Case Study in Banking Using Neural Networks

Alisa Bilal Zorić
University of Applied Sciences Baltazar, Zaprešić, Croatia

Abstract

Data Mining represents a Business Intelligence (BI) methodology which provides an insight into the 'hidden' information about its operations thus improving the process of making strategic business decisions based on a clear and understandable interpretation of existing results. Data mining can help to resolve banking problems by finding some regularity, causality and correlation to business information which are not visible at first sight because they are hidden in large amounts of data. The goal of this paper is to present a case study of usage of operations research methods in knowledge discovery from databases in the banking industry. Neural network method was used within the software package Alyuda.

Keywords: data mining, neural network, banking, alyuda
JEL classification: C45

Introduction

With increased availability of data, inexpensive storage and processing power, the amount of raw data stored in corporate databases is huge and constantly increasing. However, raw data by itself does not provide much information. Data mining is used to discover patterns and relationships in data in order to improve business decision processes. Its tools can answer business questions that in the past were too time consuming to resolve. We can define it as an interdisciplinary field that brings together techniques from machine learning, pattern recognition, statistics, database systems, data visualization, information theory, knowledge acquisition, artificial intelligence and neural networks. (Sumathi et al., 2013)

Specific uses of data mining include: *Market segmentation, Customer churn, Fraud detection, Direct marketing, Interactive marketing, Market basket analysis, Trend analysis, Credit analysis, Predicting payment default, etc*. (Ramageri et al., 2013)

In this paper, we will focus on *Customer churn.* Among the popular techniques to predict customer churn are: neural networks, support vector machines and logistic regression models. (Hung et al., 2006) We want to make a model from stored customer data to predict churn and to prevent the customer's turnover. Data mining research literature suggests that machine learning techniques, such as neural networks should be used for non-parametric datasets, because they often outperform traditional statistical techniques such as linear and quadratic discriminant analysis approaches. (Baesens et al., 2002)

As competition in banking industry becomes more global and intense, banks have to fight more creatively and proactively to gain and maintain their clients. Questions data mining can answer are:

- What transactions does a customer do before shifting to a competitor bank?
- What is the profile of an ATM customer and what type of products is he likely to buy?

- Which bank products are often availed of together by which groups of customers?
- What patterns in credit transactions show increased risk of fraud?
- What is the profile of a high-risk borrower?
- What services and benefits would current customers likely desire? (Domingo, 2003)

Banks have realized that customer relations are a very important factor for their success. The challenge banks face is how to retain most profitable customers. Literature suggests that a small change in the retention rate can result in significant impact on business. (Van den Poel et al., 2004) Using data mining technique, it is possible to build a successful predictive model which transforms data into meaningful information for the user (Jackson, 2002).

This paper proposes a neural network based approach to predict customer churn in bank. Real-world data from one of the small Croatian banks was used for creating a model for Customer churn. The main hypothesis was that clients who use more bank services (products) are more loyal, and bank should focus on those clients who use less than three products, and offer them products according to their needs.

Methodology

Data mining process

The Data Mining Process is an iterative process which does not stop when a particular solution is deployed. There are four main phases in every data mining project.

First, there is initial phase of P*roblem definition* in which specific business problem is translated into data mining problem.

Second phase is *Data gathering and preparation* phase. In this phase we transform data into pre specified format and we perform data cleansing, which is the process of detecting and correcting, or removing corrupt, inaccurate or irrelevant records. Data preparation tasks are likely to be performed multiple times, and not in any prescribed order. This phase can take up to 80 % of all analysis time. Data quality is a major challenge in data mining. (Blake and Mangiameli, 2011)

Then, there is *Model building and evaluation* phase. In this phase, various modelling techniques are selected and applied and parameters are calibrated to optimal values.

Fourth phase is K*nowledge deployment*, use of data mining within a target environment. In this phase we organize and present the results of data mining (Oracle, 2015).

Visualization techniques are more effective in understanding the output for end users (Herawan et al., 2011).

Data analysis

The used database consist information on 1866 clients on the date of analysis. We wanted to show that there is much smaller possibility for client that uses two or more bank products to leave the bank, in comparison to clients with just one product. Based on the information that we got from the bank, we determined each client's likelihood to leave the bank, whether it is low or high. We designed neural network using Alyuda NeuroInteligence software package and we got a model in which we can determine likelihood of client leaving the bank on the basis of some data. Characteristics that we used are: sex, age, private status, average monthly income, usage of internet banking and usage of two or more bank products.

