Chapter 6
A Sequential Probabilistic System for Bankruptcy Data Classification

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ABSTRACT

In the last decade, the development of bankruptcy prediction models has been one of important issues in accounting and corporate finance research fields. Indeed, bankruptcy is a critical event that yields important loss to management, shareholders, employees, and also to government. Statistical methods such as discriminant analysis, logistic and probit models were widely used for developing bankruptcy prediction systems. However, statistical-based approaches are assumes strong assumptions including linearity of the relationship among dependent and independent variables, normality of the errors which limit their applicability in bankruptcy real world problems. Recently, machine learning and soft computing techniques including artificial neural networks, support vector machines, and evolutionary intelligence have brought forth new alternatives in solving nonlinear problems with applications in bankruptcy prediction. The purpose of this chapter is to present a sequential probabilistic system for bankruptcy data classification to help manager in making decisions.

INTRODUCTION

Business failure prediction is of major importance for financial institutions and governments for making correct business decision (Thomas et, 2002; Huang et al, 2004; Khashman, 2010; Chen et al, 2013). Indeed, the increase of financial failure accelerates the economic deterioration and yields a lot of social problems (Chen et al, 2013). Thus, the problem of business failure affects investors, creditors, shareholders, and employees (Horta & AS Camanho, 2013). This highlights the importance of developing bankruptcy prediction models to serve as early warning and decision support systems (Thomas et, 2002; Huang et

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al, 2004; Khashman, 2010; Chen et al, 2013). Indeed, the benefits of using a business failure prediction model include reducing the cost of credit analysis, enabling faster decision, insuring credit collections, and diminishing possible risk (West, 2000). In addition, accurate bankruptcy prediction usually leads to better credit risk monitoring, and an increased debt collection rate (Lee & Wu, 2013). In general, the main characteristics of a good bankruptcy prediction model are as follows (Brezigar-Masten & Masten, 2012): reliability and robustness, ease of implementation, high degree of prediction accuracy and clear interpretability and transparency of decision making process.

The purpose of this paper is to present a two-stage probabilistic system to the problem of bankruptcy prediction. In the first stage, a set of initial features (inputs) is processed to select features that affect most probably the class label by using a logistic regression. Indeed, feature selection plays an important role in classification (Luukka, 2011); for instance, it allows simplifying the model, reducing computational cost, removing insignificant features, making the model more transparent and more comprehensible, providing better explanation, and reducing noise. As a result, feature selection may help enhancing the classification accuracy (Luukka, 2011). Logistic regression (Hilbe, 2009) is chosen in this study thanks to its ability to evaluate marginal probability contribution of each feature on class label. In particular, high uncertainty is expected to be related with low marginal probability contribution. Thus, the feature with the lowest probability significance is removed from the initial inputs set. In the second stage, the probabilistic neural network (PNN) (Specht, 1990) is adopted for classification task. It provides a general solution to pattern classification problems based on Bayesian theory. It is able to classify a new sample with the maximum probability of success given a large training set using prior knowledge. As a result, a sequential probabilistic system based on logistic regression for features selection and probabilistic neural network for data classification may achieve high accuracy thanks to marginal probability used for features selection and the learning ability of probabilistic neural networks. For comparison purpose, a bankruptcy classification system based on a conventional neural network trained with the initial features set is adopted as a reference model. The performance of each approach is evaluated in terms of correct classification rate (accuracy), sensitivity and specificity.

BACKGROUND

As the problem of bankruptcy prediction is a kind of binary decision in terms of two-class pattern recognition (Min et al, 2009), several advanced analytical tools that support credit risk assessment and management processes to refine the decision support systems and improve decision making. Indeed, with regard to design bankruptcy prediction systems, numerous strategies have been proposed; including statistical methods and computational artificial intelligence techniques. For instance, the previous works where statistical methods were in bankruptcy prediction include linear discriminant analysis (Tserng et al, 2012), logistic regression (Tsai et al, 2012), multinomial regression (Koksal & Arditi, 2004), regression trees (Brezigar-Masten & Masten, 2012), and multivariate adaptive regression splines (Lasheras et al, 2012). The computational artificial intelligence techniques applied to bankruptcy prediction problem include; for examples; artificial neural networks (ANN) (Thomas et, 2002; Huang et al, 2004; Khashman, 2010; Chen et al, 2013), genetic algorithm (GA) (Min et al, 2009; Chi & Hsu, 2012), ant colony optimization (ACO) (Martens et al, 2010), support vector machines (SVM) (Huang et al, 2004; Min et al, 2009), and case based reasoning (CBR) (Cho et al, 2010); to mention a few.

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