Decision making with support of artificial intelligence

Podpora rozhodování a umělá inteligence

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Abstract: Development of software modules for decision support is currently a basic trend in the creation of enterprise Information Systems (IS). The IS is basically a support system of the enterprise Decision System, therefore we can regard it as a very important factor of the competition ability and enterprise prosperity. Conventional IS modules provide the enterprise managers a lot of useful information. Nevertheless, own decision process in view of difficulty, complexity or creation disability of decision process model is very often problematic. This contribution is oriented by its content to appropriate choice realization of modules for support decision processes by using of artificial intelligence methods.

Key words: information, information systems, decision support, artificial intelligence, expert system, neural networks

Abstrakt: Tvorba softwarových modulů pro podporu rozhodování patří v současné době k základním trendům tvorby informačních systémů (IS) podniků. IS podniku je ve své podstatě podpůrný systém rozhodovacího systému podniku, a tudíž jej lze považovat za velmi důležitý faktor konkurenceschopnosti a prosperity podniku. Konveční moduly IS poskytují manažerům podniků mnoho užitečných informací, nicméně vlastní rozhodování, vzhledem k obtížnosti a složitosti sestrojení modelu rozhodovacího procesu, je mnohdy nemožné nebo velmi složité. Svým obsahem je příspěvek je zaměřený na problematiku volby vhodného způsobu realizace modulu, pro podporu rozhodovacích procesů s využitím metod umělé inteligence.

Klíčová slova: informace, informační systém, podpora rozhodování, umělá inteligence, pravidla, expertní systém, neuronové sítě

INTRODUCTION

Ruling processes represent the sequence of processes that start from an impulse requiring a decision and proceed forward until the decision is made, the process realized and checked. The basic functions of decision process is the problem defining, determining the initial situation of the problem being solved (conditions for solving the problem), setting the goal, finding the variants of solutions and their evaluation, choice of solutions (decision making). Basically, it deals with finding the specific problem.

While examining the decision making processes, we can say that to find the appropriate solutions to the problem, there is generally used the following: *exact methods, practically proved rules, rules with uncertainty or heuristic approach.*

The basic methods used for solving the problem in artificial intelligence are: logical programming, creation of expert systems, fuzzy expert systems, neural networks, hybrid intelligent systems (neural expert systems and neuro-fuzzy expert systems) and usage of genetic algorithm (Negnevitsky 2002, Pupe 1993).

One of the problems in applying the method of artificial intelligence in creation of software applications for support of the decision making processes is the choice of suitable ways or system for solving the problem of the given problematic area. *The aim of the article is to emphasize the main characteristics of artificial intelligence technologies, from the knowledge of the problem point of view, and if they are suitable to be applied in applications for decision making support.*

Supported by the Ministry of Education, Youth and Sport of the Czech Republic (Grant No. MSM 6215648904).

MATERIAL AND METHODS

Logical programming and production expert system

It is obvious that application of the *exact methods* for finding the solution is preferred. However, in some situations the exact solution by using the conventional tools and methods is complicated. For example, for several logical tasks it is more effective to apply logical programming tools, frequently used for creating the applications in the area of artificial intelligence. One of these tools is the programming language PROLOG. This language has a built-in deriving mechanism that enables to simplify solutions of logical tasks by defining sub-rules (e.g. in application of theory of graphs).

Applying *the rules based on exact methods and practical experiences* lead to creation and usage of so called *production (knowledge, i.e. expert systems)* the main part of which is the knowledge base (facts and rules) and evolving mechanism. In such cases, the rules have the form of conditional statement

IF *is condition (true)* **IMPLEMENT** *statement*

where the *condition* represents logical term and the *statement* is a command to execute.

If the exact methods are represented by rules then the problems with realization will be adequate to the complexity of the problem solution. A bit complicated situation occurs if the rules result from practical experiences of experts of the particular problematic field.

The first problem is to find the expert from the specified problematic filed (or several experts), willing to cooperate on the system creation, and the second problem is the possibility to transform his experience to the solution rules. In case of success in solving both problems, it is possible to create expert system for the support of decision making process in the particular specified field.

