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Quantum Artificial Intelligent Machines

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This paper overviews the basic principles and recent advances in the emerging field of Quantum Computers highlights its potential in fabricating "Artificial Intelligent Machines". The paper provides a very brief introduction to basic Quantum computer base phenomenon like Quantum Entanglement, Quantum Tunneling, Superposition and it presents references, ideas and research guidelines on how quantum computers can be used to deal with major AI problems such as Machine Learning in AI Machines.

Keywords: Quantum Computer, Quantum Entanglement, Quantum Tunneling, Artificial Intelligence

I. INTRODUCTION

Quantum Computers

Quantum Computer is a computer that makes direct use of quantum-mechanical phenomena, such as superposition and entanglement, tunnelling and multi-verse to perform operations on data. Quantum computers unlike classical computers that use digital electronics based on transistors can have only two states (0 or 1). Quantum computation is analog and uses quantum bits, also called qubits which is a superposition of binary digits (0 and 1). Qubit exist in the nexus of both bits. Qubit can have both values 0 and 1 at the same time. You can imagine it as a superposition of two different binary bits existing in a multiple universe, just as two identical people in two parallel universes, where one is slept and one is awake. Now by making use of these qubits we can increase the speed of our computing exponentially and it would be a huge leap in the era of computing. The field of quantum computing was initiated by the work of Paul Benioff and Yuri Manin in 1980, Richard Feynman in 1982, and David Deutsch in 1985. A quantum computer with spins as quantum bits was also formulated for use as a quantum space–time in 1968. The cryptography algorithms based on factorization that before could have taken a year to crack will now be cracked in a few minutes.

The comparison between quantum computers and classical computer is inappropriate. It's just as comparing the speed of a horse and a fighter plane; both of them have different domains of speed of their own. Just like a horse can't run at 250km/s, a plane can't fly at a low speed of 100km/s. You can imagine a operation performed on 300 digital binary bits in a classical computer while the operation performed on the same data in quantum computer will be on 2 raised to the power 300 and that would be 2.037035976334486086268445688409e+90. So from the above given conclusion you can imagine the rate of increase of pace in computing. This "quantum superposition", along with the quantum effects of entanglement and quantum tunnelling, enable quantum computers to consider and manipulate all combinations of bits simultaneously, making quantum computation powerful and fast.

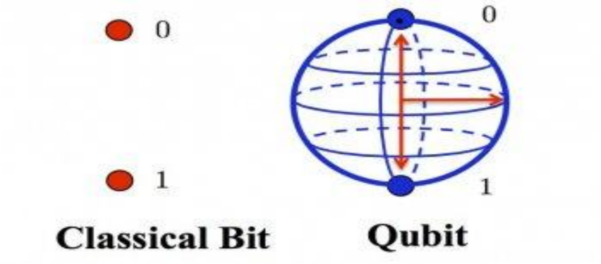

Figure 1[5]

Quantum computers can't work on algorithms that uses algorithm designed on and for classical computer since it uses binary digits, which is high or low, 0 or 1, true or false at an instance of time. We would need to redesign or refine our algorithms that can work on qubits. Large-scale quantum computers would theoretically be able to solve certain problems much more quickly than any classical computers that use even the best currently known algorithms, like integer factorization using Shor's algorithm or the simulation of quantum many-body systems. There exist quantum algorithms, such as Simon's algorithm, that run faster than any possible probabilistic classical algorithm. Quantum computers share theoretical similarities with non-deterministic and probabilistic computers. Given sufficient computational resources, a classical computer could in theory simulate any quantum algorithm, as quantum computation does not violate the Church–Turing thesis.

Is it still difficult to understand qubits? Imagine a cat inside a box, closed from all four sides. Now a viewer is told that there is a cat inside a box, this will make the viewers mind to run in all four directions, now the cat inside the box may be dead or alive, if alive it can be sleeping or awake, it can be a black cat or a white, there exist many possibilities in which the cat may exist. Similarly is the case with states of a particle.

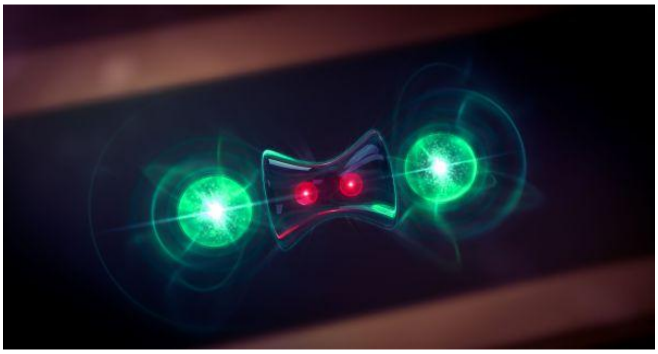

Figure 2[6]

