Improving the efficiency of the construction organization through the introduction of neural network technology

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Abstract. This article considers artificial neural networks as a tool to improve the efficiency of a construction organization. This study is relevant for areas where complex processes are associated with the lack of access to big data. So, these conditions of complex analysis show that an artificial neural network tool is able to combine in a single information storage - knowledge base - a variety of information in the field of construction and select the recommendations of specialists for users using their needs. At the same time, this study focuses on researching the effectiveness of small data analysis using the example of assessing the loyalty of companies' customers. This solution will allow you to partially or completely replace a person (specialist-expert) during the resolution of the problem.

1. Introduction

The economy of a modern state is a diversified production and economic complex. The construction industry plays a special role in this complex.

Today, the construction industries hold a special place in the global economy and are also considered an important factor in economic growth. It is a source of innovation and employment for the national economies of countries [1].

However, with the general positive impact of construction companies on the economy and development of society, it is necessary to take into account that these companies are significantly influenced by various unfavorable factors (usually) of the external environment. So in connection with them, about 47% of all new companies have a life cycle of up to five years, and only about 20% have been on the market for more than ten years [2]. In addition to this, it is worth emphasizing that today the level of competition between companies has shifted from local markets to global ones.

In such conditions, traditional statistical methods for analyzing customer loyalty are being replaced by evolutionary methods that are based on the use of information technology, artificial intelligence and innovative methods for modeling decision-making processes. They led to the introduction and popularization of artificial neural networks [3]. It should be noted that the popularization of artificial neural networks was also facilitated by the difficulties in describing and predicting the behavior of companies in the modern market. The following factors are associated with this [4]:

- deep and multiple relationships of the constituent elements of business intelligence;
- multiple feedback loops resulting from frequent causal loops.

A similar situation describes business processes as analyzed systems if an artificial neural network models a complex (multi-level) system (the relationship between this system and its external
environment) [5]. This approach provides the ability to consider nonlinearities without considering the number of closed loops present in the system itself, as well as their complex interactions and balance.

2. Materials and methods

It is possible to increase the attractiveness of the YOHOR.ru portal by introducing an expert system on the website. This is a knowledge base of specialists in the field of construction, which would automatically carry out the selection of building materials that are necessary for the client, and the necessary specialists for the provision of construction services and repair work based on the identified needs, preferences, financial capabilities and target results.

An expert system (ES) is a software package and a computing system that includes the knowledge of specialists (experts) about a certain narrow subject area in the form of a knowledge base. The main task of the expert system is to make management decisions instead of a specialist. As a rule, ES are developed to solve practical problems in some highly specialized areas, where the knowledge of experienced experts plays an important role. Expert systems are used to solve only intractable practical problems if the cost of developing and operating an ES does not exceed the content of a staff of human experts [6].

Expert systems must have some specific characteristics: the expert system uses the knowledge that it must be able to store in the knowledge base (KB), extract and process in a certain way to solve the problem. The expert system should completely replace the human expert in any specific field of activity.

ES are created using programming languages that support rule-based programming, such as Prolog and Lisp.

All ES have a similar architecture, which is based on the separation of knowledge inherent in ES and algorithms for their processing. A feature of the architecture of the expert system is the presence in its structure of a knowledge base, which the user can open directly or with the help of a special editor, view and edit [7].

Such a system, instead of a knowledge base, uses a trained neural network that will be able to operate with unreliable and incomplete data, subjective perceptions of customers and remove “noise”. This is redundant unnecessary information that is not needed for the operation of the expert system.

The use of neural network technologies in the creation of expert systems allows such systems to be self-learning, independently receiving information from external sources, processing and accumulating it.

Classic systems of expert systems and artificial intelligence do the processing sequential, as in traditional programming. Even if the order of performing actions is not strictly defined (for example, scanning of rules and facts in expert systems), the operations are still performed step by step. Such sequential processing can most likely be explained by the sequential nature of natural languages and logical inferences, as well as the structure of the von Neumann machine [8].

In contrast, the concept of information processing in neural networks arises from the principle of parallelism, which is the source of their flexibility. Moreover, parallelism can be massive (hundreds of thousands of neurons).

If the calculations are distributed among many neurons, it is practically not important that the state of individual neurons in the network differs from what is expected. Noisy or incomplete input signal can still be recognized. The damaged network can continue to perform at a satisfactory level, and training does not have to be perfect [9]. Network performance degrades rather slowly within a certain range. In addition, you can further improve the performance of the network by representing each property with a group of neurons.

Neural networks are parallel distributed processors that have a natural learning ability and operate according to the bottom-up principle. Therefore, when deciding to create an expert system based on neural network technology, it is advisable to create structured connectionist models or hybrid systems that combine both approaches.
Thus, the expert system of the YOHOR.ru portal should provide the ability to form detailed explanations for clients, why such a solution was proposed, why he needs these particular building materials and the work of specialists.

The expert system must search for reasonable options for solving the problem by choosing at each stage of reasoning the most appropriate set of rules for this situation from the knowledge base and consistently applying the selected rules. The knowledge base will be created based on the expert opinions of specialists in the field of construction and based on the experience of professionals who have been working in the construction market for a long time.

An expert system built using the mechanisms of neural networks has a mechanism for obtaining decisions based not only on a system of rules and standardized procedures, but also on precedents. For this, it is necessary to compile a "library of situations” that may arise at various stages of the assessment of a construction object. It is necessary for its creation, reconstruction or repair of materials, specialists and technologies [10].

At the same time, one can use both situations that actually took place in real practice and synthesized (synthetic) situations that might arise. With the help of experts, each situation should be represented in the form of a tree, the root of which is the initial state of the problem, the vertices correspond to different states, and the arcs correspond to the operations being carried out. The decision-making process corresponds to moving along arcs from node to node until reaching the terminal nodes corresponding to the end of the problem solution. This process is called state space search. In cases where the search process can branch, the decision is made based on the weights assigned by the experts to different arcs.

