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Role of Quantum computing in Cancer diagnosis

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Abstract

Diagnosis and exact recommendation for a cancer patient is very much sensitive and of greater influencing in cure of this diseases. Traditionally the diagnosis procedure was very time consuming and not so accurate, Quantum computing, which promises to provide far greater calculation capacity than traditional computers, could help to solve highly complex problems in the health sector, especially in the treatment of cancer. In this paper, the role of quantum computing in cancer diagnosis, future of cancer research and the significance of computational speed of quantum computer and horsepower has been given.

Keywords: Quantum computing, Cancer diagnosis, Shor algorithm, Quantum computer

INTRODUCTION

With its extraordinary computing power, a quantum computer is potentially able to solve highly complex problems, in particular optimisation issues. In the field of healthcare, quantum computers will "make it easier to analyse genetic information and identify a person's genetic heritage applications for "Researchers will then be able to use this information to decide on treatment options."

WHAT IS A QUANTUM COMPUTER?

The celebrated physicist Richard Feynman used to say: "If you think you understand quantum mechanics, then you don't." That's not a bad introduction as we try to unravel how quantum computers work.

Unlike a classical computer, which solves problems one after the other in sequence, a quantum computer is designed to solve multiple problems simultaneously. A classical computer has a memory made up of ‘bits’ of information, based on a binary system in which each ‘bit’ takes the value 1 or 0. A quantum computer however has what are known as ‘qbits’, each of which may represent the value 1, 0, or any quantum superposition of those two qubit states, which means that a quantum computer enables calculations to be carried out in parallel.

Take for example two classical computer bits. The two bits may in sequence – i.e. NOT simultaneously – take the following pairs of values: 0-0, 0-1, 1-0 and 1-1. In contrast, a quantum computer may simultaneously take all of these values. This means that with two qbits you can carry out four operations, compared with the two operations which a traditional computer can perform with two bits. L’Atelier’s more mathematically-inclined readers will recognise the general rule that with n qbits, a quantum computer may be in a quantum superposition of 2^n states and will thus possess the capacity to solve that number of problems simultaneously. This is the intriguing promise of quantum computing; a world where calculations and algorithms are processed by applying the principals of quantum mechanics

A. Quantum Computing – Cancer Diagnosis

Radiation therapy is the most widely-used form of treatment for cancers. Radiation beams are used to destroy cancerous cells or at least stop them multiplying. In practice, doctors use a linear particle accelerator, to decide on the best possible radiation dose, its level of intensity and the specific point at which the beams need to be targeted, while at the same time minimising the side-effects on the patient.

These calculations are currently made by a medical dosimetrist who uses advanced software to work out the right dosage. The software cannot however guarantee an optimal result there are too many variables to take into account. Moreover, neither the software nor traditional computers have the capacity to test all possible solutions.

That is precisely where quantum computing comes in. As it is geared to coping with a huge number of parameters, a quantum computer should be able to work out the best possible treatment for a given patient, achieving not only a more precise result but, in theory, much faster as well.

.B. Understanding the structure of proteins

Proteins are the basic building blocks of life. They are made up of amino acid chains which fold back on themselves to form three-dimensional structures. The function of each protein is thus determined by both the composition of the molecule chains created by the chemical constituents and the fold structure. Malfunction of a given protein is frequently due to its being wrongly folded.

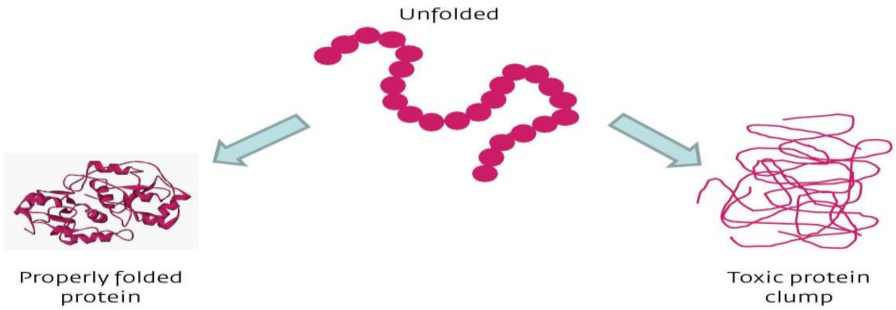

Fig.1 Structure of Protein

While the chemical composition of proteins is quite well known, their physical structure is much less well understood, due to the extremely high number of possibilities. Obtaining more detailed knowledge of the way proteins are folded will therefore lead to greater understanding of human life and to the development of new therapies and medicines.

