Quantum computing is a topic that is not being discussed enough amongst the general public even though it can revolutionise the entire prospect of the world. It can solve the current energy crisis, then further solving climate change. It can also transform the development of drugs and materials. It can affect several aspects of our daily lives but what is quantum computing?

First, let’s look back. The idea of quantum mechanics, the basis of quantum computing, has been around since 400BC. It was introduced by an Ancient Greek philosopher, Democritus. He believed that the entire universe is made up of atoms in a void that are always moving around because of some predetermined and understandable laws. Furthermore, he thought these atoms can hit and bounce off each other or even stick together to make bigger things which can be known as molecules now (Aaronson, 2013). It is obvious to see that this Ancient Greek philosopher has a pretty modern view of science and he is often accredited for his formulation of the theory of atoms in the universe. Fast forward a couple of thousand years, the concept of quantum computers was brought forward around the late 1970s and early 1980s. The name Richard Feynman is often brought up. He observed that particular quantum mechanical operations cannot be operated on classical computers (Polak & Rieffel, 2000). This just means that the computers that we are familiar with aren’t capable of computing in the quantum realm, this is still true even with the technology we have today. However, many scientists have anticipated this idea. Paul Benioff was one of these scientists. He released a paper in 1979 that exhibited the theory of quantum computing and suggested that a quantum computer could be created. There is also Yuri Manin who displayed the core idea of quantum computing in his book *Computable and Non-Computable* published in 1980 which was written in Russian and wasn’t translated until later (Gruska, 1999). It’s quite interesting to think that the concept of quantum computing is relatively ancient, yet it still manages to be a modern notion.

To completely comprehend what quantum computing is, the basics are to be understood. First, it is to know what classical computing does. The computers everyone is very familiar with are models of classical computing, but there are supercomputers that are of a higher-level performance that still follow classical computing. The rudimentary building block of a computer, the bit, can store information and be represented logically by a zero, meaning off, or a one, meaning on (Bone & Castro, 1997). Then understand that quantum computing is a simulation of quantum mechanics. This deals with the behaviour of atoms and fundamental particles like electrons and photons. The sight can further be extended to the likes of molecules which are a group of atoms bonded together.

Thinking about the molecule for caffeine allows further inspection in this aspect. With the existence of supercomputers, it is understandable to think that this molecule can be taken and represented exactly in a computer. However, it is near impossible to do so on a classical computer. This is because the amount of bits that store the information of a caffeine molecule possibly sums to roughly ten per cent of the number of atoms in the entire world (Sutor, 2020). With a quantum computer, you can represent this molecule with quantum bits or qubits for short. These can exist in the classical position of either 0 or 1, however, it can be in a state where it is both 0 and 1. This is called superposition. This state can be taken advantage of. Operating on a singular qubit, essentially performs the operation on both values simultaneously. Increasing the number of qubits can exponentially increase this ‘quantum parallelism’ obtained from the system (Bone & Castro, 1997). Trying to determine whether the qubit is 0 or 1, will collapse the superposition, forcing the qubit to be either zero or one but the outcome is seemingly random. This is called decoherence. Scientists don’t completely understand what happens but there are a lot of theories trying to explain this. In the eyes of scientists like Bone and Castro (1997), the universe is split into two parallel universes where the qubit exists as 0 in 1 universe and one in another. Unfortunately, the very reliance of the bizarre subatomic rules of quantum mechanics makes quantum computing difficult to control and fragile. Furthermore, electromagnetic waves and the temperature needs to be accounted for because it can possibly interfere with the quantum computer. Therefore, the environment must be acutely controlled (Sutor, 2020).

The science is immature and a multi-purpose quantum computer doesn’t yet exist. But that isn’t stopping investors pouring cash into quantum start-ups. (Gibney, 2019)

This perfectly describes the current state of quantum computing. We are in in a ‘quantum gold rush’ even though this industry is in its very early stages. By the beginning of this year, at least fifty-two companies globally have been funded for their quantum- technology. In 2017 and 2018, these companies received at least $450 million in private funding and venture capital took up most of this money (Gibney, 2019). Venture capital, in layman’s terms, is essentially investments in private but young companies (Kortum & Lerner, 1998). This money alone excludes large companies like Google, IBM and Alibaba, that are taking apart in this international quantum race. As Machnes said on TEDx Talks (2020), we are in the 1950s of quantum computing but it is a big deal that so much money is being invested into this. The 1950s refers to a time when classical computers were only coming about and so the machines built are big, clunky and there’s a lot of wires all over the place. This is akin to the current state of machinery needed for quantum computers. To note, the quantum chips holding these qubits need to be colder than interstellar space. The temperature is brought down to a degree just about absolute zero, this is about -273 degrees in Celsius (Narasimhachar, 2015). Even with these limitations, companies like Google and IBM have constructed quantum computers. Surprisingly, anyone can code on a quantum computer right now. IBM has made a 5 qubit, quantum computer available for free online. Under the name “IBM Quantum Experience,” there is a web interface that presents videos and tutorials for anyone at home who was interested.

On important news for quantum computing, on October 23rd, 2019, Google announced that they have achieved ‘quantum supremacy’ on the scientific journal *Nature*. This is the moment when a quantum computer has outstripped the capability of the world’s largest supercomputer for certain tasks. Google’s scientists claimed that their 53 qubit quantum processor, dubbed Sycamore, took two hundred seconds to perform a completely arbitrary mathematical operation that would take supercomputers 10,000 years (Arute, et al., 2019). However, IBM took issue with the findings. They announced that this task can be performed in 2.5 days and not the 10,000 years, with greater reliability (Pednault, et al., 2019). Even so, this is an incredible milestone for the field of quantum computing and with this, it will continue to build hype for a near science-fiction future.