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No Quantum of Solace

Quantum computing is an opportunity for Artificial Intelligence (AI), but should not mask the AI research and transfer right now — Conventional computing infrastructures for AI are more important than ever!

"I believe in the power of AI “, proclaimed EU Commission President Ursula von der Leyen. It is precisely this spirit that we need and not thinking in clichés such as "Computers have no consciousness" or "Super-AIs would not be controllable."

Let's try a similar thought experiment as the cognitive scientist Murray Shanahan: We gradually replace all the neurons in a cat's brain with microchips. The cat would probably still like to have fish to eat, chase mice, and probably still suffer hunger and feel pain. But would this machine that is now the cat's brain still have a consciousness?

The cat example illustrates a central question of AI and resembles the paradox "Ship of Theseus", which scholars have been arguing about since ancient times: Is the ship still the same after all the old planks have been replaced by new ones? Does an object lose its identity when all the individual parts are replaced? Finding an answer to this question is difficult if not impossible.

The development of a controllable so-called "Super-AI" is also impossible. But don't worry, we already know this from everyday life: A word processor hangs up. This is particularly annoying because you don't know whether an immediate restart of the computer is indicated or whether it is worth waiting a little longer. In such moments one wishes for a program that tells us for our word processor — and any other program — "Yes, it will still stop by itself" or "No, it will never stop". Unfortunately, as the halting problem tells us, such an assistant provably cannot exist, no matter how ingenious classical computers or AI systems become. Therefore, it is not possible to predict and control the behavior of "Super AIs" — but fortunately also not that of us humans either.

Even quantum computers, which are far superior to conventional computers in some tasks, would not be able to do this. However, they are extremely helpful solving "difficult" tasks, such as those that behave like yeast cells in beer brewing, whose quantity doubles again and again — one cell becomes two, then four, 8, 16, 32, 64, and so on. At some point, the runtime skyrockets and overwhelms classical computers — and us humans. As the current Corona pandemic shows: We are simply bad at dealing with exponential growth.

Today, we make use of this in digital encryption, for example. Even the fastest mainframes can't crack it, given the current state of the art, if the code is only large enough. That's because they try to find the right key essentially by trial and error. But this may take more attempts than there are atoms in the universe.

Quantum computers, meanwhile, which represent codes by atomic states, work with qubits. Because of the strange laws of the quantum world, these can be not only 0 or 1, as in conventional computers, but simultaneously 0 and 1 or even in theoretically infinite states in between. Just like a coin tossed in the air, spinning around itself. And as soon as you measure the state of one qubit, the state of the others is directly known. In this way, the quantum computer can try all possible keys simultaneously. In quantum world, no secret is safe anymore. Even Einstein could hardly imagine it and taunted it as “spookie action at distance.”

Quantum computers promise a speed advantage for research and industry. Therefore, it is very welcome that we are now investing in quantum computers! But the rush of joy must not mask the AI research and transfer right now. In 2016, scientists Iordanis Kerenidis and Anupam Prakash had indeed found a "simple" quantum algorithm for a supposedly "difficult" task to predict purchasing behavior. But student Ewin Tang found a classical algorithm just two years later that was just as fast.

Whether it is worthwhile to use quantum computers to speed-up the solution of difficult problems in general is an open question, especially since their handling is extremely complex: In order to be functional, they must be cooled to near absolute zero and, moreover, set up vibration-free so that the qubits do not get mixed up. The latter would be fatal, because, as in soccer, we only want to know who won the side election when the coin is caught. Catching needs not only conventional computers, but also a new kind of programming. In contrast to soccer, the trick is to toss the coin in such a way that the result is not random, but meaningful.

That's why we need now an equally large investment in conventional computing infrastructures specifically for AI that are accessible to research and industry. Only this way we can make Germany and Europe global AI leaders.

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