AN ENTERPRISE FINANCIAL STATE ESTIMATION BASED ON DATA MINING

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Abstract: This paper is concerned with the data mining application to business process automation. A short tutorial on stages of financial analysis of an enterprise is given. A brief description of data mining components for financial analysis of an enterprise is presented in the paper. The main element of data mining application is fuzzy neural system. The structure of fuzzy neural system includes linguistic variable "financial state", neural network and fuzzy rules. The fuzzy neural system forms the financial state estimation based on balance sheets from dataware house of an enterprise. The data mining application has been realized as software in Microsoft Visual Basic 6.0. The software was applied to estimation of financial state of Kharkov (Ukrainian) enterprises in 1999. Finally, the set of enterprises for investment was found.

Keywords: data mining, business process, financial state, fuzzy neural system.

1. Introduction

The business process automation of an enterprise is based on modern information technologies. An enterprise is a complex business system, which includes main and support business processes (BP) of different types and appointments. The complex system includes the following BP: BP of production, BP of planning and management, BP of transformation. Each BP characterizes operative information, which describes its current state. The operative information about business system stores in data warehouse. The operative information is structured subjectively. Using tools, the company manager analyzes financial state and directions of his development. Such principle is a basis of data mining technology (Fig. 1.1).
The financial resources management BP based on data mining is investigated in the paper. The fuzzy neural system (FNS) is used as a tool for operative information processing. FNS estimates the business system financial state.
The financial state estimation is the main stage of financial analysis. The method of financial analysis includes the following blocks: general financial state estimation, investigation of estimation alteration during year, financial stability analysis, solvency analysis, ability to pay analysis, business activity investigation.

Each stage of financial analysis uses the special enlistment of financial indexes. The index values are the basis of decision making for business system financial activity improvement.
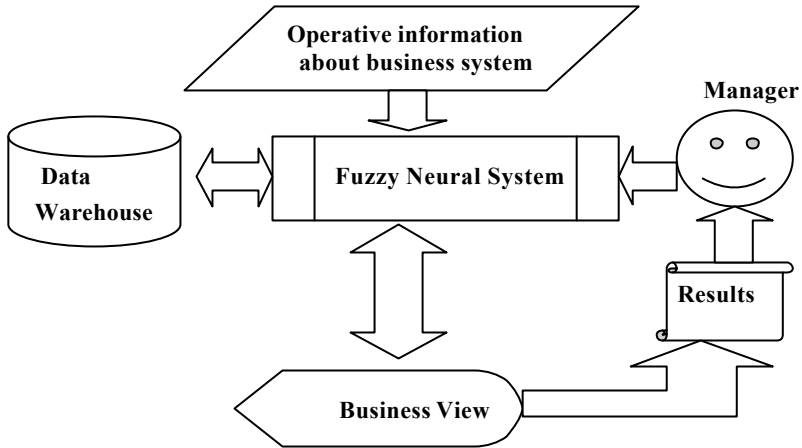

Fig. 1.1. Conceptual scheme of data mining using

The financial state indexes divide in two groups: assessment indexes and coordination indexes. Traditionally, the main idea of financial analysis is comparison of current index values with optimal values, which characterize financially stable business system (enterprise) [SHSA96]. Experts formulate the estimation of financially stable enterprise. Thus, the financial analysis is based on searching dependencies among different financial indexes and with the following comparison of index current values with optimal values. In this case FNS creates the nonlinear dependencies among different classes of financial indexes, which describe financial activity of the business system [GO98].

2. Fuzzy neural system of financial state estimation

Note, the vector of financial state indexes, as $\vec{P} = \{P_1, ..., P_r\}$:

$$P_i = \mathord{\text{j}}_i (x_1, ..., x_n), \; i = \overline{1, r},$$

where $\mathord{\text{j}}_i (x_1, ..., x_n)$ – the transformation function of balance sheet absolute parameters $x_1, ..., x_n$ into financial state index - P_i; r – quantity of financial state indexes;

$\vec{X} = (x_1,..., x_n)$ - the vector of balance sheet absolute parameters; n – general quantity of balance sheet absolute parameters, which it is necessary to use for evaluation of financial state indexes from vector $\vec{P}$.

