An overview of bank marketing forecast based on Neural Networks

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Abstract

Bank potential client prediction is one of the major business classification problems. Neural networks as powerful technique for classification has been successfully in business sector. This paper will train different neural network models to consider a Bank Direct Marketing application, which aims to predict whether someone will subscribe a deposit, according the collected information. The Basic Multilayer Feedforward Neural Network (MFNN), multiple hidden slabs MFNN, Ward Networks, Kohonen Architecture and Probalistic Neural Network (PNN) were used to do experiment for forecast poetical clients. We also considered the class unbalance and cost sensitive problem of this application by changing positive class proportion and threshold-moving. After the comparison and analysis of those experiments results, this paper demonstrates that neural network is a practical tool in financial application. Besides with the process of experiments, three suitable proposals are provided for training a relatively satisfying model.

Keywords: neural network, bank marketing, MFNN, PNN, Ward Networks.

Introduction

Neural network is a powerful machine learning tool, which are used in the field of cognitive science and engineering in the beginning. With the popularity of this technique, it is also used widely in finance to do some tasks like pattern recognition, classification, and marketing prediction (Kaastra & Boyd, 1996).

This paper will present an overview of bank marketing forecast based on neural network. There are many researches about the application of neural network has been conducted. Law and Au (1999) proposed a supervised feed-forward neural network model to predict Japanese tourist arrivals in Hong Kong. Kaefer et al. (2005) developed an alternative estimation approach for classifying new prospective consumers as “good" or “bad” prospects for direct marketing purposes. However, there are few organizations implemented neural networks successfully (Kaastra & Boyd, 1996). Zahavi and Levin (1997) also proposed that it is difficult to train a successful model, because the expertise in the application domain and neural network theory are both needed. Thus, neural net approach is not fit for target marketing.

Due to these arguments, the research problem of this paper is whether neural network is effective in bank marketing. Besides, how to train a satisfying neural network model in practical application will also be discussed.

Objectives

The primary objective of this paper is try to train a neural network model for Bank Direct Marketing, which aims to predict whether someone will subscribe a deposit, according to the collected personal information. From the results, whether neural network is effective in financial

application will be argued. Besides, with the process of experiments, some suggestion which will help improve results in practical application will be discussed.

The contribution of this paper is that it will manage to find an effective model for forecast bank potential clients, which would give reference values for similar financial applications, such as, consumers forecast for insurance company, client's behavior's forecast, can use neural network technology to achieve satisfied effect. In addition, provided suggestion could help people who are lack of experience of applying neural network.

Methodology

This part will introduce methods that we use to address bank marketing prediction. Firstly, dataset preprocessing will proposed. Then, Basic Multilayer Feedforward Neural Network (MFNN), multiple hidden slabs MFNN, Ward Networks, Kohonen Architecture, Probalistic Neural Network (PNN) will be used to make experiments. Next, experiment results will be analyzed and compared. Finally, for different application requirements, three suitable proposals for choosing model based on experiment results will be given, which are respectively paying attention to preprocess, trying multiple architecture and parameters, and combining with actual demand of the application.

This data has been obtained from http://archive.ics.uci.edu/ml/datasets/Bank+Marketing. The original data set has 45,211 instances totally, and for each instance it has16 attributes and 2 available results, whether the client subscribed a term deposit. In all attributes, there are 7 numerical attributes and 9 categorical attributes.

In the data preprocessing process, considering the original data's complex, we not only used 1-out-of-N method to encode categorical data, but also changed class proportion to address class-

unbalance problem. Compared with results without proper preprocessing, it should be mentioned that preprocess is essential part for attaining a precise and valuable experiment result.

In train issues part, we adopted 9 experiments to train different models to satisfy different demands of bank. Seven experiments are based on MFNN. The differences between them are respectively changing parameters, numbers of hidden neurons and output neurons, input variables, middle hidden slabs, positive class proportion of dataset and implemented architecture. The final two experiment use PNN and Kohonen Architecture respectively. It is argued that multiple experiments can help researchers become familiar with the feature of data. Furthermore, it shows that it always makes serious mistakes to simply apply the model following theories. In fact, different models are worthy for an attempt, which could attain a surprising result at some time.

In the result analysis part, we introduce precision and recall to describe result precisely, because they measure how precise and how complete the classification is on the positive class (Liu, 2006). The experiments effect compared with original MFNN basic model are showed in Table 1.