QUANTUM ENTANGLEMENT another phenomenon involved in the creation of quantum computers. Quantum entanglement is a physical phenomenon that occurs when pairs or groups of particles are generated or interact in ways such that the quantum state of each particle cannot be described independently of the others, even when the particles are separated by a large distance – instead, a quantum state must be described for the system as a whole. Measurements of physical properties such as position, momentum, spin, and polarization, performed on entangled particles are found to be appropriately correlated. For example, if a pair of particles are generated in such a way that their total spin is known to be zero, and one particle is found to have clockwise spin on a certain axis, the spin of the other particle, measured on the same axis, will be found to be counterclockwise, as to be expected due to their entanglement. However, this behavior gives rise to paradoxical effects: any measurement of a property of a particle can be seen as acting on that particle (e.g., by collapsing a number of superposed states) and will change the original quantum property by some unknown amount; and in the case of entangled particles, such a measurement will be on the entangled system as a whole. It thus appears that one particle of an entangled pair "knows" what measurement has been performed on the other, and with what outcome, even though there is no known means for such information to be communicated between the particles, which at the time of measurement may be separated by arbitrarily large distances[1].

Such phenomena were the subject of a 1935 paper by Albert Einstein, Boris Podolsky, and Nathan Rosen, and several papers by Erwin Schrödinger shortly thereafter, describing what came to be known as the EPR paradox. Einstein and others considered such behavior to be impossible, as it violated the local realist view of causality (Einstein referring to it as "spooky action at a distance") and argued that the accepted formulation of quantum mechanics must therefore be incomplete. Later, however, the counterintuitive predictions of quantum mechanics were verified experimentally. Experiments have been performed involving measuring the polarization or spin of entangled particles in different directions, which – by producing violations of Bell's inequality – demonstrate statistically that the local realist view cannot be correct. This has been shown to occur even when the measurements are performed more quickly than light could travel between the sites of measurement: there is no light speed or slower influence that can pass between the entangled particles. Recent experiments have measured entangled particles within less than one hundredth of a percent of the travel time of light between them. According to the formalism of quantum theory, the effect of measurement happens instantly. It is not possible, however, to use this effect to transmit classical information at faster-than-light speeds (see Faster-than-light § Quantum mechanics).

QUANTUM TUNNELLING refers to the quantum mechanical phenomenon where a particle tunnels through a barrier that it classically could not surmount. It has important applications to modern devices such as the tunnel diode and quantum computing, Tunneling is often explained using the Heisenberg uncertainty principle and the wave–particle duality of matter. Pure quantum mechanical concepts are central to the phenomenon, so quantum tunneling is one of the novel implications of quantum mechanics. Tunneling occurs with barriers of thickness around 1-3 nm and smaller, but is the cause of some important macroscopic physical phenomena. For instance, tunneling is a source of current leakage in very-large-scale integration (VLSI) electronics and results in the substantial power drain and heating effects that plague high-speed and mobile technology; it is considered the lower limit on how small computer chips can be made[2].

This process cannot be directly perceived, but much of its understanding is shaped by the microscopic world, which classical mechanics cannot adequately explain. To understand the phenomenon, particles attempting to travel between potential barriers can be compared to a ball trying to roll over a hill; quantum mechanics and classical mechanics differ in their treatment of this scenario. Classical mechanics predicts that particles that do not have enough energy to classically surmount a barrier and will not be able to reach the other side. Thus, a ball without sufficient energy to surmount the hill would roll back down. Or, lacking the energy to penetrate a wall, it would bounce back (reflection) or in the extreme case, bury itself inside the wall (absorption). In quantum mechanics, these particles can, with a very small probability, tunnel to the other side, thus crossing the barrier. Here, the "ball" could, in a sense, borrow energy from its surroundings to tunnel through the wall or "roll over the hill", paying it back by making the reflected electrons more energetic than they otherwise would have been.

FASTER THAN LIGHT It is possible for spin zero particles to travel faster than the speed of light when tunneling. This apparently violates the principle of causality, since there will be a frame of reference in which it arrives before it has left. However, careful analysis of the transmission of the wave packet shows that there is actually no violation of relativity theory. In 1998, Francis E. Low reviewed briefly the phenomenon of zero time tunneling. More recently experimental tunnelling time data of phonons, photons, and electrons have been published by Günter Nimtz.

