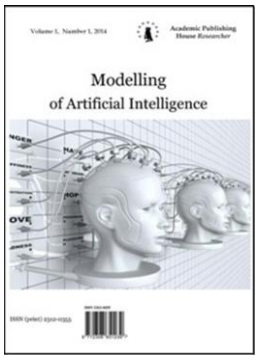

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Forecasting in Decision-Making Support Systems

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Abstract

To improve management efficiency, different methods of support tools for decision makers may be used at all stages of the management cycle. The paper addresses the application of mathematical modeling in decision making support systems. In modern conditions it is the main mathematical modeling tools produce forecasts. The new work analyses the main trends of decision making support systems, in the first place, in terms of application of prediction tools as part of such systems.

Keywords: forecasting, prediction, mathematical simulation, decision-making support system, mathematical modelling, control automation

1. Introduction

Management theory and practice often uses “a standard management cycle” concept. A standard management cycle includes a number of main stages: goal setting (or verification of a task set), situation evaluation, decision making, planning, targets setting and control of their implementation. Any decision-making support systems (DMSS) implements this very management cycle, providing decision making support at all stages.

An integral part of any management cycle is predicting the consequences of implementing the decisions made. To improve the reliability of the forecasts made at different times, different mathematical tools have been used, each of which has certain advantages and disadvantages, when applied in different situations and within certain limits.

2. Discussion

To improve management efficiency, different methods of support tools for decision makers may be used at all stages of the management cycle. Existing approaches to implementation of the formation of management decisions involve the use of DMSS or expert systems. In terms of solution of the most complicated issues, when every mistake comes at a high cost, and when a decision maker is personally responsible, the DMSS is the basic tool providing more opportunities to the manager to make a competent decision.

An integral part of the management cycle, including implemented with the use of DMSS, is the prediction of the consequences of the decisions being made. It is true for every process: activity planning, management of processes and systems, design and development of systems.

To improve the reliability of the forecasts made at different times various mathematical tools have been used: expert evaluations, formal logic, theory of probability, games theory, trend extrapolation methods, mathematical modeling, etc. (Bruce, 1996; Vypasnyak, 2014). Mathematical modeling is commonly used to predict the behavior of complex systems at a high cost

of decision errors as one of the most reliable means of prediction (Vypasnyak, 2015; Tikhanychev, 2012; Tarnovskiy, 2016).

These methods are usually divided into two basic groups of predictive estimation methods: intuitive (expert) methods dealing with the subjective judgements, and formal methods using calculation methods and mathematical models. These models are implemented through application of various mathematical tools: starting with the expert assessment methods and up to complex mathematical models implemented in factual approaches. Heuristic methods use both formal and subjective approaches (Fig. 1).

As noted previously, each of the methods in Figure 1 has its limits to applicability with their own advantages and disadvantages.

Expert methods allow prediction in non-algorithmic situations, but they are less suited to automation and have no such good operational efficiency. Heuristic methods are based on the construction of analogies. Factual methods based on time series models are simpler and more effective, but can give serious errors in case of an abrupt change of parameters, especially if these changes were not previously known. Factual methods based on problem domain models and logical and probabilistic models provide a detailed and fairly accurate prediction, but they are demanding of computing resources and less effective, especially in terms of data input.

