A. Kontsydailo, Master student
S. Yaremchuk, Ph.D. in Physics and Mathematics, Prof.
N. Krushynska., Lecturer, language advisor
Zhytomyr State Technological University

"P-ALGORITHM" METHOD MODIFICATION

In practical terms problems of locating physical field sources to fixed landing places occur quite often. They arise in industry (optimal placement of sources of pollution, sound), in the design of devices for radio-electronic equipment (providing optimal temperature mode of the chip).

Substantial problem setting

There exist: an area; sources of physical field; landing places and checkpoints. It is necessary to place the sources of the physical field on the seats so that the maximum of the field values at the control points will be the smallest. Each source should occupy one seat and one source should be assigned to one seat.

The physical field generated by the placed sources and the boundary conditions at the margin of the region is described by the linear problem of mathematical physics.

Mathematical model of the problem

Limitation:

$$\begin{cases} \sum_{i=1}^{N} x_{ij} = 1, j \in 1:\mathrm{N}, \\ \sum_{j=1}^{N} x_{ij} = 1, i \in 1:\mathrm{N}, \end{cases} \quad (1)$$

$$x_{ij} \in 0,1, i \in 1:\mathrm{N}, j \in 1:\mathrm{N}, \quad (2)$$

Goal function:

$$f(x) = \max_{k \in 1:K} f_k(x) \to \min, \quad (3)$$

where $f_k(x) = \sum_{i=1}^{N}\sum_{j=1}^{N} c_{ij}^k x_{ij}$, c_{ij}^k – the contribution of the i-source located at the j-landing place to the field values at the k-control point.

Computational scheme of the "P-algorithm" method:

1. The starting basis $\bar{x}_0^0$ for which the point x^0 corresponds is selected.
2. Let be the basis to which the point x^r corresponds, then:

2.1.The set is being constructed:

$$K_{\max}(x^r) = \{k \in 1:K \mid f_k(x^r) = f(x^r)\}.$$

There are $\bar{x}_s^r$ potentials $u_i^k(\bar{x}_s^r), v_j^k(\bar{x}_s^r)$ and ratings $\Delta_{ij}^k(\bar{x}_s^r) \ \forall k \in 1:\mathrm{K}$.

2.2.If at least one $k \in K_{\max}(x^r)$ does not have any positive evaluation, then $x^* = x^r$ it is a global minimum of the task, the end of the algorithm. Otherwise - the transition to p.2.3.

2.3. A set of cells is found $I(\bar{x}_s^r)$, each element of which satisfies the following condition:

$\forall k^* \in K_{\max}\ x^r$ *виконується* $\Delta_{i^* j^*}^{k^*}(\bar{x}_s^r) > 0.$

If it is empty, then the transition to p.4 is carried out. Otherwise - the transition to p.2.4.

2.4. Among the elements $I(\bar{x}_s^r)$ of the plural that one is chosen which satisfies the condition: $f_k(x^r - \Delta_{i^* j^*}^k(\bar{x}_s^r)) < f(x^r), \forall k \notin K_{\max}$. If these do not exist, then the transition to p.4. If there are several such elements, then the one that first leads to a single carriage should be selected. Let's denote it through i^*, j^*.

3. If the value of transportation equals to one, then a new point x^{r+1} to which the basis $\bar{x}_0^{r+1}$ corresponds is obtained. r increases by one, and s is assigned to zero. Otherwise we get the same point x^r, but another basis $\bar{x}_0^{r+1}$. r does not change, but s increases by one. Transition to p.2 is underway.

4. The solution $x^* = x^r$ is chosen. x^* is the stationary point of the method.

The disadvantage of this method is that its performance is greatly reduced by increasing the number of control points. Therefore, a modified "P-algorithm" was developed where the procedure for constructing a cycle that takes most of the time at each step of the solution of the problem is optimized. It is based on the potential method using tree-like structures [1].

To improve the work of the method, it is proposed to use parallel computations in its program implementation. In parallel, the calculation of potentials and estimates at each of the control points at each step of the algorithm is carried out.

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