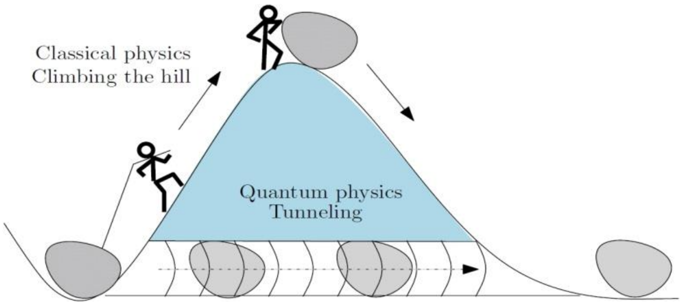

Figure 3[7]

D-Wave-II CEO and founder Geordi Rose predicted that with the help of D-Wave quantum computer we will be able to found another earth with same atmosphere and water and that within the 40 light years of earth[3].

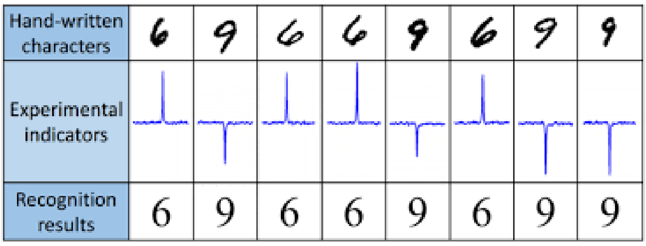

Figure 4[8]

"We are given a biased coin that comes up heads with probability p. Using this coin, construct an unbiased coin."
— Scott Aaronson, Quantum Computing since Democritus

II. QUANTUM ARTIFICIAL INTELLIGENT MACHINES

Quantum computers uses analog computation, this property of considering all possible values along with the probability of their existence and determining the lowest and highest possible energy value to make the most optimum decision, make them the best choice for building artificial intelligent machines. If we can do all that we can build a machine capable of choosing the best option of all. A machine that can traverse the decision tree is the same as several identical person living in the parallel universes making different decisions in the ongoing life. It can make the best out of the circumstances just like watching several of yourself and considering all of there decision to choose the best outcome. The robots of such caliber as human being will be able to work in critical situations as mines and industries involving poisonous chemicals. They can go to outer space and inspect the portions out of reach of manned space missions. Machine can be taught to recognize human behavior and habits from there handwriting to stimulating human emotions.

III. ACHIEVEMENTS

D-Wave Two, a quantum computer designed and created by D-Wave, consisting of 512 qubits. A joint initiative by Google and NASA to utilize the capabilities of D-Wave-II to pioneer research on how quantum computing might help[3].

Google's engineers achieved a milestone in quantum computing: they've produced the first completely scalable quantum simulation of a hydrogen molecule.
That's big news, because it shows similar devices could help us unlock the quantum secrets hidden in the chemistry that surrounds us.
Researchers working with the Google team were able to accurately simulate the energy of hydrogen H2 molecules, and if we can repeat the trick for other molecules, we could see the benefits in everything from solar cells to medicines.
These types of predictions are often impossible for 'classical' computers or take an extremely long time – working out the energy of something like a propane (C3H8) molecule would take a supercomputer in the region of 10 days.
To achieve the feat, Google's engineers teamed up with researchers from Harvard University, Lawrence Berkeley National Labs, UC Santa Barbara, Tufts University, and University College London in the UK.
"While the energies of molecular hydrogen can be computed classically (albeit inefficiently), as one scales up quantum hardware it becomes possible to simulate even larger chemical systems, including classically intractable ones," writes Google Quantum Software Engineer Ryan Babbush[4].
Chemical reactions are quantum in nature, because they form highly entangled quantum superposition states. In other words, each particle's state can't be described independently of the others, and that causes problems for computers used to dealing in binary values of 1s and 0s.
Enter Google's universal quantum computer, which deals in qubits – bits that themselves can be in a state of superposition, representing both 1 and 0 at the same time.
To run the simulation, the engineers used a super cooled quantum computing circuit called a vibrational quantum Eigen solver (VQE) – essentially a highly advanced modeling system that attempts to mimic our brain's own neural networks on a quantum level.

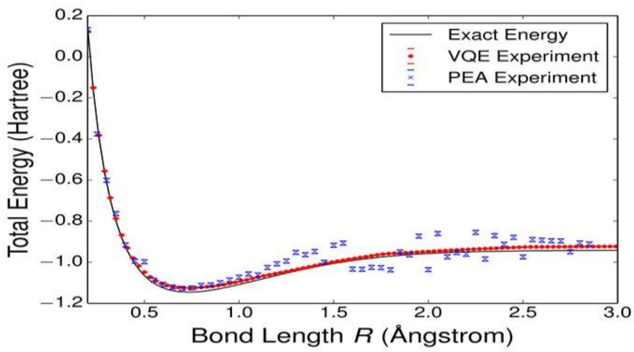

Figure 5[9]

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