# RISK MANAGEMENT AND ARTIFICIAL NEURAL NETWORK

## 1. Introduction

There are problems that are necessary to solve in decision making process such us the rate of risk of client. The artificial neural network can help us with such problems where there are a lot of criteria and cases. More see [1- 7]. One need not embrace such a quantity of information and make the right sense. Some criterion may be omitted or human fault can happen.

The most important task is to obtain the data which are the input of artificial neural network. The input data create the table where the horizontal axis X represents the criteria and vertical axis Y represents single cases.

|  | $X_1$ | $X_2$ | $X_3$ | ….. | ….. | $X_{M-1}$ | $X_M$ |
|---|---|---|---|---|---|---|---|
| $Y_1$ | $A_{1,1}$ | $A_{1,2}$ | $A_{1,3}$ | ….. | ….. | $A_{1,M-1}$ | $A_{1,M}$ |
| $Y_2$ | $A_{2,1}$ | $A_{2,2}$ | $A_{2,3}$ | ….. | ….. | $A_{2,M-1}$ | $A_{2,M}$ |
| $Y_3$ | $A_{3,1}$ | $A_{3,2}$ | $A_{3,3}$ | ….. | ….. | $A_{3,M-1}$ | $A_{3,M}$ |
| … | ….. | ….. | …… | ….. | ….. | …… | …… |
| …. | ….. | ….. | …… | ….. | ….. | …… | …… |
| $Y_{N-1}$ | $A_{N-1,1}$ | $A_{A-1,2}$ | $A_{N-1,3}$ | ….. | ….. | $A_{N-1,M-1}$ | $A_{N-1,M}$ |
| $Y_N$ | $A_{N,1}$ | $A_{N,2}$ | $A_{N,3}$ | ….. | ….. | $A_{N,M-1}$ | $A_{N,M}$ |
| $Y_{N+1}$ | $A_{N+1,1}=?$ | $A_{N+1,2}$ | $A_{N+1,3}$ | ….. | ….. | $A_{N+1,M-1}$ | $A_{N+1,M}$ |

Input table of artificial neural network

The process, called the learning of artificial neural network, is done with number of cases N and criteria M. The first column of table $X_1$ stands the rate of risk. The artificial neural network is possible to use for set up of the rate of risk of client after the process of learning and testing. When we add case $Y_{N+1}$ with criteria from $X_2$ to $X_M$, than the price $X_1$ of case $Y_{N+1}$, (cell $A_{N+1,1}$) is the rate of risk which is estimated by means of neural network.

## 2. Set up of risk

We perform the process of the use of artificial neural network in the field of risk management on the cases of set up of the rate of risk of client that can be evaluated by the scale from 0 to 100 %. The input of artificial neural network is the table of values, which presents single parameters. The horizontal axis X represents the criteria of client: $X_1$ = rate of risk, $X_2$ = sex, $X_3$ = age, $X_4$ = marital status, $X_5$ = the number of children, $X_6$ = income, $X_7$ = account, $X_8$ = debt, $X_9$ = duration of job, $X_{10}$= time of cooperation with a client, $X_{11}$= the number of purchases, $X_{12}$= the number of delayed payments. The horizontal axis represents the single cases of clients, that is $Y_1$, $Y_2$, $Y_3$, …, $Y_N$, where N is the total number of cases. When the case N + 1 has been added with its criteria (the particular data about the client) $A_{N+1,2}$, …, $A_{N+1,M}$, then the rate of risk of the client has been calculated by means of artificial neural network (the value of $A_{N+1,1}$ cell).

Most of the input data are interval quantitative or continuous data, such as for example age, number of children, income, account, debt, duration of job, time of cooperation with client, the number of purchases, the number of delayed payments. Among nominal input data belongs the sex (man =1, woman = 0) and marital status (married = 1, single = 0). The output variable represented by the rate of risk of the client is interval in the range from 0 to 100%, where 0% (100%) means that the client is not (is) the risk for us.

The first session with artificial neural network consists in the process of learning. The session of testing has been done after the process of learning, when we add the case N + 1 with its criteria (the particular data about the client) $A_{N+1,2}$, …, $A_{N+1,M}$. The suggestion of the risk of the client has been calculated by means of artificial neural network, in our case the value of $A_{N+1,1}$ cell. The calculation of set up of the rate of risk can be used in practice after the long process of learning and testing.