The indexes from vector $\vec{P}$ are used for the following linguistic variable value definition:

$$F = \{\text{" financial state"}, T, U, Gr, Sem\},$$

where $T = \{T_1, T_2, T_3\}$ – terms of linguistic variable F; U – universal set; Gr – grammatical rule; Sem – semantic rule.

The terms of linguistic variable "Financial state" are the following notions: T_1 - "stable financial state", T_2 - "unstable financial state", T_3 - "crisis financial state". The values of linguistic variable F characterize fuzzy variables v_1, v_2, v_3, which belong to universal set U. Grammatical rule Gr is the simple enumeration of terms from set T. The semantic rule is a neural network. Neural network evaluates the values of membership functions of fuzzy variables v_1, v_2, v_3. The values received are analyzed by fuzzy rules, which define concrete term of linguistic variable "Financial state".

The trapezoidal membership function was used for evaluation of fuzzy variables v_1, v_2, v_3, which have the following view [P98]:

$$v_i = \{y \hat{I} \ U, A_i(y)\}, \ i = \overline{1,3},$$

where y - linear combination of balance sheet absolute parameters $x_1,..., x_n$; $A_i(y)$ - membership function of fuzzy variable.

The scheme of FNS is presented on Fig. 2.1.

The inputs of FNS are the balance sheet absolute parameters possessed by vector $\vec{X}^t$. Input signals of FNS characterize balance sheet, which was created on a concrete date t. Usually the date t is the first number of month. The outputs of FNS are values of membership functions of fuzzy variables v_1^t, v_2^t, v_3^t, which describe the terms of linguistic variable F. Fuzzy rules analyze the values of membership functions $A_i(y^t)$, $i = \overline{1,3}$ (see Fig. 2.1). Fuzzy rules define the term-value of linguistic variable F.

The fuzzy rule formulation is based on neural network output values, which correspond to fuzzy variables v_1, v_2, v_3 and have the following structure [GO98], [P98]:

$$\textbf{IF} \, (\, A_i \, (y(\overset{\text{r}}{X}{}^t)) = NN_i \, (\overset{\text{r}}{X}{}^t) \geq z_i^t \,) \, \textbf{THEN} \, F = T_i, \, i = \overline{1,3}.$$

Parameter z_i^t defines minimal value of membership function of fuzzy variable v_i, when linguistic variable $F = T_i$, $i = \overline{1,3}$. Thus, the decision making about financial state is being performed in a fuzzy space.
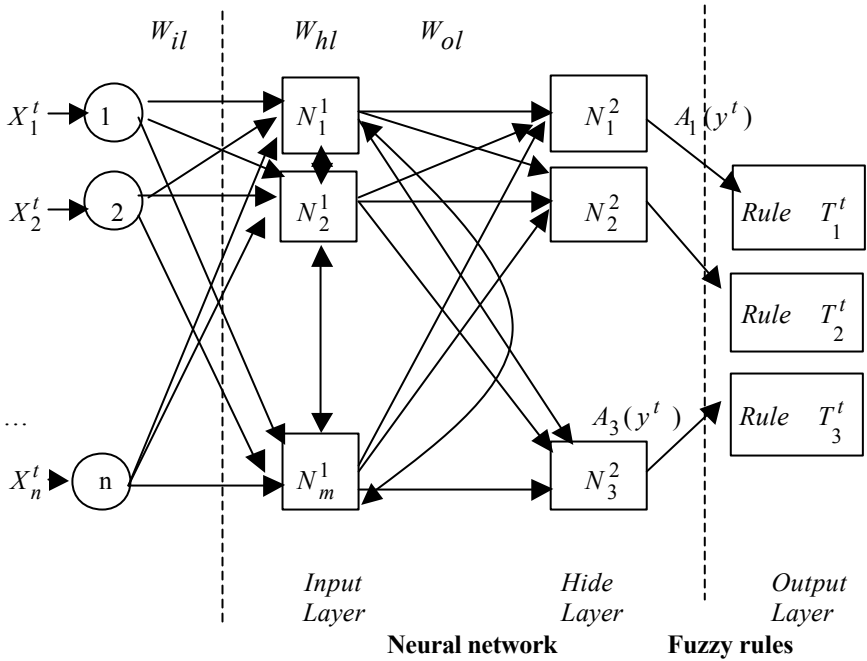

