The Effect of Cooperative Searches in Parallel GA Using Multiform Subpopulations

Hirosuke HORII

School of Information Science,
Japan Advanced Institute of Science and Technology

February 13, 1998

Keywords: Genetic Algorithms,Parallel Computation, Cooperative Search,Migration.

Genetic algorithms were proposed by J. H. Holland, as an artificial model for explain a process of the adaptation of systems in the natural world and simulate the mechanism of evolution. Now, genetic algorithms have been studied as not only the model of the evolution, but also one of the methods in the stochastic search, study and optimization.

Genetic algorithms compute genetic operators like selection, crossover and mutation, and fitness value of individuals for long generations, and so genetic algorithms need formidable computation time. But each individual can process genetic operators and calculation of fitness value synchronously and genetic algorithms are easy to parallelize. So many parallelization methods have been proposed since early studies in genetic algorithms, and the methods are categorized three descriptions, global parallelization,island model parallelization, and massivery parallelization.

In island model parallel genetic algorithms, the population is partitioned to multiple subpopulations, and subpopulations are allocated to processing elements. Migration operates under constant interval or condition, is an algorithm invite the migrants from other subpopulation.

The premature convergence is one of the problems in genetic algorithms. This problem is the stagnation of evolution that is caused by the diffusion of the projecting individual that has high fitness value. Two populations that are isolated geographically, is disturbed the exchange of their genes. Then they are isolated sexually by random genetic drift. This mechanism is called the geographic speciation in population genetics. In island model parallel genetic algorithms, each subpopulation have different genetic construction by control of the migration among subpopulations, then as a whole of the population, diversity of genes can be maintained.

Cooperation among subpopulations is the most considerable problem in island model parallel genetic algorithms. By migration that is held by constant interval or condition,

and introduction genes from other subpopulation, diversity of genes in each subpopulation is maintained and avoid the premature convergence. It is very effective for ability of search to set up migration interval,condition and selection of migrants. When a subpopulation is under searching, introducing migrants from other subpopulation gives restoration of diversity of genes, but there is a risk of disruption of good schema. So it is effective to introduce migrants after a search in each subpopulation. And it is natural that progress of search differs from subpopulation to subpopulation, so it is necessary that asynchronously migration according to each subpopulation's judgement of the situation.

The proposal in this study were as follows.

- Migration is held subject to uniformity of genetic constitution in subpopulation. And using Bias as the detection of uniformity.
- Migrants are introduced from other subpopulations that have different genetic constitution. And using Temporally Schema as indication of genetic constitution in subpopulation and difference of genetic constitution is judged by hamming distance of Temporally Schema between other subpopulations.
- Each subpopulations have specific different tendency of search by setting up different parameters of genetic operators.

The above is the proposal in this study, and these proposal was verified by appling to Knapsack Problems and Royal Road Functions. The points of becomming clear were as follows.

- The scheme of migration proposed in this study is effective to appling to combinatorial optimization problem. Specially, if Building Block Hypothesis is tendency to stand up, it can be more effective search according to partition of population and parallel search of Building Block.
- When each subpopulations have different tendency of search, the efficiency of search is going down, but the precision of search is improving.