**Applications of quantum computing**

At this point in time, there are many known applications for quantum computing, Cryptography, Cybersecurity, Drug Development, Climate change, and Artificial Intelligence, to name a few. The possibilities are almost endless for how Quantum Computing will change the world we live in as we know it. (Meyers & Deacon, 2004).

 According to many researchers, the quantum computer will bring about the end for the need for cryptography. This is an unrealistic expectation however, because the current models of the quantum computer have been unable to perform complex calculations without the aid of cryptography. The strength of the current functional quantum computers relies on cryptographic keys and complex mathematical algorithms. (Wright, 2000).

 Quantum computing could pose a threat to the well-established industry of cybersecurity. Once scientists can find a way to bypass the current lack of power needed for the quantum computer models to break encryptions and bypass security measures, the world of cybersecurity will never be the same.

 The drug development industry is going to benefit from the completion and commencement of operation of the quantum computer. Currently drug development is a time consuming that entails the draining process of enhancing the drugs currently accessible and discovering new drugs that could assist the medical field and provide health enhancements for humanity.

 It has been rumoured that the development of the quantum computer would be a key factor in the production of climate-changing agents that could potentially reverse centuries worth of damage, allowing humanity to rethink our choices and save our dying planet. With the aid of the quantum computer, we would not only be able to reverse but also redirect the damage done to the earth into a useful resource, potentially a resource like energy (Cassella, 2017). A lot of this is still speculation of course and will only be confirmed and or denied upon the completion of the quantum computer.

 Artificial Intelligence will be one of the applications that will benefit from the quantum computer the most. The combination of the similar characteristics of Artificial Intelligence and the quantum computer would prove beneficial to the advancement of technology. AI combined with quantum computing could also potentially prove beneficial to the financial sector.

*In the financial sector, the combination of AI with quantum computing may help improve and combat fraud detection.* (Lorenzo, 2020)

It seems we should not get too excited for the completion of a full scale, impervious quantum computer just yet because it seems scientists are still a way off from properly executing this phenomenon entirely. The computer scientists of the world are in a race to successfully create the first meaningful quantum computer. Statistically speaking such a feat will take another ten years to accomplish, however, an article from Scientific American, states,

*IBM, Microsoft, Google, Intel, and other tech heavyweights breathlessly tout each tiny, incremental step along the way (Greenemeier, 2018).*

These tech companies are vying for the first position. They are paving the way to the advancement of the world and hopefully soon we will bear witness to the development’s quantum computing has to offer the world.

**Models of quantum computers**

At present there are many models of the quantum computer available. The models have been classed, to separate their functions. The models being explored now are the mathematical, machine, circuit, and the algorithmic models. (Ömer, 2003). The progress models developed all over the world include, the quantum Turing machine, quantum circuit model, one-way quantum computer, and the adiabatic quantum computer.    The models that have been developed revolve around the most established physical implementations of the quantum computer, which are digital and analog.

The quantum Turing Machine is a quantum adaptation of the original Turing machine developed as a mathematical model of computation. The principle behind the QTM is to replace bits with qubits. The QTM is hoped to provide a measure for execution times, to speed calculation processes. This application could potentially move computational mathematics forward decades.

Quantum circuits, another application in development, are the quantum computer equivalent to classical Boolean feed-forward networks. Essentially, the quantum circuits would carry out matrix operations on quantum bits. Quantum circuits make use of basic quantum gates. Fundamentally, the use of quantum gates makes the manipulation of the quantum system less time consuming and more cohesive. Examples of quantum gates include the Not (N) gate, Hadamard (H) gate, and the Control-Not (CN) gate. (Yi-Lin Ju, 2007)

The one-way quantum computer, also known as the measurement-based quantum computer, (MBQC). This model of the quantum computer relates deeply to the aforementioned Quantum Circuit Model. This concept is still in the experimental stages. The one-way quantum computer notion would convey the implementation of qubit measurements used to alter the quantum circuit, thus destroying the connections it has at the same time. (Raussendorf, 2001)

Adiabatic quantum computing (AQC), is another form of quantum computing that relies on the adiabatic theorem, which is a concept in quantum mechanics, to do calculations (Anon., 2020). AQC was developed to assist with the reduction of time spent and increase the accuracy of problems, and it has since evolved to be an important application of universal importance. AQC deals with various aspects of complex computational theory, and thus despite being incomplete in its not being the final model of the quantum computer, it has proved very useful and important with the research and further development of the final quantum computer. (Albash, 2016)

**Mathematical Aspect of Quantum Computing**

The mathematical model of the quantum computer describes quantum bits, also known as qubits. The mathematical model is needed for measuring devices and their interaction with quantum bits.

*The precise nature of these mathematical formalisms provides a means of working with quantum concepts before fully understanding them. Intuition for quantum mechanics and quantum information processing will develop from playing with the formal mathematics. (Polak, 2011)*

The mathematical side of quantum computing has been nicknamed q-processing or q-computations. The mathematics of quantum computing deals with various mathematical applications, from complex linear algebra to basic probability theory. The mathematical approach has been groundbreaking thus far, due to the tireless work of engineers, physicists, and mathematicians at the frontline of this development. (Juanjo Rué, 2011)

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