the three intervals developing to a decision theory under the condition of uncertainty or incomplete information. Many scholars not only researched and expanded the three-way decisions theory, but also applied it to multiple disciplines [3-9]. In 2013, the Chinese academic conference on rough sets and soft computing specifically set up discussion class on three-way decisions. Experts and scholars from all over the world discussed the new development of the research and the future of three-way decisions. Three-way decisions use acceptance, rejection, and noncommitment to express three types in decision-making. In fact, the effect of the noncommitment equals to acceptance. As in investment issues, Results of ideas based on three-way decisions will be "invest, failure to invest, noncommitment to invest". But "noncommitment to invest" is equivalent to "now don't invest", and it also needs to undertake the risks[10-13] and various consequences when the economic situation changes. And in some emergency actions, such as for some serious patients, three-way decisions' consequences are "surgery, no surgery, noncommitment to surgery ". The risk of "noncommitment to surgery" is equivalent to the risk of "no surgery". Therefore, it is not enough to present only three-way decisions, it is necessary for us to consider the noncommitment decision' costs, and turned noncommitment decision into acceptance or rejection. And conversion costs function should be given.

This paper discusses how to deal with the three-way decisions' noncommitment decision, and gives costs function of conversion from noncommitment to acceptance or rejection. This is a further study of the three-way decision theory.

THT ESSENTIAL IDEA OF THREE-WAY DECISIONS

The essential idea of Three-way decisions is to introduce two thresholds to entity evaluation function, and construct three needed domains. Suppose U is a finite nonempty set or decision alternatives and C is a finite set of conditions. Each condition in C may be a criterion, an objective, or a constraint. Our Decision task is to make corresponding decision based on the given conditions of each entity $x \in U$. Conditions set C give the basis of the decision and the

result by constructing evaluation function. When information is uncertain or incomplete, we may not be able to determine whether the entity is to meet the conditions. In other words, evaluation function estimate whether the entity satisfies the conditions. It is not a precise value. Due to the uncertainty of the estimation, it is not appropriate to apply binary decision. We bring in the three-way decisions when the evaluations function value is neither high nor low, in which both acceptance and rejection appear unreasonable. The given thresholds are α and β:

When the evaluations function value is greater than or equal to β, we choose to accept the entity;

When the evaluations function value is smaller than or equal to α, we choose to reject the entity;

When the evaluations function value is between α and β, we neither refused nor accepted but to choose not to promise.

In decision making, when lack of information or obtain letter requires a certain price, we can give three-way decisions of acceptance, rejection and noncommitment. Rough set is a typical three-way decision-making model. The positive domain, negative domain and boundaries in Rough Set model can be interpreted to acceptance, rejection and noncommitment of the three-way decisions.

Table 1: three-way decisions table

Decision function f	Results of three-way decisions
$[0,\alpha]$	rejection
$[\alpha,\beta]$	noncommitment
$[\beta,1]$	acceptance

RISK ANALYSIS ON NONCOMMITMENT DECISION OF THREE-WAY DECISIONS

In practical application, the costs of noncommitment are often the same with misjudgment in positive or negative domains.

Such as in medical diagnosis：according to the patient's clinical performance, there aren't sufficient evidence for the doctor to determine whether patients suffer from a disease ω, while the patient is in such a state of emergency (such as life-threatening) that he must immediately makes a decision. The actual result of noncommitment decision is equivalent to no cure. Then he has to accept the risk of no cure with patients taking diseases actually. We need to clarify the price of how noncommitment decision turns into cure and no cure and then choose the smaller decision cost scheme.

In the peer review system，the journal organization experts review manuscripts to decide whether manuscripts is adopted, revised or rejected. The revised manuscript also takes revising costs and cycle, etc. We need to identify the manuscript value, in order to ensure that the costs of revise are not greater than the costs to adopt or reject.

In deciding an investment, we analyses the current situation and their condition to decide whether to invest. The actual effect of noncommitment is equivalent to no investment now. But if we missed the best investment opportunity, we may need to pay a greater price.

Suppose $\Omega=\{C,C^C\}$ is the set of two states, C expresses that entity is a member of set C, C^C express that entity is not a member of set C. To facilitate the discussion, here apply set C to signify the set itself and its corresponding states. Each state corresponds to three kinds of decision actions, a collection of these three actions is $A=\{a_P,a_N,a_B\}$. a_P, a_N and a_B respectively are the entity 's classification actions which decide x in positive domain $x\in POS_{(\alpha,\beta)}(C)$, decide x in negative domain $x\in NEG_{(\alpha,\beta)}(C)$ and decide x in boundary domain $x\in BND_{(\alpha,\beta)}(C)$. If an entity belongs to a collection of C, λ_{PP}, λ_{NP} and λ_{BP} respectively show the corresponding costs of a_P, a_N and a_B; If an entity does not belong to a collection of C, λ_{PP}, λ_{NP} and λ_{BP} respectively show the corresponding costs of a_P, a_N and a_B.