The expert system of the construction portal YOHOR.ru should have the following subsystems (Table 1).

| Subsystem                                      | Subsystem characteristics                                                                 |
|------------------------------------------------|------------------------------------------------------------------------------------------|
| A knowledge base of regulatory legal acts in   | A knowledge base containing structured texts of codes and laws of the federal level that regulate relations in the field of construction, real estate and appraisal activities, from the formation of real estate of various types to registration of transactions with them |
| the construction industry                     |                                                                                         |
| A knowledge base of regulatory legal acts of   | A knowledge base that has by-laws of the federal level, which regulate the procedures for the formation of objects of land and property relations, their involvement in the market turnover, registration of transactions and their preparation for state registration |
| land and property relations                    |                                                                                         |
| A knowledge base of local regulations          | A knowledge base that includes local-level regulatory documents that, taking into account local specifics, regulate the peculiarities of involving various types of real estate objects in the market turnover |
| A knowledge base of building technology        | A knowledge base that has various technologies for the construction of low-rise buildings, premises, repair and decoration of premises |
| A knowledge base of building materials         | A knowledge base that includes a set of existing types of building materials with the distribution of their weights by categories: purpose, cost, reliability, durability, comfort, etc. |
A knowledge base of specialists

A knowledge base that includes a set of existing types of specialists in the field of architecture, design, repair, construction, decoration, landscape design, etc.

An expert assessment knowledge base

A knowledge base that contains expert assessments of several experts with the assignment of weights to building materials, specialists and construction technologies

A knowledge base of analytical materials

A knowledge base that has the most important provisions from expert opinions and summarizing analytical materials on the possibilities of construction and repair of various objects

It is quite obvious that this takes a long time when the evaluator regularly reviews at least the lists of data that are concentrated in the listed databases and knowledge bases. In this regard, it is necessary to create new principles of information processing at each step of the implementation of standardized assessment procedures. The information processing technology should provide for the selection of the most important tasks and data sets for performing work at this formalization step in a semi-automatic mode, as well as the use of neural self-learning systems technologies [11,12].

3. Results

Unlike most well-known expert systems, here it is necessary to use an unusual set of computational procedures, as well as the following capabilities:

– systems of logical operations with textual information, which allow you to select certain semantic groups that are necessary to formalize data from documents of various types;

– identification of logical contradictions in the text data system;

– thematic sorting of data with their logical analysis;

– sorting of graphic data of various types;

– application of GIS technologies of various levels for processing cartographic information of various levels;

– the use of neural network algorithms for the implementation of the basic procedures for assessing the possibilities of using construction technologies, building materials and specialists for a specific case;

– the database search of the YOHOR.ru portal of building materials that best meet the client's task;

– automatic assessment of the level of registered specialists on the YOHOR.ru portal based on customer ratings, expert assessments, the quantity and quality of work performed.

To develop an expert system for the YOHOR.ru portal, you need the following equipment, software and tools:

– workstations, mainframes;

– web server;

– symbolic high-level programming languages such as LISP and PROLOG;

– powerful multi-window editors and debugging tools;

– the Java Expert System Shell (JESS) programming language, which provides a fully developed Java API for building an expert system;

– Text and graphic editors, spreadsheet processor, video processing tools.

In table 2, we will calculate the capital costs of developing an expert system for the operation of the YOHOR.ru portal.

| № | Expenses                                                                 | Cost amount, rub. |
|---|--------------------------------------------------------------------------|-------------------|
Table 3. Plan of income and expenses of the company in the first year of the project, thousand rubles.

| Index                          | Value     |
|-------------------------------|-----------|
| Proceeds from project         | 4 622.55  |
| implementation                 |           |
| Cost of sales                 | 4 852.22  |
| Gross profit                  | -229.67   |
| Business expenses             | 506.00    |
| Profit before tax             | -735.67   |
| Income tax, 20%               | -         |
| Net profit                    | -735.67   |

In the first year, the company is not expected to achieve profitability, as the investment costs will exceed the profitability of the enterprise.

Thanks to the promotion and SEO-promotion of the portal, the number of orders will increase and the revenue will increase (table 4).

Table 4. Plan of income and expenses for 2 and 3 years, thousand rubles.

| Index                          | 2 year  | 3 year  |
|-------------------------------|---------|---------|
| Proceeds from project         | 5547.06 | 6656.47 |
| implementation                 |         |         |
| Cost of sales                 | 4 852.22| 4 852.22|
| Gross profit                  | 694.84  | 1 804.25|
| Business expenses             | 506     | 506     |
| Profit before tax             | 188.84  | 1 298.25|
| Income tax, 20%               | 37.77   | 259.65  |
| Net profit                    | 151.07  | 1 038.60|

The return on investment of the project for the implementation of the expert system on the YOHOR.ru portal and its promotion will begin from the second year of the project operation.

Thus, the calculation of capital costs for the development of the expert system showed that to improve the YOHOR.ru portal, the total capital costs should be 1129.7 thousand rubles. The project will pay off in 2 years of project implementation. An innovative project for the development and implementation of an expert system for the YOHOR.ru portal is profitable and economically feasible.
4. Conclusion
One of the areas of application of automated systems and computer technologies in construction is the use of software and technical solutions based on neural networks, which, like biological ones, are a computing system with a huge number of parallel functioning simple processors with many connections. Neural networks can change their behavior depending on the state of their environment. The ability of neural networks to self-learn allows them to be used to create programs and technologies for artificial intelligence and expert systems, which in the construction industry will improve the quality of management of the design and construction of facilities at all stages of the construction life cycle.

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