Available online at www.sciencedirect.com
ScienceDirect
International Journal of Approximate Reasoning
49 (2008) 331–343
INTERNATIONAL JOURNAL OF APPROXIMATE REASONING
www.elsevier.com/locate/ijar

Variable precision rough set for group decision-making: An application

Gang Xie [a,b,*], Jinlong Zhang [b], K.K. Lai [c], Lean Yu [d]

[a] Center for Energy and Environmental Policy Research (CEEP), Institute of Policy and Management, Chinese Academy of Sciences, Beijing 100080, China
[b] School of Management, Huazhong University of Science and Technology, Wuhan 430074, China
[c] Department of Management Sciences, City University of Hong Kong, Hong Kong
[d] Institute of Systems Science, Academy of Mathematics and Systems Science, Chinese Academy of Sciences, Beijing 100080, China

Received 12 March 2006; received in revised form 8 March 2007; accepted 10 April 2007
Available online 22 October 2007

Abstract

This study uses the variable precision rough set (VPRS) model as a tool to support group decision-making (GDM) in credit risk management. We consider the case that the classification in decision tables consisting of risk exposure (RE) may be partially erroneous, and use a variable precision factor β_k to adjust the classification error. In this paper, we firstly combine VPRS and AHP to obtain the weight of condition attribute sets decided by each decision-maker (DM). Then, the integrated risk exposure (IRE) of attributes is obtained based on the three VPRS-based models. Subsequently, a new procedure of obtaining β_k-stable intervals for DM_k is investigated. To verify the effectiveness of these proposed methods, an illustrative example is presented. The experimental results suggest that the VPRS-based IRE have advantages in recognizing important attributes.

Keywords: Variable precision rough set; Analytical hierarchy process; Weight; Group decision-making

1. Introduction

In real life, many important decision problems are not determined by a single decision-maker (DM) but by a group of DMs [1,2]. In group decision-making (GDM), group members usually make judgments on the same decision problem independently. Due to the difference amongst group members, there may be great disagreements on the same decision problem. Therefore, how to effectively integrate the evaluation of each group member into a group's consensus is an interesting and valuable issue [3,4].

* Corresponding author. Address: Center for Energy and Environmental Policy Research (CEEP), Institute of Policy and Management, Chinese Academy of Sciences, Beijing 100080, China. Tel.: +86 10 82614654; fax: +86 10 62542619.
E-mail addresses: gxie@casipm.ac.cn, xgbill@hotmail.com (G. Xie).

0888-613X/$ - see front matter
doi:10.1016/j.ijar.2007.04.005

In the GDM field, the importance of individuals in GDM has been widely investigated. Usually, the individual importance reflects that DMs have different weights in GDM [5–7]. Ramanathan used the analytical hierarchy process (AHP) technique to obtain members' weight, and aggregate group preference [5]. Van den Honert derived group members' influence weights using the multiplicative AHP and SMART (which together form the REMBRANDT system) [6]. Considering the individual importance in the group is non-equivalent, Beynon combined the Dempster–Shafer theory of evidence and AHP to aggregate the evidence from members of a decision-making group. Based on the perceived individual levels of importance, a discount rate value is defined for each DM [7]. However, the perceived importance of each member in the literature is determined in a rather subjective way. That is to say, the personal judgment biases may influence the initial weights determination. On the other hand, in some objective approaches, the weight is often affected by insufficient knowledge or experience of some group members. Due to these reasons, neither the subjective approaches nor the objective approaches may be the best method for weight determination. Thus, a rational solution is to combine the two [8].

In [8], Turban et al. integrated objective approaches (using impact factor) and subjective approaches (using expert judgments) based on fuzzy set theory to evaluate the quality of journals. They assumed that either impact factor or expert judgments might be missing. If the impact factor of a journal is unknown, the objective weight is set to 0. If any expert cannot give judgment information of a journal, they set the weight of the expert to be 0. In this way, they remove the impact of the incomplete preference information on the results [8]. However, Turban et al. did not consider such a problem that the experts' judgment might be partially erroneous. That is, experts' scores often generate biases due to many reasons, such as experts' experience and knowledge, etc.

In fact, DMs may make mistakes during the decision-making process for the following reasons: (1) a decision must be made by DMs in a limit time [9], (2) DMs often lack complete information [9], (3) DMs are more likely to be cardinally inconsistent [10], (4) DMs exhibit bias to some extent due to their limited information processing capabilities [10], and (5) all participants in the GDM may not have equal expertise about the decision area [11]. In such situations, some analytical tools, such as AHP [5–7], linear programming [9], fuzzy set theory [8,11], and their combinations of the methods [12] were used in GDM. However, these tools are difficult to handle errors or inconsistency caused by DMs effectively. In this study, the variable precision rough set (VPRS) [15,16] technique that is able to remove this sort of error easily in GDM is used to deal with this problem.

The VPRS model, firstly proposed by Ziarko [15], is an effective mathematical tool with an error-tolerance capability to handle uncertainty problem. Basically, the VPRS is an extension of Pawlak's rough set theory [13,14], allowing for partial classification. By setting a confidence threshold value β, the VPRS cannot only solve classification problems with uncertain data and no functional relationship between attributes, but also relax the rigid boundary definition of Pawlak's rough set model to improve the model suitability. Due to the existence of β, the VPRS can resist data noise or remove data errors [17]. In order to determine a rational change interval for β, we will investigate the β-stable interval of each DM.

In our previous research in GDM, experts are invited to evaluate the risk exposure (RE) of the risk items (condition attributes) and the projects (decision attributes) [18]. Decision tables consisting of the RE are established in [19–21]. Assuming the DMs have same weights [19] and different weights [20], we use VPRS to process the data in decision tables and obtain the significance of each risk items. Then, we develop a risk avoidance group decision support system [21]. In particular, in the previous paper that we presented at RSFDGrC 2005 conference, DMs may have different weights. In that paper, we divide the weight of a DM into two parts: subjective weight and objective weight [20]. Integrated risk exposure (IRE) of the projects and risk items are computed based on the integration of RE, significance of risk items and the weights of DMs. Then, risk avoidance measures, the rank of risk avoidance strength and risk avoidance methodology are discussed. This research extends the study in [20], and we establish another two models to obtain the IRE based on the VPRS, which will be introduced in Section 3. In addition, we investigate the β_k-stable interval of each DM, and study a new application on credit risk management. Finally, a naive GDM model is also presented to compare with the three VPRS-based GDM models, and meantime some interesting results are found.

The remainder of the paper is organized as follows. In Section 2, preliminary notions related to AHP are introduced. Then, the VPRS and AHP are combined to obtain the weight of condition attribute sets decided