Table 2: Decision price table

	$C(P)$	$C^C(N)$
a_P	λ_{PP}	λ_{PN}
a_N	λ_{NP}	λ_{NN}
a_B	λ_{BP}	λ_{BN}

The value in decision price table meets the conditions：

$$\lambda_{PP} \le \lambda_{BP} \le \lambda_{NP} \qquad \lambda_{NN} \le \lambda_{BN} \le \lambda_{PN} \qquad ①$$

Risk on three-way decisions' "noncommitment decision " is reflected in two aspects：

（1） Existence：$\lambda_{BP} \ge 0$ and $\lambda_{BN} \ge 0$

（2） Importance：when "="in ① is found，the three-way decisions' noncommitment cost the same with misjudgment in positive or negative domains, and it needs to take the equivalent risk of λ_{NP} or λ_{PN} .

Based on the above two points，it is not enough to present three-way decisions, it is necessary for us to consider the noncommitment decision' costs, and turn noncommitment to acceptance or rejection. And conversion costs function should be given.

MANAGEMENT ON THREE-WAY DECISIONS' NONCOMMITMENT DECISION

We should choose the least costly solution to turn noncommitment into acceptance or rejection. Supposing evaluating function is f， we bring in λ_{PB} and λ_{NB} to express the costs. When evaluating function f is in boundary domain but we give the positive decision or negative position.

It is not difficult to draw the following conclusions：

When $\lambda_{PB} < \lambda_{NB}$， the costs of making positive decision are smaller and the decision result is more reasonable；

when $\lambda_{PB} > \lambda_{NB}$, the costs of making negative decision is smaller and the decision result is more reasonable.

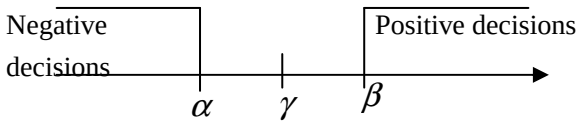

Fig. 1: Three-way decision

The realization of three-way decisions' noncommitment decision turning into binary decisions requires three important steps:

determine the classification thresholds α , β of the three-way decisions；

calculate the value of λ_{PB} and λ_{NB} ;

When $\lambda_{PB} < \lambda_{NB}$， the costs of making positive decision are smaller and the decision result is more reasonable ;when $\lambda_{PB} > \lambda_{NB}$, the costs of making negative decision are smaller and the decision result is more reasonable

input：classification threshold of the three-way decisions α , β

output：decision table like the following table 3：

Table 3: output decision table

Decision function f	result of three-way decisions	turn into the binary decisions	costs
$[0,\alpha]$	rejection	rejection	tolerance interval
$[\alpha,\beta]$	Noncommitment	rejection	$\lambda_{PB} > \lambda_{NB}$
		acceptance	$\lambda_{PB} < \lambda_{NB}$
$[\beta,1]$	acceptance	acceptance	tolerance interval

APPLICATION CASE

A Couple decided to buy a house in the city, expecting to buy it at price 7000 yuan per square meters, with living space of 90 square meters. Currently the purchasing power of them is as follows: at present their money that can be used to buy house is 20,0000 yuan and their family income per month is 8000 yuan. Please according to the present housing situation and the economic condition of the couple, help them to make decisions, whether to buy or not and why.

(1) For the total revenue, the proportion of monthly expenses for real estate is recorded as the evaluation function f . The smaller the f is, the smaller the impact on life will be. The result can be more acceptable; on the contrary, they may live in shabby conditions in a early time, and the result would not be accepted easily. It is a process for people to accept it, with the f changing from little to large. After overall consideration, the threshold values are set: α =0.3、 β =0.5. When $f < 0.3$, it is a completely acceptable payment scope. At this time the family can make the decision " to buy a house"; when $f >$ 0.5, it is beyond the expectations of the family. At this time the family can make the decision "not to buy a house"; when 0.3< f <0.5， the family hesitate about it. With three-way decision ideas, the decision in the range is temporarily not considering buying a house.