Bank products are currency account, credit, savings, internet banking, mobile banking, SMS, standing orders, etc. We grouped similar products together, so we have only one category Savings and not special savings like Open, Active, Currency, Foreign Currency, etc. We did the same thing with Credits. We did this because the bank has many different products and few customers using these products. We divided Private status into: employed, pensioners, students and unemployed. Average monthly income we divided into these categories: 0 to 5 000,00 kn, from 5 000,00 kn to 10 000,00 kn, from 10 000,00 kn to 20 000,00 kn and more than 20 000,00 kn. By age, we divided them from 0 to 25, from 26 to 35, from 36 to 50, from 51 to 60, and more than 61. We used one client as the basic unit. We achieved the uniqueness of the client by choosing them by registration number.

As we mentioned earlier, data preparation is the most time consuming phase. Problems that we had with data are: *missing values* (financial laws are changing constantly, so some data that did not exist in the past has now become obligatory) Sometimes we could add these data on the basis of other data (sex, by name and surname), sometimes we could not do that out of several reasons: we needed to contact the client in order to get the answer (average monthly income, place of birth), sometimes large amount of data was missing or it was incomplete, sometimes there was a big *number of possible input data*, *non linear dependences*, *inconsistency* (different names for the same attribute), *contain errors or exceptions*.

Description and application of the chosen method

Neural networks are considered alternative statistical methods. Today, there are tools that enable analysts to use neural networks without the knowledge of how they operate. (Batini et al., 2009) Neural networks as well as other methods of pattern recognition cannot create information from bad input data. And for them there is a rule that states: you cannot create a high quality model with bad input data (" garbage in, garbage out"). (Shinde, 2012)

Neural network is a general mathematical computing paradigm that models the operations of biological neural system. It is nonlinear predictive model that learns through training and resembles biological neural networks in structure. (Han et al, 2011) The basic building block of a neural network is the neuron. Each neuron consists of two parts: the net function and the activation function. The net function determines how the network inputs are combined inside neuron. There are three types of neurons: input, hidden and output. The output of the neuron is related to the network input via linear or non-linear transformations called activation function. (Schölkopf et al., 2002) Neural networks are typically organized in layers. Layers are made up of a number of interconnected nodes which contain an activation function. Patterns are presented to the network via the input layer, which communicates to one or more hidden layers where the actual processing is done via a system of weighted connections. The hidden layers then link to an output layer where the answer is output. Each input is sent to every neuron in the hidden layer and then each hidden layer's neuron's output is connected to every neuron in the next layer. (Shipyard, 2012)

Neural networks work very well for problems like capturing associations or discovering regularities within a set of patterns, problems where the volume, number of variables or diversity of the data is very big, problems where the relationships between variables are vaguely understood or the relationships are difficult to describe adequately with conventional approaches. (Bar, 2007)

Results

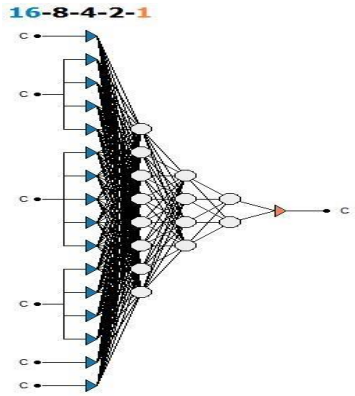
The paper used neural network method within the software package Alyida NeuroInteligence to detect Customer churn. After selecting the database, software goes through all the above mentioned phases.

In data analysis phase, we are defining three types of characteristics: characteristics which we will reject (name, surname), characteristics we will use, and determine the target characteristics that we want to calculate. Alyuda NeuroInteligence divides Data into three sets: training, validation and testing set.

In preprocessing phase program adds some columns if data is marked as Categorical. In the network design phase we are selecting a number of hidden layers. Program offers the best topology, which we can change. In our case, that is a neural network with three hidden layers with 8, 4 and 2 neurons.

Figure 1

Alyuda – Network Topology

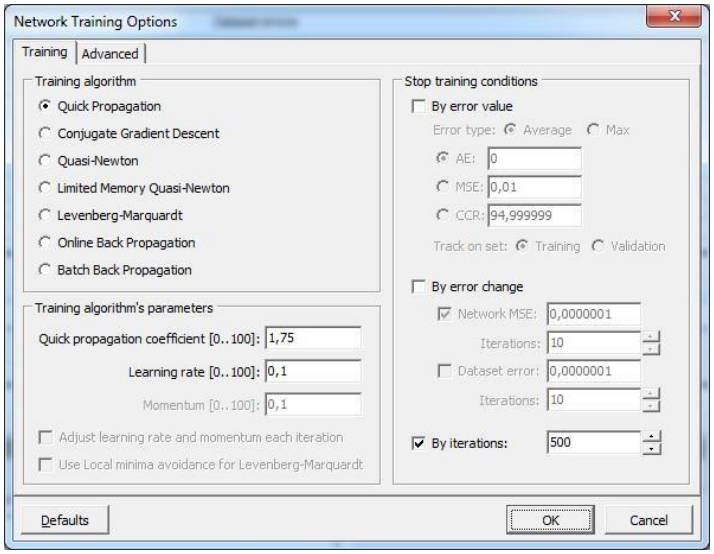


Source: Software package Alyuda NeuroInteligence (Autor's treatment)