Table 1. Effect of experiments compared with original MFNN basic model

No.	Architecture	Effect
1	original MFNN basic model	\
2	MFNN basic model—changing middle neurons' number	Limited
3	MFNN basic model—changing the output's number	Limited

4	MFNN basic model—changing the input variables.	Limited
5	MFNN basic model—changing the good class's proportion	Improving Recall and precision obviously.
6	MFNN – Ward Networks	Improving Recall and precision obviously, but less than model 4
7	MFNN – Multiple hidden slabs	Decrease
8	PNN (Probalistic Neural Networks)	Precision improves with same recall rate
9	Unsupervised Architecture—Kohonen Architecture	Decrease obviously

After the comparison and analysis of experiments result, and find the model based on MFNN architecture can result a high precision and recall rate both. The same result can be got when some attributes is been deleted also, which means that this model can help bank save time and money for collecting information. But if bank which don't care the cost of collecting information wants to improve recall rate and can accept the decrease of precision, the model based on PNN can adopted. Moreover, to solve class imbalance problem, changing the class proportion and threshold-moving are applied, which proved could improve experiments results to some extent. It can be concluded that to determine a model for a practical application, we should combine with actual demand.

Novelty

This paper focuses on a particular marketing application, bank marketing. As we referred, many researches have done in the application of neural network, but bank marketing is one of most valuable and suitable topic in this field. Compared with other application, it has more explicit target group, the people who are clients of the bank. Besides, in order to access if the product would be subscribed, more than one contact to the same client was required, which means to some extent some classification mistakes are endurable for finding potential buyers. Thus it has some reference values for similar researches.

Besides, with the process of experiments, three suitable proposals for training an effective neural network model are innovatively proposed, which could help people who do not have expertise and experience in the neural network to train a more satisfying model.

Moreover by a sequence of experiments, this paper argues that it is not like Kaastra and Boyd (1996), Zahavi and Levin (1997) said neural network is difficult to use and not fit for financial application. The result proved that neural network can apparently enhance the probability to find potential buyers. However, to attain a best result we not only need adjust our models, but also consider practical demand, just like Zahavi and Levin (1997) proposed that knowledge of related field is also important.

In addition, this paper also considered cost sensitive and class imbalance problem, which tries to minimize the cost. Zhou and Liu (2006) studied empirically the effect of sampling and threshold-moving in training cost-sensitive neural networks. In our experiments, sampling and threshold-moving are also implemented and proved effective again.

Conclusion and Significance

This paper focuses on a particular marketing application, bank marketing. To train an effective model, multiple architectures are adopted, including Basic Multilayer Feedforward Neural Network (MFNN), multiple hidden slabs MFNN, Ward Networks, Kohonen Architecture, Probalistic Neural Network (PNN). By analyzing the experiments result, relatively appropriate model in different situation is demonstrated. Besides, three proposals for apply neural network to bank marketing are provided which are essential preprocess process, multiple attempts of different models, considerations for application's actual demands

In conclusion, this research demonstrates that neural network is a practical tool in financial application, which would provide reference values for people who will intend to apply the neural network. In addition, three available proposals summarized in experiments could also help people especially not familiar with neural network to train a relatively satisfying model.

References

Guresen, E., Kayakutlu, G., & Daim, T. U. (2011). Using artificial neural network models in stock market index prediction. *Expert Systems with Applications*, *38*(8), 10389-10397.

Kaastra, I., & Boyd, M. (1996). Designing a neural network for forecasting financial and economic time series. *Neurocomputing*, *10*(3), 215-236.

Kaefer, F., Heilman, C. M., & Ramenofsky, S. D. (2005). A neural network application to consumer classification to improve the timing of direct marketing activities. *Computers & Operations Research*, *32*(10), 2595-2615.

Liu.B. (2006), Web Data Mining: Exploring Hyperlinks, Contents and Usage Data. *Springer*.

Law, R., & Au, N. (1999). A neural network model to forecast Japanese demand for travel to Hong Kong. *Tourism Management*, *20*(1), 89-97.

Zahavi, J., & Levin, N. (1997). Applying neural computing to target marketing.*Journal of Interactive Marketing*, *11*(1), 5-22.

Zhou, Z. H., & Liu, X. Y. (2006). Training cost-sensitive neural networks with methods addressing the class imbalance problem. *Knowledge and Data Engineering, IEEE Transactions on*, *18*(1), 63-77.