


Chapter 2

Access Models for Quantum Computing in Agriculture

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ABSTRACT

In this chapter, we explore access models for quantum computing in agriculture, with an emphasis on cloud-based, on-premises, and hybrid quantum-classical implementations. It defines basic tenets of quantum and how they would be utilized in agriculture areas including crop optimization, supply chain logistics, and climate forecasting. The conversation encompasses contemporary issues such as hardware restrictions, financial obstacles, poor connectivity in remote regions, and fears about data security. Enabling technologies, such as quantum software stack and integration with IoT, are also investigated. Policy and regulatory considerations are also evaluated to promote fair adoption. Lastly, prospects are the sustainable quantum infrastructure and its synergy with the AI and quantum computing for innovation and efficiency in agriculture.

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OVERVIEW OF QUANTUM COMPUTING

Quantum computation is essentially a new kind of computation, a novel way of understanding computational processes, based on quantum mechanics. Quantum computers employ quantum bits or qubits, rather than bits, which are the smallest unit of data in classical computers, which can be 0 or 1. These qubits harness two hallmark phenomena of quantum mechanics – superposition and entanglement – to process data in ways that allow quantum computers to solve problems exponentially faster than their classical counterparts (Biamonte et al., 2017a).

CLASSICAL COMPUTING VS. QUANTUM COMPUTING

Classical computing uses bits that are either 0 or 1. At the end of the day, all remainders of all addition, subtraction, multiplication, store, and, or computations are just tiny, tiny parts of these binary digits. The architecture of classical computers — processors, memory, storage — is specifically designed for such binary operations and has been evolving with clockwork regularity for decades thanks to Moore’s Law, which predicts transistor density will double about every two years (DOI Reserve for Community Guide 019, 2024). Despite this, some complex computational problems (including factorization, optimizing, or simulating molecular interactions) are impractical to solve even on the most powerful, classical supercomputers.

In quantum computing, however the quantum states of physical particles, like electrons or photons, enable computation. These quantum states may also depict 0, 1, or both at the same time (getting superimposed) and this is why quantum computers can process a huge number of possibilities at a time. Moreover, using something called entanglement — when quantum states of two or more particles become dependent on the state of the other, such that the state of one can act as evidence of the state of the other instantaneously — quantum computers are capable of coordinating their qubits in ways that would be impossible for classical bits. These properties allow quantum algorithms to simultaneously investigate multiple solutions and retrieve results more efficiently for some problem classes (DOI Reserve for Community Guide 019, 2024).

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