The process of learning of artificial neural network has been done with 200 cases in our real task (the number of cases will be tens of thousands in the commercial use). After the process of learning has been done the calculation of

set up of the rate of risk of the client has been done in 3rd case in order. It was calculated the rate of the risk of the client 42%.  This value represents high risk in the commercial field. A part of the table including the testing case (rate of risk in %) is as follows

| Order | Risk | Gender | Age | Status | Children | Income | Account | Debt | Duration | Time | Purchase | Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 35 | 0 | 65 | 1 | 0 | 11000 | 50000 | 0 | 45 | 5 | 15 | 0 |
| 2 | 60 | 0 | 25 | 0 | 1 | 10300 | 0 | 0 | 5 | 2 | 8 | 1 |
| 3 | ?=42 | 1 | 78 | 0 | 0 | 8300 | 0 | 0 | 60 | 2 | 20 | 0 |
| 4 | 75 | 1 | 19 | 0 | 0 | 4900 | 0 | 520000 | 0 | 0 | 4 | 0 |
| ….. | | ….. | ….. | ….. | … | ….. | ….. | …… | …… | … | ….. | ….. |
| ….. | | ….. | ….. | ….. | … | ….. | ….. | …… | …… | … | ….. | ….. |
| 15 | 25 | 0 | 54 | 1 | 2 | 12300 | 120000 | 0 | 32 | 7 | 38 | 0 |
| 16 | 70 | 1 | 20 | 0 | 0 | 8800 | 0 | 15000 | 0 | 1 | 6 | 1 |
| 17 | 65 | 1 | 58 | 1 | 1 | 15200 | 0 | 0 | 30 | 3 | 10 | 0 |

The part of the table – suggestion of rate of the risk

The other tests have similar results. It proves that it is possible to use the mentioned methodology for judgement of rate of the risk of the client.
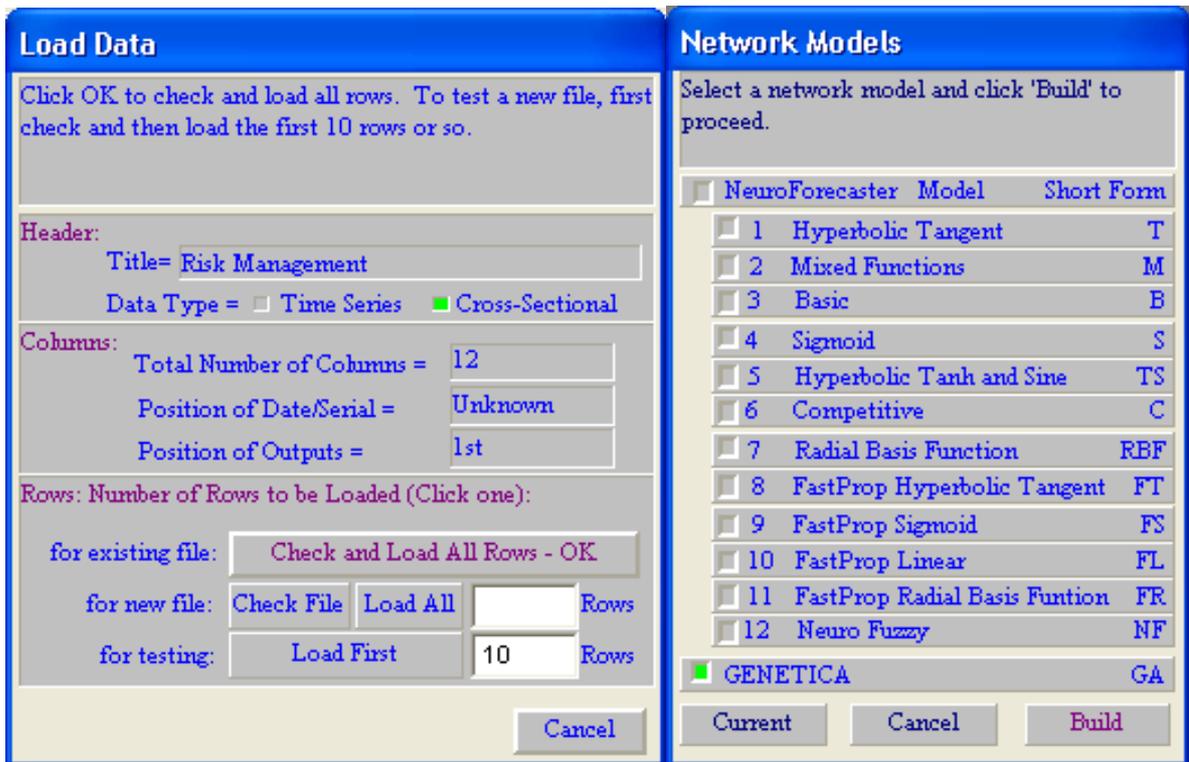
## 3. Process of calculation

