On Setting the Parameters of QEA for Practical Applications: Some Guidelines Based on Empirical Evidence

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Abstract. In this paper, some guidelines for setting the parameters of quantum-inspired evolutionary algorithm (QEA) are presented. Although the performance of QEA is excellent, there is relatively little or no research on the effects of different settings for its parameters. The guidelines are drawn up based on extensive experiments.

1 Introduction

Quantum-inspired evolutionary algorithm (QEA) recently proposed in [1] can treat the balance between exploration and exploitation more easily when compared to conventional GAs (CGAs). Also, QEA can explore the search space with a small number of individuals and exploit the global solution in the search space within a short span of time. QEA is based on the concept and principles of quantum computing, such as a quantum bit and superposition of states. However, QEA is not a quantum algorithm, but a novel evolutionary algorithm.

In [1], the structure of QEA and its characteristics were formulated and analyzed, respectively. According to [1], the results (on the knapsack problem) of QEA with population size of 1 were better than those of CGA with population size of 50. In [2], a QEA-based disk allocation method (QDM) was proposed. According to [2], the average query response times of QDM are equal to or less than those of DAGA (disk allocation methods using GA), and the convergence of QDM is 3.2-11.3 times faster than that of DAGA. In [3], a QEA-based face verification was proposed. In this paper, some guidelines for setting the related parameters are presented to maximize the performance of QEA.

2 Some Guidelines for Setting the Parameters of QEA

In this section, some guidelines for setting the parameters of QEA are investigated. These guidelines are drawn up based on empirical results.

The initial values of Q-bit are set to $\left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$ for the uniform distribution of 0 or 1. To improve the performance, we can think of the two-phase mechanism

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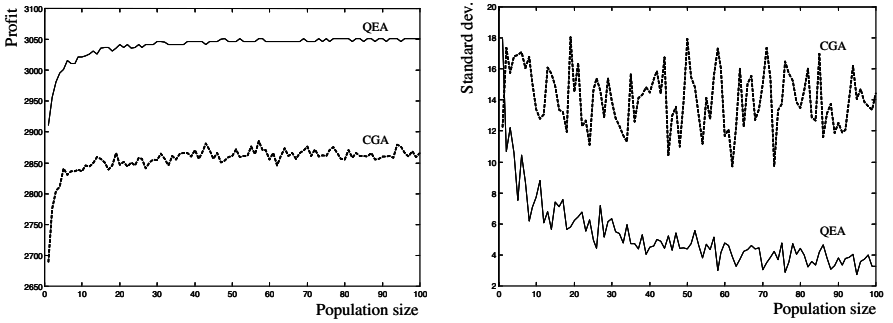

(a) Mean best profits (b) Standard deviation of profits

Fig. 1. Effects of changing the population sizes of QEA and CGA for the knapsack problem with 500 items. The global migration period and the local migration period were 100 and 1, respectively. The results were averaged from 30 runs.

for initial conditions. In the first phase, some promising initial values can be searched. If they are used in the second phase, the performance of QEA will increase.

From the empirical results, Table I in [1] for the rotation gate can be simplified as $[0 * p * n * 0*]^T$, where p is a positive number and n is a negative number, for various optimization problems. The magnitude of p or n has an effect on the speed of convergence, but if it is too big, the solutions may diverge or converge prematurely to a local optimum. The values from 0.001π to 0.05π are recommended for the magnitude, although they depend on the problems. The sign determines the direction of convergence.

From the results of Figure 1, the values ranging from 10 to 30 are recommended to be used as the population size. However, if more robustness is needed, the population size should be increased (see Figure 1-(b)). The global migration period is recommended to be set to the values ranging from 100 to 150, and the local migration period to 1.

These guidelines can help researchers and engineers who want to use QEA for their application problems.

References

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