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Quantum Inspired Intelligent Systems

With 60 Figures and 22 Tables

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Preface

Research on applying principles of quantum computing to improve the engineering of intelligent systems has been launched since late 1990s. This emergent research field concentrates on studying on quantum computing that is characterized by certain principles of quantum mechanics such as standing waves, interference, quantum bits, coherence, superposition of states, and concept of interference, combined with computational intelligence or soft computing approaches, such as artificial neural networks, fuzzy systems, evolutionary computing, swarm intelligence and hybrid soft computing methods. This volume offers a wide spectrum of research work developed using soft computing combined with quantum computing systems.

In Chapter 1, the authors present a novel Quantum-behaved PSO approach using Gaussian distribution (G-QPSO) to tune the design parameters of a Fuzzy Logic Control (FLC) system with PID (Proportional Integral Derivative) conception. The FLC-PID design is applied to a control valve with nonlinear dynamic behavior and numerical results indicate that proposed FLC-PID design with G-QPSO is effective for the control of reactor.

In Chapter 2, the authors propose to use quantum-inspired genetic algorithms for permutation flow shop scheduling, which is a typical NP-hard combinatorial optimization problem with strong engineering background. Simulations are carried out based on several single-objective and multi-objective benchmarks with some performance metrics and the results demonstrate the effectiveness of the proposed hybrid quantum-inspired genetic algorithms.

In Chapter 3, the authors explore a model for a quantum Hopfield artificial neural network, in which qubits are prepared in an initial state and allowed to evolve to steady state. Then, they derive a method for training the quantum network to converge to a stable target pattern, given an input pattern, and show that a spatial array of qubits can be trained to perform the CNOT, which with a rotation is a universal quantum gate.

In Chapter 4, the authors propose a new paradigm of intelligent systems and they apply it to engineering quantum intelligent mobile system through the fusion of quantum technology with mobile system. The authors show that this quantum intelligent mobile system has many potential applications in various areas and also offers a platform for the research on quantum or quantum-inspired technologies.

In Chapter 5, the authors show that qubit networks with long-range interactions governed by the Hebb rule can be used as quantum associative memories. They claim that the quantum associative memory model presented in this chapter is a first concrete example of the extension potential of the quantum information processing paradigm to "intelligent" tasks.

In Chapter 6, the authors propose a novel evolutionary algorithm for numerical optimization inspired by the multiple universes principle of quantum computing that presents faster convergence time for the benchmark problems. Results show that this algorithm can find better solutions, with less evaluations, when compared with similar algorithms, which greatly reduces the convergence time.

In Chapter 7, the authors illustrate how a quantum-inspired evolutionary algorithm (QIEA) using real number encodings can be constructed and examines the utility of the resulting algorithm on an important real-world problem. The author apply the proposed model to the calibration of an Option Pricing model. The results are robust but comparable to those of other algorithms.

We are very much grateful to the authors of this volume and to the reviewers for their tremendous service by critically reviewing the chapters. The editors would also like to thank Prof. Janusz Kacprzyk, the editor-in-chief of the Studies in Computational Intelligence Book Series and Dr. Thomas Ditzinger from Springer-Verlag, Germany for their editorial assistance and excellent collaboration to produce this scientific work. We hope that the reader will share our excitement on this volume and will find it useful.

January 2008

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