The process of calculation is as follows: At first it is necessary to set up the input information for calculation and fill in the table.
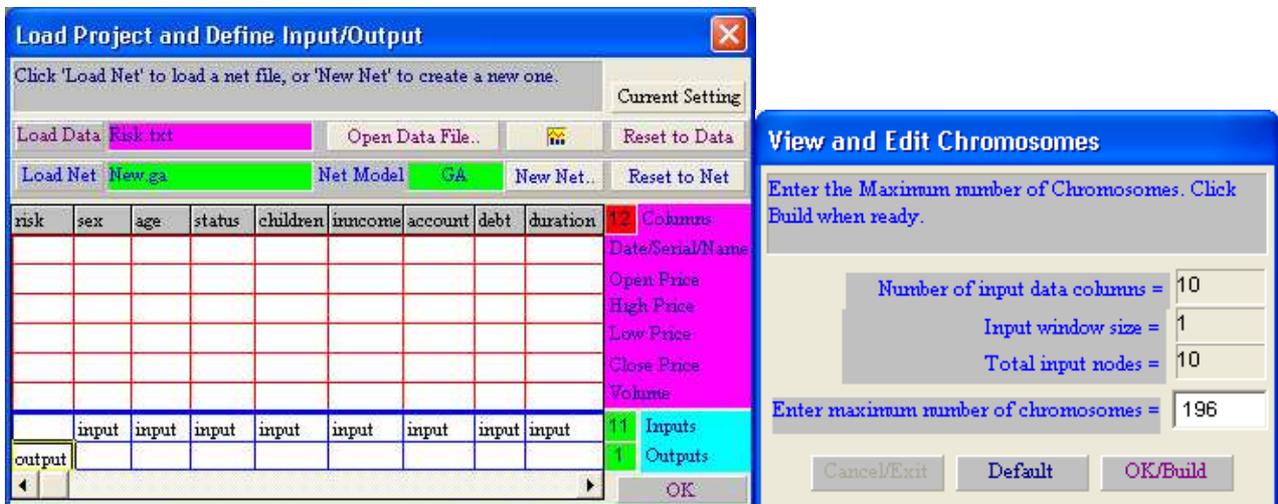


Part of input table

Then the data must be loaded and the model must be chosen. The process of tuning of artificial neural network was done and the best result was given by the Genetica model.

Load of data and choosing of network model

Further the process of set up of inputs and outputs together with the number of nodes and chromosomes must be done.