The advantage of these rules is the fact that they work according to the known rules and that is why they can explain the suggested solutions.

Fuzzy expert system

In the case that the exact rules cannot be formulated but the rules with a specific degree of certainty on the base of vague term can be specified, that is more acceptable for most of the experts, then it is possible to choose *fuzzy expert system.* The rules of such an expert system have for example the following form

IF *is the CREDIT low and RATING is excellent* **DO** *provide CREDIT,*

where low, *excellent* and *provide* are vague terms represented by the specific fuzzy set.

The advantage of fuzzy expert system is an easy and quite fast prototype realization but its tuning to the level required to its functionality can be quite hard. The problem lies in the correct design of the specific fuzzy sets of terms that figure in the rules of evolving, appropriate choice of fuzzy logic operations and optionally also the method of defuzzification.

Considering some uncertainty, we cannot count with high accuracy of the final result. Such systems can be successfully applied in many economic and technical applications.

Neural network – learning with the teacher (supervised learning)

Disadvantage of the expert systems is that they cannot learn additionally, i.e. every change of their

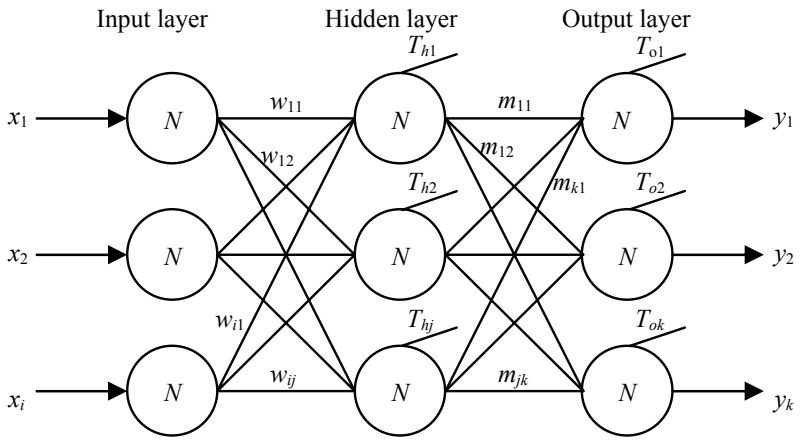

Figure 1. Three-level neural network

function needs the change of the rules. Such disadvantage eliminates the possibility of their usage even in that case when the rules of their function cannot be formulated, but on the basis of experience, the sample situations of the system behaviour could be defined, i.e. it is possible to form the set of input and correspondent output system vectors.

For creation of a system, the function of which is set according to the learning set, it is appropriate to use one- or multi- layers neural network. For larger number of applications, the three-layer neural network is enough (input layer, one hidden layer and output layer), see Figure 1.

During the process of learning, the correction of all the weighs w_{ij}, T_{hj}, m_{jk} and T_{ok}, of neurons is made in the way to minimize the differences between the real and required outputs values y_k. The process of learning is mostly done by the algorithm of back propagation errors.

In some classification tasks or in quantitative tasks, it is not possible to set output vectors for the set of output vectors. In these cases, it is possible to apply so called competent networks, where the learning of network is done without the teacher.

Competitive neural network-learning without the teacher

Competitive network is formed only by two layers of neurons – input layer (receptors) and output layer. Every input of output neuron is connected with all the receptors. Neural network learns to classify the input vectors to single classes so as the elements of each class were as similar as possible. The training algorithm contains only patterns of each class and that is why it is called teaching without the teacher. After the teaching phase, every category is represented by one output neuron that is active for output vectors of this category.

Competitive neural networks are also named as networks with selfish neurons or as networks of the type winner–takes-all. The active neuron is going to be always the one output neuron that will have the highest excitatory value (Aleksander 1995).

