Quantum-enhanced selection operators for evolutionary algorithms

Optimization

By Terra Quantum AG
terraquantum.swiss

2022

Quantum-enhanced selection operators for evolutionary algorithms

David Von Dollen, Sheir Yarkoni, Daniel Weimer, Florian Neukart, Thomas Bäck

ABSTRACT

Genetic algorithms have unique properties which are useful when applied to black box optimization. Using selection, crossover, and mutation operators, candidate solutions may be obtained without the need to calculate a gradient. In this work, we study results obtained from using quantum-enhanced operators within the selection mechanism of a genetic algorithm. Our approach frames the selection process as a minimization of a binary quadratic model with which we encode fitness and distance between members of a population, and we leverage a quantum annealing system to sample low energy solutions for the selection mechanism. We benchmark these quantum-enhanced algorithms against classical algorithms over various black-box objective functions, including the OneMax function, and functions from the IOHProfiler library for black-box optimization. We observe a performance gain in average number of generations to convergence for the quantum-enhanced elitist selection operator in comparison to classical on the OneMax function. We also find that the quantum-enhanced selection operator with non-elitist selection outperform benchmarks on functions with fitness perturbation from the IOHProfiler library. Additionally, we find that in the case of elitist selection, the quantum-enhanced operators outperform classical benchmarks on functions with varying degrees of dummy variables and neutrality.

The full article can be found here:
https://dl.acm.org/doi/abs/10.1145/3520304.3528915