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MACHINE LEARNING IN CUSTOMER PROFITABILITY FORECASTING

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ABSTRACT
The aim of this paper is presentation of the model that could be used for the measurement of current and forecasting of the future customer profitability. The purpose of this model is forecasting activities of individual customers in the future, and values that company could expect doing business with them. Modern customer profitability analysis shows that product costs are only one part of the relation enterprise-customer. General framework for defining customer profitability, besides pure financial items, has to include a lot of non-linear and non-financial elements. Machine learning methods can identify and adopt patterns and rules that exist in historical data stored in data bases and/or data warehouses. Proposed model for the forecasting of the customer profitability used two machine learning methods: neural networks and genetic algorithm.
The paper shows the ways how proposed methods of machine learning can respond to challenges related to the customer profitability forecasting, at the same time presenting main advantages and disadvantages of their application in that field.
Keywords: machine learning, neural networks, customer profitability

1. INTRODUCTION
Customer profitability analysis (CPA) refers to modern trends in business profitability research measured at the customer level. Analysis of customer profitability is only the analysis of past events, i.e. retrospective analysis. Although management finds this analysis very valuable and uses it as the basis for decision making, one different approach to profitability, view on prospective customer profitability brings a completely new knowledge important for decision making process. Prospective customer analysis forecasts elements of business relationship with the customer during its future lifetime (as the customer of company), while it finds basis for forecasting in the retrospective analysis.
Machine learning methods do not use conventional learning methods that suffer from imperfections such as inability of explicit transfer of knowledge from experts to machines or nonexistence of experts' will for knowledge transfer. Knowledge stored in historical cases makes the basis for machine

learning. Neural networks for example, are capable to identify and absorb hidden knowledge and patterns of behavior that are stored in historical data of retrospective customer analysis. They could work equally well with nonlinear and nonfinancial elements of environment which have influence on profitability results. Neural networks approved their capability for approximate describing of any continuous function. Together with robust methods of genetic algorithms used in learning process of networks, they make a good choice in the process of selecting methods for forecasting customer profitability.

The aim of this paper is to present a conceptual model of neural network that could be used in the analysis of individual customer profitability. The purpose of this model is forecasting activities of individual customers in the future, and values that company could expect doing business with them.

2. GENERAL FRAMEWORK FOR FORECASTING OF CUSTOMER PROFITABILITY

General framework for forecasting of customer profitability is defined by following:

- Type and activities of business subject which is observed
- Type and nature of customers with whom the company does business
- Input variables of a model
- Output variables of a model.

The company, which produces and distributes assortment of products such as walnuts, almonds, hazelnuts, cereals, dry fruits, etc., is used as a reference company for the purpose of creating general framework for forecasting of customer profitability.

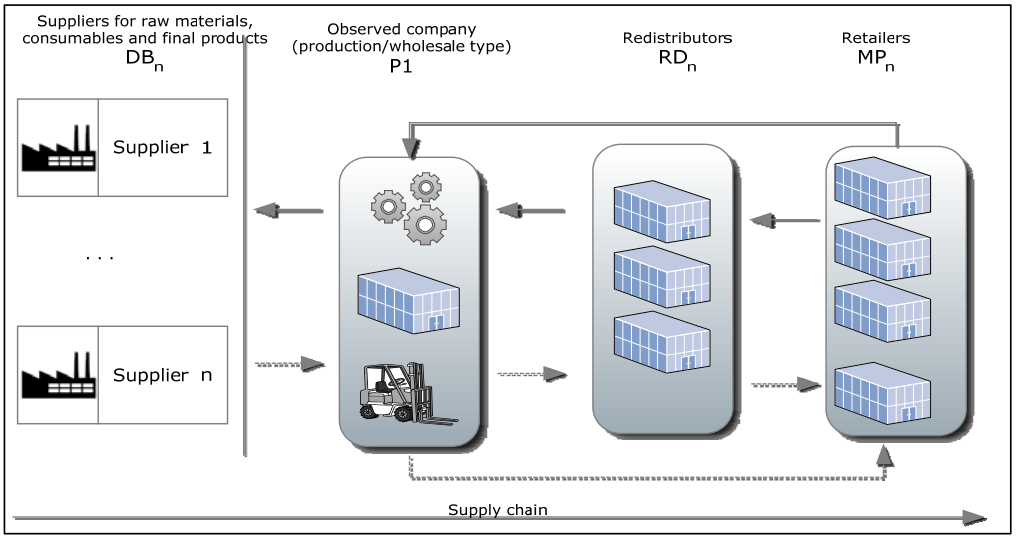

Figure 1. Data and material flow in supplier chain (adjusted from [1])

It is necessary to focus on customers who are on the right side of the observed company P1 in supply chain (Figure 1.), and their future behavior is a main object of forecasting. In order to forecast customer profitability, company needs concrete retrospective indicators of profitability, either for individual customer or groups of customers. Between a lot of models for measurement of the profitability at the level of individual customer [3,4,5,6], authors decided to use the most cited Niraj model [1]. Independent variables of a global model for forecasting of customer profitability can be classified into following groups:

L1 – Costs (T)
L2 – Customer attributes (ZK)
L3 – Company attributes (FP)
L4 – Prices (C)

L5 – Business environment (PO1)
L6 – General or social environment (PO2).

From the aspect that the model is based on the forecasting of individual customer profitability, the following indicators are interesting:
Y1 – Customer activity in the next period
Y2 – Expected revenue in the next period
Y3 - Expected net profit.

