VOL. 44 APR 2024

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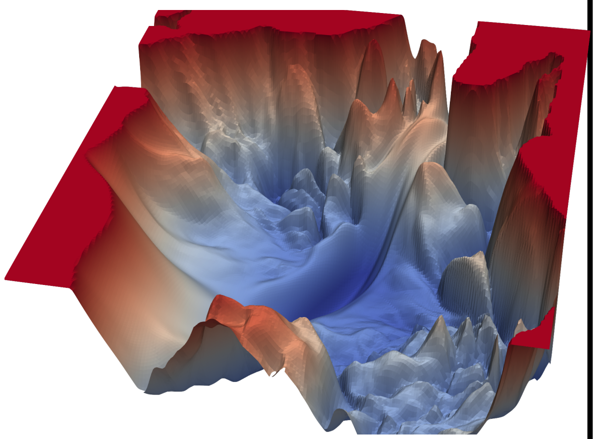
CALTECH PHYSICISTS FOUND QUANTUM ADVANTAGE

Quantum computers are on the verge of revolutionizing computation, but the search for a problem that distinctly leverages quantum capabilities has been a longstanding challenge for researchers. The crux of the matter, as John Preskill from the California Institute of Technology explains, lies in the exceptional performance of classical computers across various tasks.



In 1994, Peter Shor introduced a groundbreaking quantum algorithm for factoring large numbers. While Shor's algorithm possesses immense power and could potentially compromise internet security systems reliant on number factorization, its application is limited. Consequently, researchers are driven to explore broader realms where quantum computing can truly shine.

"We don't want to build a computer just for a single task," remarks Soonwon Choi of MIT. The quest is to identify problems that are classically arduous yet efficiently solvable through quantum methods. While researchers have occasionally believed they found such problems, including quantum algorithms outperforming classical counterparts, these claims often faced debunking by ingenious classical algorithms, notably by young researcher such as Ewin Tang.

Recently, a team led by Preskill has made significant headway by pinpointing a problem uniquely suited for quantum advantage. This breakthrough, lauded by Sergey Bravyi of IBM, involves analyzing the energy of specific quantum systems to unearth a question that challenges classical computation but can be tackled efficiently by quantum machines. The implications span beyond theoretical realms, branching into uncharted territories of physical sciences, as Choi underscores.

The crux of the problem lies in deciphering the properties of quantum systems in different energy states, particularly their ground states. Despite decades of effort, determining a system's ground state remains a formidable challenge for both classical and quantum computers. However, a shift in focus towards local minimum energy levels, propelled by recent advances in quantum algorithms, presents a promising avenue for quantum computers.

Robert Huang, one of the authors, highlights the novelty of this approach, which diverges from the conventional pursuit of ground states. The team's innovation has generated considerable excitement, especially due to its resilience against potential dequantization, as noted by Choi.

Yet, it's important to note that this breakthrough remains theoretical. Actualizing it on quantum hardware is currently beyond reach, necessitating further advancements in quantum computing technology. Nevertheless, as Bravyi emphasizes, the rapid progress in quantum computing leaves the future dynamic and unpredictable.

In essence, the discovery of a problem uniquely suited for quantum advantage marks a significant milestone in the quest for practical applications of quantum computing, promising to reshape the landscape of computational science in the years to come.

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NTU-IBM Quantum System 2024使用者大會 暨 Qiskit 量子計算 Hackathon Taiwan 2024：8/19(一)-21(三)。

計畫補助單位：MOST 科技部 Ministry of Science and Technology

IBM Quantum Computer Hub at National Taiwan University

Rm.711, Dept. of Physics /Center for Condensed Building

No. 1, Sec.4 Roosevelt Rd., Da’an Dist. Taipei City 106319, Taiwan

ntuq2018@gmail.com :+886 2-33669928 http://quantum.ntu.edu.tw/