After designing, there is training in which we can define different parameters as shown in the Figure 5.

Figure 2

Alyuda – Network Training Options



Source: Software package Alyuda NeuroInteligence (Autor's treatment)

After training the network, we get results as shown below.

Figure 3
Alyuda – Network Training Results

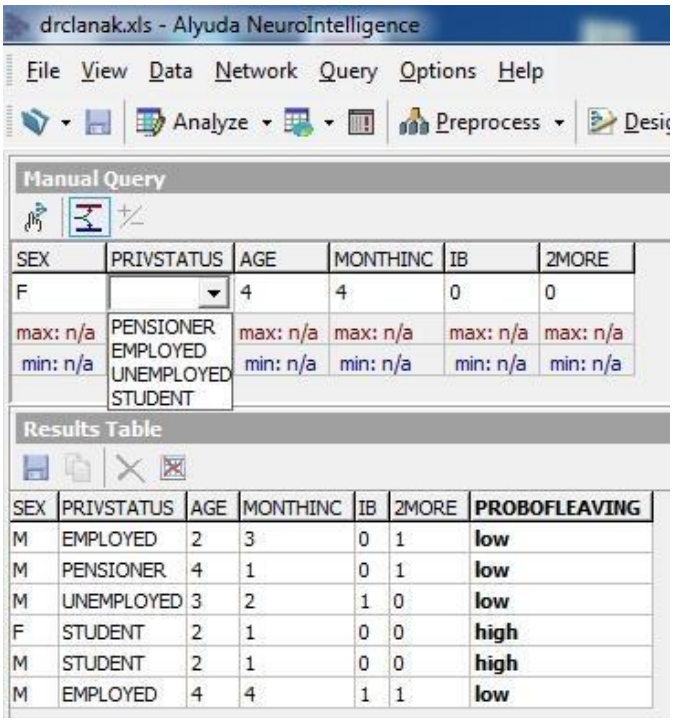
Parameters

	Training	Validation
CCR, %:	95,984252	93,959732
Network error:	0,123164	0
Error improvement:	0,000009	
Iteration:	501	
Training speed, iter/sec:	62,625026	
Architecture:	[16-8-4-2-1]	
Training algorithm:	Quick Propagation	
Training stop reason:	All iterations done	

Source: Software package Alyuda NeuroInteligence (Autor's treatment)

At the end we got model in which we can check the likelihood of client leaving the bank by entering some parameters.

Figure 4
Alyuda – Query



Source: Software package Alyuda NeuroInteligence (Autor's treatment)

We can conclude that there is "a problematic group" of young people (students) with less than three bank products, who in the future can become very important and very valuable clients. Bank should adjust its products to these clients. For example, Bank could introduce new products tailored to students' needs such as student loan, favourable interest rates, promotional use of internet banking, etc.

Also, we found out that by changing the topology of the neural network, we do not get better results. All topology we tried gave similar results.

Discussion

The Bank has very well-tailored services for pensioners, and this is the reason of high proportion of pensioners in the total number of clients (691/1866), and their likelihood of going to the competition is extremely low. The Bank offers them various benefits from lower fees for managing current accounts, loans for pensioners, free standing orders, etc. Bank should do something similar with the other groups of clients.

For example, it should enable students as much as possible on line services. We have shown that a simple analysis and application of neural networks can reach important results for the bank. It would be possible to include additional characteristics such as credit return, unauthorized overdraft, monthly consumption, the amount of savings, etc. to get different models for different problems.

Conclusion

In order to be competitive in this market, banks have to be able to predict possible churners and take proactive actions to retain valuable loyal customers. Building an effective and accurate customer churn prediction model has become an important research problem for both academics and practitioners in recent years. Profiling enables a company to act in order to keep customers may leave (reducing churn or attrition), because it is usually far less expensive to keep a customer than to acquire a new one (Berry et al., 2000).