Fig. 2.1. The structure of fuzzy neural system of financial state estimation

Using special learning algorithm, the weight matrixes of neural network (W_{il}, W_{hl}, W_{ol}) have been evaluated.

3. Software for financial state estimation

The functional structure of software for financial state estimation is presented in Fig. 3.1. The IDEF0-diagram is demonstrated in Fig. 3.1.

The data mining application was realized as software. The software was performed in Visual Basic 6.0. The main form view is presented in Fig. 3.2

The database was performed in Microsoft Access using DAO technology. The database includes the following tables: business system description, balance sheet, actives, passives.

The software also checks the reliability of balance sheets. The software also analyzes the enterprise groups. This software facility is needed for investment analysis.
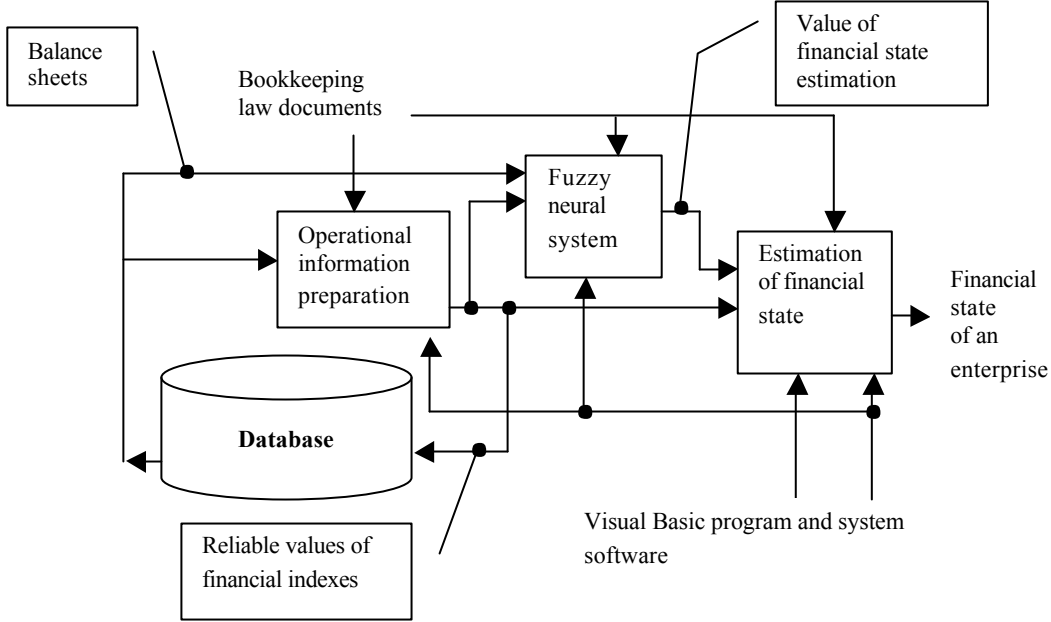

Fig. 3.1. Functional structure of software

Fig. 3.2. Software main form.

All software work results are presented in graphical form.

4. The results of software using for financial state estimation of Kharkov enterprises

The results of financial state estimation of Kharkov (Ukrainian) enterprises, which have been received, are presented in Fig. 4.1.

The operative information for estimation (see Fig. 4.1) included balance sheets of forty Kharkov enterprises. Each enterprise had two balance sheets for estimation: 1) balance sheet on December 1, 1999; 2) balance sheet on December 1, 2000.

