Application of genetic algorithm to problems for the project reality estimation

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Abstract[1]

The possibility of problem solution of the projects reality estimation by means of the modified genetic algorithm in the conditions of inaccurate and unclear initial information is being considered.

1. Introduction

Development of big projects for hi-tech branches of the domestic economy, industry, power and transport is characterized by a wide spectrum of the uncertainties connected with inaccurate and incomplete initial data by frequently changing requirements of consumers to the efficiency of the project by high level of design risk, by complexities of planning and creative activity control of developers alongside with essential resource expenses (financial, time, labour, etc.) on designing [1, 2]. In this connection, the problem of problem reality estimation being the major initial stage of its life cycle directed on detecting and lowering possible project risks at its development as well as reducing administrative errors made by the project head in conditions of subdefiniteness. To overcome difficulties caused by Non-factors (inaccuracy, incompleteness, ambiguity, etc.) [3], at early stages of the project development it is rather perspective to use the intellectual technologies allowing to "eliminate" uncertainties and to give to the project reality estimation task the quantitative definiteness. With reference to the project reality estimation the application of the genetic algorithms allowing accurately and timely to define a set of optimal solutions in case of interval initial data appears to be very effective.

2. Genetic algorithm to the project reality estimation problems in conditions of interval uncertainty

For project reality estimation the approach based on finding the vector of the expected cost for every each project development and formation of interval estimation of generalized usefulness characterizing the project viability has been offered together with the possibility of the following choice of comprehensible project alternative which simultaneously would satisfy all criteria reality taking into account their importance and wouldn't lead to excess of given financial assets.

As the task being solved has a combinatorial character and can be formulated as a search of the best solution it is expedient to apply the genetic algorithm. Before we start the description of the formal circuit of the project reality estimation let is describe assumptions being introduced:

- The number of project development of alternatives;
- The number of private project reality criteria;
- Private criteria are given in the form of indistinct trapezoid numbers and their boundaries are not intersected;
- Four project alternatives have been developed as considering a greater number of alternatives takes more efforts, more time-consuming and leads to confusion;
- The vector of the expected cost for each project development alternative is presented in the form of indistinct trapezoid number.

Let's have a restricted set from m admissible project development alternatives $X = \{x_1, x_2,\ldots,x_i\}$ where each alternative $x_i \in X$, $i=\overline{1;m}$ is estimated by a tuple from n private criteria $K=\langle k_j(x_i)\rangle$, $j=\overline{1;n}$. The task of finding the vector of the expected project cost for everyone i project development alternatives ($s(x_i) = (s_{i,1}, s_{i,2}, s_{i,3}, s_{i,4})$, where $s_{i,1}$ is a pessimistic project cost, $[s_{i,2}, s_{i,3}]$ is a project cost interval, $s_{i,4}$ is an optimistic project cost estimation) and formations of a generalized usefulness of a scalar interval estimation which characterize reality of each i project development alternative from a total number m of alternatives is put:

$$P(x_i)=\sum_{j=1}^{n} w_j^{\text{H}} p_j^{\text{H}}(x_i),\ i=\overline{1;m},\ j=\overline{1;n},$$

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where w_j^{H} is the normalized interval coefficient of relative importance of j private alternatives criterion $x_i \in X$ and $p_j^{\text{H}}(x_i)$ the normalized interval private criteria of alternatives $x_i \in X$ ($0 < p_j^{\text{H}}(x_i) < 1$).

The task is described by the following target function

$$\sum_{j=1}^{n} w_j^{\text{H}} p_j^{\text{H}}(x_i) \to \max$$

and restrictions: $w_j^{\text{H}} = [\alpha_{j\min}, \alpha_{j\max}]$, thus it is necessary that $\sum_{j=1}^{n} \alpha_{j\min} < 1$, $\sum_{j=1}^{n} \alpha_{j\max} > 1$; $s_{\min} \le s(x_i) \le s_{\max}$ ($s_{\min} = s_{i,1}$, и $s_{\max} = s_{i,4}$ – values of minimum and maximum expected project cost).

