21) OPTIMIZATION OF THE ALGORITHM OF DECISION MAKING SUPPORT SYSTEMS FOR THE WORK BASED ON A FUZZY DECISION TREE

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Abstract
The material of the article is aimed at solving urgent scientific, economical and macro-problems of the forecasting. The necessity to build a fuzzy decision tree is based on the analysis of mathematical techniques that proved its feasibility. In this article we propose to use the algorithm of methods for solving certain problems in the decision tree. The present materials examines issues of process optimization forecasting methods by using fuzzy decision support system. In the article we show how we can successfully make the architecture, algorithm, and practically realised composition program-technical system used to obtain sufficiently accurate results in prediction of macro-parameters. Although the model is adapted to solve the problem prediction of macro parameters, but it can be used for analysis and forecasts of other financial phenomena that resist explanation by the classic interplay of economic indicators.
In our article we will consider: the mechanism of decision making support system (DMSS), universal mathematical model for DMSS in prediction of economic macro-parameters. We will propose the certain scheme of using different algorithms for decision making support system. We will make recommendations concerning how to make self educational prediction model and show the necessity of non-stop upgrading knowledge bases of the model depending on different economical situations.
Key words: inflation, fuzzy set, decision tree, decision support system, models, algorithms, optimization

Introduction

To make motivated and most effective decisions, a management at different levels should be able to quickly analyze a big number of indicators that reflected state of the company and industry at all. Every day decision-makers meets the problem of searching and choosing the best solution. This problems face management of any complex system. The relevance of using computerized decision making support systems is that we need in-time and balanced decisions, which take into account interests of all parties involved in the management process and object of management. Usually it is difficult to make complex decisions because of the large number of criteria that influence on the decision making process.

Material and Methods

For successful implementation of computer decision-making support system in the management process, it is advisable to apply a complex multicriteria system and scientific-methodological apparatus of system analysis. From this point of view, the decision-making process should be considered from all sides, it means that we need to consider all kinds of providing. We have considered in detail the mathematical support for decision-making support system in managing complex systems.

It is known that to solve the problem it is necessary to decompose the system, that is, to divide it into blocks and continue to work with individual blocks separately. Since most complex systems of both technological, economic and social nature are time dependent, it is advisable to perform a temporary decomposition.

Decomposition also needs to take into account the increasing uncertainty and the impact of the human factor. Therefore, the process of managing complex systems with fuzzy input can be divided into:

1. Determined situations.

2. Situations with low levels of information uncertainty.

3. Situations with high levels of uncertainty.

In order to apply the most rational method or set of decision support methods, analytical studies of theoretical and practical developments in the field of decision support systems were conducted at each stage. The result of this analysis is the appropriateness of decision support methods and systems to the tasks that arise in management. Also, one of the conclusions of this research was to use Pareto multicriteria convolution methods for to solve multicomlex problems, since it allows us to quickly evaluate and choose the best option based on the presented criteria and the level of their significance.

In the second stage, it is advisable to add the expert judgment method to the multicriteria optimization methods, since the uncertainty requires the intervention of experts with their experience, knowledge and intuition. In the third stage, modeling tools can be used in conjunction with the method of expert judgment to reflect the trends of the company development in a particular sector of economic. They can be a means of graphically displaying information slices by any criterion or enterprise sample.

Naturally, using of multicriteria comparison methods and peer review requires adaptation and localization to the requirements determined by the specifics of managing a complex system. Therefore, for the successful implementation of the above methods, it is necessary to carry out adaptation work on their algorithms. It should be emphasized that, by its nature, the management of any complex multicriteria system is similar to the reduction of indicators to a certain ideal state, which is commonly called the ideal point.

Results and Discussion

Let's look at the described decision-making support methods for interacting with one another to find the best solution when solving problems with uncertain information. When analyzing a set of computer-assisted decision-making options, firstly we are using the Pareto method and obtain multiple variants of equal importance as the output. If this set consists of one alternative, then the task of selection on this stage can be considered complete. If the set has several options, we are applying the method of convolution to the integral criterion. This method after completion provides the alternative that is most rational. Dijkstra's (or Floyd-Worschell's) algorithms are also used to choose the shortest path for decision.

Floyd-Worschell algorithm. The purpose of constructing the algorithm is the same as for the Dijkstree method, so let's consider the theory. The construction of the algorithm is implemented on the basis of many software complexes – it is widespread in practice. Otherwise, these algorithms are very similar, which is clearly visible from the block diagram of the Dijkstra algorithm. It should be noted that using of the Dijkstra algorithm is possible only with the positive value of the arcs of the tree. When evaluating arcs using negative numbers, there is a so-called Floyd algorithm for a negative-contour graph whose velocity estimate is cubic and approximates that is the longest path algorithm in the decision tree. The algorithm requires a more powerful technical solution because of the large number of options available to iterate over possible solutions.

Step 1. Renumber the vertices of the graph by integers from 1 to N. Determine the matrix D0 by setting the value of each element equal to the length of the shortest arc connecting the vertices i and j. If the vertices in the source column do not connect arcs, put $d_{ij}^{0} = \infty$.

In addition, for everyone to put $d_{ij}^{0} = \infty$.

