Hybrid Quantum Particle Swarm Optimization Algorithm for Combinatorial Optimization Problem

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ABSTRACT

In this paper, a framework of hybrid PSO is proposed by reasonably combining the Q-bit evolutionary search of quantum PSO and binary bit evolutionary search of genetic PSO.

Categories and Subject Descriptors: I.2 [Artificial Intelligence]: Heuristic methods

General Terms: Algorithms

Keywords: QPSO, GPSO, combinatorial optimization

1. HYBRID QPSO AND GPSO (HQGPSO)

To solve combinatorial optimization problems, Kennedy et al. [1] developed a discrete PSO (DPSO); Yang et al. [2] proposed a quantum particle swarm optimization (QPSO) ; and Yin [3] proposed a genetic particle swarm optimization (GPSO). In QPSO [2], the representation of population is Q-bit and evolutionary search is in micro-space (Q-bit based representation space). In GPSO [3], the representation is binary number and evolutionary search is in macro-space (binary space). Therefore we consider the hybridization of QPSO and GPSO to develop hybrid QPSO characterized the principles of both quantum computing and evolutionary computing mechanisms. The overall evolution process in QPSO can be illustrated in the Fig.1 (a). The proposed hybrid framework, HQGPSO, is illustrated in Fig.1 (b), which can be described in detail as:

1. Initialize.

- **1.1** Set $t = 0$, initialize the QP(t), and make BP(t) by observing the states of QP(t).
- **1.2** Evaluate the BP(t), and update the local best solutions and the global best solution.
- **1.3** Store BP(t) into Parent(t).

2. Repeat until a given maximal number of iterations ($MaxIter$) is achieved.

- **2.1** Set $t = t + 1$, and update QP(t) using QPSO.
- **2.2** Make BP(t) by observing the states of QP(t), and evaluate the BP(t).
- **2.3** Select better one between BP(t) and Parent($t-1$) for each individual to update BP(t).
- **2.4** Update the local best solutions and the global best solution.
- **2.5** Update BP(t) using GPSO for a given maximal number of iteration ($gMaxIter$).
- **2.6** Evaluate the BP(t), and update the local best solutions and the global best solution.
- **2.7** Store BP(t) into Parent(t).

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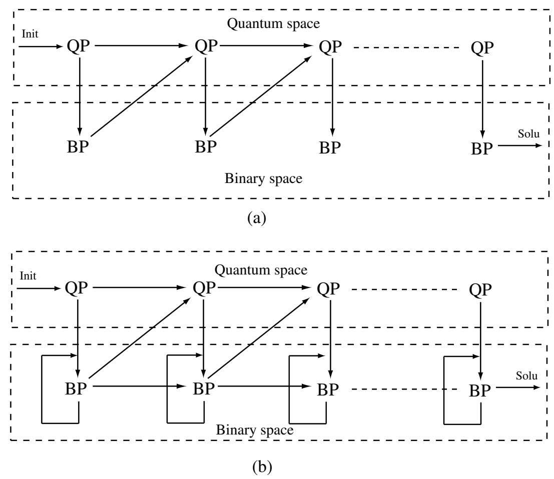

Figure 1: (a) QPSO. QP: Quantum Population, BP: Binary Population generated by random observation, Solu: Solution, (b) HQGPSO.

Experiments were carried on four knapsack problems with 100, 500, 1000, and 5000 items. The weights of the items are uniformly distributed in a large data rang $R = 10^6$ and the profits of the items is strongly correlated to the weights in these knapsack problems [4]. Results show that HQGPSO has superior performance to DPSO, QPSO and GPSO.

2. REFERENCES

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