

Assessment of Fraud Pretentious Business Region Research Articles Using Data Mining Approaches

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Abstract— In any organization, fraud detection and prevention is a daunting task because millions of dollars are lost with the different nature of fraudulent activities. Organizations have to engage intelligent and innovative techniques to detect fraud at the earliest opportunity to protect business and their shareholders, customers and employees. This paper surveyed different fraud detection research articles from the year 2004 to 2012 based on data mining techniques. This research work is used to analyze the different affected business areas which discuss the data mining algorithms by higher fraud coverage. It also highlights the important challenges and limitations involved with the data mining techniques for detecting fraudulent activities.

Keywords- Business Areas; Classification; Clustering; Data mining; Fraud Detection.

I. INTRODUCTION

As information technology and communication channels get matured, enriched over a period of time, fraudulent activities are collectively on the rise across the globe [3]. Fraud Detection is imperative for every business or organization as it impacts by increasing the cost of doing their businesses. According to an ACFE 2012 survey, participants estimated that the typical organization loses 5 percent of its revenues because of fraudulent activities every year [4]. In today's competitive environment, no one can accept the loss of 5 percent of revenues due to fraudulent activities. Most of the businesses implemented intelligent analytical techniques to control fraudulent activities to reduce their increased cost. One of the intelligent techniques called data mining, substantiated to be a competitive tool for controlling fraudulent activities. Data Mining can extract valuable patterns or knowledge from large volumes of data [25] and alarm fraud.

The main objective of this paper is to highlight the affected business areas and to discuss the most beneficial learning types, efficient data mining algorithms, important challenges and limitations involved in selecting the data mining techniques.

Section 2 reviews the affected business areas, Section 3 describes the learning methodologies used, Section 4 discusses the assessment of business fraud coverage articles, Section 5 lists the research findings of the survey and Section 5 concludes the entire work.

II. AFFECTED BUSINESS AREAS

The fraudulent activities are detected almost in all the areas of business. From the published research articles in the area of data mining, the affected business areas are listed as follows: credit card, telecommunications, financial statement, automobile insurance, health insurance, online auction, stock, tax, bank account, securities market, commercial bank (Financial institutions), audit, financial risk, crime detection and electricity and it is shown in Fig. 1.

Credit card fraud is a serious and growing problem [1]. Because of rapid growth of electronic commerce, the rate of credit card fraud losses has been increased [2] [6-9].

Telecommunication fraud burdens telecom provider's accountings and also individual users [10] [13]. Telecommunication fraud prediction uses daily network service information to predict the fraud [15]. Sim cloning and surfing are one of the types of frauds found in telecommunication [16].

Abnormalities related to frauds have consequences such as overloading the distribution supply system, decline in the supply quality and growing energy costs [18]. Abnormalities found in the electrical energy Distribution Company may be due to Non Technical Losses (NTL) in power utilities [21] [22].

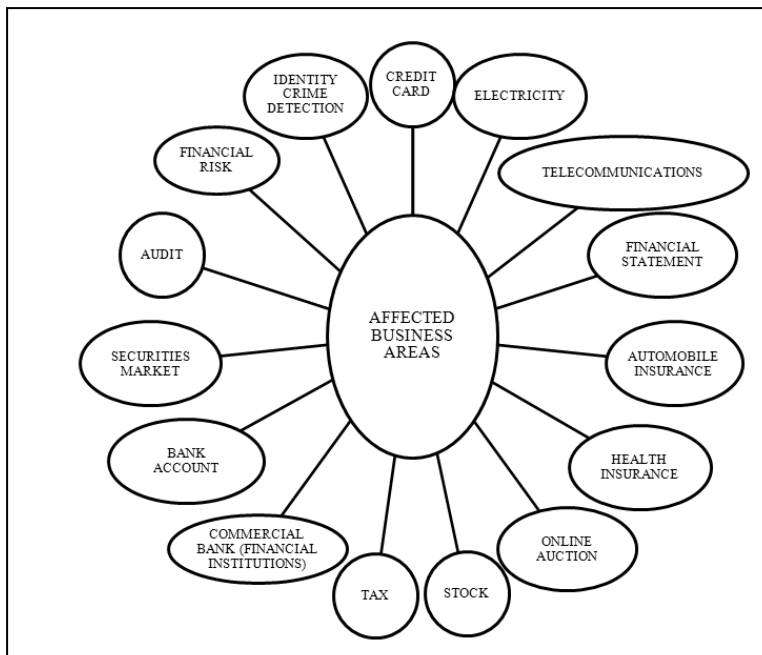


Figure 1. Affected Business Areas

Insurance fraud evaluation is done on an informal, judgmental basis and depends on individual claims personnel [26]. Health Insurance fraud detection is a challenging task [28]. Government health funding programs were affected because of consumer frauds [29]. ATM phone scams collect money for victims through fraudulent accounts [30]. Increased rate of financial statement fraud have been reported [32]. Fraudulent financial statement has become a severe economic and social problem [33]. Rapidly changing nature of financial institution services provides the opportunity for fraudsters [35].

