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Credit scoring using the hybrid neural discriminant technique

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Abstract

Credit scoring has become a very important task as the credit industry has been experiencing double-digit growth rate during the past few decades. The artificial neural network is becoming a very popular alternative in credit scoring models due to its associated memory characteristic and generalization capability. However, the decision of network's topology, importance of potential input variables and the long training process has often long been criticized and hence limited its application in handling credit scoring problems. The objective of the proposed study is to explore the performance of credit scoring by integrating the backpropagation neural networks with traditional discriminant analysis approach. To demonstrate the inclusion of the credit scoring result from discriminant analysis would simplify the network structure and improve the credit scoring accuracy of the designed neural network model, credit scoring tasks are performed on one bank credit card data set. As the results reveal, the proposed hybrid approach converges much faster than the conventional neural networks model. Moreover, the credit scoring accuracies increase in terms of the proposed methodology and outperform traditional discriminant analysis and logistic regression approaches.

Keywords: Credit scoring; Discriminant analysis; Neural networks; Model basis

1. Introduction

Starting in the late 1960s, to decide whether to grant credit to customers has gained more and more attention for credit industry due to the industry has been experiencing double-digit growth rate during the past few decades. Credit scoring has become a very important task as the credit industry can benefit from improving cash flow, insuring credit collections, reducing possible risks and implementing better managerial decisions. More and more attention has been paid to credit scoring, and resulting in many different useful techniques, known as the credit scoring models, have been developed by the banks and researchers in order to solve the problems involved during the evaluation process. The objective of credit scoring models is to assign credit applicants to either a 'good credit' group that is likely to repay financial obligation or a 'bad credit' group whose application will be denied because of its high possibility of defaulting on the financial obligation. Therefore credit scoring problems are basically in the scope of the more general and widely discussed discrimination and classification problems (Anderson, 1984; Dillion & Goldstein, 1984; Hand, 1981; Johnson & Wichern, 1998; Morrison, 1990).

In the first beginning, financial institutions always utilized the rules or principles built by the analysts to decide whom to give credit. But it is impossible both in economic and manpower terms to conduct all works with the tremendous increase in the number of applicants. Therefore, there is a need to automate the credit approval decision process. Usually, credit scoring is applied to rank credit information and to target collection activities including the applicant's application form details and the information held by a credit reference agency on the applicant. Besides, the evaluation performance can be improved by using credit scoring with streamlining the process and allowing the credit professional to focus only on unusual accounts. Moreover, the credit scoring can give the credit professional an exposure perspective, mitigate the risk flexibility, and reduce the cost of credit analysis. As a result, accounts with high probability of default can be monitored and necessary actions can be taken in order to prevent the account from being default. In response, the statistical methods, nonparametric statistical methods, and artificial intelligence approaches have been proposed to support the credit decision (Thomas, 2000).

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Generally, two essential linear statistical tools, discriminante analysis and logistic regression, were most commonly applied to construct credit scoring models. In fact, discriminante analysis is the first tool to be used in building credit scoring models. However, the utilization of linear discriminant analysis (LDA) has often been criticized because of its assumption of the categorical nature of the credit data and the fact that the covariance matrices of the good and bad credit classes are unlikely to be equal (Reichert, Cho, & Wagner, 1983). In addition to the LDA approach, logistic regression is an alternative to conduct credit scoring. Basically, the logistic regression model was emerged as the technique of choice in predicting dichotomous outcomes. For predicting dichotomous outcomes, logistic regression has been concluded as one of the most appropriate techniques (Lee, Jo, & Han, 1997). As a matter of fact, Harrell and Lee (1985) found that logistic regression is as efficient as the LDA approach. A number of explorations of logistic regression model for credit scoring applications have been reported in literature. In addition to these typical methodologies, credit scoring has also lends itself to a recent development of neural networks approach. Neural networks provide a new alternative to LDA and logistic regression, particularly in situations where the dependent and independent variables exhibit complex nonlinear relationships. Even though neural networks have shown to have better credit scoring capability than LDA and logistic regression (Desai, Conway, & Overstreet, 1997; Desai, Crook, & Overstreet, 1996; Jensen, 1992; Piramuthu, 1999; West, 2000). It is, however, also being criticized for its long training process in designing the optimal network's topology and hence has limited its applicability in handling credit scoring problems (Chung & Gray, 1999; Craven & Shavlik, 1997).

Aiming at improving the above-mentioned drawbacks of neural networks and increasing the credit scoring accuracies of the existing approaches, the objective of the proposed study is to explore the performance of credit scoring using a two-stage hybrid modeling procedure in integrating the LDA approach with neural networks technique. The rationale underlying the analyses is firstly to use LDA in modeling the credit scoring problems. Then the significant predictor variables are served as the input variables of the designed neural networks model. Besides, the credit scoring result of discriminant analysis is also included in the input layer as extra information trying to give a better initial solution and increasing the credit scoring accuracy. Please note that it is valuable to use discriminant analysis as a supporting tool for designing the topology of neural networks as we can learn more about the inner workings. Besides, as there is no theoretical method in determining the best input variables of a neural network model, the discriminant analysis procedure can be implemented as a generally accepted method for determining a good subset of input variables when many potential variables are considered and thus giving statistical support in deciding the input vector of the designed neural network model. To demonstrate the feasibility and effectiveness that the inclusion of the obtained predictor variables and the credit scoring results from discriminant analysis would improve the credit scoring accuracy of the neural network model, credit scoring tasks are performed on one bank credit card dataset. As to the structure of the designed neural network model, sensitivity analysis is firstly employed to solve the issue of finding the appropriate setup of the network's topology. Analytic results demonstrated that the proposed hybrid model provides a better initial solution and hence converges much faster than the conventional neural networks model. Besides, in comparison with the traditional neural network approach, the credit scoring accuracy increases in terms of the proposed hybrid methodology. Moreover, the superior credit scoring capability of the proposed technique can be observed by comparing the credit scoring results with those using linear discrimintant analysis and logistic regression approaches.

The rest of the paper is organized as follows. We will briefly review the literature of credit scoring and give a brief outline of discriminant analysis, logistic regression and neural networks in Section 2. The developments as well as the analytic results of credit scoring models using discriminant analysis, logistic regression, neural networks, and the hybrid neural discriminant approach are presented in Section 3. Finally Section 4 addresses the conclusion and discusses the possible future research areas.

2. Research methodology and literature review

2.1. Discriminant analysis

Discriminant analysis was first proposed by Fisher (1936) in the 1930s as a discrimination and classification tools. Nowadays, discriminant analysis has been reported as the most commonly discussed and used statistical technique in modeling classification tasks (Lee, Sung, & Chang, 1999). According to some attributes of the predictor variables, discriminant analysis tends to look for the best linear combination of the predictor variables to classify the studying objects into two or more populations at the optimum accuracy (Cooper & Emory, 1995; Dillion & Goldstein, 1984; Johnson & Wichern, 1998).

As to the statistical assumptions in implementing discriminant analysis, Johnson and Wichern (1998) explicated that discriminant analysis requires the data to be independent and normally distributed while the covariance matrix is also required to comply with the variation homogeneity assumption. If the covariance matrices of the given populations are not equal, then the separation surface of the discriminant function is quadratic and hence in this case the quadratic discrininant analysis (QDA) needs to be used. Despite the fact that LDA is only a special case of QDA with stronger assumptions which should restrict its applications, in fact LDA has been reported to be a more