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DEVELOPMENT OF THE DECISION MAKING SYSTEM ABLE FOR SELF-LEARNING

There had been developed the structure diagram and decision making model for self-learning system, able to generate advices to user, operating on the financial markets.

Key words: *self-learning, decision making system, decision tree, fuzzy logic*

Urgency

The development of technology and increasing of labour output in all the spheres belongs to the most important tasks of technological process in our society. Wide introduction of the systems for automatic regulation and control of both, the separate objects and the manufacturing as a whole makes the solution of these tasks possible. Systems of automatic control are used for control of different objects, in particular, for systems with variable parameters. There exists a great variety of systems for adaptive control, though the objective of this research is the self-learning systems for the work on the financial markets with the help of Data Mining [1].

Nowadays the systems which are able not only to execute the once programmed succession of actions over the data determined in advance, as well as to analyze the obtained information, to find the regularity, to make prognosis etc., are in increasing demand. These days a great experience in creating the automatic control systems for in different branches of national economy is accumulated. This experience allows to make a conclusion that the improvement of control efficiency means an increase in level of intellectualization of these systems, transition to so-called "clever" manufacturing systems, focused on knowledge. The sphere of the application of the systems of artificial intelligence which exist nowadays, covers medical diagnostics, interpretation of geological data, scientific researches in chemistry, biology, military science and other areas.

The automatic control self-learning system (the self-adjusted system), is the system, in which the adaptability to conditions which casually change, is ensured by automatic replacement of adjustment parameters or by automatic search of optimum adjustment. Any automatic control system has the parameters which influence its durability and quality of controlling process, and can be changed during the regulation (adjustment) of the system. If these parameters remain unchanged, and conditions of functioning (characteristics of operated object, exciting actions) change essentially, the controlling process may worsen or even become unstable. Manual adjustment of the system often appears difficult, and sometimes impossible. In such cases the usage of self-learning system is technically and economically expedient and can even occur to be the only way of a reliable control [1].

In cases when self-tuning is used in the control systems as a result of incredibility of knowledge of the object's features, the self-optimization system reminds of the process of the system's self-learning. The system in a way of automatic search surrosedly learns the unknown features of the operated object and learns how to operate this object in the best way. The usage of such systems is profitable in cases when external action can be measured for the purpose of the analysis of its features and when the change of its form is decisive for the quality of the system's operation.

The peculiarity of system is that soon it will tune, learn and accumulate experience of the user. The urgency of self-learning system is that the person does not interfere with the adjustment and learning of the system. In system which we will develop in this work, the expert estimation will be individual for each investor, its set of factors and the received traders.

Research Objective

Research objective is the development of the automated expert system for making the advises to the user, which has the self-learning ability and is capable of accumulating experience in decision-making on the basis of constantly filled up data. Development of such a system will enable to improve the efficiency of work on stock markets and increase profit of the investor.

Problem statement

The work sets the task of the development of the automated system capable to self-learning and making advises to the investors in the form of expert decisions, building the decision-making model and methods of its work.

The solution of this problem should be divided into some stages:

1. The analysis and research of initial sample of data.
2. Development of the models of acceptance of the expert decision.
3. Making an advise depending on the obtained results of the classification.

The workinability of the automatic control system to a great extent depends on the model of decision-making. A decision-making model we will search in the following kind

$$Y = f(X_1, X_2, X_3, X_4), \quad (1)$$

where Y – the result of decision making

X_1 – position of price in relation to sliding avarage;

X_2 – following the price model;

X_3 – change of interest rate;

X_4 –subjective state of trader.

Table 1 presents the description of factors‘ characteristics X_1- X_4 . The table shows that the factors of X1 and X2 are linguistic variables, the values of which bring the uncertainty to the initial data.

Table 1

Descriptions of model factors

Factor	Type	Value
X_1	Linguistic	«H» – higher the sliding average within 1% «MH» – higher the sliding average more than 1% «L» – below sliding average within 1% «ML» below the sliding average more than 1%
X_2	Linguistic	«SAE» - symmetric model with the increasing trade volumes «NAE» –asymmetrical model with the increasing trade volumes «N» asymmetrical model
X_3	Quantitative	«0» – a rate unchanged «-0.25» – decrease of rate by 0.25% «-0.5» - decrease of rate by 0.5% «0.25» – increase of rate by 0.25% «0.5» - increase of rate by 0.5%
X_4	Discrete	«1» – buy «-1» – not to buy «0» – out of market

Let us assume that a decision-making result acquires the following values

$$Y = \begin{cases} class1 - \textit{менше } 1\% \textit{ прибутку} \\ class2 - \textit{більше } 1\% \textit{ прибутку} \\ class3 - \textit{менше } 1\% \textit{ збитку} \\ class4 - \textit{більше} 1\% \textit{ збитку} \end{cases}.$$

Consequently, the building of decision-making (1) model turns into the solution of task on classification.

