Nested Genetic Algorithms with Problem Division

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Abstract

In this paper we propose a new parallel approach to genetic algorithms that has shown interesting performance concerning both the speedup and the quality of the solutions.

1 INTRODUCTION

Most of the parallel GAs divide the genetic population into several independent nests or niches, on which the selection and crossover operations act locally (Cantú-Paz, 1998). The global performance is insured by periodic migration of some individuals between subpopulations. In this paper we introduce a new parallel model for GAs for which the problem to be solved is divided among processes.

2 MODEL DESCRIPTION

Let L be the size of the individual, and np the number of processes. In our model, the process number i is evolving the genes corresponding to the places from $i * L/np$ to $(i+1) * L/np - 1$, where both the process numbers and the gene positions start from 0.

To evaluate the partial individuals generated by each process, we compose complete individuals by periodically exchanging information between processes. We estimate the fitness of each partial individual by averaging the fitness of several complete individuals containing it.

To test the new model we have used the set of standard test functions (minimization problems), the Hamiltonian circuits (HC) (Vrajitoru, 1999), and several deceptive functions. The experiments are based on 40 trials in each case with a population size of 50 and a generation number of 500. We have used a combination of the 1-point, 2-point, uniform and dissociated crossover operators.

Table 1: Average results and speedup

Average Fitness	Standard	Deception	HC
sequential	2.87	2673.73	0.946
parallel	1.69	2812.20	0.948
speedup	27.77	29.10	44.68
nr. of processes	2 - 5	4	4

Table 1 shows the average results of the sequential algorithm on each of these problems, as well as those of the best configuration of our parallel model, for which the processes exchange 2 individuals every 50 generations. The minimum for the set of standard functions is equal to 0. The maximal fitness is equal to 3000 for the deception problems, and to 1 for the HC problems. The third line presents the average speedup for each problem as a percentage of the sequential execution time. The last line contains the number of processes used in each case.

From this table we can conclude that our parallel implementation of GAs is interesting both from the point of view of the quality of the solutions, and of the speedup.

References

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