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The Dimensions of Quantum Computing

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Dimensions of Quantum Computing

Introduction

Generally, we think of computers as processing data through a sequence of ones and zeros as has been the case for many years. This has drastically improved the rate at which we can share and receive information, but there is still room for faster processing. This is where quantum computing comes in. These computers are unique because, rather than relying on specific binary bit sequences, they use what are known as qubits Rather than solely representing a 1 or a 0, qubits can also represent "any combination of both 0 and 1 at the same time" (Atkinson, 2020). This versatility allows the quantum computer to process a greater quantity of data at a much faster speed than a classical computer. While many see quantum computing as a cutting-edge form of computing that is out of our current reach, advances in the field have brought it closer to reality and perhaps eventually into everyday use.

Experts such as Jim Clarke, director of quantum hardware at Intel Labs, agree that the creation of quantum computing could be just about ten years away from being produced on a mass scale although others believe major advances could come much sooner (Greenemeier, 2018). Although the exponential data processing abilities of quantum computers are generally viewed as a positive change, an inability to adapt could prove fatal to our current encryption capabilities. This paper will outline the several aspects of quantum computing technology including: its current use, security aspects, ethical and social implications, and future use. First, let's look at how quantum computing is currently being used.

Current Use

Despite quantum computing still only exists in academic labs, there has still been quite a bit of speculation as to what it can be used for in the future. Researchers believe that it would be

best put to use within the context of biotechnology, drug manufacturing, and more general manufacturing just to name a few (Leprince-Ringuet, 2020). Because of the widespread potential use of quantum computing, large scale corporations like ExxonMobil among numerous other companies have been pursuing partnerships with companies like IBM to conduct research into how machines with quantum capabilities may be able to increase the efficiency of production lines and the quality of products in general (Leprince-Ringuet, 2020).

One of the major issues faced by computer scientists in terms of quantum computing is the fragility of the machines. If someone were to bump into an early-stage quantum computer or if say the ground shook, it would likely fail to transmit entire sequences of data as a result (Greenemeier, 2018). One of the ways researchers have gone about addressing this issue is by keeping the computers at sub-zero temperatures which appear to have a stabilizing effect (Greenmeier, 2018). The freezing method described here appears to work consistently but would still be difficult to implement on a mass scale due to how constant and low the temperature needs to remain at all times. While challenges like these may stump researchers now, innovation can be sudden and would considerably shorten quantum computing's path to everyday use. Now that we have discussed the current use of quantum computing, we will discuss the security aspects of the technology.

Security Aspects

One of the major concerns regarding quantum computers is the idea that these computers would be able to encrypt information faster than humans would be able to comprehend or decipher it. This potential would make it much easier for a computer to steal personal information before the victim even has time to do anything about it. The risk is even greater when we consider the fact that, if a quantum computer can decrypt information, it would have

access to some of the most of common actions we take on the devices we use such as sending emails, downloading software updates, using online banking, among many other actions so common that we often take them for granted (Totzke, 2017).

It is also important to note that quantum computing would likely render our current encryption systems obsolete which could be fatal to individual, national, and even global information privacy if not dealt with (Totzke, 2017). This is why many experts say that it is crucial that we transition to a standard quantum encryption system before quantum computers reach the mass market (Totzke, 2017). If we are able to make a collective switch over to a quantum computing network over a classical one before individual devices have quantum capabilities, then quantum computing will likely result in a drastic increase in the strength of encryption even on the weakest levels of encryption because of the speed and efficiency the technology would be capable of (Rosales, 2019). Having talked about the security aspects of quantum computing, we will now look at the technology's ethical and social implications.

Ethical and Social Implications

If quantum computers can process information faster than humans are capable of deciphering it, the computer has a certain power over us weakening the control we have over it and the information it can withhold from us. This risk likely belongs more in the category of artificial intelligence, a field which is advancing at an even faster rate than quantum computing. It is difficult to say whether we will be able to control artificial intelligence which has quantum capabilities especially if computers are able to reach a state comparable to sentience. The potential dangers of quantum computing are further legitimized by the fact that the Government Accountability Office (GAO) released a report in 2020 classifying the technology as "one of the long-term emerging threats facing the United States" (Atkinson, 2020).

It is also worth considering that quantum computing may drastically alter the way we think about and use the internet and technology in general. This could perhaps make it difficult for older generations to adapt to the new technologies that may arise as a result. Equally if not more important is the fact that quantum computing, especially when it is a new technology on the market, will likely only be available to wealthy individuals who can afford it creating a critical social and communication gap between rich and poor which is already a widespread issue with current technology (Atkinson, 2020). Moving on from ethical and social implications, we will now discuss the future use of quantum computing.

Future Use

Ideally, quantum computing can eventually be incorporated into countless areas of our daily lives making everything we do and need to do as convenient for us as it can possibly be. Given quantum computing's speed and efficiency with data, it is likely that computers will be able to replace humans in a variety of different professions. Some of these include clerks, cashiers, bankers, certain forms of entertainment, and several other professions (Galeon, 2017).

Although it will be applicable to nearly every profession, it is unlikely quantum computing would be able to take over the human element of fields like healthcare without compromising patient comfort. Although the job market is evolving with and in response to technology, it is important to consider how much advances like quantum computing will be able to do with greater efficiency than we ourselves can.

Most if not all of these potential changes rely on the assumption that researchers will find a way to make quantum computing accessible to the general public which could potentially turn into a social issue as discussed in the corresponding previous section of this paper. Some possible and highly probable solutions to this obstacle are the development of computer chips

which possess quantum computing capabilities as well as the implementation of quantum computing onto cloud services similar to those currently run by companies like IBM and Google (Galeon, 2017). While these solutions appear to be highly plausible, it is important to note that innovations, along with advancing researchers' general knowledge of their fields, can also bring about unforeseen challenges and obstacles that force experts to reevaluate their projections about the field.