The tree solution method is widely used in practice for the solution of task of classification with indefinite initial data, which allows to determine the set of rules of classification of the type «If, - Then». These rules will be the system's advice to the user. Let us consider the main provisions of decision tree method.

Main provisions of the decision tree method

Decision tree method is one of methods of automatic analysis of enormous arrays of data [2]. The first ideas of creation of decision trees start in the works of Khovlend and Khant of the end of 50-s of the XX century. However the fundamental work which gave an impulse for the development of this direction was the book of Khant, Merin and Stone «Experiments in Induction», that was published in 1966.

The sphere of application of decision tree method can be united in three classes:

– definition of data: decision trees allow to keep information about the retrieval of data in a compact and comfortable for processing form which contains exact descriptions of objects;

– classification: decision trees cope with the tasks of classification, that is the correlation of objects to the one formerly described classes;

– regression: if a variable does not have the exact value, the decision trees enable to determine dependence of this target variable on independent (output) variables.

Fig. 1 shows the example of decision tree. This tree presents the aggregate of knots and leaves, which are marked on the figure as an oval and rectangles. The knots contain the terms (tests), and the leaves contain the mark of the class.

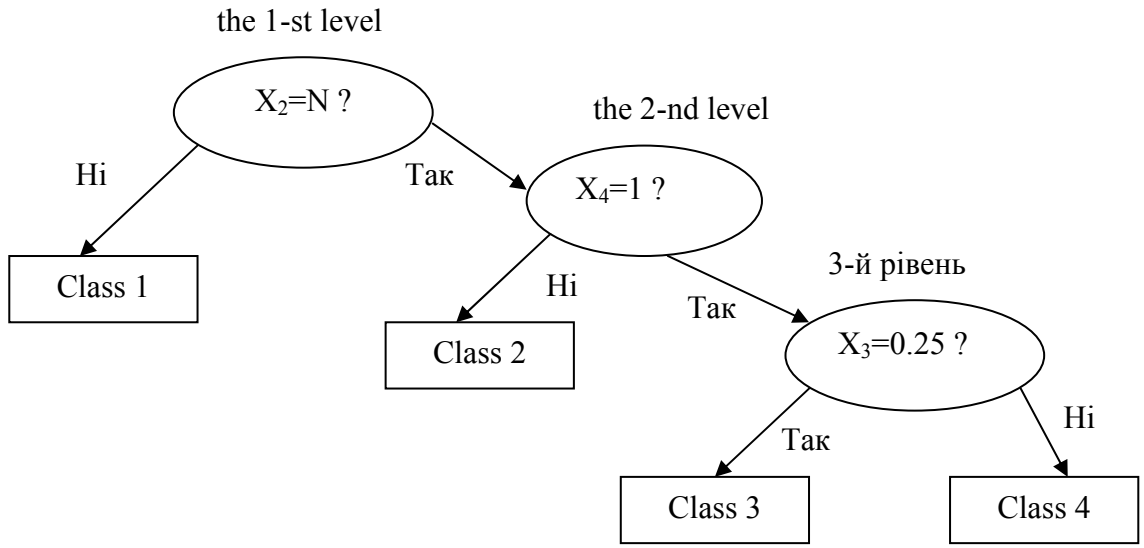

Fig. 1. Example of the decision tree.

To make a decision with the help of the decision-making tree it is necessary to execute the following steps:

1) to estimate a market condition by the vector of factors of Kh=(X1, X2, X3, X4) (this step is executed by the user of the system);

2) to deterine the class of income increase by motion of vector X on decision tree from the top levels to the low ones (this step is done by the system).

Today there many algorithms which realize decision trees of CART, C4.5, Newid, Itrule, CHAID, Cn2 etc. In this work for the development of the model of acceptance of expert decision it was decided to use the algorithm of C4.5 [3].

Principle provisions of algorithm c4.5.

