World's best results for quantum unstructured search on Honeywell Quantum System H0

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BEIT engineers, supported by Honeywell Quantum Solutions Team, conducted several experiments on Honeywell System Model H0 quantum computer. This machine uses qubits built using trapped-ion technology, arranged in a 6-qubit quantum register with all to all connectivity. Honeywell System Model H0 had achieved Quantum Volume of 64 - making it one of the most advanced and capable contemporary quantum computing systems.

High coherence times and low error rates of Honeywell System H0, combined with BEIT's breakthrough algorithms allowed for successful unstructured search in 32- and 64-element spaces (arXiv:2010.03841).

President of Honeywell Quantum Solutions commented on the results:

> *We look to enable users with the most capable quantum computing environment. We're thrilled to see how BEIT has used our systems in ground breaking demonstrations of Grover's algorithm and how they have leveraged Honeywell's technology differentiators."*
> *– Tony Uttley*

In general, cornerstone quantum algorithms are deemed too complex for current NISQ computers. A method for finding a marked pattern among many others in a black box approach, called *unstructured search*, is one of these algorithms. Finding a solution for search spaces larger than 8 elements on the actual hardware eluded all the attempts before early 2020 runs of BEIT's algorithms on machines employing superconducting qubits (arXiv:2007.06539).

Quantum computers can represent the patterns efficiently: 6-qubit machines like Honeywell System Model H0 can process 64 of these, thus defining a 64-element *search space*. Future hardware improvements will double the search space with each additional qubit. Quantum unstructured search was first presented theoretically in Grover's search algorithm, named after Lov Grover who had proven that quantum computers can perform unstructured search quadratically faster than the classical ones — a seemingly impossible feat. In a quantum setting, these algorithms manage, for example, to pull out a single white ballot in 12 tries with probability near 100%, from a ballot box containing also 63 black ones.

BEIT engineers implemented several of proprietary unstructured search algorithms, designed to utilise features unique to Honeywell System Model H0 including Mid-circuit Measurement. BEIT's algorithms not only fit in today's quantum systems but also provably scale optimally with growing numbers of qubits (arXiv:2006.05828), so they can be used on larger systems when such become available.

The hardware runs were executed from BEIT's R&D office in Kraków, Poland over Honeywell Quantum Solutions's web API in close collaboration with Honeywell Quantum Solutions Team operating their machine in Broomfield, CO.

BEIT's hardware-agnostic algorithms and their hardware-aware implementations minimize the number of 2-qubit gates, shortening quantum circuits so they can be executed on actual quantum computing hardware with high success probabilities.

For further comments and general inquiries about quantum computing R&D, please, reach out to office@beit.tech.

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BEIT Inc. is a Quantum Software company incorporated in Delaware, US, running its R&D Center in Kraków, Poland. The goal of the company is to commercialize the methodology for performing hard computations on quantum computers or other super-parallel architectures. The company has two main areas of activity:

1. Developing IP in (quantum computers) and "quantum inspired" technologies.
2. Conducting bespoke R&D, implementation and consulting projects