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QUANTUM-INSPIRED EVOLUTIONARY ALGORITHMS IN SEARCH AND OPTIMIZATION

PhD Student: Robert Nowotniak

Supervisor: Prof. Jacek Kucharski

* *Computer Engineering Department*

The Faculty of Electrical, Electronic, Computer and Control Engineering

Technical University of Lodz, Poland

e-mail address: rnowotniak@kis.p.lodz.pl

Abstract:

The presented research concerns a new class of artificial intelligence techniques, drawing inspiration from both the biological evolution and unitary evolution of quantum systems. Intensive studies in this new area (Quantum-Inspired Evolutionary Algorithms) have been conducted since the beginning of the last decade. Quantum computing provides a valuable source of inspiration to create new heuristic methods for searching and optimization. Additional random factors, inspired by the unique quantum phenomena (superposition of states, quantum parallelism, interference, probability amplitudes), introduce a "new dimension" to the evolutionary algorithms. Numerous examples published in recent years have shown that additional random factors in evolutionary algorithms can improve performance of the algorithms in a variety of applications. The current scientific problem is to find effective methods of creating and tuning evolutionary algorithms with the quantum-inspired elements involved on selected stages. The conducted research includes both theoretical considerations and their verification in precisely planned numerical experiments. An attempt has been made to adapt selected existing theories (convergence analysis, building blocks propagation analysis) to Quantum-Inspired Evolutionary Algorithms. Also, the algorithms have been implemented in a GPU-based massively parallel computing environment. As a result, about a few hundred speedup has been gained in comparison to previous sequential implementations of the algorithms. This approach allows effective tuning of the algorithms parameters with modern meta-optimization techniques.