Study of Elite Population Algorithm

Application to the problem of location assignment and vehicle scheduling at maritime terminal

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1. Introduction

In this work, we propose a new genetic method using the evolution theory to improve solution convergence considering NP-hard combinatory optimization problems. The algorithm is used to solve an NP-hard problem which is the Integrated Problem of Location Assignment and Vehicle Scheduling in maritime terminal at import (IPLAVS).

2. Reviews of literature

Many works discussed multi-population strategy in genetic algorithm. We analyzed particularly the works of Cantu-Paz [1] [2] [3] and the thesis of T. McMaHon [4]; T. McMahon developed a distributed genetic algorithm with migration. Authors used a migration of individuals from each population to the adjacent population. The algorithm was applied to the design of composite laminate structure.

3. Description of Elite Population Algorithm

Generally, for classical genetic algorithms, the best solution converges to a local optimum. In fact, after some iterations, all the individuals in the population converge to this same solution. This phenomenon is known in evolution theory as “convergent evolution”. This convergence is the consequence of evolution in similar biomes. Individuals converge to similar solutions even if they are distantly related. Unrelated organisms, adapted to similar environments, often develop analogous structures . This genetic phenomenon explains the different varieties or races in animal or plant species.

If we generate different populations, each population will converge to a specific solution, which is a local optimum or may be an absolute optimum. In some research, scientists use multi-population genetic algorithms with “migration” of some individuals between the different populations.

Our approach is to create a central population or “Elite Population” and inject in this population the best individuals of each population at every evolution. The “Elite Population” is subject to evolutions and migrations and will converge to a special optimum. Theoretically, in spite of cross operations and selective migrations the “Elite Population” will have a serious chance to converge to the global optimum or to a local optimum better than the local optimums of the other populations.

Considering the mutation and crossover operators, many definitions can be used, it is important to determine efficient operators adapted to the problem. In our approach, we use different evolution operators and during the run time, the process observes the efficiency of every operator. To improve the resolution quality, at every time of the process, the efficient operators are used intensively.

We define a specific data to observe the evolution of each individual. This data is a list determining the genetic history of that individual. The genetic history list describes the sequence of evolution operators and populations given the associated individual. The study of that data proves that the use of an “Elite Population” gives efficient solutions to IPLAVS. This data is also used to determine the efficiency of operators during the running time and adapt the frequency of their use to their efficiency.

The algorithm is applied to the problem of location assignment and vehicle scheduling at maritime terminal. This application proves the efficiency of the elite population optimization strategy compared to others classical genetic approaches.

4. Conclusion

Many parallel genetic algorithms are developed and discussed in reviews of literature. Some of these algorithms use different populations with a migration phenomenon of some individuals between these populations.

Our approach use a set of populations evolving in isolation and an "Elite Population" supporting the migration of the best individuals of the isolated populations. Numerical results prove the efficiency of our approach compared to classical parallel genetic algorithms and exact methods.

References

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