MULTI-METHOD ANALYTICAL HIERARCHICAL TECHNOLOGY FOR GROUP MULTI-ATTRIBUTE CHOICE

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ABSTRACT

The paper presents a new multi-method technology PAKS-M for group choice of multi-attribute objects. The technology provides reducing the dimension of the attribute space; constructing several hierarchical systems of composite criteria and an integral quality index, which aggregate initial attributes; the classification and/or ordering of multi-attribute objects using several decision making methods. This technology significantly reduces the time and complexity of solution of multiple criteria tasks, and allows analyzing and explaining the results.

Keywords: group multi-attribute choice, reduction of dimension of the attribute space, hierarchical aggregation of attributes, composite criteria, integral quality index.

1. Introduction

A group choice of multi-attribute objects is one of the widespread problems of decision making. When object properties are characterized with large number of numerical (point, interval) and/or verbal attributes, it is very difficult for an expert and/or decision maker (DM) to select the best object, rank or classify objects, because, as a rule, the objects are not comparable formally with each other according to their attributes.

The paper describes a new multi-method technology PAKS-M (Progressive Aggregation of the Classified Situations by many Methods) for group comparing, ordering, and classifying multi-attribute objects. This analytical technology allows one to determine the preferable criteria, analyze the obtained results, and assess the quality of choice.

2. Literature Review

The known decision making methods [Saaty, Shang, 2007], [Doumpos, Zopounidis, 2002], [Roy, Bouyssou, 1993], [Vincke, 1992], [Hwang, Lin, 1987] et al are not suitable for solving the multiple criteria tasks in the attribute space of large dimension as they require significant labor costs in order to receive, process and present big volumes of information about objects, knowledge of experts and/or the preferences of DM.

3. Group Multi-Attribute Choice

The task of group multi-attribute choice is formulated as follows. The given collection of objects (alternatives, options) $A_1,\ldots,A_p$ are evaluated by one or several experts upon many criteria $Q_1,\ldots,Q_m$. Each criterion Q_i has a scale with discrete numerical or verbal grades, which are ordered in some cases. Based on the knowledge of experts and/or preferences of DM, it is required: (1) to select one or several best objects; (2) to order all

objects; and (3) to distribute all objects by several classes (categories). Let us consider the basic stages of solving a multicriteria choice task using the PAKS-M technology.

4. Basic Stages of Technology

Firstly, an expert and/or DM forms the set $K_1,\ldots,K_m$, $m\geq 2$ of initial characteristics of objects that reflect the basic properties of the given objects. The scale $X_i=\{x_i^1,\ldots,x_i^{g_i}\}$, $i=1,\ldots,m$ with numerical or verbal evaluation grades, is built for each initial indicator.

Further, the dimension of the attribute space is reduced consecutively by constructing a hierarchical system of criteria. The various combinations of initial attributes (tuples of estimates in the space $X_1\times\ldots\times X_m$) are aggregated step by step into smaller sets $L_1,\ldots,L_n$, $n<m$ of new attributes (composite criteria) formulated by the expert or DM. The formation of the rating scale $Y_j=\{y_j^1,\ldots,y_j^{h_j}\}$, $j=1,\ldots,n$ of a composite criteria is considered as tasks of ordinal classification. The verbal grades of criteria scales are built using different techniques, for instance, the tuple stratification, ZAPROS and ORCLASS methods of verbal decision analysis.

The construction of hierarchical systems of criteria and formation of verbal rating scales of criteria are subjective non-formalized procedures. In the PAKS-M technology, several hierarchical systems of composite criteria, which variously aggregate initial characteristics, are constructed. At each level of hierarchy including the highest level, an expert/DM establishes which of the attributes are considered as the independent criteria and which are combined into any particular composite criterion.

At the conclusive stage, a multi-attribute choice task is solved for each hierarchical system of criteria that is considered as a viewpoint of any expert/DM. In order to increase the validity of the final decision, we use several methods of group multicriteria choice, for instance, the ARAMIS method, the lexicographic ordering by the grades of evaluations, the weighted sums of ranks, Borda procedure, and other techniques. Then the expert/DM analyzes the results, and makes the conclusive choice.

5. Conclusions

An important feature of the PAKS-M technology is the opportunity to create different hierarchical systems with various ways of criteria aggregation, solve an initial task using several methods, and give a clear explanation of the results obtained. The PAKS-M technology was applied for the multi-aspect evaluation of efficiency of research projects and the multicriteria selection of a perspective computing complex.

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6. Key References

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