

**The Weizmann Institute of Science
Faculty of Mathematics and Computer Science**

Foundations of Computer Science Seminar

Room 155, Ziskind Building
on Monday, Jul 08, 2024
at 11:15

Omri Shmueli
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will speak on

Quantum Algorithms in a Superposition of Spacetimes

Abstract:

Quantum computers are expected to revolutionize our ability to process information. The advancement from classical to quantum computing is a product of our advancement from classical to quantum physics -- the more our understanding of the universe grows, so does our ability to use it for computation. A natural question that arises is, what will physics allow in the future? Can more advanced theories of physics increase our computational power, beyond quantum computing?

An active field of research in physics studies theoretical phenomena outside the scope of explainable quantum mechanics, that form when attempting to combine Quantum Mechanics (QM) with General Relativity (GR) into a unified theory of Quantum Gravity (QG). QG is known to present the possibility of a quantum superposition of causal structure and event orderings. In the literature of quantum information theory, this translates to a superposition of unitary evolution orders.

In this talk we will show a first example of a computational model based on models of QG, that provides an exponential speedup over standard quantum computation (under standard hardness assumptions). We define a model and complexity measure for a quantum computer that has the ability to generate a superposition of unitary evolution orders, and show that such computer is able to solve in polynomial time two well-studied problems in computer science: The Graph Isomorphism Problem and the Gap Closest Vector Problem, with gap $O(n^{1.5})$.

The talk is based on <https://arxiv.org/abs/2403.02937>.