UDC 681.5

THE NOTION OF THE "COMMON FIXED POINT" AS ONE OF THE FACTORS OF THE LOCAL EVOLUTIONAL SEARCH EFFICIENCY

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This article is devoted to the efficiency evaluation of the local evolutional algorithms. Efficiency evaluation is one of the most important aspects in creating of the new optimization approaches.

The problem that discrete optimization deals with is to find an extremum of function on a discrete set of points. If the function domain comprises a finite number of points the problem of discrete optimization can be solved basically always by trying out the whole set. However, being finite the set can be too large so the enumerative techniques prove to be inefficient. [1] the overwhelming majority of such problems have a distinct application character and it is very topical for modern science as well as for manufacturing to find a qualitative solution for them. "Classic" methods such as genetic algorithms, annealing simulation algorithms, neural networks etc. have common traits: all of them are adaptive iterative and stochastic algorithms. Their every step deals with the value of a qualitative function and every single one of them can prove its convergence to the absolute optimum.

One of the more reliable methods is a heuristic search method. The heuristic search is a kind of state space search that utilizes the knowledge of the problem to find a more effective solution. It is usually easy to make heuristic algorithms that quickly find a solution, but it is impossible to prove that the heuristic algorithm always finds the solution that is close to the optimal one. [2] Moreover one of the major drawbacks of such methods is the absence of a predictable procedure.

The local evolutional approach is based on the synthesis of the heuristic and the evolutional approaches. The heuristic approach contributed the use of local heuristics (i.e. local rules of solution search). The evolutional one contributed the parallel development of many search processes (the population) and the selection model.

The peculiarity of the local evolutional approach is the ability to conduct the search in a strongly bounded solution space. This peculiarity allows to substantially reduce time costs compared to traditional methods and to increase the quality of the solution.

Additional compression of the search space becomes possible when using heuristics of a special kind, particularly, the recursive ones. One of the most topical problems while developing solution algorithms based on the recursive heuristics is the evaluation of their work efficiency and estimation of the moment when the search space reduction stops and further work of the heuristic algorithm becomes a waste of time and computing power.

We will introduce several definitions.

<u>Definition 1</u>. *Heuristics fi* is a functional image $S \to S$. Heuristics allows to move in the solution search space S in the direction of the evaluation function $\varphi(s) \geq \varphi(fi(s))$ (1) lack of growth where $\varphi(s) : S \to R$.

<u>Definition 2</u>. Recursive heuristics is the heuristics that results in a fixed point (FP) – $fi(s) = fi^2(s)$.

If we set any point of the initial search space after implementing the first heuristics we will inevitably come down to the reduced space and never exceed its bounds. That is why the search space compression should be considered a result of the approach to the solution search and not a workaround.

It is easy to prove the term character of the recursive heuristic calculation. Unfortunately, it is impossible to prove generally the convergence of the recursive heuristic calculation, because in our case the halt condition will be $\forall fi(s) : fi(s)=s$ (3), and this situation depends on the heuristic system applied and can be unrelated to reaching optimum.

A stable (and efficient) work of heuristics is usually mentioned as the main factor influencing the heuristic search efficiency.

The first point worth paying attention to is the search space compression effect when using recursive heuristics. In this case the search space power equals $|S^*|$.

<u>Definition 3</u>. We will express the fact of the search space compression with the *ratio of reduction* $r=|S|/|S^*|$. This ratio characterizes the heuristics system as a whole and is connected with efficiency.

<u>Definition 4</u>. We will express the fact of the search space compression due to the work of separate heuristics with the ratio $r_i=|S|/|S_i|$ which we will call the heuristic power. It is calculated as an average power of the S/α_i partition classes.

Another factor connected with efficiency is the fact that heuristics have "common fixed points" (CFP). The fact of this possession indicates the search efficiency loss in these points up to a halt. In other words, such points make the calculations "thrash".

Definition 6. We will define the search efficiency loss record coefficient in CFPs as $p = \frac{\sum |S_i|}{|S^*|} = \frac{\sum |S_i|}{|S^*|} \cdot \frac{|S|}{|S|} = r \cdot \sum \frac{1}{r_i}$. It equals the average number of "malfunctioning" heuristics at any given moment of calculations.

We will introduce time cost estimation as $t = p \cdot \frac{|S|}{r}$ i.e. we suppose that the bigger the reduced space is and the bigger the losses because of inefficient calculations in CFPs, the longer the calculations will take. This estimation characterizes the time cost expressed through conventional units. However, it neglects both time complexity of the heuristics and their work character.

Thus it is easy to see that the main merits of the local evolutional approach is a relatively short time for the search for a quasi-optimal solution, it depends directly on the losses due to the inefficient work of the heuristics in CFPs. That is why with regard to the heuristic work character it is usually possible to suggest heuristic management strategy for the time of calculations. The aim of such strategy is to minimize the presence in CFPs thus reducing time loss due to inefficient calculations.

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UDC 622.232

CONTRIBUTION OF THE AMENDMENT OF THE FIFTH ORDER IN THE ASYMPTOTICS OF FUNCTION OF DISTRIBUTION COORDINATE OF THE ELEMENTARY ACT OF SORPTION

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The problem of dynamics of sorption is the cornerstone of many chemical and nature protection technologies connected with the cleaning of harmful emissions. To model this process we use the equations of mathematical physics. Thus let's solve the system of the differential equations in the private derivatives describing kinetics of sorption and balance of absorbed impurity. For linear isotherms and standard regional conditions such a system (see [1]) is reduced to the equation

$$-\omega'_\xi = e^{-\tau}\left(e^{-\xi} + \int_0^\tau e^\tau d_\tau \omega\right), \qquad (1)$$

where ω – the given concentration of absorbed substance, ξ and τ – the respectively dimensionless coordinate and time [2].

It is obvious that the elementary act of sorption – a casual event. The respectively dimensionless concentration $\omega(\xi,\tau)$ can be interpreted as statistical probability of penetration of particles of impurity in absorbing layer on depth ξ. Respectively $1-\omega(\xi,\tau)$ – probability of absorption of a molecule such layer of a sorbent, and

$$f(\xi,\tau) = \frac{\partial(1-\omega(\xi,\tau))}{\partial\xi} = -\omega'_\xi(\xi,\tau) \qquad (2)$$

– density of probability of the elementary act of sorption.

Using (1), it is possible to find the initial moments of a random variable without solving the equation (see [3])