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THE GRANULAR EVOLUTIONARY ALGORITHMS IN UNCERTAIN IDENTIFICATION PROBLEMS

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ABSTRACT

The paper is devoted to applications of evolutionary algorithms in identification of structures being under the uncertain conditions. Uncertainties can occur in boundary conditions, in material parameters or in geometrical parameters of structures and are modelled by three kinds of granularity: interval mathematics, fuzzy sets and theory of probability. In order to formulate the optimization problem for such a class of problems by means of evolutionary algorithms the chromosomes are considered as interval, fuzzy and random vectors whose genes are represented by: (i) interval numbers, (ii) fuzzy numbers and (iii) random variables, respectively. Description of evolutionary algorithms with granular representation of data is presented in this paper. Various concepts of evolutionary operator such as a crossover and a mutation and methods of selections are described. In order to evaluate the fitness functions the interval, fuzzy and stochastic finite element methods are applied. Several numerical tests and examples of identification of uncertain parameters are presented.

In the majority engineering cases it is not possible to determine exactly all parameters of the physical systems. It is necessary to introduce some uncertain parameters which describe the granular character of data. Representation of uncertain values may have different forms. It depends of the physical meaning of the considered problem and the assumed model of uncertainty. There are several formal frameworks in which information granules can be built [7] among them interval analysis, fuzzy sets and random variables [3] can be considered.

The aim of an identification problem is to find some unknown parameters of a mechanical system having some measurements of physical quantities such as displacements or natural frequencies [4]. The identification problem is considered as the minimization of a functional which depends of an error between measured and computed physical quantities as e.g. displacements in the sensor points.

The evolutionary algorithms [1], as the global optimization technique for searching uncertain values, can be applied in finding the interval parameter [7], fuzzy models [8],

fuzzy controllers [11], fuzzy rules [2], random parameters and others. In such algorithms, the chromosome consists of uncertain genes. Therefore, the evolutionary operators are modified for uncertain types of data.

This paper describes a new conception of application of the granular evolutionary algorithm in identification problems with uncertain parameters. The following systems are considered as the granular models (i) interval numbers, (ii) fuzzy numbers and (iii) random variables. The proposed granular evolutionary algorithm is examined for testing bench-mark, due to the optimal parameters of the algorithms (population size, probability of mutation and crossover) are found. Next, the algorithm is applied for identification problem in mechanical structures. The paper presents the application of the algorithm in finding the shape, material coefficients and boundary conditions of the mechanical structures.

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