УДК 658.512.032

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MODEL SYNTHESIS OF COMPLEX MULTIFACTOR ASSESSMENT OF THE "QUALITY" OF A PROJECT TEAM APPLICANT

The general task of decision-making is formulated and structured in the context of multicriteriality and uncertainty of initial data. The probability and reasonability of regularizing the problem of multicriteria selection of solutions based on the theory of utility is grounded. The problem of structural and parametric identification of developing a generalized scalar assessment of alternative solutions is formulated in view of a set of heterogeneous partial criteria.

Keywords: *synthesis, project, model.*

Introduction

The widespread of modern computer technology, its intensive use as a way of automating human intellectual activity in all spheres has become an additional impetus to the study and formalization of decision-making processes. All these factors determine the special importance of study the methods and means of decision-making while training specialists in various spheres.

Academician V.M. Glushkov was one of the first scholars who formulated the necessary conditions which should be met by the decisions that are made: their timeliness, completeness and optimality [1]. With the development of science, the accumulation of data, the complication of production processes, the tasks of multicriteria optimization have appeared. The fulfillment of the above conditions cannot be performed because of the limitations of certain knowledge, the impossibility or inaccuracy of the quantitative measurement of a part of the characteristics, the incompleteness, inaccuracy of the initial data and the formal description which lead to various types of information uncertainty, that is weak formalization of the intellectual procedure of understanding the decision-making process.

Setting the general task of decision-making

The formalization of decision-making processes, the transition from non-formal subjective procedures to norm-reasoned objective rules is one of the most important scientific tasks of the current time. The theory of making efficient decisions is an interdisciplinary scientific area integrating into system analysis, utility theory, psychology, introspective analysis (expert evaluation methodology), etc. Specific interest in the theory of decision-making is based on the fact that all household, professional, social, political activity is a sequence of acts of making and implementing decisions. At the same time, the effectiveness of individual decisions does not only determine the personal success of each individual, but also, in many cases, affects a more or less wide range of interacting (system related) people [2].

The decision-making procedure is an obligatory stage of any purposeful activity. At the same time, despite the diversity of activities, the decision-making process can be structured by identifying the required steps [3]:

1. goal formalization;
2. determining the complete set of admissible solutions of X;
3. developing the metric (the criterion for the effectiveness assessment) $K(x)$, in which the relative value of the effectiveness of any solution $x \in X$ can be measured.

At the same time, the difficulty of developing a normative theory of effective formally objective decision-making is greatly hampered by the fact that a decision-making procedure is determined as an act of conscious selection of probabilities of an alternative from the admissible set. Thus, decision-making is an intellectual, creative act, based on the following model:

$$x^\circ = \arg \underset{x \in X}{\operatorname{extr}} K(x), \tag{1}$$

where x° is effective solutions, x is a set of admissible solutions,

$K(x)$ is the criterion for effectiveness assessment, i.e. the metric in which the "quality" of the solution is measured.

In a particular case, if the criterion of effectiveness is scalar, i.e. single, the problem of selection does not cause fundamental difficulties and is reduced to establishing an ordinal order relation on the numerical axis. In this case the best solution is the extreme one, i.e. extreme element of the sequence. However, such a situation is extremely rare and is of just theoretical interest.

In general case, any system, technical, production, environmental, social has a lot of "properties". Each local "property" characterizes the system according to one or a group of "qualities", and their totality characterizes the "quality", "effectiveness", "utility" of the system as a whole.

Model synthesis of complex multifactor assessment of applicants

In general case, the task of multifactor complex assessment of the "quality" of applicants is:

$$K(x) = F\left[\lambda, k_i(x)\right]; \quad i = \overline{1,n} \tag{2}$$

where F is the operator that defines the structure of the assessment model;

λ is the isomorphism coefficient, $k_i, i = \overline{1,n}$ is particular characteristics.

The general idea of the regularization of the problem of multicriteria selecting a solution lies in its scalarization, i.e. replacing the initial multicriteria task with a single-criterion or a sequence of single-criterion tasks.

Therewith, this general basis of all methods of regularizing the task of multicriteria optimization is the theory of utility, according to which, the usefulness of solution – $K(x)$ is considered as a generalized scalar assessment of the "quality" (effectiveness) of the solution $x \in X$.

The utility function is presented as an additive model:

$$K(x) = \sum_{i=1}^{n} \lambda_i k_i(x), \tag{3}$$

where $k_i(x)$ is a set of partial criteria;

λ_i is the degree of relative importance of particular criteria, which makes $k_i(x)$ equal.

The assessment of such values is difficult, therefore, a more convenient form of assessment is used. To eliminate the polymorphism, (3) is transformed to (4):

$$K(x) = \sum_{i=1}^{n} a_i k_i^{H}(x), \tag{4}$$

where $k_i^{H}(x)$ is normalized partial criteria;

a_i is a dimensionless coefficient of relative importance that meets the requirement:

$$0 \le a_i \le 1; \sum_{i=1}^{n} a_i = 1. \tag{5}$$

Regardless the type of extremum (min or max) of the particular criterion, its best value at the set X should correspond to the maximum (= 1), and to the worst – minimum (= 0) value of the utility function:

$$k_i^{НЛ}(X) = \begin{cases} \max k_i(x) \text{ если} k_i \to \max; \\ \min k_i(x) \text{ если} k_i \to \min. \end{cases}$$

$$k_i^{НХ}(X) = \begin{cases} \min k_i(x) \text{ если} k_i \to \max; \\ \max k_i(x) \text{ если} k_i \to \min, \end{cases}$$

where $k_i(x)$ is the value of the i^{th} characteristics for the applicant $x \in X$;

$k_i^{НЛ}(x), k_i^{НХ}(x)$ is the best and worst value of the i^{th} characteristics at the whole set of applicants X.

