A physics-based Ising solver based on standard CMOS technology

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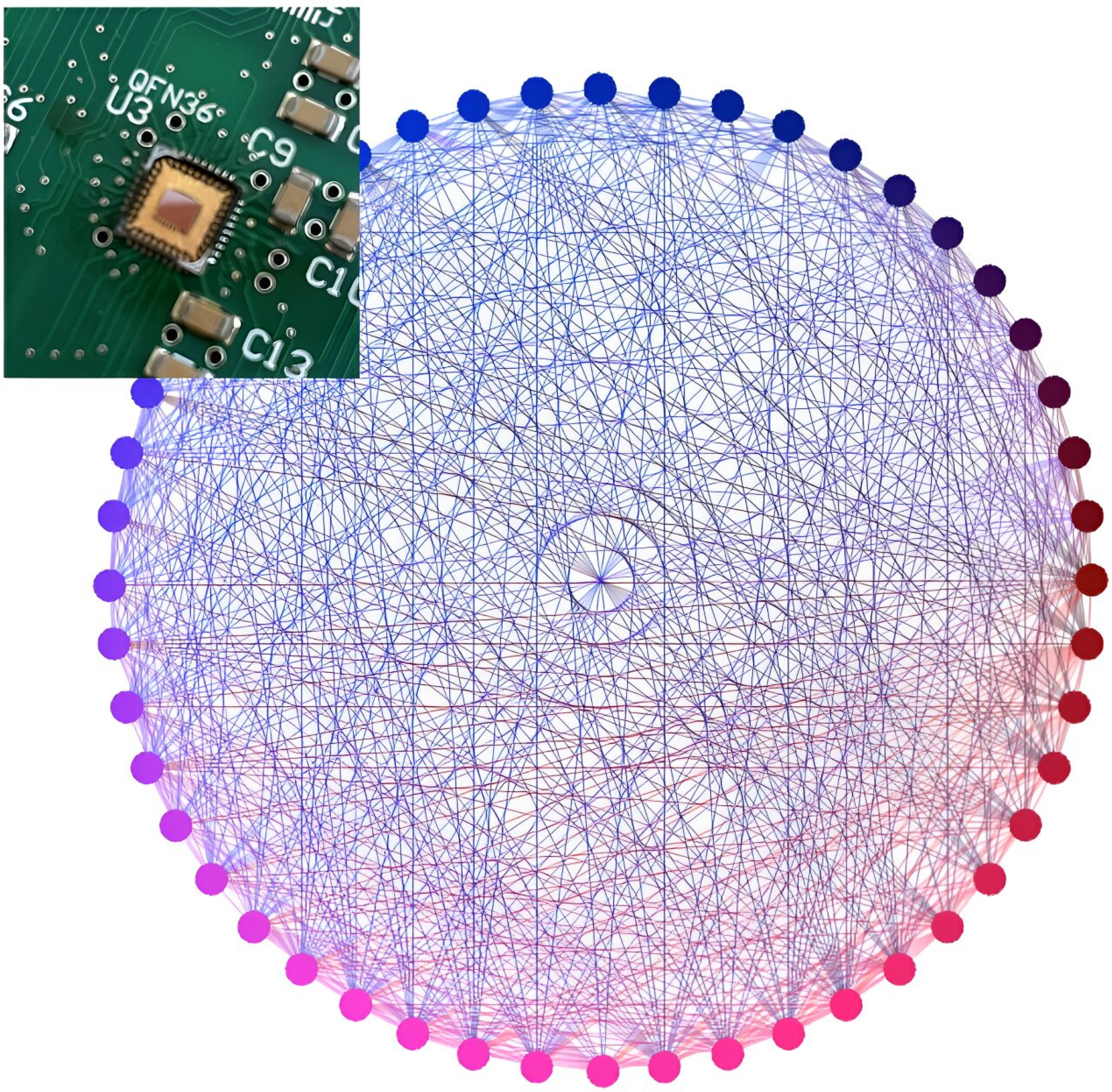

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A 48-node graph with 90% of the edges connected. The figure showcases the complexity of an all-to-all connected architecture. Credit: Lo et al.

Quantum computers, systems that perform computations by exploiting quantum mechanics phenomena, could help to efficiently tackle several complex tasks, including so-called combinatorial optimization problems. These are problems that entail identifying the optimal combination of variables among several options and under a series of constraints.

Quantum computers that can tackle these problems should be based on reliable hardware systems, which have an intricate all-to-all node connectivity. This connectivity ultimately allows graphs representing arbitrary dimensions of a problem to be directly mapped onto the computer hardware.

Researchers at University of Minnesota recently developed a new electronic device based on standard complementary metal oxide semiconductor (CMOS) technology that could support this crucial mapping process. This device, introduced in a paper in *Nature Electronics*, is a physics-based Ising solver comprised of coupled ring oscillators and an all-to-all node connected architecture.

"Building an all-to-all connected hardware where each node (i.e., oscillator) can 'talk' to all other nodes is extremely challenging; as the number of coupled nodes (N) increases, the number of connections per node increases by $\sim N^2$. This results in a quadratically increasing electrical loading and hardware overhead for each node which makes the coupling less efficient and less uniform," Chris Kim, one of the researchers who carried out the study, told Phys.org.

"Previous works, including our own, focused on locally connected architecture where each node could talk to only a handful (e.g.,