Results of research on development of an intellectual information system of bankruptcy risk assessment of the enterprise

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Abstract. The article represents research results about the knowledge base development for the intellectual information system for the bankruptcy risk assessment of the enterprise. It is described the process analysis of the knowledge base development; the main process stages, some problems and their solutions are given. The article introduces the connectionist model for the bankruptcy risk assessment based on the analysis of industrial enterprise financial accounting. The basis for this connectionist model is a three-layer perceptron with the back propagation of error algorithm. The knowledge base for the intellectual information system consists of processed information and the processing operation method represented as the connectionist model. The article represents the structure of the intellectual information system, the knowledge base, and the information processing algorithm for neural network training. The paper shows mean values of 10 indexes for industrial enterprises; with the help of them it is possible to carry out a financial analysis of industrial enterprises and identify correctly the current situation for well-timed managerial decisions. Results are given about neural network testing on the data of both bankrupt and financially strong enterprises, which were not included into training and test sets.

1. Introduction

Currently bankruptcy risk assessment is of great importance. The urgency of the issue resulted in development of numerous methods and methodologies for bankruptcy risk assessment with some degree of possibility. However there are a lot of problems here. These are methods that could assess unsuccessful outcome which are almost absent. The majority of those methods failed for a number of reasons. Consequently, an urgent problem is development of systems that can overcome challenges of existing models and take into account our country specifics.

2. A process analysis of knowledge base development of an intellectual information system for bankruptcy risk assessment of the enterprise

Connectionist simulation is made in several steps.

At the first step an index range for further study is determined. For bancruptcy risk assessment the authors propose to use 10 indexes that characterise financial and economic activity of the enterprise: x1 is working capital ratio; x2 is acid test ratio; x3 is absolute liquidity ratio; x4 is liquid capital ratio

in assets; x5 is concentration ratio of capital loans; x6 is long term fund raising ratio; x7 is borrowed and own funds ratio; x8 is turn-round of float; x9 is turn-round of owned capital; x10 is product profitability.

Correctness of this index system is proved by the research "Decision support system for bankruptcy risk management of the enterprise".

At the second step the authors sampled companies with accurate financial accounting on the basis of which they did calculations of the given indexes. Several problems are solved here:

1) Search for time quasi-homogeneous data.

Since 2011 till 2013 there was relative macroeconomic stability: inflation was about 6-7%, fluctuation of the dollar with respect to the ruble was about 10 %. Therefore it is possible to say that 2011 – 2013 time period gives quasi-homogeneous financial statistics for financial analysis.

2) Search for quasi-homogeneous data at inter-branch level.

Difference in index values and their norms from branch to branch caused reduction of studied enterprises to one basic Russian Classification of Economic activities (OKVED). During this research the authors decided to process financial accounting of the enterprises with basic OKVED 29 – Machinery and equipment production apart from OKVED 29.6 – Arms and weapons production.
This OKVED was selected due to two main reasons: 1. The proposed 10 indexes for the research obtained during previous studies were selected for industrial enterprises; 2. Industrial sector is an object of state focused attention being a key sector for the Gross Domestic Product formation and influenced by crisis phenomena of different levels.

3) Search for one-type data.

To get one-type data of enterprises the authors bought quarterly subscribing to the information system "SKRIN" where they exported data from of financial accounting of 155 enterprises since 2011 till 2013 [1].

At the third step for calculating values of marked indexes the authors instantiated two program modules in Delphi XE3: the first module realized parsing of xls files with financial accounting data; the second module realized data pre-processing, i.e. normalizing. For holding calculated index values the authors established database on My SQL Server 5.3.

At the fourth step a type of neural network was chosen, it was a three layer perceptron with back propagation algorithm as a training one. The reason for this choice was relative simplicity of realization together with scalability and a wide range of tasks that could be completed with the help of perceptrons.

At the fifth step the authors built and trained neural network by means of the program Deductor Studio, which had a good tool set for data analysis and building artificial neural networks.

At the sixth step the authors did validity check of obtained neural model for bankruptcy risk assessment of the enterprise on the basis of testing with the help of data set trained in the program Deductor Studio. At the end of testing they obtained results that sufficiently reflected the state of things at analyzed enterprises.

3. Structure of intellectual information system (IIS) and knowledge base

The interaction mechanism of the basic IIS subsystems is as follows:

1) A knowledge expert or engineer enters financial accounting data into the system by means of a special form, which allows inserting data by hand or loading the file in xls format.

2) Data pre-processing, i.e. normalizing, is realized. Heterogeneous quantities can be as input so output. It is evident that connectionist simulation results should not depend on units of measurement of the quantities. The network should interpret their values consistently, all the input and output quantities should be normalized to one gauge. To increase rate and quality of training it is necessary to realize optional pre-processing that adjusts classification of values before training. Normalizing to one gauge is provided by norming of every variable on the scatter range of its values.

At that it is necessary to be oriented not to extreme values but to typical ones, i.e. data statistic characteristics as medium and dispersion. In this case the majority of data has one gauge, i.e. typical values of all variables are comparable.

3) After pre-processing the data is recorded on the database MySQL.

4) The connectionist model is built (trained) on the basis of available data. Then this model is used for bankruptcy risk assessment of the enterprise. The processed information and information processing method in the form of the connectionist model form the knowledge base of the intellectual information system. So in general it is possible to say about two-level knowledge representation in IIS: the first level is factual information, data; the second level is neural network that identifies the way of manipulation of factual information.