The synthesis of decision tree is taken to such a task: known selection of investor:

$$T = \{X^i, Y^i\},\ i = \overline{1,n}, \tag{4}$$

where $X^i = \{X_1, X_2, X_3, X_4\}$ vector of market condition, formed by the investor as an I-th estimation;

$Y^i \in \{class_1, class_2, class_3, class_4\}$ – is the real result of decision-making for the I-th estimation of investor;

n – amount of investor estimations of the market (degree of selection).

It is necessary to build a function with the help of the formatted initial selection

$$X_1 \times X_2 \times X_3 \times X_4 \to Y, \tag{5}$$

that converts the space of factors into prognostication of class of income increase.

To build a tree on every internal knot, it is necessary to find such condition (verification), which would break up a selection, associated with this knot into the subsets. One of attributes (factors) must be chosen as the sort of such verification. The general rule for the choice of an attribute is possible to formulate so: the chosen attribute must break up a selection so, that the got subsets consisted of objects which belong to one class, or were maximally close to it, that the amount of objects from other classes in each of these subsets would be as less as possible. In the algorithm of S 4.5 such criterion of selection is suggested [3]:

$$Gain(X) = Info(T) - Info_X(T), \tag{2}$$

Where $Info(T)$ –entropy of general selection;

$Info_X(T)$ –entropy of factor X, which is calculated on the formula:

$$Info_X(T) = \sum_{i=1}^{n} \frac{|T_i|}{|T|} * Info(T_i). \tag{3}$$

Structure of automated system

Fig. 2 presents the structural diagram of the system, able for self-learning and making advices for the user. This system consists of three blocks:

– base of estimations of market condition;

– classification of estimation by the method of decision tree;

– automated subsystem of making decision.

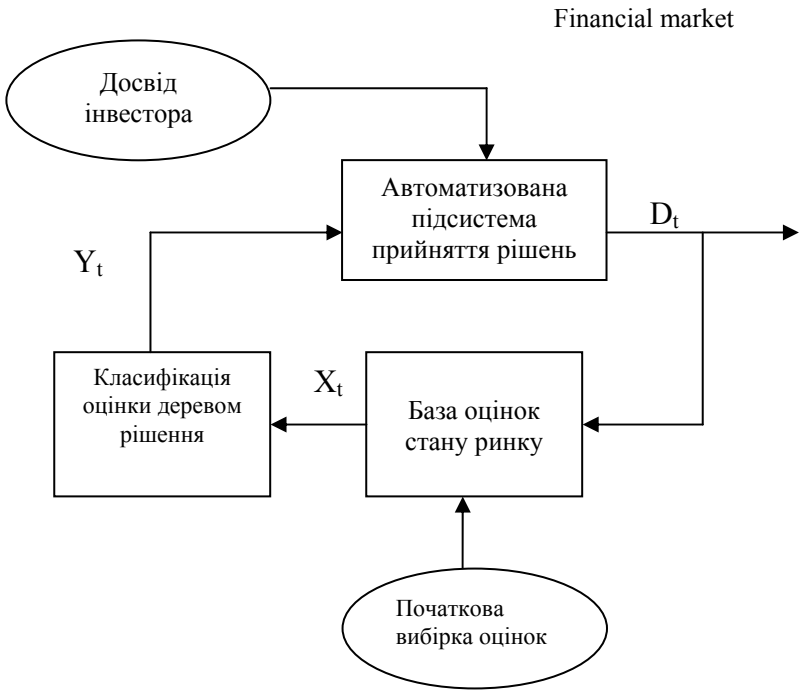

Fig. 2. SDtructural diagram of decisions making automated control system

With the help of the initial selection of market condition estimations, the system forms the decision tree which in future will enable to classify the subsequent vectors of estimations in the class of income increase. Getting the results of classification, the system makes the advice to the investor, on the basis of which, taking into account the own experience, an investor makes a decision, which will be entered to the base of estimations of market condition with further usage by the system for classification of the next estimation.

Conclusions

There had been developed the methodology for improving the fficiency of decision making on the basis of classification of estimations of market condition by the method of decision tree. The structural diagram of expert automated control system, able for self-learning and making advice to the investor for work on the financial market was created for this purpose. In addition, the authors had built the decision making models, with the help of which the system makes a decision, described its characteristics and principle of operation. The next step in the development of expert system and receipt of practical results is planned by the authors as the formulation of the algorithm of synthesis of decision tree and algorithm of reduction of his knots to increase the accuracy of classification, to check up the system operation in actual operating conditions on the financial market.

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