Stock price manipulations were using the stock market data itself [37]. Online review manipulation shows the decreased function of products' true quality [38]. Minimizing the tax fraud is an important challenge for government [39]. Credit application fraud is a special case of identity crime [40]. Fraudulent activity in securities market and financial losses caused is more in number [41]. The numbers of shoppers in c2c sites are growing and online customer suffers from online auction fraud [42]. Fraud audit approach considers the fraud triangle to better detect fraud [43].

The main objective of the above stated business areas is to identify the fraudulent activities and to minimize the potential loss.

III. LEARNING METHODOLOGIES

Fraud detection methods can be supervised, unsupervised or semi-supervised depending on various factors [17]. To the best of our knowledge, most of the credit card, telecommunication, financial statement, automobile and health care fraud detection systems used supervised learning methods. Unsupervised learning is mostly used with outlier detection methods.

Unsupervised and supervised methods were combined to analyze the data and found to be beneficial [12]. Unsupervised learning does not depend on the rules and it was used in any distribution utility [24]. Since it was impossible to define all patterns of stock price manipulation, an unsupervised learning method was used [37].

IV. ASSESSMENT OF BUSINESS FRAUD COVERAGE ARTICLES

Data mining algorithms proved to be very efficient for handling complex and uncertain data. Most of the fraud detections systems use classification and clustering tasks. Classification is a data mining task that assigns items from a group of target classes. Classification algorithms accurately predict the target class for each item in the data.

In the case of classification tasks, the most frequently used algorithms for fraud detection activities are C 4.5 decision trees, Artificial Neural Networks, Logistic regression, Nave Bayes Classifier, Case based reasoning,

Support Vector Machines, Random Forests, Bagging, Bayesian networks, K-nearest neighbor, Hidden Markov Models, Ada boosted nave Bayes, Radial Basis function network, Genetic algorithms and K Reverse Nearest Neighbors. Refer Table 1 to understand the benefits of these classification algorithms to detect fraudulent activities.

TABLE I. ASSESSMENT OF FRAUD COVERAGE BUSINESS ARTICLES WITH DATA MINING ALGORITHMS

Business Area	Data Mining Algorithms with higher Fraud Coverage	Benefits	References
Credit card	Random forests & Support Vector Machines	Perform well with high dimensional data and carry automatic variable selection ability/ superior performance across a range of applications	[1]
	Case-based learning model and genetic algorithm	Online learning with less time and cost	[2]
	Self-organizing Map (SOM)	Effective and profitable real time fraud detection/ follow unsupervised learning and extracts interesting patterns from input data	[7]
	BOAT algorithm	Handles maximum number of fraud cases with high speed and less cost	[8]
	Bayesian Networks / Artificial Neural Networks	Greater accuracy with respect to true positive and false positive parameters / very high processing speed	[9]
	Genetic algorithms	Performance is improved by 200% with variable misclassification cost compared with existing one	[11]
Telecommunication	Self-organizing map and K-means / Among decision trees, neural networks and SVM/ Among ensembles such as bagged trees, bagged neural networks, boosted trees and boosted neural networks, stacking and generalization	Can improve the clustering results/ SVM showed better performance as a single classifier/ boosted trees showed better performance	[12]
	Binary SVM uses Radial Basis Function networks	Detects with high accuracy	[13]
	FP tree based association mining technique	Detect known and unknown data pattern accurately and efficiently	[14]
	Back propagation neural network	Accuracy of false fraud case prediction is above 90%	[15]
Audit	Explorative techniques such as OLAP, cluster analysis, kohenen-neural network/ predictive techniques such as regression, classification and neural network.	The results will give insights to auditors/ build model from past data and apply the same on new data	[17]

TABLE II. ASSESSMENT OF FRAUD COVERAGE BUSINESS ARTICLES WITH DATA MINING ALGORITHMS (CONTINUED)

Business Area	Data Mining Algorithms with higher Fraud Coverage	Benefits	References
Electricity	Fuzzy clustering technique	Shows better performance in the identification of fraudulent residential and commercial customers	[18]
	Rough sets and knowledge discovery in databases	Helps to identify normal and fraudulent behavior	[19]
	Self-organizing map	Promising technique for high voltage electricity consumers	[20]
	Decision tree/ Naïve Bayes	Shows the highest classification accuracy/ shows the fastest processing time	[21]
	Support Vector Machines	Gives high discrimination and better result for hidden data classification	[22]
	Genetic algorithm and SVM hybrid model	Detects with the hit-rate of 60% which is more beneficial to electric distribution companies	[23]
	The differential algorithm	Shows the feasible results	[24]
Automobile Insurance	Adaboosted naïve Bayes	Provides interpretable decision support and efficient learning	[26]
	Combination of SMOTE to over sample the fraud samples and random under sampling to under sample the non-fraud samples	Produces high prediction accuracy	[27]
Health care Insurance	Local outlier factor algorithm	Very effective in finding outliers	[29]
Bank Account	Bayesian classification and association rule techniques	Proved to be effective and efficient	[30]
	Ontology driven data mining algorithms	Proven to be a powerful tool to perform collective analysis of a large body of knowledge	[31]
Financial statement	Different classifiers such as multi-layer feed forward neural network, support vector machine, genetic programming, group method of data handling and logistic regression were compared with feature selection and without feature selection.	Genetic programming performed well which gives less misclassifications and takes less time	[32]
	Logistic regression, decision tree, neural networks and Bayesian classification	Not well suited for the adaptive economic environment	[33]
Financial risk	Linear logistic, Bayesian network and ensemble	Detected as top three classifiers based on the increase in accuracy and detecting unnoticed fraud cases	[34]
	KDB networks	Have the highest predictive capability through the bagging procedure	[36]
Stock	Peer group analysis	Detects abnormal stock price change and decides an accurate time to raise an alarm	[37]
Tax	Neural Network	Get suitable conclusions about tax fraud based on market condition and periodical financial reports.	[39]
Identity crime detection	Communal detection and spike detection algorithm	Is faster than other classifiers(Naïve Bayes, SVM, C4.5 decision tree, Logistic regression, Very fast machine learner algorithm)	[40]

