Quantum Recognition Using the Quantum Perceptron

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Abstract

In this note, the authors describe a method by which the quantum perceptron can be trained to recognize whether specific genuinely quantum interactions have taken place with its N ions. This could have implications for quantum fault diagnosis and quantum cloning by learning.

Consider a quantum computation [1]. The prepared quantum states are input at the left end, quantum gates operate in the middle, and measurements are performed on the right end. Let there be M lines of quantum states, counting from topmost line to bottom-most line. Let the lowest N lines with $N < M$ belong to the N ions of a quantum perceptron [2]. The perceptron states are prepared along with the rest of the $M - N$ states and the quantum computation proceeds. After a certain amount say x percent of the computation is completed, but before the whole of it is completed, the lowest N lines are taken away from the rest of the computation and the three-step environment voltage of "pre-trained perceptron control" is applied to the ions. The N ions evolve to their final condition, generate an electric field at a distance, the "result," and if the result is not as expected for the particular intervention (x percent), then the entire M lines are halted. Thus much quantum computational expenditure is saved by this early-stage diagnosis.

In future work, we hope to address the training stage. We will also apply this diagnostic procedure to known quantum algorithms, including the modern NISQ ones [3]. The training stage study might suggest that the N ions "acquire" part of the overall quantum state of the upper lines, which gets summarized by the three-step *quperceptron* controlling voltage, and broadcast as a distal electric field pattern. We hope to quantify how much of the upper line state information is captured by the field pattern. Thus in this way the *quperceptron* could be serving as a partial quantum cloning machine.

References

[1] N David Mermin. *Quantum computer science: an introduction*. Cambridge University Press, 2007.

[2] Aman Chawla. A framework for quantum character recognition. March 2024.

[3] John Preskill. Quantum computing in the nisq era and beyond. *Quantum*, 2:79, 2018.