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An intelligent-agent-based fuzzy group decision making model for financial multicriteria decision support: The case of credit scoring

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Abstract

Credit risk analysis is an active research area in financial risk management and credit scoring is one of the key analytical techniques in credit risk evaluation. In this study, a novel intelligent-agent-based fuzzy group decision making (GDM) model is proposed as an effective multicriteria decision analysis (MCDA) tool for credit risk evaluation. In this proposed model, some artificial intelligent techniques, which are used as intelligent agents, are first used to analyze and evaluate the risk levels of credit applicants over a set of pre-defined criteria. Then these evaluation results, generated by different intelligent agents, are fuzzified into some fuzzy opinions on credit risk level of applicants. Finally, these fuzzification opinions are aggregated into a group consensus and meantime the fuzzy aggregated consensus is defuzzified into a crisp aggregated value to support final decision for decision-makers of credit-granting institutions. For illustration and verification purposes, a simple numerical example and three real-world credit application approval datasets are presented.

Keywords: Multicriteria decision analysis; Fuzzy group decision making; Intelligent agent; Credit scoring; Artificial intelligence

1. Introduction

Without doubt credit risk evaluation is an important topic for research in the field of financial risk management. Generally, an accurate evaluation of credit risk could be transformed into a more efficient use of economic capital. When some customers fail to repay their debt, it leads to a direct economic loss for the lending financial organizations. If a credit-granting institution refuses loans to applicants with good credit scores, the institution loses the revenue it can earn from the applicant. On the other hand, if a credit-granting institution accepts applicants with bad credit scores, it may incur losses in the future – i.e. when the applicant fails to repay the debt. Therefore, credit risk evaluation is of extreme importance for lending organizations. Furthermore, credit risk evaluation has become a major focus of finance and banking industry due to the recent financial crises and regulatory concerns reflected in Basel II. For any credit-granting institution, such as a commercial bank or a retail financial company, the ability to discriminate good customers from bad ones is crucial for survival and development. The need for reliable models that can predict defaults accurately is imperative, in order to enable the interested parties to take either preventive or corrective action (Wang et al., 2005; Lai et al., 2006b,d).

In credit risk evaluation, credit scoring is one of the key analytical techniques. As Thomas (2002) defined, credit scoring is a technique that helps some organizations, such as commercial banks and credit card companies, determine whether or not to grant credit to consumers, on the basis of a set of predefined criteria. Usually, a credit score is a number that quantifies the creditworthiness of a person, based on a quantitative analysis of credit history and other criteria; it describes the

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extent to which the borrower is likely to pay his or her bills/debt. A credit score is primarily based on credit reports and information received from some major credit reporting agencies. Using credit scores, banks and credit card companies evaluate the potential risk involved in lending money, in order to minimize bad debts. Lenders can also use credit scores to determine who qualifies for what amount loan and at what interest rate. The generic approach of credit scoring is to apply a quantitative method on some data of previous customers – both faithful and delinquent customers – in order to find a relationship between the credit scores and a set of evaluation criteria. One important ingredient to accomplish this goal is to seek a good model so as to evaluate new applicants or existing customers as good or bad.

Due to the importance of credit risk evaluation, there is an increasing research stream focussing upon credit risk assessment and credit scoring. First of all, many statistical analysis and optimization methods, such as linear discriminant analysis (Fisher, 1936), logistic analysis (Wiginton, 1980), probit analysis (Grablowsky and Talley, 1981), linear programming (Glover, 1990), integer programming (Mangasarian, 1965), *k*-nearest neighbor (KNN) (Henley and Hand, 1996) and classification tree (Makowski, 1985), are widely applied to credit risk assessment and modeling tasks. Although these methods can be used to evaluate credit risk, the ability to discriminate good customers from bad ones is still a problem; the existing methods have their inherent limitations and can be improved further. Recent studies have revealed that emerging artificial intelligent (AI) techniques, such as artificial neural networks (ANNs) (Lai et al., 2006b,d; Malhotra and Malhotra, 2003; Smalz and Conrad, 1994), evolutionary computation (EC) and genetic algorithm (GA) (Chen and Huang, 2003; Varetto, 1998) and support vector machine (SVM) (Van Gestel et al., 2003; Huang et al., 2004; Lai et al., 2006a,c) are advantageous to statistical analysis and optimization models for credit risk evaluation in terms of their empirical results.

