Instituto Tecnológico y de Estudios Superiores de Monterrey

Quantum Computing

Reading 12

# Quantum Theory, the Chuch-Turing principle, and the Uiversal Quantum Computer

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**Abstract**

In this text, that is based on the paper: "Quantum Theory, the Chuch-Turing principle,and the Uiversal Quantum Computer" by W. David Deutsch, two ideas are extracted arbitrarily and discussed, according to the interest of the author.

# 1 Idea 1

*Qui custodiet ipsos custodes*

How can we make sure that computers are doing a good job at what we expect them to do? I had not thought about this before. This is an issue that is well hidden from most of the population that uses computers, but it is very relevant to Computer Scientists, and is is specially important to Quantum Computer Scientists, because we are building a new kind of computer, so we need to make sure that we have this issue under control.

Right here I will take a moment to point out how important it is to be constantly asking questions about the results we are getting out of a certain activity. This is a special skill for scientists (that maybe should be spread) that is crucial for technological development. Specially in the case of building computers, we do not let some *ok* tests fool us into thinking that we have built a perfect universal quantum computer (or that we have achieved quantum supremacy).

In the Paper, Deutsch argues about a myriad topics regarding universal quantum computers, but this one was the one that left me thinking the most, because this is an issue that also occurred when developing today's computers, and it is interesting to see how there are many things that translate into the development of both computing devices even when their physical and mathematical foundations are very different.

# 2 Idea 2

*Not only what to measure, but also when to measure*

Fortunately, Turing left a strong basis for computation, but in his time, not even digital computers were available, and how would they be? When precisely Turing left the mathematical insights for the future development of these devices. In my short career as a quantum computer scientist, I think that the most important part of quantum algorithms is to design them in such a way that we take advantage of the quantum mechanical phenomena occurring in the qubits, and this is closely related with what and when to measure.

Specially in the quatum teleportation protocol, I believe that it requires of course a new approach to design algorithms that has to see with a quantum point of view. In a classical computer, we can always know what is going on with "perfect" accuracy, and in quantum computers we can not, but this is in fact, a very important part of the quantum teleportation protocol. This is just scientists hacking the rules again.