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METHODS FOR SOME TYPES OF PROBLEMS OF PATH OPTIMIZATION ON AN ORIENTED GRAPH AND THEIR APPLICATION TO MINE DESIGN

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For a variety of projects (complexes of interlinked operations) in different branches their fulfillment may be represented as paths on an oriented graph. For projects in the mining industry vertices are characterized with certain states of equipment fleet, operations, worked-out space and workings. Multi-objective optimization of project fulfillment results from the search of a balance of interests of a company — the subsoil user and the state — the subsoil owner. Multi-objective optimization problems are mostly solved by reduction to a one-criterion problem by selecting the most important criterion and imposing constraints corresponding to the other criteria or combining target functions for all criteria. Another form of solution is the search of the Pareto set for the problem.

The problems in question consist in the search either the optimal path or the Pareto set of paths either without any constraint on paths or with a single or multiple additive constraint(s). Except the ordinary optimal path problem, the other three types are reduced to a single or multiple problem(s) of finding the set of suboptimal routes with or without constraints, the route P being regarded as Δ-suboptimal if the target index value for it satisfies $W(P) \leq W(P_{\mathrm{OPT}}) + \Delta$. For the case of unconstrained two-criteria problems this idea is substantiated with the two simple assertions:

1. Let the target indices of a path P for the 1^{st} and the 2^{nd} criteria $W_1(P)$, $W_2(P)$ are, resp., the sum of weights w_{1kl} and w_{2kl} of arcs $(k,l) \in P$. Then for any α, $0 \leq \alpha \leq 1$, the optimal path for weights of arcs $\alpha w_{1kl}+(1\text{-}\alpha) w_{2kl}$ belongs to the Pareto set.

2. Let (W_{1X}, W_{2X}) be the pair of $(W_1(P), W_2(P))$ for an arbitrary Pareto-optimal path. Then the entire Pareto set may be represented as $S_{P1} \cup S_{P2}$ where $S_{1X} = \{P \mid W_1(P) \leq W_{1X}\}$, $S_{2X} = \{P \mid W_2(P) \leq W_{2X}\}$, S_{P1} is the set of $P \in S_{1X}$ for which for any $Q \in S_{1X}$ satisfying $W_1(Q) \leq W_1(P)$ the inequality $W_2(Q) > W_2(P)$ is valid and S_{P2} is determined symmetrically.

These assertions are generalized to cases of more criteria and constrained optimization. Instead of methods of constrained path optimization by the problem approximation [1], efficient exact methods are proposed by further development of the suboptimal optimization method [2].

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