Here again, a quantum computer will in theory be able to simultaneously test a huge number of possible protein fold structures and identify the most promising ones much more rapidly than any traditional computer. Quantum Shor algorithm is used for predicting the folding patterns for lattice protein folding models.

A quantum computer provides a technique that enables medical researchers to model protein folding. The latest research indicates that nature optimises the amino acid sequences so as to create the most stable protein. Simulating the folding of proteins could lead to a radical transformation of our understanding of complex biological systems and our ability to design powerful new drugs.

This application looks into how to use the quantum computer to explore the possible folding configurations of these interesting molecules. With an astronomical number of possible structural arrangements, protein folding in an enormously complex computational problem. Scientific research indicates that nature optimizes the amino acid sequences to create the most stable protein - which correlates well to the search for the lowest energy solutions.

C. The Future of Cancer Research?

In the hands of cancer researchers, a quantum computer that can outrun the computational speed of tens of thousands of traditional super computers would rapidly accelerate the pace of research in "genomics, genetics, radiation physics, and biomedical imaging,"

This creates a backlog of research waiting to be performed; however, a computer running at quantum speed would accelerate complex research, which would be a positive development for cancer researchers who are looking for a faster result that will ultimately benefit their patients' outcomes.

If the slowest aspect of cancer research, which is generally computing time, could be ported to a parallelized system like a quantum computer, it would turn hours of a problem into minutes. May be seconds.

There may be enough traditional computing power—like that found at TACC—to effectively process equations and perform the complex modelling that will ultimately lead to cancer cures, but there are too many experiments in line.

Currently experiments are broken into parts small enough to be processed within the time allowed on existing super computer clusters to which his team is given access. For example, if we take a DNA sequence that's "30 billion base pairs of nucleotides, a number that's 3 billion characters long, and break it into little pieces [that are] 150 characters long, and then reassemble it. And we do this 30 or 40 times a day, over the course of several months."

III.COMPUTING HORSEPOWER VERSUS CANCER

Real-time imaging systems, such as computed tomography (CT) scans and magnetic resonance images, could be vastly improved by the availability of computers that process data much more quickly than traditional computers.

"If we break it down to computing power, a CT scan, for example, is actually a re-imaging approach to making an image clearer. That takes time to compute. What limits resolution in a CT scan is the time it takes to do iteration after iteration and combine that data for the clearest picture," ."In almost every instance when we look at fighting cancer it's 'how quickly can we scan through virtual experiments?' or 'how quickly can we get a good picture of it?' and that almost always falls on available computer power."

Benefits of high-tech cancer research like DNA modelling and protein folding arrive about every 6 months. These forward steps in cancer research are really more often just ways to have better knowledge of current cancer treatment options. But "quantum leaps" in cancer research could take place if scientists had access to computers with spectacular improvements in speed, and this excites

"Quantum computing speed in the hands of researchers could mean a massive speeding up of the rate in which rational choices can be made and the cures will follow."

IV. CONCLUSION

The future of the health sector is to provide preventive medicine, tailored healthcare, automating certain surgical operations using robots, aggregating patient data to establish a more accurate health profile and – not least – all the new apps that allow us to track the state of our bodies on a daily basis. All this ends up in power of computer calculation. Nevertheless, DNA sequencing came about in the wake of rapid increases in computing power in line with Moore's Law. So the next revolution is likely to come from quantum computers, which hold out the promise of enormous benefits for the medical sector.

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