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Error correction for quantum computers

Quantum computers do not exist yet. But ever since it was recognized that they could also be used in chemistry, there has been a new wave of hype about their development. Dr. Alexandru Paler is one of the few researchers in the world who is developing software for error-corrected quantum computers.

Using quantum computers, certain problems encountered in the computer sciences could be solved much more efficiently than with conventional computers. These include, for example, searching extremely large databases or the factorization of large numbers.

A variety of concepts for quantum computer designs are currently being developed. Until now, the most success at laboratory scale has been with superconducting qubits, the development of which has been driven by companies such as Google. In this type of design, the heart of it all - a tiny chip - is surrounded by a huge cooling unit; this unit is supposed to protect the extremely error-prone quantum computer from outside influences. “This is an extremely expensive undertaking,” says Paler. “If we can manage to build the smallest component of a quantum computer, one qubit, for a Dollar - something we are still far away from achieving, today - a whole quantum computer could still cost millions.”

However, Paler takes the long view. For him, it is not yet important when and in what form quantum computers actually arrive. “I hope that the work I’m doing now will be used in ten to twelve years,” he says. Until then Paler is developing software that sends commands for error correction to the hardware in a feedback loop; in turn, the hardware signals whether the error correction was successful. The software then executes algorithm synthesis.

In his LIT project, named CHARON, Paler is developing the first components for this software based on an architecture of superconducting qubits and topological error correction codes. In about five years, he will be far enough along that he will need an actual connection to an actual quantum computer to be able to continue work. “Picture Windows or Linux to yourself - they work on your PC as well as on your smartphone,” says Paler. “The control software I am working on is similar. Depending on the design of the quantum computer it will have to be adapted, but in general it will function on most of the first-generation machines.”

In the meantime, major players such as Google, IBM and Microsoft have become involved in this research.

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