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THE USE OF GENETIC ALGORITHMS IN STRAIGHT FORWARD ENGINEERING PROBLEMS – THE INFLUENCE OF THE GENETIC OPERATORS

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ABSTRACT

Nowadays, the use of nature and genetic-inspired optimization methods for solving engineering problems is becoming recurrent. One of the most popular methods is the Genetic Algorithm (GA) optimization search. Genetic algorithms [1-4] are random search techniques based on the survival of the fittest and based on natural selection. They are used to obtain accurate or approximate solutions to optimization problems that are not well suited for standard optimization algorithms. The algorithm is started by creating a random initial population made up of an array of individuals; an individual represents a candidate solution and it is any point to which one can apply the function to be optimized. The individual (chromosome) may be binary encoded. At each generation, parents may be selected at random from the current population of individuals to form a mating pool to produce the children for the next generation. Other selection processes based on the fitness value of the individual (tournament or roulette) may be used to create a mating pool. Crossover and mutation operators are then applied to form offspring; the former combines two parents from the mating pool, whereas the latter applies random changes in some individuals. In order to enhance the algorithm efficiency other operators should also be employed.

The population size, the crossover frequency to which the operator is applied (crossover probability) and the mutation probability, whose main purpose is to increase the population diversity, are the main parameters that affect the search behaviour. When the selective pressure is too high, the search concentrates on the fittest members often converging to a local optimum or performing some kind of local vicious stagnation, demanding the action of a balancing diversity operator. An adequate balance between these two opposing factors (population diversity and selective pressure) is essential for the accomplishment of a successful global optimization search. However, this balance depends on the optimization problem, and it has a tremendous influence on the use of other operators.

The work presented in this paper deals with the use of genetic algorithms in the

resolution of straightforward engineering problems that can be formulated as optimization problems. A deep analysis of the influence of each genetic operator is made for a set of mathematical functions and for some engineering problems. This analysis was performed pursing the definition of indicators able to point out an unbalanced selection/diversity relation, specifying and quantifying which counterpart is preponderant. A new adjustable selective operator is introduced to the GA operators set in order to increase and adjust the selection strength.

Although an engineering problem can be straightforward, it can be difficult to formulate it accurately as an optimization problem. The problem of the determination of parameters of constitutive models is an example of it. In this work, the GA will be used to determine the parameters for a hyperelastic constitutive model. Additionally, the three truss problem was adopted to foresee the behaviour of the algorithm and the influence of the new genetic operators in a constraint optimization problem.

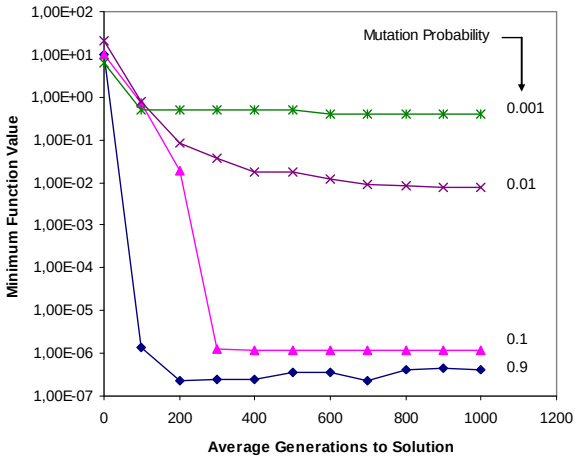

Fig. 1: Example of Mutation Probability effect

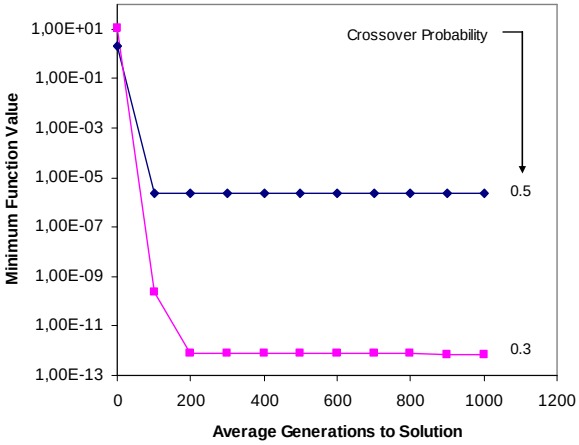

Fig. 2: Example of Crossover Probability effect

Optimization test: minimum search of $f(x,y)=x^2+y^2$; Mutation operator: random bit change; Crossover operator: one point crossover

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