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Short Communication

Exponential Acceleration of Quantum Computing - The Key to Universal Quantum Computer Implementation

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There are a number of fields in computer science and physics overlap. Quantum machine learning, for example, is the main field of crossover between quantum physics and artificial intelligence research. The underlying models of machine learning, such as deep neural networks, have become increasingly complicated and expensive as datasets become more complex. Based on this, the combination of machine learning and quantum computing technology has rapidly become a promising research area in quantum information science. This paper presents a reflective review of the research hotspots in quantum machine learning.

On the one hand, well-designed quantum algorithms such as Harrow Hassidim Lloyd (HHL) Algorithm and quantum principal component analysis can show exponential advantages over traditional algorithms in solving machine learning problems. On the other hand, machine learning can be used to solve more difficult problems in quantum science, such as quantum many-body problems, structure transformation in disordered materials, quantum non-deterministic detection, etc. There are already some applications of quantum machine learning in various fields, despite the fact that the technology is still in its infancy.

The quantum generation adversarial network (QGAN) based on the quantum machine learning framework VQNet can be used to restore human portraits, which is one of the major breakthroughs in this field. Utilizing the parallel computing capabilities of quantum computing, quantum generative adversarial networks can be implemented through quantum circuits, thereby accelerating the training speed of datasets, and improving the accuracy of network models. QGAN broken image restoration application combines quantum generative adversarial network and classical GLCIC network. The network also uses two discriminators, global discriminator and local discriminator, to ensure that the generated images conform to global semantics while maximizing the local clarity and contrast. A quantum machine learning method based on superconducting quantum bits shows its feasibility in this application, which is a significant step forward for quantum computing technologies. Among the more direct applications of quantum generative adversarial networks under epidemic is the system for recognizing people wearing masks in security screening systems.

The properties of quantum computing and machine learning seem to fit well together, but overall quantum machine learning is still in its early stages. The hardware conditions for implementing quantum machine learning algorithms are also not yet in place, and not all classical algorithms can be accelerated by quantum computing. Until a general-purpose quantum computer is built, it is difficult for quantum machine learning algorithms to demonstrate their power in data processing in practical applications. A quantum computer built by Google with 53 quantum bits has achieved quantum superiority by performing the same calculations in 200 seconds that would take a classical supercomputer 10,000 years to achieve. However, the requirement of 1 million quantum bits for a general-purpose quantum computer is still quite far away at this point.

Two main aspects are likely to dominate the development process in the future. In the first place, it makes sense to continue to improve quantum computing's performance and focus on quality while expanding the number of quantum bits. Ascertain a high level of precision and low noise in the experimental session, and minimize crosstalk and noise. In addition, quantum computing is expected to break through thousands of bits within the next five years, but scientists still want to explore the application of quantum computing to areas such as machine learning at the stage of quantum computing with noise, resulting in near-term applications.