Conclusion

For those of us living now, it is best that we start imagining and planning for a post quantum computing world considering how many different facets of life it is bound to affect. Whether quantum computing affects business production, encryption, the job market, the division between rich and poor, or even the way we use technology in general, it is most likely going to stay and is not going away anytime soon. While we cannot fully account for what quantum computing will change about the future of our world, it is definitely a topic we should all take interest in because it will most likely become a part of our individual and collective existence regardless of whether or not we want it to. Quantum computing, in many ways, has the potential to be the technology of nearly everything in our future which is something to look forward to rather than try to prevent from happening. Even though asking people to become aware of the potential of quantum computing may seem like a minor task with few short-term effects, doing so will make us better equipped to handle this new technology and ultimately able to utilize it well or else it may evolve into something that cannot be easily controlled.

References

Atkinson, D. (2020). Quantum computing: The promises and potential perils. *Computer and Internet Lawyer*, *37*(1), 4–15. Retrieved February 8, 2021, from https://search-proquest-com.mutex.gmu.edu/trade-journals/quantum-computing-promises-potential-perils/docview/2336258556/se-2?accountid=14541

This reference is relevant to my research because it gives me a balanced argument about the topic that weighs the pros and cons of quantum computing. This is critical for creating a strong essay as it shows the whole range of arguments regarding quantum computing and personal information without favoring one side over the other. Although I will likely develop my own opinion on quantum information as it relates to privacy as I conduct more research, it is best to consult balanced references like this to get started. Even though it may seem like one is presenting relatively objective information on the surface, when one analyzes the information they present, it may be more skewed to one perspective over another. This is why articles like this one are so important for research on any topic.

Galeon, D. (2017). Here's what a world powered by quantum computers looks like. *Futurism.* Retrieved February 12, 2021, from https://futurism.com/future-quantum-computer

This article is important because it takes a future perspective towards the topic of quantum computing. Not only does it assess where the technology currently stands but it also provides potential innovations that could occur. This also leads the author to discuss what it would take for those innovations to occur and how likely it is that they will be surpassed. Although quantum computing as a concept is still somewhat in the future, it is always helpful to look as far ahead as possible to be as informed as possible preceding a major innovation in a

field especially one like computer science. For these reasons, this article is an important addition to this paper's research.

Greenemeier, L. (2018). How close are we -really- to building a quantum computer? *Scientific American*. Retrieved February 12, 2021, from https://www.scientificamerican.com/article/how-close-are-we-really-to-building-a-quantum-computer/

This source was especially valuable because, beyond acting as a succinct overview of what quantum computing is, it also includes an interview with an expert on the subject. Because of the variety of questions asked, the reader is given an honest assessment of the current state of quantum computing regarding numerous dimensions of the subject. Also, given the style of the interview, the expert's answers are less obscured by technical jargon which can certainly be an obstacle to understanding within the field of computer science. The goal of the expert during this interview, and with Scientific American in general, is to make these complex concepts accessible for a general audience. Given all of the above reasons, this article is an incredibly valuable resource for this paper.

Leprince-Ringuet, D. (2020). Quantum computers are coming. Get ready for them to change everything. *ZDNet*. Retrieved February 12, 2021, from https://www.zdnet.com/article/quantum-computers-are-coming-get-ready-for-them-to-change-everything/#:~:text=One%20example%3A%20by%20simulating%20molecular,manufacture%20fertilizers%20with%20better%20yields

While this article initially focuses on quantum computing within the context of a small company, it then expands into the broader reactions that other fields especially business have had

to the potential of quantum computing. This is perhaps an overlooked dimension of this topic but it is important nonetheless. Understanding how industries are reacting to the development of quantum computing gives insight into the potential of it as an everyday form of technology as well as the extent to which companies will trust it as it becomes more of a reality. Along with the business interests brought in by quantum computing, this article also discusses some potential uses for the technology in specific materials in which the presence of the technology would make said material more efficient. For these reasons, this article is a critical component of the research for this paper.

Rosales, M. (2019). Quantum computing and the threat to classical encryption methods. *ProQuest Dissertations Publishing*, *1754*. Retrieved February 8, 2021, from https://search-proquest-com.mutex.gmu.edu/dissertations-theses/quantum-computing-threat-classical-encryption/docview/2377973371/se-2?accountid=14541

This reference is relevant to my research because it gives me some historical context as to what exactly quantum computing changes about previously established computing methods. Encryption is essential for the sharing of any personal information online and being able to understand how encryption traditionally works and how that will change will give me useful insight to incorporate into my research. This article will also help me understand the technical aspects of quantum computing more than I did previously. Understanding the historical roots of quantum computing gives important context to the developments which are currently being made surrounding the technology. For this reason, this paper is important to take into account for this paper's research.

Totzke, S. (2017). How quantum computing increases cybersecurity risks. *Network World*. Retrieved February 8, 2021, from https://search-proquest-com.mutex.gmu.edu/trade-

journals/how-quantum-computing-increases-cybersecurity/docview/1901442148/se-2?accountid=14541

This reference is relevant to my research because it focuses specifically on the cybersecurity angle of quantum computing. Specifically, the author looks into the ethical side effects of quantum computing which is an interesting dimension of this topic I didn't initially think of but which seems like a good addition to the areas my research will cover. Also, since cybersecurity is a specific field within itself, this reference will help me to start looking into how opinions on quantum computing change across disciplines. Cybersecurity is the realm that most of the legal concerns surrounding quantum computing will be rooted in. This especially makes this article important to the research for this paper.