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APPLIED PROGRAMS FOR OPTIMIZATION PROBLEMS

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A B S T R A C T

In the national economy, thin-walled structures such as shells are widely used, which leads to the fact that they are subject to increasingly stringent requirements, which are associated not only with saving money and materials during the construction of various structures, but also with the creation of structures of minimum weight. In this regard, the issues of optimal design of underground structures are an urgent task.

K E Y W O R D S

single-vaulted stations, vertical and horizontal pressure, specific gravity, design, vibrations, soil internal friction angle, minimum weight.

INTRODUCTION

Recently, the development and application of packages of applied optimization programs (APP-OP) have become more and more widespread. Like PPP, designed to solve other classes of problems, PPP-OP have two main features [1-5]:

– PPP is a set of software tools focused on solving a certain class of problems;

– the PPP includes a monitor (control program) and a set of software modules. According to the method of communication with the user, PPP is distinguished: library type, with a specialized and universal monitor. In addition, according to the principle of operation, it is possible to distinguish between PPPs operating in automatic (batch) or interactive (human-machine dialogue) modes.

In addition to these common features, PPP-OP have their own characteristics. They can be either invariant with respect to the classes of objects being optimized or oriented towards them.

PPP-OP is devoted to a fairly extensive literature [1], including review [1-5], which can be fully acquainted with the existing developments in this area. Therefore, we will not dwell on the review in detail, but consider the principles of organization and features of some of the most interesting PPP-OP in our opinion.

The software package "Optimization" [1] is designed as a package with a universal monitor and for solving a wide class of non-linear programming problems. This package is invariant with respect to the object and can be used in various CAD systems. At the same time, optimization problems are set and solved in an interactive mode with control through an alphanumeric display. When the package is used autonomously, the optimization task in the form of a load module is prepared by the user, and all work is done in batch mode.

The authors divide non-linear programming problems into 4 classes: unconstrained optimization problems; problems of global optimization in hypercube; minimization problems with constraints in the form of inequalities; general non-linear programming problems (with constraints such as equalities and inequalities). To solve these classes of problems, the package provides 4 types of optimization modules. For all tasks, a single form of representation of numerical characteristics has been developed - a task passport, which is filled in by the user. The package also adopted a single representation (also in the form of passports) of the characteristics of all optimization modules included in the package and based on both regular and statistical search methods.

A distinctive feature of the "Optimization" package in comparison with a small number of existing PPP-OP is the automatic selection of an optimization module for solving a specific problem, which occurs in two stages. At the first stage, the condition for the applicability of the modules to the solution of this problem is considered. In this procedure of "formal choice", the problem to be solved from the composition and the library is associated with several optimization modules according to some formal features. At the second stage, the "optimal choice" procedure is performed. Of all the formally admissible modules, the one with a higher efficiency rating according to a user-specified criterion (reliability, speed, accuracy) is selected. For all admissible tasks and for each subclass of tasks, the personal account of each module contains the following estimates:

- total number of tasks (K_1);
- number of solved tasks (K_2);
- time spent on all tasks (T_1);
- time spent on solved tasks (T_2);
- number of function calculations for all assigned tasks (Kf_1);
- number of function calculations for solved problems (Kf_2);
- average actual accuracy of the solution by function (for test problems) (E_f);
- average actual accuracy by arguments (E_0).

Based on these ratings, the final ratings of module effectiveness are determined: reliability $P = K_2 / K_1$; performance $T = Kf_2 / K_2$; accuracy E=Ef.

As the package is used and the solutions from the tasks are completed, the personal accounts of the modules are replenished.

Efficiency assessments can only be "integral" - for all tasks set and solved by the module, but can also be attributed to various subclasses of tasks. Assigning a task to a subclass occurs in the same way as when the task is admissible at the stage of formal selection, i.e. according to the task sheet.

We consider the application of such a two-stage approach to the problem of automating the choice of algorithms in PPP-OP to be very appropriate and promising. However, it should be noted that the authors do not consider the issues of automating the adjustment of algorithms to subclasses of problems, switching algorithms in the course of solving a problem, or the formation of an optimizing sequence of algorithms, automating additional research of models, if necessary, because task identification by formal features specified in the task passport can lead in some cases to too "broad" subclasses. These issues, in our opinion, should be reflected in the creation of self-learning optimization systems.

Developed under the leadership of A.I. Polovinkin, PPP-OP is part of a package for automating search design [2] and is an example of a problem-oriented PPP. It uses efficient algorithms for random search of both local and global extremum developed by the authors. The package can work both in automatic and interactive modes. It provides procedures for setting tasks, forming a model (from the library of models) and choosing an optimization algorithm (from the optimization software package). The package is managed using a universal monitor. The problem orientation of the package is determined by the class of constructed objects for which the general SPP of search design is intended.

In general, PPP-OP, their state and development problems, it can be concluded that library-type packages are still the most common, and packages with universal monitors have been developed only recently. A large and quite justified development is the interactive mode in PPP-OP. However, it should be noted that both library-type packages and dialog packages require a significant degree of user training. And since the user uses the package to solve practical problems from his field of activity, then in this case his high classification is required in two areas at once: optimization methods and the main specialty, which is far from always achievable. Therefore, the development of packages and systems with a universal monitor, operating in a batch mode, with universal monitors capable of automatically choosing the optimal algorithms for solving a given problem, is also of great scientific and applied importance.

It is also natural to note the increasing development of problem-oriented PPP-OP, which, having maximum speed (due to the use of algorithms specially oriented to the object), less computer memory occupied, allow you to automatically generate mathematical models of optimization problems for a class of objects and issue all the necessary information on the designed object.

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