Step 2. For an integer m, which in turn becomes 1, 2,..., N, determine by the magnitude of the elements of the matrix Dm – 1 the magnitudes of the elements of the matrix Dm, using the recursive relation

$$d_{ij}^{m} = \min\left\{d_{im}^{m-1} + d_{mj}^{m-1}, d_{ij}^{m-1}\right\}.$$

When determining the value of each element of the matrix Dm, fix the corresponding shortest path. After the procedure for determining the magnitude of the elements (i, j) of the matrix Dm, calculate the length of the shortest path that connects the vertices i and j.

The above algorithms allow you to solve the problem:

$$f(x_1^0, x_2^0, y) = \left(\sum_{j=1}^{l-1} a_{y_j y_{j+1}}\right) \times T\left(\left(x_1^0 - y_1\right), \left(x_2^0 - y_1\right), a_{y_1 y_2}, \ldots, a_{y_{l-1} y_l}\right)$$ –

evaluation functional for alternative y. You need to find an alternative to y * that for

$$\forall y \in Y, y \neq y^* : f(y) \geq f(y^*).$$

However, none of these algorithms solves the problem of finding the longest path that connects the pairs of vertices when specifying the preference in a clear form and the problem of finding the optimal path that connects the pairs of vertices when specifying the preference in a fuzzy form (i.e. by vector).

Based on the analysis, we can conclude that the current methods of solving such problems can only find the shortest paths that connect certain pairs of vertices. None of the methods considered makes it possible to determine the longest paths in a tree and to find the optimal solutions to the problem when setting the preference in a non-rigid form, that is, when defining transitions in a tree using vectors.

That is, based on the analysis, it can be argued that to solve the problem and, accordingly, to create a decision-making system that will allow to carry out an effective analysis of the development of an unstable phenomenon, which requires the construction and processing of a corresponding decision tree, it is necessary to propose methods using which can be solved by the following tasks:

1. You need to find the alternative y * that for $\forall y \in Y, y \neq y^* : f(y) \geq f(y^*)$ provided

$$f(x_1^0, x_2^0, y) = \left(\sum_{j=1}^{l-1} a_{y_j y_{j+1}}\right) \times T\left(\left(x_1^0 - y_1\right), \left(x_2^0 - y_1\right), a_{y_1 y_2}, \ldots, a_{y_{l-1} y_l}\right). \quad (1)$$

2. Such a set must be found $Y' \subseteq Y$, what for $\forall y' \in Y'$ the condition is: $\neg \forall y \in Y, y \notin Y'$, that $\forall i, i = \overline{1, K}, f_i(y') \geq f_i(y)$ (if you need to find the longest path); or you need to find one $Y' \subseteq Y$, that for $\forall y' \in Y'$ the condition is: $\neg \forall y \in Y, y \notin Y', y = (y_1, \ldots y_l),$ $\forall i, i = \overline{1, K}, f_i(y') \leq f_i(y)$ where l is the number of elements in the vector y that (if you need to find the shortest route),

$$f(x_1^0, x_2^0, y) = \left(\sum_{j=1}^{l-1} a_{y_j y_{j+1}}\right) \times T\left(\left(x_1^0 - y_1\right), \left(x_2^0 - y_1\right), a_{y_1 y_2}, \ldots, a_{y_{l-1} y_l}\right); i = \overline{1, K} - K$$

– evaluation functionals for the alternative.

If the integral estimates are approximately the same, then the method of expert evaluation of the proposed options is used. An expert may, based on his experience and knowledge, carry out additional analysis to identify the most rational alternative. Let us summarize the produced sequence of methods in the scheme (Fig. 1).

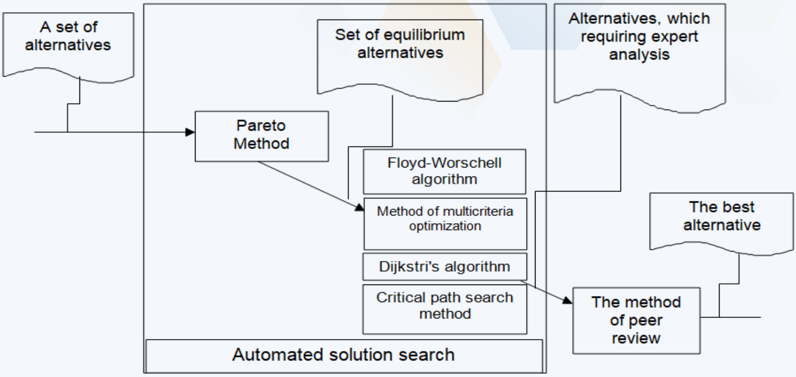

Fig. 1. Scheme of application of decision support methods.
Source: Created by the author himself.

Conclusions and Outlook

To form a mathematical model for decision-making support system which would be able to manage a complex systems, we are using the method of target optimization, the optimization method for the ideal point. The mathematical apparatus for the selection and evaluation of criteria for further analysis of options involves the use of the method of expert evaluation. To choose an alternative, a set of methods is involved, namely: the Pareto optimization method, the integral criterion optimization method, the Dijkstra algorithm, Floyd – Worschell, and the expert evaluation method is proposed as an additional analysis method. To support decision making when managing complex systems, it is necessary to build a separate mathematical model of the domain.

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