ARTIFICIAL INTELLIGENCE LABORATORY

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

PHYSICS OF COMPUTATION SEMINAR

Date: Wednesday, October 21, 1998
Time: Talk at **4pm**
Refreshments after the talk
Place: NE43, 8th-floor AI Playroom

Parallel quantum computation and quantum codes

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To make quantum computation work, we have to maintain the computer's quantum state for long periods of time, as free as possible from decoherence and interaction with the environment. To avoid a proliferation of storage errors in quantum data, it might help to parallelize quantum algorithms, and do as much work as possible simultaneously. The question, then, is what algorithms can be efficiently parallelized, and which have to be performed serially. In classical computation, this is the distinction between the classes NC and P.

Martin Nilsson and I have proposed a definition of QNC, the quantum analog of the efficient parallel class NC. In this talk, I will exhibit several useful gadgets and prove that various classes of circuits can be parallelized to logarithmic depth, including circuits for encoding and decoding standard quantum error-correcting codes, or more generally any circuit consisting of controlled-not gates, controlled pi-shifts, and Hadamard gates. Finally, while the Quantum Fourier Transform can be parallelized to linear depth, I will conjecture that an even simpler *staircase* circuit cannot be parallelized to less than linear depth, and might be used to prove that QNC $<$ QP.

Host: Seth Lloyd

This talk is part of a seminar series on adapting computers and computations to the constraints of, and opportunities afforded by, microphysics; and on the development and application of the physical theory of computation and information. If you would like to receive electronic notice of these seminars, send email to "poc@mit.edu."

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