Data mining is a technique used to extract vital information from existing huge amount of data and enable better decision-making for the banking and retail industries. They use data warehousing to combine various data from databases into an acceptable format so that the data can be mined. The data is then analysed and the information that is captured is used throughout the organization to support decision-making. (Jayasree et al., 2013)

In this paper we have shown that more and more young people use internet banking and that bank should offer different products/services which could be arranged without the client coming to the bank, such as savings that can be arranged and used only on the internet. It is necessary to develop new products that could be offered to such customers in order to keep them.

Cross-selling is one of the most important ways to increase the profitability of existing customers while increasing their loyalty. By selling additional products to customers we associate with them, thus increasing their loyalty. (We have seen that more loyal customers are those who use more than two bank products) Analysing the data available we can determine what the next best offer for a particular client is. For example, bank could offer car insurance together with the car loan.

This research was made on database of small Croatian bank using only one method, Neural networks. We could access other important information that could help banks to get competitive advantage by using other methods such as segmentation, decision trees, self-organizing maps. We wanted to show the simple usage of a complex method and to encourage others in similar research. Today, there are many very good software packages for data mining that do not require much pre-knowledge to use, and the results are very useful.

References

1. Baesens, B., Viaene, S., Van den Poel, D., Vanthienen, J., Dedene, G. (2002), "Bayesian neural network learning for repeat purchase modelling in direct marketing", European Journal of Operational Research, Vol. 138 No. 1, pp. 191–211.
2. Bar, M. V., (2007), "The Computational Intelligence Techniques for Predictions-Artificial Neural Networks", Scientific Editorial Committee, No. 184.
3. Batini, C., Cappiello, C., Francalanci, C. and Maurino, A., (2009), "Methodologies for data quality assessment and improvement", ACM Computer Surveys, Vol. 41 No. 3, pp. 16-27.
4. Berry, M. J., Linoff, G. S. (2000), "Mastering Data Mining: The Art and Science of Customer Relationship Management", Wiley Computer Publishing, New York.
5. Blake, R., Mangiameli, P. (2011), "The effects and interactions of data quality and problem complexity on classification", Data Inform, pp. 160-175.
6. Domingo, R. (2003), "Applying data mining to banking", available at: www.rtdonline.com (accessed June 16th 2015)
7. Han, J., Kamber, M., Pie, J., (2011), Data Mining Concepts and Techniques, Elsevier, Burlington.
8. Herawan, T., Deris, M.M. (2011), "A soft set approach for association rules mining", Knowledge-Based Systems, Vol. 24 No 1, pp. 186-195.
9. Hung, S.Y., Yen, D.C., Wang, H.Y. (2006), "Applying data mining to telecomm churn management", Expert Systems with Applications, Vol. 31 No. 3, pp. 515–524.
10. Jackson, J., (2002), "Data mining: a conceptual overview", Communications of the Association for Information Systems, Vol. 8 No. 19, pp. 267-296.
11. Jayasree, V., Siva Balan R.V. (2013), "A review on data mining in banking sector", American Journal of Applied Sciences, Vol. 10 No. 10, pp. 1160-1165.
12. Oracle (2015), "Data Mining Concepts", available at: http://docs.oracle.com/cd/B28359_01/datamine.111/b28129/process.htm#DMCON002 (accessed June 18th 2015)
13. Ramageri, B.M., Desai, B.L. (2013), "Role of data mining in retail sector", International Journal on Computer Science and Engineering, Vol. 5 No 1, pp. 47-50.
14. Shinde, P., (2012), "Data mining using artificial neural network tree", Journal of Engineering, available at: http://www.iosrjen.org/Papers/NSER'2012/C0280912.pdf (accessed May 15th 2015)
15. Sumathi, S., Sivanandam, S. N. (2013), "Introduction to Data Mining Principles", Studies in Computational Intelligence, Vol. 29 No. 3, pp. 1-20.
16. Van den Poel, D., Larivie're, B. (2004), "Customer attrition analysis for financial services using proportional hazard models", European Journal of Operational Research, Vol. 157 No. 1, pp. 196–217.

About the author

Alisa Bilal Zorić is a doctoral student in Faculty for Commercial and Business Sciences at Celje, Slovenia. She graduated from Faculty of Science, Department of Mathematics at Zagreb and she has an MBA from Faculty of Economics in Zagreb. Prior to returning to school to pursue her doctorate, Alisa spent ten years designing and developing business information systems for Siemens and Banksoft. She is currently working as an assistant at the University of Applied Sciences Baltazar Zapresic where she teaches math and computer courses. Her current research interests include educational data mining and knowledge management from a data mining perspective. Author can be contacted at **alisa.bilal.zoric@bak.hr**