The Fig. 4.1 demonstrates how many balance sheets were estimated as stable, unstable and crisis. However, general quantity of balance sheets presented in Fig. 4.1 is only seventy-nine. This fact means that one balance sheet was estimated worse than crisis state. This balance sheet characterizes the financial state of bankrupt enterprise.

Using the approach proposed, the financially stable enterprises were found. These enterprises were recommended for investment in 2000.

The results of financial state estimation of the Kharkov enterprise "Bolshevik" are presented in Fig. 4.2.

The estimation dynamic is presented in Fig. 4.2. This enterprise produces winter lather clothes. In this case the enterprise had more financial resources before and after winter season. The enterprise had finances before winter season, as they were needed for production preparation. The enterprise had finances after winter season, because it was profit. This fact is demonstrated in Fig. 4.2 in "01.04.98" and "01.1 0.98" positions. During summer and winter the enterprise did not have enough finances, because, first, summer period is not a season for lather clothes, second, in winter the enterprise has to direct all finances in production activity.
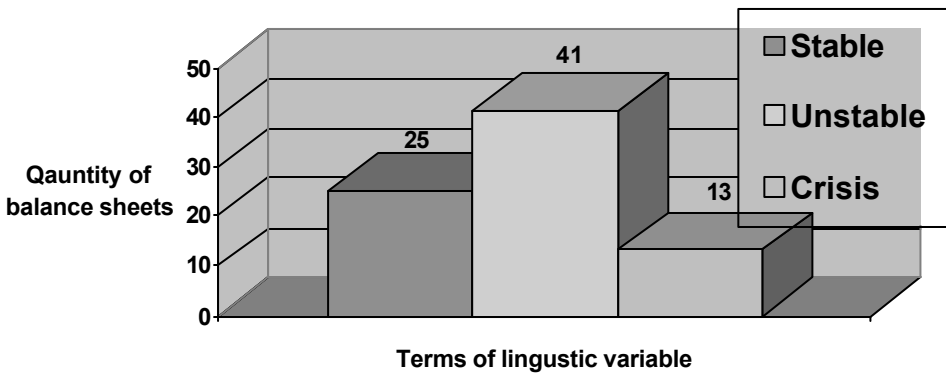

Fig. 4.1. Results of financial state estimation of forty Kharkov (Ukrainian) enterprises in 1999
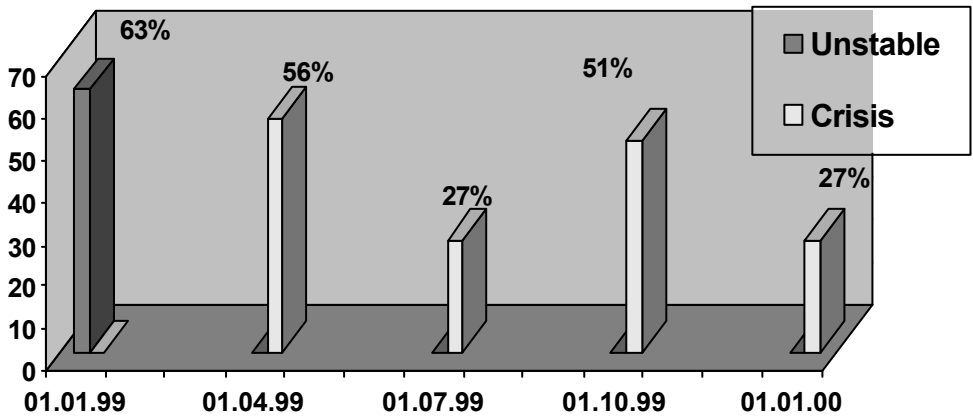
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Fig. 4.2. "Bolshevik" financial state estimation in 1999 (Kharkov, Ukraine).

Therefore, analyzing Fig. 4.2 the manager of "Bolshevik" enterprise has received business view about annual financial state. This view he can use for improvement of business process of financial resource management at the next year.

Thus, the approach of financial state estimation has been presented in the paper. The approach is based on data mining. The data mining application includes the fuzzy neural system of financial state estimation. Using the application realized, manager of an enterprise is controlling a business process development.

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