3. SSN NETWORK MODEL FOR FORECASTING CUSTMOER PROFITABLITY

Model for forecasting of customer profitability presents dependence of individual customer on independent model's variables. Those variables are latent so it could be concluded that the proposed model is a network of cause-and-effect relations which are mostly nonlinear and asymmetric. Taking into account all assumptions related to the proposed model and enormous quantity of transaction data, it could be said that this model is very complex. The model will be implemented through development of structural neural network (SNN) which represents a special form of multi-layered neural network.

Neural network is usually presented by oriented graph that is developed through phases of modeling of a hidden layer of variables through activity of nonlinear function on linear combination of input variables, and modeling of output layer of neuron which defines output variables as a linear combination of hidden network layer. It is necessary to make normalization of input and output variables of the model, meaning that all values represented by different units and marginal values should be reduced to rank [0,1] or [-1,1]. Usual algorithm that is used for correction of the network weight factors in the process of learning is a back propagation algorithm. More robust methods of genetic algorithms in learning process of networks do not use back propagation algorithm, but forward propagation algorithm [2]. By using this method, genetic algorithm forms new generations of weight factors that are applied on each data template for learning. Final format of network is got by calculation of total error which represents sum of individual errors of each data template, and by choosing generation with the minimum total error.

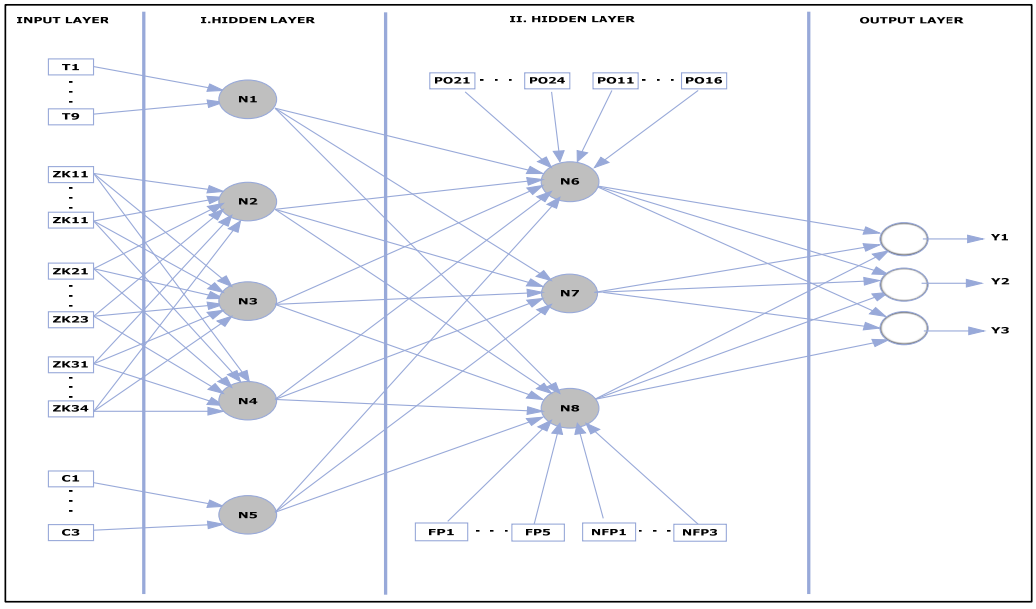

Figure 2. Architecture of the projected SNN network

SNN network (Figure 2.) is used for presenting the previously described model for forecasting of customer profitability. Input layer consists of data sources related to current customer probability in time period t. The first hidden layer has five neurons (N1-N5) which symbolize latent variables of prices, costs, customer attributes related to complexity, size and payment behavior. The second hidden layer synthesizes all customer attributes in neuron N7, and introduces additional neurons N6 and N8 which symbolize latent variables of business and social environment and specific quality of observed company.Each neuron of the second hidden layer is linked with neurons of the first layer, and the last two neurons have additionally input variables which define environment and attributes of observed company. Output layer has three neurons that represent output of neural network: expected customer activity and revenue and net profit in period t+1. Observed company has data stored in its business information system for the period of the last five years.

The aim of developing SNN model is enabling the process of network learning based on the existing data and verification of network ability to predict values of output variables for period t+1, on the basis of data for period t. Figure 2. presents the starting model of SNN network for the problem that belongs to group of problems with continued values of input and output. It has 8 hidden neurons in two layers. Delta rule will be used as a starting rule of learning, and the activation function will be the sigmoid function.
It should be noted that the selection of right network topology and its parameters (number of hidden neurons, learning rule, activation function, momentum and etc.) is subject to change in the phases of learning, in order to reach optimal model of forecasting. The proposed model has a lot of input variables. One of the tasks for future research will be researching the importance of specific variables for the model. Possible omitting of the less important variables from data model could make the model more applicable, of course if their omitting will not reduce forecasting abilities of the model. The aim of the future research could also be finding possibilities for extending the output set of variables.

4. CONCLUSION

The paper shows that a calculation of customer profitability is a complex process. This process needs the general framework which will have all necessary input variables and measures for presenting customer profitability. The company should be analyzed in its narrow and broad environment that influence on how a company does its business. Calculation of correlation coefficients, differentiation of customer base and clear indicators of customer individual profitability make the basis for decision making in the process of customer management. Neural networks are a logical selection of a tool in the process of analyzing and forecasting customer profitability. The reason lies in the characteristics of their structure and ability of learning and generalization. Also, they are capable to adjust themselves according to the changes in the environment. The model for forecasting of customer profitability proposed in this paper is a good starting point for future research in that area. Successful implementation of the proposed model could make preconditions for integration of this model within the existing information system of company and proactive customer management.

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