PRESERVING DIVERSITY IN CHANGING ENVIRONMENTS THROUGH DIPLOIDY WITH ADAPTIVE DOMINANCE

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Genetic algorithms have been applied to a diverse field of problems with promising results. While most of these mainly address stationary problems, there's another group where the problem is dynamic, represented by a changing fitness function. These class of problems are characterized mainly by a need for a mechanism to adapt to the change. The best approach depends on the nature of the change in the fitness function. Different characteristics of changing fitness functions can be exploited in different ways to obtain an optimal solution. In dynamic environments, diversity plays an important role in genetic algorithm performance. The main approaches in coping with changing environments and preserving diversity are summarized in [Branke, 99]. One of these is the use of diploidy, however as shown in [Lewis, 98] diploidy alone is not sufficient and other modifications are needed. In this study a diploid representation for the individuals is used. Each individual consists of two chromosome strings, a string to represent the phenotype, a fitness value and an age value showing for how many generations the individual has survived. When determining the phenotype, a dominance map is applied to the two chromosome strings. In this implementation, a domination array composed of real numbers in $[0.0, 1.0]$, where each value shows the dominance factor of the allele 1 over the allele 0 for the corresponding location on the chromosomes, is used. The domination array evolves along with the individuals through the generations. The reproduction phase consists of mating pool determination, meiotic cell division with crossing over for gamete formation, mutation and the actual mating phase to form two new individuals. Offspring do not replace the parents and since population size is constant, individuals to survive into the next generation are determined by way of a fitness proportional method at the end of each generation. A possible replacement of aged individuals occurs at this stage where the aged individual may get replaced by a randomly created individual.

The main features of this algorithm contributing to preserving diversity are the use of a diploid representation with an adaptive domination mechanism, the use of a meiotic cell division in the reproduction phase and the use of a possible replacement policy of aged individuals. The algorithm used in this study is explained in greater detail in [Uyar, 99] by the same authors. To see the effects of each feature seperately, the algorithm is run with each feature either turned on or off. The results are obtained based on a variation of the 0-1 knapsack problem where the desired sum takes on random values at random intervals. The progression of the population diversity is observed through plotting the genotypic and phenotypic convergence rates of the population and tracking the algorithm's performance in following the change. It is shown in this study that different features of the chosen diploid algorithm address the issue of diversity from different aspects. The choice of which feature to use and which not to use depends mainly on defining the basic nature of the change in the environment and determining what each class of problem requires. At the time of submission, this is still a work in progress but the results obtained are promising.

References

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