ARTIFICIAL INTELLIGENCE LABORATORY

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

PHYSICS OF COMPUTATION SEMINAR

Date: Tuesday, December 9, 1997
Time: Talk at **4pm**
Refreshments after the talk
Place: NE43, 8th-floor AI Playroom

Universal Computation by Self-assembly of DNA

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In his early studies of reversible computation, Charles Bennett imagined an enzymatic Turing Machine which modified a heteropolymer (such as DNA) to perform computation with asymptotically low energy expenditures. Len Adleman's recent experimental demonstration of a DNA computation, using an entirely different approach, has led to a wealth of ideas for how to build DNA-based computers in the laboratory, whose energy efficiency, information density, and parallelism have potential to surpass conventional electronic computers. In this talk, we examine one mechanism used in all designs for DNA-based computers—the self-assembly of DNA by hybridization and formation of the double helix—and show that this mechanism alone theoretically suffices to support universal computation. To do so, we join the purely mathematical Tiling Problem (proposed in 1961 bu Hao Wang and solved in the negative by Richard Berger shortly thereafter) with the branched DNA constructions of Nadrian Seeman, to produce self-assembled and algorithmically patterned two-dimensional lattices of DNA. This theoretical proposal has already gathered some experimental support. A competition experiment suggests that an individual logical step can proceed correctly by self-assembly, while a companion experiment suggests that unpatterned two dimensional lattices of DNA will self-assemble and can be visuallized. We have reason to hope, therefore, that this experimental system will prove fruitful for investigating issues of thermodynamics of computation by self-assembly. It may also lead to interesting new materials.

Host: Tom Knight

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."