Support Programm at IMPA June 05, 2022

Research and Study Intentions

I am eager to continue my scientific activity in the field of quantum computing.

In my 5th semester work, I showed how unstably the ideally simulated VQE and QAOA algorithms work for the traveling salesman problem for 12 qubits. Even without any noise they could not find a feasible solution.

In my last project I implemented the thermal relaxation noise model and used it to demonstrate how local Grover's operator can improve the quantum search algorithm by reducing its circuit depth and thus reducing the effect of noise on the outcome of the algorithm.

It was theorized that we can use the "reset" gate to decrease the depth of the circuit of the unit increment operator. I have shown that it is not possible to effectively use the "reset" gate to reduce the depth of any unitary transformation without using information from the intermediate measurement. However, in some cases "reset" can be used for partial destruction of entanglement, which can potentially lead to less noise exposure.

I intend to continue my study of the effects of noise on quantum circuits. My current tasks are to find a description of the influence of a simple noise model on the quantum search algorithm in terms of density matrix and test the hypothesis that the "reset" in the Shor's algorithm affects its exposure to noise.

The problem of high noise stands in the way of expanding the capabilities of quantum processors. That means that there is a need to use various optimizations: the local Grover operator, error-correcting codes, the use of additional qubits to reduce the depth of the circuit. My project has the potential of finding the most noise-resistant improvements to algorithms and new optimization techniques.

Ultimately, I am interested in the fields of quantum cryptography, quantum chemical simulations and quantum finite automata. My idea is to find an overlap between the potential of quantum computers and the quantum nature of chemical simulations. I already have experience with optimization algorithms, such as VQE and QAOA, which can be used in chemistry simulations. This summer I will be participating in 2022 Qiskit Global Summer School: Quantum Simulations and hope to gain as much experience as I can.

Currently, I have one last year left before receiving a Bachelor's degree from St. Petersburg State University. But I have no supervisor to help me write my dissertation. Ideally, I would like to apply to the Master's degree at IMPA and get my Bachelor's online, if such an option is possible. Or I could complete my last year of Bachelor's degree in Brazil, if you know the right program. As I plan to advance my career in the academical field, after a Master's degree I will be aiming for a Ph.D.

Yours truly,

Ivan Ogloblin

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