For solution of the problem given the following circuit of the modified genetic algorithm operation is offered.

Step 1. The initial data are entered: $k_j(x_i)$; $s_{\min}$ и $s_{\max}$; *kol* is a number of iterations, d is a crossingover position, q is a mutation position, w_j is an interval coefficient of the relative importance of j private alternatives criterion.

Step 2. Normalization of private criteria $p_j^{\text{H}}(x_i)$ for everyone i alternatives of project development and w_j^{H} interval coefficients of private criteria relative importance is being carried out. As the project criteria are interval values, i.e. only boundaries of analized parameter of values change of the project being developed are known. The indistinct interval approach offered by the author in operation is used [2].

Step 3. Necessary conditions of optimization (target function and restrictions) being defined.

Step 4. Parents-individuals are being formed, i.e. four variants of vectors of the expected cost for every i alternative of the project development considering restrictions are being formed $s_{\min} \le s(x_i) \le s_{\max}$:
$s^{\text{P}}(x_1) = (s_{1,1}^{\text{P}}, s_{1,2}^{\text{P}}, s_{1,3}^{\text{P}}, s_{1,4}^{\text{P}})$, $s^{\text{P}}(x_2) = (s_{2,1}^{\text{P}}, s_{2,2}^{\text{P}}, s_{2,3}^{\text{P}}, s_{2,4}^{\text{P}})$,

$s^{\text{P}}(x_3) = (s_{3,1}^{\text{P}}, s_{3,2}^{\text{P}}, s_{3,3}^{\text{P}}, s_{3,4}^{\text{P}})$,

$s^{\text{P}}(x_4) = (s_{4,1}^{\text{P}}, s_{4,2}^{\text{P}}, s_{4,3}^{\text{P}}, s_{4,4}^{\text{P}})$.

with the use of the random numbers generator.

Step 5. Normalization of the expected cost criterion for every i alternative of the project development ($s^{\text{P}}(x_1), s^{\text{P}}(x_2), s^{\text{P}}(x_3), s^{\text{P}}(x_4)$) similar to step 2 is carried out.

Step 6. The operation of single-point crossingover over the received variants of parents-individuals (a point crossingover $1 \le d < 4$) is being produced. As a result of the crossingover operation 12 individuals-descendants have been received: $s^{\text{D}}(x_1) = (s_{1,1}^{\text{P}}, \ldots, s_{1,d}^{\text{P}}, s_{2,d+1}^{\text{P}}, \ldots, s_{2,4}^{\text{P}})$, $s^{\text{D}}(x_2) = (s_{2,1}^{\text{P}}, \ldots, s_{2,d}^{\text{P}}, s_{1,d+1}^{\text{P}}, \ldots, s_{1,4}^{\text{P}})$ etc. The received individuals-descendants are checked on correspondence to restrictions.

Step 7. The operation of a single-point mutation of the received individuals-descendants (a mutation point $q < 4$) is being produced. From the coming individual-descendant the new individual-descendant with mutation genes has been received $s'^{\text{M}}(x_i) = (s_{i,1}^{\text{M}}, \ldots, s_{i,q}'^{\text{M}}, \ldots, s_{i,4}^{\text{M}})$.

Step 8. Values of target function for all population individuals (variants of the project expected cost vectors) are being calculated.

Step 9. Four individuals (four vectors) with the greatest values of target function which going to the parents for the following iteration have been selected.

Step 10. The received results are being saved, and break check is being produced. If the given amount of iteration is fulfilled, we pass to step 11, otherwise return to step 6.

Step 11. The output of results is being carried out: vectors variants $s(x_i) = (s_{i,1}, s_{i,2}, s_{i,3}, s_{i,4})$ of the expected project cost and scalar interval estimations of generalized the project development usefulness $P(x_i)$ for every i the project development alternative.

4. Conclusion

In the work presented operation for overcoming the difficulties caused by Non-factors at early stages of project development, an approach with the genetic algorithm usage is offered which, allows to raise the validity of decision-making on possibility of project implementation and due to this to lower the risk of its unsuccessful implementation.

References

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