In view of the case,with accumulation fund loan method and the "mortgage calculator——equal principal repayment method", the results are as follows:

Total price: 630000 yuan
Total loan: 441000 yuan
Total repayment: 669596.1 yuan
Total interest: 228596.1 yuan
Initial payment: 189000 yuan
Repayment schedule: 240 month
Monthly payment: 2789.98 yuan

Fig.2 computing result

At this time $f =$ 2789.98/8000=0.35， 0.3< f <0.5， the results of three-way decisions is "not considering buying a house":

Table 4: Case output in three-way decisions

decision function f	case output three-way decisions
$[0,0.3]$	buy a house
$[0.3,0.5]$	temporarily not considering buying a house
$[0.5,1]$	not to buy a house

(2)But for ordinary families, choosing the right time to buy a house is a major decision of the family， and once the decision-making is wrong, they will suffer great losses. Such as when they decide not to buy one at the right time, they may lose the best price advantage; and when buy a house at wrong time, one may receive a lot of interests and at the same time hold up the money. Besides, the actual effect of "temporarily not consider to buy a house" is equivalent to not to buy a house. It also needs to take losses when should buy but didn't do it. We analyze values of λ_{PB} (costs of evaluating function f are in boundary domain but we give the positive decision)and λ_{NB} (costs of

evaluating function f are in boundary domain but we give the negative decision) as follows.

λ_{PB} includes two factors：related factors（early high repayment pressure）, less related causes（prices may fall）. λ_{NB} includes two factors：related factors（early high repayment pressure, but all of them can't overcome）, less related causes（prices may rise）. Score the comprehensive risk of related factors and less related causes from 1to10. The higher the score is, the higher the risk is. Choose the weighting method to conduct the risk assessment of the above four factors respectively：

λ_{PB} = related factors（early high repayment pressure）*30% + less related causes（prices may fall）*70% = 7*30%+1*70%=2.8

λ_{NB} = related factors（early high repayment pressure, but all of them can't be overcome）*30% + less related causes（prices may rise）*70% = 3*30%+8*70%=6.5

Obviously at this time $\lambda_{PB} < \lambda_{NB}$, although evaluating function f is in boundary domain, the positive decision is better than the negative decision. So in the case of necessity, turning "temporarily not consider to buy a house" into "buy a house" is less risky.

(3)input：classification threshold of the three-way decisions: α =0.3、β =0.5
output：decision table like table5：

Table5: Case output three-way decisions auxiliary

decision function f	result of three-way decisions	turn into the binary decisions	costs
$[0,0.3]$	buy a house	buy a house	tolerance interval
$[0.3,0.5]$	temporarily not considering buying a house	buy a house	$\lambda_{PB} > \lambda_{NB}$
$[0.5,1]$	not to buy a house	not to buy a house	tolerance interval

CONCLUSION

We do not deny the importance of three way-decisions in the decision-making problems, but to perfect it. On the basis of the given three-way decisions, we give the process converting noncommitment decision into binary decisions, which provides reference comments for decision-makers. And it has important application value under the condition without risky commitment.

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REFERENCES

[1] Li H X, Liu D, Zhou X Z. *Journal of chongqing university of posts and telecommunications：Natural Science*, v. 22, p. 624-630, **2012**
[2] Jia X Y, Shang L, ect. Three decision-making theory and application, Nanjing University Press, **2012**.10
[3] Liu D, Yao Y Y, Li T R. *Computer Science*, v. 38, p. 245-250, **2011**
[4] Jia X Y, Shang L, Chen J J. *China's progress in artificial intelligence*. p.193-198, **2009**
[5] Yu H, Wang G Y. *Decision-making and rough set theory and its research progress. Beijing：Science Press*, **2011**
[6] Yu H, Chu S S. *Computer Science*,v.38, p. 221-224, **2011**
[7] Jia X Y, Shang L. *Journal of Chinese Computer Systems*, v. 11, n. 11, p. 2603-2606, **2013**
[8] Azam N, Yao J T. *Proceedings of the 7th International Conference on Rough Sets and Knowledge Technology*,LNAI 7414, p. 399-408, **2011**
[9] Deng X F, Yao Y Y. *Proceedings of the 8th International Conference on Rough Sets and Current Trends in Computering*, **2012**
[10] Jia X Y, Liao W H, Tang Z M, et al. *Information Sciences, In Press.* http://dx.doi.org/10.1016/j.ins, **2012**

[11] Li H X, Zhou X Z. *International Journal of Computational Intelligence Systems, v.* 4, p. 1-11, **2011**
[12] Li H X, Zhou X Z, Zhao J B, et al. *Proceedings of the 8th International Conference on Rough Sets and Current Trends in Computing(RSCTC2012)*, **2012**
[13] Liu D, Yao Y Y, Li T R. *International Journal of Computational Intelligence Systems* v. 4, p. 66-74, **2011**