The task of structural identification of the model of a generalized assessment is solved by the method of comparative identification.

Let us consider the sequence of pairs (initial data) of probable alternatives that are obtained while the candidates are compared in pairs.

At the output the following sequence will be obtained:

$$x_1 \succ x_2 \succ x_3 \succ \ldots \succ x_n$$

On the basis of this sequence, the following system of inequalities (according to the theory of utility) will be developed for each pair:

if $x_1, x_2 \in X$ и $x_1 \succ x_2$, so

$$K(x_1) > K(x_2); \tag{6}$$

if $x_1, x_2 \in X$ и $x_1 \prec x_2$, so

$$K(x_1) < K(x_2); \tag{7}$$

if $x_1, x_2 \in X$ и $x_1 \approx x_2$, so

$$K(x_1) = K(x_2); \tag{8}$$

the system of inequalities can be written as:

$$\begin{aligned} &K(x_2) - K(x_1) \le 0; \\ &K(x_3) - K(x_2) \le 0; \\ &. \\ &. \\ &. \\ &K(x_n) - K(x_{n-1}) \le 0. \end{aligned} \tag{9}$$

If the number of equalities $\le$ n, the system enables determining the numerical values of all parameters a_i, otherwise the problem does not have a unique solution and the regularizing rule should be added to it.

Substituting model (4) in (9), the system of inequalities is obtained:

$$\begin{aligned}
&\sum_{i=1}^{n} a_i k_i^H(x_2) - \sum_{i=1}^{n} a_i k_i^H(x_1) \le 0;\\
&\sum_{i=1}^{n} a_i k_i^H(x_3) - \sum_{i=1}^{n} a_i k_i(x_2) \le 0;\\
&.\\
&.\\
&.\\
&\sum_{i=1}^{n} a_i k_i^n(x_n) - \sum_{i=1}^{n} a_i k_i(x_{n-1}) \le 0.
\end{aligned} \qquad (10)$$

where $k_i^H(x)$ is known values ; $a_i(x)$ is unknown model parameters (3).

Solving the system of inequalities (10), the values of the parameters a_i are determined.

The incorrectness of the considered task is connected with the fact that the system of inequalities (9) determines the n-dimensional polyhedron, any point of which is an admissible solution.

The rule for selecting a unique solution should be specified; the Chebyshev point is selected as a solution [3], i.e. the point which is equidistant from all the faces of the polyhedron. It is located in the center of the region and is most resistant to probable boundaries of an admissible set.

Conclusion

Any goal-directed activity, as an obligatory stage, includes the decision-making procedure, which includes the selection of the most effective way of achieving the goal from a set of the most effective admissible ways.

A fundamental feature of the decision-making process is the fact that it is an intellectual process.

That means that this process is uncontrollable and unobservable unlike natural physical ones.

That means that the carrier of the information which is necessary to identify the decision-making model is a human expert, i.e. a person who makes a decision (a decision-maker).

The models suggested in the article can be used for designing and developing a decision support system in managing labor resources of projects and enterprises.

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Надійшла до редколегії 10.07.2017

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СИНТЕЗ МОДЕЛИ КОМПЛЕКСНОГО МНОГОФАКТОРНОГО ОЦЕНИВАНИЯ «КАЧЕСТВА» ПРЕТЕНДЕНТОВ В КОМАНДУ ПРОЕКТА

Н.В. Косенко

Сформулирована и структурирована общая проблема принятия решений в условиях многокритериальности и неопределенности исходных данных. Обоснована возможность и целесообразность регуляризации задачи многокритериального выбора решений на основе теории полезности. Сформулирована проблема структурно – параметрической идентификации формирования обобщенной скалярной оценки альтернативных решений с учетом множества разнородных частных критериев.

Ключевые слова: *синтез, проект, модель.*

СИНТЕЗ МОДЕЛІ КОМПЛЕКСНОГО МНОГОФАКТОРНОГО ОЦІНЮВАННЯ «ЯКОСТІ» ПРЕТЕНДЕНТІВ ДО КОМАНДИ ПРОЕКТУ

Н.В. Косенко

Сформульована і структурована загальна проблема прийняття рішень в умовах багатокритеріальності та невизначеності вихідних даних. Обґрунтовано можливість та цілеспрямованість регуляризації задач багаточисельного вибору рішень на основі теоретичної корисності. Сформульована проблема структурно-параметричної ідентифікації формування-загальної скалярної оцінки альтернативних рішень з урахуванням множинності різнорідних приватних критеріїв.

Ключові слова: *синтез, проект, модель.*