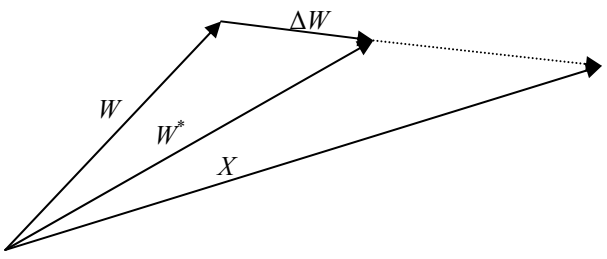

Figure 2. Weight correction of winning neurons

Training algorithms that are used for network adaptation have one common feature. During the teaching, only the weight vector W of the active neuron is modified in such a way that the weight vector is shifted towards the input vector about the value $\Delta W = (X - W).\alpha$ (see Figure 2), where α is a learning coefficient and the new value of the vector of the winning neuron will be $W^* = W + \Delta W$.

In the case that with each output vector there must be active only one output neuron and the order of output neuron is also required, taking in mind the distance of points represented by vectors, it is possible to choose realization of *Kohenen neural network (self-organizing map).*

Hybrid systems

The solution of the main disadvantages of expert systems, i.e. incapability of self learning, and on the other hand absence of neural networks lying in impossibility to explain designed solution, is applying hybrid systems – neural or optionally neuro-fuzzy expert systems.

In such expert systems, knowledge is contained in values of the synaptic weights of neural network as a whole. Change of the random weigh in neural network leads towards an unpredictable result. The hybrid system must be able to reason the solution as well as expert system so the hybrid system has to apply the rule that helps to reason the founded solution. And for that reason, the hybrid system containing neural network, as a knowledge base has to contain the module enabling extraction of the rules from the learned neural network.

Systems using the genetic algorithm

In the cases, when for creation of the system for decision making support we do not know the exact algorithm nor the rules for creation of production or fuzzy expert system, it is impossible to create learning algorithm but we dispose with the set of final solutions and the rule for quantitative evaluation of these solutions. For finding better (sub optimal) or optimal solutions, a genetic algorithm can be used.

The set of known solutions then creates chromosomes of output population and by using the method of crossbreeding and mutation of the genes of chromosomes, it is possible to generate new population. The process

of breeding the individuals is made by the arbitrary exchange of genes (element) chromosomes and mutation of the arbitrary change of gene element.

Regarding that also in the nature, the new population does not substitute completely the old one. In the process of breeding, the weakest individual is substituted and the stronger ones survive, so that it will prevent us from the possible degradation of population. The process of mutation will prevent the possible stagnation of population extension and enables the birth of better individuals.

RESULTS AND DISCUSSION

In this article, there are mentioned the possibilities of choice of a tool of artificial intelligence for the support of decision making processes in connection to the conditions and information that are disposable for creation of variants of solutions. The basic for choice of a tool is the method of solution making. When we use the exact method, then we consider only the possibility of logical programming. In the opposite case, the choice of tools is based on the knowledge representation (rules, vague rules, solution patterns), requirement of the necessity of solution proof, possibility of self learning.

Some of the methods mentioned above have already been applied in finance (Konečný et al. 2001), in insurance (Konečný et al. 2002) and in solution of task optimalization. The realization of an experimental module for model creation based on three-level neural network and supervising learning is nowadays in the final phase.

Problematic of the application creation for decision process support using modern methods in the field of artificial intelligence was solved by the Department of Computer Science within the research task No. MSM 6215648904.

CONCLUSION

The information systems of the companies cover the major part of the transaction processes and the large amount of the processes at the level of the strategical and tactical decision-making.

Intensive implementation of the information technologies in many areas of the human activities cause gathering of the large amount of the data. The volume of the internal and external databases grows rapidly and the problem is to take advantage of data they contain. To get the new information from the large and incompatible database sources is possible but very inefficient. A manager often needs the information very fast to achieve competitive advantage and to solve problems at the level of strategic decision-making.

The transformation process of the data to information and to knowledge that is used in the process of desicion-making is called Business Intelligence. Its technologies of data warehouse, OLAP analysis and data mining are very actual and popular in the present enterprises. The most interesting method used for the data mining is artificial intelligence and theory of neural networks.

Our research of possibilities of neural networks in decision making supports many concrete examples from agriculture and food industry (for instance the assessment of the food quality or composing of the corresponding trend indicator). We will propose presentations of our issues at some national or international conferences and publication of them in some scientific journals as the Agricultural Economics or the Acta Universitatis Agriculturae.

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Arrived on 1st June 2005

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