5) Decision output is done by means of the output subsystem, which cooperates with knowledge base during interpretation of methods and database data.

6) Problem solving and work with a model (specimens) and data is done in a special module – working space. Query description (soled problem, data and methods from database) are presented in working space.

7) The subsystem illustrates the way of a solved problem (or why is has not solved the problem) and used knowledge. It makes easier system testing for an expert and increases confidence of a user in obtained results.

8) The term "user interface" covers all aspects of cooperation between the user and IIS. In this system an interface on the base of cooperation formation is used. The user enters data or an order into special forms (boxes). Form names (or report/table manes) are promptings for enter. Computer can give some output as a result and ask the user if it is necessary to continue an interactive process [2].

4. Theoretical bases and mathematical models of knowledge base

For building artificial neural network the authors selected 125 enterprises with basic OKVED 29.

One quarter of these enterprises is bankrupts, i.e. these enterprises were adjudged bankrupts by the Supreme Commercial Court of the Russian Federation or against which they instituted bankruptcy proceedings.

The authors calculated input data values, i.e. 10 indexes, on the basis of financial accounting annual data for 2011-2013. So they obtained 347 training specimens (irregular units of observation were deleted from the population).

There is only one output variable, it is bankruptcy. The variable id dyadic: 0 means that the enterprise is "healthy", 1 means that it is bankrupt.

Network configuration and its training is done with the help of the program Deductor Studio.

Choosing an optimal quantity of neural processing elements on the core layer is made by means of the theorem of Arnold – Kolmogorov – Khekht-Nilsen.

Therefore, taking into account made calculations it is possible to conclude that a quantity of neural processing elements on the core layer should be in the interval [3;39]. Calculated a mean value the authors have: N optimal = 22 neural processing elements.

During Building and training the network the authors used the following parameters:

- training algorithm – back propagation of error;
- significance initialization – automatical;
- quantity of input factors – 10;
- quantity of output factors – 1;
- quantity of neural processing elements on the core layer – 22;
- quantity of training specimens – 347;
- training set – 95% (330 bars);
- testing set – 5% (17 bars);
- activation function type – sigmoid;
- training rate – 1;
- gauge of acceptable mistake (the stopping down condition) – 0,05;

- mean mistake for training set – 0,01 (1 %)
- mean mistake for testing set – 0,047 (4,7 %)
- training period – 5 мин. 14 сек.
- quantity of training stages – 22047;
- taken into account from training set – 98,55%;
- taking into account from testing set – 94,44% [3].

5. Algorithm of information processing during bankruptcy risk assessment

Algorithm of information processing during bankruptcy risk assessment with the help of the connectionist model is presented by means of functional models and includes the following stages.

At the first stage one realizes data origination for network training. Then they make parsing of xls files (financial accounting – forms No 1, 2), which contain data for calculations, calculate 10 financial and economic indexes, which are the most crucial from the point of view of bankruptcy risk assessment of the enterprise.

At the second stage data pre-processing – data normalization – is realized. Neural network works with time-series values from 0 till 1. Input index values greatly exceed the limit. To use neural network it is necessary to normalize input time-series, save prepared data in MySQL database.

At the third stage training of artificial neural network is realized, i.e. model building. This stage includes three main steps: data input with further data diffusion to output directions, finding and back propagation of the error and significant adjustment; and this when network characteristics are already collated by means of an experiment.

At the fourth stage they assess bankruptcy risk of the enterprise. It is supposed that for this operation they need just data input and its data diffusion to output directions [4,5].

6. Mean values of 10 indexes for industrial enterprises

Obtained values will help in financial analysis of industrial enterprises and correct definition of the situation for timely management decision-making.

Mean index values for financially stable enterprises:

1) working capital ratio – 2,2;
2) acid test ratio – 1,1;
3) absolute liquidity ratio – 0,38;
4) liquid capital ratio in assets – 0,44;
5) concentration ratio of capital loans – 0,41;
6) long term fund raising ratio – 0,05;
7) borrowed and own funds ratio – 0,86;
8) turn-round of float – 7,38;
9) turn-round of owned capital – 2,16;
10) product profitability – 10,55%.

7. Testing of connectionist model

The authors tested obtained connectionist model with the data of bankrupt enterprises that were not taken into training and testing sets. For example, for OJSC “Izhevsk machine-building plant”, Izhevsk city, which was declared a bankrupt in first quarter 2012, they obtained the following results: the first quarter 2010 – risk level is 0,07 (absence of bankruptcy); the first quarter 2011 – 0,99 (the plant is bankrupt); the first quarter 2012 – 1,0 (the plant is bankrupt). The authors also tested the model with the data of financially stable enterprise (it was not taken into training and testing sets) CJSC “Sibkabel”, Tomsk city. The results were as follows: the first quarter 2010-2012 – 0 (absence of bankruptcy). It is necessary to say that basic OKVED of CJSC “Sibkabel” is 31.1 what shows that the obtained model can be applied to enterprises of other branches.

A possible solution to this problem is usage of connectionist technologies, which are a high-efficiency tool.

Conclusion

At the result of the research the authors obtained connectionist model for bankruptcy risk assessment of the enterprise on the basis of new 10 indexes of enterprise activity, which are the crucial for bankruptcy risk assessment.

Calculations are made for industrial enterprises with basic OKVED – 29. It eliminates the problem of inter-branch disagreements when one assesses index values for identifying bankruptcy risk of the enterprise.

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