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THE DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE, CS DIVISION

Presents the Spring 2014 EECS Seminar Series

Dr. David Doty

California Institute of Technology

"Molecular Computing: Computation by Chemistry and Geometry"

Monday, March 17, 2014 • 10:00 a.m. • HEC 450

Abstract

The computing revolution of the 20th century focused on the systematic manipulation of information. In this century a new revolution is underway, and its goal is the *systematic manipulation of matter*. While top-down technologies such as lithography are able to control the position of individual molecules, these techniques are expensive, specialized to a single goal, and require the presence of a machine. Bottom-up methods for designing molecules that automatically manipulate themselves are far less developed but hold great promise. In the past decade, DNA nanotechnology has demonstrated that it is possible to rationally design molecules, which can be synthesized at the cost of a few hundred dollars, that automatically self-assemble nanoscale structures of moderate complexity and carry out small-scale digital computation and analog control. The coming decades will witness an exponential surge in the complexity and scale of molecular engineering achievable by these techniques.

My talk will concentrate on the role that computer science has played and will play in understanding the principles, abilities, and fundamental physical limitations of bottom-up molecular technologies. This role goes far beyond software modeling: the molecules themselves are executing a computation by virtue of how they interact. From this perspective, I will focus on two very mature areas from the natural sciences, chemical kinetics and crystal formation, and argue that elucidating their abilities as engineering tools ultimately requires an understanding of the theory of computing.

Biography

David Doty received his Ph.D. in Computer Science at Iowa State University in 2009, supervised by Jack Lutz. His thesis focused on applying the theory of computation to theoretical problems in molecular self-assembly. He was a Computing Innovation Fellow with Erik Winfree at the California Institute of Technology where he continued as a postdoc. He proves theorems about molecular computing and conducts physical experiments implementing molecular self-assembly with DNA.

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