Bankruptcy prediction using hybrid neural network with "Colonies of ants and defect ceiling"

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Abstract

This paper deals with the risk of non-repayment of loans by firms. Thus, controlling the risk of default of loans has become one of the major strategic axes of the management of banking organizations. The objective of this paper is to compare the classification techniques of companies: Discriminant function analysis and the Artificial Neural Network(ANN) and a hybrid algorithm. The hybrid algorithm we used, combines ANN, ant colonization algorithm and degraded ceiling algorithm in order to predict enterprise failure risk.
We evaluate our solution using data collected from Polish companies in different periods, this database has been extracted from the database: Emerging Markets Information Service (EMIS).

Keywords: Forecasting; Corporate bankruptcy; Default risk estimation; AD; ANN; ACO.

1. Introduction

The standards of the Basel Accords constitute a prudential device intended to better understand the risks that can affect the survival of a bank. Among these risks, we find in particular the risk of market, option, credit, operational, etc. The credit risk, also called counterparty risk, is the risk the more widespread. If there are several types of credit risk, that of non-reimbursement is a major risk.

In the wake of the financial crisis, a new "version" has seen the light of day under the name of Basel III. This last, back in force in 2010 (for an implementation in place by January 1st , 2019) is composed of several main axs: strengthen the level and the quality of own funds, put in place two liquidity ratios in order to improve the management of liquidity risk and cap the effect of lever.

Accordingly, it is very important for the banks to be able to monitor the financial soundness of companies primarily in perspective. In effect, the banking institutes must prevent the bankruptcy of companies and therefore achieve models that allow you to understand the causes of bankruptcy by highlighting the variables more meaningful to classify the best failing firms and companies not faulty.

Different varieties of prediction models exist: the models parametric and non-parametric statistical as well as the methods of artificial intelligence.

Many research are based on the discriminant function analysis (Altman, 1968 ., Altman, Haldeman and Narayanan, 1977 ., Conan and Holder, 1979). However, the method of the discriminant function analysis has been criticized by several authors (Eisenbeis, 1977 ., Deakin, 1976 ., joy and Tollefson, 1975) because the validity of the results found by this technique is dependent on their restrictive assumptions, in this case the assumption of normality of the distribution of each of the variables (ratios) deductions and the hypothesis of independence between the latter.

To compensate for the shortcomings of the method of the discriminant function analysis, a solution is to use the non-parametric statistical methods, requiring any hypothesis concerning the distribution of variables (ratios). Two categories of techniques have been used: the recursive partitioning and the estimate non-parametric laws of distribution of the ratio, Mandy Carolin and Ganuci (1997) use the method of the kernel and the nearest-neighbor method, which are the two estimation procedures used the most.

In the face of the numerous constraints related to traditional statistical methods, methodologies under a different logic have been used: neural networks, genetic algorithms, SVM, etc They relate to artificial intelligence, more precisely to the branch relating to automatic learning. The first application of neural networks to the estimation of the risk of bankruptcy has been carried out on the banking data (Bell and alii, 1990).

The use of neural networks from data of non-financial businesses is then intensified. However, there are several disadvantages that have a considerable impact on the performance of artificial neural networks, we can mention: the difficult interpretation of the role played by each variable (ratio) in the process of failure, add to this, the local minimum problem, the selection of the topology of the network (number of layers, number of neurons by layer) and the initial weights.

The growing popularity of new hybrid methods confirms that they are able to overcome several difficulties of neural networks classics, and to obtain the best results. However, many other methods meta-heuristic such that the simulated annealing (Abbasi and Mahlooji,2012), Richards, McDonald and Aitkenhead,2008), optimization by particulate swarms (Zhang and Yuen, 2013), searching taboo, or colonies of ants (Lu and Liu, 2013, zbakir and al. 2009., Sivagaminathan and Ramakrishnan, 2007) have been used with success in different areas of research such as engineering and operational research.

This paper has set itself the goal to compare the predictive power of three models of forecasting of the risk to know: the discriminant function analysis also called Scoring, artificial neural networks and hybrid model that incorporates a neural networks with "Colonies of ants and defect ceiling".

2. Literature Review

During the last decades, the models to forecast the bankruptcy has been often used to try through the Accounting ratios selected, to predict the failure of a firm. The studies may be listed in three classes according to the classification method used.