Although almost all classification methods can be used to evaluate credit risk, some combined or ensemble classifiers, which integrate two or more single classification methods, have turned out to be efficient strategies for achieving high performance, especially in fields where the development of a powerful single classifier system is difficult. Combined or ensemble modeling research is currently flourishing in credit risk evaluation. Recent examples are neural discriminant model (Lee et al., 2002), neuro-fuzzy model (Piramuthu, 1999; Malhotra and Malhotra, 2002), fuzzy SVM model (Wang et al., 2005) and neural network ensemble model (Lai et al., 2006b). A comprehensive review of literature about credit scoring and modeling is provided in two recent surveys (Thomas, 2002; Thomas et al., 2005).

Inspired by the combined or ensemble techniques, this study attempts to apply a group decision making (GDM) technique to support credit scoring decisions, using advanced computing techniques (ACTs). As is known to all, GDM is an active search field within multicriteria decision analysis (MCDA) (Beynon, 2005). In GDM, group members first make their own judgments on the same decision problems independently, i.e. decision actions, alternatives, projects and proposals and so on. These judgments from different group members are then aggregated to arrive at a final group decision. Different from the traditional GDM model, this study utilizes some artificial intelligence (AI) techniques to replace human experts. In the proposed approach, these AI agents can be seen as decision members of the decision group. Like human experts, these intelligent agents can also give some evaluation or judgment results on a specified problem, in terms of a set of predefined criteria. Relative to human experts' judgments, evaluation results provided by these intelligent agents (based on a set of criteria) are more objective because these intelligent agents are little affected by external considerations. Nevertheless, since some of the parameters and sampling of these intelligent agents are variable and unstable, these agents can often generate different judgments even though the same criteria are used. For handling these different judgments, we apply the fuzzification method. Thus the problem is further extended into a fuzzy GDM analytical framework. In this study, we try to propose an intelligent-agent-based fuzzy GDM model for credit scoring.

Generally, the proposed fuzzy GDM model is composed of three stages. In the first stage, some intelligent techniques as intelligent agents are used to analyze and evaluate the decision problems over a set of criteria. Because of different sampling and parameter settings, these intelligent agents may generate different judgments on the same decision problems. For handling these different judgments, the fuzzification method is utilized to formulate fuzzy judgments in the second stage. In the third stage, using classical optimization techniques and defuzzification method, these fuzzy opinions are finally aggregated into a group consensus as the final criterion for decision-making.

The purpose of this study is to propose an intelligent-agent-based fuzzy GDM model to support financial multicriteria decision making (MCDM) problems. Using the proposed model, many practical financial MCDM problems, such as enterprise financial condition diagnosis and financial risk analysis, can be solved effectively. For these real-world problems, decisions are made on the basis of a set of pre-defined criteria. Therefore, the proposed fuzzy GDM is suitable for solving these financial MCDM problems. As an illustration, a class of real-world MCDM problem concerning loan application approval is investigated in this study, using the credit scoring technique. Granting loan to applicants is an important financial decision problem, associated with credit risk of applicants, for most financial institutions. Usually, for applicants seeking small amounts of loans, the credit decision can be based on a standard scoring process. However, when amounts of loans are large, the decision-making process becomes more complex. In most situations, the decisions are made by a decision group not only because of the business opportunity at stake but also because of wider implications of the decision in terms of responsibility. DeSanctis and Gallupe (1987) highlight the reason for GDM – may be the problem is too significant for