Using a Higher Order Quantum-Inspired Genetic Algorithm to Optimize the Solution to the Knapsack Problem

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Abstract

Although computers have increased in computational ability over the past decade, one category of problems, the NP-Complete problem set, still alludes modern technology. Currently, standard genetic algorithms and machine learning techniques, like neural networks, are used to solve these problems. However, quantum computing, which uses superposition and entanglement to speed up computation, has emerged as a potential solution to these problems. To reduce the time complexity of some NP-Complete problems, specifically the Knapsack Problem, I will utilize a quantum-inspired genetic algorithm that has been modified to run on both the IBM QASM Simulator and the IBM System One Computer. By taking advantage of the IBM Qiskit Toolkit and the computational ability of a quantum computer, I will run 10 generations of the QIGA-2 and expect a better optimization of the knapsack problem. In each generation, the quantum population will be modified by manipulating probability amplitudes and changing mutation constants. After every generation, the rotation of each qubit in the population will be recorded for later use. Based upon preliminary data collected with premature manipulation of amplitudes, the proposed algorithm was significantly better than that of the previous researchers. When comparing the obtained profit values with the highest value from the researchers, the sample mean was significantly higher, around \$7086.29, when compared to \$5907.12. After running a 1-sample T-test, a two-tailed p-value of 0.0054 was obtained and the null hypothesis was rejected. Future experiments would include implementing an advanced method for manipulating amplitudes and finding a real-life application for the proposed algorithm.