Parametric statistics methods

The parametric methods of statistical classification establish a functional relationship between the explanatory variables -including the act of distribution is supposed to be known – and the explained variable, relationship - whose form is given a priori. Three main families of methods exist.

One-dimensional

The one-dimensional methodology founder of Beaver (1966), which has developed a dichotomous classification one-dimensional, that is to say based on a single ratio the most discriminant. Its method, exploratory in nature, is no longer applied at present.

Discriminant function analysis

As early as 1968, Altman says that.A one-dimensional analysis makes it difficult account of the complexity of the process of failure. The analysis of Altman (1968) reveals itself to be more effective than that conducted by Beaver (1966) since it results in a rate of good overall rankings of 95%. The superiority of the discriminant function analysis has been proven by Deakin (1972), comparing the two methods from the same sample, it class properly 87% of businesses, whereas the one-dimensional classification developed by Beaver Do class properly that 80% of enterprises.

The linear discriminant function analysis currently remains the most used method. Thanks to the analysis of the contribution of each ratio, constitutes an aid to the understanding of the bankruptcy.

Several disadvantages are related to the use of the linear discriminant function analysis. The accounting variables used must indeed follow a law multi-normal and their variance-covariance matrices must be the same for the sample of failing companies and for the businesses non-faulty.

The Artificial Intelligence algorithms

The binding character of the assumptions required for the effective implementation of traditional statistical methods, especially the discriminant function analysis, have led some researchers to test the effectiveness of other methods under a different logic: the Artificial Neural Network (RNA) and genetic algorithms(GA), as well separators with wide margin(SVM). They rely on the artificial intelligence, more specifically of the Branch relating to the automatic learning.

Neural networks

A lot of studies compare the performance of the neural networks with the discriminant function analysis of Altman (1968). You can list the work of Odom and Sharda (1990), that of coats and Fant (1993) and that of Kerling and podding (1994). All the authors confirm that the neural networks give better results than the other models. The only study that puts in discussion These results has been conducted by Altman, Marco and Varetto (1994), which show that the discriminant function analysis is more efficient than the neural networks. Tam and Kiang (1990 and 1992), Fletcher and Goss (1993) and Salchemberg et al. (1992) studying the neural networks with other models, such as the linear regression. All the authors confirm that the networks provide the best results.

Among the frustrations, which have a considerable impact on the performance of artificial neural networks, we include for example: the problem local minimum, the selection of the architecture (Number of layers, number of neurons by layer) and of initial weight, or the choice of control parameters.

The Hybrid Neural Network

The hybrid models who know a very large academic craze. They allow the effect of eliminating the disadvantages linked to neural networks and to improve the performance.

For almost three decades, researchers have focused on the hybrid models, such as the work of (Foster and al. 1992), which demonstrates the superiority of the hybrid model. Another very interesting study for the work presented is that of (Barney et alii 1999), which incorporates a genetic algorithm in a network of neurons. Also , (Yim and Mitchell, 2002) show a comparison between the Hybrid Neural Networks and other models and they get that the HNN provide the best performance.

The growing popularity of new hybrid methods confirms that they are able to overcome several difficulties of the classical neural networks, and to obtain better results concerning the forecasting of the failure of a firm. However, many other methods meta-heuristic such that the simulated annealing , optimization by particulate swarms, searching or colonies of ants [280,313,347] have been used with success in different areas of research such as engineering and operational research. A more thorough integration of neural networks with these algorithms could therefore give rise to other useful applications in the financial distress (Tkac, and Verner, 2016).

3. Models

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3.1 Descriminant function Analysis

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3.2 Neural Networks

A) Neurone Formel

Each neuron resides in a function, called transfer, which deals with a set of information (the inputs) in order to obtain a result (the output). The transfer function, chosen by the user, consists of a mathematical treatment, usually non-linear, of the input. Each input is assigned a weight which influences the result (Figure 1).

