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Methods of Multi-Criteria Optimization in Problems of Simulation of Trucking Industry

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Abstract

Efficiency of a transport enterprise can be substantially enhanced by optimization methods at the stages of synthesis, analysis and decision-taking, which makes it possible to obtain, in specific situation, the best of possible solutions. The simulation of motor transport enterprise's operation is closely associated with using vector numeric schemes that practically present structural and parametric models of motor transport enterprise's functions. This is connected with the fact that motor transport enterprises are defined by a relatively large quantity of their specific and individual properties that become sophisticatedly interdependent in the course of their functioning.

The article describes the basic features and methods of multi-criterion optimization in simulating the motor transport enterprises' operations.

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Keywords: Multi-criterion optimization, simulation, choice of solutions, motor transport enterprise, solution quality.

1. Main text

In organizing and managing of motor transport enterprises (MTE) (for example, the passenger ones) the tasks of efficient use of the passenger transport were always essential, which amounted to building a rational routing system of the city, optimum traffic schedule, passenger servicing quality, passenger safety, etc. All this raises certain

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requirements for the efficiency of motor transport enterprise operation management. A systematic approach, methods and models of a systematic analysis and the theory of mathematical simulation are the most effective tools for addressing this problem [Belokurov and Skryl (2011/2002/2008), Hibbs (2000), Kaufmann (1988)]. This is connected with the fact that the motor transport enterprises' systems under study are described by a fairly large quantity of their specific features, which become sophisticatedly interdependent during functioning and are described by multi-criterion optimization models (MCOM) [Belokurov (2008/2004)].

Modern systems of object application, such as models of a motor transport system and, generally, of passenger transport of a large city are described, as a rule, by a fairly large quantity of qualitative and quantitative factors and the existence of complex dependencies between them.

The simulation and optimization of parameters and functioning modes of a MTE is a difficult task of a large scale. One of the means of solving this task is employment of an efficient apparatus of multi-criterion optimization [Belokurov et al. (2004), Belokurov and Belokurov (2000)].

The use of MCOM procedures implies a number of organizational and computational restrictions. So, for instance, the exhaustive scanning of a large number of versions of non-dominated solutions from iteration to iteration results in over-filling of the computing environment memory, in which case the search time increases and the accuracy of obtained solutions decreases.

Conversion of the initial vector form of presenting criteria to the scalar mode calls for theoretical substantiation of the causes of choosing one or other "main" criterion or means of building a criterion-based convolution, which, in turn, reduces the efficiency of the solution obtained and calls for substantiation of the adequacy of the resultant scalar model [Belokurov et al. (2004), Belokurov (2009)].

The main drawback of the existing methods of screening and choosing the solutions is that the selection of part of the "good", from the viewpoint of the set task of versions is based, as a rule, on a random choice. Under such circumstances there are no objective reasons for choosing one or other part of the multitude of non-dominated solutions.

A step-by-step search of solutions and the selection conducted by using it is described by different means of formalization linked to a specific method. Acceptance of a final solution on the formed multitude of non-dominated alternatives is also hampered [Belokurov (2009)]. These specific features of MCOM schemes present, in their turn, higher requirements for mathematical provision and software.

Obviously, the most convenient method of addressing the task is the use of efficient procedures leading to the improved quality of the solution obtained. Thus it is necessary to choose the solution on a sound basis both in search iteration and in choosing the final solution.

Let's formalize the mathematical model of the task of multi-criterion choice. Let there be m of initial versions of solution, each of which has a certain multitude $X_i \in D(i=\overline{1,m}, D=D_1 \times D_2 \times \ldots \times D_m)$ of its realization (x is a symbol of Descartes product). Each realization of the X version is determined by a certain multitude X – quantitative indicator of task parameters.

The choice of a concrete solution is linked to a certain value of the optimization criterion vector value $Q=(Q_1(X),\ldots,Q_n(X))$.

Then MCOM task is generally reduced to the model [Belokurov and Skryl (2011), Belokurov et al. (2009)]:

$$\begin{aligned}
&Q=(Q_1(X),Q_2(X),\ldots,Q_n(X))\xrightarrow[X\in D]{}Opt,\\
&D: D_1 \times D_2 \times \ldots \times D_m,\\
&X=\{A_i \le X_i \le B_i, i=\overline{1,m}\},\\
&f_\mu=(X_i)\le 0, i=\overline{1,m}, \mu=1,2,3,\ldots,
\end{aligned} \tag{1}$$

where: Opt is an operator realizing some optimization principle; X is a version of solution determined by the multitude $X = (X_1,\ldots,X_m)$ – technical-economic, or quantitative parameters and setting parametric restrictions for the area of search; *Q* – is a vector of optimization criteria; *A*, *B* – are parametric restriction for the area of search *D*, representing a multitude of possible versions of solution; f_μ – are functional restrictions the area of search *D*.