TABLE I. ASSESSMENT OF FRAUD COVERAGE BUSINESS ARTICLES WITH DATA MINING ALGORITHMS (CONTINUED)

Business Area	Data Mining Algorithms with higher Fraud Coverage	Benefits	References
Tax	Neural Network	Get suitable conclusions about tax fraud based on market condition and periodical financial reports.	[39]
Identity crime detection	Communal detection and spike detection algorithm	Is faster than other classifiers(Naïve Bayes, SVM, C4.5 decision tree, Logistic regression, Very fast machine learner algorithm)	[40]
Securities market	Artificial Neural Network and SVM/ C4,5 decision trees, K-Means clustering algorithms	Outperform multivariate statistic techniques in terms of sensitivity/ pattern extraction technique outperform the baseline	[41]
Online auction	Social network Analysis	Capable of detecting sophisticated and hidden relationships between fraudsters and partners	[42]
	Combination of Exploratory data analysis technique-Andrews curves with the empirical method for outlier Andrews curves detection	Accuracy of about 80%	[44]
Crime detection	ID3 decision tree	Output results are easy to understand	[45]

Decision tree, neural networks and Bayesian belief networks are the three methods which have very good classification capabilities and most widely used method to detect fraudulent activities. The decision tree was easy to obtain fraud information and to extract if-then rules [5]. Neural networks are efficient in handling inconsistent data and it is suitable for the problems where algorithmic solutions are not known [5] [9]. Bayesian belief networks allow dependencies that exist between attributes [5] and it has very high accuracy with respect to true positive and false positive rate [9]. Neural networks, decision trees and SVM are the most recommended methods of fraud detection [12]. Even though many advanced techniques are available in the literature, simple techniques have been proved to be effective in many situations [17]. Genetic algorithms can perform learning with optimal time and cost and provides the best solution for selecting optimal parameters [23]. Clustering analysis finds clusters of data objects that are similar in some concept to one another. When the target data are not clearly understood and do not have a class label, then clustering was chosen as a modeling technique [28]. Some of the clustering algorithms used frequently in fraud detection were self-organizing maps and k-means clustering and it is listed in Table 1.

Support Vector Machine(SVM) is another popular data mining technique used in fraud detection that are more theoretical, easy to analyze, data driven and robust. The performance of SVM is better than the other classifiers like multilayer feed forward neural network, case-based reasoning, logistic regression and discriminant analysis [32]. Probabilistic networks have high predictive capacity when compared to logistic regression, neural networks and discriminant analysis [36]. Very few associations discovering algorithms such as FP tree based pattern matching were used.

V. RESEARCH FINDINGS

- Exploration of Data mining is extensive in the field of fraud detection.
- Wide area of business utilized Data Mining techniques because of its higher accuracy, less time to market and cost effective.
- Most of the analysis were done with the traditional data mining algorithms. Very few research papers used new techniques and hybrid data model with respect to fraud detection.
- Most of the research work concentrated on improving the fraud detection accuracy, time and cost.
- Even though many data mining algorithms which yields less misclassification and takes less time to process, it depends on the data set at hand.
- Data mining techniques selected for the fraud detection was based on the effectiveness of the adaptive economic environment.
- It has been noted that when appropriate domain knowledge was integrated into the system, then some techniques perform better and accurately, because this provides understandable results to the business experts.

VI. CONCLUSION

Due to market uncertainties, declining economic growth and significant growth of online e-commerce makes fraud widespread. This paper reviewed the affected business areas and assessed the higher fraud coverage data mining algorithms. This paper also highlighted the important challenges and limitations involved with data mining techniques for detection of fraudulent activities. The findings show that the data mining techniques applied in various business areas were found to be effective in terms of accuracy, time and cost to a great level. It tackled with unseen and uncertain data to a greater extent. As a future work, the performance of the appropriate data mining techniques will be measured with the fraud detection benchmark data sets.

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