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Warning signals for potential accounting frauds in blue chip companies – An application of adaptive resonance theory

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Abstract

With the constantly changing and deceptive strategies that can be concealed in complex of financial statements, traditional means of financial analysis is unable to detect these accounting frauds in advance. In order to detect new accounting frauds and find out the true meaning of off-balance sheet arrangements, we propose an easy and feasible method using an unsupervised learning system. In unsupervised learning, the training of the network is entirely data-driven and no target results are provided. The features that do not help in clustering can be removed. With unsupervised learning it is possible to learn larger and more complex relations than with supervised learning. In the demonstration, we extract four non-traditional warning signals using adaptive resonance theory, with Enron and WorldCom as prototypes to identify the possibility of potential fraud of a company that investors or analysts may be concerned with.

Keywords: Warning signals; Unsupervised learning; Accounting frauds; Adaptive resonance theory

1. Introduction

Although there are certain companies investors consider to be very safe, the confidence has been shaken by a number of accounting frauds in many large American companies, ranging from hospital suppliers to underwater optical cable and security systems. Large investment banks and independent public accountants have also been involved. In order to secure business from the companies concerned, investment banks present false advice to the public. When the consulting services become very lucrative, there is increasing conflict of interest between the auditing role and consulting role.

Because financial statements are the basis for measuring a company's performance, accounting frauds not only damage the confidence of investors but also damage all the management analysis related to performance. The Sarbanes-Oxley Act of 2002 was imposed to deal with some of these serious frauds, but the suggested reforms still fail to address the major problem that chief executive officers (CEOs), chief financial officers (CFOs), and other directors and officers serve their personal interests to the detriment of shareholders.

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With the esoteric and deceptive strategies in the complexity of financial statements, the traditional forms of financial analysis are unable to detect versatile accounting frauds. In order to detect these accounting frauds and to find out the true meaning of off-balance sheet arrangements, we propose an easy and feasible method using an unsupervised learning system. We use the factor of whether or not significant motive or pressure exists as the complement coding. Even if there are a lot of complex off-balance sheet arrangements, for the frauds involving millions or billions of losses, some items must have abnormal changes or there must be serious liquidity problems. Based on these conjectures and an unsupervised learning system, we sketch out four warning signals.

With unsupervised learning it is possible to learn larger and more complex relations than with supervised learning. The training is entirely data-driven and no target results are provided. The features that do not help in clustering can be removed. The qualitative match-based unsupervised learning of adaptive resonance theory (ART) allows memories to change only when input from the external world is close enough to internal expectations, or when something completely new occurs. This feature makes the ART system well suited to problems that require on-line learning of large and evolving databases, so that it can be used for the analysis of accounting frauds.

2. Neural networks and accounting frauds

Neural network programs are already being used in several financial applications – for fraud detection, economic forecasting, risk management, and establishing credit ratings. For example, Zaromin [26] surveys neural networks used in the financial applications. Welch et al. [25] use a back propagation neural network model to detect bid pricing fraud. Brockett et al. [2] use Kohonen's self-organizing map [12] to uncover automobile bodily injury claims fraud. Lin et al. [14] use a fuzzy neural network to assess the risk of fraudulent financial reporting. However, there are still very few papers that analyze accounting frauds using neural networks.

Most of the applications use the back propagation model with one hidden layer. Lin et al. detect only 7 out of 20 actual fraud cases. The correction rate is much lower than that of guessing. The bad performance of their prediction may come from the misusing of traditional financial ratios as warning signals and therefore the misspecification of the fuzzy functions.

According to Peterson and Zikmund [19], it is the fraud triangle that encourages criminality. First, there must be a significant motive or pressure to commit the fraud. Second, the perceived opportunity to be able to commit the fraud undetected must be present. The third element is rationalization, or finding a morally acceptable excuse. The Sarbanes-Oxley Act of 2002 prohibited most of the frauds from auditors, analysts, and owners' borrowing. It also improves the transparency of reports. But as long as the significant motive or pressure exists, fraud will always be possible.

Accounting frauds make the traditional methods of financial analysis ineffective. For example, the Association of Certified Fraud Examiners (ACFE) 2005 and 2006 fraud surveys [23] also indicate that about 40% of the frauds are detected by tips. Thus, internal audit, internal control, and external audit are relatively ineffective, and so it is very important to propose ex ante warning signals to detect potential frauds for investors or analysts.

Supervised and unsupervised learning differ only in the causal structure of the model. The multi-layer perceptron (MLP) and radial basis function (RBF) are supervised learning types, whereas the self-organizing map (SOM) and adaptive resonance theory (ART) are unsupervised learning types. In supervised learning, the model defines the effect of inputs on outputs. In contrast, with unsupervised learning, the training of the network is entirely data-driven and no target results for the input data are provided. With unsupervised learning it is possible to find larger, more complex, and more versatile frauds than with supervised learning. In SOM, the distance function is essential, and it is part of quantitative analysis. Since distance is no longer important in fraud pattern recognition, the qualitative analysis of ART is more suitable. Using ART, many unimportant features that do not help in clustering can be removed.

Most clustering methods require the number k of clusters to be either specified in advance or selected a posterior from a set of clustering solutions over a range of k. Hruschka et al. [11] therefore propose evolving clusters in gene-expression data. ART can also solve the problem. After extracting important features, a fuzzy ART may be more suitable to analyze versatile accounting frauds in future, such as a fuzzy model of non-uniform coders based on an overlap level of fuzzy sets and a fuzzy equalization proposed by Nobuhara et al. [18], or a unified fuzzy-probabilistic framework proposed by Straszecka [22].