Using a Quantum Genetic Algorithm to Optimize the Allocation of Cyber Security Budgets

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Abstract

Although computers have increased in computational ability, one category of problems, the NP-Complete problem set, still alludes modern technology. However, quantum computing, a computational method that utilizes quantum mechanics to overcome the limitation of a two-state system, has emerged as a potential solution. The uniqueness of this researcher's current work starts with optimizing NP-Complete problems, specifically the Knapsack Problem. By taking advantage of the Qiskit Toolkit and the IBM Qasm Simulator, an evolving qubit population was modified using a quantum-inspired genetic algorithm. With a two-tailed p-value of 0.0054 when compared to previous research, the quantum algorithm provided a better optimization of the knapsack problem. However, one caveat of all genetic algorithms is their ability to fall into local maxima. To avoid this issue, the current research implements a disaster algorithm. After implementing this algorithm, without tuned hyper-parameters, the optimization of the knapsack problem increased by 3.75%. Since the proposed new algorithm had significant results, it can be utilized for various applications of the knapsack problem. One novel and concrete application explored by this research deals with the budget allocation for a Small-Medium Enterprise (SME) to minimize the impact of hacker exploits. Using a capture-the-flag model, the known vulnerabilities as well as the confidentiality of the data can be used as inputs to calculate explicit and implicit costs. On top of that, specific controls implemented by SME can mitigate the impact of the exploit, thereby lowering explicit and implicit costs. The new proposed algorithm, and respective application of the knapsack problem, can optimize the mitigation of a given exploit via the implementation of specific controls while remaining under a budget.