WCCI 2014 Tutorial Proposal: Quantum and Reversible Circuits Design Using Genetic Algorithms

*Martin Lukac**

Tutorial's Abstract

In this tutorial we will present the application of genetic algorithms to the design of quantum circuits. Quantum circuit is one possible representation for algorithms realized in quantum computing and thus designing quantum circuits with minimal number of quantum gates bears importance similarly to the design and minimization of classical circuits in currently available technologies. The tutorial will start by explaining the concepts of quantum information including qubits (units of quantum information), unitary operators (the logic operation applied to qubits), measurement and initialization (tools to transform classical information to quantum information and to retrieve quantum information) and we will illustrate the quantum algorithms by explaining the Deutsch's algorithm. Next we introduce the quantum circuit representation and introduce the various quantum gates used in the synthesis of quantum circuits and we discuss the concept of the cost of the realization of a quantum circuit with respect to the number of used quantum gates. This part will also include the explanation of the ancilla qubits (qubits required to make an arbitrary non reversible Boolean function reversible). We also show how quantum circuits can implement purely reversible Boolean circuits and thus how they can be used to design classical functions such as the universal Toffoli gate or a Majority gate. From this point on we focus on the first on the introduction of genetic algorithm for the design of quantum circuits, the gene representation and the evolutionary operators. We illustrate the evolutionary design by examples and discuss the current problems and future directions in this area.

*Graduate School of Information Sciences,Tohoku University, Sendai, Japan,Email: lukacm@ecei.tohoku.ac.jp