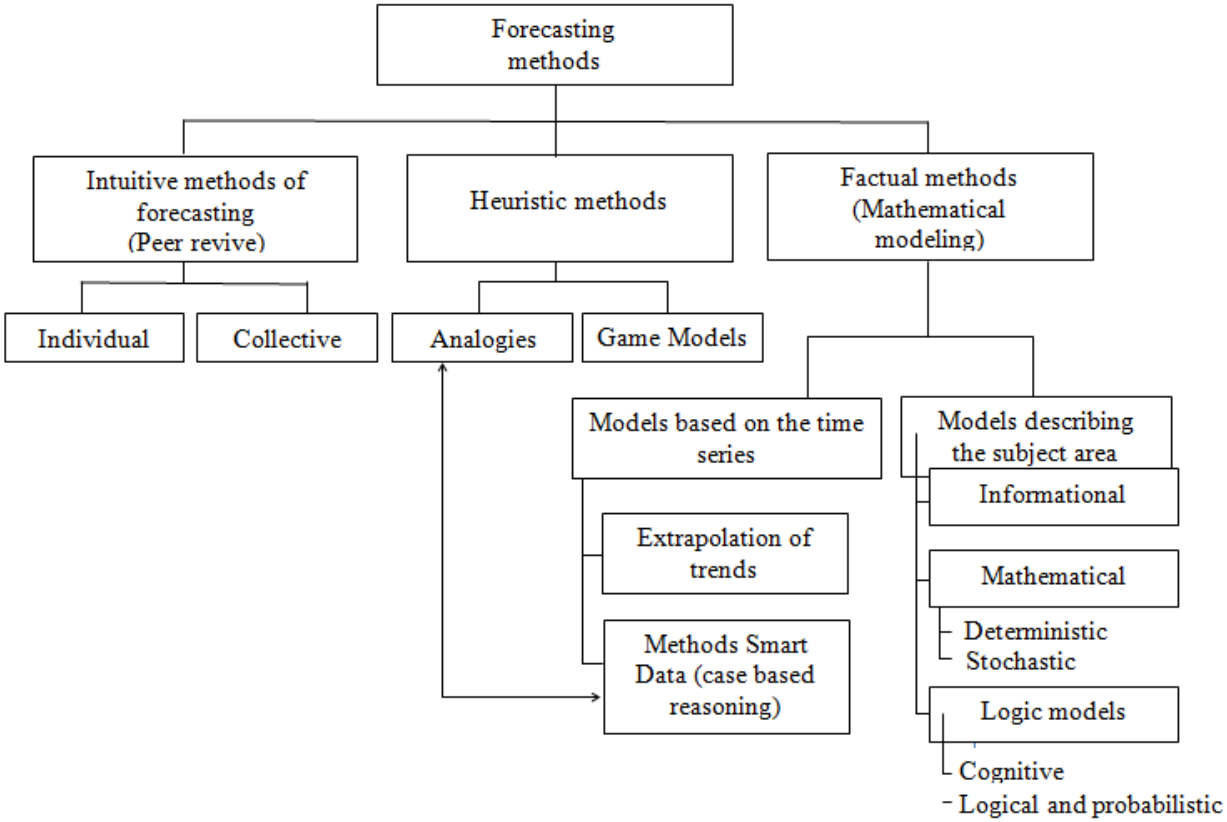

Fig. 1. Generalized classification of forecasting methods

Selecting a certain prediction tool in DMSS is determined by the conditions of implementing a certain management cycle and specific features of each prediction method.

Application of prediction tools in automated DMSS that ensure management of complex man-machine systems has certain features (Tikhanychev, 2016; West, Harrison, 1997; Xu, Zhou, 2011; Xu, 2013):

- high cost of error decisions that require a high prediction accuracy;
- automation of initial data collection, their processing, formation of aggregated output model data significantly reduces the respective requirements for the system components, including mathematical models;

- prediction efficiency shall meet the requirements for the duration of management cycle, which in its turn is determined by the responsiveness of the controlled system;
- DMSS is usually designed for addressing ill-defined problems.

In order to obtain acceptability assessment, these features are associated to the characteristics of certain prediction methods. The use of expert approaches requires involvement of a representative expert group for each specific problem, while this can take quite a long time. Reducing the number of experts impairs the accuracy of prediction. Moreover, it is theoretically possible, when no experts in a specific problem can be involved in the process, the work of the whole DMSS prediction subsystem can be wiped out. These drawbacks of the expert approach reduce the possibility of their use in the automated DMSS (Tarnovskiy, 2016; Zhang et al., 2015; Lototsky, 2016).

At the same time, the main shortcomings of mathematical models can be fended off due to their diversity, allowing the user to select the type of a model for a specific task, as well as use the automation software and equipment to improve the efficiency of data input and analysis of simulation results. Herewith, the accuracy of simulation is generally not impaired, ensuring prediction validity while maintaining the efficiency of its obtaining. Working with non-algorithmic problems with the use of models in automated DMSS has no special problems, as automated systems by definition handle the formal data, even when describing non-algorithmic situations.

3. Conclusion

The analysis of management practices shows that prediction of the results of the decisions made in a changing environment is one of the most important stages of decision making. Thus, developing DMSS shall require implementation of prediction tools designed, in the first place, on the basis of mathematical modeling.

Thus, based on the analysis of the requirements for prediction means in DMSS and considering the specific features of prediction methods, it is appropriate to apply mathematical modeling as one of the most reliable and efficient prediction tool to predict the behavior of complex systems under automated control.

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