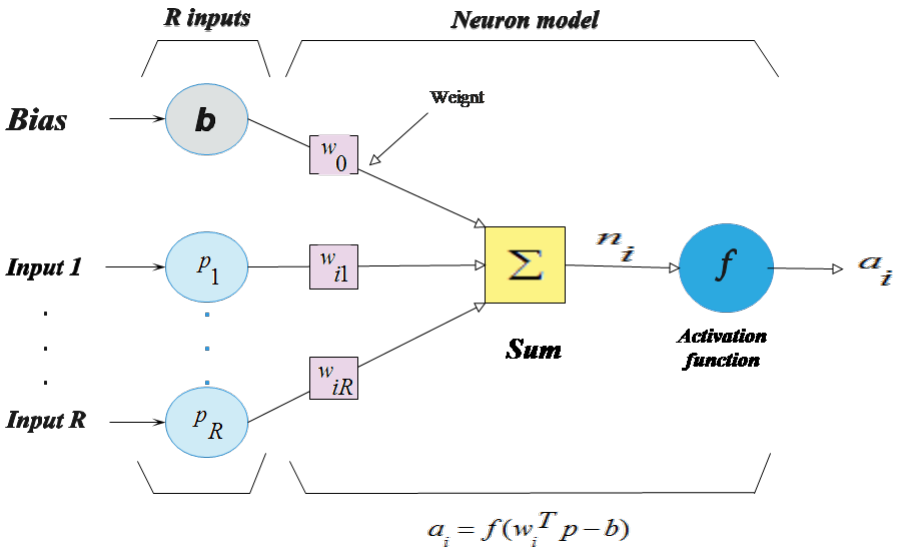

Figure 1: Neural formel

w_{ij} : est la connexion du neurone(ou de l'entre)j vers le neurone qui est dsign souvent dsign le poids i.
n_i : Is called potential(inspired by the biology), the potential n_i eis linear combination of variables $\{p_i\}$ weighted by $\{w_{ij}\}$ to which is added a constant term(bias).

$$n_i = \sum_{j=1}^{R} w_{ij} p_i - b \text{ or in the form matrix } n_i = W^T p - b$$

f activation function (it is recommended to use for F a function "sigmoid")

B. Neural Network (MLP)

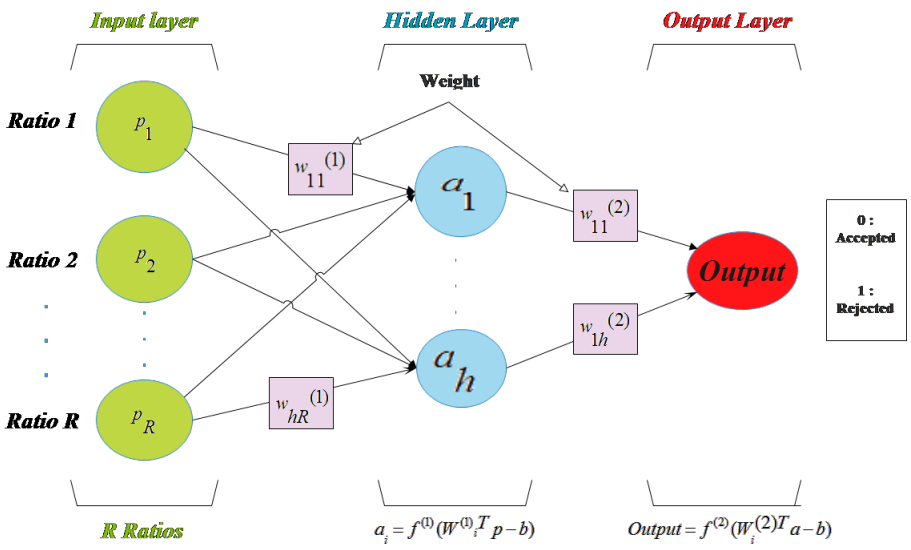

Figure 2: Three-layer neural network architecture.

$w_{ij}^{(l)}$: weight linking the i^{th} neuron of the layer Layer $l-1$ to i^{th} neuron in the Layer L
$f^{(l)}$: is called activation function of the layer l

A Neural Networkon (MLP) is composed of three kinds of neurons: input neurons, neurons of output and the hidden neurons. The neurons of entry have for inputs the R accounting ratios pre-selected (to true to say are not of neurons because they do not realize no treatment of the information); the neurons exit have for output the dichotomous variable is faulty / non-faulty. The hidden neurons are neurons that treat the information between input neurons and the neurons of the output. The network used can be more or less complex, i.e. to be composed of a variable number of layers of neurons. A layer is a set of neurons which do not exchange of information between them. In contrast, within each layer the neurons are connected to neurons in the previous layer: all of the outputs of a layer is therefore all the inputs of the next layer. The weights assigned to each input thus determine the transmission of the information.

4. Results
5. Conclusion
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