Set up of inputs and output, nodes and chromosomes

It is necessary to set up the ranges for learning and testing. The process of testing can be checked by watching of Weight histogram and AEI histogram, which show the state of process of calculation of artificial neural network and by means of viewer, which shows the topology of artificial neural network. All information about the process of testing, learning and forecasting is shown on the display.
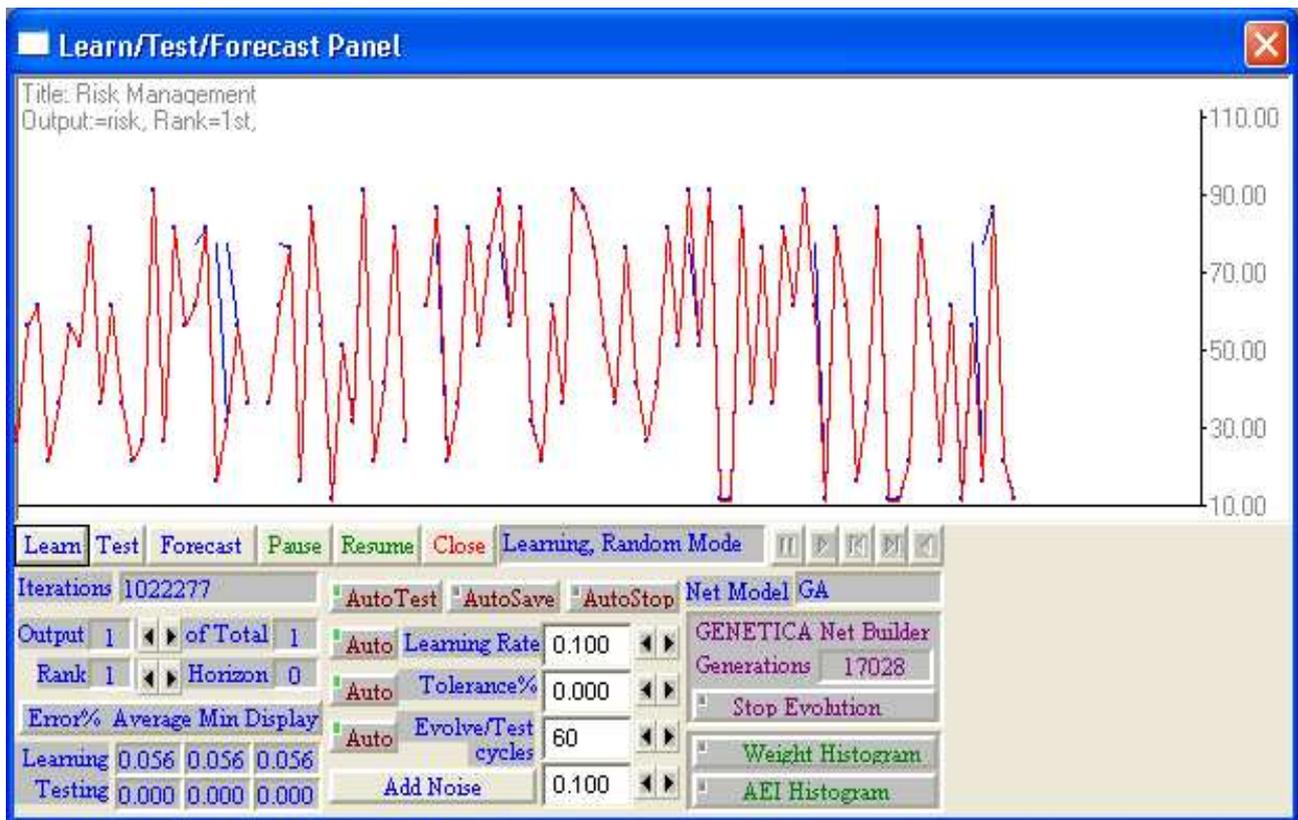
Process of calculation

The results can be displayed as a table, where in the column Forecast1 in 3rd case in order is the calculated value 42 %.



| | Sequence | risk | Forecast1 | Error1 |
|---|---|---|---|---|
| 1 | 1 | 35 | 35.000042 | -4.2E-005 |
| 2 | 2 | 60 | 60 | 0 |
| 3 | 3 | empty | 42.009909 | empty |
| 4 | 4 | 75 | 75.000008 | -8E-006 |
| 5 | 5 | 15 | 14.999765 | 0.000235 |
| 6 | 6 | 85 | 84.999992 | 8E-006 |
| 7 | 7 | 55 | 55.000004 | -4E-006 |
| 8 | 8 | 10 | 10.000175 | -0.000175 |
| 9 | 9 | 50 | 50 | 0 |
| 10 | 10 | 30 | 30.000002 | -2E-006 |
| 11 | 11 | 90 | 89.999985 | 1.5E-005 |
| 12 | 12 | 20 | 19.999926 | 7.4E-005 |

Part of table of rate of risk with suggestion

At the end, we can sum up, that the artificial neural network had 11 inputs and 1 output. The topology of network consisted of one input, two hidden layers and one output layer. The transfer functions Hyperbolic Tangent, Sigmoid and Hyperbolic Tanh and Sine and model Genetica were tested. The Genetica model which uses the pruning of neural network gives us the best results.

# 4. Conclusion

The artificial neural network has been done on the commercially sold software NeuroForecaster of NIBS Ltd. The genetic algorithm was used for pruning of artificial neural network structure. The important condition for the correct process of estimation of prices via artificial neural network is the use of correct data during the process of learning.

The use of artificial neural network seems to be perspective as a mean of suggestion of the rate of the risk of the client, especially in the field called data mining. It is possible to solve various problems given by various input and output data by this methodology. The mentioned task and their tests are the proof of a possible use of methodology in practice. Especially the fact that one need not embrace such an amount of cases with many criteria makes an evidence of the use of such methodology in practice.

Generally we can say that the artificial neural network can help us in the field of risk management. When we have the correct data and we tuned the artificial neural network very well, the results of calculation can help us in the decision making process. This method supports the discovery of risk situation caused by client, investment, loan, mortgage, etc. Thus the losses caused by wrong decision can be prevented. The artificial neural networks cannot replace the traditional deterministic models, but they can be used as a tool for the support of decision making process, when conventional methods fail.